MAZAGON DOCK SHIPBUILDERS LIMITED
(Formerly known as Mazagon Dock Ltd.)
CIN : U35100MH1934GOI002079
(A Government of India Undertaking)
Shipbuilders to the Nation
Dockyard Road, Mazagon,
Mumbai 400 010.
INDIA

Preferred Make

&

Technical Specification

I N D E X

Sr. No.	Description	Page Nos.	
	TECHNICAL SPECIFICATIONS	**From**	**To**
I	CIVIL & INTERIOR WORKS	4	407
II	PLUMBING WORKS	408	434
III	ELECTRICAL WORKS	435	624
IV	FIRE FIGHTING	624	665
V	LIFT	666	672
VI	HVAC WORKS	673	695
VII	STP	696	712

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

I CIVIL WORKS TECHNICAL SPECIFICATIONS

GENERAL INSTRUCTION :

i. The detailed specifications given hereinafter are for the items of works described in the schedule of quantities attached herein & shall be guidance for proper execution of work to the required standards.

ii. It may also be noted that the specification are of generalized nature & these shall be read in conjunction with the description of item in schedule of quantities & drawings. The work also includes all minor details of construction which are obviously & fairly intended & which may not have been referred to in these documents but are essential for the entire completion in accordance with standard Engineering practice.

iii. Unless specifically otherwise mentioned, all the applicable Latest codes & standards published by the Indian standard Institution & all other standard which may be published by them before the date of receipt of tenders, shall govern in all respects of dosing workmanship quality & properties of materials & methods of testing, method of measurements etc. Wherever any reference to any Indian Standard specifications occurs in the documents relating to this contract, the same shall be inclusive of all amendments issued to or revisions there of, if any, up to the date of receipt of tenders.

iv. In case there is no I.S.I specification for the particular work, such work shall be carried out in accordance with the instructions in all respects, & requirements of the Engineers-in-Charge. Materials shall be conforming to Indian Standard / BSI /ASTM Latest codes as applicable.

v. The work shall be carried out in a manner complying in all respects with the requirements of relevant bye-laws of Municipal Corporation under the jurisdiction of which the work is to be executed or as directed by the Engineer-in-Charge and, unless otherwise mentioned, nothing extra shall be paid on this account.

vi. Samples of various materials, fitting etc. proposed to be incorporated in the work shall be submitted by the contractor for approval of the Engineers-in-Charge before order for bulk supply is placed.

vii. The contractor shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials in any place. No excavated earth or building materials shall be stacked on areas where other buildings, roads, services, compound walls etc. are to be constructed.

viii. The contractor shall maintain in perfect condition all works executed till the completion of the entire work allotted to him. Where phased delivery is contemplated, this provision shall apply to each Phase.

ix. The contractor shall give a performance test of the entire installation(s) as per standard specifications before the work is finally accepted & nothing extra whatsoever shall be payable to the contractor for the test.

x. The contractor shall clear the site thoroughly of all scaffolding materials & rubbish etc.

left out of his work & dress the site around the building to the satisfactions of the EIC & his decision in writing shall be final & binding on all concerned.

xi. **Post construction inspection and testing:** After completion of the work and during maintenance period liability of the contractor, the work shall also be subjected to 'Post construction inspection and testing'. In case the materials or articles incorporated in the work are found to be inferior, though the sample collected for the same might have been passed at the time of execution, it shall be the responsibility of the contractor to replace the same at his own cost., failing which the cost be adjusted from the outstanding security deposit, as per the terms and conditions of the contract for the work.

xii. Concerned Engineering Division /Engineer In charge, shall be the sole deciding authority as to the meaning, interpretations and implications for various provisions of the specifications and its decision in writing shall be final and binding on all concerned.

xiii. In case any different or discrepancy between the specification & the description in the schedule of quantities, the schedule of quantities shall generally take precedence. In case of any difference or discrepancy between specification & drawing; the latest working drawing shall generally Govern. But prior to resolving all the above and any other discrepancy it shall be brought to the notice of Engineer In Charge, resolved mutually prior to implementation of that work. All works shall be carried out as per the Latest working drawings, specification, Indian standard codes & work done to the satisfaction of EIC.

xiv. The flooring after installation shall be protected by temporary Plaster of paris with a bottom layer of HDPE sheet/ cheaper soft puf Mat , which shall be removed after all other works in the room is completed as required by EIC and unless otherwise mentioned elsewhere in Tender document, nothing extra shall be paid on this account.

xv. Waterproofing Guarantee of minimum 05 years shall be provided by the contractor for the waterproofing work carried out by him; papers for the same shall be handed over to the EIC/Owner.

xvi. Temporary Barricading and safety nets horizontally along Perifery of the building, temporary handrail at elevated openings etc. shall be installed by the contractor, based on site requirement and unless otherwise mentioned elsewhere in Tender document, nothing extra shall be paid on this account.

xvii. Mortor Mixing shall be done mechanically. Hand mixing if permitted by EIC for mortar shall be carried out in clean (unrusted) Galvanised steel side closed tray.

xviii. Sand should not be stacked adjacent to constructed walls, but away if in rooms while tiling, internal Plastering or conducting other works.

xix. Sample tiles, Granite, stones, laminate or any other finishing material which requires Architects /E.I.C approval after being approved shall be kept with the Engineer-in-Charge in the Site mock up room for reference till the completion of the work; ; nothing extra shall be paid on this account. All finishes which are to be incorporated in the work shall strictly conform to the approved samples.

xx. **Scaffolding** – The payment will be made once only for execution of all items for such

works. The elevational area of the scaffolding shall be measured for payment purpose.

xxi. **Demolition & Dismantling :-** The Contractor shall visit site prior to quoting and collect all the necessary information required for carrying out demolition work.

xxii. In case of any hardware/fixtures/accessories are not required as per working drawings, an equivalent amount towards the same shall be deducted/recovered from the respective items.

xxiii. In case of items where Basic Rate(s) have been stipulated, the Contractor shall have to submit necessary documentary evidence against procurement of such items. However, if the basic rates of the items procured are lesser than those stipulated in the BOQ, recovery of the difference in the rates shall be deducted from the Contractor's invoices.

MDL will be removing all the Servicable material needed for MDL from the structures which are to be demolished prior to handing over the work site to the contractor .The contractor will get all the unservicable material got from the demolished structures; Contractor has to take away all generated scrap like Steel Reinforcement,structural steel, wooden scrap,electrical wire,Roofing sheets etc. . The work includes disposal of unservicable material outside MDL site to approved Muncipal location , contractor shall take into account the time required for necessary gate pass and security checks required for taking out the demolished material from the MDL site , all activities shall be done as per MDL factory rules. The demolition equipments,safety measures to be adopted shall be specified in writing by the contractor to MDL prior to start of work .

The contractor shall use less vibration demolition tools /equipments during the demolition work. Signage's (Safety instructions related) shall be displayed in areas of demolition .Safety nets , temporary barricading etc. & all other safety related measures shall be adopted as per standard safety practices in construction industry and safety measures required by MDL factory rules.

The work includes identification of required working underground lines (connected to the structures which are to be demolished) which are to be removed, this shall be based on site visit , & as per inputs and discussion with MDL authorities . The serviceable pipes etc. and unserviceable items regarding underground facilities shall be listed separately. The unservicable pipes generated out of this activity shall be taken away from site .The underground working lines if any required shall be diverted from locations away from Proposed location of buildings; this work to be conducted in consultation with MDL.

The unserviceable items debris while carting away in trucks shall be measured and noted checked by MDL Engineering in charge & MDL Security."

A. Pricing

The rate for each item of work shall, unless expressly stated otherwise, include the following (but not limited to the list given below) for the completion of works in all respects as per conditions of Contract, technical specifications, drawing :

1. All taxes such as GST, Royalty,Transportation, Freights, Packing and forwarding charges Insurance , local taxes and all the prevailing taxes etc.

2. All requirements and expenses for completion of work/item as per Rules and Regulations of Local Bodies, State Government and Central Government of India.
3. All materials,Labour,equipments, accessories, consumable, controls and instruments, tools, tackles, plants, scaffolding/double scaffolding labour, maintenance, fixing, cleaning, , making good hauling, hoisting etc., for carrying out the item/work.
4. Wastage on material and labour.
5. Loading, Unloading, handling/double handling, setting out protection from weather, temporary supports, platforms, construction of temporary godown/store for keeping of store etc., and the maintenance, of the same, dismantling of temporary works, disposal of debris and all other labour necessary for the execution of works.
6. Testing the installation as often as necessary, Contractors to arrange for all special instruments and tools required for such testing or getting it tested at approved lab.
7. Painting of all equipment, pipes, and supports etc., as per color codes to be decided for various systems.
8. Fees for testing the materials, equipment or overall installation by appropriate authorities as approved by MDL as per the latest version of IS. The testing lab will be decided by MDL/Consultant. Cost of the testing of materials shall be borne by the contractor.
9. Necessary coordination with all concerned agencies/persons involved in the completion of work.
10. All requirements of specification and drawings. Description of work given in the schedule of quantities is a brief description and shall be read in conjunction with specifications and drawings whether specifically mentioned or otherwise.
11. Removal of wrappings/ covering and carting away all unwanted material including POP.

The rates quoted by the tenderer will be deemed to be for the finished work complete in all respects with accessories, fitting, mounting arrangements normally provided with such equipment and/or needed for execution, completion, safe operation of equipment as required though they may not have been specifically mentioned in technical specifications, drawings and/or schedule of equipment.

All minor Masonry, Carpentry and Civil works such as cutting opening in Masonry Walls, Internal Partitions, Chasing on walls, etc. and making good the same to match existing works shall be provided by the contractor, whenever, asked for by the Consultant.

Mode of measurement shall be based on relevant IS Codes.

In case of any discrepancy(s) between the specifications mentioned herein and relevant IS Code(s)/Standards, the stipulations of the relevant IS Code(s)/Standards shall prevail.

II – LIST OF INDIAN STANDARDS:

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

Following are the various pertinent Indian Standards, relevant to buildings work:

(All Latest Versions of I.S. codes shall be referred)

I. S. CODE NO.	**S U B J E C T**
A. CIVIL WORKS	
1. CARRIAGE OF MATERIALS	
4082-1996	Recommendations on stacking & storage of construction materials and components at site.
2. EARTH WORK	
1200 Pt. I-1992	Method of measurement of Earth work.
4081-2013	Safety code for Blasting and related drilling operations.
6313 (Part 2) 2013	Anti Termite Measures in Buildings Part – 2 Pre-constructional chemical treatment .
3. MORTAR	
196-1966	Atmospheric conditions for testing (Reaffirmed - 2006)
269-2015	Ordinary Portland cement Specification. (Sixth Revision)
383-2016	Coarse and fine aggregates from natural sources for concrete.
455-2015	Portland slag cement
650-1991	Standard sand for testing of cement
712-1984	Building Limes
1489-2015	Portland pozzolana cement Fly ash based
1514-1990	Methods of sampling & Test for Quick Lime & Hydrated Lime. (Reaffirmed - 2010)
1542-1992	Sand for Plastering (Reaffirmed – 2009)
1727-1967	Methods of tests for pozzolanic materials (Reaffirmed – 2008)
2250-1981	Code of practice for preparation and use of masonry mortar. (Reaffirm-2010)
2386-1963	Methods of Test for Aggregates for Concrete
2386 Pt.I-1963	Particle size and shape(Reaffirm- 2016)
2386 Pt. II-1963	Estimation of deleterious materials and organic impurities(Reaffirm- 2016)
I. S. CODE NO.	**S U B J E C T**

2386 Pt.III-1963	Specific gravity, density, voids, absorption and bulking(Reaffirm- 2016)
2686-1977	Cinder as fine aggregate for use of Lime Concrete. (Reaffirmed – 2009)
3025-1987	Methods of sampling & test (Physical & Chemical) for water & waste water (Reaffirmed-2014)
3068-1986	Broken brick (burnt clay) coarse aggregate for use in lime concrete (II-R.) (Reaffirmed – 2009)
3182-1986	Broken brick (Burnt clay) fine aggregate for use in lime mortar.) (Reaffirmed – 2009)
3812-2013 (Part1)	Pulverized Fuel Ash - For Use as Pozzolana in Cement, Cement Mortar and Concrete
4031-1996	Methods of physical tests for hydraulic cement (Reaffirmed – 2016)
4032-1985.	Method of chemical analysis of hydraulic cement (Reaffirmed - 2009)
4098-1983	Lime pozzolana mixture (Reaffirmed - 2009)
6932 (Pt.I to X)	Methods of Test for Building Lime
6932 (Pt.I)-1973	Determination of insoluble residue, loss of ignition, silicon-dioxide, ferric & Alum. Oxide,
6932 (Pt.II)-1973	Determination of carbon dioxide content
6932 (Pt.III)-1973	Determination of residue on slaking of quick lime.
6932 (Pt.IV)-1973	Determination of fineness of hydrated lime
6932 (Pt.V)-1973	Determination of unhydrated oxide
6932 (Pt.VI)-1973	Determination of volume yield of quick lime
6932 (Pt.VII)-1973	Determination of compressive and transverse strength.
6932(Pt.VIII)-1973	Determination of workability
6932 (Pt.IX)-1973	Determination of soundness
6932 (Pt.X)-1973	Determination of popping and pitting of hydrated Lime.
4. CONCRETE WORK	
383	Coarse and fine aggregate from natural sources for concrete (Reaffirm - 2016)
456-2000	Code of practice for plain and reinforced concrete(Reaffirm - 2016)
516-1959	Method of test for strength of concrete (Reaffirmed in 2013)

1199-1959	Method of sampling and analysis of concrete(Reaffirmed in 2013)
I. S. CODE NO.	**S U B J E C T**
1200 (Pt.II)-1974	Methods of measurements of cement concrete work. (Reaffirm - 2007)
1322-1993	Bitumen felts for water proofing and damp proofing. (Reaffirm - 2008)
1661- 1972	Code of practice for application of cement lime plaster finishes.(Reaffirm-2016)
2386-1963 (Pt.1 to 8)	Methods of test for aggregate for concrete.(Reaffirm- 2016)
2386 (Pt.I)-1963	Test for particle size and shape.(Reaffirm- 2016)
2386 (Pt.II)-1963	Test for estimation of deleterious materials and organic impurities.(Reaffirm- 2016)
2386 (Pt.III)-1 963	Test for specific gravity, density, voids, absorption and bulking.(Reaffirm- 2016)
2386 (Pt.IV)-1963	Mechanical properties.(Reaffirm- 2016)
2645-2003	Specification for integral water proofing compounds (Reaffirm- 2017)
2686-1977	Specification for cinder aggregate for use in lime concrete. (Reaffirm - 2009)
3812-2013 Part2	Fly Ash using as admixtures in cement ,mortar , concrete.
7861-1975 (Pt.I)	Hot weather concreting. .(Reaffirmed -2011)
7861-1981 (Pt.II)	Cold weather concreting. .(Reaffirmed -2011)
9103-1999	Admixture for concrete. .(Reaffirmed -2013)
5. R.C.C. WORK	
432-1982 Part 1	Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement: Part 1 Mild Steel and Medium Tensile Steel Bars.(Reaffirmed -2015)
432-1982 Part II	Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement: Part 2 Hard-Drawn Steel Wires.(Reaffirmed -2009)
456-2000	Code of practice for plain and reinforced concrete.(Reaffirmed -2016)
457-1957	COP for general const. of plain & reinforced concrete for dams & other massive structure. .(Reaffirmed -2009)
516-1959	Methods of test for strength of concrete.(Reaffirmed -2013)

1161-2014	Specifications for steel tubes for structural purposes
1199-1959	Methods of sampling and analysis of concrete. (Reaffirmed - 2013)
1200 (Pt.II) -1974	Method of measurement of cement concrete work (Reaffirmed -2007)
I. S. CODE NO.	**S U B J E C T**
1200(Pt.V) -2007	Method of measurement of form work. (Reaffirmed - 2013)
1343-2012	Code of practice for pre-stressed concrete.
1566-1982	Hard drawn steel wire fabric for concrete reinforcements (Reff. 2009)
1785-1983 (Part-I& II)	Specifications for plain hard-drawn steel wire for prestressed concrete: Part 1 Cold drawn stress-relieved wire (Reaffirmed - 2013)
1786-2008	High strength deformed steel bars and wires for concrete reinforcement (Reaffirmed - 2013)
2090-1983	Specifications for high tensile steel bars used in prestressed concrete. (Reaffirmed – 2009)
2204-1962	Code of practice for construction of reinforced concrete shell roof. (Reaffirmed - 2010)
2210-1988	Criteria for the design of shell structure and folded plates (Reaffirmed - 2008)
2502-1963	COP for bending and fixing of bars for concrete reinforcement. (Reaffirmed - 2008)
2750-1964	Specifications for steel scaffoldings(Reaffirmed - 2010)
2751-1979 (Reaf-2008)	COP for welding of mild steel bars & Deformed bars for reinforced concrete construction.
2911-(Pt.I)-SEC 1 -2010	Code of practice for design & Constn. of pile foundations- Driven Cast In-situ Concrete Piles
2911(Pt.I)-SEC 2 -2010	Design & construction of Pile Foundations - Bored precast concrete piles.
2911 (Pt.III)-1980	Under reamed pile foundations(Reaffirmed – 2010)
2911 (Pt.IV)-2013	Load test on Piles
3201-1988	Criteria for design and construction of precast trusses & Purlins. (Reaffirmed - 2009)
3370.(Part I)-2009	Code of practice for concrete structures for storage of liquids-General requirements.
3370.(Part II)-2009	Code of practice for concrete structures for storage of liquids- Reinforced concrete structures

3414-1968	Code of practice for design and installation of joints in buildings. (Reaffirmed - 2010)
3558-1983(Reaf-2008)	Code of practice for use of immersion vibrators for consolidating concrete
3696 (Pt.I & II)	I-1987: Safety code of scaffolds; II-1991: Safety code of ladders
3935-1966	Code of practice for composite construction. (Reaffirmed – 2008)
I. S. CODE NO.	**S U B J E C T**
4014-1967 (Pt. I & II)	COP for steel tubular scaffolding (I: Definition/Material; II: Safety provision) (Reaffirmed 2010)
4926-2003	Code of practice for Ready Mix Concrete(Reaffirmed – 2017)
4990-2011	Specifications for plywood for concrete shuttering work.
10262-2009	Guidelines for concrete mix design proportioning (Reaffirmed - 2017)
1893-2016 Part 1	Criteria for Earthquake Resistant Design of structures
6. EQUIPMENTS	
460-1985 (Pt-I,II& III)	Specification for test sieves. (Reaffirmed - 1998)
1791-1985	Specification for batch type concrete mixer. (Reaffirmed – 2015)
2430-1986	Methods for sampling of Aggregates for concrete. (Reaffirmed – 2009)
2505-1992	General requirement for concrete vibrators, immersion type(Reaffirmed – 2008)
2506-1985	General requirements for screed board concrete vibrators(Reaffirmed – 2016)
2514-1963	Specification for concrete vibrating tables. (Reaffirmed - 2017)
2722-1964(Reaf-2016)	Specification for portable swing weighbatchers for concrete (single and double bucket type).
2750-1964	Specification for steel scaffolding. (Reaffirmed – 2010)
7. BRICK WORK:	
1077-1992	Common burnt clay building bricks(Reaffirmed – 2011)
1200 (Pt.III)-1976	Method of measurements of brick work. (Reaffirmed - 2007)
2116-1980	Sand for masonry mortars. (Reaffirmed - 2007)
2212-1991	Code of practice for brick work(Reaffirmed - 2009)

2250-1981	Code of practice for preparation & use of masonry mortar. (Reaffirmed - 2010)
3495 (Pt.ItoIV)-1992	Methods of tests of burnt clay building bricks: Part 1 Determination of compressive strength Part 2 Determination of water absorption Part 3 Determination of efflorescence Part 4 Determination of warpage(Reaffirmed - 2011)
5454-1978	Method for sampling of clay building bricks. (Reaffirmed - 2010)
2185 (Part 3) 1984	Auto claved cellular (Areated) Concrete Blocks. (Reaffirmed - 2010)
8. STONE WORK:	
1121 (Pt.I)-2013	Methods of test for determination of strength properties of natural building stones: Part I Compressive strength
1122-1974	Method of test for determination of true specific gravity of natural building stones
1123-1975	Methods for identification of natural building stones(Reaffirmed – 2008)
1124-1974	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones(Reaffirmed - 2013)
1125-2013	Determination of weathering of Natural building stones - Method of Test
1126-2013	Determination of durability of natural building stones - Method of test
1129-1972	Recommendation of dressing of natural building stones (Reaffirmed - 2013)
1200 (Pt.IV)-1976	Method of measurement of stone masonry. (Reaffirmed - 2007)
1597. (Pt.I)-1992	Code of practice for construction of Rubble stone masonry. (Reaffirmed - 2011)
1597 (Pt.II)-1992	Code of practice for construction of ashlar masonry (Reaffirmed - 2011)
1805-1973	Glossary of Terms relating to stone Quarrying and dressing. Reaffirmed - 2008)
4101 (Pt.I)-1967	Stone facing. (Reaffirmed - 2010)
9. MARBLE WORK:	
1122-1974	Methods for determination of specific gravity and porosity of natural building stones (Reaffirmed - 2008)
1124-1974	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones (Reaffirmed - 2013)
1130-1969	Marble (blocks, slabs and tiles) (Reaffirmed - 2008)
10. WOOD WORK:	

204-1991/92	Tower bolts (Part I-1991: ferrous metals; Part II - 1992 : Non ferrous metals).
205-1992	Non-ferrous metal butt hinges(Reaffirmed - 2012)
206-2010	Tee and strap hinges(Reaffirmed - 2012)
207-1964	Gate and shutter hooks and eyes. (Reaffirmed - 2011)
208-1996	Door handles (Reaffirmed - 2017)
281-2009	Mild steel sliding door bolts for use with padlocks
287-1993(Reaf-2008)	Recommendation for maximum permissible moisture contents of timber used for Different purposes.
303-1989	Plywood for general purpose (Reaffirmed - 2013)
I. S. CODE NO.	**S U B J E C T**
362-1991	Parliament hinges(Reaffirmed - 2010)
363-1993	Hasps and staples(Reaffirmed - 2008)
364-1993	Fanlight catch(Reaffirmed - 2008)
401-2001	Code of practice for preservation of timber(Reaffirmed - 2011)
419 - 1967	Putty for use on window frame (Reaffirmed - 2009)
451-1999	Technical supply condition for wood screws(Reaffirmed - 2010)
452-1973	Door springs, rat-tail type (Reaffirmed 2010)
453-1993	Double acting spring hinges. (Reaffirmed – 2008)
723-1972	Steel counter sunk head wire nails. (Reaffirmed - 2011)
729.1979	Drawer locks, cup board locks, and box locks (Reaffirmed 2012)
848-2006	Synthetic resin adhesive for plywood (phenolic and aminoplastic). (Reaffirmed - 2011)
851-1978	Synthetic resin adhesive for construction work (Non-structural) in wood (Reaffirmed 2009)
852-1994	Specifications for animal glue for general wood working purposes. (Reaffirmed 2009)
1003-1994	Timber panelled and glazed shutters
1003(Pt.I)-2003	Door shutters . (Reaffirmed – 2008)
1003 (Pt.II)-1994	Window and ventilator shutters (Reaffirmed - 2011)
1019-1974	Rim latches. (Reaffirmed - 2012)
1141-1993	Code of practice for seasoning of timber (Reaffirmed 2009)
1200	Method of measurement of Building and Civil Engineering works

1200 (Pt.XIV)-1984	Glazing. (Reaffirmed - 2007)
1200 (Pt.XXI)-1973	Wood work and joinery. (Reaffirmed - 2007)
1322-1993	Bitumen felts for water proofing and damp proofing. (Reaffirmed – 2008)
1328-1996	Veneered decorative plywood(Reaffirmed - 2011)
1341-1992	Steel Butt hinges (Reaffirmed - 2012)
1378-1987	Oxidized copper finishes. (Reaffirmed - 2016)
1568-1970	Wire cloth for general purposes. (Reaffirmed - 2013)
1658-2006	Fiber hard board. (Reaffirmed - 2011)
1659-2004	Block boards(Reaffirmed 2014)
1823-1980	Floor door stoppers. (Reaffirmed - 2012)
I. S. CODE NO.	**S U B J E C T**
1868-1996	Anodic coating on Aluminium & its alloy (II Rev.) (Reaffirmed 2016)
875-1987 Part1	Dead loads –Unit weight of bldg. & stored materials(Reaffirmed – 2008)
2191-1983	Wooden flush door shutter (cellular and hollow core type). (Reaffirmed - 2011)
1837 - 1966	Fan light pivots (Reaffirmed 2010)
2095-2011	Plain Gypsum Plaster Boards
3828 - 1966	Ventilator chains (Reaf. 2010)
4835 - 1979	Polyvinyl acatete dispssion base adhesive for wood (2009)
2191 (Pt.I)-1983	Plywood face panels. (Reaffirmed - 2011)
2191 (Pt.II)-1983	Particle board face panels and hard board face panels. (Reaffirmed-1991)
2202-1999	Wooden flush door shutters (solid core type)
2202 (Pt.I)-1999	Plywood face panels for wooden flush door shutters (Reaffirmed – 2016)
2202 (Pt.II)-1983	Particle board face panels for wooden flush door shutters. (Reaffirmed - 2011)
2209(Pt.I)-1976	Mortise locks (vertical type) (Reaffirmed 2012)
2380-1981 Part 22 & 23 / 1977 Part 1-21	Method of test for wood particle board and boards from lignocellulosic materials (Reaf.2013)
2681-1993	Non ferrous metal sliding door bolts(aldrop) for use with pad locks Reaffirmed - 2008)

2835-1987	Flat transparent sheet glass . (Reaffirmed - 2018)
3087-2005	Wood particle boards (medium density) for general purpose (Reaffirmed -2010)
3097-2006	Veneered particle boards (Reaffirmed -2011)).
3400 (Part I)-2012	Method of test for vulcanized rubber
3400-(Pt.II)-2014	Hardness
3400-(Pt.IV)-2012	Accelerated aging & Heat resistance
3400 (Pt.IX)-2014	Determination of density.
3564-1995	Door closers (Hydraulically regulated) (Reaffirmed – 2008)
3618-1966	Phosphate treatment of iron and steel for protection against corrosion. (Reaffirmed - 2007)
3818-1992	Continuous (Piano) hinges(Reaffirmed – 2012)
3847-1992	Mortise night latches(Reaffirmed – 2012
4020-1998 (1 to 16)	Door shutters –Methods of Test (Reaffirmed – 2008)
I. S. CODE NO.	**S U B J E C T**
4021-1995	Timber door, window and ventilator frames(Reaffirmed – 2016)
4948-2002	Welded steel wire fabric for general use. (Reaffirmed - 2017)
4992-1975	Door Handles for Mortise locks (vertical type). (Reaffirmed - 2010)
51 87-1972	Flush bolts (Reaffirmed - 2010)
5523-1983	Method of testing anodic coating on aluminium & its alloys. (Reaffirmed -2016)
5930-1970	Mortise latch (vertical types) (Reaffirmed - 2010)
6318-1971	Plastic window stays & fasteners(Reaffirmed - 2010)
6607-1972	Rebated mortise locks (vertical type) (Reaffirmed – 2010)
6760-1972	Slotted countersunk head wood screws. (Reaffirmed - 2010)
71 96-1974	Hold fasts (Reaffirmed -2012)
71 97-1974	Double action floor springs (without oil check) for heavy doors(Reaffirmed - 2010)
7534-1985	Sliding locking bolt for use with padlocks. (Reaffirmed – 2010)
8756 - 1978	Mortise ball catches for use in wooden almirah (Reaffirmed -2012)
14856-2000	Glass fibre reinforced plastic (GRP) panel type door shutters for internal use – Specifications (Reaffirmed -2016)
1 1 . S T E E L W O R K	

63-2006	Whiting for paints & putty. (Reaffirmed - 2010)
198-1978	Varnish gold size. (Reaffirmed - 2009)
12406 - 2003	Medium density fibre board for general purpose - (Reaffirmed -2013)
277-2018	Specification for galvanised steel sheets (plain and corrugated)
278-2009	Galvanised steel barbed wire for fencing. (Reaffirmed - 2015)
800-2007	Code of practice for use of structural steel in general building construction(Reaffirmed - 2013)
806-1968	Code of practice for use of steel tube in general building construction(Reaffirmed - 2013)
813-1986	Scheme of symbols for welding. (Reaffirmed – 2008).
814-2004	Covered electrodes for metal arc welding of structural steel (Reaffirmed 2010)
817-1966	Code of practice for training and testing of metal arc welders. (Reaffirmed – 2008)
818-1968	COP for safety & healthy requirements in electric & gas welding & cutting operation. (Reaffirmed – 2008)
1038-1983	Steel doors, windows and ventilators (Reaffirmed - 2011)
1081-1960(Reaf-2011)	COP for fixing & glazing of metal (steel & aluminium) doors, windows & ventilators
I. S. CODE NO.	**S U B J E C T**
1148-2009	Hot rolled steel rivet bars (upto 40 mm diameters)for structural purposes
1161-2014	Steel tubes for structural purposes
1182-1983(Reaf-2010)	Recommended practice for radiographic examination of fusion welded butt joints in steel plates.
1200 (Pt-VIII)-1993	Method of measurements of steel work and iron works(Reaffirmed – 2007)
1363-2002 (Pt. 1-3)	Hexagon bolts, nuts & lock nuts (dia. 6 to 39 mm) & black hexagon screws (dia. 6 to 24 mm).(Reaf-2018)
1599-2012	Metallics materials – Bend Test (reaffirmed 2015).
1608-2005	Mechanical testing of metals –tensile testing (Reaffirmed 2011)
1821-1987	Dimensions for clearance holes for metric bolts. (Reaffirmed - 2008)
1852-1985	Rolling and cutting tolerance for hot rolled steel products. (Reaffirmed - 2013)
2062-2011	Hot Rolled Medium and High Tensile Structural steel (Reaffirmed – 2016)
4351-2003	Steel door frames. (Reaffirmed – 2008)
4736-1986	Hot-dip zinc coatings on Mild steel tubes. (Reaffirmed – 2016)

6248-1979	Metal rolling shutters and rolling grills (Reaffirmed – 2011)
SSPC-SP3 (SSI-St3)	Surface Preparation of Structural steel surface -Power Tool Cleaning– Swedish standard ST 3
SSPC-SP10(SSI-Sa2 ½)	Surface Preparation of Structural steel surface – Shot Blasting - Swedish standard Sa 2 1/2
7452-1990	Hot rolled steel sections for doors, windows & ventilators. (Reaffirmed – 2013)
12. FLOORING:	
210-2009	Grey iron casting (Reaffirmed 2014)
653-1992	Sheet linoleum (Reaffirmed 2016)
809-1992	Rubber flooring materials for general purpose(Reaffirmed 2016)
1122-1974	Methods for determination of specific gravity of natural building stones (Reaffirmed – 2008)
1124-1974	Method of test for water absorption of natural building stones(Reaffirmed – 2013)
1130-1969	Marble (blocks, slabs and tiles). (Reaffirmed – 2008)
1197-1970	Code of practice for laying of rubber floors. (Reaffirmed – 2016)
1198-1982	Code of practice for laying and maintenance of linoleum floors(Reaffirmed – 2016)
1200 (Pt.XI)-2013	Method of measurements of pavings and floor finishes.
1237-2012	Cement concrete flooring tiles. (Reaffirmed – 2016)
I. S. CODE NO.	**SUBJECT**
1443-1972	Code of practice for laying and finishing of cement concrete flooring tiles(Reaffirmed – 2016)
1661-1972	Code of practice for application of cement and cement lime plaster finishes(Reaffirmed – 2016)
2114-1984	Code of practice for laying in situ terrazzo floor finish(Reaffirmed – 2016)
2571-1970	Code of practice for laying in situ cement concrete flooring(Reaffirmed – 2016)
3400-(Part 1 to 22)	Method of Test of vulcanized rubbers.
3400 (Pt.II)-2014	Hardness
3400 (Pt.X)-1977	Compression set at constant strain. (Reaffirmed – 2008)
3462-1986	Unbacked Flexible P.V.C. Flooring. (Reaffirmed – 2016)
4631-1986	Code of practice for laying of epoxy resin floor toppings (Reaffirmed – 2016)
5318-1969	Code of practice for laying of flexible P.V.C. sheet & tiles flooring(Reaffirmed – 2016)

5389-1969	Code of practice for laying of hardwood parquet and wood block floors. (Reaffirmed – 2007)
9197-1979	Specifications for epoxy resin, hardeners and epoxy resin compositions for floor topping (Reaffirmed – 2016)
73-2013	Paving Bitumen
13. ROOFING/MISCELLANEOUS :	
277-2018	Galvanised steel sheets (plain and corrugated)
458-2003	Concrete pipes (with and without reinforcement) (Reaffirmed -2013)
14871-2000	Fibre Reinforced Cement - Long Corrugated or Asymmetrical Section Sheets and Fittings for Roofing and Cladding (Reaffirmed -2010)
651-2007	Salt glazed stone ware pipes and fittings(Reaffirmed -2017)
702-1988	Industrial Bitumen(Reaffirmed -2009)
1199-1959	Method of Sampling & Analysis of concrete. (Reaffirmed - 2013)
1200 (Pt.IX)-1973	Method of measurements of roof covering (including cladding) (Reaffirmed - 2007)
1200 (Pt.X)-2013	Method of measurements of ceiling and lining
13607 - 1992	Ready Mixed Paint, Finishing, General Purposes, Synthetic (Reaffirmed 2009)
1322-1993	Bitumen felts for water proofing and damp-proofing. (Reaffirmed - 2008)
1346-1991	Code of practice for waterproofing of roof with bitumen felts(Reaffirmed 2010)
I. S. CODE NO.	**SUBJECT**
1609-1991	Code of practice for laying damp proof treatment using bitumen felts (Reaffirmed 2010)
1626-1994(Part I-III)	Asbestos cement building pipes, gutters and fittings (Spigot and socket types) (Reaffirmed 2010)
1834-1984	Specification for hot applied sealing compounds for joints in concrete. (Reaffirmed - 2010)
1838-(Pt.I & II)-1983	Preformed filler for expansion joints in concrete- non-extruding and resilient type Bitumen impregnated fiber). (Reaffirmed - 2015)
2115-1980	Code of practice for flat roof finish:mud phuska. (Reaffirmed - 2007)
2633-1986	Method of testing uniformity of coating on zinc coated articles. (Reaffirmed – 2016)
3007-(Pt.I)-1999	Code of practice for laying of corrugated asbestos cement sheets. (Reaffirmed – 2009)
3007-(Pt.II)-1 999	Code of practice for laying of semi corrugated asbestos cement sheet. (Reaffirmed - 2009)

3348-1965	Fiber insulation boards. (Reaffirmed - 2009)
3607-1979	Magnesite for chemical Industry. (Reaffirmed – 2010)
71 93-2013	Specifications for glass fiber base & Bitumen felts.
8183-1993	Bonded mineral wool. (Reaffirmed 2017)
BS 8539: 2012	Code of practice for the selection and installation of post-installed anchors in concrete and masonry
14. FINISHING	
75-1973	Linseed oil, raw and refined. (Reaffirmed – 2010)
77-1976	Linseed oil, boiled, for paints. (Reaffirmed - 2009)
104-2017	Specification for ready mixed paint, brushing, zinc chrome, priming.
133-2013	Enamel, interior (a) under coating (b) finishing colour as required
137-2017	Ready mixed paint, brushing, matt or egg-shell flat, finishing, interior, to Indian Standard Colour, as required.
158-2015	Ready mixed paint, brushing, bituminous, black lead free acid alkali, water and heat
168-1993	Ready mixed paint, air drying for general purpose.(Reaffirmed 2012)
217-1988	Cut back bitumen (reaffirmed 2009)
218-1983	Creosote and anthracene oil for use as wood preservatives (Reaffirmed 2009)
337-1975	Varnish, finishing interior. (Reaffirmed – 2009)
I. S. CODE NO.	**S U B J E C T**
341-2016	Black Japan, types A, B, and C
347-1975	Varnish, shellac for general purpose. (Reaffirmed – 2012)
348-1968	French polish. (Reaffirmed – 2009)
419-1967	Putty for use of window frames. (Reaffirmed – 2009)
427-2013 428-2013	Distemper, dry, colour as required. Washable distemper

524-1983	Varnish, finishing, exterior, synthetic;air drying. (Reaffirmed – 2015)
525-1968	Varnish, finishing, exterior and general purposes. (Reaffirmed – 2009)
533-2007	Gum spirit of turpentine (oil of turpentine)
712-1984 1200 (Pt. XII)-1976	Specification for building limes. (Reaffirmed - 2009) Method of measurements of plastering and pointing(Reaffirmed - 2007)
1200 (Pt.XIII)-1994	Method of measurements of white washing, colour washing, distempering and other finishes(Reaffirmed - 2007)
1200 (Pt.XV)-1987	Methods of measurements of painting, polishing & varnishing. (Reaffirmed - 2007)
2095-2011-Pt.I; 2001-PT II-1996-PT III)	Gypsum plaster boards
14862-2000	Fibre Cement Flat Sheets - (Reaffirmed - 2010)
2339-2013	Aluminium paint for general purposes
2547-1976 (Pt I & II)	Gypsum building plaster (Reaff. 2007)
2933-1975	Enamel, Exterior (a) Under coating (b) Finishing(Reaff. 2009)
5410-2013	Cement paint
6278-1971	Code of practice for white washing & colour washing. (Reaffirmed - 2016)
14276-1995	Cement particle board(Reaffirmed -2009)

15. DEMOLITION AND DISMANTLING:	
1200(Pt.XVIII)-1974	Method of measurements of demolition and dismantling(Reaffirmed -2007)
16. SAFETY CODES	
818-1968	Safety and healthy requirements in Electric and gas welding and cutting operations. (Reaffirmed -2008)
3696 (Pt.I)-1987	Safety code for scaffolds(Reaffirmed -2012)
3696 (Pt.II)-1991	Safety code for ladders(Reaffirmed -2012)
3764-1992	Safety code for Excavation works (Reaffirmed -2012)
4081-2013	Safety code for blasting and related drilling operation
4130-1991	Safety code for Demolition of Building(Reaffirmed -2012)
5916-2013	Safety code for construction involving use of hot bituminous materials
6922-1973	Structural subject to underground blasts code of practice for safety and design of structure subject to underground blasts.
7293-1974	safety code for Working with construction machinery (Reaffirmed -2012)
17. ROAD	
IRC:15-2011	Specifications and Code of Practice for Construction of Concrete Roads
IRC:44-2008	Guidelines for Cement Concrete Mix Design for Pavement"
IRC:SP:63-2004	Guidelines for the Use of Interlocking Concrete Block Pavement
IRC 58 -2015	Guidelines for the design of Plain Jointed Rigid Pavements for Highways
MORTH	Specification for Road & Bridge works
18. MISCELLANEOUS	
6313 -Part 3 -2013	Code of Practice for Anti-termite Measures in Buildings - Treatment for Existing Buildings(Reaffirmed -2011)

III – MANDATORY TESTS

NOTES:

The mandatory tests shall be carried out when the quantity of materials to incorporated in the work exceeds the minimum quantity specified.

Optional tests specified or any other tests, shall be carried out in case of specialised works or important structures as per direction of the Engineer-in-Charge.

Testing charges, including incidental charges and cost of sample for testing shall be borne by the contractor for all mandatory tests.

In case of non-IS materials, it shall be the responsibility of the contractor to establish the conformity of material with relevant Manufacturer's specifications/other Standards, if any, by carrying out necessary tests. Testing charges including incidental charge and cost of sample for testing shall be borne by the contractor for such tests.

THE MANDATORY TESTS SHALL BE AS FOLLOWS:

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work	Frequency of testing
Reinforced cement concrete work **Note:- IS no. refered shall be the latest revision applicable.**					
Water for Construction purposes	Ph value Limits of Acidity Limits of Alkality Percentage of solids Chlorides Suspended matter Sulphates Inorganic solids Organic solids	Lab	IS 3025	Water from each source	Before commencement of work & there after : Mandatory – Once in one year from each source;Optional: once in 3 months from each source; Municipal supply - optional.
Reinforced cement	b) slump test	Field	IS: 1199	a) 20 cu.m. for slabs,beams and connected columns . b) 5 Cu.m in case of cloumns	a) 20 cu.m. Part there of or more frequently as required by the Engr.-in-Charge. b) Every 5 Cu.m.

concrete	c) cube test	Lab IS : 516	a) 20 cu.m. In slab, beams, & connected columns. b) 5 cum in case of columns	a) every 20 cum of a day's concreting .(Ref. as per frequency of sampling). b) Every 5 cum.
Material	**Test**	**Field / laboratory test** **Test procedure**	**Minimum quantity of material / Work for carrying**	**Frequency of testing**
Ready mixed cement (IS-4926) concrete	Cube test	Lab IS-516 and as per para 6.3.2 of IS-4926-2003	50 cum	One for every 50cum of production or every 50 batches, whichever is the greater frequency
Note : for all other small items and where RCC done in a day is less than 5 cum, test may be carried out as required by Engineer-in-Charge.				
Mortars:				
Sand	Bulking of Sand	Field	20 CU.M.	Every 20 cu.m or part thereof or more frequently as decided by E.I.C
	Silt content	Field IS:383	20 CU.M.	Every 20 cu.m or part thereof or more frequently as decided by E.I.C
	Particle size and distribution	Field Laboratory decided by E.I.C IS:383	40 CU.M.	Every 40 cu.m. of fine aggregate / sand required in RCC. work only.

	Organic Impurities	Field .. DO..	20 CU.M.	Every 20 cu.m. or part thereof or more frequently as decided by the E.I.C
	Chloride & sulphate	Optional		Once in three months.

Material	**Test**	**Field / laboratory test**	**Test procedure**	**Minimum quantity of material / Work**	**Frequency of testing**
Cement	Test requirement	Fineness (m^2/kg)	IS 4031 (Part-II)	Each fresh lot	Every 50 MT or part Thereof
		Normal consistency	IS 4031 (Part-IV)		
		Setting time (minutes) a) Initial b) Final	IS 4031 (Part-V)		
		Soundness a)Le-Chat expansion (mm) b) Autoclave (%)	IS 4031 (Part-III)		

		Compressive Strength (Mpa) a) 72+/-1 hr b) 168+/-2hr	IS 4031 (Part-VI)		
Stone Aggregate	a) Percentage of soft or deleterious materials	General visual inspection / Lab test where required by the Engr-in-Charge	IS 2386 Part II	One test for each source	One test for each source
Material	**Test**	**Field / laboratory test**	**Test procedure**	**Minimum quantity of material / Work**	**Frequency of testing**
	Particle size distribution	Field / Lab	-	10 cu.m	Every 40 cum. Or part thereof and
	Once in three months for each source for coarse and fine aggregates required in RCC works, for a minimum quantity - 10 cum for coarse aggregate and 40 cum for fine aggregate.				
	a) Estimation of Organic impurities	Field / Lab	IS 2386 Part II	10 Cum	-do-
	b) Specific Gravity	Field / Lab	IS 2386	10 Cum	-do-
	a) Bulk Density	Field / Lab	IS 2386	10 Cum	-do-

	b) Aggregate crushing strength	Field / Lab	IS 2386	10 Cum	-do-
	c) Aggregate impact value	Field / Lab	IS 2386	10 Cum	-do-
Timber	Moisture	Field (by moisture meter) Laboratory test as required by Engineer-in-Ch.		1 Cu.M.	Every one Cum or part thereof
Flush Door	End immersion test Knife test Adhesion test	Laboratoy	IS: 2202 (Part 1) & (Part II)	26 shutters	As per sampling and testing as instructed by the Engineer-in-Charge.

Material	**Test**	**Field / laboratory test**	**Test procedure**	**Minimum quantity of material / Work**	**Frequency of testing**
Bricks	Testing of bricks / brick tiles for dimensions Compressive strength Water absorption Efflorescence	Laboratory	IS 3495 Part I to IV	No. of bricks to be selected & bricks lot 20 : 2001 to 10000 32 : 10001 to 35000 50 : 35001 to 50000 20 : for every addl. 50000 or part thereof. If < 20000, As per decision of EIC.	Permissible defective bricks in the sample 1 2 3 1

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test	Frequency of testing
Concrete Blocks	Dimensions of block Block Density Compressive strength Water absorption Drying shrinkage Moisture movement	Field Laboratory	IS 2185 – Part 1	20 blocks from every consignment of 5000 blocks.	As per sampling and testing as instructed by the Engineer-in-Charge.

Steel for RCC	Physical tests a) Tensile strength b) Retest c) Re-bound test d) Nominal mass e) Bend test f) Elongation test g) Proof stress	Lab	/ field	IS 1608 IS 1786 IS 1786 IS 1786 IS 1599 IS 1786 IS 1786	Each lot from each source from each diameter of bar	Below 100 Tonnes Dia < 10 mm one sample for each 25 tonnes or part thereof If dia is >10 mm but less than 16 mm: One sample each 35 tonnes or part thereof. If dia >16 mm one sample for each 45 tonnes	Above 100 Tonnes Dia < 10 mm one sample for each 40 tonnes or part thereof If dia is >10 mm but less than 16 mm One sample for each 45 tonnes or part thereof. If dia >16 mm one sample for each 50 tonnes.

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test	Frequency of testing
	Chemical Composition		IS 1786 s as pe latest amendments		For every batch no.and diameter wise to be tested and as directed by the Engineer-in-Charge.
Soil core test	OMC Proctor density		As per IS 12175	Two for every 50 sqm	As per para 1.10 & 1.11 of this book
Ceramic tiles			As per IS 13630	3000 tiles and more for each manufacturer and thereafter for every 3000 tiles or part thereof.	

TESTING, TOLERANCE, ACCEPTANCE AND MODE OF PAYMENT:

a) The material should pass all tests and tolerance in dimensional, chemical, physical properties should be within the limit as stipulated in relevant IS for acceptance. Such materials shall be accepted as standard.

b) Payment shall be restricted to standard unit mass, or as specified in the schedule of work, without making any cost adjustment towards mass or any other properties, provided the material pass all the tests and tolerances are within the specified limits.In case of non-standard materials, materials not covered under any IS Specifications, such as aluminium sections, the payment shall be made based on the actual unit weight basis as determined by testing at random sampling.

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

SECTION 'A'- CIVIL WORKS

1. EARTH WORK

1.1. SCOPE OF WORK:

The scope of work covered under this specifications pertains to excavation of foundations, trenches, pits and over areas, in all sorts of soils, soft and hard rock, correct to dimensions given in the drawing including shoring, protections of existing underground utilities if any, such as water lines, electric cables etc., dewatering and shoring if necessary, stacking the useful materials as directed within the lead specified, refilling around the foundation and into the plinth with selected useful excavated earth and disposing off the surplus earth/materials within specified lead and finishing the surface to proper levels, slopes and camber etc. all complete.

1.2. SITE CLEARANCE:

Before the earth work is started the area coming under cutting and filling shall be cleared of all obstructions, loose stones, shrubs, rank vegetation, grass, brush-wood, trees and saplings of girth upto 30 cm. measured at a height of one metre above ground and rubbish removed upto a distance of 150 metres outside the periphery of the area under clearance. The roots of trees shall be removed to a minimum depth of 60 cm. below ground level, or a minimum of 30cm. below formation level whichever is lower, and the hollows filled up with earth, levelled and rammed. This work is deemed to be included in the earth work items and no separate payment will be admissible for the work.

The trees of girth above 30 cm. measured at a height of one meter above ground, shall only be cut after permission of the Engineer-in-charge is obtained in writing. The roots shall also be removed as described in the preceding sub-para. Payment for cutting and removing roots of such trees shall be made separately. Any material obtained from the site will be the property of the Owner and the useful materials as decided by the Engineer-incharge will be conveyed and properly stacked as directed within the lead specified.

1.3. SETTING OUT AND MAKING PROFILES :

Masonry or concrete pillars will be erected at suitable points in the area to serve as bench marks for the execution of the work. These bench marks shall be connected with G. T. S. or any other permanent bench mark approved by the Engineer-in-charge. Necessary profiles with pegs, bamboos and strings or Burjis (marking using masonry)shall be made to show the correct formation levels before the work is started. The contractor shall supply labour and materials for setting out and making profiles and Burjis for the work at his own cost and the same shall be maintained during the excavation work. The grid Co-

ordinate or other reference points Shall be confirmed along with E.I.C. It shall be the responsibility of the contractor to set out centre lines correctly with reference to the drawings and install substantial reference marks. Checking of such alignment by the E.I.C will not absolve the contractor from his responsibility to execute the work strictly in accordance with the drawings.

1.4. EXCAVATION :

The contractor shall notify the Engineer-in-charge before starting excavation and before the ground is disturbed, to enable him to take existing levels for the purpose of measurements. The ground levels shall be taken at 1 to 5 metres intervals in uniformly sloping ground and at closer distance where local mounts, pits or undulations are met with, as directed by the Engineer-in-charge. The ground levels shall be recorded in field books and plotted on plans, which shall be signed by the Contractor and the Engineer-in-charge, before the earth work is actually started. The labour required for taking levels, shall be supplied by the Contractor at his own cost. The Contractor shall perform excavation in all types of soils, murrum, soft and hard rock, boulders etc. in foundation, over areas and in trenches to widths, lines, levels, grades and curves as shown in the drawing or lesser widths, lines and levels as directed by the Engineer-in-charge and as per items in the schedule of quantities.

1.4.1. The item in the schedule of quantities shall specify the excavation in trenches or over areas. For this purpose, the excavation for any depth in trenches for foundation not exceeding 1.5 m. in width or 10 sqm. on plan shall be described as **Excavation in foundation trenches.**

1.4.2. Excavation exceeding 1 .5m in width as well as 10 sqm. on plan (excluding trenches for pipes, cables etc.) and exceeding 30 cm in depth shall be described as **Excavation over areas.**

1.4.3. Excavation exceeding 1.5m in width as well as 10 sqm. on plan but not exceeding 30 cm. in depth shall be described as Surface Excavation.

1.5. Classification of Earth Work: The earth work shall be classified under the following main categories and measured separately for each category.

a) All types of soils, murrum, boulders.

b) Soft rock.

c) Hard rock.

1.5.1.

a) **All types of Soils, Murrum, Boulders :** This includes earth, murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof and soft and hard murrum, shingle etc. which is loose enough to be removed with spades, shovel and pick axes. Boulders not more than 0.03 cum. in volume found during the course of excavation shall also fall under this classification.

b) **Excavation in Soft Rock :** This shall include all materials which are rock or hard conglomerate, all decomposed weathered rock, highly fissured rock, old masonry, boulders bigger than 0.03 cum. in volume but not bigger than 0.5 cum. and other varieties of soft rock which can be removed only with pick axes, crow bars, wedges and hammers with some difficulty. The mere fact that the contractor resorts to blasting and/or wedging and chiselling for reasons of his own, shall not mean the rock is classificable as hard rock.

c) **Excavation in Hard Rock :** This includes all rock other than soft rock mentioned in para 1.5.1 (b) viz. soft rock, occurring in masses, boulders having approximate volume more than 0.5 cum. plain or reinforced cement concrete, which can best be removed by blasting or chiselling and wedging where blasting cannot be permitted owing to any restriction at site.

i) **Excavation in Hard Rock by Blasting :** Where blasting is permitted the excavation in rock shall be done by means of blasting. No heavy blasting will be permitted and only controlled/muffled blasting will be permitted at the discretion of the Engineer-in-Charge. The Contractor shall be governed by the relevant statutory laws, rules and regulations on explosives, pertaining to the acquisition, transport, storage, handling and use of explosive which shall be rigidly followed and shall obtain himself all necessary materials and equipment for blasting. Blasting shall be executed through a licensed blaster with prior permission from police authorities. Prior to blasting sufficient notice shall be given to concerned parties to avoid danger to people, materials and nearby structures. All the damages caused by careless blasting if any shall be made good by the contractor at his own expenses.

ii) **Excavation in Hard Rock by Chiselling and Wedging :** Where blasting is not permitted and if the Engineer-in-Charge so desires, the excavation shall be done by chiselling and wedging or any other agreed method.

NOTE : All the excavated hard rock obtained shall be stacked properly and neatly within the specified lead by the contractor as directed by the Engineer-in-Charge.

1.6. EXCAVATION PARAMETERS : The excavation under all classifications in areas in trenches or in pits shall be carried out systematically. Cutting shall be done from top to bottom and no under-pining or undercutting will be allowed. The bottom and sides of excavation shall be dressed to proper level, slopes,steps, camber etc. by removing high spots, and ramming thoroughly as directed by the Engineer-in-charge.

All the excavation shall be carried out strictly to the dimensions given in the drawing. The width shall generally be of the width of mudmat concrete and depth as shown in drawing or as directed by the Engineer-in-Charge, according to availability of the desired bearing capacity of soil below. Any excavation if taken below the specified depths and levels, the contractor shall at his own cost fill up such overcut to the specified level with cement concrete 1:4:8 in case of excavation in all types of soils and with cement concrete 1:2:4 in case of excavation in soft and hard rock.

After the excavation is completed, the contractor shall notify the Engineer-in-Charge to that effect and no further work shall be taken up until the Engineer-in-Charge has approved the depth and dimensions and also the nature of foundation materials. Levels and measurements shall also be recorded prior to taking up any further work. Contractor has to ensure Proper temporary barricading around the excavated area till backfilling in pits is completed.

1.7. SHORING :

Unless separately provided for in the schedule of quantities, the quoted rate for excavation shall include excavation of slopes to prevent falling in soil by providing and/or fixing, maintaining and removing of shoring, bracing etc. The contractor would be responsible for the design of shoring for proper retaining of sides of trenches, pits etc. with due consideration to the traffic, superimposed loads etc. Shoring shall be of sufficient strength to resist the pressure and ensure safety from slips and to prevent damage to work and property and injury to persons. It shall be removed as directed after items for which it is required are completed. Should the slips occur, the slipped material shall be removed and slope dressed to a modified stable slope. Removal of the slipped earth will not be measured for payment.

DEWATERING :

Unless specifically provided for as a separate item in the schedule of quantities, rate (excavation item) shall also include bailing or pumping out all water which may accumulate

in the excavation during the progress of further works such as mud mat concrete, R.C. footings, shuttering etc. either due to seepage, springs, rain or any other cause and diverting surface flow by bunds or other means. Care shall be taken to ensure that the water discharged sufficiently away from the foundations to keep it free from nuisance to other works in the neighbourhood.

1.8. DISPOSAL OF EXCAVATED MATERIALS :

a) **ANTIQUITES :** Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government.

b) **USEFUL MATERIALS :** Any material obtained from the excavatiion which in the opinion of the Engineer-in-Charge is useful, shall be stacked separately in regular stacks as directed by the Engineer-in-Charge and shall be the property of the Government.

No material excavated from foundation trenches of whatever kind they may be are to be placed even temporarily nearer than about 3 m. from the outer edge of excavation. Discretion of the Engineer-in-Charge in such cases is final. All materials excavated will remain the property of the Owner. Rate for excavation includes sorting out of the useful materials and stacking them separately as directed within the specific lead.

Materials suitable and useful for backfilling or other use shall be stacked in convenient place but not in such a way as to obstruct free movement of materials, workers and vehicles or encroach on the area required for constructional purposes. It shall be used to the extent required to completely backfill the structure to original ground level or other elevation shown on the plan or as directed by the Engineer-in-Charge. **Materials not useful in anyway shall be disposed off, levelled and compacted as directed by the Engineer-in-charge within a specified lead. The site shall be left clean of all debris and levelled on completion.**

1.9. BACKFILLING IN SIDES OF FOUNDATIONS, PLINTH, UNDER FLOOR ETC. :

The back filling shall be done after the concrete or masonry has fully set and shall be done in such a way as not to cause under-thrust on any part of the structure. Where suitable excavated material is to be used for back filling, it shall be brought from the place where it was temporarily deposited and shall be used in backfilling. The scope of work for back filling/filling in foundation, plinth, under floors etc. shall include filling for all the buildings covered under the contract. Surplus earth available from one building, if required, shall

be used for backfilling/filling for other buildings also within the specified lead mentioned in the item.

All timber shoring and form work left in the trenches, pits, floors etc. shall be removed after their necessity ceases and trash of any sort shall be cleared out from the excavation. All the space around the foundation masonry or concrete and the sides of excavation shall be backfilled to the original surface with approved materials in layers not exceeding 150 mm. in thickness, watered and well consolidated by means of rammers to atleast 90% of the consolidation obtainable at optimum moisture content (Proctor density). Flooding with water for consolidation will not be allowed. Areas inaccessible to mechanical equipment such as areas adjacent to walls and columns etc. shall be rammed by hand rammer or by hand held power rammers to the required density. The backfill shall be uniform in layer thickness and free from large lumps, stones, shingle or boulder not larger than 75 mm. in any direction, salt, clods, organic or other foreign materials which might decompose. The backfilling in plinth and under floors shall be done in similar way in layers not exceeding 150 mm thick and shall be well consolidated by means of mechanical or hand operated rammers as specified to achieve the required density.

Test to establish proper consolidation as required will be carried out by the Contractor from Owner/Architect/RCC Consultant approved Testing Lab. Two tests per 50 sqm. will be taken to ascertain the proper consolidation.

1.10. FILLING IN PLINTH AND UNDER FLOORS:

After the available suitable excavated materials are exhausted as backfilling, the contractor shall notify the Engineer-in-Charge, of the fact and levels taken jointly with Engineer-in-Charge. The earth, murrum, sand, gravel etc. or such materials suitable for filling proposed to be filled under floors and so mentioned in the item of schedule of quantities shall then be brought to site from approved locations and sources.

i) **Earth Filling :** The earth, soft murrum etc. so brought shall be filled up in layers of 15 cm depth, each layer being well watered and consolidated by approved hand or mechanical rammers or other suitable means to achieve the required density.

ii) **Gravel or Sand Filling :** Gravel if required to be filled under floors, shall be washed gravel of approved quality and of size varying from 12 mm to 20 mm; it shall be uniformly blinded with approved type of soil and/or sand to obtain full compaction. Gravel shall be filled in specified thickness and shall be well watered and rammed entirely to the satisfaction of the Engineer-in-Charge.

If sand is required to be filled under floors, it shall be clean, medium grained and free from impurities. The filled in sand shall be kept flooded with water for 24 hrs. to ensure maximum consolidation. Any temporary work required to maintain sand under flooded condition shall be done by the contractor at his own cost. The surface shall then be well dressed and got approved from Engineer-in-Charge before any other work is taken over the fill.

1.11. LEAD & LIFT

LEAD : The lead for disposal/deposition of excavated materials shall be as specified in the respective item of work. For the purpose of measurements of lead, **the area to be excavated or filled or area on which excavated material is to be deposited/disposed off shall be divided in suitable blocks and for each of the block, the distance between centre lines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route adopted.**

LIFT : Lift shall be measured from ground level. Excavation up to 1.5 m depth below ground level and depositing excavated material on the ground shall be included in the item of earthwork for various kinds of soil. Extra lift shall be measured in unit of 1.5 m or part thereof. Obvious lift shall only be measured; that is lifts inherent in the lead due to ground slope shall not be measured except for lead upto 250 m. All excavation shall be measured in successive stages of 1 .5 m stating the commencing level. This shall not apply to cases where no lift is involved as in hill side cutting.

1.12. MODE OF MEASUREMENTS:

1.12.1. All excavation in areas shall be measured net. The dimensions for the purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, rafts or other foundations, multiplied by the mean depth from the surface of ground determined by levels. Excavation for side slopes will not be paid for. Excavation in areas having depths less than 30 cms. shall be measured as surface excavation on square metre basis,mentioning the average depth of excavation.

Reasonable working space beyond concrete dimensions shall be allowed for waterproofing and shuttering works in underground water tanks, sumps, septic tanks etc., where considered necessary in the opinion of the Engineer-in-Charge. However the same shall be limited to the following:

i) Waterproofing and works upto 2M depth	Maximum upto 600mm from face of concrete surface
ii) Waterproofing and works beyond 2M depth	Maximum upto 900mm from face of concrete surface.

1.12.2. Wherever direct measurements of rock excavation are not possible, volume of rock be calculated on the basis of length, breadth and depth of stacks made at site as mentioned in para 1.5.1 (c). The net volume shall be worked out by reducing it by 50%, taking the voids into consideration as 50%. Similarly to arrive at net quantity to be paid in the case of soil, reduction @ 20% of corresponding stack/truck measurements shall be made.

1.12.3. The rate for excavation shall include carting and disposing and levelling the excavated materials within the specified lead. The rate shall also be inclusive of cost of all tools, plants, explosives, shoring, dewatering at various stages, labour, materials etc. to complete all the operations specified.

1.12.4. The backfilling and consolidation in sides of foundation and in plinth with excavated material will be paid separately as per the rates in schedule of quantities. Actual quantity of consolidated filling shall be measured and paid in cubic metres upto two places of decimal conveying within the specified lead, picking of selected stacked materials, conveying it to the place of final backfill, compaction to the required proctor density etc.

1.12.5. Payment for filling and consolidation inside the trenches, sides of foundations, plinth etc. with selected materials brought by the contractor other than the excavated material, shall be paid for separately as per the rates in schedule of quantities which includes cost of such materials/excavation, royalty, its conveyance within the specified lead, watering, consolidating, dressing etc. Actual quantity of consolidated filling shall be measured and paid in cubic metres upto two places of decimal.

1.12.6. The rate quoted in cum. for items of excavation is deemed to include the necessary additional quantity of excavation involved beyond the authorized dimensions of para (for waterproofing and shuttering works in underground watertanks, sumps, septic

tanks, Raft etc.) which may be necessary to be carried out for carrying out the work by standard engineering practices, decided upon by the contractor. Therefore no extra payment will be made for any excavation done other than the required quantity as per the plan dimension indicated in the drawings.

1.12.7. Measurements for excavation over areas shall be determined by levels or by "Dead men" or both at the discretion of the Engineer-in-Charge. If however the Engineer-in-Charge decides on measurement by levels, levels of site shall be jointly taken and recorded by the Engineer-in-Charge or his representatives and the contractor, before commencement of the work and after completion of the work and the quantity of work done shall be computed based on these levels. The volume of earth work shall be computed based on "Simpsons formula" or any other approved method at the discretion of the Engineer-in-Charge.

2. ANTITERMITE TREATMENT:

2.1. GENERAL :

Preconstructional anti-termite treatment is a process in which soil treatment is applied to a building in early stages of its construction. The purpose of antitermite treatment is to provide the building with a chemical barrier against the sub-terranean termites.

Antitermite treatment being a specialized job, calls for thorough knowledge of the chemicals, soils, termite to be dealt with and the environmental conditions, in order to give effective treatment and lasting protection to the property undergoing treatment. It is, therefore, imperative that the works of antitermite treatment should be got executed through specialized agencies only. The specialized agency should be preferably a member of the Indian Pest Control Association and shall have sufficient experience of carrying out similar works of magnitude envisaged in this tender.

The preconstructional soil treatment is required to be applied during the construction stages of the sub-structure upto plinth level. The contractor has to be watchful of the various stages of sub-structure works and arrange to carry out the soil treatment in time after proper co-ordination with E.I.C and other contractors if any, working at site.

2.2. SCOPE :

The scope of preconstructional antitermite treatment covers the soil treatment with approved chemicals in water emulsion in foundation trenches for columns, plinth beams, pile caps, brick walls, service trenches, lift pits, steps, ramps etc. in top surfaces of plinth filling, at junction of walls and floor,in expansion joints etc. in stages as detailed in this

specifications and drawings. Unless otherwise stipulated, the antitermite treatment will be carried out as per I.S.6313 (part II) and/or as per direction of the Engineer-in-Charge.

2.3. SITE PREPARATION :

In order to ensure uniform distribution of the chemical emulsion and to assist penetration, the following site preparation shall be carried out:

a) Remove all trees, stumps, logs or roots from the building site.

b) Remove all concrete form work if left anywhere, levelling pegs, timber off-cuts and other builders debris from the area to be treated.

c) If the soil to be treated is sandy or porous, preliminary moistening will be required to fill capillary spaces in soil in order to prevent the loss of emulsion through piping or excessive percolations.

d) In the event of water logging of foundation, the water shall be pumped out before application of chemical emulsion and it should be applied only when the soil is absorbent.

e) On clays and other heavy soils where penetration is likely to be slow and on sloping sites, where run-off of the treating solution is likely to occur, the surface of the soil should be scarified to a depth of 75 mm atleast.

f) All sub-floor levelling and grading should be completed, all cutting, trenches and excavations should be completed with backfilling in place, borrowed fill must be free from organic debris and shall be well compacted. If this is not done supplementary treatments should be made to complete the barrier.

2.4. CHEMICAL TO BE USED :

The effectiveness of chemical depends upon the choice of the chemical, the dosage adopted and the thoroughness of application. The chemical solutions or emulsions are required to be dispersed uniformly in the soil and to the required strength so as to form an effective chemical barrier which is lethal and repellent to termites.

Soil Treatment : One of the approved chemicals in water emulsion, recommended by the Indian Pest Control Association (IPCA), and approved by the Engineer-in-Charge, shall be used uniformly over the area to be treated.

The contractor should produce voucher(s) for the chemical purchased and should get verified the sealed container(s) of the specified chemical from the Engineer-in-Charge before preparing the emulsion/use for the treatment. The emulsion should be fresh stock; date to be confirmed by the contractor prior to purchase.

2.5. MODE AND RATE OF APPLICATION :

The chemical emulsion as stated above will be applied uniformly by sprayers at the prescribed rates as detailed below in all the stages of the treatment.

2.5.1. Treatment in Foundation Trenches : In case of normal wall load bearing structures, column pits, wall trenches and basement, the treatment shall be @ 5 ltrs./sqm. of surface area of the bottom and sides to a height of atleast 300 mm. After the foundation work, the sides shall be treated @ 7.5 ltrs./sqm. of vertical surface of substructure on each side. After the earth filling is done, treatment shall be done by rodding the earth at 150 mm. centers close to wall surface and spraying the chemical with the above dose i.e. 7.5 ltrs./sqm.

In case of framed structure, the treatment shall start at a depth of 500 mm. below ground level. From this depth the backfill around the columns, beams and R.C.C. basement walls shall be treated @ 7.5 ltrs./sqm. of the vertical surface and @ 5 ltrs./sqm. for the horizontal surface at the bottom in the trenches/pits.

2.5.2. Treatment on Top Surfaces of Plinth Filling : The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 litres/sqm. of the surface area before sub-base to floor is laid. If filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes upto 50 to 75mm. deep at 150 mm. centers both ways shall be made with crow bars on the surface to facilitate saturation of the soil with the emulsion

2.5.3. Treatment at Junction of Walls and Floors : Special care shall be taken to establish continuity of the vertical chemical barrier on the inner wall surfaces from the finished ground level (or from level where the treatment had stopped) upto the level of the filled earth surface. To achieved this a small channel 30 x 30 mm. shall be made at all the junctions of wall/column with floor (before laying sub-grade) and rod holes made in the channel upto the finished ground level at 150 mm apart and the iron rod moved backward and forward to break the earth and chemical emulsion poured along the channel @ 7.5 litres (or at recommended quantity) per sqm. of the vertical wall/column

surfaces so as to soak the soil right upto the bottom. The soil shall be tamped back into place after this operation.

2.5.4. Treatment for Expansion Joints : The soil beneath the expansion joints shall receive special attention when the treatment under 2.5.1 above is in progress. This treatment shall be supplemented by treating through the expansion joint after sub-grade has been laid at the rate of 2 litres per metre length of expansion joint.

2.6. PRECAUTIONS DURING TREATMENT :

a) Utmost care shall be taken to see that the chemical barrier is complete and continuous. Each part of the area shall receive the prescribed dosage of chemical emulsion.

b) The treatment should not be carried out when it is raining or when the soil is wet with rain or sub-soil water.

c) Once formed, the treated soil barrier shall not be disturbed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

2.7. PRECAUTIONS FOR HEALTH HAZARDS AND SAFETY MEASURES :

2.7.1. All the chemicals mentioned above are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mist or swallowed. Persons handling or using these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given in 2.7.2 to 2.7.5 particularly when handling these chemicals in the form of concentrates

2.7.2. These chemicals are usually brought to the site in the form of emulsifiable concentrates. The containers should be clearly labelled and should be stored carefully so that children and pets cannot get at them. They should be kept securely closed.

2.7.3. Particular care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water specially before eating

and smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water. If chemicals splash into the eyes they shall be flushed with plenty of soap and water and immediate medical attention should be sought.

2.7.4. The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed during mixing.

2.7.5. Care should be taken in the application of chemicals/soil-toxicants to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.8. GUARANTEE :

The contractor has to furnish the guarantee for 10 (ten) years from the date of completion of work, stating that in case of reappearance of termites within the building area due to defective materials or workmanship or due to any other reasons, the contractor will carry out the necessary post constructional treatment to keep the entire area free from termite, once again, without any extra cost during the guarantee period.

2.9. MODE OF MEASUREMENT :

The payment will be made on the basis of plinth area measurements at ground floor only for all the stages of treatment in sqm. correct to two places of decimals. Rate includes the cost of materials, labour and all tools,plants, sprayers required for complete operation.

3. HARD CORE / SOLING UNDER FLOORS / FOUNDATIONS :

3.1. SCOPE OF WORK :

The work covered under this specification includes all type of soling work either by bricks or by rubble stones laid under floors/foundations, hand packed, complete as per under mentioned specification and applicable drawings.

3.2 RUBBLE STONE SOLING : The rubble stone shall be of best variety of black trap/granite/basalt or other approved variety of stone available locally. The stone shall be hard, durable, free from defects and of required size and shall be approved by the Engineer-in-Charge before incorporation in the work.

3.3 Preparation of Surface : The bed on which rubble soling is to be laid shall be cleared of all loose materials, levelled, watered and compacted and got approved by the

Engineer-in-Charge before laying rubble soling. Cable or pipe trenches if shown in the drawing and as required by the Engineer-in-Charge shall be got done before the soling is started.

3.4 Workmanship : Over the prepared surface, the stone shall be set as closely as possible and well packed and firmly set. The stones shall be of full height and shall be laid so as to have their bases of the largest area resting on the sub-grade. Soling shall be laid in one layer of 230 mm. or 150 mm. or other specified thickness and no stones shall be less than 230 mm. or 150 mm. depth or specified thickness of soling with a tolerance of 25mm. After packing the stones properly in position, the interstices between them shall be carefully filled with quarry spoils or stone chips of larger size possible, to obtain a hard, compact surface. Spreading of loose spoils or stone chips is prohibited.

The entire surface shall be examined for any protrusions and the same shall be knocked off by a hammer and all interstices shall be filled with approved murrum. Excess murrum if any over the surfaces shall be removed. Unless otherwise specified, the murrum shall be supplied by the contractor at his own cost from the selected areas. The surfaces shall then be watered and consolidated with mechanical or sufficiently heavy wooden tampers and log-rammers as approved by the Engineer-in-Charge to give the required slope or level and dense sub-base. After compaction, the surface shall present clean look. Adequate care shall be taken by the contractor while laying and compacting the rubble soling to see that concrete surfaces in contact with soling are not damaged.

3.5 MODE OF MEASUREMENT :

The quoted rate shall be per square metre of the soling of specified thickness or in cu.m basis as per the BOQ (schedule of quantities). The linear dimensions shall be measured upto two places of decimals of a metre and are worked out correct to the two places of decimals of a square metre. Plan areas of soling work actually done limiting to the dimensions as per drawings shall be measured for payment. The rate shall include all the materials, labour, transport etc. and no extra payment shall be made for work done at different levels. The rate shall also include the cost of preparation of surface, all materials and labour, watering, consolidation etc. all complete.

4. PLAIN / REINFORCED CONCRETE AND ALLIED WORKS:

4.1. SCOPE :

Scope of the specification deals with the structural (Reinforced cement concrete) and general use of plain and reinforced cement concrete.The specifications cover the qualitative and quantitative requirements in respect of selection of ingredients, proportioning, manufacture of concrete, transport, placing, consolidation, curing,

finishing, acceptance criteria etc., These specifications also cover the requirement of form work and reinforcement.

4.2. Unless otherwise specified, the manufacture and placing of concrete shall be done by weigh batching. However, in the specific cases where mechanized batching system (Ready mix concrete), mechanical transport and pumping is specified the same shall be followed as per the terms of the contract.

4.3. CEMENT CONCRETE (PLAIN AND REINFORCED):

4.3.1. The quality of materials and method and control of manufacture and transportation of all concrete work in respect of mix, whether reinforced or otherwise, shall conform to the applicable portions of these specifications.

4.3.2. Mandatory tests: The Engineer-in-Charge shall have the right to inspect the sources of materials, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipments and the quality control system. The contractor shall arrange such an inspection and the Engineer-in-Charge approval shall be obtained prior to starting the concrete work. List of mandatory test for RCC to be carried out is enclosed as Annexure "A".

4.3.3. Materials for Standard Concrete : The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Ordinary Portland Cement (Portland pozzolana cement or other type of cement shall be used if specifically required based on soil report or site specific requirements), clean sand, natural coarse aggregate, clean water, ice and admixtures if specially called for on drawings or schedule of quantities.

4.3.3.1. Cement: Unless otherwise specified or called for in the contract specifications, cement shall be any of the following and the type selected should be appropriate for the intended use and as per the contract conditions, specifications and drawings.

a) 33 Grade Ordinary Portland cement conforming to IS 269

b) 43 Grade ordinary Portland cement conforming to IS 8112

c) 53 Grade ordinary Portland Cement conforming to IS 12269

d) Portland slag cement conforming to IS 455.

e) Porland pozzolana cement (fly ash based) conforming to IS 1489 (Part I)

f) Portland pozzolona cement (calcined clay based conforming to IS 1489 (Part 2)

g) Sulphate resisting Portland cement conforming to IS 12330.

In case the job requires specific use of any of the following cements the same shall be used with the prior approval of the EIC and necessary precautions with regard to their setting and hardening time, time required for de-shuttering, curing etc., shall be followed after carefully complying with specific literature with regard to those types.

1. High Alumina cement - conforming to IS 6452

2. Low heat cement - conforming to IS 12600

3. Super sulphate cement - conforming to IS 6909

4. Rapid Hardening cement - conforming to IS 8041

5. Blended Cement for finishing work as below

Other combinations of Portland Cement with mineral admixtures of quality conforming to relevant Indian Standards laid down may also be used in the manufacture of concrete provided that there are satisfactory data on their suitability, such as performance test on concrete containing them and only in such case where in specifically called for in the contract.

4.3.3.1(A). Mineral Admixtures

Pozzolana: Pozzolanic materials conforming to relevant Indian Standards may be used with the permission of Engineer-in-charge, provided uniform blending with cement is ensured.

Fly ash (pulverized fuel ash): Fly ash conforming to Grade 1 of IS 3812 may be used as part replacement of **ordinary** Portland cement provided uniform blending with cement is ensured.

Silica fume: Silica fume conforming to a standard approved by the deciding authority can be used as part replacement of cement provided uniform blending with the cement is ensured.

Note: The silica fume (very fine non –crystalline silicon dioxide)is a by-product of the manufacture of silicon,ferrosilicon or the like, from quartz and carbon in electric arc

furnace. It is usually used in proportion of 5 to 10 **percent** of the cement content of a mix.

Rice husk ash: Rice husk ash giving required performance and uniformity characteristics may be used with the **approval** of the deciding authority.

Note: Rice husk ash is produced by burning rice husk and contain large proportion of silica. To achieve amorphous state, rice husk may be burnt at controlled temperature. It is necessary to evaluate the **product** from a particular source for performance and uniformity since it can range from being as deleterious as silt when incorporated in concrete. Water demand and drying shrinkage should be studied before using rice husk.

Metakaoline: Metakaoline having fineness between 700 to 900m²/kg may be used as pozzolanic material in concrete.

Note: Metakaoline is obtained by calcination of pure or refined kaolintic clay at a temperature between 650 0C and 850^{0}C, followed by grinding to achieve a fineness of 700 to 900 m²/kg. The resulting material has high pozzolanicity.

Ground Granulated Blast Furnace Slag: Ground granulated blast Furnace slag obtained by grinding granulated blast furnace slag conforming to IS 12089 may be used as part replacement of ordinary Portland cement provided uniform blending with cement is assured.

A certified report attesting to the conformity of the cement to I.S. specifications by the cement manufacturers chemist shall be furnished to the Engineer-in-Charge, if demanded. The Contractor, shall make his own arrangements for the storage of adequate quantity of cement at no extra cost at the site of work as per instructions and approval of the Engineer-in-Charge.

Specification for Storage:

Cement in bags shall be stored and stacked in a shed, which is dry, leak-proof and moisture proof as far as possible. Storage under tarpaulins will not be permitted. Flooring of the shed shall consists of the two layers of concrete blocks /dry bricks laid on well consolidated earth to avoid contact of cement bags with the floor. Stacking shall be done about 150 to 200 mm clear above the floor (concrete blocks /dry bricks) using wooden planks. Cement bags shall be stacked at least 450 mm clear off the walls and in rows of two bags leaving in a space of at least 600 mm between two consecutive rows. In each row the cement bags shall be kept closed together so as to reduce air circulation. Stacking shall not be more than ten bags high to avoid lumping

under pressure. In stacks more than eight bags high, the cement bags shall be arranged in header and stretcher fashion i.e alternately lengthwise and crosswise so as to tie the stacks together and minimize the danger of toppling over.

Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage arrangements shall be such that there is no dead storage consignments in cement shall be stored as received and shall be consumed in the order of their delivery.

Cement held in store for a period of ninety (90) days or longer shall be retested before use in work. Should at any time the Engineer-in-Charge have reasons to consider that any cement is defective, then irrespective of its origin and/or manufacturers test certificate, such cement shall be tested immediately at a National Test Laboratory/Approved Laboratory (As Approved by Owner/Architect/RCC Consultant), and until the results of such tests **are** found satisfactory, it shall not be used in any work.

4.3.3.2. Aggregates :

a) **"Aggregate"** in general designates both fine and coarse inert materials used in the manufacture of concrete.

b) **"Fine Aggregate"** is aggregate most of which passes through 4.75 mm I.S. sieve.

c) **"Coarse Aggregate"** is aggregate most of which is retained on 4.75 mm I.S. sieve. Aggregate shall comply with requirement of IS 383. As far as possible preference shall be given to **machine** broken and graded aggregate.

All fine and coarse aggregates proposed for use in the work shall be subject to the Engineer-in-Charge's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer-in-Charge.

Aggregate shall, except as noted above, consists of natural sand, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion to the reinforcement or may impair the strength and/or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary test on concrete specified herein-after.

Sampling and testing : Sampling of the aggregates for mix design and determination of suitability shall be taken under the supervision of the Engineer-in-Charge and delivered to the laboratory, well in advance of the schedule for placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to the Engineer-in-Charge in advance of the work for use, in determining suitability of the proposed aggregate.

Storage of aggregates : All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate must be of specified quality not only at the time of receiving at site but also at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregate from bins or stock piles.

Coarse aggregate shall be piled in layers not exceeding 1.00 metres in height to prevent conning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after re-mixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

Specific Gravity : Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without special permission of the Engineer-in-Charge.

4.3.3.2.1. Fine Aggregate: Fine aggregate except as noted above, and for other than light weight concrete shall consist of River natural sand or only if permitted crushed manufactured sand of type used for concrete (from source approved by E.I.C. as mentioned in clause below) conforming to I.S. 383. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, loam, alkali, organic matter, mica, salt or other deleterious substances which can be injurious to the setting qualities/strength/durability of concrete.

4.3.3.2.2. Machine Made Sand : Machine made sand will be acceptable, provided the constituent rock composition is sound, hard, dense, non-organic, uncoated and durable against weathering. Machine made sand shall be accepted provided grading & finer particle limits conform to IS 383.

4.3.3.2.3. Screening and Washing : Sand shall be prepared for use by such screening or washing or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fractions. Sand with silt content more than 3 percent will not be permitted to be used unless the same is washed and silt content is brought within 3% by weight.

Foreign Material Limitations : The percentages of deleterious substances in sand, delivered to the mixer shall not exceed the following:

		Percent by weight	
Sl.No	**Substances**	**Uncrushed**	**Crushed**
i)	Material finer than 75 micron	3.00	15.00
ii)	Shale	1.00	--
iii)	Coal and lignite	1.00	1.00
iv)	Clay lumps	1.00	1.00
v)	Total of all above substances including items (i) to (iv) for	5.00	2.00

GRADATION : Unless otherwise directed or approved, the grading of sand shall be within the limits indicated hereunder.

I.S. Sieve Designation		Percentage passing for		
	Grading Zone -I	Grading Zone -II	Grading Zone -III	Grading Zone -IV
9.5 mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-1 00
300 micron	5-20	8-30	8-30	20-65
150 micron	0-10	0-10	0-10	0-15

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron (I.S.) sieve by not more than 5%, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron (I.S.) sieve or to percentage passing any other sieve size on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to Grading Zone IV shall not be used unless mix designs and preliminary tests have shown its suitability for producing concrete of specified strength and workability.

Fineness Modulus : The sand shall have a fineness modulus of not less than 2.2 or more than 3.2. The fineness modulus is determined by adding the cumulative percentages retained on the following I.S. sieve sizes (4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.

4.3.3.2.4. Coarse Aggregate : Coarse aggregate for concrete, except as noted above and for other than light weight concrete shall conform to I.S. 383. This shall consist of natural or crushed stone and gravel, and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, sag, alkali, mica, organic matter or other deleterious matter.

The coarse aggregate and fine aggregate shall be tested from time to time as required by the Engineer-in-Charge to ascertain its suitability for use in construction and the charges for testing aggregate shall be borne by the contractor as specified herein after.

Screening and Washing : Crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so demanded by Engineer-in-Charge.

Grading : Coarse aggregates shall be either in single or graded, in both the cases. The grading shall be within the following limits:

I.S. Sieve Designation	Percentage passing for single sized aggregates of						Percentage passing for graded			
	63 mm	40 mm	20 mm	16mm	12 .5mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
75 mm	100	-	-	-	-	-	-	-	-	-
53 mm	85-	100	-	-	-	-	100	-	-	-
37.5 mm	0-30	85-	100	-	-	-	95-100	100	-	-
19 mm	0-5	0-20	85-	100	-	-	30-70	95-100	100	100
13.2 mm	-	-	-	85-100	100	-	-	-	90-1	-
11.2 mm	-	-	-	-	85-100	100	-	-	-	90-
9.5 mm	-	0-5	0-20	0-30	0-45	85-	10-35	25-55	30-70	40-85
4.75 mm	-	0-5	0-5	0-10	0-20	0-20	0-5	0-10	0-10	0-10
2.36 mm	-	-	-	-	0-5	0-5	-	-	-	-

The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only in such quantities that will not, in the opinion of Engineer-in-Charge, affect adversely the strength

and/or durability of concrete, the maximum size of coarse aggregate shall be the maximum size specified above, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of form. Plums above 160 mm. and upto any reasonable size can be used in plain mass concrete work of large dimensions upto a maximum limit of 20% by volume of concrete when specifically approved by Engineer-in-Charge. For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm. less than the minimum clear distance between the reinforcing main bars or 5mm less than the minimum cover to the reinforcement whichever is smaller. The amount of fine particles occurring in the Free State or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per I.S. 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of its oven dry weight in air, as determined by I.S.2386.

Foreign Material Limitations : The percentages of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following :

		Percentage by weight of	
Sl.No.	**Substances**	**Uncrushed**	**Crushed**
i)	Material finer than 75 micron I.S.	3.00	3.00
ii)	Coal and lignite	1.00	1.00
iii)	Clay lumps	1.00	1.00
iv)	Soft fragments	3.00	--
v)	Total of all the above substances	5.00	5.00

4.3.3.3. WATER :

Water used for both mixing and curing shall be clean and free from injurious amounts of deleterious materials.viz oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable waters are generally satisfactory for mixing and curing concrete. In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in I.S. 456 - 2000. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The samples shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

Average 28 days compressive strength of at least three 150 mm. concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water as per IS - 516.

The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than (+/-) 30 minutes from the initial setting time of control test block prepared with the same cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of I.S. 4031 (Part 5).

Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-in-Charge may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values:

a) Limits of acidity : To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5 ml. of 0.02 normal NaOH. The details of test shall be as per I.S. 3025 (Part 22)

b) Limits of alkalinity : To neutralize 100 ml sample of water, using mixed indicator , it should not require more than 25 ml. of 0.02 normal H2SO4. The details of test shall be as per I.S. 3025 (Part 23).

c) Permissible limits for solids shall be as under (water):

Sl.No.	Type of solid	Tested as	Permissible limit (Max.)
i)	Organic	IS 3025 (Part 18)	200 mg / l
ii)	Inorganic	IS 3025 (Part 18)	3000 mg / l
Iii)	Sulphates (as SO2)	IS 3025 (Part 24)	400 mg / l
iv)	Chlorides (asCl)	IS 3025 (Part 32)	2000 mg / l for concrete not containing embeddedsteel and 500 mg/l for
v)	Suspended matter	IS 3025 (Part 17)	2000mg / l

d) The PH value of water shall be not less than 6.

DESIGN MIX CONCRETE :

All reinforced concrete in the works shall be "Design Mix Concrete" as defined in I.S. 456-2000.

4.4.1. Mix Design : This is to investigate the grading of aggregates, water cement ratio, workability and the quantity of cement required to give works cubes of the characteristic strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Mix proportioning shall be carried out according to the ACI standard designation ACI- 613 or Design of concrete mixes - Road research Note No.4, Department of Scientific and Industrial Research U.K. or I.S. 10262 - 2009.

4.4.2.

After award of the work, if so desired by the contractor, he/they may be allowed by the Engineer-in-Charge, till the designed mix is obtained, to carry out the reinforced concrete work in foundation and plinth as per equivalent nominal mix against the specified design mix concrete as per I.S. Codes. However, all other specification for design mix shall govern for nominal mix also and nothing extra shall be paid for use of extra cement. Where the quantity of RCC is very small, under such circumstance equivalent nominal mix can also be permitted by the Engineer-in-Charge.

GRADES OF CONCRETE : The concrete shall be in grades designated as below.

Group	Grade	Specified Characteristic compressive strength of
Ordinary concrete	M 10	10
	M 15	15
	M 20	20
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High strength	M 60	60
	M 65	65
	M 70	70
	M 75	75
	M 80	80

NOTE :

1. The characteristic strength is defined as the strength of material below which not more than 5% of the test results are expected to fall.

2. In the designation of a concrete mix, letter "M" refers to the mix and the number to the specified characteristic compressive strength of 150 mm. size cubes at 28 days expressed in N/ mm^2.

3. Minimum Cement Content, Maximum Water Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum size.

		Plain concrete			**Reinforced concrete**		
Sl No.	**Exposure**	**Minimum cement content Kg/m^3**	**Maximum Free Water Cement Ratio**	**Minimum grade of concrete**	**Minimum Cement Content Kg/m^3**	**Maximum Free Water Cement Ratio**	**Minimum Grade of concrete**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	-	300	0.55	M-20
ii)	Moderate	240	0.60	M-15	300	0.50	M-25
iii)	Severe	250	0.50	M-20	320	0.45	M-30
iv)	Very	260	0.45	M-20	340	0.45	M-35
v)	**Extreme**	280	0.40	M-25	360	0.40	M-40

NOTE:

1. Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in mineral admixtures. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2. Minimum grade for plain concrete under mild exposure condition is not specified.

Nominal cover to meet Durability Requirements

Exposure	**Nominal concrete cover in mm not**
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

NOTES

1. For main reinforcement up to 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.

2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm

3. For exposure conditions 'severe' and ' very severe' , reduction of 5 mm may be made, where concrete grade is M 35 and above.

Nominal cover to meet specified period of fire resistance

Fire resis--tance	**Nominal cover**						
	BEAMS		**SLABS**		**RIBS**		**COLUMNS**
	Simply Supported	Continuous	**Simply Supporte**	Continuous	**Simply Supporte**	Continuous	
H	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**	**mm**
0.5	20	20	20	20	20	20	40
1	20	20	20	20	20	20	40
1.5	20	20	25	20	35	20	40
2	40	30	35	25	45	35	40
3	60	40	45	35	55	45	40
4	70	50	55	45	65	55	40

NOTES

1. The nominal covers given relate specifically to the minimum member dimensions as per drawing

2. Cases that lie below the bold line require attention to the additional measures necessary to reduce the risks of spalling.

Adjustments to Minimum cement contents for Aggregates other than 20 mm Nominal Maximum size:

Sl.No	Nominal maximum Aggregate size mm	Adjustments to Minimum cement content kg/ m3
(1)	**(2)**	**(3)**
i)	10	+40
ii)	20	0
iii)	40	-30

For concrete of compressive strength greater than M55 design parameters given in the standard may not be applicable and the values may be obtained from specialized Literatures and experimental results.

The mix shall be designed to produce the grade of concrete having the required workability and characteristic strength not less than appropriate values given in the table above.

DEGREE OF CONTROL:

Selection of Water Cement Ratio : Since different cements and aggregates of different maximum size, grading, surface texture, shape and other characteristics may produce concretes of different compressive strength for the same free water cement ratio, the relationship between strength and free water-cement ratio should preferably be established for the materials actually to be used. In the absence of such data, the preliminary free water-cement ratio (by mass) corresponding to the target strength at 28 days may be selected from the relationship shown in Fig.1 of I.S. 10262 .

Alternately, the preliminary free water cement ratio (by mass) corresponding to the target average strength may be selected from the relationship in Fig.2- I.S. 10262, using the curve corresponding to the 28 days cement strength to be used for the purpose.

Other relevant items to be used with design of mix should strictly conform to the relevant clauses and appendices of I.S. 10262.

The calculated mix proportions shall be checked by means of trial batches as per IS 10262

The free water cement ratio selected as above, should be checked against the limiting water cement ratio for the requirement of durability and the lower of the two values should be adopted.

Whenever there is a change either in required strength of concrete or water cement ratio or workability or the source of aggregates and/or cement, fresh tests shall be carried out to determine the revised proportion of the mix to suit the altered conditions. While designing mix proportions, over wet mixes shall always be avoided.

While fixing the value for water cement ratio for Design Mix assistance may be derived from the standard graph showing the relationship between the 28 days compressive strength of concrete mixes with different water-cement ratios and the 7 days compressive strength of cement tested in accordance with I.S.269.

It will be contractors sole responsibility to establish the concrete mix designs for different grades of concrete specified in the work consistent with the workability required for nature of work and also taking into consideration the assumed standard deviation which will be expected at site or by establishing the standard deviation based on 30 test results at site for each grade of concrete so as to produce concrete of required strength, durability and surface finish. The materials and proportions used in making the tests to be carried out either at site or under laboratory, conditions shall be similar in all respects to those to be actually employed in the works, as the object of these tests is to determine the proportions of cement, aggregates and water necessary to produce the concrete of the required consistency to give such specified strength.

4.4.3. STANDARD DEVIATION:

The standard Deviation for each grade of concrete shal be calculated separately.

STANDARD DEVIATION BASED ON TEST RESULTS:

a) **Number of test results -** The total number of test results required to constitute and acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 test results, as early as possible, when a mix is used for the first time.

b) **Standard deviation to be brought up to date -** The calculation of the standard

deviation shall be brought upto date after every change of mix design and at least once a month.

Determination of standard deviation :

i) Concrete of each grade shall be analysed separately to determine its standard deviation.

The standard deviation of concrete of a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified for test strength of sample:

ii) Estimated standard **deviation S** = $\sqrt{\{ \Sigma \Delta^2 \div (n-1)\}}$

iii) Where Δ = Deviation of the individual test strength from the average strength of a sample and n = Number of sample test results.

iv) When significant changes are made in the production of concrete (for example changes in the materials used, mix design, equipments or technical control), the standard deviation value shall be separately calculated for such batches of concrete.

Assumed Standard Deviation:

Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in table below may be assumed for design of mix in the first instance. As soon as the results of samples are available, actual calculated standard deviation shall be used and the mix designed properly. However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in table below, it shall be permissible to use that value.

Grade of Concrete	Assumed Standard Deviation N/mm2
M 10 M 15	3.5
M 20 M25	4.0

M30 M35 M40	5.0

Note: The above values correspond to the site control having proper storage of cement: weigh batching of all materials: controlled addition of water: regular checking of all materials: aggregate gradings and moisture contents: and periodical checking of workability: and strength. Where there is deviation from the above the values given in the above table shall be increased by 1 N / mm.^{2}

4.4.4. Proportioning, Consistency, Batching and Mixing of Concrete:

4.4.4.1. Proportioning :

Aggregate : The proportions which shall be decided by conducting preliminary tests shall be by weight. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weigh batchers conforming to I.S. 2722, capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Engineer-in-Charge that supply of **properly** graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stacked in separate stock piles. The gradings of coarse and fine aggregates shall be checked as frequently as possible, as determined by the Engineer-in-Charge, to ensure maintaining of grading in accordance with samples used in preliminary mix design. The materials shall be stock piled well in advance of use.

Cement : The cement shall be measured by weight. Every facility should be provided to the Engineer-in-Charge for sampling and inspection of stored cement at site of work.

Exposure conditions: General environment:

S.No:	Environment	Exposure Conditions
(1)	(2)	(3)
i)	Mild	Concrete surfaces protected against weather or aggressive conditions,except those situated in coastal area.

ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wet Concrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground water
iii)	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation.Concrete completely immersed in sea water Concrete exposed to coastal environment.
iv)	Very severe	Concrete surfaces exposed to seawater spray, corrosive fumes or severe freezing conditions whilst wet. Concrete in contact with or buried under aggressive sub-soil/ground water .
v)	Extreme	Surface of members in tidal zone Members in direct contact with liquid/solid aggressive chemicals.

WATER : Only such quantity of water shall be added to the cement and aggregate in the concrete mix as to ensure dense concrete, specified surface finish, satisfactory workability, consistent with strength stipulated for each class of concrete. The water added to the mix shall be such as not to cause segregation of materials or the collection of excessive free water on the surface of the concrete.

Definition of water cement ratio :The water cement (W/C) ratio is defined as the weight of water in mix (including the surface moisture of the aggregates) divided by the weight of the cement in the mix.

Water cement ratio :The actual water cement ratio to be adopted shall be determined in each instance by contractor and approved by the Engineer-in-charge.

Proportioning by water-cement ratio :The W/C ratio specified for use by the Engineer-in-Charge shall be maintained. Contractor shall determine the water content of the aggregate as frequently as directed by the Engineer in-Charge as the work progresses and as specified in I.S. 2386 part III and the amount of mixing water added at the mixer shall be adjusted as directed by the Engineer-in-charge so as to maintain the specified W/C ratio. To allow for the variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

4.4.4.2. Consistency and slump : Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined, the consistency of mix shall be maintained throughout the progress of the corresponding parts of the work and approved tests e.g. slump tests, compacting factor tests etc. in accordance with I.S. 1199, shall be conducted from time to time to ensure the maintenance of such consistency.

The following tabulation gives a range of workability which shall generally be used for various types of construction unless other wise instructed by the Engineer-in-Charge.

Workability of concrete :

Placing condition	Degree of	Slump
(1)	(2)	(3)
Blinding Concrete; Shallow Sections;	Very low	See note 1.
Mass concrete; Lightly reinforced Sections in slabs, Beams, walls, columns; Floors; Hand placed pavements; Canal lining;	Low	25-75
Heavily Reinforced sections In slabs, beams, walls, columns,	Medium	50-1 00 75-100
Trench fill, In-situ piling	High	100-150
Tremie Concrete	Very High	See note 2.

Note :

1. For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used.

2. the 'very low' category of workability where strict control is necessary, for example pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

3. In the 'Very high' category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

PRODUCTION OF CONCRETE:

QUALITY ASSURANCE MEASURES:

In order that the properties of the completed structure be consistent with the requirements and the assumptions made during the planning and the design, adequate quality assurance measures shall be taken. The construction should result in satisfactory strength, serviceability and long term durability so as to lower the overall life-cycle cost. Quality assurance in construction activity relates to proper design use of adequate materials and components to be supplied by the producers, proper workmanship in the execution of works by the contractor and ultimately proper care during the use of structure including timely maintenance and repair by the owner.

Quality assurance measures are both technical and organizational. Some common cases should be specified in a general Quality Assurance Plan which shall identify the key elements necessary to provide fitness of the structure and the means by which they are to be provided and measured with the overall purpose to provide confidence that the realized project will work satisfactorily in service fulfilling intended needs. The job of quality control and quality assurance would involve quality audit of both the inputs as well as the outputs. Inputs are in the form of materials for concrete; workmanship in all stages of batching, mixing, transportation; placing, compaction and curing; and the related plant, machinery and equipments; resulting in the output in the form of concrete in place. To ensure proper performance, it is necessary that each step in concreting which will be covered by the next step is inspected as the work proceeds.

Each party involved in the realization of a project should establish and implement a Quality Assurance Plan, for its participation in the project. Suppliers and contractors activities shall be covered in the plan. The individual quality assurance plans shall fit into the general Quality Assurance Plan. A quality assurance plan shall define the tasks and responsibilities of all persons involved ,adequate control and checking procedures, and the organization maintaining adequate documentation of building process and its results. Such documentation should generally include:

a) test reports and manufacturers certificate for materials, concrete mix design details;

b) pour cards for site organization and clearance for concrete placement;

c) record of site inspection of workmanship, field tests

d) non-conformance reports, change orders;

e) quality control charts;

f) statistical analysis.

NOTE – Quality control charts are recommended wherever the concrete is in continuous production over considerable period.

4.4.4.3. Batching and mixing of concrete :

BATCHING

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixes on any site or in any one plant. In batching concrete, the quantity of both cement and aggregate shall be determined by mass; admixture, if solid, by mass; liquid admixture may however be measured in volume or mass; water shall be weighed or measured by volume in a calibrated tank (see also IS 4925)

Ready mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off site batching and mixing plants (see IS 4926)

Except where it can be shown to the satisfaction of the engineer-in-charge that supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading of aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock – piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the Engineer-in-charge to ensure that the specified grading is maintained.

The accuracy of the measuring equipment shall be within +/- 2 % of the quantity of cement being measured and within +/- 3 percent of the quantity of aggregate, admixtures and water being measured.

Proportion / Type and grading of aggregate shall be made by trial in such a way so as to obtain densest possible concrete. All ingredients of the concrete should be used by mass only.

Volume batching may be allowed only where weigh-batching is not practical and provided accurate bulk densities of materials to be actually used in concrete have earlier been

established. Allowance for bulking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by Engineer-in-charge to ensure that the specified grading is maintained.

It is important to maintain the water-cement ratio constant at its correct value. To this end determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible the frequency for a given job being determined by the Engineer-in-charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture content. For the determination of moisture content in the aggregates IS 2386 (Part 3) may be referred to. To allow for the variation in mass of aggregate due to variation in their moisture content, suitable adjustments in the masses of aggregates shall also be made. In the absence of exact data only in the case of nominal mixes the amount of surface water may be estimated from the values given in table below.

Surface water carried by aggregate

Sr. No.	**Aggregate**	**Approximate quantity of surface water**	
		Percent by mass	**l/m³**
(1)	(2)	(3)	(4)
i)	Very wet sand	7.5	120
ii)	Moderately wet sand	5.0	80
iii)	Moist sand	2.5	40
iv)	Moist gravel or crushed rock	1.25 –2.5	20 – 40
	Coarser aggregate less the water it		

No substitutions in materials used on the work or alterations in the established propositions except as permitted as above shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

MIXING:

Concrete shall be mixed in a mechanical mixer. The mixer should Comply with IS 1791 and IS 12119 requirements. The mixers shall be fitted with water measuring (metering) devices; water proportion in Concrete mix should be as per IS 456:2000 requirement. The mixing shall be continued until there is a uniform distribution of the materials and the

mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete should be remixed.

For guidance, the mixing time shall be at least 2 min. For other types of more efficient mixers, manufacturers recommendations shall be followed; for hydrophobic cement it maybe decided by the Engineer-in-Charge.

Workability should be checked at frequent intervals.

Dosage of retarders, plasticisers and superplasticisers shall be restricted to 0.50, 1.0 and 2.0 % respectively by weight of cementitious materials and unless higher value is agreed upon between the manufacturer and constructor based on performance test.

Each time the work stops, the mixer shall be cleaned out and when next commencing the mixing, the first batch shall have 10% additional cement to allow for sticking in the drum.

4.5. SAMPLING AND TESTING CONCRETE IN THE FIELD: Facilities required for sampling materials and concrete in the field, if Engineer-in-Charge so desires, shall be provided by contractor at no extra cost. The following equipment with operator shall be made available at Engineers request (all must be in serviceable condition):

1.	Slump Cone	6 nos. as per ISI
2.	Cube moulds for concrete	24 Nos
3.	Cube moulds for cement mortar	6 Nos.
4.	Cement testing equipment Soundness accelerated	1 No.
5.	Oven	1 Set
6.	Cube Testing Machine-200T	1 Set
7.	Weigh Balance (Digital)	2 No.
8.	IS Sieves	4 No.
9.	Glass-measuring Cylinders	12 Nos.
10.	Ultrasonic Equipment	1 No.
11.	Micro Meter	2 No.
12.	Vernier caliper	2 No.
13.	Moisture Meter	2 No.
14.	Equipment for measuring cover in concrete	2 No.

4.6. TESTING : Different tests required to be carried out for concrete works including the mix design, cube tested as per the above specifications shall be got done by the

contractor at his own cost in one of the approved laboratories. **The choice of Approved Testing laboratory shall rest with Owner/Architect/ RCC Consultant.** All incidental charges / cost shall be borne by the contractor. All test as per Bureau of Indian standard code.

The contractor has to arrange to transport all the materials, cubes etc. to be tested, to the laboratory at his own cost.

4.7. SAMPLING AND STRENGTH TEST OF CONCRETE:

Samples from fresh concrete shal be taken as per I.S. 1199 and cubes shall be made, cured and tested at 28 days in accordance with I.S. 516 .

In order to get a relatively quicker idea of the quality of concrete, option tests on beams for modulus of rupture at 72 (+/-) 2 hours or at 7 days or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose, the values given in table below may be taken for general guidance in the case of concrete made with ordinary Portland cement. In all cases, the 28 days compressive strength specified shall alone be the criterion for acceptance or rejection of the concrete. If however, from test carried out in particular job over a reasonably long period, it has been established to the satisfaction of the Engineer-in-Charge that a suitable ratio between 28 days compressive strength and modulus of rupture at 72 (+/-) 2 hours or 7 days or compressive strength at 7 days may be accepted, the Engineer-in-Charge may suitably relax the frequency of 28 days compressive strength, provided the expected strength values at the specified early age are consistently met.

Optional Tests Requirements of Concrete:

Grade of Concrete	**Compressive strength on 15 cm cubes min. at 7 days**	**Modulus of rupture by beam**	
		At 72 (+/-) 2hours	**At 7 days N / mm2**
		N / mm²	
M 10	7.0	1.2	1.7
M 15	10.0	1.5	2.1
M 20	13.5	1.7	2.4
M 25	17.0	1.9	2.7
M 30	20.0	2.1	3.0
M 35	23.5	2.3	3.2

M 40	27.0	2.5	3.4

4.7.2. Frequency of Sampling :

Sampling Procedure : A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, i.e. the sampling should be spread over the entire period of concreting and cover all mixing units.

Frequency : The minimum frequency of sampling of concrete of each grade shall be in accordance with following:

Quantity of concrete in the work (in cum.)	**Number of samples**
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional for each additional 50 cum. or part there of

At least one sample shall be taken from each shift. Where concrete is continuous production unit, such as ready - mixed concrete plant, frequency of sampling may be agreed upon mutually by suppliers and purchasers.

4.7.3. Test Specimen : Three test specimen shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7days or at the time of striking the form work or to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in I.S. 9013 - 1978. The specimen shall be tested as described in I.S. 516 - 1959.

4.7.4. Test Strength of Samples : The test strength of the samples shall be the average of the strength of three specimen. The individual variation should not be more than (+/-) 15 percent of the average.

4.7.5. Consistency : Slump test shall be carried out as often as demanded by the Engineer-in-Charge and invariably from the same batch of concrete from which the test

cubes are made. Slump tests shall be done immediately after sampling.

4.7.6. Standard Deviation : Vide clause 4.4.3 of this specification.

4.8. ACCEPTANCE CRITERIA :

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:

(a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in column 2 of Table below

(b) Any individual test result complies with the appropriate limits in column of Table below.

Characteristic Compressive Strength Compliance Rquirement:

Specified grade	**Mean of the Group of 4 Non-overlapping consecutive**	**Individual test results in N/mm²**
(1)	**(2)**	**(3)**
M 15	= / > f_{ck}+ 0.825 x standard deviation (rounded off to nearest 0.5 N/mm² or = / > f_{ck} + 3 N / mm²	= / >fck –3 N/ mm²
M 20 Or Above	= / > > f_{ck} + 0.825 x established standard deviation (rounded off to nearest 0.5 N/ mm²	= / > fck – 4 N / mm²

Note – In the absence of established value of standard deviation, the values given in (assumed standard deviation) may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

Flexural Strength

When both the following conditions are met, the concrete complies with the specified flexural strength.

(a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2

(b) The strength determined from any test result is not less than the specified characteristic strength less 0.3N/mm^2

Quantity of Concrete Represented by Strength Test Results.

The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in column 2 of above table or in item (b) of flexural strength, only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to $60m^3$

If the concrete is deemed not to comply pursuant to above the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

Concrete of each grade shall be assessed separately

Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge.

4.9. ADMIXTURES :

Admixtures, if used shall comply with IS 9103. Previous experience with and data on such materials should be considered in relation to the likely standards of supervision & workmanship to the work being specified. Admixtures should not impair durability of the

concrete not combined with the constituent to form harmful compounds nor increase the risk of corrosion of reinforcement.

The workability, compressive strength and the slump loss of concrete with & without the use of admixtures shall be established during the trial mixes before use of admixtures.

The relative density of liquid admixtures shall be checked for such drum containing admixtures and compared with the specified value before acceptance.

The chloride content of the admixtures shall be independently tested for each batch before acceptance. If two or more admixtures are used simultaneously in the same concrete mix data should be obtained to assess their interaction and to ensure their compatibility.

General :

Admixture may be used in concrete only with the approval of Engineer-in-charge based upon evidence that, with the passage of time neither the compressive strength nor its durability reduced. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturers instructions and in the manner and with the control specified by Engineer-in-Charge.

i) **Calcium Chloride :** Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1 .5 percent of the weight of cement in each batch of concrete.

ii) **Air Entraining Agents :** Where specified and approved by Engineer-in-charge, neutralized vinsol resin or any other approved air entraining agent may be used to produce the specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard C260, Air Entraining admixtures for concrete. The recommended total air content of the concrete is 4% (+/-) 1%. The method of measuring air content shall be as per I.S.1199.

iii) **Retarding Admixtures :** Where specified and approved by Engineer-in-Charge, retarding agents shall be added to the concrete mix in quantities specified by Engineer-in-Charge.

iv) **Water Reducing Admixtures :** Where specified and approved by Engineer-in-Charge, water reducing lignosulfonate mixture shall be added in quantities specified by Engineer-in-Charge. The admixtures shall be added in the form of a solution.

v) **Water Proofing Agents :** Where specified and approved by Engineer-in-Charge, chloride and sulphate free water proofing agents shall be added in quantities specified by Engineer-in-Charge.

vi) **Other Admixtures :** Engineer-in-Charge may at his discretion, instruct contractor to use any other admixture in the concrete.

4.10. INSPECTION OF STRUCTURES :

Immediately after stripping the form work, all concrete shall be carefully inspected and any defective work or small defects, either removed or made good before concrete has thoroughly hardened, as instructed by Engineer-in-Charge.

In case of doubt regarding the grade of concrete used or results of cube strength are observed to be lower than the designed strength as per specifications at 28 days, compressive strength test of concrete based on core test, ultrasonic test shall be carried out by the digital ultrasonic concrete tester by an approved agency as directed by the Engineer-in-Charge all at the cost of the contractor. In case these tests do not satisfy the requirements, the E.I.C will be at liberty to reject the concrete, and the contractor, at his own cost, has to dismantle and re-do the same or carry out such remedial measures as approved by the E.I.C.

4.11. TESTING OF STRUCTURES :

4.11.1. Optional Tests : Engineer-in-charge, if he so desires, may order for tests to be carried out on cement, sand, coarse aggregate, water etc. in accordance with the relevant Indian Standards.

Tests on cement will be carried out by the Contractor from approved lab and shall include (i) fineness test, (ii) test for normal consistency, (iii) test for setting time, (iv) test for soundness, (v) test for compressive strength, (vi) test for heat of hydration (by experiment and by calculations) in accordance with I.S.269.

Tests on sand shall include (i) sieve test, (ii) test for organic impurities, (iii) decantation test for determining clay and silt content, (iv) specific gravity test, (v) test for unit weight and bulkage factor, (vi) test for sieve analysis and fineness modulus.

Tests on coarse aggregate shall include (i) sieve analysis, (ii) specific gravity and unit weight of dry, loose and rodded aggregate, (iii) soundness and alkali aggregate reactivity, (iv) petrographic examination, (v) deleterious materials and organic impurities, (vi) test for aggregate crushing value.

The test on aggregates would normally be ordered to be carried out only if Engineer-in-charge feels the materials are not in accordance with the specifications or if the specified concrete strengths are not obtained and shall be performed by contractor at an approved test laboratory. Contractor shall have to pay all the charges of optional tests. If the work cubes do not give the stipulated strengths, Engineer-in-Charge reserves the right to ask contractor to dismantle such portions of the work, which in his opinion are unacceptable and re-do the work to the standards stipulated at contractors cost.

The unit rate for concrete shall be all inclusive including making preliminary mix design and test cubes, works cubes, testing them as per specifications, slump tests, optional tests etc. Complete. The contractor will have to make arrangements for transportation to the laboratory and testing charges will be borne by the contractor.

The contractor should also conduct **conclusive tests** such as ultrasonic pulse velocity test as per IS 13311(Part 1), core test etc. to prove the suitability of concrete, in case cube tests give unsatisfactory results. The cost of the conclusive test should be borne by the contractor.

4.11.2. Core Test : The points from which cores are to be taken and the number of cores required, shall be at the discretion of the Engineer-in-Charge and shall be representative of the whole of concrete concerned.

In no case, however, shall fewer than three cores be tested. Cores shall be prepared and tested as described in I.S. 516

4.11.3. Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75%.

In case the core test results do not satisfy the requirements as above or where such tests have not been done, load test (See below) may be resorted to.

4.11.4. LOAD TESTS ON PARTS OF STRUCTURE :

Load tests should be carried out as soon as possible after expiry of 28 days from the time of placing of concrete.

The structure should be subjected to a load equal to full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed.

Note: Dead load includes weight of the structural members plus weight of finishes and walls or partitions, if any, as considered in the design.

The deflection due to imposed load only shall be recorded. If within 24 hours of removal of the imposed load, the structure does not recover at least 75% of the deflection under super imposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80%, the structure shall be deemed to be unacceptable.

If the maximum deflection in mm. shown during 24 hours under load is less than $40L^2/D$, where L is the effective span in M. and D the overall depth of the section in mm, it is not necessary for recovery to be measured and the recovery provision as above will not apply.

4.11.5. Other non-destructive test methods may be adopted, in which case the acceptance criteria shall be agreed upon between the Engineer-in-Charge and the Contractor and the test shall be done under expert guidance.

MEMBERS OTHER THAN FLEXURAL MEMBERS:

Members other than flexural members should be preferably investigated by analysis.

Non – destructive tests:

Non-destructive tests are used to obtain estimation of properties of concrete in the structure. The methods adopted include ultrasonic pulse velocity [see IS 13311 (Part 1)] and rebound hammer [IS 13311 (Part 2)], probe penetration, pull out and maturity. Non destructive tests provide alternatives to core tests for estimating the strength of concrete in a structure, or can supplement the data obtained from a limited number of cores. These methods are based on measuring a concrete property that bears some relationship to strength/ the accuracy of these methods, in part is determined by the degree of correlation between strength and the physical quality measured by the non-destructive tests.

Any of these methods may be adopted, in which case the acceptance criteria shall be agreed upon prior to testing.

4.11.6. TESTING OF UNDERGROUND WATER TANK/SEPTIC TANK/UNDERGROUND STRUCTURES :

The tank will be tested after the completion according to the procedure laid down here:

The middle compartment shall be filled first to its full height and the leakage if any shall be checked on its outer surfaces and if found, the same shall be examined carefully and defects rectified/grouted if necessary. The drop in level of surface of water shall also be

recorded for 48 hours. If this drop in level exceeds 20 mm. and shows any leakage in the said walls, necessary steps shall be taken in consultation with the Engineer-in-Charge.

After this compartment is tested to the satisfaction of the Engineer-in-Charge, all water from middle compartment shall be pumped into side compartment to the full height and checked for water leakages from the outer surfaces of the tank as well as inner surface of the middle compartment. The drop in level of surface of water shall also be checked as stated above and defects rectified.

The external surface of the tank shall then be plastered and cured as per the specifications and back filling shall be taken up thereafter. The water from the compartments shall then be pumped out and the inner surface of the tank in all compartments then be checked and defects rectified.

After satisfactory completion of checks, internal plaster shall be taken up as specified in the specifications.

The contractor shall be responsible for carrying out the complete test, rectifying the leakages if any. The cost of providing all equipments, labour for carrying out tests shall be borned by the contractor. The rates quoted for concreting items for constructing under ground water tank shall be inclusive of testing of RCC tank for water tightness as per above specifications. The contractor shall make his own arrangement to tap the water as per the contract . If supply of water not stipulated under Schedule 'A', the contractor shall make his own arrangement as per contract conditions at his own cost.

Liquid retaining structure shall be constructed as per IS 3370.

4.11.7. UNSATISFACTORY TESTS :

Should the results of any test prove unsatisfactory, or the structure shows signs of weakness, undue deflection or faulty construction, contractor shall remove and rebuild the member or members involved or carry out such other remedial measures as may be required by Engineer-in-Charge. Contractor shall bear the cost of so doing, unless the failure of the member or members to fulfill the test conditions is proved to be solely due to faulty design. The cost of load and other tests shall be borne by Contractor.

4.12. CONCRETE IN ALKALI SOILS WATER & AGGREGATES:

Some aggregates containing particular varieties of silica may be susceptible to attack by alkalis (Na20 and K20) originating from cement and other sources, producing an expansive reaction which can cause cracking and disruption of concrete. Damage to concrete from this reaction will normally only occur when all the following are present together.

a) A high moisture level, within the concrete.

b) A cement with high alkali content, or another source of alkali;

c) Aggregate containing an alkali reactive constituent.

Where the service records of particular cement / aggregate combination are well established, and do not include any instances of cracking due to alkali-aggregate reaction, no further precautions should be necessary. When the materials are unfamiliar, precautions should take one or more of the following forms:

a) Use of non-reactive aggregate from alternate sources

b) Use of low alkali ordinary Portland cement having total alkali content not more than 0.6 percent (as Na2O equivalent).

Further advantage can be obtained by use of fly ash (Grade I) conforming to IS 3812 or granulated blast furnace slag conforming to IS 12089 as part replacement of ordinary Portland cement (having total alkali content as Na2O equivalent not more than 0.6 percent) provided fly ash content is at least 20 % or slag content is at least 50 percent.

a) Measures to reduce the degree of saturation of the concrete during service such as use of impermeable membranes

b) Limiting the cement content in the concrete mix and thereby limiting total alkali content in the concrete mix as per approval of Engineer- in-charge.

Chlorides in the concrete

Whenever there is chlorides in concrete there is an increased risk of corrosion of embedded metal. The higher the chloride content or if subsequently exposed to warm moist conditions, the greater the risk of corrosion. All constituents may contain chlorides and concrete may be contaminated by chlorides from the external environment. To minimise the chance of deterioration of concrete from harmful chemical salts, the levels of such harmful salts in concrete materials, that is, cement, aggregates, water and admixtures, as well as by diffusion from the environment should be limited. The total amount of chloride content (as Cl) in the concrete at the time of placing shall be as given below in the table.

Limits of Chloride Content of Concrete

Sl. No	Type or Use of Concrete	Maximum Total Acid soluble Chloride Content Expressed as
(1)	(2)	(3)
i)	Concrete containing metal and steam cured at	0.4
ii)	Reinforced concrete or plain concrete containing	0.6
iii)	Concrete not containing embedded metal or any	3.0

The total acid soluble chloride content should be calculated from the mix proportions and the major chloride contents of each of the constituents. Whenever possible the total chloride content of the concrete should be determined as per the approval of the Engineer-in-Charge.

Sulphates in concrete:

Sulphates are present in most cements and in some aggregates; excessive amounts of water-soluble sulphate from these or other mix constituents can cause expansion and disruption of concrete. To prevent this, the total water-soluble sulphate content of the concrete mix, expressed as SO3, should not exceed 4 per cent by mass of the cement in the mix. The sulphate content should be calculated as the total from the various constituents of the mix as per the approval of the Engineer-in-Charge.

The 4 percent limit does not applied to concrete made with super sulphated cement complying with IS 6909 or as approved by the Engineer-in-Charge.

4.13. PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION & APPROVAL :

Before the concrete is actually placed in position, the inside of the form work shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially at bottom of columns and wall forms, to permit removal of saw dust, wood shavings, binding wire, rubbish, dirt etc. Opening shall be placed or holes drilled so that these materials and water can be removed easily. Such openings / holes shall be later suitably plugged.

After installing the formwork water shall be used to clean the formwork like beams and slabs if any leak points are identified it should be closed by temporary removable packing (removable formwork sealing mastic tape of Ultratech or approved equivalent) ; so that no cement slurry flows out from formwork.

The props shall be tighted by using wooden/steel -packing plates/wedges prior to concreting in case of slab concreting.

The various traders shall be permitted ample time to install drainage and plumbing lines, floor and trench drain, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedments to be cast in the concrete as indicated on the drawing or as necessary for the proper execution of the work. All such embedments shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.

Slots, openings, holes, pockets etc. shall be provided in the concrete work in the positions indicated in the drawings or as directed by the Engineer-in-Charge. Necessary formworks/ sleeve/pipes/insert plates shall be provided prior & checked for alignment & location at all location shown in the drawing; all complete prior to concreting.

Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.

Prior to concrete placement, all works shall be inspected and approved by Engineer-in-Charge, and if found unsatisfactory, concrete shall not be poured until all defects have been corrected at contractors cost.

Approval by Engineer-in-Charge of any and all materials and work as required herein shall not relieve contractor from his obligations to produce finished concrete in accordance with the drawings and specifications.

4.13.1. RAIN OR WASH WATER :

No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rain shall be entirely removed,if there is any sign of cement and sand having been washed from the concrete mixture. To guard against damage which may be caused by rain, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitable drains and sumps shall be provided.

4.13.2. BONDING MORTAR :

Immediately before concrete placement begins, prepared concrete surfaces, except form work, which will come in contact with concrete to be placed, shall be covered with a bonding mortar of same strength of concrete.

4.13.3. TRANSPORTATION :

All buckets, containers or conveyers used for transporting concrete shall be mortar-tight. All means of conveyance shall be adopted to deliver concrete of the required consistency and plasticity without segregation or loss of slump whatever method of transportation is employed. Chute shall not be used to transport the concrete without the written permission of the Engineer-in-Charge and concrete shall not be rehandled before placing.

4.13.4. Retempered or Contaminated Concrete :

Concrete must be placed in its final position before it becomes too stiff to work. On no account water shall be added after the initial mixing. Concrete which has become stiff or has been contaminated with foreign materials and which has not been placed within half an hour of mixing water with cement shall be rejected.

4.13.5. CLEANING OF EQUIPMENT :

All equipments used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipe lines and other equipments shall be thoroughly cleaned after each period of placement.

4.13.6. PROCEDURE FOR PLACING OF CONCRETE :

1. Engineers Approval of Equipment and Methods : Before any concrete is placed, the entire placing programme, consisting of equipment, layout proposed procedures and methods shall be submitted to Engineer-in-Charge and no concrete shall be of such size and design to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.

2. Time Interval Between Mixing and Placing : Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer and once compacted it shall not be disturbed.

3. Avoiding Segregation : Concrete shall in all the cases be deposited as nearly as practicable directly in its final position and shall not be rehandled or caused to flow in a

manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible, and in narrow forms, contractor shall provide suitable prop and Elephant Trunks to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in columns and thin walls. Concrete shall be placed for free fall from a lowheight i.e within 1.5 m as possible to avoid segregation.

4. Placing by Manual Labour : Except when otherwise approved by Engineer-in-Charge, concrete shall be placed in the shuttering by shovels or other approved implements and shall not be dropped from a height more than 1.0 m. or handle in a manner which will cause segregation.

5. Placing by Mechanical Equipment : The following specifications shall apply when placing of concrete by use of mechanical equipment is specially called for while inviting bids or is warranted, considering the nature of work involved.

The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the middle of the bucket of hopper and this principle of a vertical discharge of concrete shall be adhered-to through out all stages of delivery until the concrete comes to rest in its final position.

Type of buckets : All concrete shall be conveyed from the mixer to the place of final deposit in suitable buckets, dumpers, containers which shall be leak-tight. All means of conveyance shall be adopted for delivering concrete to the required consistency/ workability and plasticity without segregation.

Central bottom dump buckets of a type that provides for positive regulation of the amount and rate deposition of concrete in all dumping position shall be employed.

Operation of Bucket : In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1.0 m. The bucket shall be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner which results in separation of ingredients or disturbance of previously placed concrete will not be permitted.

6. Placement in Restricted Forms : Concrete placed in restricted forms by borrows, buggies, cars, short chutes or hand shovelling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

7. Chutting : Where it is necessary to use transfer chutes, specific approval of Engineer-in-Charge must be obtained to type, length, slopes, baffles, vertical terminal and timing of operations. These shall be so arranged that almost continuous flow of concrete is obtained at the discharge and without segregation. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the waste water shall be kept clear of the forms. The concrete shall not be permitted to fall from the end of the chutes by more than 1.0 m. Chutes, when approved for use, shall have slopes not flatter than 1 vertical to 3 horizontal and not steeper than 1 vertical to 2 horizontal, chutes shall be of metal or metal line and of rounded cross section. The slopes of all chute sections shall be approximately same. The discharge end of the chutes shall be maintained above the surfaces of the concrete in the forms.

8. Placing by Pumping/ Pneumatic Placers : Concrete may be conveyed and placed by mechanically operated equipment e.g. pumps or pneumatic placers, only with the written permission of Engineer-in-Charge. The slump shall be held to the minimum, necessary for conveying concrete by this method.

When pumping is adopted, before pumping of concrete is started, the pipelines shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. The concrete mix shall specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

When pneumatic placer is used, the manufacturers advice on layout of pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at the end.

Manufacturers advice shall be followed regarding concrete quality and all other related matters when pumping/ pneumatic placing equipments are used.

9. Concrete in Layers : Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 cm. to 90 cm. (depending on the concrete part)as directed by Engineer-in-Charge. These shall be placed as rapidly as practicable to prevent the formation of cold joints or planes of weakness between each succeeding layers within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit, shall spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum of shovelling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by Engineer-in-Charge.

Bedding of Layers : The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed.

COMPACTION :

4.13.7. COMPACTION : Concrete shall be compacted during placing, with approved vibrating equipment, until the concrete has been consolidated to the maximum practicable density, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution is to be exercised not to over vibrate the concrete to the point of segregation.

1. Type of Vibrators : Vibrators shall conform to I.S. specifications. Type of vibrators to be used shall depend upon the structure where concrete is to be placed. Shutter vibrators, to be effective, shall be firmly secured to the form work which must be sufficiently rigid to transmit the vibrations and strong enough not to be damaged by it. Immersion vibrators (Poker /Needle type) shall have No load frequency amplitude and acceleration as per I.S.2505 depending on the size of the vibrator. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted. Surface Vibrators (pan vibrator /vibrating screed) shall be used for Ground floor slab /concrete pavement only if permitted by E.I.C. Vibrating table used for Precast concrete works.

2. Use of Vibrators : The exact manner application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm. apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibration at the top of lift, e.g. in a column or wall.Vibrator should not touch the side of shuttering while vibrating unless specifically required for precast elements. The amount of time that the vibrator must remain in the concrete will depend on the vibrator's frequency and amplitude and the concrete's workability.

3. Melding successive batches : When placing concrete in layers, which are advancing horizontally as the work progress, great care shall be exercised to ensure adequate vibration, blending and melding of the concrete between the successive layers.

4. Penetration of vibrators : The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

5. Vibrating against reinforcement : Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

6. Use of Form Attached Vibrators : Form attached vibrators shall be used only with specific authorisation of Engineer-in-Charge.

7. Use of surface vibrators : The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, such as highways, runways and similar construction, surface vibrations by specifically designed vibrators may be permitted, upon approval of Engineer-in-Charge.

4.13.8. STONE POCKETS AND MORTAR PONDAGES : Formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to a sufficient depth and shape as directed by Engineer-in-Charge.

4.13.9. PLACEMENT INTERVAL : Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete and before the start of a subsequent placement.

1. Special Provision in Placing : When placing concrete in walls with openings, in floors of integral slab and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slabs as the case may be. Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by Engineerin-charge.

2. Placing Concrete Through Reinforcing Steel : While placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the reinforcement steel make placing difficult, it may be necessary to temporarily move the top steel aside for proper placement; the reinforcing steel shall be restored back to design drawing position.

4.13.10. BLEEDING : Bleeding or free water on top of concrete being deposited in to the forms, shall be caused to stop the concrete pour and the conditions causing this

defect corrected before any further concreting is resumed. This can be avoided by controlling the water cement ratio.

4.14. CONSTRUCTION JOINTS AND KEYS :

Concrete shall be placed without interruption until completion of the part of the work between predetermined construction joints, as specified therein after. Time lapse between the pouring of adjoining units shall be as specified in the drawings or as directed by Engineer-in-Charge.

Construction joints and cold joints:

Joints are a common source of weakness and therefore it is desirable to avoid them. If this is not possible, their number shall be minimized . Concreting shall be carried out continuously up to construction joints the position and arrangement of which shall be indicated by the designer. Construction joints should comply with IS 11817.Location of joint should be confirmed with E.I.C based on the type & member of the concrete structure .

Construction joints shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete, in order to create rough/uneven surface . It is recommended to clean out laitance and cement slurry by using wire brush on the surface of joint immediately after initial setting of concrete and to clean at the same immediately thereafter. The prepared surface should be in a clean saturated surface dry condition when fresh concrete is placed, against it. In the case of construction joints at locations where the previous pour has been cast against shuttering the recommended method of obtaining a rough surface for the previously poured concrete is to expose the aggregate with a high pressure water jet or any other appropriate means.

Fresh concrete should be thoroughly vibrated near construction joints so that mortar from the new concrete flows between large aggregates and develop proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear keys may be provided.

Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces.

In location of break in concreting work, a properly formed construction joint shall be formed where the work has stopped. Joints shall be either vertical or horizontal, roughned at exposed construction joint edges or as shown in drawing. In case of an inclined or

curved member, the joints shall be at right angles to the axis of the member. Vertical joints in walls shall be kept to a minimum. Vertical joints shall be formed against a stop board, horizontal joints shall be level and wherever possible, arranged, so that the joint lines coincide with the architectural features of the finished work. Battens, shall be nailed to the form work to ensure a horizontal line and if directed, shall also be used to form a grooved joint. For tank walls, similar work joints shall be formed as per I.S. 3370. Concrete that is in the process of setting shall not be disturbed or shaken by traffic. Horizontal and vertical construction joints and shear keys shall be located and shall conform in detail to the requirements of the plans unless otherwise directed by Engineer-in-Charge. Where not described, the joints shall be in accordance with the following:

1. Column Joints : In a column, the joint shall be formed 75 mm. below the lowest soffit of the beams including haunches if any. In flat slab construction the joint shall be 75 mm. below the soffit of column capital. At least 2 hours shall elapse after depositing concrete in column, piers or walls, before depositing in beams, girders or slabs supported thereon.

2. Beam and Slab Joints : Concrete in a beam shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and at the centre or within the middle third of the span unless otherwise shown in drawing. Where a beam intersects a girder, the joints in the girder shall be offset a distance equal to twice the width of the beam and additional reinforcement provided for shear. The joints shall be vertical throughout the full thickness of the concrete member. A joint in a slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidable at right angles to the principle reinforcement, the joint shall be vertical and at the middle of span.

3. Joints in Liquid Retaining Structures : Vertical construction joints in watertight construction will not be permitted unless indicated on the drawings. Where a horizontal construction joint is required to resist water pressure, special care shall be taken in all phases of its construction to ensure maximum watertightness. Water stops PVC / Swellable Hydrophilic Profiles & sealants shall be used at construction joints and around pipe penetrations as shown in the drawings and laid as per approved manufacturer's specification.

4. Dowels : Dowels for concrete work, not likely to be taken up in the near future, shall be wrapped in tar paper and burlap.

5. Mass Foundations : Mass foundations shall be poured in lifts not exceeding 1.5 m. in height unless, otherwise indicated on the drawings and approved by Engineer-in-Charge.

6. Treatment of Construction Joints on Resuming Concreting : Drier shall be used for the top lift or horizontal pours to avoid a laitance. All laitance and loose stones shall be thoroughly and carefully removed by wire brushing/ hacking and surface washed.

Just before concreting is resumed, the roughened joint surface shall be thoroughly cleaned and loose matter removed and then treated with a thin layer of cement grout of proportion specified by Engineer-in-Charge and worked well into the surface. The new concrete shall be well worked specially against the prepared face before the grout mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joint plane.

4.15. CURING, PROTECTING, REPAIRING, AND FINISHING:

1. Curing : All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays or ponded water as in case of horizontal concrete components like slabs & concrete roads etc, continuously saturated covering of sacking, canvas, hessain or other absorbent materials, or approved effective curing compounds (in cases of water scarcity as required by E.I.C) applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

Certain types of finish or preparation for overlaying concrete must be done at certain stages of curing process and special treatment may be required for specific concrete surface finish.

Curing of concrete made of high alumina cement and supersulphated cement shall be carried out as directed by Engineer-in-Charge.

1. Curing with Water : Fresh concrete shall be kept continuously wet for a minimum period of 14 days from the date of placing of concrete, following a lapse of 12 to 24 hours after laying concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin immediately as the concrete has hardened. Water shall be applied to unformed concrete surfaces within 1 hour after concrete has set. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

2. Continuous Spraying : Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose sprinklers and spraying

devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by Engineer-in-Charge.

3. Alternate Curing Methods : Whenever in the judgment of Engineer-in-Charge, it may be necessary to omit the continuous spray method, covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. Any type of covering which would stain or damage the concrete during or after the curing period, will not be permitted. Covering shall be kept continuously wet during the curing period.

For curing of concrete in pavements, side-walks, floors, flat roofs or other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by Engineer-in-Charge. Special attention shall be given to edges and corners of the slab to ensure proper protection to these areas. The ponded areas (with weak ratio of sand cement mortar compartments and at edges, which shall be removed after curing operation) shall be kept continuously filled with water during the curing period.

4. Curing Compounds : Surface coating type curing compound shall be used only on special permission of Engineer-in-Charge. Curing compounds shall be liquid type while pigmented, conforming to ASTM C 309 / U.S. Bureau of Reclamation Specification. No curing compound shall be used on surface where future blending with concrete, water or acid proof membrane or painting is specified.

5. Curing Equipment : All equipments and materials required for curing shall be on hand and ready for use before concrete is placed.

6. Moist Curing: Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking , canvas, hessian or similar materials and kept constantly wet for at least seven days from the date of placing concrete. In case of ordinary Portland cement and at least ten days where mineral admixtures or blended cement are used. The period of curing shall not be less than ten days of concrete exposed to dry and hot wheather conditions. In the case of concrete the mineral admixtures or blended cement are used, it is recommended that the above minimum periods may be extended to fourteen days as per the approval of the Engineer-in-Charge.

7. Membrane Curing: Approved curing compounds may be used in lieu of moist curing with the permission of Engineer-in-charge. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membranes such as polyethylene sheeting covering, closely the concrete

surface may also be used to provide effective barrier against evaporation.

For the concrete containing Portland pozzolona cement, Portland slag cement or mineral admixtures increased period of curing may be decided by Engineer-in-charge.

The rate of strength development at early age of concrete made with super sulphated cement is significantly reduced at lower temperatures. Super sulphated cement concrete is seriously affected by inadequate curing and the surface has to be kept moist for at least seven days or more as per the approval of the Engineer-in-Charge.

4.16. PROTECTING FRESH CONCRETE :

Fresh concrete shall be protected from the elements, from defacements and damage due to construction operations by leaving forms in place for ample period as specified later in this specification. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by Engineer-in-Charge, shall also be taken to protect immature concrete from damage by debris, excessive loading, vibrations, abrasion or contact with other materials etc. that may be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that workmen enter the area of freshly placed concrete, Engineer-in-Charge may require that bridges be placed over the area.

4.17. REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE :

Immediately after the shuttering is removed, the surface of concrete shall be very carefully checked and all defective areas called to the attention of Engineer-in-Charge who may permit patching of the defective areas or else reject the concrete unit either partially or entirely. Rejected concrete shall be removed and replaced by Contractor at no additional expense. Holes left by form bolts etc. shall be filled up and made good with mortar composed of one part of cement to one and half parts of sand passing through 2.36 mm. I.S. sieve after removing any loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of the concrete. Concrete surface shall be finished as described under the particular item of work.

Superficial honey combed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of Engineer-in-Charge and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with wooden float. Excess water shall be avoided. Unless instructed otherwise by Engineer-in-Charge, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities,

care being taken to avoid damaging the surfaces. Surface irregularities shall be removed by grinding.

If reinforcement is exposed or the honey combing occurs at vulnerable position e.g. ends of beams or columns, it may be necessary to cut out the member completely or in part and reconstruct. The decision of Engineer-in-Charge shall be final in this regard. If only patching is necessary, the defective concrete shall be cut out till solid concrete is reached (or to a minimum depth of 25 mm.), the edges being cut perpendicular to the affected surface or with a small under cut if possible, anchors, tees or dowels shall be provided in slots whenever necessary to attach the new concrete securely in place. An area extending several centimetres beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

1. Use of Epoxy : The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Engineer-in-Charge. Epoxies shall be applied in strict accordance with the instruction of the manufacturer. New concrete shall be laid within stipulated time as per manufacturer specification so that the epoxy bonding surface is in tacky stage.

2. Method of Repair : Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows:

The hole to be patched shall be roughened and thoroughly soaked with clean water until absorption stops.

A 5 mm. thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly proud of the surrounding surface. The concrete patch shall be built up in 10 mm. thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian. Steel trowel shall not be used for this purpose. The mix for patching shall be of the same materials and in the same proportions as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.

Mortar filling by air pressure (guniting) shall be used for repair of areas to large and/ or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by Engineering-in-Charge, to match the shade of the patch with the original concrete.

3. Curing of Patched Work : The patched area shall be covered immediately with an approved non-staining water-saturated material such as gunny bags, which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray of sprinkling water for not less than 10 days.

4. Approval by Engineer-in-Charge : All materials, procedures and operations used in the repair of concrete and also the finished repair work shall be subject to the approval of Engineer-in-Charge. All fillings shall tightly bonded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

4.18. FINISHING :

This specification is intended to cover the treatment of concrete surfaces of all structures.

1. Finish for Formed Surfaces : The type of finish for formed concrete surfaces shall be as follows, unless otherwise specified by the Engineer in charge:

For surfaces against which backfill or concrete is to be placed, no treatment is required except repair of defective areas.

For surfaces below grade, which will receive waterproofing treatment, the concrete shall be free of surface irregularities which would interfere with proper application of the water-proofing materials which is specified for use.

Unless specified, surfaces which will be exposed when the structure is in service shall receive no special finish, except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of holes left by form ties and rods and clean up of loose or adhering debris.

Surfaces which will be exposed to the weather and which would normally be levelled, shall be sloped for drainage. Unless the drawing specify a horizontal surface or shows the slope required, the tops of narrow surfaces such as staircase treads, walls, curbs and parapets shall be sloped across the width approx. as 1 in 30. Broader surfaces such as walkways, roads, parking areas and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete, sub floors to be covered with concrete topping, terrazzo or quarry tile and similar surfaces shall be smooth, screeded and leveled to produce even surfaces. Surface irregularities shall not exceed 6mm. Surfaces which will not be covered by backfill, concrete or tile topping such as outside decks, floors of galleries and sumps, parapets, gutters, sidewalks, floors and slabs shall be consolidated, screeded and floated.

Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screeded surface has attained a stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints and edges shall be tooled as called for on the drawings or as directed By Engineer-in-Charge.

2. Standard Finish for Exposed Concrete : Exposed concrete shall mean any concrete other than floors or slabs exposed to view upon completion of the job. Unless otherwise specified on the drawings, the standard finish for exposed concrete shall be of smooth finish.

A smooth finish shall be obtained with use of lined or plywood forms having smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms, the joint marks shall be smoothed off and all blemishes, projections etc. removed, leaving the surfaces reasonably smooth and unmarred.

3. Integral Cement Concrete Finish : When specified on the drawings, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified in the drawings and as per I.S.2571. The surface shall be compacted and then floated with a wooden float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand **shall not be** sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

4. Rubbed Finish : A rubbed finish shall be provided only on exposed concrete surfaces as specified on the drawings. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, off sets leveled and voids and/ or damaged sections immediately saturated with water and repaired by filling with concrete or mortar of the same composition as was used in the surfaces. The surfaces shall then be thoroughly wetted and rubbed with carborandum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

4.19. PROTECTION :

All concrete shall be protected against damage until final acceptance by Engineer-in-Charge.

4.20. FOUNDATION BEDDING, BONDING AND JOINTING :

All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering as may be indicated in the plans or as Engineer-in-Charge may direct to meet the various situations encountered in the work.

Soft or spongy areas shall be cleaned out and back filled with either a soil cement mixture, lean concrete or clean sand fill compacted to minimum density of 90% Modified Proctor, unless otherwise mentioned in schedule of quantities.

Prior to construction of form work for any item where soil will not act as bottom form, approval shall be obtained from Engineer-in-Charge as to the suitability of the soil.

4.21. PREPARATION OF ROCK STRATA OF FOUNDATIONS :

To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed:

Concrete shall not be deposited on large sloping rock surface. Where required by Engineer-in-Charge or as indicated on the plans, the rock shall be cut to form rough steps or benches to provide roughness or a more suitable bearing surface.

Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unshattered condition.

Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.

Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer-in-Charge.

Before placing concrete on rock surfaces, all water shall be removed from depressions to permit through inspection and proper bonding of the concrete to the rock.

4.22. PREPARATION OF EARTH STRATA OF FOUNDATIONS :

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soils shall be removed and replaced with suitable earth and well compacted as directed by the Engineer-

in-Charge. Where specified, lean concrete shall be provided in the earth stratum for receiving concrete. The surface of absorptive soil against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn from the freshly placed concrete and later shall help to cure the concrete.

4.23. PREPARATION OF CONCRETE SURFACES :

Preparation of concrete surface upon which additional concrete is to be placed later, shall preferably be done by scarifying and cleaning while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet as directed by Engineer-in-charge. Great care shall be taken in performing this work to avoid removal of too much mortar and the weakening of the surface by loosening of aggregate. When it is not practicable to follow the above method, it will be necessary to employ air tools to remove laitance and roughen the surface.

The final required result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

4.24. BONDING TREATMENT (MORTAR) :

After rock or concrete surfaces upon which new concrete is to be placed have been scarified, cleaned and wetted as specified herein, it shall receive a bonding treatment, immediately before placement of the concrete.

The bonding medium shall be a coat of cement sand mortar. The mortar shall have the same cement-sand proportion as the concrete which shall be placed on it. The water cement ratio shall be determined by placing conditions and as approved by Engineer-in-Charge.

Bonding mortar shall be placed in sufficient quantity to completely cover the surface about 10 mm. thick for rock surface and about 5 mm. thick for concrete surfaces. It shall be brushed or broomed over the surface and worked thoroughly into all cracks, crevices and depressions. Accumulations or puddles of mortar shall not be allowed to settle in depressions and shall be brushed out to a satisfactory degree as determined by Engineer-in-Charge.

Mortar shall be placed at such a rate that it can be brushed over the surface just in advance of placement of concrete. Only as much area shall be covered with mortar as can be covered with concrete before initial set in the mortar takes place. The amount of mortar that will be permitted to be placed at any one-time, or the area which is to cover, shall be in accordance with Engineer-in-Charge.

4.25. CLEANING AND BONDING OF FORMED CONSTRUCTION JOINTS :

Vertical construction joints shall be cleaned as specified above or by other methods approved by Engineer-in-Charge. In placing concrete against formed construction joints, the surfaces of the joints, where accessible, shall be coated thoroughly with the specified bed-joint bonding mortar immediately before they are covered with concrete or by scrubbing with wire brooms, dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint by carefully puddling and spading with aid of vibrators and suitable tools.

4.26. EXPANSION AND CONTRACTION :

Provision shall be made for expansion and contraction in concrete by use of special type joints located as shown in the drawings. Construction joint surfaces shall be treated as specified in the specifications, shown in the drawings or as directed by Engineer-in-Charge.

4.27. HOT WEATHER REQUIREMENTS :

All concrete work performed in hot weather shall be in accordance with I.S. 456, except as herein modified.

Admixtures may be used only when approved by Engineer-in-Charge.

Adequate provision shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyers to direct sunlight and the use of reflective paint, on mixers etc. The temperature of the freshly placed concrete shall not be permitted to exceed 300^0C.

Consideration shall be given to shading aggregate stock piles from direct rays of the sun and spraying stock piles with water, use of cold water available and burying, insulation, shading and/ or painting white the pipe lines and water storage tanks and conveyances.

In order to reduce loss of mixing water, the aggregates, wooden forms, subgrade, adjacent concrete and other moisture absorbing surfaces, shall be well wetted prior to concreting. Placement and finishing shall be done as quickly as possible.

Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot wind for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

4.28. PLACING CONCRETE UNDER WATER :

Under all ordinary conditions all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to I.S.456 and procedure shall be as follows:

Method of Placement : Concrete shall be deposited under water by means of tremies or drop bottom buckets of approved type.

4.29. DIRECTION, INSPECTION AND APPROVAL :

All work requiring placement of concrete underwater shall be designed, directed and inspected with regard to the local circumstances and purposes. All under water concrete shall be placed according to the plans or specifications and as directed and approved by Engineer-in-Charge.

4.30. PRECAST CONCRETE PRECAST REINFORCED CONCRETE

Precast concrete & precast reinforced concrete shall comply with I.S. 456, and with the following requirements:

General requirements : Precast reinforced concrete units such as Precast concrete Jalli, fencing posts, door and window frames, lintels, Pre stressed Hollow core slabs, Drain covers , boundary walls , trench etc. shall be of grade of mix as specified and cast in forms or moulds. The forms / moulds shall be of fiber glass or of steel sections for better finish. Provision shall be made in the forms and moulds to accommodate fixing/lifting devices such as nibs, clips, hooks, bolts and forming of notches and holes. Precast concrete shall be cast on suitable bed or platform with firm foundation and free from wind. The contractor may precast the units on a cement or steel platform which shall be adequately oiled provided the surface finish is of the same standard as obtained in the forms. Each unit shall be cast in one operation. Contractor shall be responsible for the accuracy of the level or shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit. All the lugs , lifting , corner angle ,inserts shall be laid as per drawing & E.I.C requirement prior to concreting. Care should be taken during lifting and shifting operation to prevent edge breakage.

Concrete used for precasting the units should be well proportioned, mixed, placed and thoroughly compacted by vibrations or tamping to give a dense concrete free from voids and honeycombing.

Precast articles shall have a dense surface finish showing no coarse aggregate and shall have no cracks or crevices likely to assist in disintegration of concrete or rusting of steel

or other defects that would interfere with the proper placing of the units. All angles of the precast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The arises shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true to the lines. On being fractured, the interior of the units should present a clean homogenous appearance.

The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed in respect of all items except fencing posts or electric posts where the minimum cover shall be 25 mm.

CURING

After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold. The concrete shall be cured at least for 7 days from the date of casting.

The precast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled. Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected at the time of lifting.

Controlled Steam curing shall be done for specific Precast concrete elements if required by E.I.C; methods and duration shall be as standard construction practices.

For Precast concrete Kerb manufacturing Vacuum wet press process with extremely high hydraulic pressure and simultaneous vacuuming shall be implemented . These kerbs conform to most of the requirements of EN 1340:2003.

MARKING

Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

Precast units shall be stored, transported and placed in position in such a manner that they will not be overstressed or damaged. The lifting and removal of precast units shall be undertaken without causing shocks, vibration or under bending stresses to or in the units. Before lifting and removal takes place, contractor shall satisfy Engineer-in-Charge or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise affect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

a. PRECAST CEMENT CONCRETE JALI :

The Jali shall be of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 6 mm nominal size) reinforced with minimum 1 .6 mm thick mild steel wire, unless otherwise specified.

Fixing : The Jali shall be set in position true to plumb and level before the joints, sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement : 3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

Measurement : The Jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to a cm. The thickness shall not be less than that specified.

Rate : The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sill and soffits, which will be paid for under relevant items of plastering.

CURING :

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each units shall be kept constantly watered or preferably by completely immersed in water if the size of unit so permits. Otherwise curing practices as given in clauses stated earlier shall be followed.

4.31 SLOTS, OPENINGS ETC. :

Slots, openings or holes, pockets etc. shall be provided in the concrete work in the positions indicated in the drawings or as directed by the Engineer-in-Charge. Any deviation from the approved drawings shall be made good by contractor at his own expenses without damaging any other work. Sleeves, bolts, inserts etc. shall also be provided in concrete work where so specified.

4.32 GROUTING :

4.32.1 Standard Grout : Grout shall be provided as specified in the drawing.

The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as follows:

Use	**Grout thickness**	**Mix. proportions**	**W/C. Ratio in (Max.)**
a)Fluid mix	Under 25 mm.	One part Portland cement to one part sand.	0.44
b) General	25 mm. and over but less than 50 mm.	One part Portland cement to 2 parts of sand.	0.53
c) Stiff mix.	50 mm. and over	One part Portland cement to 3 parts of sand.	0.53

Sand shall be such as to produce a flowable grout without any tendency to segregate. Sand, for general grouting purposes, shall be graded within the following limits:

Passing I.S. sieve 2.36 mm.	95 to 100%
Passing I.S. sieve 1.18 mm.	65 to 95%
Passing I.S. sieve 300 micron above	10 to 30%
Passing I.S. sieve 150 micron above	3 to 10%

Sand for fluid grouts shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.

Sand for stiff grouts, shall meet the usual grading specifications and concrete.

Surface to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.

Anchor bolts, anchor bolt holes and bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material.

Prior to grouting, the hardened concrete surfaces to be grouted, shall be saturated with water. Water in anchor bolt holes shall be removed before grouting is started.

Forms around base plates shall be, reasonably, tightened to prevent leakage of the grout.

Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more release from entrapped air, link chains can be used to work the grout into place.

Grouting through holes in base plate shall be by pressure grouting.

Variations in grout mixes and procedures shall be permitted if approved by the Engineer-in-Charge.

4.32.2 Special Grout : Special grout where specified on the drawing shall be provided in strict accordance with the manufacturers instructions/ specifications on the drawings. In case of Vibratory equipment foundation epoxy Grout may be used only if mentioned in the drawing.Epoxy Grout shall be laid as per approved manufacturers specification.

4.33 INSPECTION :

All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of Engineer-in-Charge.

All rejected materials supplied by contractor and all rejected work or construction performed by contractor, as is not in conformance with the specifications and drawings, shall immediately be replaced at no additional expense.

Approval of any preliminary material or phase of work shall in no way relieve the contractor from the responsibility of supplying concrete and/ or producing finished concrete in accordance with the specifications and drawings.

All concrete shall be protected against damage until final acceptance by the E.I.C.

4.34 CLEAN UP :

Upon the completion of concrete work, all forms, equipments, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.

All debris i.e. empty containers, scrap wood etc. shall be removed to dump daily or as directed by the Engineer-in-Charge.

The finished concrete surfaces shall be left in a clean condition to the satisfaction of the Engineer-in-Charge.

4.35 PLAIN CEMENT CONCRETE FOR GENERAL WORK :

For plain cement concrete work, the specification for materials viz. cement, sand, fine and coarse aggregates and water shall be the same as that specified in reinforced concrete work specification.

But the proportion of mix will be nominal and the ratio of fine and coarse aggregate may be slightly adjusted within limits, keeping the total value of aggregates to a given volumes of cement constant to suit the sieve analysis of both the aggregates. Cement shall on no account be measured by volume, but it shall always be used directly from the bags (i.e. 50 kg/bag).

The proportion of cement, sand, aggregate and water for concrete of proportion 1:5:10, 1:4:8, 1:3:6 & 1:2:4 by volume shall generally consist of quantities as given below :

Proportion of Ingredients	**Cement**	**Quantity of materials used per bag of cement**			
		Fine aggregate (sand)	**Coarse aggregate**	**Total of fine sand coarse aggregates**	**Water**
1:5:10	1	175 ltrs.	350	800	60 ltrs.
1:4:8	1	140 ltrs.	280	625	45 ltrs.
1:3:6	1	105 ltrs.	210	480	34 ltrs.
1:2:4	1	70 ltrs.	140	330	32 ltrs.

The quantity of water used shall be such as to produce concrete of consistency required by the particular class of work and shall be decided by the use of a slump cone. Sufficient care should be taken to see that no excess quantity of water is used. The final proportion of the aggregate and quantity of water shall be decided by the Engineer-in-charge on the basis of test in each case.

Mix proportion	**Cement**	**Sand**	**Coarse Aggregate in CUM**			**Water**
Ordinary mix in volume	**in bags**	**in cum**	**40 mm**	**20 mm**	**12 mm**	
1:5:10	2.60	0.475	0.6623	0.2583	-	156

1:4:8	3.40	0.500	0.6883	0.6883	-	153
1:3:6 (with 40mm	4.4	0.485	0.672	0.672	0.262	176
1:3:6 (with 20 mm	4.4	0.485	-	0.727	0.242	162.5
1:2:4 (with 20 mm	6.4	0.47	-	0.705	0.235	205
1:2:4 (with 40 mm	6.4	0.47	0.544	0.241	0.126	235
1:1.5:3	8.0	0.441	-	0.6615	0.2205	240
1:1:2	12.2	0.45	-	0.675	0.225	330

The slump shall be specified for each class of work and shall in general be as follows:

Type of concrete	**Max. slump (in mm.)**
Mass concrete	50
Concrete below water proofing treatment	50
Coping	25
Floor paving	50

All plain concrete should be preferably mixed in a drum type powder driven machine with a loading hopper which will permit the accurate measure of various ingredients. If hand mixing is allowed by E.I.C, it should be done on a water tight platform/ G.I. Steel tray (to ensure that water cement shall be within the cointainer i.e tray).

The mixing of each batch in the concrete mixer shall continue for not less than 1.5 minutes after the materials and water are in the mixer. The volume is mixed materials per batch shall not exceed the manufacturers rated capacity of the mixer. The mixer shall rotate at a peripheral speed of about 60 metres per minute.

Concrete shall be poured and consolidated in its final position within half an hour of mixing. The retempering of concrete which has partially hardened, that is remixing with or without additional cement aggregate or water shall not be permitted. Concrete of mix 1:3:6 and 1:2:4 will be required to be vibrated if specified and directed by the Engineer. In case of the thickness of concrete is more than 150 mm., it may be vibrated as directed by the Engineer.

The concrete shall be cured for 10 days in ordinary weather and 15 days in hot weather.

Measurements for the work done shall be exact length, breadth and depth shown in figures on the drawings or as directed by the Engineer and after the concrete is consolidated. No extra shall be paid for excess quantity resulting from faulty workmanship.

4.36 SPECIFIC REQUIREMENTS FOR CONCRETE AND ALLIED WORKS :

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

The following specific requirements shall be met within addition to those provided in the clause of specification for Concrete and allied works.

General : The contractor shall be solely responsible for supplying mixed concrete in accordance with the specification for concrete and allied works and also this specification.

Water : Clean water in pipes under pressure shall be provided by the contractor with all necessary equipment for giving a nozzle pressure of not less than 2.0 kg/ sqcm. for the convenient and effective jetting of rock foundations and concrete surfaces, for cooling aggregate required for concrete, for curing concrete and other requirements.

Fire Protection System : The contractor shall provide and maintain at all times in adequate fire protection system to protect his equipment, materials and construction. In case of an emergency, the contractor shall permit the Engineer-in-Charge to use the system for protecting equipment, works etc. on the project.

Concrete : The rates for all concrete work should be based as per specifications and taking into consideration the guidelines indicated in special instruction under relevant clause.

The Placement Intervals : Each placement of concrete shall be allowed to set for a period of 48 hours and longer when required, before the start of subsequent placement. A time gap between the two adjoining pours in the horizontal plane and the two adjacent pours in the vertical plane shall be 7 days and 3 days respectively; all if permitted by the EIC depending on site condition.

4.37 FINISHING OF CONCRETE :

1. General : Unless otherwise specified, concrete finishes shall conform to the following specifications: Finish F1, F2 and F3 shall describe formed surface.

Finish U1, U2 and U3 shall describe un-formed surface.

Off sets or fins caused by disposed or misplaced form sheathing lining or form sections or by defective form lumber shall be referred to as abrupt irregularities. All other irregularities shall be referred to as gradual irregularities. Gradual irregularities shall be measured as deviation from a plane surface with a template 1.5 m. long for formed surface and 3 m. long for unformed surfaces.

2. Formed Surfaces :

Finish F1—shall apply to all formed surfaces for which finish F2, F3 or any other special finish is not specified and shall include filling up all form tie holes.

Finish F2—shall apply to all formed surfaces so shown on the drawings or specified by the Engineer-in-Charge. This shall include filling all form tie-holes, repair of gradual irregularities exceeding 6 mm., removal of ridges and abrupt irregularities by grinding.

Finish F3—shall apply to all formed surfaces exposed to view or where shown in the drawings or specified by the Engineer-in-Charge. Finish F3 - shall include all measures specified for Finish-F2 and in addition, Filling air holes with mortar and treatment of the entire surface with sack rubbed finish. It shall also include clean up of loose and adhering debris. Where a sack rubbed finish is specified, the surfaces shall be prepared within two days after removal of the forms.

The surface shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part cement to one and half parts by volume of fine (minus No. 16 mesh) sand. Only sufficient mixing water to give the mortar a workable consistency shall be used. The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids. The mortar rubbed in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean so that the surface presents a uniform appearance without air holes, irregularities etc.

Curing of the surface shall be continued for a period of ten (10) days.

3. Unformed Surfaces :

Finish U1—shall apply to all unformed surfaces for which the finish U2, U3 or any other special finish is not specified and shall include screeding the surface of the concrete to the required slope and grade. Unless the drawing specifies a horizontal surface or shows the slope required, the tops of narrow surfaces such as stair, treads, walls, curbs and parapets shall be sloped approximately 10 mm. per 300 mm. width. Surfaces to be covered by backfill or concrete sub-floors to be covered with concrete topping, terrazzo and similar surfaces shall be smooth screeded and leveled to produce even surface, irregularities not exceeding 6 mm.

Finish U2—shall apply to all unformed surfaces as shown in the drawing or specified by the Engineer-in-Charge and shall include screeding and applying a wood float finish to the surface of the concrete to the required slopes and grade.

Repair of abrupt irregularities unless a roughened texture is specified. Repair of gradual irregularities exceeding 6 mm.

Finish U3—shall apply to unformed surfaces for which a high degree of surface smoothness is required, where shown on the drawing or specified by the Engineer-in-Charge. This shall include screeding, floating and applying a steel trowel finish to the surface of the concrete to the required slopes and grade.

Repair of abrupt irregularities.

Repair of gradual irregularities exceeding 6 mm., finishing joints and edges of concrete with edging tools.

MODE OF MEASUREMENT FOR CONCRETE WORK :

General : Concrete as actually done shall be measured for payment, subject to the following tolerances, unless otherwise stated hereinafter. Any work done extra over the specified dimensions shall not be measured for payment.

a) Linear dimensions shall be measured in full centimetres except for the thickness of slab which shall be measured to the nearest half centimetre.

b) Areas shall be worked out to the nearest 0.01 sqm.

c) Cubic contents shall be worked out to the nearest 0.001 cum.

d) The concrete shall be measured for its length, breadth and height/ depth limiting dimensions to those specified on drawings or as directed by the Engineer-in-Charge.

NOTE : The sizes of RCC members as assumed in the estimate are based on preliminary drawings and are likely to be changed. The contractor is not entitled to any extra claim due to such changes.

Deductions:

No deductions shall be made for the following :

a) Ends of dissimilar materials e.g. joists, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc. upto 500 sq cm. in cross section.

b) Opening upto 0.1 sqm. (1000 sq cm)

c) Volume occupied by reinforcement.

d) Volume occupied by pipes, conduits, sheathing etc. not exceeding 25 sq cm. each in cross sectional area. Nothing extra shall be paid for leaving and finishing such as

cavities and holes.

i. COLUMN FOOTING :

R.C.C. in foundation and footings shall be measured for its length, breadth and depths limiting dimensions to those specified in drawing or as ordered in writing by the Engineer-in-Charge. In case of tapering portions of column footings, the quantities shall be calculated by the Formula : **Volume V = H/3 x [A1 + A2 + sqrt {A1 x A2}] ;** where A1 = Area at top of footing, A2 = Area at bottom of footing and H = Height of footing.

ii. COLUMN :

Column shall be measured from top of footings to the plinth level and from plinth level to the structural slab level and to the subsequent structural slab levels. Measurements for higher grade concrete in columns at its junction with lower grade concrete beams shall be restricted to the column section supporting the beam in question.

iii. WALL

All walls shall be measured from top of the wall footing to the plinth level and from plinth level to the top of structural first floor and to subsequent floors.

iv. BEAM AND LINTEL :

Beam shall be measured from face to face of the columns, walls, cross beams including haunches if any. The depth of the beams shall be measured from the top of the slab to the bottom of the beam except in the case of inverted beam where it shall be measured from top of slab to top of beams. The beams and lintels with narrow width even though acting as facia in elevation in some cases, will be measured as beams and lintels only.

v. SLAB :

The length and breadth of slab laid to correct thickness as shown in the detailed drawings or as ordered by the Engineer-in-Charge shall be measured between beams, walls and columns.

vi. CHAJJAS, FACIAS, FINS AND MULLIONS:

a) Chajjas shall be measured net from supporting faces upto the edges of chajjas without any facia.

b) Facia shall be measured full excluding chajja thickness.

c) End fins shall be measured full.

d) Intermediate fins, mullions shall be measured between chajjas or other supporting structural members.

e) Parapets shall be measured from top of slab/ chajja.

vii. STAIRCASE :

The concrete in all members of staircase like waist slabs, steps, cantilever steps, stringer beams etc. shall be measured for their length, breadth and depth, limiting dimensions to those specified on drawings. No deductions shall be made for embedded plugs, pockets.

Rates: The rate for P.C.C/ R.C.C. shall include the cost of all materials, labour, transport, tools and plants and all the operations mentioned hitherto, including or excluding the cost of form work and/ or reinforcement as mentioned in the schedule of quantities. The rates also shall include the cost of testing materials, mix design, cube test and allied incidental expenses.

5 FORM WORK :

5.0. GENERAL :

The form work shall consist of **Film faced shuttering plywood** ,shores, bracings, sides of beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts etc. complete which shall be properly designed and planned for the work. The false work shall be so constructed that up and down vertical adjustment can be made smoothly. Wedges may be used at the top or bottom of timber shores, but not at both ends, to facilitate vertical adjustment or dismantling of form work. The formwork shall be clean, smooth & straight .

5.1. DESIGN OF FORM WORK :

The design and engineering of form work as well as its construction shall be the responsibility of Contractor. If so instructed, the drawings and calculations for the design of the form work shall be submitted well in advance to the Engineer-in-Charge for approval before proceeding with work, at no extra cost . Engineer-in-Charges approval shall not however, relieve Contractor of the full responsibility for the design and construction of the form work. The design shall take into account all the loads vertical as well as lateral that the forms will be carrying including live and vibration leadings.

5.2. TOLERANCES :

Tolerances are a specified permissible variation from lines, grade or dimensions given in drawings. No tolerances specified for horizontal or vertical building lines or footings shall be constructed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

5.2.1. TOLERANCES FOR R.C. BUILDINGS :

i. Variation from the plumb:

a. In the line and surfaces of columns, piers, walls and in buttresses: 5 mm. per 2.5 m., but not more than 25 mm

b. For exposed corner columns and other conspicuous lines.
In any bay or 5 m. maximum: (+/-) 5 mm.

In 10 m. or more: (+/-) 10 mm.

ii. Variation from the level or from the grades indicated on the drawings.

a. In slab soffits, ceilings, beam soffits and in arrises.
In 2.5 m.: (+/-) 5 mm.

In any bay or 5 m. maximum: (+/-) 8 mm.

In 10 m. or more: (+/-) 15 mm.

b. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.
In any bay or 5 m. maximum: (+/-) 15 mm.

In 10 m or more: (+/-) 10 mm.

iii. Variation of the linear building lines from established position in plan and related position of columns, walls and partitions.

In any bay or 5 m. maximum: (+/-) 10 mm.

In 10 m or more: (+/-) 20 mm.

iv. Variations in the sizes and locations of sleeves, openings in walls and floors except in the case of and for anchor bolts: (+/-) 5 mm.

v. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls: (+) 10 mm./(-) 5 mm.

vi. **Footings:**

a) Variation in dimensions in plan: (+) 50 mm./(-) 5 mm.

b) Misplacement or eccentricity: 2% of footing within the direction of misplacement but not more than 50 mm.

c) Reduction in thickness: (-) 5% of specified thickness subject to maximum of 50 mm.

vii. **Variation in steps.**

a) In a flight of stairs.
Rise:

Tread:

b) In consecutive steps. (+/-) 3.0 mm. (+/-) 5.0 mm.
Rise: (+/-) 1.5 mm.

Tread: (+/-) 3 mm.

5.2.2. TOLERANCES IN OTHER CONCRETE STRUCTURE :

A) All structures:

i) Variation of the constructed linear outline from established position in plan.
In 5 m.: (+/-) 10 mm.

In 10 m. or more: (+/-) 15 mm.

ii) Variation of dimensions to individual structure features from established positions in plan.
In 20 m. or more: (+/-) 25 mm.

In buried constructions: (+/-)150 mm.

iii) Variation from plumb, from specified batter or from curved surfaces of all structures.

In 2.5 m.: (+/-) 10 mm.

In 5.0 m.: (+/-) 15 mm.

In 10.0 m. or more: (+/-) 25 mm.

In buried constructions: (+/-) Twice the above limits

iv) Variation from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves and visible arises.

In 2.5 m.: (+/-) 5 mm.

In 7.5 m. or more: (+/-) 10 mm.

In buried constructions: (+/-) Twice the above limits.

v) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members. (+)12 mm./(-) 6 mm.

vi) Variation in the thickness of slabs, walls, arch sections and similar members. : (+)12 mm./(-) 6 mm.

B) Footings for columns, piers, walls, buttresses and similar members:

i) Variation of dimensions in plan: (+)50 mm./(-)12 mm.

ii) Misplacement or eccentricity: 2% of footing within the direction of misplacement but not more than 50 mm.

iii) Reduction in thickness: 5% of specified thickness subject to a maximum of 50 mm.

Tolerances in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for concrete form work (ACI 347)

5.3. TYPE OF FORMWORK :

Form work may be of timber, **Film faced plywood**, metal, plastic or concrete. For special finishes, the formwork may be lined with plywood, steel sheets, oil tempered hard board etc. Sliding forms and slip forms may be used with the approval of Engineer-in- Charge.

5.4. FORMWORK REQUIREMENTS :

Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for in the drawings. Ample studs, waler braces, straps, shores etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Forms shall be strong enough to permit the use of immersion vibrators. In special cases, from vibrators may also be used. The shuttering shall be close boarded. Timber shall be well seasoned, free from loose knots, worm holes, warps or other surface defects in contact with concrete. Faces coming in contact with concrete shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete. Mould releasing agents shall be applied to inside surface of formwork, Mould releasing agents of approved construction chemicals companies shall be used. All the formworks after laying shall be checked for watertightness, the formwork face to be in contact with concrete shall be cleaned.

Plywood shall be used for exposed concrete surfaces, where called for. Sawn and wrought timber may be used for unexposed surfaces. Inside faces of forms for concrete surfaces which are to be rubbed finished shall be planed to remove irregularities or unevenness in the face. Form work with lining will be permitted.

All new and used from lumber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness and cleanliness of surfaces. Form lumber unsatisfactory in any respect shall not be used and if rejected by Engineer-in-Charge shall be removed from the site.

Shores supporting successive stories shall be placed directly over those below or be so designed and placed that the load will be transmitted directly to them. Trussed supports shall be provided for shores that cannot be secured on adequate foundation.

Formwork, during any stage of construction showing signs of distortion or distorted to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings, shall be repositioned and strengthened. Poured concrete affected by the faulty formwork, shall be entirely removed and the formwork corrected prior to placing new concrete.

Excessive construction camber to compensate for shrinkage settlement etc. that may impair the structural strength of members will not be permitted.

Forms for substructure concrete may be omitted when, in the opinion of Engineer-in-Charge, the open excavation is firm enough to act as the form. Such excavations shall be slightly larger than required by the drawings to compensate for irregularities in excavation and to ensure the design requirement.

Forms shall be so designed and constructed that they can be stripped in the order required and their removal do not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conforming to the architectural features of the structure as to location of joints and be as directed by Engineer-in-Charge.

Where exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the desired concrete surfaces could be obtained which require a minimum finish.

BRACINGS, STRUTS AND PROPS :

Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bracings. Only Steel pipes, steel pipes with props braced, double steel scaffolding , platforms ,stairs shall be used as per site requirement . Packing/ tightening to Props shall be done prior to start of concreting necessary checking required shall be conducted.

The shuttering for beams and slabs shall be so erected that the shuttering on the sides of beams and under the soffit of slab can be removed without disturbing the beam bottoms.

Repropping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.

If the shuttering for a column is erected for the full height of the column, one side shall be left open (partly only for height as per site requirement) and built upon sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides all the above points mainly to limit the drop of concrete to 1.0 m. or as directed by Engineer-in-Charge.

5.5. INSPECTION OF FORM WORK :

Following points shall be borne in mind while checking during erection of form work and form work got approved by the Engineer-in-charge before placing of reinforcement bars :

a. Any member which is to remain in position after the general dismantling is done, should be clearly marked.

b. Material used should be checked to ensure that, wrong items / rejects are not used.

c. If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.

d.

i. The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.

ii. Sole plates shall be properly seated on their bearing pads or sleepers.

iii. The bearing plates of steel props shall not be distorted.

iv. The steel parts on the bearing members shall have adequate bearing areas.

e. Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

f. Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.

g. The stacked materials shall be placed as catered for, in the design.

h. When adjustable steel props are used, they should :

i) be undamaged and not visibly bent.

ii) have the steel pins provided by the manufacturers for use.

iii) be restrained laterally near each end.

iv) have means for centralising beams placed in the forkheads.

i. Screw adjustment of adjustable props shall not be over extended.

j. Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightended / clamped down after adjustment to prevent their shifting.

k. No member shall be eccentric upon vertical member.

l. The number of nuts and bolts shall be adequate.

m. All provisions of the design and / or drawings shall be complied with.

n. Cantilever supports shall be adequate.

o. Props shall be directly under one another in multistage constructions as far as possible.

p. Guy ropes or stays shall be tensioned properly.

q. There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.

r. Required camber shall be provided over long spans.

s. Supports shall be adequate, and in plumb within the specified tolerances. The formwork shall be in line & level and internal dimensions for components like RCC beams, columns etc to be checked and Shall be as per the latest approved structural design drawing.

5.6. FORM OIL :

Use of form oil shall not be permitted on the surface which require painting. If the contractor desire to use form oil on the inside of formwork of the other concrete structures, a non staining mineral oil or Mould Releasing agent of Sika/Fosroc or approved equivalent make or other approved oil CEMOL-35 of Ms. Hindustan Petroleum Co. Ltd. may be used, provided it is applied before placing reinforcing steel and embedded parts. All excess oil on the form surfaces and any oil on metal or other parts to be embedded in the concrete shall be carefully removed. Before treatment with oil, forms shall be thoroughly cleared of dried splatter of concrete from placement of previous lift.

5.7. CHAMFERS AND FILLERS :

All corners and angles exposed in the finished structure shall be formed with mouldings to form chamfers or fillers on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 20 x 20 mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

5.8. VERTICALCONSTRUCTION JOINT CHAMFERS:

Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above except where not permitted by Engineer-in-Charge for structural or hydraulic reasons.

5.9. WALL TIES :

Wire ties passing through the walls, shall not be allowed. Also through bolts shall not be permitted. For fixing of formwork, alternate arrangements such as coil nuts shall be adopted at the contractors cost.

5.10. REUSE OF FORMS :

Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary repaired and the inside retreated to prevent adhesion, to the satisfaction of Engineer-in-charge. Warped lumber shall be resized. Contractor shall equip himself with enough shuttering to complete the job in the stipulated time.

5.11. REMOVAL OF FORMS :

Contractors shall record on the drawings or a special register, the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed there from.

In no circumstances shall forms be struck until the concrete reaches a strength of the at least twice the stress due to self weight and any construction erection loading to which the concrete may be subjected at the time of striking formwork.The removal of forms (minimum period before striking formwork) shall be as per IS 456 :2000.

In normal circumstances (generally where temperatures are above 15 ^{0}C.) and where ordinary Portland cement is used and adequate curing is done the forms may be struck after expiry of the following periods :

Stripping time:

Sl.No.	Type of form work	Minimum period before striking form work
a)	Vertical form work to columns, walls beams	16 – 24 h

b)	Soffit form work to slabs (Props to be refixed immediately after removal of formwork)	3 days
c)	Soffit form work to beams (Props to be refixed immediately after removal of formwork	7 days
d)	Props to slabs: 1) Spanning up to 4.5 m 2) Spanning over 4.5 m	7 days 14 days
e)	Props to beams and arches; 1) spanning up to 6 m 2) spanning over 6 m	14 days 21 days

For other cements (i.e other than ordinary Portland cement) and lower temperature, the stripping time recommended above may be suitably modified; additional days would be required than above till the desired strength is achieved.

The number of props left under the sizes and the position shall be such as to able to safey carry the full dead load of the slab, beam or arch., as the case may be together with any live load likely to occur during curing or further constructions.

Where the shape of the element is such that the form work has the re-entrant angles the form work shall be removed as soon as possible. After the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

Striking shall be done slowly with utmost care to avoid damage to arise and projection and without shock or vibration, by gently easing the wedges. If after removing the formwork, it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

Reinforced temporary openings shall be provided, as directed by Engineer-in-Charge, to facilitate removal of formwork which otherwise may be in-accessible.

Tie rods, clamps, form bolts etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours nor later than 40 hours after concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties withdrawn from walls and grade beams shall be pulled towards the inside face. Cutting ties back from the faces of walls and grade beams will not be permitted. Work damaged due to premature or careless removal of forms shall be re-constructed at contractors cost.

The concrete surface that will receive plaster after removal of formwork shall be hacked roughned by tacha about 6 mm depth at closer spacing, prior to concrete starting to be more hardened.

MODE OF MEASUREMENT :

In case the items of concreting are inclusive of cost of form work, no separate measurements shall be taken for form work. However, if the form work is to be paid separately and the item exists in the Schedule of Quantities for various types of form work, the net area of exposed surface of concrete members as shown in drawings coming in contact with form work shall be measured under item of formwork in square meters.

All temporary formwork such as bulk heads, stop boards provided at construction joints which are not shown in the drawings shall not be measured.

No deductions shall be made for openings/ obstructions upto an area of 0.1 sqm. and nothing extra shall be paid for forming such openings.

The rate shall include the cost of erecting, centering, shuttering materials, transport, deshuttering and removal of materials from site and labour required for all such operations etc.

6 STEEL FOR CONCRETE REINFORCEMENT :

Please refer special ''APPENDIX-F'' for steel reinforcement

6.1. SCOPE OF MATERIAL:

The contractor shall make his own arrangement for procurement of Reinforcement steel bars and wires for use in Reinforced Cement Concrete works. Unless otherwise specified in drawings / Schedule of quantities, the steel bars shall be of "High strength deformed

steel bars and wires" conforming to the IS 1786 (latest revision), in the following strength grades:

a) Fe 415, Fe 415D;

b) Fe 500, Fe 500D;

c) Fe 550, Fe 550D; and

d) Fe 600.

Where **"Fe"** stands for specified minimum 0.2% proof / yield stress in N/mm^2 and **"D"** stands for same specified minimum 0.2% proof / yield stress but with enhanced specified minimum percentage elongation.

In areas of Seismic Zones 3,4,5 reinforcement bar to be used shall be of Type Fe 500 Super ductile rebars.

Plasma Fe 500 D Reinforcement bars(using Electrolytic Plasma Technology)Type of rebars are coated with zinc and treated with an additional surface passivation for higher resistance to corrosion; or CRS corrosion resisting steel type of rebars shall be used in coastal , in areas where corrosion resisting rebars are required as per drawing /if required by Engineer in charge.

6.2. TERMINOLOGY:

Elongation: The increase in length of a tensile test piece under stress, expressed as a percentage of the original gauge of a standard piece.

Longitudinal Rib -A uniform continuous protrusion, parallel to the axis of the bar/wire (before cold-working, if any).

Nominal Diameter or Size- The diameter of a plain round bar/wire having the same mass per metre length as the deformed bar/wire.

Nominal Mass -The mass of the bar/wire of nominal diameter and of density 0.00785 kg/cu mm per meter.

Nominal Perimeter - 3.14 times the nominal diameter of a deformed bar/Wire.

Percent Proof Stress -The stress at which a non-proportional elongation equal to 0.2% of the original gauge length takes place.

Uniform elongation - The elongation corresponding to the maximum load reached in a tensile test (also termed as percentage total elongation at maximum force).

Tensile Strength - The maximum load reached in a tensile test divided by the effective cross-sectional area of the gauge length portion of the test piece (also termed as ultirnate tensile stress).

Transverse Rib - Any rib on the surface of a bar/wire other than a longitudinal rib.

Yield Stress - Stress (that is, load per unit cross sectional area) at which elongation first occurs in the test piece without increasing the load during the tensile test. In the case of steels with no such definite yield point, proof stress shall be applicable.

The high strength deformed steel bars and wires for concrete reinforcement shall be hot rolled steel without subsequent treatment or hot rolled steel with controlled cooling and tempering and cold worked steel, and reinforcing bars and wires which may be subsequently coated.

6.3. TESTS:

The contractor shall submit the test certificate of manufacturer. Regular tests on steel supplied by the contractor shall be performed by the contractor at the approved lab, in presence of the Engineer in charge as per relevant Indian Standards. Engineer-in-charge may require Contractor to perform necessary tests of samples at random as per relevant B.I.S. All cost of such tests and incidentals to such tests shall be borne by the Contractor. The quality, grade, colour coding embossing marks etc. all shall be to the entire satisfaction of the Engineer-in-Charge. Steel not conforming to above test criteria shall be rejected.

The Chemical, Physical & Mechanical properties of the steel reinforcement bars shall be as per IS 1786. Unless otherwise specified, Selection and Preparation of Test Sample shall be as per the requirements of IS 2062.

All test pieces shall be selected either from the cuttings of bars / wires; or from any bar/wire after it has been cut to the required or specified size and the test piece taken from any part of it. In neither case, the test piece shall be detached from the bar/wire except in the presence of the EIC or his authorized representative.

The test pieces shall be full sections of the bars/wires and shall be subjected to physical tests without any further modifications. No reduction in size by machining or otherwise shall be permissible, except in case of bars of size 28 mm and above. No test piece shall be

annealed or otherwise subjected to heat treatment. Any straightening which a test piece may require shall be done cold.

For	Title	IS No	ISO No.
i	Mechanical testing of metals -Tensile testing	1608	6892
ii	Methods for bend test	1599 7438 & 1786	15630-1
iii	Method for re-bend test for metallic wires & bars	1786	15630-1

THE PROPERTIES AS PER IS 1786 – 2008 ARE REPRODUCED BELOW:

Chemical Composition of the bars produce shall conform to the following requirement:

Constituents			Maximum Permissible Percent					Permissible max. Variation
	Fe 415	Fe 415D	Fe 500	Fe 500D	Fe 550	Fe 550D	Fe 600	
Carbon	0.300	0.250	0.300	0.250	0.300	0.250	0.300	0.020%
Sulphur	0.060	0.045	0.055	0.040	0.055	0.040	0.040	0.005%
Phosphorus	0.060	0.045	0.055	0.040	0.050	0.040	0.040	0.005%
Sulphur & Phosphorus	0.110	0.085	0.105	0.075	0.100	0.075	0.075	0.010%

Notes:

1. For guaranteed weldability, the carbon equivalent, CE using the formula:
   CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15

Shall not be more than 0.53 percent, when micro-alloy/low alloys are used. When micro-alloy/low alloys are not used, carbon equivalent using the formula:

2. CE = C + Mn/6

Shall not be more than 0.42 percent. Reinforcement bars/wires carbon equivalent above 0.42 percent should, however be welded with precaution. Use of low hydrogen basic coated electrodes with matching strengths bars/wires is recommended.

Contractor shall satisfied above notes 1&2.

Mechanical Properties of High Strength Deformed Bars and Wires

Sl. No.	Property			Maximum Permissible				
		Fe 415	Fe 415D	Fe 500	Fe 500D	Fe 550	Fe 550D	Fe 600
1	2	3	4	5	6	7	8	9
i	0.2 Percent Proof stress / yield stress, Min, N/mm²	415.0	415.0		500.0	550.0	550.0	600.0
ii	Elongation, Percent, Min. on gauge length 5.65 ;A, where A is the Cross – sectional area of the test piece	14.5	18.0	12.0	16.0	10.0	14.5	10.0
iii	Tensile strength, Min	10% more than the actual 0.2% proof stress/yield stress but not less than 485.0 N/mm²	12% more than the actual 0.2% proof stress/yield stress but not less than 500.0 N/mm²	8% more than the actual 0.2% proof stress/yiel d stress but not less than 545.0 N/mm²	10% more than the actual 0.2% proof stress/yield stress but not less than 565.0 N/mm²	6% more than the actual 0.2% proof stress/yiel d stress but not less than 585.0 N/mm²	8% more than the actual 0.2% proof stress/yield stress but not less than 600.0 N/mm²	6% more than the actual 0.2% proof stress/yiel d stress but not less than 660.0 N/mm²
Sl.	**Property**			**Maximum Permissible**				

No.		Fe 415	Fe 415D	Fe 500	Fe 500D	Fe 550	Fe 550D	Fe 600
iv	Total elongation at maximum force, percent, Min of gauge length 5.65 ;A, where A is the cross sectional area of the test piece	-	5	-	5	-	5	-

Note: To satisfy Clause 26 of IS 456 -2000, no mixing of different types of grades of bars shall be allowed in the same structural members as main reinforcement, without prior written approval of the Engineer-in-Charge.

6.4. QUALITY :

Steel not conforming to specifications shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill, scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-Charge. If welding is allowed by E.I.C , the work shall be carried as per I.S. 2751, according to best modern practices and as directed by the Engineer-in-Charge. In all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars welded. Substitution of reinforcement will not be permitted except upon written approval from Engineer-in-charge.

6.5. STACKING & STORAGE :

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. The steel for reinforcement shall not be kept in direct contact with ground. Fresh / Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deteriorations. Care shall be taken to protect steel from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

6.6. NOMINAL SIZES

The nominal sizes of bars/wires shall be 4mm, 5 mm, 6 mm, 8 mm, 10 mm, 12 mm, 16 mm, 20 mm, 25 mm, 28 mm, 32 mm, 36 mm, 40 mm. (Other sizes viz. 7 mm, 18 mm, 22 mm, 45 mm and 50 mm may be procured on specific stipulations).

6.7. NOMINAL MASS

For the purpose of checking the nominal mass, the density of steel shall be taken as 0.00785 kg/mm^3 of the cross-sectional area per metre. Unless otherwise specified, the tolerances on nominal mass shall be as per following Table.

Tolerances on Nominal Mass

SN	Nominal Size in mm	Tolerance on the nominal mass in Percent		
		Batch	Individual sample	Individual sample for coils
1	2	3	4	5
i)	Up to and including 10	± 7	- 8	± 8
ii)	Over 10 up to and	± 5	- 6	± 6
iii)	Over 16	± 3	- 4	± 4

6.8. LAPS :

Laps and splices for reinforcement shall be shown on the drawings. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the drawings, shall be approved by the Engineer-in-Charge. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

6.9. BENDING :

All bars shall be accurately bent according to the sizes and shapes shown on the detailed working drawing / bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and re-bent in a manner that will weaken the material. Bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25 mm. in diameter which may be bent hot if specifically approved by the Engineer-in-Charge. Bars that depend for their strength on cold working shall not be bent hot. Bars bent hot shall not be heated beyond cherry red

colour (not exceeding 645^{0}C) and after bending shall be allowed to cool slowly with out quenching. Bars incorrectly bent shall be used only after straightening and re-bending be such as shall not, in the opinion of the Engineer-in-Charge, weaken the material. No reinforcement bar shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

BENDING AT CONSTRUCTION JOINTS :

Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

6.10. FIXING / PLACING AND TOLERANCE ON PLACING :

Reinforcement shall be accurately fixed by any approved means maintained in the correct position as shown in the drawings by the use of blocks, spacers and chairs as per I.S. 2502 to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing point shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

TOLERANCE ON PLACING OF REINFORCEMENT :

Unless otherwise specified, reinforcement shall be placed within the following tolerances :

Tolerance in spacing

a) For effective depth, 200 mm or less + /- 10 mm

b) For effective depth, more than 200 mm + /- 10 mm

6.11. COVER TO REINFORCEMENT :

Nominal cover is the design depth of concrete cover to all steel reinforcements, including links. It is the dimension used in design and indicated in the drawings. It shall be not less than the diameter of the bar. Unless otherwise specified, cover to reinforcement shall be provided generally as per guidelines of IS 456.

Nominal cover to meet durability requirement:

Minimum values for the nominal cover of normal weight aggregate concrete which should be provided to all reinforcement, including links depending on the condition of exposure described in 4.4.4.1 above and as per (nominal cover to meet durability requirements).

However for a longitudinal reinforcing bar in a column nominal cover shall in any case not be less than 40 mm or less than the diameter of such bar. In the case of columns of minimum dimension of 200 mm or under, whose reinforcing bar do not exceed 12 mm , a nominal cover of 25 mm may be used.

For footings minimum cover shall be 50 mm.

Nominal cover to meet specified period of fire resistance

Minimum values of nominal cover of normal-weight aggregate concrete to be provided to all reinforcement including links to meet specified period of the resistance as per the tables given under clause of this specifications.

The cover shall in no case be reduced by more than one third of specified cover or 5 mm whichever is less.

Unless indicated otherwise on the drawings, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish shall be as follows:

a) At each end of reinforcing bar not less than 25mm., nor less than twice the diameter of such, bar.

b) For a longitudinal reinforcing bar not less than 25 mm., nor more than 40 mm., nor less than the diameter of such bar. In the case of column of maximum dimensions of 200 mm. or under, whose reinforcing bars do not exceed 12 mm., a cover of 25 mm. may be used.

c) For longitudinal reinforcing bar in a beam, not less than 25mm., nor less than diameter of such bar.

d) For tensile, compressive, shear, or other reinforcement in a slab, not less than 25 mm, nor less than the diameter of such bar, and

e) For any other reinforcement not less than 15 mm, nor less than the diameter of such bar.

f) Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals (as in the case of concrete in contact with earth faces contaminated with such chemicals), acid, vapour, saline atmosphere, sulphurous smoke (as in the case of steam-operated railways) etc. and such increase of cover may be between 15 mm. and 50 mm. beyond the figures given in (a to e) above as may be specified by the Engineer-in-Charge.

g) For reinforced concrete members, totally immersed in sea water, the cover shall be 40 mm. more than specified (a to e) above.

h) For reinforced concrete members, periodically immersed in sea water or subject to sea spray, the cover of concrete shall be 50 mm. more than that specified (a to e) above.

i) For concrete of grade M 25 and above, the additional thickness of cover specified in (f), (g) and (h) above may be reduced to half. In all such cases the cover should not exceed 75 mm.

j) Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by providing dense impermeable concrete with approved protective coating, as specified on the drawings. In such case the extra cover, mentioned in (h) and (i) above, may be reduced by the Engineer-in-Charge, to those shown on the drawing.

k) The correct cover shall be maintained by cement mortar briquettes or other approved means. Reinforcement for footings, grade beams and slabs on subgrade shall be supported on precast concrete cover blocks as approved by the Engineer-in-Charge. The use of pebbles or stones shall not be permitted.

l) The minimum clear distance between reinforcing bars shall be in accordance with I.S. 456 or as shown in drawing.

6.12. THE BARS SHALL BE KEPT IN CORRECT POSITION BY THE FOLLOWING METHODS.

a) In case of beam and slab construction precast cover blocks in cement concrete of M50 or more Grade of concrete about 4 x 4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcement.

b) In case of cantilevered and doubly reinforced beams or slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.

c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them; or with block of M50 or more Grade of concrete of required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.

d) In case of other R.C.C. structure such as arches, domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-Charge.

6.13. INSPECTION :

Erected and secured reinforcement shall be inspected and approved by Engineer-in-Charge prior to placement of concrete.

6.14. MODE OF MEASUREMENT FOR REINFORCEMENT FOR R.C.C. WORKS :

Reinforcement as detailed in schedule of quantities shall be measured for payment lineally as per the cutting length nearest to a centimetre shown in bar bending schedule submitted by the contractor and approved by the Engineer-in-Charge and weight calculated based on the standard weights as per I.S.1786, as indicated in the following table:

Nominal size in mm	**6**	**7**	**8**	**10**	**12**	**16**	**18**	**20**
Cross Sectional area in	28.30	38.50	50.30	78.60	113.10	201.20	254.	314.30
Mass / Weight in Kg	0.222	0.302	0.395	0.617	0.888	1.580	2 .000	2 .47
Nominal size in mm	**22**	**25**	**28**	**32**	**36**	**40**	**45**	**50**
Cross Sectional area in	380.3	491.1	614.0	804.6	1018.3	1257.2	1591.1	1964.30
Mass / Weight in Kg / RM	2 .980	3.850	4.830	6.310	7.990	9.850	12.500	15.420

No allowance shall be made/ be measured in the weight for rolling margin. If weight of bar(s) found to be more than the standard weights, the measurement / payment shall be restricted to the standard weights as above. However, if weight of bar(s) found to be less than the standard weights (but within the permissible limit), the measurements / payment for the same shall be as per standard weights.

Only authorized laps shall be measured. The cost of steel used by the contractor in the reinforcement of beams, slabs and columns etc. will be paid as per the rate of reinforcement only upto the extent shown in the drawings. As far as possible laps in bars

shall be avoided. Any laps and hooks provided by the contractor other than authorised as per approved bar bending schedule will be considered to have been provided by the contractor for his own convenience and shall not be measured for payment. Pins, chairs, spacers shall be provided by the contractor wherever required as per drawing and bar bending schedule and as directed by the Engineer-in-Charge and shall be measured for payment. Fan hooks as required shall be provided by the contractor under this item and shall be measured for payment.

The rate shall include the cost of all materials and labour required for all above operations including transport, wastage, straightening, cutting, bending, binding and the binding wire required. Bar bending schedule shall be prepared by the contractor and the same shall be submitted by contractor to the E.I.C.

7. READY MIX CONCRETE :

(SPECIFICATIONS FOR READY MIXED CONCRETE, CONFORMING TO IS 4926)

7.1 Ready mix Concrete shall conform to latest revision of IS : 4926 following are the requirement for supply of R.M.C

7.1.A Concrete delivered at site shall be in a plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden

7.1.B The process of continuing the mixing of concrete at a reduced speed during transportation to prevent segregation.

7.1.C Truck mounted equipment designed to agitate concrete during transportation to the site of delivery.

7.1.D Concrete produced by completely mixing cement, aggregates, admixtures if any and water at a stationary central mixing plant and delivered in containers fitted with agitating devices. The concrete may also be transported without being agitated as a special case and as requested.

7.1.E Concrete produced by placing cement, aggregates and admixtures, if any other than those to be added with mixing water, in a truck mixer at the batching plant , the addition of water and admixtures to be added along with mixing water, and the mixing being carried out entirely in the truck mixer either during the journey or on arrival at the site of delivery. No water shall be added to the aggregate and cement until the mixing of concrete

commences.

7.2. MATERIALS :

7.2.1. **The cement** used shall be of specified grade ordinary Portland cement of Grade 43 Grade conforming to IS:8112 / ordinary Portland cement of Grade 53 Grade conforming to IS:12269 or Portland cement 33 Grade conforming to IS: 269 or Portland slag cement conforming to IS: 455 or Portland-pozzolana cement conforming to IS: 1489 or rapid hardening Portland cement conforming to IS: 8041 as may be specified at the time of placing the order. If the type is not specified, ordinary Portland cement shall be used.

7.2.2. **Fly ash** when used for partial replacement of cement, shall conform to the requirements of IS-3812 (Part I) and as specified by the users.

7.2.3. **The aggregate** shall conform to IS: 383. Fly ash when used as fine aggregate shall conform to the requirements of IS 3812 – (Part - II).

7.2.4. **Water** used for concrete shall conform to the requirement of IS 456-2000.

7.2.5. **The admixtures** shall conform to the requirements of IS : 456-2000 and their nature, quantities and methods of use shall also be specified. Fly ash when used as an admixture for concrete shall conform to IS : 3812 (Part II) . However, partial replacement of cement by fly ash shall not be more than 15% of designed requirement.

In case if fly ash is used more than 15%, the same shall be guided under table 5.1 of the IS, and in which case specific care shall be taken in terms of curing, protecting, repairing, finishing, de-shuttering etc. as detailed in the Chapter “FLY ASH CONCRETE”, here in after.

7.3. SUPPLY :

The ready-mixed concrete shall be manufactured and supplied on either of the following basis :

i) Specified strength based on 28-day compressive strength of 15 -cm cubes tested in accordance with IS : 456-2000.

ii) Specified mix proportion.

NOTE : Under special circumstances and as specified the strength of concrete in (a) above may be based on 28-day or 7-day flexural strength of concrete instead of compressive strength of 15-cm cube tested in accordance with IS : 456-2000.

7.3.1. When the concrete is manufactured and supplied on the basis of specified strength, the responsibility for the design of mix shall be that of the manufacturer and the concrete shall conform to the requirements specified.

7.3.2. When the concrete is manufactured and supplied on the basis of specified mix proportions, the responsibility for the design of the mix shall be that of the purchaser and the concrete shall conform to the requirements specified.

7.4. GENERAL REQUIREMENTS:

7.4.1. When a truck mixer or agitator is used for mixing or transportation concrete, no water from the truck-water system or from elsewhere shall added after the initial introduction of the mixing water for the batch, when no arrival at the site of the work, the slump of the concrete is less that specified, such additional water to bring the slump within limits shall be injected into the mixer under such pressure and direct flow that the requirements for uniformity specified.

7.4.2. Unless otherwise specified when a truck or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be complete within 1 ½ hour (when the prevailing atmospheric temperature above 20^0C) and within 2 hours (when the prevailing atmosphere temperature is at or below 20^0C) of adding the mixing water to the mix of cement and aggregate or adding the cement to the aggregate which ever is earlier.

7.4.3. The temperature of the concrete at the place and time of delivery shall be not less than 5^0C. Unless otherwise required by the purchaser, the concrete shall be delivered when the site temperature is less than 2.5^0 C.

7.4.4. Adequate facilities shall be provided by the manufacturer/supplier to inspect the materials used for the process of manufacture and methods of delivery of concrete. He shall also provide adequate facilities to take samples of the materials used.

7.4.5. The tests for consistency or workable shall be carried out in accordance with requirements of IS 1199 by such other method as may be agreed to between the purchaser and manufacturer.

7.4.6. The sampling and testing of concrete shall be done in accordance with the relevant requirements of IS 456, IS 1199 and IS 516.

7.4.7. The compressive strength and flexural strength tests shall be carried out in accordance with the requirement of IS: 516 and the acceptance criteria for concrete whether supplied on the basis of specified strength or on the basis of mix proportion, shall

conform to the requirements and other related requirements of IS: 456.

7.4.8. The testing shall be carried out in accordance with the requirements and the cost shall be borne by the Contractor.

7.4.9. The manufacturer shall keep batch records of the quantities by mass all the solid materials, of the total amount of water used in mixing and of the results of all tests. If required insisted, the manufacturer shall furnish certificates, at agreed intervals, giving this information.

7.4.10. Mode of measurement for ready mixed concrete (RMC) will be the same as mode of measurement for concrete work already mentioned .However, consumption of RMC shall be maintained at site. Wastage, spillover, wastage due to pump blockage etc. shall not be considered for payment.Pumping charges shall be included in the rates.

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Vacuum Dewatered Flooring (Vdf/ Tremix Flooring):

Concrete in specified proportions of mix shall be laid in alternate bays or approved dimensions. The top surface will be finished as specified after surface vibration and shall be leveled. Immediately after surface vibration, a filter pad consisting of two layers shall be placed upon the surface of the wet concrete such that the bottom layer acts as filter and upper layer acts as water duct. Place a tight plastic sheet over the filter pad projecting slightly outside on all sides as the top cover to produce air-tight seal. Connect suction hose to a vacuum pump to extract the excess of water and to compact the concrete. Finish the surface by power floating and trowelling to achieve level, wear resistant floor with minimum dusting. The concrete surface shall be power trowelled at least twice to ensure wear resistance, sealing of capillary pores to reduce permeability and dusting.

Steel:

Providing and fixing in position M.S/TOR steel conforming to IS : 432 / 1786

reinforcement of specified diameter and grade Fe415 /FE500as per detailed drawings and schedules including cutting, bending, hooking the bars binding with wires as required including all lead and lift etc. complete. (Binding wire shall be of 16 gauge, annealed with chair supports including cost of transporting, de-coiling and straightening of bars as per specifications. Binding wire shall not be measured for payment) (8mm dia. at 450mm c/c both ways at the center)

Water cement ratios lower than 0.4 shall be used to achieve low permeability and high strength concrete in dewatered specialty floor toppings.

Poor or dirty aggregates and gap grading which contribute to shrinkage shall be avoided.

Preferred grading of fine aggregate for floor concrete shall be:

Sieve size	**Percent passing, by weight**		
	Normal weight aggregate	Lightweight aggregate	Heavy duty toppings.
3/8 in	100	100	95
No.4	95-100	85-100	95-100
No.8	80-90	--	65-80
No.16	50-75	40-80	45-65
No.30	30-50	30-65	35-45
No.50	10-20	10-35	5-15
No.100	2.5	5-20	0.5

Aggregates shall be devoid of clay lumps, coal and lignite, materials finer than No.200 sieve and lightweight chert and organic impurities such as peat and humus.

Pozzolanas, as admixtures or replacement for part of the Portland cement can be used to improve the workability of fresh concrete and reduce thermal cracking.

Over sanded mixes, that is, mixes with more fine aggregate than needed, are likely to produce floors with poor wear resistance and excessive shrinkage and hence shall be avoided.

Admixtures which produce low shrinkage concrete shall be used

Sampling of fresh concrete:

For ready mixed concrete and concrete from stationary mixers, two or more samples should be taken from the middle of the batch, with not more than 15 minutes time between taking the first and the last.

Testing of Concrete:

Slump test

A slump test is used to measure the consistency or stiffness of concrete.

A change in slump generally means a change in the amount of water in the mix but it may also mean other changes such as air content, aggregate gradation, sand content, temperature, hydration rate, or setting time.

The acceptable slump could be from 50 to 100mm

It is essential to consider the slump at the point of placement. To deal with unavoidable slump loss, a small predetermined amount of water may be held back at the ready mix plant to be used for a single on site adjustment of the mix. In such a case, make all tests after the adjustment.

Testing the cylinders

Compression tests of concrete cylinders to assess the compressive strength of concrete shall be done. The ends of the test cylinders should be ground or capped. The end of the cylinder must be a smooth, plane surface to assure even loading and accurate test results.

The minimum strength at 28 days shall be 25N/mm2 and will depend on the design requirement of floor class.

Consolidating

Vibrating screeds with truss assemblies shall be used to strike off and straightedge the concrete and to provide consolidation. Its use shall be limited to concrete with slump less than 75mm.

Jointing and edging tools

In order to make neat rounded edges next to the forms, edgers shall be used. Use a 3mm radius edger wherever edging is specified for joints subject to regular vehicular traffic. A larger radius will produce a joint that becomes rough and difficult to maintain.

Grooving:

In order to create a weakened section, the groove depth should be about one –fourth of the slab thickness.

25mm deep for a 100mm slab

37.5mm deep for a 150mm slab

Revolving disk floats shall be used to float low slump concrete or slab toppings. They are also used for additional compacting or floating following normal floating operations when the slab is stiff enough to support the machine without damage to the flatness of the slab.

Sequence of steps in making a slab on grade

1. Site Preparation	2. Placing Concrete	3. Finishing concrete
A. Prepare the sub grade	A. Deliver concrete to proper locations(s)	A. Bull float OR use straightedge.
B. Establish grades (elevations)	B. Spread or distribute concrete	B. WAIT for bleed water to disappear.
C. Set edge forms, temporary bulkheads, and screed guides.	C. Vibrate concrete	C. Edge and joint as needed.
D. Install vapor barrier, if any	D. Strike off	D. Float

E. Install reinforcement, if any	(Sometimes 2C and 2D are combined in a single operation)	E. Trowel, if required.
F. Get tools and materials ready		F. Saw joints as needed
		G. Cure

Subgrade Preparation

Slabs on ground are supported by the subgrade on which they are cast. Subgrades should provide uniform support throughout. There should not be any hard spots or soft spots. If the subgrade is not uniform, a subbase of sand, gravel, crushed stone, or other granular material should be used over it.

All sub bases or subgrade material should be compacted to uniform bearing capacity, and to meet any specific requirements.

Dampen sub grade or sub base before concrete is deposited ONLY if needed to prevent plastic shrinkage or other severe problems. There should be no standing water.

Under severe drying conditions that threaten plastic shrinkage cracking, water can be sprinkled on the subgrade before concreting. However, there should be no free water standing on the subgrade when concrete is placed, nor should there be any muddy or soft spots.

Compaction around buried pipes:

Electrical conduit and pipes should be covered with at least 50mm of sub base so that they do not cause cracking by restraining slab shrinkage or reducing slab thickness. Metal, rigid plastic or wax-impregnated cardboard ducts with watertight joints are recommended for heating ducts. The backfill material should be compacted in layers so that it will not settle and cause the slab to crack.

Placement sequence:

Concrete floors shall be constructed in long strips starting at one side of the floor. Alternate long lanes shall be cast

Two sides of each panel should be left open for at least 2 days to allow expansion to occur.

Reinforcement must be located at or (preferably) above mid-depth of the slab. The best position depends on the design concept and weather exposure, but it must not be allowed below mid-depth.

If it is to be a working joint that is expected to open and provide relief for drying shrinkage, it is best to discontinue all steel at the joint.

Isolation joints used to separate the slab from walls, footings, columns, and other rigid structures, are made with asphalt-impregnated sheets or other suitable joint materials.

The metal keyed joint form is not recommended for slabs subject to heavy wheel traffic.

Here are some of the important dos and don'ts of placing concrete in flatwork:

1. DO deposit the concrete as close to its final location in the slab as possible. The less you have to move it, the better.

2. DO start by depositing concrete in a corner and work away from the corner.

3. If a slab is on a slope, DO start at the low end and work uphill.

4. DO deposit concrete into (instead of away from) previously deposited concrete.

5. DON'T move concrete horizontally with a vibrator. That is a sure way of causing segregation.

6. DON'T vibrate high slump (more than 5 in.) concrete in slabs on grade.

7. DON'T let concrete for slabs drop from a chute or bucket (free fall) more than about 2 ft if the slump is more than 4 in. Limit the drop to about 3 ft when slump is less than 4 in.

8. DO use the proper tools to move concrete horizontally. These tools are square nose shovels or come alongs. Do not use garden tools.

Vibrating (consolidating) the concrete

Surface vibration for consolidating slabs upto 6 in.thick shall be done provided they are unreinforced or contain only light mesh. Low- frequency vibrating screeds – 3000 to 6000 vibrations per minute – are the most common means.

- ✓ DON't use a vibrator to move concrete horizontally ("run the concrete) because the coarse aggregates will separate from the mortar.
- ✓ DON'T leave a vibrator in the concrete too long (over vibrate) in concrete mixes which have a slump of more than about 3 in. If in doubt about the adequacy of compaction, it is generally better to vibrate more in stiffer mixes (slump less than 3.) because the danger of over vibrating stiff mixes is small.

Trowelling

Trowelling follows immediately after floating, and no trowelling should ever be done unless the surface has first been floated.

Joints in a floor on grade

Isolation joints permit the slab to move up or down (very slightly) relative to walls, columns or footings. Contraction (control) joints permit slabs to shrink without excessive cracking between joints. Construction joints are stopping places for a day's work

Isolation joint material must be compressible and thick enough to permit such movement. Joint material ½ in. thick is commonly used. In freeze-thaw regions, caulking may be required for long term joint maintenance.

Isolation joints are made of performed asphalt impregnated fiber sheeting or similar materials. It is important that the joint filler extend the full depth of the joint and not protrude above it. There should be no concrete-to-concrete contact

Isolation joints around column – should be either circular or diamond shaped.If no isolation joints are used around columns, or if the corners of the isolation joint do not meet the contraction joints, radial cracking may occur.

contraction joints

Contraction joints should be placed on or straddling column lines, with intermediate joints between column lines to keep the maximum distance between joints at 24 to 36 times the slab thickness. The resulting panels should be as nearly square as practical, dividing a large floor area into relatively small panels.

Avoid elongated and L-shaped panels. Never make the long side more than $1^1/_2$ times as long as the short side.

The edge forms or bulkheads for slab-on-grade construction joints are generally keyed for 6 in. or thicker slabs so that the slab will have a tongue-and-groove joint after concrete has been cast on both sides.

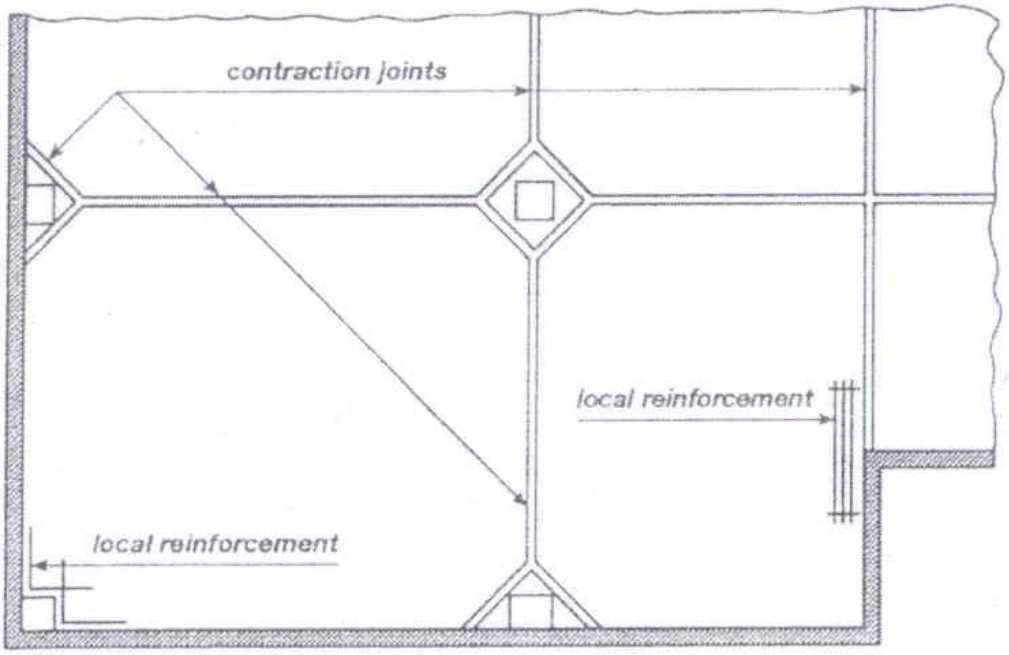
If construction joints occur where neither a contraction joint nor an isolation joint is wanted, tie bars or welded wire fabric may be used across the joint.

When to saw – Joints should be sawed as soon as the concrete is hard enough not to be torn or damaged by the blade, but before random cracks can form in the concrete slab. With wet cut saws, usually this condition occurs from 4 to 12 hr after finishing is complete, although sawing as late as 24 hr may be successful under some conditions.

Sawing techniques require a wait of 4 hours or more and a saw cut one –fourth the depth of the slab in order to get a good contraction joint.

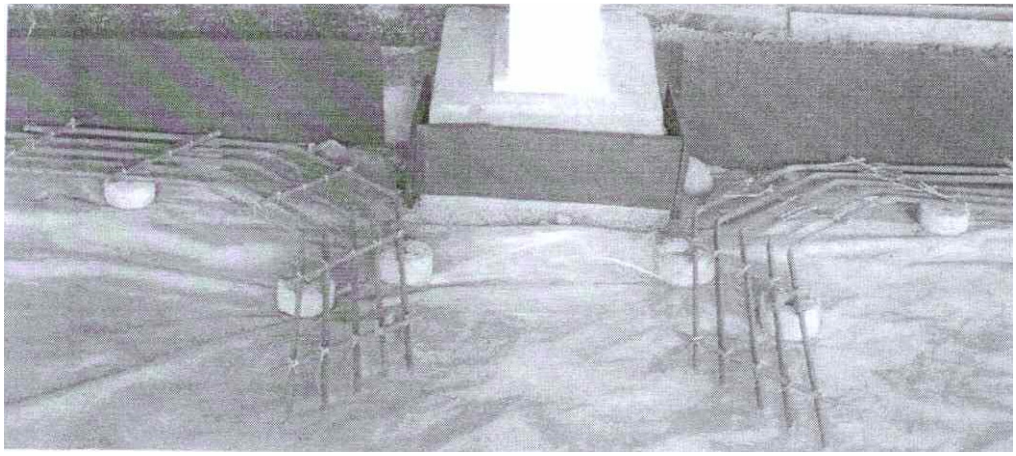
Joint Details

Contraction Joint

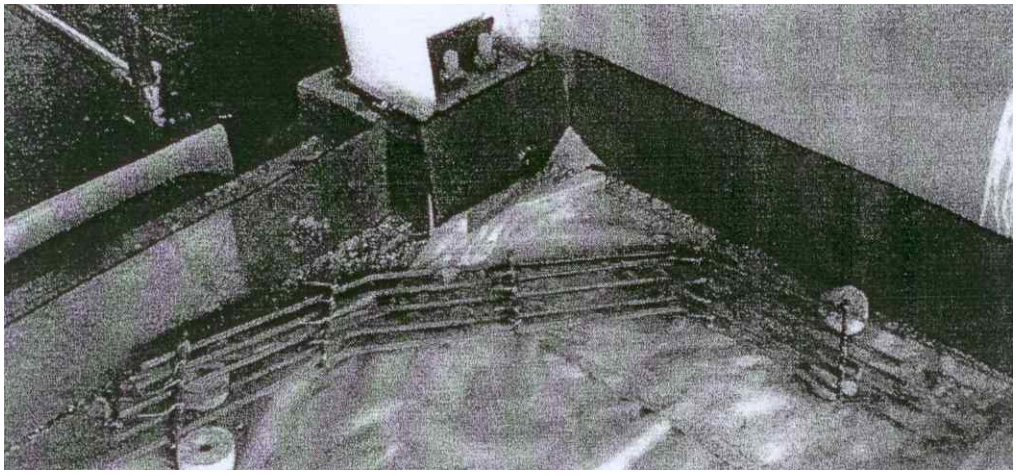


Column – Floor Joint Details

Two State Constructions : Column Isolation with Isolation

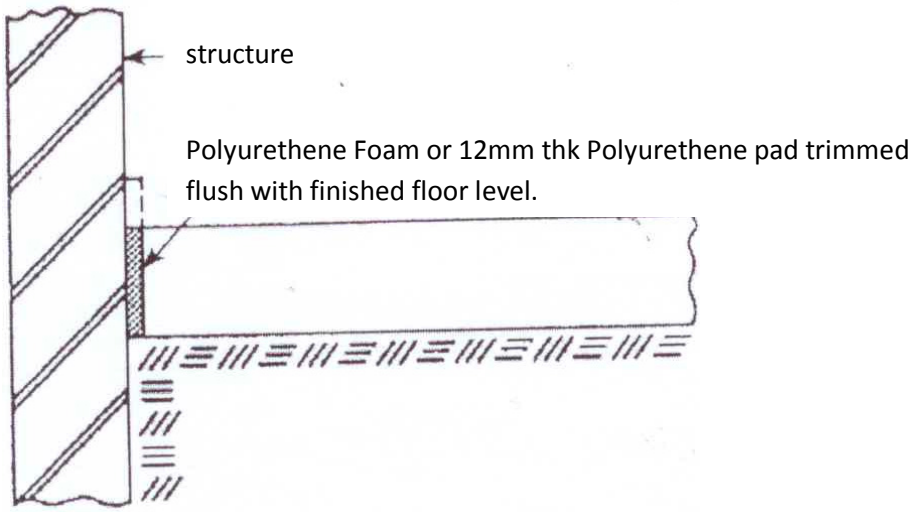


One Stage Construction: Column Isolation & Auxiliary Reinforcement.



Column Isolation & Auxiliary Reinforcement at Column in Corners.

Insulation Joint



Polyurethene Foam : 12mm Thickness & 10mm above Floor level.

Curing:

Concrete should be kept continuously moist for 7 days unless otherwise specified. To avoid crazing and cracking do not allow the concrete surface to become dry during this period.

Ponding – Although seldom used, one of the best methods of curing concrete is to cover the concrete with water

Erect sunshades in hot weather to keep the sun from overheating the concrete surface.

To keep shrinkage to a minimum, apply the following rules:

1. Use the stiffest mix that can be handled and consolidated satisfactorily.

2. Reduce the water demand (total amount of water) of the mix by these practices:

    - Use the largest maximum size of aggregate that is practical.
    - Keep aggregate and cement temperatures low.
    - Use aggregates free of clay and other fines.

- Plan for the shortest possible travel time between ready mix plant and the job.

Other factors to consider besides shrinkage that influence the amount of curling in a slab included:

- High water tables or wet subgrades – Will cause slab curling because they increase the moisture differential across the slab thickness.

- Slab thickness – thin slabs will curl more than thicker slabs when joint spacing is 15 to 20ft. With joint spacing greater than this range, vertical curling is the same for thin or thick slabs.

- Concrete modulus of elasticity E (a measure of concrete stiffness) – Concretes with a low modulus curl less than high-modulus concretes. Lower strength concretes have a lower E and thus curl less.

- Vapor barriers – Avoid if possible. If vapor barriers are necessary they should be covered with a layer of compactable fill. A fill thickness of 2 to 3 in. is common, although some authorities recommend as much as 6 in. to protect the vapor barrier from concrete truck traffic and to maintain a level subgrade.

The amount of bleeding is affected mostly by:

1. Slump – High slump concrete will bleed more than low slump concrete if the slump is caused by excess water and not by admixtures.

2. Air- entrainment – Non-air-entrained concrete will bleed more than air-entrained concrete.

3. Aggregate gradation – Concrete made with gap –graded aggregate or with coarse

3. Aggregate gradation – Concrete made with gap –graded aggregate or with coarse sands which do not have much material finer than a No.50 mesh sieve will bleed more than concrete made with a sand which has enough fine material.

4. Too little cementitious material in the mix.

The surface should not be damaged by the finishing operations. However, it is usually best to avoid excessive bleeding by adjusting the concrete mix before it is delivered.

Causes of random cracks are due to poor joints.ie.

a. Joints too far apart

b. Sawed or grooved joints not installed soon enough and /or deep enough

c. No contraction joints at re-entrant corners

d. Inadequate isolation joints at walls, columns, footings etc.

Concretes made with small aggregates and overly wet concrete mixes will need closer joint spacings.

Incomplete bond between the topping and base slab in two-course floors shall be avoided. Several precautions can be taken during construction to assure bond between the topping and base slab.

1. Clean the surface of the base slab, removing all dirt, grease, plaster, etc. Use stiff wire brushes or abrasive blast new slabs if necessary. If the base slab is old, mechanical roughening should be used.

2. The surface of the base slab should be slightly damp – not wet

3. Apply a coating of sand-cement grout using a stiff bristle broom.

4. Place the topping before the grout coat dries.

Map cracking and crazing

Fine hairline map cracks occur mostly on troweled surfaces. Like most of the other cracks that occur in concrete, map cracks are caused by shrinkage.

Precautions to avoid map cracking:

Water brought to the surface during floating should be allowed to evaporate before continuing finishing operations. Also water should not be sprinkled on the surface to make finishing easier.

Delayed curing or lack of curing can cause map cracking, particularly if rapid drying of the concrete is likely. Avoid it

Wide map cracks may mean that aggregate are reacting chemically with the alkalies in the cement resulting in alkali-aggregate (or alkali-silica) reactivity.

Shrinkage-compensating concrete slabs

To take advantage of the expansion, enough steel reinforcement is used in the top half of the slab to resist the expansion and prestress of concrete to a low level.

Reinforcement should be at least 0.15 percent by cross sectional area, located in the top half of the slab.

Measurement for industrial flooring

Measurement to done in Cu M if one item taken with all above details. OR Sq m if thickness specified.

If separate item given than concreting can be taken in Cu m

Vacuumed Dewatering can be taken in Sq m.

Cutting and filling poly sulphide sealant can be taken in Rmt.

8. FLY ASH CONCRETE

NOTES:

a) The fly ash should have consistent quality satisfying the requirements of Grade-1 FA of IS 3812 and Class-F of ASTM C-618.

b) The source of fly ash should be so selected that test results of fly ash samples collected from these sources during last one year at frequency of maximum one month interval should satisfy the requirements of above codes.

c) The characterization of fly ash which will be used should be done as per above two codes for each batch of fly ash.

d) The fly ash should be stored in bins at the plant.

e) All concrete should be manufactured at RMC plant.

f) The mix proportion should be approved by competent authority. The information to be supplied for approval would be identified by the competent authority.

g) Any change in mix proportion, after approval, should be concurred by appropriate authority.

h) Samples to be taken, at each time of casting, shall be tested for 7 days and 28 days.

i) All ingredients of concrete should satisfy the requirements of relevant IS codes and

specifications.

8.1.0. Curing, Protecting, Repairing and Finishing

8.1.1. Curing: All concrete shall be cured by keeping it continuously damp for the period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays or ponded water, continuously saturated covering of sacking, canvas, hessain or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter the quality of curing water shall be the same as that used for mixing concrete.

Certain types of finish or preparation for overlaying concrete must be done at certain stages of curing process and special treatment may be required for specific concrete surface finish.

Curing of concrete made of high alumina cement and super sulphated cement shall be carried out as directed by Engineer-in-charge.

8.1.2. Curing of concrete with low water binder ratios having partial replacement of cement by pozzolanic materials.

8.1.3. The structural elements with concrete having water binder ratio less than or equal to 0.4 or partial replacement of cement by pozzolanic materials (5% or above replacement by silica fume or high reactivity metakaoline, or 15% or above by fly ash) shall be cured in two stages, initial curing and final curing.

i) The initial curing should be started not later than 3 hours or initial setting time, whichever is lower, after placement of concrete. The concrete surface exposed to environment should be covered by plastic sheet or other type of impermeable covers. The initial curing should be continued upto a minimum period of 12 hours or 2 hours plus final setting time of concrete, whichever is higher.

ii) Final curing should be done with water. It should commence immediately after initial curing and continue upto a minimum period of 14 days.

8.1.4. CURING WITH WATER

Fresh concrete shall be kept continuously wet for a minimum period of 14 days from the date of placing of concrete, following a lapse of 12 to 24 hours after laying concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin immediately

after the concrete has hardened. Water shall be applied to uniformed concrete surfaces within 1 hour after concrete has set. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

8.1.5. CONTINUOUS SPRAYING

Curing shall be assured by use of ample water supply under pressure in pipes, with all necessary appliances of hose sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by Engineer-in-charge.

8.1.6. ALTERNATE CURING METHODS:

Whenever in the judgement of Engineer-in-charge, it may be necessary to omit the continuous spray method, covering of clean sand or other approved means such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. Any type of covering which would slain or damage the concrete during or after the curing period, will not be permitted. Covering shall be kept continuously wet during the curing period.

For curing of concrete in pavements, side walks, floors, flat roofs or other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by Engineer-in-charge. Special attention shall be given to edge and corner of the slab to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

8.1.7. CURING COMPOUNDS :

Surface coating type curing compound shall be used only on special permission of Engineer-in-charge. Curing compounds shall be liquid type while pigmented, conforming to U.S Bureau of Reclamation Specification. No curing compound shall be used on surface where future blending with concrete water or acid proof membrane or painting is specified.

8.1.8. Curing Equipment: All equipments and materials required for curing shall be on hand and ready for use before concrete is placed.

8.2 Form Work

8.2.1 General: The form work shall consist of shores, bracings, sides of beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts etc. complete which shall be properly designed and planned for the work. The false work shall be so constructed that up and down vertical adjustment can be made smoothly. Wedges may be used at the top or bottom of timber shores, but not at both ends, to facilitate vertical

adjustment or dismantling of form work.

8.2.2 Design of Form Work: The design and engineering of form work as well as its construction shall be the responsibility of Contractor. If so instructed the drawings and calculations for the design of the form work shall be submitted well in advance to the Engineer-in-charge for approval before proceeding with work, at no extra cost. Engineer-in-charge approval shall not however, relieve Contractor of the full responsibility for the design and construction of the form work. The design shall take into account all the loads vertical as well as lateral that the forms will be carrying including live and vibration headings.

8.2.3 Type of Form Work: Form work may be of Film faced Plywood, timber, plywood, metal, plastic or concrete. For special finishes, the form work may be lined with plywood, steel sheets, oil tempered hard board etc. Sliding forms and slip forms may be used with the approval of Engineer-in-charge.

8.2.4 Formwork Requirements: Forms shall conform to the shapes, lines grooves and dimensions including camber of the concrete as called for in the drawings. Ample studs, water braces, straps, shores etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Forms shall be strong enough to permit the use of immersion vibrators. In special cases, form vibrators may also be used. The shuttering shall be close boarded. Timber shall be well seasoned, free form sap, shakes, loose knots, worm holes, wraps or other surface defects in contact with concrete. Faces coming in contact with concrete shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently light to prevent loss of water and fine material from concrete. Mould releasing agents shall be applied to inside surface of form work, Mould releasing agents of approved construction chemicals companies shall be used. All the formworks after laying shall be checked for watertightness, the formwork face to be in contact with concrete shall be cleaned.

Ply wood shall be used for exposed concrete surfaces, where called for Sawn and wrought timber may be used for unexposed surfaces. Inside faces of forms for concrete surfaces which are to be rubbed finished shall be planned to remove irregularities or unevenness in the face. Form work with lining will be permitted.

All new and used form lumber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness and cleanliness of surfaces. Form lumber unsatisfactory in any respect shall not be used and if rejected by Engineer-in-charge shall be removed from the site.

Shores supporting successive stories shall be placed directly over those below or be so designed and placed that the load will be transmitted directly to them. Trussed supports shall be provided for shores that cannot be secured on adequate foundation.

Form work, during any stage of construction showing signs of distortion of distorted to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings, shall be repositioned and strengthened; depending on EIC. Poured concrete affected by the faulty formwork, shall be entirely removed and the formwork corrected prior to placing new concrete.

Excessive construction camber to compensate for shrinkage settlement etc. that may impair the structural strength of members will not be permitted.

Forms for substructure concrete may be omitted when, in the opinion of Engineer-in-charge, the open excavation is firm enough to act as the form. Such excavations shall be slightly larger than required by the drawings to compensate for irregularities in excavation and to ensure the design requirement.

Forms shall be so designed and constructed that they can be stripped in the order required and their removal do not damage the concrete. Face form work shall provide true vertical and horizontal joints, conforming to the architectural features of the structure as to location of joints and be as directed by Engineer-in-charge.

Where exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the desired concrete surfaces could be obtained which require a minimum finish.

8.2.5 Bracings, Struts and Props: Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bracings.

The shuttering for beams and slabs shall be so erected that the shuttering on the sides of beams and under the Soffits of slab can be removed without disturbing the beam bottoms.

Repropping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.

If the shuttering for a column is erected for the full height of the column, one side shall be left open (partly only for height as per site requirement) and built upon sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides all the above points mainly to limit the drop of concrete to 1.0 m or as directed by Engineer-in-charge.

Only Steel pipes, steel pipes with props braced, double steel scaffolding, platforms, stairs shall be used as per site requirement.

Packing/ tightening to Props shall be done prior to start of concreting necessary checking required shall be conducted.

8.2.6 Inspection of Form Work

Following points shall be borne in mind while checking during erection of form work and form work got approved by the Engineer-in-charge before placing of reinforcement bars.

a) Any members which is to remain in position after the general dismantling is done, should be clearly marked.

b) Material used should be checked to ensure that wrong items/rejects are not used.

c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening measures must be adopted.

d) i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground. ii) Sole plates shall be properly seated on their bearing pads or sleepers. iii) The bearing plates of steel props shall not be distorted. iv) The steel parts on the bearing members shall have adequate bearing areas.

e) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

f) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.

g) The stacked materials shall be placed as catered for, in the design.

h) When adjustable steel props are used, they should

i) Be undamaged and not visibly bent.

ii) Have the steel pins provided by the manufacturers for used

iii) Be restrained laterally near each end.

iv) Have means for centralising beams placed in the fork heads

v) Screw adjustment of adjustable props shall not be over extended

j) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement/elastic shortening of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/clamped down after adjustment to prevent their shifting.

k) No member shall be eccentric upon vertical member

l) The number of nuts and bolts shall be adequate.

m) Provisions of the design and/or drawings shall be complied

n) Cantilever supports shall be adequate

o) Props shall be directly under one another in multistage constructions as far as possible.

p) Guy ropes or stays shall be tensioned properly

q) There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.

r) Required camber shall be provided over long spans

s) Supports shall be adequate, and in plumb within the specified tolerances.

8.2.7 Form Oil : Use of form oil shall not be permitted on the surface, which require painting. If the contractor desire to use form oil on the inside of form work of the other concrete structures, Mould Releasing agent of Sika/Fosroc or approved equivalent make /a non staining mineral oil or other approved oil CEMOL-35 of M/s. Hindustan Petroleum Co. Ltd may be used, provided it is applied before placing reinforcing steel and embedded parts. All excess oil on the form surfaces and any oil on metal or other parts to be embedded in the concrete shall be carefully removed. Before treatment with oil, forms shall be thoroughly cleared of dried splatter of concrete from placement of previous lift.

Any loss of water through the shuttering should be strictly prevented from placement specially for concrete mix with low water binder ratio or having partial replacement of cement by pozzolanic material. In case of wooden shutter approved quality of form oil or plastic sheet can be use for this purpose.

8.2.8 Chamfers and Fillers : All corners and angles exposed in the finished structure shall be formed with mouldings to form chamfers or fillers on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 20 x 20mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaces to the same texture as the forms to which it is attached.

8.2.8.1 Vertical Construction Joint Chamfers: Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above except where not, permitted by Engineer-in-charge for structural or hydraulic reasons.

8.2.8.2 Wall Ties : Wire ties passing through the walls, shall not be allowed. Also through bolts shall not be permitted. For fixing of form work, alternate arrangements such as coil nuts shall be adopted at the contractors cost.

8.2.8.3 Reuse of Forms : Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak shall be suitably plugged and joints examined and where necessary repaired and the inside retreated to prevent adhesion, to the satisfaction of Engineer-in-charge. Warped lumber shall be resized. Contractor shall equip himself with enough shuttering to complete the job in the stipulated time.

8.2.8.4 Removal of Forms : Contractors shall record on the drawings or a special register,the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed there from.

In no circumstances shall forms be struck until the concrete reaches a strength of at least twice the stress due to self weight and any construction erection loading to which the concrete may be subjected at the time of striking form work.

Strikking shall be done slowly with utmost care to avoid damage to arise and application and without shock or vibration by gently easing the wedge etc. After removing the form work, if it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

Reinforced temporary openings shall be provide as directed by Engineer-in-charge, to facilitate removal of form work which otherwise may be in accessible.

Tie, rods, clamps form-bolts etc. which must be entirely removed from walls or similar structures shall be loosened not sooner that 24 hours not later than 40 hours after concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties withdrawn from walls and grade beams shall be pulled towards the inside face. Cutting ties back from the faces of walls and grade beams will not be permitted. Work damaged due to premature or careless removal of forms shall be re-constructed at contractor's cost.

COAL TAR EPOXY COATING

Scope of work

Applying of coal tar epoxy on concrete surface below plinth level with approved make available in market after getting approval of brand from engineer in charge.

Surface preparation

All surfaces must be cured according to the supplier’s recommendations. Remove all form release and curing agents by sandblasting, shot blasting, mechanical scarification, or suitable chemical means. Patch holes or cracks. Concrete must be free of moisture as much as possible (moisture seldom drops below 15% in concrete). Test for moisture or dampness by taping an 18 inch by 18 inch plastic sheet (4 mils thick) on the bare surface, sealing all of the edges. After a minimum of 16 hours, inspect for moisture, discoloration, or condensation on the concrete or the underside of the plastic. If moisture is present, the source must be located and the cause corrected prior to painting. Brush blasting required for immersion service.

APPLICATION PROCEDURES

- Surface preparation must be completed as indicated.
- Mix contents of each component thoroughly with power agitation. Make certain no pigment remains on the bottom of the can. Then combine three parts by volume of Part A with one part volume of Part B. Thoroughly agitate the mixture with power agitation. Allow the material to sweat-in as indicated. Re-stir before using.
- If reducer solvent is used, add only after both components have been thoroughly mixed, after sweat-in.
- Apply paint at the recommended film thickness and spreading rate as indicated.

Measurements

The measurements shall be taken in sq m.

SHALITEX BOARD

Providing and fixing required thickness of Pre-molded compressible filler board in black color, conforming to highway clause 1015 having minimum density of 100±5 Kg/m3, water absorption less than 0.09Kg/m2 and compression recovery of 93%. The product should be non-deteriorating and non-staining.

Material

Material should be of STP or Shalimar or equivalent make sample to be approved by the engineer in charge.

Procedure

- The area where the board is to be fixed should be thoroughly cleaned
- The boards are to be cut as per the thickness and fixed at the desired location using liquid bitumen by applying the same to the surface and then sticking the board to it.
- The top of the board is to be kept 10 to 15mm below the concrete surface.
- This gap is to be filled by using polysulphide sealant.

Measurement

Measurement to be done in Square Meter.

GP2 GROUTING

Scope

Grouting gap between structural steel base plates of column and RCC column pedestal and also grouting of anchor bolts with GP2 of Fosroc or equivalent make.

Application

All surfaces should be free from dirt, dust, grease, oils, and other contaminants.

Surfaces should be pre-wetted/ saturated with clean water for 4 to 6 hours; free surface water should be removed before grouting with GP2.

Mixing

Add GP2 powder to potable water in the ratio recommended for its consistency. Approximate ratios are as per below

Flow able Grout: Water/25kg grout bag 4.25 L

Plastic Grout: Water/25kg grout bag 3.25 L

Manual mixing is not at all recommended. Use mechanical mixer like paddle or revolving drum type. Full 5 minutes mixing to get homogeneous consistency is required. Fluid grout should be placed within 20/30 minutes. In gelled material no further addition of water is allowed and should be discarded.

Placement

Pouring head should be used for base plate grouting. For holding down bolt in 10 cm and above diameter hole or grout bed exceeding 80 mm thickness well graded clean aggregate from 5 mm to 15 mm in saturated surface dry condition may be used along with grout up to 25 to 30% of grout weight.

Edge finish/Curing

Plastic grout may be used for edge finish. Exposed edges after 8 hours of grouting should be kept under steel plate up to 24 hours and then normal curing with wet hessian or ponding may be carried out.

Measurement

Measurement will be done in KG and contractor to maintain consumption records. All records to be dully signed by the engineer in charge.

9. DAMP PROOF COURSE :

9.1 SCOPE OF WORK : The work covered under this specifications consists supplying and laying plain cement concrete as damp proof course with or without waterproofing admixture in accordance with this specification and applicable drawings.

9.2 WORKMANSHIP : Surface to receive damp proof course shall be cleaned and carefully swept to remove all dust, laitance etc. and shall be approved by the Engineer-in-Charge. Damp proof course shown shall be cement concrete as per proportion indicated in the schedule. Approved water proofing compound @ 3% by weight of cement or as directed by the manufacturer shall be mixed in concrete mix. The damp proof course shall be laid to the full width of the wall and the edges shall be straight, even and truly vertical. Wooden forms shall be used to obtain good edges. No masonry work shall be commenced on freshly laid damp proof course unless it is cured for 48 hours of its laying but the curing of cement concrete shall be continued along with the masonry work. Specifications for cement, sand, aggregate and water shall be as described herein before for concrete works.

9.3 MODE OF MEASUREMENT : The work shall be measured in Sqm. area actually laid limited to sizes as shown in drawing. The rate shall include cost of all the materials, labour etc.

* * *

10. PRECAST REINFORCED CEMENT CONCRETE JALLI :

GENERAL :

The item refers to manufacturing, supplying and fixing in position reinforced cement concrete jalli with thickness, proportion, design and pattern as specified in the description of item of schedule of quantities.

MATERIALS :

The concrete shall consist of a mix as specified in the item and specifications for cement concrete shall be similar to that specified under cement concrete. Reinforcement shall be as specified in the item description or as shown in the drawing or as directed by the Engineer-in-charge.

MANUFACTURE :

Precast jalli of approved design and thickness as specified in description of item shall be cast at site and fixed in position at all floors and levels as shown the drawing by the contractor. Steel moulds to manufacture approved size, design and thickness of reinforced jalli as per drawings shall be manufactured and got approved before starting large scale casting. Reinforced jalli shall be cast at site. M.S. reinforcement of 6 mm. dia. or as specified shall be bent to the exact shape of jalli to run vertically and horizontally along centre of all walls and suitably kept in position. Use of teak wood/shuttering plywood moulds can be allowed at the discretion of the Engineer-in-charge. Precast Jalli shall be made by filling the moulds of the approved design, pattern with complete batch of 1:2:2 (using 10 mm. down graded stone aggregate) cement concrete so that the entire work may set in one time. If one batch is sufficient to complete a unit, each succeeding batch should follow the preceding batch as quickly as possible. The specifications for reinforced cement concrete shall conform to I.S. 456 and as specified earlier. The jalli shall be cast according to drawing, design and as approved by the Engineer-in-charge. Necessary holes and keys for M.S. dowels to house in the jalli shall be left for fixing. Jallies shall be cured in a curing tank for a minimum period of 14 days. All the imperfection in surfaces and edges shall be repaired with neat cement paste to finish with sharp and smooth edges. The jalli so manufactured shall be perfectly at right angles when checked with straight

edge. Jallies which are not approved due to defective pattern, shape, finish etc. shall be removed forthwith from the site of work.

FIXING :

The jalli shall be fixed in position in cement mortar 1:2 in preformed opening true to line, level and plumb with 6 mm. M.S. pins, all as per drawing or as directed by the Engineer-in-charge. Jalli with damaged edges of surfaces shall not be fixed. The joints shall be cured for a minimum period of 7 days. After grouting the sides with cement mortar etc., the jalli shall be rechecked for its levels and alignment. Finally the jambs, sills and soffits shall be plastered embedding the jalli uniformly on sides. The jalli shall be cleaned off all the mortar splashes, dirt etc.

MODE OF MEASUREMENT:

The jalli shall be measured in square metre and shall be measured between the limiting dimensions of unplastered sides, base and top. Any portion of jalli embedded in the supporting wall shall not be measured for payment. Dimensions shall be measured correct upto two places of decimal of a metre and the area worked out upto two places of a decimal of square metre. No deduction shall be made for the openings in the jalli. The thickness shall not be less than that specified.

RATES :

Rate to include the cost of the following :

i) Providing the precast jalli of approved design conforming to specifications detailed above including concrete reinforcement, moulds etc.

ii) All materials, equipment, labour for handling, transporting, hoisting and fixing the jalli in position including scaffolding, forming grooves if necessary, touching up all sides wherever necessary as per drawing and specifications.

* * * *

REPAIR OF CONCRETE WORK

All repair work will be done using Epoxy Mortar and Epoxy grouting as per the seriousness of the defect.

Concrete with satisfactory test results by with otherwise minor defects shall only be considered unsatisfactory.

Repair of concrete shall be made by skilled workmen. Repairs shall be made as soon as practicable after removal of forms and in a manner to meet the requirements for the finish specified for the particular location.

The extent of repair shall be decided upon by the Engineer-in-charge. The cost of repairs of defective areas shall be borne by the contractor. The Engineer-in-charge may adopt at his discretion any other method of repairing like epoxy grouts or guniting etc., which will be carried out by the contractor at his cost as per the specifications supplied by the Engineer.

Epoxy mortar

Epoxy mortar with quarts sand and SUNEPOXY 358 or approved equivalent brand including applying bonding coat of epoxy with hardener formulations in required porportion (as per manufacturers recommendations) in layers of built up thickness of 20& 40 mm, etc. complete. Epoxy morter shall be applied in wet on wet condition. i.e. epoxy morter should be applied when bond coat is wet.

Epoxy grouting repair work

Injecting approved low viscosity epoxy grout SUNEPOXY 358 or approved equivalent brand with viscosity at 400-500 CP, into concrete at slab, beams, columns etc. by suitable gun/ pump at required pressures drilling and inserting 12mm dia brass grouting multi perforated nipples upto 30mm to 40mm depth, using M Seal around the nipple cutting of nipples after curing, cleaning etc. complete.

1 1 . STRUCTURAL STEEL :

SCOPE OF WORK :

The work covered by this specification consists of furnishing and erecting of structural steel complete in strict accordance with this specifications and the applicable drawings.

MATERIALS :

11.1.1. All structural steel shall be of standard sections as marked on the drawings and shall be free of scale, blisters, laminations, cracked edges and defects of any sort. The Contractor shall furnish duplicate copies of all mill orders and/ or also the test report received from the mills, for the structural steel sections to satisfy the Engineer-in-Charge.

11.1.2. All structural steel and electrodes shall comply in all respects with I.S. for structural steel.

WORKMANSHIP :

All workmanship shall be of first class quality in every respect to the greatest accuracy being observed to ensure that all parts will fit together properly on erection.

All ends shall be cut true to planes. They must fit the abutting surfaces closely. All stiffeners shall be fit tightly at both ends.

All butt ends of compression members shall be in close contact through the area

of the joints.

All holes in plates and section between 12 mm. and 20 mm. thick shall be punched to such diameter that 3 mm. of metal is left all around the hole to be cleaned out to correct size by reamer.

The base connection shall be provided as shown on drawings and the greatest accuracy of workmanship shall be ensured to provide the best connections.

Figured dimensions on the drawings shall be taken.

ERECTION AND MARKING :

Erection and fabrication shall be according to I.S. 800-2007. During erection, the work shall be securely braced and fastened temporarily to provide safety for all erection stresses etc. No permanent welding shall be done until proper alignment has been obtained.

Any part which do not fit accurately or which are not in accordance with the drawings and specifications shall be liable to rejection and if rejected, shall be at once be made good.

Engineer-in-Charge shall have full liberty at all reasonable times to enter the

contractors premises for the purpose of inspecting the work and no work shall be taken down, painted or despatched until it has been inspected and passed. The contractor shall supply free of charge all labour and tools required for testing of work.

DELIVERY AT SITE :

The contractor shall deliver the component parts of the steel work in an undamaged state at the site of the works and the Engineer-in-Charge shall be entitled to refuse acceptance of any portion which has been bent or other wise damaged before actual delivery on work.

SHOP DRAWINGS :

The shop drawings of structural steel based on contract drawings shall be submitted to the Engineer-in-Charge. The necessary information for fabrication, erection, painting of structure etc. must be furnished immediately after acceptance of the tender.

PAINTING :

Painting should be strictly according to I.S. 1477 (PartI-Pretreatment) and I.S. 1477 (Part II-painting).

Painting should be carried out on dry surfaces free from dust, scale etc. The paint shall be approved by the Engineer-in-Charge. The painting system for main framework trusses, columns, steel staircase structural steel shall be Surface preparation by shot blasting & epoxy painted or as specified in the drawings & requirement of EIC. Surface preparation shall be by mechanical means for insert plates, corner angles & enamel /epoxy painted all as specified in the drawings & requirement of EIC.

One coat of shop paint shall be applied on steel, except where it is to be encased in concrete or where surfaces are to be field welded.

WELDING :

Welding shall be in accordance with I.S. 816, I.S. 819, I.S. 1024, I.S. 1261, I.S. 1323 and I.S. 9595 as appropriate. For welding of any particular type of joint, welders shall give evidence of having satisfactory completed appropriate tests as described in any of I.S. 817, I.S. 1393, I.S. 7307 (Part-I), I.S. 7310 (Part-I) and I.S. 7318 (Part-I) as relevant.

11.1.3. Welding Consumables : Covered electrodes shall conform to I.S. 814 and or I.S. 1395 as appropriate.

Filler rods and wires for gas welding shall conform to I.S. 1278.

The filler rods and bare electrodes for gas shielded metal, arc welding shall conform to I.S. 6419 and I.S. 6560 as appropriate.

11.1.4. Types of Welding: Arc welding (direct or alternating current) or Oxyacetylene welding may be used. Field welding may be used. Field welding shall be by D.C.

11.1.5. Size of Electrode Runs: The maximum gauge of the electrodes for welding any work and the size of run shall be based on the following tables.

Average thickness of plate or section	**Maximum gauge or diameter of electrodes to be used.**
Less than 3/16"	10 S.W.G.
3/16" and above but less than 5/16"	8 S.W.G.
5/16" and above but less than 3/8"	6 S.W.G.
3/8" and above but less than 5/8"	4 S.W.G.
5/8" and above but less than 1"	5/1 6"dia.
1" and above thick section	3/8" dia.

Note : On any straight weld the first run shall not ordinarily be deposited with a larger gauge electrode than No. 8 S.W.G. For subsequent runs the electrode shall not be increased by more than two electrode size between consecutive runs.

11.1.6. Welding Contractors : The contractor shall ensure that each welding operator employed on fabrication or erection is an efficient and dependable welder, who has passed qualifying tests on the types of welds which will be called upon to make. Sample test shall have to be given by the contractor to the entire satisfaction of the Engineer-in-charge.

11.1.7. Welding Procedure :

a) Welding should be done with the structural steel in flat position in a down hand manner wherever possible. Adequate steps shall be taken to maintain the correct arc length, rate of travel, current and polarity for the type of electrode and nature of work. Welding plant capacity shall be adequate to carry out the welding procedure laid down. Adequate means of measuring the current shall be available either as a part of the welding plant or by the provision of a portable ammeter. In checking the welding current, a tolerance of 10% or 30 amperes from the specified value whichever is less shall be permitted.

b) The welding procedure shall be such as to ensure that the weld metal can be fully

and satisfactory deposited through the length and thickness of all joints so that distortion and shrinkage stresses are reduced to the minimum and thickness of welds meet the requirements of quality specified.

WORKMANSHIP :

11.1.8. Preparation of Fusion Faces : Fusion faces shall be cut by stearing machine or gas cutting and later dressed by filling or grinding so that they shall be free from irregularities such as would interfere with the deposition of the specified size of weld to cause the defects. Fusion faces and the surrounding surfaces shall be free from heavy slag, oil paint or any substance which might affect the quality of the weld or impede the progress of welding. The welding face shall be free of rust (parent structural steel) and shall have metal shine surfaces.

The parts to be welded shall be brought into as close contact as possible and the gap due to faulty workmanship or incorrect fit up shall not exceed 1/16". If separation of 1/16" or more occurs locally, the size of the fillet weld shall be increased at such position by an amount of equal to the width of the gap.

The parts to be welded shall be maintained to their correct position during welding. They shall be securely held in position by means of tack welds, service bolts, clamps or rings before commencing welding so as to prevent and relative movement due to distortion, wind or any other cause.

11.1.9. Step Back Method Should be Used to Avoid Distortion : The minimum leg length of a fillet weld as deposited should not be less than the specified size and the throat thickness as deposited should be not less than that tabulated below:

Throat Thickness of Fillet

Angle between fusion faces	60^0-90^0	91^0-100^0	101^0-106^0	107^0-113^0	114^0-120^0
Throat thickness in cms.	0.70	0.65	0.60	0.55	0.50

In no case should a concave weld be deposited without the specific approval of the Engineer-in-Charge unless the leg length is increased above the specified length so that the resultant throat thickness is as great as would have been obtained by the deposition of a flat.

All welds shall be deposited in a pre-arranged order and sequence taking due account of the effects of distortion and shrinkage stresses.

After making each run of welding, all slag shall be removed and final run shall be protected by clean boiled linseed oil till approved.

The weld metal, as deposited, shall be free from crack, slag, excessive porosity, cavities and other faults. Testing of weld shall be conducted at location of welds as per EIC requirement.

The weld metal shall be properly fused with the parent metal without overlapping or serious undercutting at the toes of the weld.

The surfaces of the weld shall have a uniform and consistent contour and regular appearance.

In welds containing crack, porosity or cavities in which the weld metal tends to overlap on the parent metal without proper fusion, the defective portions of the welds shall be out cut and re-welded. Where serious under cutting occurs, additional weld metal shall be deposited to make good reduction. Testing of welded joints shall be done as per relevant IS codes 3600, 4260, 7307, 7310, 7318.

MODE OF MEASUREMENT:

All structural steel shall be measured on weight basis of kgs or in metric tonnes or quintals as mentioned in the schedule of quantities. The length or areas of various members including gusset plates shall be measured correct to two places of decimals and the net weight worked out from the standard steel tables approved by Indian Standard Institution. No separate measurements shall be taken for welding, riveting, bolting, field connections etc. The rate shall include cost of all labour, materials, scaffolding, transport and also cost of welding, riveting and bolting, field connections if any all to complete the job as per specifications.

12. BRICK WORK :

SCOPE OF WORK :

The work covered under this specification pertains to procurement of well burnt clay bricks of class 35 unless otherwise specified and workmanship in building walls of various thickness, in strict compliance with the specifications and applicable drawings.

MATERIALS:

Brick shall be well burnt clay bricks of designated class and shall satisfy the strength criteria and shall be got approved by the Engineer-in-Charge before incorporation in the work. The bricks shall be hand moulded or machine moulded and shall be free from nodules of free lime, visible cracks, flaws, warpage and organic matter.

In general, the nominal size of bricks (F.P.S.) shall be 22.9 x 11.4 x 7 cm. (9"x4.5"x2.75"). Permissible tolerance on dimensions shall not be more than (+/-) 8%. The contractor shall get approved the sample and source of bricks from Engineer-in-Charge before procurement on large scale and shall maintain the same for the entire work. The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour.

Bricks for Mumbai / Pune and surrounding areas, unless otherwise specified, shall be as per relevant IS of class designation 35 of size 22.5 x 11.1 x 7 cm. Permissible tolerance on dimensions shall not be more than (+/-) 8%.

Unless otherwise specified, bricks for Eastern Zone works (Kolkata / Bhubneshwar / Shillong etc.) shall be of class designation 75 of size 25 x 12.5 x 7.5 cm. Permissible tolerance on dimensions shall be as per relevant IS.

In case the size of bricks used in the work is found lesser than the specified one but within the permissible tolerance i.e. {-} 8% , the following shall apply:

i. Extra cement consumed due to more number of joints and due to additional thickness of plaster than the specified in the tender to match with adjoining columns and beams, shall be borne by the contractor without any extra cost .

ii. If the plastering to be done is more than the specified thickness to maintain the plaster surface to perfect line, level and plumb with adjoining columns, beams, walls etc., the contractor shall be responsible to provide more thickness of plaster at his own cost and nothing extra will be paid on this account.

In case the size of bricks used in the work is found more than the permissible, the contractor shall chip out the exposed edges of bricks upto the required level of wall to receive specified thickness of plaster.

Bricks shall generally conform to I.S. 1077. In any case minimum crushing strength shall not be less than 35 kg/cm^2 and water absorption shall not be more than 20% by weight. The Engineer-in-Charge shall have the right to reject bricks obtained from any field where the soil has an appreciable quantity of sulphates and chlorides. The specifications for cement, sand and water shall be same as described herein before under cement concrete.

Bricks shall be thoroughly soaked in water before using till the bubbles ceases to come up. No half or quarter brick shall be used except as closer. The closer shall be cut to required size and used near the end of the walls. The walls shall be raised truly to plumb. The type of bond to be adopted shall be decided by the Engineer-in-Charge, but vertical joints shall be laid staggered.

WORKMANSHIP :

Four courses of brick work with four joints should not exceed by more than 40 mm., the same bricks piled one over the other without mortar.

Brick work shall not be raised more than 10 courses a day unless otherwise approved by the Engineer-in-Charge. The brick work shall be kept wet for at least 7 days. Brick work shall be uniformly raised alround and no part shall be raised more than 1.0 metre above another at any time.

All joints shall be thoroughly flushed with mortar of mix as specified in the schedule of quantities, at every courses. Care shall be taken to see that the bricks are bedded effectively and all joints completely filled to the full depth.

The joints of brick work to be plastered shall be raked out to a depth not less than 10 mm. as the work proceeds. The surface of brick work shall be cleaned down and watered properly before the mortar sets.

The adhesion between the brick masonry surface and the concrete surface of columns, beams, chajjas, lintels etc. should be proper by ensuring that the concrete surface coming in contact with brick masonry is hacked/ chipped/ keyed, cleaned and cement slurry is applied so that a proper bond is achieved between the two dissimilar materials. It is the responsibility of the contractors to ensure that there will not be any cracks/ fissures anywhere in the brick masonry.

In case the cracks appear subsequently in those areas, they should be made good by cement grouting or epoxy putty grouting/ poly sulphide compound grouting or as per standard modern specifications/ methods with the prior approval of the Engineer-in-Charge, at the cost of the contractor.

All the courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Specified mortar of good and approved quality shall be used. Lime shall not be used where reinforcement is provided in brick work. The mortar should completely cover the bed and sides of the bricks. Proper care should be taken to obtain uniform mortar joint throughout the construction the walls should be raised uniformly in proper, approved bond. In construction of the wall, first of all two end corners are carefully laid to line and level and

then in between portion is built, with a cord stretching along the headers or stretchers held in position at the ends. This helps in keeping the alignment of the courses and maintaining them in level. Similarly all other courses are built. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances :

a. Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

b. Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5mm.

c. Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

d. Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.

e. A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 meter rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

No brick work shall be carried on during frosty weather except with the written permission of the Engineer-in-Charge, who will give special directions as to the manner in which the work is to be performed. All brick work laid during the day, shall, in seasons liable to frost, be properly covered up at night as directed by the Engineer-in charge. Should any brick work be damaged by frost, the brick work shall, at the discretion of the Engineer-in-Charge, be pulled down and made good, at the cost of the contractor.

Concrete surfaces of columns, beams, lintels, chajjas etc. coming in contact with masonry work shall be wire brushed and shall include cleaning brickwork covered with fungus or deleterious materials.

Brick work shall be well watered/ cured throughout the day for at least a week from the date of building and the work shall be protected from sun and rain.

HALF BRICK WORK:

Materials and workmanship for a half brick or brick on edge partition wall shall be as specified above. The wall shall be stiffened by R.C.C. stiffeners of size 115 mm. wide x 80 mm. thickness to the full length of wall and shall be provided with 2 Nos. 6 mm. diameter M.S. bars or as specified in the schedule as bottom reinforcement (only the M.S. reinforcement will be paid separately under relevant item). These bars shall be securely anchored at their end where the partition end. The free ends of the reinforcement shall be

keyed into the mortar /P.C.C bed block of the main brick work to which the half brick work is joined. Overlaps in reinforcement, if any, shall not be less than 30 cm.

The rates for brick work shall include the cost of the following:

i. Providing and fixing necessary single or double scaffolding and removing the same after the work is completed.

ii. Form work for stiffeners concrete as required.

iii. Watering, curing, lifting of materials to any height.

iv. Raking out of joints to receive plaster.

v. Forming slab sittings, cutting or leaving holes for lugs of windows, doors, sills, switch boxes etc.

vi. Making good all holes, chases, etc. to any depth due to conduit pipes, holdfasts, bolts, switch & plug boxes etc.

vii. Bedding and pointing precast lintels, sills etc. in or on walls. For the purpose of measurements, the thickness of one brick wall and over shall be taken in terms of multiples of half brick.

SAMPLING AND TESTS:

Samples of bricks shall be subjected to the following mandatory tests :

a) Dimensional tolerance b) Water absorption c) Efflorescence d) Compressive strength

Note : 1. Cost of above tests shall be borne by the contractor.

2. Frequency of test shall be as per relevant IS specifications.

MODE OF MEASUREMENT :

13.1 a) For Brick Work Measured in Cubic Metres :

The contract rate shall be for a unit of one cubic metre of brick masonry as actually done. 230 mm. thick (or as specified in schedule) brick walls shall be taken as one brick thick.

All openings in brick work for doors, windows and ventilators shall be deducted to get the net quantity of actual brick work done.

Openings or chases required for P.H. or electrical inserts less than 0.1 sqm. and bearing of precast concrete members shall not be deducted.

No extra payment shall be made for any extra work involved in making the above openings or placements.

13.1 b) For brick work measured in square metre :

Half brick thick masonry walls shall be measured in sqm. All openings in brick work for doors and windows and ventilators shall be deducted to get the net quantity of actual work done. Openings or chases required for P.H. or Electric inserts less than 0.1 sqm. and bearing of precast concrete members shall not be deducted. No extra payment shall be made for extra work involved in making the above openings or placements.

13. STONE MASONRY :

SCOPE OF WORK :

The work covered under this specifications consists of supplying and erecting stone masonry walls with available best quality of stone in strict compliance with this specifications and applicable drawings.

RANDOM RUBBLE MASONRY :

13.1.1. Material : The rubble shall be of the best quality trap/granite/ballast stones obtained from the approved quarry. The sample of the stone, to be used shall be got approved from the Engineer-in-Charge. All stones shall, generally, be freshly quarried and shall be sound, dense, hard, free from segregation, cracks, weathered portions and other structural defects or imperfections, tending to off set soundness and strength. The percentage of water absorption shall generally not exceed 5% by weight. All stones shall be wetted before use. Stones shall be neatly worked to requisite sections and forms and shall have fully dressed beds and joints. At least 50% of the stones shall be 0.015 cum in content when reckoned individually. The length of stones for stone masonry shall not exceed three times the height and the breadth or base shall not be greater than three fourth the thickness of wall, or not less than 15 cm. The height of stone may be upto 30 cm. Stones shall be laid on the natural beds and shall run sufficiently inside the wall thickness. No hollow space shall be left out and inter spaces of stones being filled with mortar and stone chips, driven hard & not with mortar only.

All mortar to be used shall be of the type and proportion mentioned in the item. Cement, sand and water to be used shall conform to their relevant specifications as described under cement concrete. The masonry shall be laid to plumb, lines levels, curves, shapes

as shown in drawings. All required holes for passage of water or pipes are to be embedded during construction as specified. The cement to be used should be Ordinary Portland Cement. Lime putty shall be added to the cement sand mix ratio 1 cement: 1 lime putty : 6 fine sand or as required by E.I.C.

All stones shall be wetted before laying in masonry. Concrete surfaces of columns, beams, lintels, chajjas etc. coming in contact with masonry shall be properly chipped, washed and wetted before start of masonry work. The concrete surface coming in contact of masonry shall be given a thick coat of cement slurry as the masonry work progresses in height. Clean chips and sprawls carefully selected to fit in the space shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints or mortar. However, proper shaping and dressing of stones shall be done prior to their laying in masonry and hammering shall not be resorted to often after the stones are laid in position. The bond stones shall be used in every square meter area of masonry wall and shall extend from front to back to thin walls having width of 600mm and shall overlap by at least 150mm in walls having thickness more than 600mm when laid from both sides. Engineer-in-Charge may permit cement concrete 1:2:4, in-situ / pre-cast, to act as bond stone, as required. When the work has to be started on the old or the one completed a long while ago or in the previous working seasons, care shall be taken to roughen and clean old surface satisfactorily without disturbing the masonry before laying the new. It shall be wetted before laying the bedding mortar.

A key between the stones by providing a groove in one stone to take a corresponding concealed projection in the edges on the other stone.

When practicable, the whole masonry in any structure shall be carried out upto a uniform level throughout. But when breaks are unavoidable in carrying the work continuously in uniform level, sufficiently long steps shall be left. All junction of walls shall be formed at the time when walls are being built. Cross walls should be carefully bonded into the main walls. All masonry built in cement mortar shall be kept continuously wet for 14 days from the date of laying. Should the mortar perish i.e. becomes dry, white or powder through neglect of watering and if the masonry shows hollow joints or non adherence of mortar to the stones or if the work does not conform to drawings and specifications, the work shall be pulled down and rebuilt by the contractor at his own cost and risk. All masonry shall be thoroughly cleaned and washed down on completion and all stains, adhering mortar removed from the surface and raking of joints carried out as the scaffolding is being lowered and removed. Holes left in masonry for supporting scaffolding shall be filled and made good before pointing/ plastering.

KHANDKI FACING STONE MASONRY :

The specifications for Random rubble masonry as given in item No. 14.1.1 shall generally apply to these for quality of stones, workmanship etc. except for the following:

The face of the stones shall be square/ rectangular in shape and shall be so dressed alround that those can be set on proper bases and shall render uniform joints. The stones may have bushing on the face but shall not project more than 40 mm. The external faces shall be laid in courses of about 200 mm. height or as specified and the internal face shall be finished with rubble backing.

The other specifications, mode of measurements etc. shall be same as per specifications for R.R. Masonry mentioned above.

MODE OF MEASUREMENT :

All stone masonry shall be measured in cubic metres as actually done. All openings for windows, doors, lintels etc. shall be deducted to get the net quantity of actual work done. Openings or chases required for P.H. and electrical inserts less than 0.1 sqm. and bearings of precast concrete members shall not be deducted. The rate shall also include cost of corner stones, bond stones, scaffolding ,labour, curing etc.

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14. PRECAST CEMENT CONCRETE SOLID BLOCK MASONRY:

Scope of Work : The work covered under this specifications pertains to procurement of best quality locally available or locally manufactured precast cement concrete solid block and workmanship in building walls of various thickness in strict compliance with the specifications and applicable drawings.

Material : Precast cement concrete solid blocks shall be of best quality locally available/ manufactured at site and should be approved by the Engineer-in-Charge before incorporation in the work. The ingredient and the cement concrete used shall confirm to relevant I.S. as stipulated in specification for cement concrete works herein before.

Minimum crushing strength of the solid blocks shall be 40 to 60 Kg/ sqcm. at 28th day after curing. The type of the bond to be adopted will be decided by the Engineer-in-Charge but vertical joints shall be staggered. The size of the blocks shall be 390 x 190 x 140 mm. and 390 x 190 x 100 mm. and the proportion used in making the blocks shall be 1:11 (1 cement : 11 fine and coarse aggregates)/ 1:6 . The blocks shall be cured well at least for 14 days before incorporation in to the work. The cement mortar for concrete blocks masonry shall be 1:4 and joints shall not be more than 10 mm. thick.

Workmanship and Mode of Measurement : The workmanship and mode of measurement shall be as stipulated in the specification for brick work as applicable stated earlier and concrete block masonry with 140 mm. thick block shall be measured in sqm. nearest to two places of decimals of a metre. The rate quoted shall include cost of all materials, labour including form work in casting the blocks, curing, transporting, handling, hoisting the blocks to proper level, curing masonry etc. complete.

15. CEMENT CONCRETE FLOORING (IPS) :

SCOPE OF WORK :

The work covered under this specification consists of providing and laying at all levels and floors, flooring of different types, strictly in accordance with these specifications and relevant drawings.

CEMENT CONCRETE FLOORING (INDIAN PATENT STONE) :

Materials : The specifications for materials, grading, mixing and the quantity of water to be added shall generally conform to their relevant specifications described under plain and reinforced concrete. The maximum size of coarse aggregate shall be 10 mm. The fine aggregate shall consist of properly graded sand. Concrete shall be mixed preferably by machine, and hand mixing shall be avoided as far as practicable.

Preparation of Base : The base concrete surface shall be thoroughly chipped to remove laitance, caked mortar, loose sand, dirt etc. cleaned with wire brush and washed clean and watered until no more water is absorbed. Where the base concrete has hardened so much that roughening the surface by wire brushes is not possible, the same shall be roughened by chipping or hacking at close intervals. The surface shall be soaked with water for at least 12 hours and surface water removed and dried before laying the topping. Before laying the concrete, cement slurry at 2.75 kg./ sqm. of surface shall be applied for better bond. Concrete flooring shall then be laid in alternate bays in pattern and joints, wide/ flush as per drawing. The edge of each panel into which the floor is divided shall be supported by wooden or metal strips duly oiled to prevent sticking. The panels shall be of uniform size and, unless otherwise specified, no dimension of panel shall exceed 2 m. and the area of a panel shall not be more than 2 sqm. However, the exact size of panel shall be decided by the Engineer-in-Charge to suit the size of the room. The joints in the floor finish shall extend through the borders and skirting/dado. The border shall have mitred joints at the corners of the room. Where glass/ aluminium dividing strips are proposed to be provided, the same shall be fixed in cement mortar 1:2 @ 1.5m. centres or as specified in

the schedule for full depth (Preferably 1 mm below, it should be checked that it should not cause injury) of the finished floor.

The depth of dividing strips shall be the thickness as proposed for the finished floor in the item. In the case of flush joins, alternate panels only may be cast on same day. At least 48 hours shall elapse before the concreting of adjacent bay is commenced.

Mixing : The topping concrete shall be of mix of one part of cement, two parts of sand and 4 parts of well graded stone chips of 10 mm. maximum size. The ingredients shall be thoroughly mixed with just sufficient water to the required plasticity, having water cement ratio not more than 0.4.

Laying : The free water on the surface of the base shall be removed and a coat of cement slurry to the consistency of thick cream shall be brushed on the surface. On this fresh grouted base, the prepared cement concrete shall be laid immediately after mixing. The concrete shall be spread evenly and laid immediately after mixing. The concrete shall be spread and levelled carefully. The concrete shall be completed and brought to the specified levels by means of a heavy straight edge resting on the side forms and down ahead with a sawing motion in combination with a series of lifts and drops alternatively with small lateral shifts, either mechanically or manually as directed by the Engineer-in-Charge.

Concreting shall be done in alternate bays; care shall be taken to ensure that the edges of the previously laid bays are not broken by carelessness or hand tamping. Immediately after laying the concrete, the surface shall be inspected for high or low spots and any needed correction made up by adding or removing the concrete and whole surface is again levelled. When the layer is made even, the surface shall be completed by ramming or beating and then screed to a uniform line and level. Before the initial set commences, the surface shall be trowelled to smooth and even surface free from defects and blemishes and tested with straight edges. No dry cement or mixture of dry cement and sand shall be sprinkled directly or empty gunny bags spread over the surface of the concrete to absorb excess water coming on top due to floating.

Finishing the Surface : After the concrete has been fully compacted, it shall be finished by trowelling or floating. Finishing operations shall start shortly after the compaction of concrete and shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled intermittently at intervals for several times so as to produce a uniform and hard surface. The satisfactory resistance of floor to wear depends largely upon the care with which trowelling is carried out. The object of trowelling is to produce as hard and close knit a surface as possible.

The time interval allowed between successive trowelling is very important. Immediately after laying only just sufficient trowelling shall be done to give a level surface. Excessive trowelling in the earlier stages shall be avoided as this tends to work a layer rich in cement to the surface, some time. After the first trowelling, the duration depending upon the temperature, atmospheric conditions and the rate of setting of cement used, the surface shall be retrowelled many times at intervals to close any pores in the surface, and to bring to surface and scrap off any excess water in concrete or laitance (it shall not be trowelled back into the topping). The final trowelling shall be done well before the concrete has become too hard but at such a time that considerable pressure is required to make any impression on the surface. Trowelling of rich mix of dry cement and fine aggregate on to the surface shall not be permitted. Trowel marks should not be seen on the finished surface.

Where broom finish is specified, after the concrete has been thoroughly compacted, and when most of the surface water has disappeared, the surface shall be given broom finish with an approved type of brass or M.S. fiber. The broom shall be pulled gently over the surface from edge to edge in such a manner that corrugation shall be uniform in width and depth, the depth shall be not more than 1.5 mm. Brooming shall be done when the concrete is in such a condition that the surface will not be torn or unduly roughened by the operation. Coarse or long bristles which cause irregularities or deep corrugation shall be trimmed out. Brooms which are worn or otherwise unsatisfactory shall be discarded.

After the concrete in the bays has set, the joints of the panels by cement cream and neatly floated smooth or jointed. Care should be taken that just the minimum quantity of cream for joint is used and excess spilling over the already finished surface shall be removed when the cream is still green.

In case of wide joints the same shall be filled with pigmented cement concrete (1:2:4) using approved pigment and the joint shall be finished in perfectly straight line.

Steel Trowel Finish : Areas where Marblex tiles are proposed to be used are required to have base concrete finished smooth by steel trowel.

Curing : The completed flooring shall be protected from sun, wind and rain for the first two days and movement of persons over the floor is prohibited during this period. The finished surface shall be covered and cured continuously form the next day after finishing, at least for a period of 7 days. Bunding with murrum for curing is prohibited as it will leave permanent stain on the finished floor.

Pond Curing shall be done by spreading sand and kept damp throughout the curing period of seven days minimum. The surface shall be protected from any damage to it

whatsoever. The surface shall then be allowed to dry slowly. All corners, junctions of floor with plastered wall surface shall be rounded off when required at no extra cost.

Mode of Measurement : The rate for flooring and skirting shall be in square metre of the area covered.

The length and width of the flooring shall be measured net between the faces of skirting or dado or plastered faces of walls which is the proudest.

All openings in flooring exceeding 0.1 sqm. in area where flooring is not done shall be deducted and net areas only shall be measured and paid for. Flooring under dado, skirting or plaster shall not be measured for payment.

Nothing extra shall be paid for laying the floor at different levels in the same room.

The dimensions shall be measured upto two places of decimals of a metre and area worked out upto two places of decimal of a square metre.

16. NON METALLIC CONCRETE HARDENING FLOORING.

16.1. GENERAL :

To withstand heavy wear and tear, concrete flooring with non metallic concrete hardening powder / liquid shall be laid as wearing layer as detailed below:

16.2. NON METALLIC CONCRETE HARDENING COMPOUND :

Non Metallic cementitious hardening powder shall be of approved quality

16.3. CEMENT CONCRETE UNDER LAYER :

Cement concrete flooring of specified thickness and mix shall be laid as specified and generally conforming to specifications laid down for cement concrete flooring. The top surface shall be roughened with brushes while the concrete is still green and the form shall be kept projecting up 12 mm. over the concrete surfaces, to receive the non metallic hardening compound topping.

In cases the top concrete while green shall be sprinkled with Non metallic hardner powder of approved make in dosage as per Medium /heavy traffic (Traffic intensity as in our Project case as specified in drawing/ required by E.I.C) specified by the Product manufacturer.

16.4. NON METALLIC CONCRETE HARDENER TOPPING :

The Non Mettalic concrete hardener powder shall be manually sprinkled/ mechanical spreader uniformly (evenly spread) in proportion at two intervals at different directions as specified by approved manufacturer over the Concrete slab while the concrete is Green. The topping shall be laid true to provide a uniform and even surface. It shall be finished using manual trowel by wooden float/mechanically Power trowel (ride on trowel type) with disc/ blades as required by the Engineer-in-charge.

CURING, PRECAUTIONS, MEASUREMENTS ETC. :

Specifications for curing, precautions, quantity measurements etc. shall be same as specified for cement concrete flooring.

17. CEMENT CONCRETE FLOORING WITH RED OXIDE TOPPING

17.1. GENERAL :

Red oxide of iron when used, gives an improved appearance to concrete flooring. The specifications shall be as under.

17.2. RED OXIDE OF IRON :

Red oxide powder as the name indicates is a fine powder of iron oxide, red in colour normally available in market shall be obtained in adequate quantity and stores in clean dry place. Powder should conforms to IS 44 Grade 2, shades /tones should conforms to IS 5.

17.3. PREPARATION OF BASE :

The specifications for cement concrete flooring (I.P.S.) shall be followed for this work also.

17.4. UNDER LAYERS :

The under layer of flooring of specified thickness shall be of cement concrete 1:2:4 mix using 10mm. maximum size coarse aggregate. The dividing strips of aluminium or glass if required to be retained shall not be removed and kept in position properly. After the consolidation is over, the top surface shall be left rough by drawing diagonal lines 2 mm. deep at 75 mm. centres both ways.

17.5. TOP LAYER :

17.5.1. Mortar: The top layer shall consist of uniform and smooth layer of specified thickness and of mix 1.3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement if required as per site requirement .

17.5.2. The cement shall be mixed dry with red oxide powder in the proportion of 1 part of red oxide & 3 parts of cement. This mixture shall be used in both the cases i.e. for mixing mortar for top layer and also for floating coat. Full quantity of materials required for one room shall be mixed and kept ready to ensure uniform colour. Net mortar shall be prepared in usual manner.

Alternate panels shall then be taken in hand for laying under layers, top layers as process repeated. Rounding at the junction with the wall shall be done, if required, to a radius of 25 mm.

17.6. CURING: Similar to Cement concrete flooring (IPS).

17.7. MODE OF MEASUREMENT: Similar to Cement concrete flooring (IPS).

GENERAL NOTE FOR ALL TILING WORKS:

Where the size of flooring Tiles and height of risers, skirting or dado does not admit full size of other finished size tiles, the tile(s) are to be cut / sawn to the required size and nothing extra shall be paid for the same. Sand should not be stacked adjacent to constructed walls, but away if in rooms while tiling. Full cement paste should be pasted to back of wall tiles prior to pressing against the wall. Tile should be laid on roughned wall plastered/concrete surface. Tile which absorb water should be dipped in water prior to laying as per standard construction practices. Coloured readymade grout / White cement with coloured pigment shall be used of approved make for jointing location of colour matching the tiles ,sample for this activity shall be firstly conducted at one location got it approved from the EIC prior to proceding with the rest of the tiling work. Sample of the tiles shall be brought by the contractor got it approved from Architect/EIC prior to order.

Floor tiles & wall tiles shall be fitted by cementitious Polymer modified tile adhesive depending on the bases new or existing & if on plaster / concrete screed /mortar bedding, base preparation shall be site conditions & work done as per manufacturer specification.

The type of tile adhesive shall be selected based on the type of tile Ceramic or vitrified & application/ location & properties required.

Floor & wall tiles subjected to water shall be grouted at joints with polymer modified cementitious water repellant joint filler (Colour, drop effect water repellent & Mould resistance) for wet areas.

Floor & wall tiles jointing shall be done with three component epoxy system chemical resistant joint filler where it would there is a requirement of Hygiene in kitchen etc. & wet areas like swimming pools,& if fungus resistance, resistance to stains & chemical resistance is required.The epoxy joint shall be used as per manufacturer's specification.

Tile Grout which allows light to pass & Other special requirement of Tile Grout as a Green Product which provides photo luminescence during dark shall be used in cases if required by Architect / EIC.

Notched trowel shall be used for bed laying. When applying on walls, the adhesive should be applied in horizontal parallel strokes for dry areas, and vertical strokes for wet areas. Do not apply in swirls as this causes air pockets to form. The tile should be pressed into place with a twisting and/or sliding action to ensure a good contact with the adhesive. It is recommended that during tile fixing, an occasional tile is lifted back up, to verify that the desired contact is being achieved.

suggests the following:-

• 200mm × 200mm — 8mm notched trowel

• 250mm × 250mm — 10mm notched trowel

• 300mm × 300mm — 12mm notched trowel

• 400mm × 400mm and above — 12 mm notched trowel and buttering of the tile

TERRAZZO / CEMENT TILE FLOORING, SKIRTING/ DADO ETC:

17.8. MORTARS :

17.8.1. Cement Mortar : This shall be prepared by mixing cement and sand in specified proportions given in schedule of quantities, in a mixer. Hand mixing will not be allowed.

17.8.1.1. Proportioning : The unit of measurement for cement shall be a bag of cement weighing 50 kg and this shall be taken as 0.035 cum. Sand in specified proportion shall be measured in boxes of suitable size. It shall be measured on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage which shall be determined as per IS specifications and as per the method given herein before.

17.8.1.2. Mixing : The mixing of mortar shall be done at site of work in mechanical mixer. Hand mixing, if permitted, shall be done as directed by the Engineer-in-charge.

17.8.1.3. Mixing in Mechanical Mixer : Cement and sand in the specified proportion shall be mixed dry, Care shall be taken not to add more water than that shall bring the mortar to the consistency of a stiff paste.

Only the quantity of mortar, which can be used within 30 minutes of its mixing shall be prepared at a time. Mixer shall be cleaned with water each time, before suspending the work.

17.8.2. Hand Mixing : The measured quantity of sand shall be levelled on clean (unrusted) Galvanised steel side closed tray /closed masonry plastered platform and cement bags emptied on top. In hand mixing the quantity of cement shall be increased by 5% above the specified, with no extra cost. The cement and sand shall be thoroughly mixed dry by being turned over and over backwards and forwards several times till the mix is of a uniform colour. The quantity of dry mix which shall be used within 30 minutes shall then be mixed in thoroughly with just sufficient quantity of water to bring the mortar to the consistency of a stiff paste. Mixing of mortar on floor slabs or landings of staircase shall not be allowed.

17.8.3. General : Mortar shall be used as soon as possible after mixing and before it has begun to set, and in any case within 30 minutes after the water is added to the dry mixture. Mortar unused for more than 30 minutes shall be rejected and removed from the site of work.

17.9. MATERIALS :

The terrazzo/ cement tiles for flooring and skirting shall be hydraulically pressed under a minimum pressure of 140 kg./sqcm. and shall conform to I.S. 1237 in respect of constituent materials, manufacture, shape, tolerances, wearing layers, colour, appearance, general quality of tiles, strength, resistance to wear, water absorption and other tests. The tile shall be nominal size and thickness as specified in the schedule for flooring, skirting, dado work etc. and shall be of approved make.

E.I.C or his representative shall be at liberty to inspect the manufacture of tiles even at the factory to ascertain whether the manufacture is as per the approved tiles for its quality of materials and manufacture. Tiles to be used for skirting and dado shall be semipolished before placing in position. Contractor shall submit samples for flooring and skirting tile for approval of the Engineer-in-charge. The Engineer-in-charge may direct new samples made with varying proportions, sizes and colour of terrazzo chips against varying base

before conveying his decision about the approved samples. No claims will be entertained for rejected samples. The contractor shall ensure the terrazzo finish as per approved sample for the entire qty. of tiles, by dry mixing of the cement, marble chips, powder, white cement, pigments etc. in the same proportions. For wearing layer of all tiles, the contractor shall use the cement from one consignment only to ensure uniformity in background colour/ shade.

If there is a doubt about the quality of the tiles, they shall be tested from each consignment as specified in I.S. 1237 and cost of testing shall be borne by the contractor. Sample tiles after being approved shall be kept with the Engineer-in-Charge for reference till the completion of the work. All tiles which are to be incorporated in the work shall strictly conform to the approved samples.

The tiles shall be stored in room or under such cover as will prevent exposure to dampness, sun, rain, accidental injury or staining. Tiles to be incorporated in the work shall be immersed in water for a minimum period of 6 hours before use.

17.10. BEDDING/ BACKING COAT :

In case of flooring / skirting, the mortar bedding / backing shall be of cement mortar of specified thickness and mix as specified in the schedule of work. All the ingredients of cement mortar shall be got approved by the Engineer-in charge before incorporating in the work.

17.11. CLEANING OF SURFACE & LAYING OF CEMENT MORTAR BEDDING :

Before laying the cement mortar bedding the concrete floor surface shall be thoroughly hacked, cleaned of all mortar scales, concrete lumps etc. brushed, washed with water to remove mud, dirt etc. from the surface and shall be thoroughly wetted. Until and unless the surface is approved by the Engineer-in-charge, the flooring shall not be started. A bedding of cement mortar (1:4 of specified thickness or more if required to make up the level or grade) shall be laid evenly and to the required slopes as directed. The terrazzo tiles shall then be laid immediately after laying the mortar. All tiles shall be truly and evenly set in a thick slurry of cement of honey like consistency applied to the sides and bottom and over the prepared base at the rate of 4.4 kg/sqm over such an area would accommodate about 20 tiles. The tiles shall then be tamped down with wooden mallet until they are properly bedded and exactly in true plane and line, with the adjacent tiles. Care shall be taken to ensure that the tiles are solidly bedded without voids and air pockets. All tiles shall be extended upto the unplastered surfaces of masonry walls/ RCC columns/ RCC walls. Wherever full tiles / half tiles can not be fixed, tiles shall be cut /sawn from full tile

to the required size and their edges rubbed smooth to ensure a straight and true joint. The tiles shall be close jointed in matching cement slurry and the cement slurry oozing out through the thin joints shall be immediately wiped clean. The joints between the tiles shall not be greater than 1.5 mm. and shall be kept in straight lines or to suit the required pattern. The junction between wall plaster and tile work shall be finished neatly and without any waviness. All tiles shall be laid as to have continuous lines from various rooms to the passage. No change of lines shall be permitted at junction between rooms and passage. The joints shall be fine and made neatly indistinguishable by grouting of the joints @ 2.20 kg/sqm of grey cement slurry mixed with suitable colouring pigments to match with the tiles. People should not be allowed to walk over the freshly laid tiles.

Adjustment of levels in thickness of mortar bedding due to different type of flooring if any, shall be done by the contractor within a reasonable limit/distance as directed by the Engineer-in-Charge without any extra cost .

17.12. CURING, POLISHING & FINISHING:

The day after the tiles are laid, all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shade of the topping of the wearing layer of the tiles.

The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be ground evenly with machine fitted with coarse grade grit Polish Stone (No. 60). Water shall be used profusely with grinding. After grinding, the surface shall be thoroughly washed, remove all grindings, mud cleaned and mopped, and the joints opened out during grinding shall be grouted once again wherever necessary with matching cement. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit Stone (No. 120) and shall be grouted again the opened out joints with matching cement.

The final grinding with machine fitted with the finest grade grit Stone (NO.320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor as ordered by the Engineer-in-charge.

For small areas or where circumstances so required, hand polishing may be permitted in lieu of machine polishing after laying, entirely at the discretion of the Engineer-in-charge. For hand polishing, the following carborundum stone shall be used. The polishing shall be done in such a manner that there are no visible scratches on the terrazzo tiles. If scratches are observed, the tiles shall be removed and replaced by new tiles.

1st Grinding	Coarse Grade stone (No. 60)
2nd Grinding	Coarse Grade stone (No. 60)
Final Grinding	Fine grade stone (No. 120)

In all other respects, the process shall be similar as for machine polishing. After the final polish, oxalic acid crystals ground into powder shall be dusted over the surface (@ 2/3 1b per 100 sft. or 32.5 gm. per sqm.), sprinkled water and rubbed hard with Namdah" block (pad of woolen rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean. If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

The finished floor shall not sound hollow when tapped with a wooden mallet.

17.13. TERRAZZO / CEMENT TILE SKIRTING :

Terrazzo tile in skirting shall be of size as specified in drawing, schedule of quantities or as directed by the Engineer-incharge, hydraulically pressed and shall be obtained from the same source as for the terrazzo/ cement tiles for flooring. The design and shade of the skirting tiles shall be exactly similar to that of flooring tiles. The specifications for materials and workmanship shall be same as for flooring except that the skirting tile shall be laid against a 12 mm. thick backing of cement mortar 1:3 to the full height of skirting, thus allowing uniform projection beyond the plastered surfaces. In case of dado, the back of tiles shall be buttered with a coat of grey cement slurry/paste and edges with grey or white cement slurry/paste as the case may be, with or without pigment to match the shade of tiles and set in the backing/bedding mortar. Any cutting of brick work, concrete etc. required due to unevenness of brick surface shall be carried out at no extra cost to maintain this uniform projection beyond the plastered surfaces.

The skirting tiles shall be true in plane, line, level and plumb or in slope. The vertical lines of skirting tiles should be in line with that of flooring tile lines. The colour of the skirting tile and floor tile shall match. The undone portion of plaster work left above the terrazzo tile skirting work shall be finished round or as directed by the Engineer-incharge in the matching plaster. The item of plastering shall be inclusive of this plaster finishing above the skirting tiles (groove shall be provided above the skirting tile if required by the Architect/E.I.C.), required to be done after laying of skirting tiles. No additional payment will be admissible for this extra operation.

17.14. SAMPLING AND TEST:

Tiles required for carrying out tests described below shall be taken by "random sampling". Each tile samples shall be marked to identify the consignment from which it was selected. Minimum quantity of tiles for carrying out the test and frequency of test shall be as per IS: 13801. Cost of these tests shall be borne by the contractor.

Mandatory Tests	No. of Samples	Results
a) For conformity to requirements of shape and dimensions, wearing layer and general quality.	12 tiles	Concavity & Convexity shall not exceed 1 mm. Perpendicularity shall not exceed 2% of the length of edge. Straightness shall not exceed 1% of the length
b) For wet transverse strength test	6 tiles	Strength shall not be less than 30 kgf/cm^2
c) For resistance to wear test	6 tiles	Average wear shall not exceed 3.50 mm and wear on individual specimen shall not exceed 4 mm.
d) For water absorption test	6 tiles	Shall not be more than 10%

17.15. MODE OF MEASUREMENT :

The length and / or width of the flooring / skirting / dado shall be measured net between the faces of skirting or dado or plaster faces of walls which is the proudest, and height of skirting / dado shall be measured from the finished level of floor. All openings exceeding 0.1 sqm. in area where tiling is not done shall be deducted and net areas only shall be measured and paid for. Flooring under dado, skirting or plaster shall not be measured for payment. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same room.

All dimensions shall be measured correct upto 2 places of decimal of a meter and area so worked out shall be correct upto two places of decimal of a sqm. for flooring, skirting, dado etc.

Note: Wastage in tile cutting to get the required dimension of rooms etc. as specified in drawing or as directed by the Engineer-in-charge shall have to be taken into consideration by contractor while quoting the rate for work to be measured as above. No extra claim on this account will be entertained.

17.16. PLAIN CEMENT TILE FLOORING & SKIRTING :

The specifications, mode of measurements etc. in respect of terrazzo tiles in flooring and skirting shall be applicable in general to plain cement tiles except that no marble chips & white cement shall be used in tile manufacture.

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18. IN-SITU TERRAZZO FLOORS, SKIRTING, TREADS OF STAIRCASE, WINDOW SILLS ETC.

18.1. FLOORING :

In situ terrazzo flooring, the underlayer shall consists of cement concrete mix 1:2:4 (the maximum size of aggregate used shall not exceed 10 mm.) the thickness of which shall be as specified in item of schedule of quantities.

The terrazzo topping shall consist of white cement or grey cement wherever specified in the schedule of quantity with or without pigment and marble chips of best approved quality, shade and grade all mixed in proper proportion as provided in I.S. 2114 and/ or approved by the Engineer-in-charge. The total combined thickness of the underlayer and topping shall as provided in the I.S. Specification and as specified and approved by the Engineer-in-Charge. Other selective quartz,granite ,glass chips shall be mixed depending on the Architectural requirement.

The floor surface shall be thoroughly cleaned of all dirt, dust, laitance and loose material, thoroughly wet with water and then smeared with cement slurry. Cement concrete under layer immediately be laid in regular bays not exceeding 1.5 sqm. in area or as directed and allowed to harden. The surface of screed shall be well scratched whilst it is not sufficiently hard to form key for terrazzo topping 25 x 1 .5 mm. aluminium dividing strips or 3mm. thick glass dividing strips whichever specified in the item of schedule of quantities shall be placed to form bays as directed. When the screed has sufficiently hardened but not later than 24 hours, it shall be thoroughly cleaned down, washed with water and brushed over with neat cement slurry of about the consistency of thick cream.

Terrazzo top layer shall then be laid in alternative bays in plastic condition, well troweled into position. Surplus moisture and cement slurry from surface shall be removed and allowed to set sufficiently hard to stand machine or hand grinding, thoroughly cleaned to reveal surface voids, and grouted with neat cement of the same tint as used in terrazzo. When dry and hard, machine grinding with grit blocks as per specifications for terrazzo tiles shall be done with 3 to 5 days between successive grinding during which the terrazzo shall be cured and grouted with neat cement of same tint, if required. The entire surface shall then be kept wet for at least seven days. The edges of treads and window sills shall have straight edges and corners properly rounded up. In case of window sills, only top layers is covered under the relevant item and concrete base layer under RCC item. The window sills and treads of staircase shall be hand polished instead of machine polished.

Cleaning and applying oxalic acid shall be same as specified for terrazzo tile flooring.

18.2. IN-SITU SKIRTING & DADO ETC. :

In situ skirting and dado shall be as specified in the schedule of finishes.

The surface shall be prepared as per plastering work to rough finish or as required by the architects, the dado or skirting shall be sectionalised as for in situ floor. If shown and required, the junction of the floor and dado shall be rounded to a proper, neat and uniform round to the satisfaction of the Engineer-in-charge. After the work is complete, the surface shall be kept continuously wet for 7 days. Unless otherwise specified, skirting and dado shall match the floor.

Terrazzo skirting and dado shall consist of under coat of 1:4 cement- sand plaster of the thickness specified. This shall be laid simultaneously with the borders of the flooring and same joints as in the floor shall continue. The topping shall be terrazzo as per specifications for in-situ terrazzo flooring except that in-situ polishing shall be done by hand to the satisfaction of Engineer-in-charge. 1.5 mm thick aluminium strip joint (wherever mentioned 3mm. glass strips shall be fixed) shall be provided in situ terrazzo in both direction or as directed. Care shall be taken to see that the terrazzo in skirting and dado matches the floors. The dado work in columns shall be done in one operation for the full height of the column. The shape of the finished surface shall be uniform for all such columns treated and checked for its accuracy during the progress of work.

18.3. MODE OF MEASUREMENT :

Mode of measurement for cast-in-situ terrazzo flooring and dado shall be same as per terrazzo tile flooring and skirting.

The rate shall include all materials, curing, rounding of junctions, labour, scaffoldings etc.

19. KOTAH STONE FLOORING/ SKIRTING/ FACIA / SHELVES :

MATERIALS : . The stone shall be hard, sound, durable, homogeneous in texture and resistant to wear. These shall be without any soft veins, cracks or flaws and shall have uniform colour. They shall have natural surface free from broken flakes on top. Hand cut/ machine cut for exposed edges and machine polished. Kotah stone shall be of the best quality and of the specified thickness, size and the shade, which shall be got approved by the Engineer-in-charge. The contractor shall get it one time polished at vendor shop and only the similar colour & texture Kota stones shall be sorted and delivered at site. The number of passes for final polishing shall be done at site to the requirement of Architect and to satisfaction of E.I.C.

The slabs / tiles shall be rectangular or square in shape or as per pattern shown in drawing and as directed by the Engineer-in-charge. The sizes given in schedule of quantities are tentative and can vary only slightly as per the availability in the market. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the item. Tolerance of (+/-) 2 mm shall be allowed for the thickness. In respect of length & width, tolerance in length & width shall be permissible upto (+/-) 5 mm for hand cut slabs & (+/-) 2 mm for machine cut slabs. At its thinnest, no stone shall be thinner than the specified thickness.

Uniformity of size and colour / shade shall generally be maintained for the stones used in any one room. The exposed surface shall be machine polished to a smooth, even and true plane and the edges hand cut and dressed true and squares. The evenness of the surface of slabs and edges of the slab shall not be marred by careless dressing or handling and no patching up shall be allowed for the slab. The edges shall be quite straight. The under face may be left as required or rough dressed. Before taking up the work, samples of stone slabs to be used and their dressing and polishing shall be got approved by the Engineer-in-charge and kept in his office as approved sample and the stone slabs to be used shall conform to the same.

BEDDING/ BACKING COAT : In case of flooring / skirting / dado, the mortar bedding / backing shall be of cement mortar of thickness and mix specified in the schedule of work.

CEMENT MORTAR: Cement mortar bedding shall be as specified under relevant specification for terrazzo / plain cement tile flooring.

CONSTRUCTION DETAILS: Cement mortar as specified for bedding shall be uniformly mixed. The amount of water added shall be the minimum necessary to give just sufficient

plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the stones. Before spreading the mortar, the sub-floor or base shall be cleaned of all dirt, set mortar scum or laitance and of loose materials by hacking and brought to original levels and then well wetted without forming pool of water on surfaces.

FIXING THE STONE SLAB/ TILE : Before laying, the stone shall be thoroughly wetted with clean water, neat cement grout (2.75 kg/ sqm.) of honey like consistency shall be spread on the mortar bed over as much areas as could be covered with the slabs within half an hour. The specified type of stone shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slope in the mortar bed. Each stone shall be gently tapped with wooden mallet till it is firmly and properly bedded.

There shall be no hollows left. If there is a hollow sound on gently tapping off the slab, such slab shall be removed and reset properly. The joints shall be grouted with matching cement slurry. Approved pigment shall be used in cement slurry to match with shade of stone. Pigment required to match the shade of stone shall be supplied by the contractor at no extra cost. The stone adjoining the wall shall go about 12mm. under the plaster, skirting or dado for the wall. All stone slabs, tiles shall be so laid as to have continuous lines from various rooms to the corridors. No change of lines shall be permitted at junction between rooms and corridors. Only one piece machine cut, Kotah stone shall be used for treads and risers, unless otherwise specified in the tender schedule.

CURING : The work shall be kept well wetted with damp sand or water for seven days.

POLISHING AND CLEANING: When the bedding and joints have completely set and attained required strength, the surface shall be machine polished to give smooth, even and true plane to the flooring. All flooring shall be thoroughly cleaned and handed over free from any mortar stains etc. Polishing shall be done as per relevant IS and IS-14223 (Specification for polished building stones).

SKIRTING AND DADO/ FACIA : The quality and type of stone shall be same as mentioned for flooring except of their height and thickness or backing coat which shall be as mentioned in item schedule. The backing shall conform to the specifications for cement mortar specified for item of terrazzo tiles. Contractor should take into consideration the fact that touching up of the plaster at the junction of skirting / dado is invariably done after the skirting/ dado/ facia work is completed and quote rates accordingly. Nothing extra for the same shall be entertained.

Fixing, curing, polishing and cleaning shall be as specified herein before under cement/ terrazzo tile skirting. Polishing may be done by hand, but a smooth surface and fine

polishing shall be obtained. Joints shall be finished in white cement with addition of colour pigment matching tile. The junction of plaster and the upper edges of the dado/ skirting shall be finished smoothly as directed by the Engineer-in-charge without any extra cost.

MODE OF MEASUREMENTS : Flooring, skirting and dado/ facia shall be measured same as that for terrazzo cement tile, flooring/ skirting/ dado. Unless otherwise specified, shelves shall be paid on area basis in sq m. calculated to two places of decimal, where length and breadth shall be measured inclusive of bearings correct to a cm. The permissible tolerance in the specified thickness shall be (+/-) 2 mm.

Note : Wastage in obtaining the required machine cut, hand cut sizes as specified from the commercial sizes available in market shall be taken into consideration by contractor while quoting the rate for work and no extra claim on this account shall be entertained.

TANDUR STONE / CUDDAPPA STONE / POLISHED SHAHABAD STONE / BLUE WADI STONE FLOORING / SKIRTING / DADO:

The specifications for these items shall be similar to those for Kotah stone as above.

20. GLAZED TILE FLOORING, DADO/ SKIRTING/ FACIA.

20.1. MATERIALS :

White Glazed Tiles : The tiles shall be of approved make and shall generally conform to IS :13712. They shall be flat and true to shape and free from cracks, blisters, welts, crazing spots, chipped edges, corners or other imperfections detracting from their appearance. The glazing shall be of uniform shade.

The wall tiles shall be of square or rectangular of nominal sizes such as 450x300 mm, 300x200mm, 150x150mm, 100x100mm, 100x200mm or other as directed by the EIC. The length of all four sides shall be measured correct to 0.1 mm and average length-breadth shall not vary more than (+ / -) 0.8 mm from specified dimensions. The variation of individual dimensions from average value of length/breadth shall not exceed (+ / -) 0.5 mm. Tolerance in thickness shall be (+ / -) 0.4 mm. Size of tiles different form the specified one, may be allowed to be used with prior approval of the EIC.

The thickness of the tiles shall not be less than 5 mm or as specified in the items and shall confirm to I.S. 13712 in all respects. Samples of tiles shall be got approved by the Engineer-in-charge before use on the work. Top surface of tile shall be glossy or matt as specified. The underside of tiles shall not have glaze on more than 5% of the area in order to have proper adherence to the back.

20.2. PREPARATION OF SURFACE & LAYING :

Sub grade concrete or RCC slab or side brick wall/ or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for tile flooring.

The bedding/backing for the tile shall be of C.M. 1.3 or as specified and shall be applied and allowed to harden. The mortar shall be roughened with wire brushes or by scratching diagonal lines 1.5mm deep at 7.5mm centre both ways.

The back of tiles shall be buttered with a coat of grey cement slurry paste or Polymer modified cement based tile adhesive as bedding laid as per manufacturer specification and joints with white cement with pigment matching colour of tile/coloured ready tile grout - Polymer modified cement based Grout or Epoxy Grout of approved make laid as per manufacturer specification and set in the bedding mortar . The tiles shall be tapped gently with wooden mallet and corrected to proper planes and lines. The tile shall be butt jointed in pattern and joints shall be as fine as possible. The top of skirting/ dado shall be truly horizontal and joints truly vertical.

After a period of curing of 7 days minimum, the tiles shall be cleaned and shall not sound hollow when tapped.

The surface during laying shall be checked with a straight edge 2 m. long. Where full size tiles cannot be fixed, these shall be cut/sawn to the required size & their edges rubbed smooth to ensure straight and true joints.

Tiles shall enter not less than 10mm. under side skirting.

After the tiles have been laid, surplus cement grout shall be cleaned off.

20.3. MORTAR AND BEDDING :

Cement mortar for bedding shall be of proportion specified in items schedule and shall conform to the specification for materials, preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere withe even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned of all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be even and smoothly spread over the base by use of screed battens to proper level or slope.

Cement mortar of thickness and proportion as specified in the schedule for dado shall be applied to the wall after preparing the wall surface as specified under cement plaster 20mm. thick and brought to correct line and plumb and the surface left rough to receive the tiles.

20.4. FIXING OF TILES FOR FLOORING :

The tiles before laying shall be soaked in water for atleast 2 hours. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles which are fixed on the flooring adjoining the wall shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Neat cement mortar grout 1:2, using fine sand (table III, zone-IV and as per I.S. 383) of honey like consistency shall be spread over the bedding mortar just to cover as much area as can be tiled within half an hour. The joints of the tiles shall be filled with neat white cement mixed with colour pigment and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. The surface of the flooring during laying shall be frequently checked with a straight edge about 2M long to obtain a true surface with the required slope. The joints between tiles shall not exceed 1.00 mm. in width / or in case required shall be thickness of tile spacer all as required by Architect/E.I.C. The joint shall be grouted with white cement mixed with tile colour matching colour Pigment. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with plastic sheet with POP layer and allowed undisturbed for 14 days.

20.5. FIXING TILES FOR DADO & SKIRTING/FACIA :

The dado work, shall be done only after fixing the tiles/slabs on the floor. The approved white/coloured glazed tiles before laying shall be soaked in water for atleast 2 hours. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff.

The back of the tile shall be covered (full area of the tile) with this layer of cement mortar 1:2 using fine sand (table III, zone IV, I.S. 383) and the joint of the tile with neat white cement mixed with colour pigment (to match tile colour). The tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from bottom of wall upwards without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining/ as per tile spacer. The tiles shall be jointed with white cement mixed with colour pigment (to match tile colour). Any thickness difference in the thickness of the tiles shall be arranged out in cushioning mortar so that all tiles faces are in one vertical plane. The joints between the tile shall not exceed 1.00 mm. in

width/ as per tile spacer and they shall be uniform. Tile Spacer shall be used only if gap is required by the Architect /EIC.

While fixing tiles in dado work, care shall be taken to break the joints vertically. The top of the dado shall be touched up neatly with the rest of the plaster above, height of the dado depending on architectural drawing / EIC requirement.

After fixing the dado/skirting etc. they shall be kept continuously wet for 7 days.

If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

20.6. CLEANING :

After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting over shall be washed thoroughly clean. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry saw dust. It shall be removed only after completion of the construction work and just before the floor is used.

20.7. POINTING AND FINISHING :

The joints shall be cleaned off with wire brush to a depth of 3 mm. and all dust and loose mortar removed. Joints shall then be flush pointed with white cement mixed with colour pigment and floor kept wet for 7 days and then cleaned. Finished floor shall not sound hollow when tapped with a wooden mallet.

20.8. MODE OF MEASUREMENT :

Dado/flooring/skirting shall be measured in sqm. correct to two places of decimal. Length and breadth shall be measured correct to 1 cm. between the exposed surfaces of skirting

or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm.

The rate shall include all the cost of labour and materials involved.

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21. CHEQUERED CEMENT TILES / STEPPING STONE VITRIFIED (SELF EMBOSSED LINES) TILES IN STAIR TR EADS AND LANDINGS:

21.1. SCOPE OF WORK :

The work envisaged under these specifications consists of supplying and laying chequered cement tiles in the treads of staircase steps and over landings.

21.2. MATERIALS :

Cement Chequered Tiles: The size of tiles including nosing shall be as shown in drawing and shall have the thickness not less than 28 mm.

The nosing edge of the tile shall be rounded and the front portion of the tiles for a minimum of 75 mm from and including the nosing shall have grooves running parallel to the nosing and at centres not exceeding 25 mm. Beyond that the nosing tiles shall have normal chequered pattern, centre to centre distance being not less than 25 mm. and not more than 50 mm. The nosing shall have the same wearing layers as the top portion of the tile.

The overall thickness of the tile as mentioned earlier shall not be less than 28 mm with the top layer measured from the top of the chequers which shall not be less than 6 mm. The tiles shall be given the first grinding before delivery to site. The tiles shall conform to the specification for terrazzo tiles/cement tiles, in respect of method of manufacture and the mix of the backing and wearing layers, as specified in the item.

Stepping Stone Vitrified (self embossed lines) Tiles: Stepping Stone for treads Full body vitrified double (full) bull nosed with tread lines (self embossed Tread lines) for tread part of Johnson Endura Stepping Stone series or approved equivalent make, upto 1200 mm length in single piece in length. Full body vitrified for riser & for skirting in landing of Johnson Endura Stepping Stone series or approved equivalent make, upto 1200 mm length in single piece.

21.3. PREPARATION OF SURFACE AND LAYING :

The method of preparation of surface and laying shall generally be similar to as specified herein before under terrazzo tile flooring.

21.4. CURING, POLISHING AND FINISHING :

The specifications shall be the same as specified herein before under terrazzo tile flooring except that polishing of the treads nosing and chequered grooves, after laying shall be done by hand. Special care shall be taken to polish the nosing and the grooves in such a manner as to get a uniform erection for the grooves and the nosing and their finish shall match with the finish of the flat portion of the tiles.

21.5. MODE OF THE MEASUREMENT :

Length shall be measured from finished face of skirting, dado or wall plaster correct to a centimetre and the width shall be measured from the outer edge of the tread to the finished face of riser. In the case of tiles laid over the landing, the mode of measurement shall be as per terrazzo tiles specifications. The area shall be in square metres correct to two places of a decimal.

The rate shall include the cost of all materials and labour, transport, scaffolding etc. required in all the operations described above.

* * *

22. MARBLE STONE FLOORING, TREADS, RISERS, SILLS, CLADDING, DADO ETC. :

22.1. MARBLE STONE SLABS :

The colour and quality of marble slabs shall be of the kind of marble specified in Schedule of item/drawings/as directed by the Engineer-in-charge. The marble from which the slabs are made, shall be of selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. Before starting the work, the contractor shall get the samples of marble slabs approved by the Engineer-in-charge. All slabs which goes into work shall strictly conform to the samples, failing which the entire materials are likely to be rejected.

The slabs shall be machine polished and machine cut to the dimensions specified in items of schedules of quantities/drawings and as directed by the Engineer-in-charge.

22.2. DRESSING OF SLABS :

Every stone shall be cut to the required size and shape, fine dressed on all sides to the full depth so that a straight edge laid along the side of the stone is full in contact with it. The top surface shall also be fine dressed to remove all waviness. The top surface of slabs shall be machine polished and exposed edges machine cut, or as specified in the Schedule of item and as directed by the Engineer-in-charge. All visible angles and edges of the slabs shall be true, square or as required, and free from chippings and the surface shall be true and plane.

The thickness of the slabs shall be 25 mm. or as specified in the description of item. The minimum size of stone to be used for various items shall be as mentioned in the schedule of quantities/drawings of this tender. Marble stones of approved smaller sizes other than mentioned in the schedule of quantities, if required for bands, borders, flooring etc. shall be provided and laid as directed by the Engineer-in-charge.

Any opening of required size and shape at any desired place in flooring, bands, borders etc. shall be made in such a way that marble bounded by number of marble stones/slabs. No broken or defaced stone shall be permitted in the work.

22.3. BEDDING/BACKING MORTAR :

The bedding/backing shall be of cement mortar/lime mortar of mix and thickness as specified in the description of the item.

22.3.1. **Mixing :** The mixing of mortar shall be done in mechanical mixer or hand mixing as specified/as directed by the Engineer-in-Charge.

a) **Mixing in Mechanical Mixer :** Cement and sand in the specified proportion shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste.

Only the quantity of mortar, which can be used within 30 minutes of its mixing shall be prepared at a time.

Mixer shall be cleaned with water each time, before suspending the work.

b) **Hand Mixing :** If approved by Engineer-in-Charge, hand mixing shall be allowed. The measured quantity of sand shall be levelled Galvanised steel side closed tray / closed clean Plastered masonry platform and cement bags emptied on top. In hand mixing, the quantity of cement shall be increased by 5% over the approved constant, with no extra cost. The cement and sand shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture gives an uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed with just

sufficient quantity of water to bring the mortar to the consistency of stiff paste.

c) **General :** Mortar shall be used as soon as possible after mixing and before it has begun to set, and in any case within 30 minutes after the water is added to the dry mixture. Mortar unused for more than 30 minutes shall be rejected and removed from the site of work immediately.

22.4. LAYING - FLOORING :

Before laying the cement mortar bedding/backing, the concrete/brick, floor/wall surfaces shall be thoroughly hacked, cleaned of all mortar scales, concrete lumps etc., brushed, washed with water to remove mud, dirt etc. from the surface and shall be thoroughly wetted. Until and unless the surface is approved by the Engineer-in-Charge, the flooring shall not be started. A bedding of cement mortar of 20 mm average thickness with the minimum thickness at any place on the slab not less than 13mm. shall be laid evenly and to the required slopes as directed. The marble slabs shall be thoroughly washed and cleaned and then be laid on the bedding/ backing with cement floating at the rate of 4.39 kg./sqm. All slabs shall be truly and evenly set in a thick cement slurry or paste like consistency applied to the sides and bottom and over the prepared base. The slabs shall then be tamped down with a wooden mallet until they are exactly in true plane and line with adjacent slabs. All slabs shall be extended upto the unplastered surface of masonry walls/RCC columns/RCC walls. The slabs shall be filled at joints with white cement mixed with Pigment (colour to match the colour of tile)& the extra filling shall be immediately wiped clean. The grains of marble stone shall be matched as shown in drawing or as directed by the Engineer-in-Charge. All slabs shall be so laid as to have continuous lines from various rooms to the corridors. No change of lines shall be permitted at junction between rooms and corridor, if the same flooring is specified in both the places. the flooring shall be covered with plastic sheet with POP layer and allowed undisturbed for 14 days.

22.5. MARBLE SILLS, TREADS ETC. :

Marble stone for sills shall be of approved quality. Dressing of stone slab, mortar mix. for bedding/backing, laying etc. shall be similar to as described above as far as applicable. Marble slabs of specified thickness and width shall only be provided. The length of the each slab required for the sill shall be of the pattern which shall coincide with the lines of the mullions of windows where it is laid or as directed by the Engineer-in-Charge. Normally it shall not be less than 1.0 m. length.

22.6. 24.6 MARBLE STONE DADO & CLADDING :

Only machine cut and machine polished marble stone will be used. Brass cramps and brass pins / if connection requires anchors with clips, brackets based on the cladding panel requirement of it shall be done as per Hilti or approved make shall be provided. The brass pins shall be provided at the meeting of two marble slabs both ways horizontally and vertically. The brass cramps shall be provided at the places approved by the Engineer-in-Charge. Marble to be used shall be of approved size, colour, type of veins and laid as specified in schedule of quantities or to the pattern shown in drawings or as directed by the Engineer-in-Charge. Laying of marble stone shall be similar as stated above as far as applicable. Fixing methodology shall be as per design requirement & work shall be done as per approved manufacturer's specification.

22.7. POLISHING AND FINISHING :

The polishing and finishing shall be carried out in the similar manner as specified under chapter "TERRAZZO / CEMENT TILES FLOORING, SKIRTING / DADO ETC." as far as it is applicable.

22.8. MEASUREMENT :

Marble stone flooring, sills, treads, risers, dado cladding etc. shall be measured in square metre correct to two places of decimal. The length and breadth shall be measured between the finished faces correct to two places of decimal of metre. No deduction shall be made nor extra paid for any opening of area upto 0.05 sqm. Nothing extra shall be paid for working at different levels.

NOTE : Wastage in marble slab cutting to get the required dimensions, as specified in drawing or as directed by the Engineer-in-Charge shall be deemed to be considered by the contractor while quoting the rate for work. The work shall be measured as above and no extra claim will be entertained on this account.

22.9. RATE :

The rate shall include the cost of all materials, transport tools, plants, scaffolding and labour involved in all operations described above.

23. CERAMIC TILE FLOORING, DADO / SKIRTING / FACIA.

23.1. MATERIALS :

Ceramic Tiles : The tiles shall be of approved make and shall generally conform to IS : 13712-2006. They shall be flat and true to shape and free from cracks, blisters, welts, crawling, crazing spots, chipped edges, corners or other imperfections detracting from their appearance. The glazing shall be of uniform shade.

The tiles shall be of square or rectangular of nominal sizes as mentioned in schedule of quantities and as directed by the EIC. The length of all four sides shall be measured correct to 0.1 mm and average length-breadth shall not vary more than (+ / -) 0.8 mm from specified dimensions. The variation of individual dimensions from average value of length/breadth shall not exeed (+ / -) 0.5 mm. Tolerance in thickness shall be (+ / -) 0.4 mm. Size of tiles different form the specified one, may be allowed to be used with prior approval of the EIC.

The thickness of the tiles shall not be less than 6 mm or as specified in the items and shall confirm to I.S. 13712 in all respects. Samples of tiles shall be got approved by the Engineer-in-charge before use on the work. Top surface of tile shall be glossy or matt as specified. The underside of tiles shall not have glaze on more than 5% of the area in order to have proper adherence to the back.

23.2. PREPARATION OF SURFACE & LAYING :

Sub grade concrete or RCC slab or side brick wall/ or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

The bedding/backing for the wall/skirt tile shall be of C.M. 1.3 or as specified and shall be applied and allowed to harden. The mortar shall be roughened with wire brushes or by scratching diagonal lines 1.5mm. deep at 7.5mm. centre both ways.

The back of wall/skirt tiles shall be buttered with a coat of grey cement slurry paste and edges with cement slurry and set in the bedding mortar. The tiles shall be tapped gently with wooden mallet and corrected to proper planes and lines. The tile shall be butt jointed in pattern and joints shall be as fine as possible. The top of skirting/ dado shall be truly horizontal and joints truly vertical.

After a period of curing of 7 days minimum, the tiles shall be cleaned and shall not sound hollow when tapped.

The surface during laying shall be checked with a straight edge 2 m. long. Where full size tiles cannot be fixed, these shall be cut/sawn to the required size & their edges rubbed smooth to ensure straight and true joints.

Tiles shall enter not less than 10mm under side skirting.

After the tiles have been laid, surplus cement grout shall be cleaned off.

23.3. MORTAR AND BEDDING :

Cement mortar for bedding shall be of proportion specified in items schedule and shall conform to the specification for materials, preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned of all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be even & smoothly spread over the base by use of screed battens to proper level or slope.

Cement mortar of thickness and proportion as specified in the schedule for dado shall be applied to the wall after preparing the wall surface as specified under cement plaster as specified in schedule of quantities and brought to correct line and plumb and the surface left rough to receive the tiles.

23.4. FIXING OF TILES FOR FLOORING :

The tiles before laying shall be soaked in water for atleast 2 hours. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles which are fixed on the flooring adjoining the wall shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Neat cement mortar grout 1:2, using fine sand (table III, zone-IV and as per I.S. 383) of honey like consistency shall be spread over the bedding mortar just to cover as much area as can be tiled within half an hour. The edges of the tiles shall be smeared with neat cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. The surface of the flooring during laying shall be frequently checked with a straight edge about 2M long to obtain a true surface with the required slope. The joints between tiles shall not exceed 1.00 mm. in width. The joint shall be grouted with /matching colour mixed with white cement slurry. After fixing

the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand / POP and allowed undisturbed for 14 days.

23.5. FIXING TILES FOR DADO & SKIRTING/FACIA :

The dado work, shall be done only after fixing the tiles/slabs on the floor. The approved ceramic tiles before laying shall be soaked in water for atleast 2 hours. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff.

The back of the tile (full area of the tile)shall be covered with this layer of cement mortar 1:2 using fine sand (table III, zone IV, I.S. 383) and the edge of the tile smeared with neat cement slurry. The tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from bottom of wall upwards without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. The tiles shall be jointed with coloured cementitious Tile joint filler grout of approved make or white cement mixed with colour pigment; colour to match tile . Any thickness difference in the thickness of the tiles shall be arranged out in cushioning mortar so that all tiles faces are in one vertical plane. The joints between the tile shall not exceed 1.00 mm. in width and they shall be uniform.

While fixing tiles in dado work, care shall be taken to break the joints vertically. The top of the dado shall be touched up neatly with the rest of the plaster above.

After fixing the dado/skirting etc. they shall be kept continuously wet for 7 days.

If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

23.6. CLEANING :

After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting over shall be washed thoroughly clean. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry saw dust /POP. It shall be removed only after completion of the construction work and just before the floor is used.

23.7. POINTING AND FINISHING :

The joints shall be cleaned off with wire brush to a depth of 3 mm. and all dust and loose mortar removed. Joints shall then be flush pointed with cement and floor kept wet for 7

days and then cleaned. Finished floor shall not sound hollow when tapped with a wooden mallet.

23.8. MODE OF MEASUREMENT :

Dado/flooring/skirting shall be measured in sqm. correct to two places of decimal. Length and breadth shall be measured correct to 1 cm. between the exposed surfaces of skirting or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm.

The rate shall include all the cost of labour and materials involved.

24. VITRIFIED TILE FLOORING, DADO / SKIRTING / FACIA :

24.1. MATERIALS :

Vitrified Tiles: The tiles shall be of approved make like Fully Vitrified / Marbonite / Granamite/ Fully Polished Vitrified Tiles/ Double charged Vitrified Tiles or equivalent and shall generally conform to the approved standards. They shall be flat and true to shape, free from cracks, crazing spots, chipped edges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The Floor tiles shall be square or rectangular of nominal sizes such as: 600 x 600 mm; 900 x 900 mm, 300x300mm or as per tender schedule / drawings or as directed by the Engineer-in-Charge. Thickness shall be as per recommendations of the approved manufacturers. Anti Skid tiles shall be for Toilet areas as per Architectural drawings.

Cool Roof SRI Tiles of approved make shall be used for Terrace & Balcony application as per architectural drawing.

Technical specifications of the tiles shall be generally conforming to the following standards:

TECHNICAL SPECIFICATIONS FOR VITRIFIED TILES

NO	PROPERTY	EXPECTED
1	Deviation in length	(+/-) 0.6%
2	Straightness of sides	(+/-) 0.5%
3	Rectangularity	(+/-) 0.6%
4	Surface flatness	(+/-) 0.5%
5	Water absorption	< 0.50%
6	Mohs. hardness	> 6

7	Flexural strength	> 27 N / mm²
8	Abrasion resistance	< 204 mm²
9	Skid resistance (friction coefficient)	> 0.4
10	Glossiness	Min. 85% reflection

The tiles shall conform to the relevant standards in all respects. Samples of tiles shall be got approved from the Engineer-in-charge before bulk procurement for incorporation in the work.

24.2. PREPARATION OF SURFACE FOR FLOORING: Following procedure shall be followed:

- **Sub grade** concrete or RCC slab or side brick wall / or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

- **Mortar and bedding:** Cement mortar for bedding shall be prepared of mix 1:4 or as specified in the schedule of items, to a consistent paste and shall conform to the specification for materials, preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned off all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be evenly and smoothly spread over the base by use of screed battens to proper level or slope.

- Once the mix is prepared, no further water be added and the same shall be used within one hour of adding water. Apply on an average 20 mm thick bedding of mortar over an area of 1 sqm. at a time over surface of the area for laying tiles, in proper level and allowed to harden sufficiently to offer a fairly good cushion for the tiles to set.

LAYING OF TILES FOR FLOORING : The tiling work shall be done as per the pattern shown in the drawing or as directed by the Engineer-in-Charge. As a general practice laying of tiles shall be commenced along one side of the walls planning to have cut size tile only on other side or if design requirement then as per site requirement all as shown in the Architectural drawing. Cut tiles, if any, shall be laid along wall with necessary border pattern as shown / directed by the Engineer-in-Charge. Tiling work shall be completed by pressing tiles firmly into place along the wall / floor. Cement to the back of the tile to be

applied to ensure proper and full bedding. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles, which are fixed on the flooring adjoining the wall, shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Press gently the tile with wooden mallet for even adherence at the back of the tile.

The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with white cement mixed with pigment matching colour of tile. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand / POP and allowed undisturbed for 14 days.

24.3. FIXING TILES FOR DADO & SKIRTING / FACIA : : The fixing of tiles on wall surfaces shall be done only after completing fixing of the tiles on the floor. Following procedure shall be followed:

- The back of tiles shall be cleaned off and covered with layer of approved adhesive like ARDEX ENDURA or equivalent if specified in the drawing /specification /BOQ items all as required by EIC with proper trowelling as per manufacturers recommendations.

- The edges of the tiles shall be smeared with the adhesive and fixed on the wall one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly fixed in level with the adjoining tiles. There shall be no hollows on the back or in joints. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with approved adhesive. The joints shall be kept in straight line or as per the approved pattern.

- While fixing tiles in dado / skirting work, care shall be taken to break the joints vertically. The top line shall be touched up neatly with the rest of the plaster above. If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

- The fixing shall be done from bottom of wall to upward without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. All tiles faces shall be in one vertical plane.

24.4. GROUTING OF JOINTS IN FLOOR / SKIRTING / DADO: The joints, if specified, shall be cleaned off and all dust and loose particles removed. Joints shall then be filled with approved adhesive like ARDEX ENDURA or equivalent grouts. After finishing the grouting process, after 15 minute, wipe off excess grout with a damp sponge and polish the tiles with a soft & dry cloth for a clean surface. The Finished work shall not sound hollow when tapped with a wooden mallet.

24.5. CLEANING : As directed by the Engineer-in-Charge, the tiles shall be cleaned by mild acid (However, Hydrofluoric acid and its derivatives should not be used). After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout / adhesive that may have come out of the joints shall be cleaned off before it sets. The dado / skirting shall be thoroughly cleaned. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When drying, the floor shall be covered with oil free dry sawdust. It shall be removed only after completion of the construction work and just before the floor is used.

24.6. MODE OF MEASUREMENT AND RATE: Dado / flooring / skirting shall be measured in sqm correct to two places of decimal. Length and breadth shall be measured correct to 1 cm. between the exposed surfaces of skirting or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm. The rate shall include all the cost of labour and materials involved.

24.7. CLEANING AGENTS FOR VITRIFIED TILES:: Vitrified tiles are resistant to all chemicals (except hydrofluoric acid and its derivatives), hence commercially available detergents and cleaning agents can also be used for regular maintenance. Any spills and stains must be removed immediately. If left dry they may leave stains, which may be difficult to remove completely.

CLEANING AGENTS FOR VITRIFIED TILES

STAINS	**CLEANING AGENT**
Robin Blue	Household detergent / Warm water
Marker ink	Turpentine / Acetone / Trichloroethylene
Pen ink	Acetone / Isopropyl alcohol
Methylene blue	Isopropyl alcohol / Acetone
Sauce	Ammonia solution
Cement	Turpentine / Acetone / Trichloroethylene /
Tea	Hydrochloric acid / Bleaching powder
Coffee	Sodium hydroxide / Potassium hydroxide
Beer	Sodium hydroxide / Potassium hydroxide
Diesel	Acetone / Petrol

Lab indicator	Acetone / Isopropyl alcohol
Cement and grouting	Hydrochloric acid
Pencil mark	Benzene or Toluene or Xylene
Plaster of Paris (POP)	Ammonium sulphate solution
Iodine (Tincture iodine)	Sodium hydroxide / Potassium hydroxide
Hair dye	Per chloric acid
Paan	Lemon juice or citric acid
Marker pen	Acetone

OT (other tiles). TANDUR STONE/CUDDAPPA STONE/POLISHED SHAHABAD STONE / BLUE WADI STONE FLOORING / SKIRTING / DADO : The specifications for Tandur, Cudappa, polished Shahabad and blue Wadi stone flooring / skirting / dado shall be similar to those respecting specifications for Kotah stone flooring / skirting / dado specified herein before in all respects.

* * *

25. RED OR WHITE ROUGH DRESSED SAND STONE FLOORING

25.1. Stone Slabs: The slabs shall be red or white as specified in the description of the item. The stone slabs shall be hard, sound, durable and tough, free from cracks, decay and weathering. In case of red sand stone, white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of slabs approved by the Engineer-in-charge. The slabs shall be hand or machine cut to the requisite thickness along planes parallel to the natural bed of stone and should be of uniform size if required.

25.2. Dressing of Slabs: Every slab shall be cut to the required size and shape, and rough chisel dressed on the top, so that the dressed surface shall not be more than 6 mm from a straight edge when placed on it. The edge of depressions or projections shall be chisel dressed in a slant so that the surface does not have sharp unevenness. The edges shall also chisel dressed to a minimum depth of 20mm so that the dressed edge shall at no place be more than 30 mm from a straight edge butted against it. Beyond this depth the sides may be dressed slightly splayed so as to form inverted `V` shaped joint with adjoining slabs. All angles and edges of the slabs shall be true, square and free from chipings & the surface reasonably true and plane. Where slabs are used for treads without nosing, the exposed edges shall be rough chisel dressed to full depth and cut to uniform thickness. The thickness of the slabs after it is dressed shall be 40 mm or as specified in the description of the item with a permissible tolerance of (+/- 2mm).

25.3. Laying

25.3.1. Base concrete on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be of cement mortar 1:5 (1 cement: 5 coarse sand) or as given in description of the item.

25.3.2. The average thickness of the bedding mortar under the slabs shall be 20 mm and the thickness at any place under the slabs shall not be less than 12 mm.

25.3.3. The slab shall be laid in the following manner: Mortar of specified mix shall be spread under each slab. The slab shall be washed clean before laying. It shall then be laid on top, pressed and larried, so that all hollows underneath get filled and surplus mortar works up through the joints. The top shall be tapped with a wooden mallet and brought to level and close to the adjoining slabs, with thickness of joint not exceeding 5mm. Subsequent slabs shall be laid in the same manner. After laying each slab surplus mortar on the surface of slabs shall be cleaned off and joints finished flush.

25.3.4. In case pointing with other mortar mix is specified, the joint shall be left raked out uniformly and to a depth of not less than 12 mm when the mortar is still green. The pointing shall be cured for a minimum period of 7 days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engr.-in-charge.

25.3.5. Slabs that are fixed in the floor adjoining the wall, shall enter not less than 12 mm under the plaster, skirting or dado. The junction between wall plaster skirting and floor shall be finished neatly and without waviness.

25.3.6. The finished floor shall not sound hollow when tapped with wooden mallet.

25.4. Finishing: Any unevenness existing between the edges of slab joints shall be removed by chiselling in a slant.

25.5. Measurements: The flooring work shall be measured in square metre correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm. Nothing extra shall be paid for laying the floor at different levels in the same room / area.

25.6. Rate: The rate shall include the cost of all materials and labour involved in all the operations described above. Where pointing is to be done, this will be paid extra unless specifically included in the description of the item.

26. PVC SHEET / TILES FLOORING :

26.0. P.V.C Flooring material gives a resilient and non-porous surface which can be easily cleaned with a wet cloth as dust and grime do not penetrate the surface. Since a burning cigarette will damage the neat surface of the PVC sheet, special care should be taken to prevent burning cigarette stumps to come in contact with the PVC flooring materials. It shall be laid on a base that is finished even and smooth such as concrete, metal or timber boarding. Unevenness or undulations in the base will show badly on the surface and are liable to damage the P.V.C sheet / tiles.

26.1. Materials

26.1.1. The PVC flooring material shall conform IS : 3462. It may be in the form of tiles, sheets or rolls as specified. It shall consist of a thoroughly blended composition of thermoplastic binder, filler and pigments. The thermoplastic binder shall consist substantially of one or both of a) Vinyl chloride polymer and b) Vinyl chloride copolymer The polymetric material shall be compounded with suitable plasticizers and stabilizers

Thickness : The preferred thickness of PVC tiles for normal floor covering shall be 1.5, 2.0, 2.5, 3.0 or 4.0 mm.

26.1.2. Thickness of PVC sheets shall be measured with micrometer or Ratechet type or a dial gauge graduated to 0.02 mm. The micrometer shall have flat bearing surfaces of at least 6.5 mm diameter at both contact points.

- For sheets and rolls the thickness of the specimen shall be measured at twenty scattered points.

- For polystyrene wall tiles, the cavity depth of the test specimen shall be measured at five points taken at random on the rear surface of each tile with a suitable depth gauge.

26.1.3. The width of flooring sheets and rolling in continuous length shall be 1000, 1500 and 2000 mm. When supplied in rolls the length of the rolls shall not be less than 10 metre. The measurement shall be carried out with a travelling microscope or suitable scale graduated to 0.02 mm. Each tile shall be measured for length and width at the three quarter point in each direction.

26.1.4. Tolerance

(a)	**In Thickness**	**(+/-)** 0.15 mm
(b)	**In Width: as under:**	

(i)	300 mm square tiles	(+/-) 0.2mm
(ii)	600 mm square tiles	(+/-) 0.4mm
(iii)	900 mm square tiles	(+/-) 0.6mm
(iv)	Sheets and rolls	(+/-) 0.1 per cent

26.1.5. Adhesive: Rubber based adhesives are suitable for fixing PVC flooring over concrete, wooden and metal sub-floors. PVA based adhesives shall be used for concrete and wooden sub floors. PVA based adhesives are not suitable for metallic surfaces and also for locations where there is constant spillage of water.

26.2. Preparation of Sub-Floors: Before laying PVC sheets / tiles, it is essential to ensure that the base is thoroughly dry and damp proof as evaporation of moisture can not take place once the PVC flooring is laid. Moisture slowly damages the adhesive resulting in PVC sheet / tiles being separated from the base and curled up. In case of new work a period of 4 to 8 weeks shall be allowed for drying the sub-floor under normal conditions. Concrete sub-floors on the ground floor shall be laid in two layers. The top of the lower layer of concrete shall be painted with two coats of A-90 grade (conforming to IS: 1580) applied at the rate of 1.5 kg/sqm. The top surface of the lower layer shall be finished smooth while laying the concrete so that the bitumen can be applied uniformly. The bitumen shall be applied after the concrete has set and is sufficiently hard. Bitumen felt conforming to IS : 1322 shall be sandwiched in the sub-floor laid in two layers.

In new concrete floor, the smooth finish required shall be produced by using cement slurry spread on fresh concrete floor and finished smooth. If the concrete floor is old and surface not even, the surface should be made smooth by first cleaning it free of all foreign material and then a layer of cement mortar 1:2 of average thickness of 6 mm shall be applied on the surface finishing the surface smooth. The finished surface shall be cured for 7 days and then allowed to dry thoroughly.

Where it is expected that the dampness may find its way from the surrounding walls, the same shall also be effectively damp-proofed upto atleast 150 mm above the level of the sub-floor and the damp proof treatment below the floor shall be extended over the walls.

26.3. Laying and Fixing

26.3.1. Prior to laying, the flooring tiles / rolls / sheets shall be brought to the temperature of the area in which it is to be laid by stacking in a suitable manner within

or near the laying area for a period of about 24 hours.

26.3.2. Where air-conditioning is installed, the flooring shall not be laid on the sub-floor until the conditioning units have been in operation for at least seven days. During this period the temperature shall neither fall below 20^0C nor exceed 30^0C. These conditions shall be maintained during laying and for 48 hours, there after.

26.3.3. Before commencing the laying operations, the sub-floor shall be examined for evenness and dryness. The sub-floor shall then be cleaned with a dry cloth. The PVC flooring shall not be laid on a sub-floor unless the sub-floor is perfectly dry. Dryness of the sub-floor shall be tested conforming to relevant IS codes and manufacturers recommendations as directed by the Engineer-in-Charge.

26.3.4. The layout of the PVC flooring on the sub-floor to be covered should be marked with guidelines. The PVC flooring shall be first laid for trial, without using the adhesive, according to the required layout.

26.3.5. The adhesive shall be applied by using a notched trowel to the sub-floor and to the back side of the PVC sheet tile flooring. When set sufficiently for laying, the adhesive will be sticky to touch, but will not mark the fingers. In general, the adhesive will require about half an hour for setting. It should not be left after setting for too long a period as the adhesive properties will be lost owing to dust films and other causes.

26.3.6. Care should be taken while laying the flooring under high humidity conditions so that condensation does not take place of the adhesive. It is preferable to avoid laying under high humidity conditions.

26.3.7. The area of adhesive to be spread at one time on the sub-floor depends entirely upon local circumstances. In case of a small room, adhesive may be spread over the entire area but relatively small areas of tiles/sheets flooring should be treated in a larger room.

26.3.8. When the adhesive is just tack free the PVC flooring sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the bed surface. After laying the sheet in position, it shall be pressed with suitable roller weighing about 5 kg to develop proper contact with the sub-floor. The next sheet with its back side applied with the adhesive shall be [laid edge to edge] with the sheet already laid and fixed in exactly the same manner as the first sheet was fixed. The sheets shall be laid edge to edge so that there is minimum gap between joints.

26.3.9. The alignment should be checked after laying of each row of sheet is completed. If the alignment is not perfect, the sheets may be trimmed by using a straight

edge. The tiles shall be fixed in exactly the same manner as for the sheets. It is preferable to start laying of the tiles along one side of the walls planning to have cut size tile only on other side all shown in the Architectural drawing. Care should be taken that the tiles are laid close to each other with minimum gap between joints. The tiles should always be lowered in position and pressed firmly on to the adhesive. Care should be taken not to slide them as this may result in adhesive being squeeze up between the joints. PVC tiles after laying shall be rolled with a light wooden roller weighing about 5 kg to ensure full contact with the under layer. Any undulations noticed on the PVC surface shall be rectified by removing and relaying the tiles after thorough cleaning of the underside of the affected tiles. The adhesives applied earlier in such places shall be thoroughly removed by using proper solvents and the surface shall be cleaned to remove the traces of solvents used. Work should be constantly checked against guidelines in order to ensure that all the four edges of adjacent tiles meet accurately.

26.3.10. Any adhesive which may squeeze up between sheets or tiles should be wiped off immediately with a wet cloth before the adhesive hardens. If, by chance, adhesive dries up and hardens on the surface of the sheet or tile, it should be removed with a suitable solvent. A solution of one part of commercial butyleacetate and three parts of turpentine oil is a suitable solvent for the purpose.

26.3.11. A minimum period of 24 hours shall be given after laying the flooring for developing proper bond of the adhesive. During this period, the flooring shall not be put to service. It is preferable to lay the PVC flooring after completion of plastering, painting and other decorative finish works so as to avoid any accidental damage to the flooring.

26.3.12. When the flooring has been securely, fixed, it shall be cleaned with a wet cloth soaked in warm soap solution (two spoons of soap in 5 litres of warm water).

26.3.13. When the edges of the PVC sheets or tiles are exposed, as for example, in doorways and on stair treads, it is important to provide protection against damage of flooring materials. Metallic edge strips may be used and should be securely fastened to the sub floor to protect edges of the flooring.

26.4. Precaution for Maintenance

26.4.1. PVC flooring subject to normal usage may be kept clean by mopping with soap solution using a clean damp cloth. Water shall not be poured on the PVC flooring for cleaning purpose as the water may tend to seep through the joints and cause the adhesive to fail. To maintain a good wearing surface a good appearance, the flooring may be periodically polished. When polish is applied frequently, a thick layer builds up which collects dirt and dust and is tacky to walk on.

26.4.2. If the traffic is light, the floor shall be given frequent brushing regular polishing by an application of new polish every 4 to 6 weeks. Under moderate traffic conditions the floor shall be given an occasional wash with a wet mop but no detergents shall be used so that the polish is not removed.

Application of polish may be done every one to three weeks. PVC flooring should not be over waxed. When this condition develops, the coatings should be cleared off with white spirit or paraffin and a light even coat of polish applied. When the PVC flooring has been polished, it will remain bright for a considerable period if dry mop is applied each day. It is this daily `dry polish` that maintains the glossy surface. After exceptionally heavy traffic PVC flooring should be swept with a hair broom, rubbed with a mop or cloth frequently rinsed in clean water and finally rubbed dry.

26.5. Measurements: Length and breadth shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm. Nothing extra shall be paid for providing PVC flooring in borders and margins, irrespective of their width.

26.6. Rate: The rate shall include the cost of all materials and labour involved in all the operations described above, except those described under “Precaution for Maintenance”. The rate does not include the cost of sub floor or damp proof treatment if any. It also does not include the cost of metallic edge strip to protect edge of flooring, wherever provided, it shall be paid separately.

26.7. PVC Asbestos Floor Tiles: Material, Dimensions and Tolerance, colour and finish, physical requirements and test shall be as per IS:3461 and the rest shall be as per specification for “PVC Sheet / Tile Flooring” as described above.

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27. LINOLEUM FLOORING

27.0. Linoleum may be used on any base that is finished even and smooth, such as concrete, timber boarding or mastic asphalt. Unevenness or undulations in the base will show badly on the surface even and are liable to damage the linoleum. Linoleum flooring is suitable only for locations wholly inside the building. Linoleum is not resistant to indentations from heels or static load. Heavy objects left in one position may leave indentations. As linoleum flooring can become dangerously slippery when highly polished or wet, care should be taken to use polish with reduced tendency to slipperiness. If full damp proofing of the base surface can not be ensured, the linoleum should not be used for floor covering. Linoleum is a combustible material and should not be used where an incombustible flooring is required. Linoleum flooring is a specialised work, which shall be carried out through specialist firms. A water sealant coating is necessary upon installation, and it's imperative that the seams between tiles are as thin possible, to protect from water penetration under the flooring.

27.1. Materials

27.1.1. Linoleum: Linoleum shall conform in all respects to IS: 653. Linoleum shall be of thickness specified in the description of the item. Linoleum shall be of either plain, moire, jaspe or marble type or a combination of the above types as shown in drawings or as directed by the Engineer-in-charge.

Linoleum shall be stored in a clean, dry & well-ventilated place without exposure to direct sunlight as directed by the Engineer-in-charge. Before starting the work the contractor shall get the samples of Linoleum approved by the Engineer in charge.

Recommended thickness: Linoleum used shall be of a thickness adequate for the conditions of surface and situation. The following thickness shall generally be used.

SN	SITUATION	THICKNESS
a)	For public buildings, cinemas, restaurants, ships and the	6 to 6.7 mm
b)	For offices, shops and the like, depending upon the	3.2 to 4.5 mm
c)	For residential house	3.2 mm

27.1.2. Adhesive: The adhesive used for laying the linoleum shall be those recommended by manufacturers of the floor covering and shall conform to specifications laid down for adhesive in IS: 1198. It shall be of heavy consistency and of reasonably short drying time.

27.2. Laying: It shall conform to IS: 1198.

27.2.1. Before laying linoleum it is essential to ensure that the base is thoroughly dry

and damp proof as per relevant IS and/or as directed by the Engineer-in-Charge, as moisture slowly rots the base and damage the adhesive resulting in the linoleum being separated from the base and curled up. Damp proofing where required may be either with an impervious membrane incorporated in the thickness of the base or with a layer of mastic asphalt of 12.5 mm minimum thickness spread and finished even and smooth on the concrete or other base; the work shall be done as per approved manufacturers specification.

27.2.2. Linoleum shall be kept at a temperature of not less than 20^0C for at least 48 hours before it is unrolled. Linoleum shall be unrolled and loose laid out flat for 2 to 3 days before it is cut to size, as it shrinks in length and expands in width after rolling. Till the expansion of spread roll stops, the two widths of linoleum should be allowed overlap and after the expansion stops it should be cut to fit. Laying should be taken up only after the sheets are finally cut to size after expansion is stopped. Linoleum pieces shall be cut to the required size and shapes with a sharp straight edge and gauge as explained below and laid dry to the margin and pattern as shown in the drawings or as directed by the Engineer-in-charge.

27.2.3. The length for borders shall be first cut and adjusted. Linoleum shall then be adjusted in the central portion with their edges overlapping the adjacent pieces by about 12 mm. The edges shall then be cut with the help of a special instrument called the `Gauge` which enables the marking of the edge of the top pieces exactly over edge of the adjacent piece, so that when the overlapping is cut along the line, the edges of adjacent sheets butt against each other without any gap, what so ever.

27.2.4. Adhesive shall then be brushed over the base, which shall have been thoroughly cleaned in advance, and shall be allowed to become tacky. The sheets shall then be firmly pressed down and rolled with a light cast iron 70 kg roller, to ensure that they stick evenly to the base and no air pockets are left under them. If any air pockets are left, the sheets shall be removed and re-laid after brushing more adhesive on the base and roll. The sheets shall be laid with butt joints throughout and the joints shall be very fine. Sandbags shall be placed over the edges and joints to keep the sheets pressed down and prevent curling. Linoleum shall not be used for coves, skirting and dado.

27.2.5. Coves of wood or metal may be formed to cover or mask the joints between the linoleum flooring and the wall facing where so required, but this shall be paid for separately.

27.3. Finishing: After laying, any adhesive contaminating the face of the sheets shall be removed immediately with kerosene oil or spirit. The flooring shall be cleaned with soap and wet cloth wiped dry. It shall then be wax polished to give a smooth shining surface,

taking care to endure that the flooring does not become slippery due to excessive polish.

27.4. Precautions: Linoleum shall not be creased, as it will crack. Excess water, which is liable to creep into the joints and strongly alkaline soaps, shall not be used for cleaning. Mild bar soap may be used. Linoleum shall be handled carefully with its exposed face protected from damage by sharp points.

27.5. Measurements: Length and breadths of superficial area of the finished work shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. No deductions shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

27.6. Rate: The rate shall include the cost of all materials and labour involved in all the operations described above but will not include the cost of sub-base floor or damp proof treatment stated above.

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28. WOODEN FLOORING

28.0. Seasoning and Preservation: All timber used for timber floors shall be thoroughly seasoned in accordance with IS : 1141. After seasoning, the timber shall be treated with preservative in accordance with IS : 401. Seasoning and preservative treatment shall not be paid for separately and the rate quoted for the item shall be inclusive of the same.

28.1. Supporting Joists: Main beams and joists of the class of wood sections specified in the description of the item for beams and joists, or as instructed by the Engineer-in-charge shall be fixed in position to dead levels. The width of the joints shall not be less than 50 mm. The arrangement and spacing of beams, joists etc. shall be as per design furnished.

28.2. Boards: It shall be of the class of timber and thickness specified in the description of the item. The timber shall be as specified in preceding chapters for wood work. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall be maintained throughout except where the width of the room is not an exact multiple of the boards. In the latter case, the difference shall be equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed 3 metre anywhere. Ordinarily, the minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-charge.

The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planing shall be paid for extra. Unless otherwise described in the item, the longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm while the heading joints shall be of the square butt type and shall occur over the centre line of the supporting joists. Heading joists in adjacent boards shall be placed over the same joists.

Laminated Flooring or Engineered hard wood flooring of approved make with surface multilayered protective floor finish (with wear ,scratch,impact,easily cleanable, Hygienic,water resistance,fire resistance, anti static properties) with Dense core material impact resistance . Installation by Perfect fold 3.0 click installation system. Colour & texture as specified in Architectural drawing & Floor laid to line & level & work done as per approved manufacturer's specification & complete to the satisfaction of E.I.C

28.3. Iron Screws: Iron screws shall be of the slotted counter sunk head type, of length not less than the thickness of planks plus 25 mm subject to a minimum of 40 mm, & of designation of No.9 Brass conforming to IS :451.

28.4. Fixing: The joists on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and close to the walls. Each adjoining board shall be carefully joined and shall be tightened in position and screwed. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zigzag manner. The screws shall be countersunk and screw holes filled with approved stopping.

The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminium) at the junction. The metal strip shall be fixed to the end of the planks by screws. The strips shall be paid for extra. The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified. The floor shall be planed in both directions and made perfectly even, true and smooth.

NOTE : No wood of any kind shall be placed within 60 cm of any fire place or flue. Provision shall be made for ventilating the space below the floor in case of ground floor and between and top of ceiling in the case of upper floors. Such arrangements shall be paid for separately.

28.5. Finishing: The surface of the floor shall be bees waxed or finished otherwise as directed by the Engineer-incharge. The lower face shall be painted or treated with wood preservative as directed. The finishing shall be paid separately unless specifically

included in description of the flooring item.

28.6. Measurements: Length and breadth of superficial area of the finished work shall be measured correct to a cm. The area shall be calculated in sqm correct to two places of decimal. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

28.7. Rate: The rate shall include the cost of labour and materials involved in all the operations described above, with the exceptions noted in the relevant sub paras.

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29. WOOD WORK IN FRAMES, SHUTTERS AND PANELLING :

29.1. WOOD WORK :

All timber mentioned in the item in schedule of quantities shall be from the heart of a sound tree of nature growth entirely free from sap wood. It shall be uniform in texture, straight in fiber and shall be well and properly seasoned. It will be free from large, loose, dead or cluster knots, wedges, injuries, open shakes, borer holes, rot, decay date, discoloration, soft or spongy spot, hollow pockets, pith or centre bore and all other defects or any other damages of harmful nature which will affect the strength, durability, appearance and its usefulness for the purpose for which it is required. **Only properly seasoned timber shall be used**.

TEAK WOOD:

First Class Teak Wood: Individual hard and sound knot shall not be more than 25mm in diameter and aggregate area of all knots shall not exceed one percent of the area of the piece. Sapwood shall not be allowed.

Second Class Teak Wood: Individual hard and sound knot shall not be more than 40 mm in diameter and aggregate area of all knots shall not exceed one and half percent of the area of the piece. Wood shall be generally free from sapwood, but traces of sapwood may be allowed.

HARD WOOD:

No individual hard and sound knot shall exceed 25mm in diameter and aggregate area of all knots shall not exceed one percent of the area of the piece. Sapwood is very perishable and should not be used.

The samples of species to be used shall be deposited by the contractor with the Engineer-in-Charge before commencement of the work. The contractor shall produce cash vouchers and certificate from standard kiln seasoning plant operator about the timber section to be used on the work having been kiln seasoned by them, failing which it would not be so accepted as kiln seasoned. Seasoning of timber shall be judged from its moisture content as laid down in I.S. 287. The seasoning of timber shall conform to I.S.1141. Scantling of all types of timber shall be straight. Warped scantling shall not be used. Before use in works, the scantling shall be kept in covered and well-ventilated place and shall be got approved.

The workmanship shall be of best quality. All wrought timber is to be sawn, planed, drilled or otherwise machine worked to the correct sizes and shall be as indicated in drawing or as specified. All joinery work shall fit truly and without wedging or filling. Wood work in frames shall be wrought. All frame joints shall be put together with white lead and pinned with hard wood pins securing with corrosion resistant star shaped metal pins as approved by the Engineer-in-charge. If after fixing in position, any shrinking or substandard materials or bad workmanship is detected, the contractor shall, forthwith remove them and replace the same at his own cost, all as directed by the Engineer-in-charge.

Individual members shall be of continuous length. The finished size and sections shall be as per drawing or as specified. The heads and posts of frames shall be through tennoned into the mortises to the full widths as shown in the drawing. All necessary mortising, tennoning, grooving, matching, tonguing, housing rebate and other necessary works for correct jointing shall be carried out, in the best workmanship like manner. Joints not specifically indicated shall be recognised form of approved joints for each position. The door frames shall be provided with 6 nos. approved iron hold fasts, fabricated out of 30 x 3 mm. section, 300 mm. long (150 mm. long for cross partitions) M.S. flats with spliced end in case they are abutting brick masonry works. These M.S. hold fasts shall be embedded in plain cement concrete 1:3:6 block of size 300 x 75 mm. depth (100 x 75 mm. for cross partitions) and for full width of brick masonry. For frames abutting concrete surfaces, 6 nos., 100 mm. long coach screws with sunk heads minimum 10 mm. from face of frames, shall be provided. Each screw shall be secured in concrete with lead wool sufficiently stuffed in the pre-drilled holes to receive the screws. Top member of door frames for opening exceeding 1.25 m. in width, shall be secured with a coach screw 100 mm. long in centre of member. All other T.W. scantlings shall be fixed to structural openings with wood screws of suitable size & rawl plug so as to get in effective hold of at least 40 mm. Suitable teak wood plugs shall be provided to conceal the screw heads. The door frame shall rest on concrete sub- base in ground floor or structural floor slab in case of upper floors, the extra length of sides of frames thus embedded below finished floors shall not be measured for payment. All parts of wood work resting on or set in masonry

or concrete i.e side connected to masonry/concrete shall be well painted with two coats of bituminous paint or solignum (termite protection) as directed by the Engineer-in-charge, prior to installations. All nails, screws, hold fasts, plates, plugs, pins required for wood work joinery and fixing work, shall be provided by the contractor, at his own cost. All materials shall be approved by Engineer-in-charge before using in works. Painting of door frames shall be carried out as per specifications for painting for wood work.

All the embedded timber shall be given two coats of hot tar or solignum before erection. This is incidental to the item and shall not be measured for payment.

29.2. TEAK WOOD PANELLED SHUTTERS :

Teak wood door shutter shall generally conform to standard laid in I.S. for requirements of materials, construction workmanship and shall be of specified thickness and of 1st class C.P. teak wood of approved design with stiles, top, bottom and lock rail generally as per drawing. Wherever shown, each panel shall be in a single width piece, but when two or more pieces have to be used and are permitted, all of them shall be of equal width and shall be jointed with a tongue and groove joint with chamfered edges glued together and reinforced with metal dowels.

29.3. TEAK WOOD GLAZED SHUTTERS :

The specifications for teak wood panelled shutter shall generally apply to glazed shutters for frame, stiles etc.

The sash and beading required for glazing shall be of the best teak wood and shall be fixed as per the design shown in relevant drawing. Any mouldings, carvings shown shall be worked out from the teak wood member of bigger size.

29.4. GLAZING :

Glazing shall be generally with minimum 4 mm. thick plain sheet glass/bajra glass unless otherwise mentioned in the schedule of quantities. The detailed specifications for glazing given hereafter shall be followed generally.

29.5. FLUSH DOOR SHUTTERS :

Solid core flush door shutters shall be of 5 ply construction and approved make generally conforming to the I.S. specification 2202 (specification for wooden flush door shutter- solid core type). The finished thickness of the shutter shall be as mentioned in the schedule of items.

29.6. FACE VENEERS :

Commercial face veneers used in flush door shutter shall conform to the requirements laid down in I.S. 303 -1989 specifications for ply wood for general purposes (revised) interior grade.

Decorative face veneers used in flush door shutters shall be of grade - I and shall conform to the requirements of decorative veneer specified for grade - I decorative ply wood in I.S. 1328 specifications for veneered decorative ply wood interior grade. Thickness of veneers shall not exceed 1 mm.

29.7. ADHESIVES :

Phenol formaldehyde synthetic resin (liquid type adhesives) conforming to I.S. 848 specifications for synthetic resins shall be used for bonding.

29.8. LIPPING :

The lipping shall be of best quality hard wood variety unless otherwise mentioned. In case teak wood lipping is mentioned in the schedule of quantities, it shall conform the specification for best quality teak wood. The internal lipping alround the shutter sides shall be one piece of size not less than 25 mm. wide and depth equal to the thickness of core. In case of double leaf shutters, the meeting stiles shall have lipping of not less than 35 mm. deep. **Thickness of external lipping, wherever specified in the item, shall not be more than 10mm and not less than 6mm.**

29.9. WORKMANSHIP AND FINISH :

All the faces of the door shutter shall be at right angles. The shutter shall be free from twist and warp in its plane. Both faces of the door shutters shall be sanded to a smooth even texture. The workmanship and finish of the face panels shall be in conformity with those specified in I.S. 303 specification for plywood for general purpose (revised) for commercial type and I.S. 1659 specification for block boards.

29.10. TESTS :

Tests shall be conducted as per mandatory test requirement, by the Contractor at Approved Lab at contractors cost and acceptance criteria shall be as per I.S. 2202. The

flush door shutters manufactured shall be inspected for its quality and workmanship and tested at the factory before dispatching. All facilities shall be extended for such inspection and testing. The sampling and testing shall be as per the IS requirements and all costs towards test including sample for various tests shall be borne by the contractor.

29.11. TOLERANCE :

Tolerance on nominal width and height shall be (+/-) 3 mm. Tolerance on nominal thickness shall be (+/-) 1.5mm. The thickness of the individual shutter shall be uniform throughout.

29.12. MISCELLANEOUS :

Wherever mentioned in the Schedule of quantities, vision panels, venetians, plastic laminates, push plates etc. shall be provided in the flush doors.

The vision panels shall be of size mentioned in the drawing and shall be provided with teak wood lipping alround the glass. The glass shall be minimum 4 mm. thick or as specified of best quality (Saint Gobain /Asahi India Glass/ Gujarat Guardian - Modiguard or equivalent approved), free from defects.

Teak wood venetians or louvers shall generally conform to relevant specifications of timber. Necessary grooves and rebate in frames shall be provided as per drawing.

Formica or approved equivalent plastic laminate of required design, required shade and colour shall be provided and fixed on flush door to the required size on any side of the shutter as shown in drawing. It shall be fixed with appropriate water based adhesive for plastic laminate & wood joinery. Fixing shall be done in such a way that there shall not be any air gap, warpage or undulations on the surface. Finished surface of formica shall be cleaned with wax polish.

The shutters shall be painted on commercial facing side with two coats of synthetic/flat oil paint of approved shade and make over an approved coat of primer. The decorative veneer side of the shutter shall be wax or french polished with two or more coats so as to render a satisfactory surface.

The flush doors shall be single leaf or double leaf type as mentioned in the schedule of quantities. In case of double leaf shutters, the meeting of the stiles shall be rebated 20 mm. and shall be either splayed or square type and the T.W. lipping around the meeting shall not be less than 35 mm. deep. The meeting stiles shall be in single piece.

Sufficient care shall be taken to prevent any damage and loss of shape during handling, transporting, stacking, fixing etc. The door shutters shall be handled with utmost care to prevent any surface damage, warping etc.

29.13. MODE OF MEASUREMENT :

The work covered under the respective items in schedule and the above specifications shall be measured as follows :

The cubic contents for wood work shall be measured for the finished size, limiting to those shown in the drawings or ordered by the Engineer-in-charge. The cross sectional dimensions shall be measured equivalent to nearest enclosing rectangle (least rectangle/square) for wrought and planed sizes. The cubical content shall be worked out correct upto three places of decimals of a cubic metre. The frames embedded below finished floor shall not be measured.

The square meter areas for shutters shall be measured for the exposed surfaces of shutter between frames from inside or outside whichever is more. The linear dimensions shall be measured upto two places of decimals of a metre. The area for payment shall be worked out correct upto two places of decimals of a square metre. The rate for shutters shall include:

i. Cost of supply assembly and erecting in position.

ii. Cost of polishing, painting, supplying wood preservative, screws, nails, hold fasts etc.

iii. Cost of labour for making adjustments in frames, if required, shutters and also for fixing required fittings and fixtures.

iv. In case of flush doors, the rate for individual item mentioned in the schedule of quantities shall include cost of shutters, labour for provision of glass for vision panel, plastic laminate sheet push plate, teak wood louvers etc., transporting charges and labour for fixing of fixtures and fastenings except fixing of door

v. closers and painting and polishing as specified.

30. PRESSED STEEL DOOR FRAME :

30.1. Scope of work : This specification lays down the requirements regarding material, dimensions and construction of steel door frames for internal and external use.

30.2. Material : Steel door frames shall be manufactured from commercial mild steel sheets of 1.25 mm. thickness, conforming to I.S. 513 (for cold rolled carbon steel sheets) or I.S. 1079 (for hot rolled carbon steel sheet and strip). Sheets shall be galvanised for 240 g / Sqm. Zinc deposit on its surface including both sides as per IS 277 – 2003; Material

from Sail Jyoti -GP Galvanised sheet from SAIL make or approved equivalent shall be used for fabrication. Fire Rated steel door of Fire Rating as per requirement as in architectural drawing shall be of approved make and complete as per manufacturers specification. Fire Doors are designed to meet the life safety requirements by primarily compartmentalizing and containing the spread of fire. Doors are tested and certified to Indian, American and British Standards, UL certified. Doors complement the existing passive fire-fighting systems already in use in the buildings.Fire rating to 2 /3/4 hours as per requirement. Fire rated Locks mortise locks & lever handles, Panic bar , Fire rated Glass for vision Panel – Borosilicate & Interlayered ; Doors shall conform to IS 3614 , BS 476 Part 22, BS 6206. Glass shall be fully toughened monolithic non wired fire resistant glass conforming to DIN EN 13024-1. Fire stop silicone /Putty / Impregnating Insulating blocks of approved make shall be used as required location.

Metal Door frames and door shutters made upof Galvanize steel (base steel as per IS 513 of 0.58 mm thick D quality, galvanized as per IS 277 with Zinc of 120 GSM) Pure polyester powder upto 50-60 microns thick **.** Outer frame section should be of 100x 58mm x 1.2mm thick.

The snug fitting door leaf and the frame combine into an elegant flush-fitting door design. Robust and long-lasting steel frame with a grooved profile and a PVC seal for acoustic and energy efficiency. Profile threshold can be an option based on requirement.

Optional rebated aluminum threshold with a PVC seal. Stainless steel ball bearing butt hinges for smooth operation.

PVC laminated steel with elegant wood finish patterns on the surface or Polyurethane finish all finish & fixtures Trims and lever handles etc. to suit various applications shall be as per Architectural drawing requirement.

Door hardware comprising of Locks-mortise,W.C.Lock; Lever handles & Pull handles- D/ H / offset Type handle, door closers, concealed door closers, Eye viewer,door guard, floor stop, wall stop or other fittings shall be as per Architectural drawing.

Finishes –wood décor, wood grain finishes.

30.3. Standard sizes, Tolerances and Designations :

Sizes : The overall sizes and types of door frames shall be as shown in drawings. 5 mm. clearance on all the four sides shall be allowed for the purpose of fitting the frame into modular openings.

Tolerances : The sizes indicated in drawings for door frames shall not vary by more than (+/-) 2 mm.

30.4. Profile : Steel door frames with or without fanlight shall be made in the profile as per I.S. 4351 (latest version) as per drawings. Any of the three profiles mentioned in I.S. 4351 or sizes specified in the schedule of work may be supplied to suit doors of either hand, opening inwards or outwards, as specified or directed.

30.5. Construction : Each door frame shall consist of hinge jamb, lock jamb, head and, if required, angle threshold. The whole shall be rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit.

30.6. Base ties and angle thresholds : Base ties shall be of pressed mild steel 1.25 mm. thick adjustable to suit floor thickness of 25, 30, 35 or 40 mm. and removable, or alternatively, thresholds of mild steel angle of section 50 x 25 mm., minimum, shall be provided for external door frames.

30.7. Fittings: Fixing Lugs: There shall be three adjustable lugs with split end tail to each jamb without fanlight, and four for jamb with fanlight. The head of the fixing lug shall be of 120 mm. long and shall be made from flat steel strip 25 mm. wide and not less than 1 .60 mm. thick.

The tail of the lugs for use with door frame profile shall be 200 mm. long and shall be made of steel strip not less than 40 mm. wide and not less than 1.0 mm. thick.

Mortar Guards: Mortar guards specified in the tender shall be provided. These shall be welded to the frame at the head of the frame for double shutter doors to make provision for bolts.

Note: The term 'double-shutter doors' indicates 'Pairs of side-hung doors', that is, two side-hung doors mounted in one frame thus forming a two-leaf door rebated together at the lock strike.

Lock Strike Plate: There shall be an adjustable lock-strike plate of steel, complete with mortar guard, to make provision for locks or latches complying with the relevant Indian Standards. Lock-strike plates may be of brass when so specified in the tender; otherwise they shall be of galvanised mild steel and fixed at 75 cm. to 90 cm. from finished floor level.

Shock Absorbers: For side-hung door, there shall not be less than three buffers of rubber or other suitable material inserted in holes in the rebate and one shall be located on the centre line of the lock-strike plate and the other two at least 45 cm. above and below the

centre line of the lock-strike plate. For double-shutter doors, there shall be two buffers of rubber or similar suitable material inserted in holes in the rebate in the lock jamb only at the head and spaced 15 cm. at either side of the centre line of the door.

30.8. Mode of Measurements : The length shall be measured in running metres correct to a cm. out to out of the frames. Threshold angle/base tie will not be measured for payment, cost of which shall be included in pressed steel frame.

31. FACTORY MADE PARTICLES BOARD PANELLED DOOR SHUTTERS /BLOCK BOARD SHUTTERS / MOULDED SKIN PANEL SHUTTER

31.1. GENERAL : Factory made particle board panelled door shutters shall be made of kiln seasoned and chemically treated timber as specified generally with stiles and top rails of 100 mm. in width, bottom rail and lock rails of 150/1 75 mm. width and panels made of 12 mm. thick both side commercial veneered teak wood particle board or as specified in schedule of quantities, bonded with phenol formaldehyde synthetic resin adhesive

Factory made shutters, as specified shall be obtained from factories to be approved by the Engineer-in-Charge and shall conform to I.S. 2202 (Part-I) & PART II. The contractor shall inform well in advance to the Engineer-in-Charge the name and address of the factory where from the contractor intends to get the shutters manufactured. The contractor will place order for manufacture of shutters only after written approval of the Engineer-in-Charge in this regard is given. The contractor is bound to abide by the decision of the Engineer-in-Charge and recommend the name of another factory from the approved list, in case the factory already proposed by the contractor is not found competent to manufacture quality shutters.

The contractor will also arrange stage-wise inspection of the shutters at factory of the Engineer-in-Charge or his authorised representative. Contractor will have no claim if the shutters brought at site are rejected by Engineer-in-Charge in part or in full lot due to bad workmanship/quality. Such shutters will not be measured and paid and the contractor shall remove the same from the site of the work within seven days after the written instructions in this regard are issued by Engineer-in-Charge or his authorised representative.

Flush doors can be easily installed with minimum efforts made out of high quality wood with excellent tooling and finishing properties, the doors are made with chemically treated seasoned hardwood battens and frames.

The cross bands veneers are uniformly dried to the requisite moisture content, bonded with special quality Phenol formaldehyde synthetic resin as per the guidelines of IS:2202. Flush Doors are treated for total termite and borer protection.

- Manufactured with selected and high quality hard wood timber.
- Timbers used to manufacture Doors to be treated with anti-termite borer chemical before sawing.
- Frames and battens to be seasoned in advance seasoning chamber for equalize the moisture content.
- All the frames and battens to be cut through ripsaw machine and planer for equal size and thickness.
- The width of battens and frames should be wider as per the specification of BIS.
- Extra lock rail is provided for the convenience of handle and lock fittings.
- Special care is to be taken during the assembly of battens to avoid any gap inside the door.
- High solid content water proof PF Resin to be used for high strength.
- Doors are conditioned before cutting to avoid the warping and twisting.
- Doors are finished with highly precised wide belt sander.
- All doors are strictly tested as per the BIS guidelines.
- Door thicknesses of 30/ 32/ 35 mm.

Skin door by laminating two pieces of molded door skins over it. Honeycombs as well as solid timber strips infill are used to fill up the hollow core between the door skins for strength and stability; door skins are to be made of high quality HDF.

Resin coated finish doors for wet areas.

MOULDEN SKIN PANEL DOOR SHUTTERS
Skins used on the door as face panel are very high density wood fiber skins, source skins are 100% environment friendly & are manufactured by using 100% wood fiber & E1 glue ; seasoned & dried hardwood internal framing (Rail & stile) is used with choice of internal core construction (solid or Best quality Alternative Green Tubular Core). These doors are thermosetting resin bonded, hydraulic hot pressed. Door shutter in 2/3 /4 /6 number of Panels.

Hard wood Door frame shall be Kiln Dried, Seasoned, Chemically Treated & Finger Jointed (FT) - For better stability & strength

ACOUSTIC DOOR
Kutty's Nishabdh- sound proof doors or approved equivalent make for 33 STC and 40 STC standard performance and hi- performance respectively. These doors are used for sound reduction in Auditorium, Multiplexes , Cineplex & Hotels etc shall be used if required as specified in Architectural drawing.

LEAD LINE (X-RAY ROOM) DOORS

Door with radiation protection in X-Ray or CT scan room Kutty's lead line doors or approved equivalent make shall be used if required as specified in Architectural drawing.

31.2. TIMBER :

The timber to be used in door shutters shall generally conform to relevant I.S. specifications for materials, moisture content, seasoning, preservation and workmanship. **Seasoned Timber shall only be used.**

All timber shall be from the heart of a sound tree of mature growth, entirely free from sapwood. It shall be uniform in texture, straight in fiber and shall be well and properly seasoned. It shall be free from large, loose, dead or cluster knots, soft or spongy spots, hollow pockets, pith or centre heart, waves, injurious open shakes, borer holes, rot, decay date, discoloration and all other defects or any other damages of harmful nature which will affect the strength, durability, appearance of its usefulness for the purpose for which it is required.

31.3. PARTICLE BOARD PANELS :

It shall be of well seasoned teak timber particles of uniform thickness, bonded with liquid phenol formaldehyde synthetic resin adhesive of the hot press type. The particle board shall be either flat plate on press or extrusion type as approved by the E.I.C conforming to the latest I.S. specifications. Panels shall be embedded into frames to a minimum of 12 mm.

31.4. SEASONING AND TREATMENT :

All timber to be used for sills and rails shall be kiln seasoned to the required standards as per I.S. 1141.

31.5. ADHESIVE :

The adhesive for bonding of stiles, rails etc. shall be of highly water resistant type synthetic resins (liquid type) adhesive conforming to relevant specifications for synthetic resins.

31.6. WORKMANSHIP AND FINISH :

The workmanship shall be done by experienced first class skilled Carpenters. All members shall be in continues length. All the faces of the door shutter shall be secured and in true planes. All wrought timber is to be sawn, planed, drilled or otherwise moulded work to the correct size and shapes indicated in drawing or as specified. All joinery work shall fit truly and without wedging or filling. All the faces of the shutters shall be sanded to smooth even texture. The finished sizes and sections shall be as per drawing or as specified. The shutters shall be got approved from the Engineer-in-Charge at factory site before carting the same to the site of work. The shutters damaged during the cartage and if any sub-standard materials or bad workmanship is detected, the contractor, shall forthwith remove them and replace the same at his own cost, all as directed by the Engineer-in-charge.

31.7. PRIMER COAT :

All factory made panel door shutters with seasoned teak wood/hard wood frame shall be painted with approved Primer coat as per I.S. specifications .

31.8. TESTS :

Tests shall be conducted as per mandatory test requirement by the E.I.C at the contractors cost. All shutters shall have manufacturer's trade marks.

31.9. TOLERANCES :

Tolerances on nominal width and height shall be (+/-) 3 mm. Tolerance on nominal thickness shall be (+/-) 1 .5 mm. The thickness of the shutter frame shall be uniform through out with a variation not exceeding 1 mm., when measured at two points.

31.10. SAMPLES :

Sample of door shutter shall be got approved before manufacturing on large scale.

31.11. FIXING:

The shutter shall be fixed to teak wood or rolled M.S./EZ door frame (teak wood/rolled steel in door frames paid under relevant items) with necessary fittings as per drawing (cost of fittings and fixtures paid under relevant items). The shutter shall be painted as specified. The shutters of specified thickness and of required sizes as fixed in position as shown in drawing/schedule of quantities shall be measured for payment. The length and width of the shutter fixed in position shall be measured correct upto three places of decimal of a metre and the areas so worked out shall be corrected upto two places of

decimal of a square metre. The area of the shutter shall be measured for the exposed surfaces of shutter between frames from inside or outside whichever is more.

31.12. RATE TO INCLUDE :

The rate quoted by the contractor shall be :

i) for supplying and fixing in position of finished shutters with necessary fittings and fixtures as per drawings (excluding cost of fittings and fixtures which shall be paid under relevant items).

ii) painting/polishing as specified and as directed by the Engineer-in-charge.

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32. GLASS FIBRE REINFORCED PLASTIC (GRP) PANEL TYPE DOOR SHUTTERS

32.1. SCOPE

The specification for Glass Fibre Reinforced Plastic (GRP) Panel Type Door Shutters shall generally conforming to IS 14856 and other associated IS Codes as regards to types, sizes, material, construction, workmanship, finish, performance requirements and sampling etc. for use in residential and industrial buildings, except the large size door shutters for industrial and special buildings like workshops, garages, godowns, etc. For larger size door internal concealed strengthening by reinforcement and heavier size frame members, in fill materials shall be used, drawing by the vendor should be submitted prior to fabrication.

Pultruded fiber glass door frames; door with complete composite fixing arrangement for making the corners as well as for fixing the Hinges and the Hole passes.

REFERENCES: The above cited IS 14856 shall be referred with its associated codes.

32.2. TERMINOLOGY

Aggregate Defects: Presence of impurities such as pin holes, impurities and traces of mending more than 5 each or 5 in aggregate for defects at localized place.

Blistering: Air or solvent entrapped during moulding.

Colour Blots: Colour blots occurring on account of uneven distribution of colouring material.

Crazing: Fine hair cracks on the surface.

Defective Impregnation: Imperfect impregnation of glass fibre with unsaturated polyester resin.

Gelcoat: A gelcoat of UV stabilized, fire retardant, isophthalic quality mixed with 1 5'percentby weight, aerosil powder (500 micron ground silica) suitably formulated to high viscosity given to exposed exterior sections of the moulded door shutter to provide a smooth glossy finish, enhance aesthetics and improve weathering and water resistant properties of the moulded door shutter. The thickness of the coat shall be between 0.35 to 0.40 mm.

Impurities: Foreign matter present, other than specified.

Laminate: A reinforced resin sheet or moulding.

Pin Holes: Pores of size less than 1mm appearing on the surface.

Small Pores: Pores of size more than 1mm appearing on the surface.

Wrinkle: A slight ridge or furrow on surface.

Base Block: A wooden or suitable material provided within the door/shutter frame to facilitate fixing of fittings and other accessories.

RTM Process: Resin Transfer Moulding includes all forms of resin injections, resin infusion vacuum infusion and vacuum press moulding. Moulding is done in a closed mould under differential pressure.

Hand Lay Up: Hand Lay up process consist of laying gelcoat with appropriate layers of Chop Strand Mat (CSM) and resin in open moulds.

32.3. HANDING: Handing and direction of closing of shutters shall be designated in accordance with IS 4043.

32.4. MATERIAL

Glass Fibre Chopped Strand Mat (CSM): The glass fibre chopped strand mat used shall be as per IS 11551.

Glass Fibre Rovings: The glass fibre rovings shall be as per IS 11320.

Isophthalic Resin: Isophthaic resin shall be of fire retardant grade as per IS 6746.

Curing Agents

1. Catalyst used shall be Methyl Ethyl Ketone Peroxide (MEKP), benzyl peroxide, acetyl aceto peroxide, etc.

2. Accelerator used shall be cobalt napthalate, cobalt octonate, N.N. dinethyl anilene, etc.

Fillers and Additives

1. Permissible fillers are fiench chalk powder (Talc) and calcium carbonate.

2. Aluminium trihydrite, antimony trioxide, minimum 5 percent, by weight of isophthalic resin, shall be used for fire retardancy.

3. The fillers and additives content shall not exceed 10 percent by weight of isophthalic resin.

Auxiliary Chemical: Polyvinyl alcohol (PVA) or other semipenetrant release agents and wax shall be used as a mould release agent.

Pigments: Pigments compatible with isophthalic resin and gelcoat shall be used to obtain the shade of finish as mutually agreed between the manufacturer and the purchaser.

Base Blocks: Base blocks for fixing fixtures in shutter with screws shall be of seasoned and treated hard wood or any other suitable material.

Polyurethane Foam: Slabs of minimum density of 32 kg/cum and of thickness 4 mm less than the shutter thickness with (+/-) 0.5 mm tolerance shall be used.

32.5. CONSTRUCTION / FABRICATION

32.5.1. The GRP shutter shall have hollow rails and stiles monolithically cast with panels.

32.5.2. The shutters shall be contact moulded by either hand lay up or Resin Transfer Moulding (RTM) process in two pieces as shown in Fig. 1. The process shall consist of laying gelcoat of 0.35 mm to 0.40 mm thickness laid over with three layers of GRP mat (one layer of 300 CSM mat and two layers of 450 CSM) for each of the web (panel) portion and four layers of GRP mat for the flange (rails and stiles) portion (one layer of 300 CSM mat and three layers of 450 CSM mat). While closing the two pieces, additional layer of 450 CSM

mat shall be provided in the web portion. The CSM mat shall be bonded with isophthalic resin in the ratio not less than 1:2 (one part of mat to two parts of isophthalic resin and fillers and additives) by weight. The edges shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient rovings shall be laid in the corners to have smooth curve while laying the CSM mat. If the shutter is moulded using the RTM process, then moulding shall be done either by laying gelcoat followed by laying of the GRP mat. Core material shall be placed in location in the hollow sections. The GRP mat shall be bonded by injecting under pressure isophthalic resin in a ratio not less than 1:2 (one part of mat to two parts of isophthalic resin). Alternatively, if the shutter is moulded without using gelcoat then the process is to lay the FRP mat in the mould with the core material blocks in location in the hollow section. The GRP mat shall then be bonded by injecting under pressure, isophthalic resin in a ratio not less than 1:2 (one part of mat to two parts of isophthalic resin).

32.5.3. Blocks of any seasoned hardwood of bulk density not less than 450 kg/m3 at 12 percent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle sliding door bolt, Mortise lock, etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter.

32.5.4. Blocks shall be provided at predetermined places in the shutter so as to fix hinges, Mortise locks, tower bolts, aldrops, door closures, etc.

32.5.5. The finished surface shall be buffed and polished 3 IS 14856 with wax.

32.6. DIMENSIONS, SIZES AND TOLERANCES

32.6.1. **Dimensions of Components and Tolerances:** The finished dimensions and tolerances of the different components of door shutter shall be as given below:

Dimensions and Tolerances of Components of Door Shutters

SN	**Description**	**Width** (in mm)	**Thickness** (in
i	Vertical stile, top and freeze rail	90 (+/-) 3	30 (+/-) or 35 (+/-) I
ii	Lock rail	120 (+/-) 3	30 (+/-) or 35
iii	Bottom rail	150 (+/-) 3	30 (+/-) or 35

Minimum thickness of GRP laminate of **hollow rails and stiles** shall be 3 mm.

Minimum thickness of GRP laminate used for **panel in the shutter** shall be 5 mm.

32.6.2. **Sizes and Types:** Sizes and types of the shutters shall be generally as per working drawings issued for the work or shall conform to the modular sizes as per IS 14856.

32.6.3. **Tolerances:** Tolerances on the sizes of door shutters shall be _~mm.

32.7. LOCATIONS OF FI'ITINGS AND ACCESSORIES

32.7.1. The lock rail of door shutters shall be so placed that its centre line is at a height 850 + 5 mm from the bottom of the shutter.

32.7.2. Each door shutter shall be fixed to the frame with three hinges of the type specified, unless otherwise specified. These location shall be, one at the centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication, by depressing the profile has been made.

32.7.3. Other fixtures shall also be provided at the locations where blocks have already been provided

32.8. FINISH

32.8.1. The surface of the moulded shutters shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects.

32.8.2. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable.

32.8.3. Panels, rails and stiles of the door shutters shall be flat and shall have smooth and level surface.

32.8.4. Shutter shall be finished in colour & design as specified in the agreement item.

32.9. TESTS

32.9.1. **Tests on Material:** Following tests shall be conducted on FRP laminate (without removing gel coat) cut from door shutter. The method of carrying out the test shall be as per the reference code mentioned against each test. Acceptable criteria shall be as mentioned against each test.

Tests on GRP Laminate

SI No.	Tests (as per IS requirement)	Acceptable Value
i)	Fibre glass content Annex B	25 percent (Min)
ii)	Barcol hardness Annex C	30 BHU (Min)
iii)	Tensile strength Annex D (MPa)	100 (Min)
iv)	Bending strength Annex E (MPa)	120 (Min)
v)	Elastic modulus Annex F in bend (MPa)	1500 (Min)
vi)	Water absorption Annex G	0.5 percent (Max)
vii)	Fire retardancy Annex H	100 mm length of the specimen

32.9.2. Requirements on Shutters

The following tests in accordance with IS 4020 (Parts 1 to 16) shall be conducted on the door shutters:

32.9.2.1. Dimensions and Squareness Test: Door shutters, when tested in accordance with 1S 4020 (Part 2), the dimensions of nominal width and height shall be within a limit of (+/-) 5mm. The door shutter shall not deviate by more than 1mm on a length of 500 mm. The thickness of the door shutter shall be uniform throughout with the permissible variation of not more than 0.8 mm between any two points. The nominal **thickness** of the shutter shall be within a limit of (+/-) 1.5mm.

32.9.2.2. General Flatness Test Door shutters, when tested in accordance with IS 4020 (Part 3), the twist, cupping and warping shall not exceed 6 mm.

32.9.2.3. Local Planeness Test: Door shutters, when tested in accordance with 1S 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

32.9.2.4. Impact Indentation Test: Door shutters, when tested in accordance with IS 4020 (Part 5), shall have no defects such as cracking, tearing or delamination and the depth of indentation shall not be more than 0.2 mm.

32.9.2.5. Edge Loading Test: Door shutters, when tested in accordance with IS4020 (Part 7), the deflection of the edge at the maximum load shall not be more than 5 mm. On removal of the loads, the residual deflection shall not be more than 0.5 mm, failing which the test may be repeated on the other edge in the reverse direction. Also there shall be no lateral buckling by more than 2 mm during loaded condition and no residual lateral buckling after removal of the load.

32.9.2.6. Shock Resistance Test

1. Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 8), there shall be no visible damage in any part of the door after twenty-five blows on each end.

2. Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 8), the normally hung shutter, with hangings, fixings and fastenings should withstand without any significant permanent deformation and without deterioration the five impacts on both sides of the shutter.

32.9.2.7. Buckling Test: Door shutters, when tested in accordance with IS 4020 (Part 9), shall not show **any** deterioration and any residual deformation more than 5 mm after 15 min of unloading and the initial deflection also shall not be more than 50 mm.

32.9.2.8.

32.9.2.9.

32.9.2.10.

32.9.2.11. Slamming Test

Anyone of the following tests shall be used.

1. Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 10), shall not have any visible damage in any part of the door at the end of 50 successive impacts.

2. Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 10), shall not have any visible damage in any part of the door at the end of I00 successive impacts.

32.9.2.12. Misuse Test

Door shutters, when tested in accordance with 1S4020 (Part 11), there shall not be any permanent deformation of the fixing or any other part of the door set in hindering its normal working after the test.

32.10. SAMPLING AND CRITERIA FOR CONFORMITY: The sampling and criteria for conformity shall be in accordance with IS 4020 (Part 1).

32.11. MARKING

1 All door shutters conforming to this specification shall be marked with the following information:

a) Name of manufacturer or trade-mark, if any.

b) Lot number/date of manufacture for identification.

c) ISI Certification mark if any.

32.12. MODE OF MEASUREMENT: Square metre area for shutters shall be measured for the exposed surfaces of shutter between frame work from inside or outside, whichever is more. The linear dimensions shall be measured upto two places of decimals of a metre. The area for payment shall be worked out correct upto two places of decimal of a square metre.

32.13. RATE TO INCLUDE: The rate quoted by the contractor shall include supplying and fixing the shutters including supplying and fixing all fittings and fixtures as per item and / or drawing. Unless otherwise specified, frame work for the shutters & fittings shall be measured and paid separately under relevant item.

33. FITTINGS AND FIXTURES:

33.1. SCOPE OF WORK :

The work covered under these specifications consist of supplying different types of fittings and fixtures required for doors, windows, ventilators etc. The supply shall be in accordance with the specification, drawings / approved samples. Samples of various fittings and fixtures proposed to be incorporated in the work shall be submitted by the contractor for approval of the Engineer-in-charge before order for bulk supply is placed.

33.2. GENERAL :

All fittings and fixtures shall conform to relevant IS code and made of brass, anodized aluminium, iron oxidised (M.S.) or as specified. These shall be well made reasonably smooth and free from sharp edges, corners, flaws and other defects. Screw holes shall be counter sunk to suit the heads of the specified screws. All hinges pins shall be of steel for brass hinges and aluminium alloy NR-6 or steel pins for aluminium hinges with nylon washers or as specified. All riveted heads pertaining to hinge pins shall be well formed. Screws supplied for fittings shall be of the same metal and finish as the fittings. However brass cadmium plated/chromium plated screws shall be supplied with aluminium fittings. Samples of each fixture/ fitting shall be furnished by the contractor for approval of the Engineer-in-Charge. Order for procurement of fittings and fixtures in bulk shall be placed only after approval by the Engineer-in-Charge.

The fittings and fixtures to be incorporated in the work shall be strictly according to the approved sample. Fittings shall be fixed in proper position as shown in the drawing and

as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with a screwdriver and not hammered in. Recess shall be cut to the exact size and depth for the counter sinking of hinges. The fittings and fixtures shall be fixed in a workman like manner and any damages done either to fittings and fixtures or to the shutter frames etc. should be rectified by the contractor at his own cost.

Fittings shall be of Mild steel, Stainless steel, aluminium, brass or as specified. The fittings shall be well made, smooth, and free from sharp edges and corners, flaws and other defects.

Mild steel fittings shall be bright satin finish black stone anodized or copper oxidised (black finish), nickel chromium plated or as specified.

Brass fittings shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

Aluminium fittings shall be anodized to natural matt finish or dyed anodic coating less than grade AC 10 of IS: 1868

Stainless steel fittings shall be non-magnetic, rust & moisture proof, strong & sturdy. Pin of hinges shall also be of stainless steel.

33.3. BUTT HINGES : Brass and aluminium hinges shall be manufactured from the extruded sections and shall be free from cracks and other defects. M.S. butt hinges shall be cranked and manufactured from M.S. sheets. All butt hinges shall conform to latest I.S. specifications butt hinges shall generally condorm to releval I.S viz IS 1341 (M.S.) IS : 205 (Cast brass & aluminium, IS : 362 (Parliament hinges); IS : 453 spring hinges, IS : 3818 (Piano hinges) etc. The size of butt hinges shall be taken as the length of the hinge. Width of the hinge shall be measured from the centre line of hinge pin to end of flange.

33.4. PARLIAMENTARY HINGES : These shall be manufactured from extruded section for brass and aluminium and from M.S. sheets for iron oxidised and shall be free from cracks and other defects. The size of the parliamentary hinges shall be taken as the width between open flanges, while the depth shall be as specified.

33.5. PIANO HINGES :

These shall be generally conformed to I.S. 3818 and shall be made of either brass oxidised, aluminium anodized, iron oxidised (M.S.) or as specified. Piano hinges shall be fixed in the entire length of the cupboard shutters in a single piece. No joints shall be allowed.

33.6. TOWER BOLTS : These shall generally conform to IS 204 (Part I & II). They shall be well made and shall be free from defects.

The tower bolts shall be of the following types :

i. MS Semi barrel tower bolt with M.S sheet pressed barrel and G.I. bolt or with M.S barrel and M.S Sheet bolt.

ii. Oxidised brass barrel tower bolt with brass sheet barrel and rolled or drawn brass bolt.

iii. Anodised aluminium tower bolt with barrel and bolt of extruded sections of aluminium alloy.

In case of M.S. tower bolt plates and straps after assembly shall be firmly anodize or spot welded properly.

The knobs of brass tower bolts shall be cast and the bolt fixed into the knob firmly as per I.S. specifications. The tower bolt shall be finished to correct shape and pattern so as to have a smooth action. Wherever specified, aluminium barrel tower bolts shall be manufactured from extruded sections of barrel & bolts.

Knobs shall be properly screwed to the bolt and riveted at the back. The size of the tower bolt shall be taken as the length of barrel without top socket.

33.7. Door Latch :

This shall be of MS, cast brass or as specified shall have smooth sliding action. MS Latch shall be copper oxidised (black finish) or as specified. Brass Latch shall be finished bright, CP or oxidised or as specified

33.8. ALDROPS :

These shall be oxidised brass or anodized aluminium, iron oxidised or as specified and shall be capable of smooth sliding action and shall be as per relevant I.S. Brass sliding door bolt (aldrop) shall be made from rolled brass generally confirming to IS : 2681. M.S. sliding door bolt shall generally conform to I.S.281. The hasp shall be of cast brass and screwed to the bolt in a workman like manner. Alternatively the hasp and the bolt may be in one piece. Bolts shall be finished to shape and threaded with worth standard and provided with round brass washers and nuts of square or hexagonal shape. All components shall be smooth and polished. The leading dimensions of aldrop shall be as the length of the bolt and specified diameter.

33.9. DOOR HANDLES- BOW/PLATE HANDLES :

These should generally conform to IS : 208. Unless otherwise specified door handles shall be of 100 mm size & windows handles of 75 mm size. These shall be of cast brass of specified size, shape and pattern as approved by the Engineer-in-charge. All edges and corners shall be finished smooth and correct to shape and dimensions. Brass handles shall be finished bright, chromium plated or oxidised as specified. Anodised aluminium or iron oxidised (M.S.) handles shall be of specified size, shape and pattern. The size of the handle is taken as the inside grip of the handle. In case of iron oxidised handles, the same shall be manufactured from M.S. sheet pressed into oval section as per I.S.

33.10. MORTISE LOCK & LATCH :

This should generally conform to I.S. 2209. Handles shall conform to IS 4992.

Mortise lock with latches and a pair of level handles shall be 6 levers, with zinc alloy pressure die cast/brass or as specified body of approved quality, and shall be right or left handed as specified. The pair of handles shall be either brass chromium plated or Anodized aluminium of approved shape and pattern or as specified. It shall be of the best Indian make of approved quality. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face. Level handles with springs shall be mounted on plates and shall be of approved quality, Anodized aluminium or as specified.

33.11. HYDRAULIC DOOR CLOSER :

This shall be generally conform to IS : 3564. Hydraulic door closer shall be of approved quality and make. The operation of the Hydraulic door closer shall be very smooth.

This should be of H.D.-66 for external/main doors and elegant - 63 for all internal doors. The overall height should not be more than 170 mm. for H.D.-66 and 160 mm. for elegant - 63, base shall be 110 x 60 mm. for H.D.-66 and 100 x 55 mm. for elegant - 63 weighing not less than 4.5 kg. for H.D.-66 and 4 Kg. for elegant - 63. Speed of the Hydraulic door closer shall be adjustable and latch closing also shall be adjustable type. Suspension and lubrication of door closer shall be in perfect line and level.

33.12. The contractor shall provide for all the incidentals required for fixing these fixtures and fittings such as cadmium plated screws etc. Fittings and fixtures shall be fixed securely in a workman like manner all as directed by the Engineer-in-charge. Any of the fixtures damaged during the fixing shall be removed and new one fixed in their place and the surface of joinery made good where affected, at his own expense. Mortise plates shall be used over holes where the bolts enter in the wood work. Metal sockets shall be provided

to all bolts where the shoot enter brick, stone, concrete etc. The incidental Fixtures like mortise plates, metal sockets, screws etc. shall not be paid for separately.

33.13. MORTISE NIGHT LATCH : This is a mortise lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room.

This should generally conform to IS: 3847. It shall be cast or sheet brass, cast or sheet aluminium alloy or mild steel as specified and of approved make. These shall be bright finished or copper oxidised (black) finish as specified. Normal size of the latch shall be denoted by the length of the face over the body in millimetres.

33.14. FLOOR DOOR STOPPER: The floor door stopper shall conform to IS: 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified. The size of door stopper shall be determined by the length of its plate. The body of the door stopper shall be cast in one piece. All parts of the door stopper shall be of good workmanship and finish and free from surface and casting defects. Aluminium stopper shall have anodic coating of not less than grade AC-10 of IS 1868.

33.15. MODE OF MEASUREMENT AND RATE : Unless otherwise specified, all fittings including all necessary accessories shall be measured in numbers and the rate shall include the cost of all materials including taxes, octroi, excise duty, if any, loading, unloading, transporting, cost of screws, bolts and other accessories and fixing the same complete.

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34. GLASS AND GLAZING :

34.1. SCOPE OF WORK :

The work covered by this specification include furnishing and fixing the glass panes to teak wood or steel doors and windows, strictly in accordance with these specifications and drawings.

34.2. MATERIALS :

i) **Glass :** The glass shall be special selected / selected ordinary quantity glass of M/s. Saint Gobain India or of equivalent manufacture, as specified. Toughened float glass of approved manufacturer shall be used wherever specified. The glass shall be free from bubbles, flaws specks, waves, air holes, distortion, scratches, cracks or other defects. The

glasses in bulk quantities shall be brought to site in Makers original packings and Makers guarantee shall be produced if called for by the Engineer-in-charge. The glass shall be of required thickness as mentioned in the items of schedule of quantities and/or drawing or as directed by the Engineer-in-charge. The contractor shall submit the sample of the glass which he proposes to use on the work and only such approved quality of glass shall be used in the works. The glass brought to site shall be protected against damages. Wherever frosted (obscure) glass is mentioned in the item of schedule of quantities and / or shown in drawings, the glass shall be of sand blown pattern (Sand blasted) and shall also be got approved from the Engineer-in-charge.

ii) **Beading :** The beading shall be of teak wood of superior quality timber in case of teak wood doors and windows and/or required sizes mentioned in the items of schedule of quantities and/or shown in drawing. In case of steel / Aluminium doors and windows, the beading shall be anodised aluminium beading of channel section as per sizes mentioned in the item and / or shown in the drawing. The junction of the beadings shall be mitre jointed.

iii) **Dimensions, Thickness and weight of the glass:** Unless otherwise specified, these shall be as per table given below. All panes shall have properly squared corner and straight edges

Normal thickness	**Range of thickness**	**Weight in kg / sqm**
3.0 mm	2.8 to 3.2 mm	07.5
4.0 mm	3.8 to 4.2 mm	10.0
4.8 mm	4.6 to 5.1 mm	11.9
5.5 mm	5.2 to 5.8 mm	13.5
6.3 mm	6.0 to 6.6	15.5

34.3. WORKMANSHIP :

The glass shall be cut to the required sizes of panels where it is to be fitted, and it shall be so cut that it fits properly in the frames without rattling. Pre-measurement of each panel prior to the cutting of glass is essential.

The beading shall then be fixed to glass panes and screwed at close intervals not more than 10 cm. from each corner and the intermediate not more than 20 cm. apart. When the glass panes are fixed with aluminium beading having mitred joints, epoxy resin or silicon sealant shall be applied covering the area in contact between the glass panes and sash

bars and also between glass panes and the beading. In case of louvers, all the exposed edges of the glass shall be ground properly.

All glass panes shall be fixed within the aluminium framing by use of CP brass or SS screws and the joints sealed with epoxy resin or silicon sealant to make the unit completely waterproof. Glazing or caulking compound around the perimeter of glass shall not be permitted. Fixed glass panes shall be supported by setting blocks. There shall be no whistling or rattling.

34.4. GENERAL :

After the inspection is over and permitted by the Engineer-in-charge, glass panes shall be cleaned off any labels, paints smears and spots and shall be washed from both the sides and all glazing left clear, perfect and free from rattling. The contractor shall provide all the scaffolding, tools and plants for fixing the glass panes at his own cost. In case of steel windows, any hardware if fixed in position, shall be removed temporarily before fixing the glass panes and which shall be re-fixed back in position, all at the contractors cost.

34.5. MODE OF MEASUREMENT :

The rate for teak wood door/window shutters and/or steel door/window shall normally cover the cost of glass and glazing also, unless otherwise mentioned. In case the glazing is carried out as a separate item, the measurement shall be taken out to cut size of teak wood/steel door/window frames forming the sides of glass panes and area calculated to two places of decimal of a square meter.

The rate shall include the cost of supplying and fixing the glass panes, all materials, labour, transport, scaffolding etc.

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35. STEEL DOORS, WINDOWS AND VENTILATORS:

SCOPE OF WORK :

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

The work covered under these specifications consist of supplying steel windows and doors and ventilators, fixing, glazing etc. complete in strict accordance with the specifications and relevant detailed/shop drawings.

35.1. GENERAL :

The contractor shall submit 6 copies of shop drawing covering all types of work under this specification before manufacture. The drawing shall show all dimensions, details of construction, installation, relating to adjoining and related work etc.

35.2. MATERIAL :

Shutters, frames etc. as dimensioned in the drawing shall be fabricated from I.S. standard sections rolled . No glazing bars shall be provided unless otherwise shown in drawing. Glazing used will be clear sheet glass of special selected quality manufactured by Saint Gobain India or approved equivalent, unless otherwise specified. Steel sections shall be free from rolling or other defects. They shall be easily welded and punched and shall be cold straightened and shall conform to latest I.S. 1038 . The anticorrosive shop coat of paint shall be given before the materials are brought to site.

35.3. COUPLING BARS FOR COMPOSITE DOORS,WINDOWS AND VENTILATORS :

All doors, window, ventilators units shall be so constructed that those if required may be coupled together by means of the standard mullion and weathered transom bars and coupling pieces.

All steel hinges shall be projected steel hinges with non magnetic stainless steel pins and washers to permit complete ease in cleaning the glass and shall be welded or rivetted to the frame.

35.4. FABRICATION :

The frames shall be square and flat and shall be constructed of sections cut to length, mitred and welded at corners. All welding shall be electrical flash butt welding excepting for the welding of steel sheets for the shutters.

Sections shall be formed true to details with clean straight, sharply defined profiles and free from defects that may impair its durability. All works shall be accurately formed to the required dimensions, line and level. All joints shall be continuously reinforced, fitted and continuously welded at the edges. Surface along joints shall be ground to attain a smooth level surface even and flush with adjoining surfaces. All frames shall be properly

reinforced for the attachment of hardware. The heads of frames for openings wider than 1.2 m. shall be reinforced to prevent sagging or deflection when installed.

35.5. INSTALLATION :

The doors, windows and ventilators brought to site shall be stacked up side down on wooden runner under cover. Fixing shall be done as per latest Indian Standard Specifications. The size of the prepared openings shall be checked first and these should be cleaned off all obstructions.

The doors/windows/ventilators shall not be forced into the walls but shall fixed into prepared openings in workmen like manner.

All joints between masonry/concrete and the metal shall be fully filled with approved mastic filler/putty / Acrylic Latex caulk /Polyurethane foam Sika boom of Sika make or approved equivalent in order to ensure water tightness/insulation. The joints shall be neatly pointed with matching cement and excess material shall be removed as per approved manufacturer specification based on the material used.

All brick jambs and sill holes shall be cut 50 mm. square and 100 mm. deep for fixing hold fasts. In contact with concrete members connection of door frames shall be done by metal frame anchor – HRD-C of Hilti or SXRL of Fischer make.

Any hard ware if fixed in position shall be removed before fixing the frames in the structural openings and moving parts shall be secured with wire or string during erection and while the building work is being completed to prevent damage to the part. Hardware shall be fixed as late as possible preferably just before the final coat of paint is applied. It shall be fitted in workmanlike manner so that it may not be marked and mutilated by hammers and screws and pins are not marked and mutilated by hammers and screwdrivers. It shall be tested for correct operations to the satisfaction of the Engineer-in-charge.

35.6. DETAILS OF COMPONENT PARTS :

35.6.1. **Doors :** Door shutters shall be hung on projecting hinges of 67 mm size and shall be fitted with mortise lock and two brass or bronze lever handles. In case of double leaf doors, the first closing leaf of double leaf doors shall also be provided with brass or bronze tower bolts concealed in the section at top and bottom. These shall be so constructed as not to work loose or drop by their own weight and necessary lugs, fittings, screws etc. shall be provided and fitted properly at site.

35.6.2. **Windows :** Window shutters shall be hung on projecting hinges. One leaf of

the hinges shall be welded into a slot in the outer frame and the other leaf of the hinges riveted to the opening shutters. Hinges may be of the friction type in which case the window shall not be fitted with peg stay. In case of non-friction projecting hinges, a brass or bronze three holes peg stays 300 mm. long with pegs and brackets, welded or rivetted to the frame shall also be provided. Handles shall be of brass or bronze, and shall be mounted on a mild steel handle plate welded to the shutter in such a way that it should be fixed after the shutter is glazed. The handles shall have a two point nose which shall engage with brass, bronze or aluminium alloy as specified, striking plate, on the fixed frame so that it can hold the shutters in a slightly openable as well in a fast position.

35.6.3. **VENTILATORS : a) Top hung ventilators :** These shall be fixed with plain hinges, riveted to the fixed frames or welded to it after cutting a slot in it. A peg stay 300 mm. long of brass or bronze with three holes, as in case of windows shall be provided.

The locking bracket shall either be fitted to the fixed frame or to the ventilators.

b) **Centre Hung Ventilators :** These shall be hung on two pairs of brass of lead/tin/bronze cup pivots, riveted to the inner and outer frame of the ventilators to permit these to swing through an angle of approximately 85 deg. The opening portion of the ventilators shall be so balanced that it remains open at any desired angle under normal weather condition.

A bronze or brass spring catch shall be provided at the top centre of the ventilator. A brass cord pully wheel in a mild steel or malleable iron brackets, shall be fitted with screws or welded at the sill and a cord eye shall be fixed to inner frame of ventilators to facilitate opening of ventilators.

35.6.4. **Composite Units :** Composite units consist of a combination of two or more units of doors, windows, ventilators etc. as the case may be. The different units shall be coupled by using coupling sections. The coupling sections shall be made from M.S. sheet 3.15 mm. in thickness and 56 mm. wide as per I.S. 1038 para 5.2 and these shall be fixed with bolts and nuts.

Wherever the ventilators, windows and doors shall have coupling section, shall be applied between the junctions Non shrink cementitious filler/ Acrylic Latex caulk / One pack elastomeric siliconised acrylic sealant /One-part, low modulus neutral cure silicone sealant /Polyurethane foam Sika boom of Sika make or approved equivalent in order to ensure water tightness/insulation.

Double sealed with EDPM / TPE gaskets and joints are fusion welded ensuring no gaps remain anywhere. Windows and doors have multipoint locking system to ensure tight shutting down.

To calculate height or width of composite units, add 2.5 cm. for each mullion or transom coupling bar for each unit.

35.7. FINISHING : All steel surfaces shall be thoroughly cleaned of rust, scale and dirt by pickling and marking. A shop priming coat of superior quality red oxide or equivalent shall then be given before despatch. Alternatively, where so specified, the steel surfaces shall be treated for rust proofing by the hot dip zinc spray or electro galvanising process, having a coating of not less than 60 microns thickness or as specified. Zinc spray articles shall be given one coat of priming coat of superior quality red oxide or equivalent.

Final finishing with two coats of synthetic enamel/flat oil paint of approved make and shade shall be given after the doors,windows and ventilators are erected/fixed in final position. The rate shall be inclusive of final finishing coats including the priming coat.

In case of galvanised doors, windows and sashes, their surfaces shall be treated with copper acetate solution or other approved mordant solution to ensure proper adherence of paint, unless the galvanised surface has weathered adequately at the time of final painting.

Non-ferrous parts and working parts such as handle stays, catches, handle pins, hinge pins etc. shall not be painted.

35.8. GLASS AND GLAZING : Specifications for glazing given in this book under chapter Glass and Glazing, shall also be applicable for steel doors / windows / ventilators.

35.9. MODE OF MEASUREMENT : The mode of measurements for steel doors, windows and ventilators for complete item of supply and fixing in position shall be on area basis calculated in sqm. correct to two places of decimal. The height and width of members shall be measured outer to outer edge of the members correct to 1 mm.

The rate for steel door, window and ventilator shall include cost of all fittings, materials, hold fasts, glazing, painting, labour etc.

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36. ROLLING SHUTTERS :

36.1. SCOPE OF WORK & GENERAL :

Item refers to supplying and fixing rolling shutters of size and type as specified in the description of item.

36.2. MATERIALS :

Rolling shutters complete with accessories shall be of approved quality and as specified. These shall be suitable for fixing in position as specified i.e. outside or inside; on or below lintel or between jambs of the opening. Rolling shutter shall be hand/gear operated as specified in the item of schedule of quantities. For hand operated shutters, it shall be push and pull type. For gear operated shutters, it shall be provided with reduction gear operated by mechanical device with chain, crank, shaft and handle. The shutter shall consist of 80 mm. wide MS laths 1.25 mm thick or gauge as specified of best quality mild steel sheet machine rolled. Laths shall be inter-locked together throughout their entire length and jointed together at the end with end locks. These shall be mounted on specially designed pipe shaft. The spring shall be of best quality and shall be manufactured from the tested tensile spring steel wire or strip of adequate strength to balance the shutter in all positions. The spring, pipe shaft etc. shall be supported on strong mild steel or malleable cast iron brackets. Both the side guides and bottom rails shall be jointless and of single piece of pressed steel of minimum 16 gauge thickness. The top cover of shaft, spring etc. shall be of the same materials as that of lath. No extra payment shall be made for the hood, brackets etc. to cover the shaft etc. The reduction gear arrangement operated by the mechanical device shall be of the best quality and shall be easy in operation.

36.3. FIXING :

Brackets shall be fixed on the lintel/beam or under the lintel/beam as specified in item with rawl plugs and screws, bolts, washers etc. The shaft along with the spring shall then be fixed on the brackets. The lath portion (shutters) shall be laid on ground and the side guide channels shall be bound with it. The shutter shall then be placed in position. The side guide channels shall be fixed to the wall through the plates welded to the guides. These plates and brackets shall be fixed by means of steel screws, bolts and rawl plugs drilled into the wall. The plates and screws, bolts shall be concealed in plaster to make their locations invisible. Fixing shall be done accurately in a workman like manner that the operation of the shutter is easy and smooth. All grout holes and damages on the wall while fixing of shutters shall be made good by the contractor at no extra cost . The contractor shall ensure smooth and easy working of shutters. All the members of the rolling shutter shall be thoroughly cleaned off dust, scales, rust etc. and shall be given approved priming coat of red oxide paint before fixing the shutter in position and then shall be painted with two coats of flat/synthetic enamel Final coat of paint of approved quality and shade.

36.4. MODE OF MEASUREMENT :

The area of rolling shutters shall be measured in square metre correct upto two places of decimal. Width and height shall be taken for net opening correct to a centimeter.

36.5. RATE :

The rate shall include the cost of materials, labour involved in all the operations described above.

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37. M. S. GRILLS / RAILINGS :

37.1. GENERAL :

The contractor shall submit 6 copies of shop drawings covering all types of work under this specifications before manufacture. The drawing shall show all dimensions, details of construction, installation relating to the adjoining work.

37.2. MATERIALS :

All structural steel shall conform to I.S. 226 sections for grills and shall be free from loose mill scales, rusts, pittings or any other defects affecting its strength and durability.

37.3. FABRICATION :

The grill shall be fabricated to the design and pattern shown in the drawings. All joints shall be made in best workman like manner with slotting and welding as required to the specified size and shape. The edge of the M.S. flats shall be suitably mitred before welding to get the desired shape. The joints shall be filled to remove excess stay after welding. Screws, nuts, washers, bolts, rivets and any other miscellaneous fastenings, devices shall be of steel and shall be provided by the contractor.

Manufactured M.S. grills then be fixed in between the posts, balusters, M.S. frame work etc. to correct alingnment. Any undulations, bends etc.found shall be rectified by the contractor at his own cost. The complete assembly of grill/railing so fixed shall be firm and there shall not be any lateral movements.

37.4. SAMPLES :

Samples of grill and railings shall be submitted for approval of the Engineer-in-Charge and to be got approved before taking up for mass fabrication.

37.5. INSTALLATION :

The approved grills shall be fixed in position where specified and shown in drawings including in masonry walls, teakwood frames, hand railings etc. Any damages to walls, frames etc. caused during fixing the grills shall be made good by grouting with cement mortar/packing/repairing properly at the contractors cost.

37.6. PAINTING :

Painting shall be done as per the specifications specified under painting.

37.7. MODE OF MEASUREMENT :

Actual area of M.S. grill manufactured and fixed in position shall only be measured in square metre for payment. All measurements shall be taken to two places of decimal of a metre and area shall be calculated to second place of decimals of a square metre.

The rate is to include the cost of all materials, labour, transporting, fabricating, installing, scaffolding if necessary, grouting etc. complete.

37.8. FINISHING/PAINTING/POLISHING FOR RAILING :

Teak wood hand rail shall be polished with wax polish/ french polish/solignum with two or more coats over one coat of wood primer or painted with two coats of synthetic enamel paint/flat oil paint of approved make and shade over one coat of approved primer. M.S. grills, balusters etc. also to be painted as per specifications specified under painting/polishing.

37.9. MODE OF MEASUREMENTS (HAND RAILS) :

Hand railing shall be measured for payment in running metre. The length shall be measured along the top centre line of the hand rail and shall be measured between ends of balusters, newels, posts as the case may be upto two places of decimals of a metre. Rate shall include fabrication, leaving suitable pockets, grouting the same, providing and fixing suitable teak wood plugs, fixing, all labour, materials, transport, painting/polishing, finishing and scaffolding if necessary.

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38. ALUMINIUM ENTRANCE DOORS, WALL SPANS, GLAZING ETC.

38.1. SCOPE OF WORK :

The scope of work in the present tender item includes fabrication, supply and installation of anodised matt finished aluminium entrance doors (colour as per Architectural requirement), glazing etc. strictly in accordance with these specifications and relevant detailed approved shop drawings.

38.2. GENERAL :

The material, fabrication and hardware shall conform to the IS 1948. The contractor shall submit 6 copies of shops drawings covering all type/details of work as generally shown in Architectural drawing and envisaged under these specifications before manufacture. The drawing shall show all dimensions, details of construction, installation of fixtures and relation to adjoining and related works. No fabrication work shall be undertaken prior to obtaining approval of the shop drawings from the Engineer-in-Charge. The tenderer shall intimate at the time of tendering, the type of sections he proposes to use on the works.

38.3. MATERIALS :

Aluminium alloy for extruded sections for the above work shall correspond to I.S. 733 & 737 specifications or any further revision there of(extruded sections shall conform to I.S.

Designation HE 9- WP. Hollow sections shall conform to I.S. Designation HV9-WP) and shall be anodised before incorporating in the work. Anodic coating shall conform to IS 1868. The frame work, stiles, mullions, beadings, transoms and handles etc. shall be of aluminium anodised sections as shown in detailed approved drawings. All aluminium sections shall be of INDAL or other equivalent make as per drawing. The contractors can also propose nearest alternative sections they manufacture/posses without changing the elevation, structural stability & functional requirement. E.I.C reserves the right to accept the alternative section or otherwise. The sections shall be structurally suitable to withstand all the loads, the members have to sustain. Counter sunk screws, nuts, bolts, washers, rivets and other miscellaneous fastenings devices shall be of approved brass cadmium plated or stainless as specified in the approved drawing. Each door leaf shall be prepared to receive glazed panel of required thickness. Glazing shall be done with neoprene dry set glazing gasket (of best quality and approved make) with snap-in-bevelled anodised matt finish aluminium (colour as per Architectural requirement) metal glazing stops inside and outside. All doors shall have off- set pivots, double action (180^0 minimum swing) floor springs with oil check boxes of approved manufacture. All doors shall have 4 lever concealed brass body mortise lock without handles as per manufacturers design, with concealed flush C.P. brass tower bolts provided at suitable locations. All doors shall have push plates of design shown in the approved drawing as described in the schedule of quantities. All entrances shall be without thresholds. All aluminium surfaces in contact with masonry or concrete shall be given a thick coat of bitumastic paint. After fabrication, aluminium sections shall be protected from construction hazards that may damage their appearance or finish. All exposed surfaces of aluminium door entrance shall be protected by masking tape during transshipment and erection. All sections and hardware shall have anodic film and cover a minimum thickness of 0.015 mm.

38.4. FABRICATION :

The frames shall be manufactured square and flat, the corners of the frame being fabricated to true right angle. All the fixed, sliding and opening frames shall be constructed of sections which have been cut to length, mitred, welded and mechanically fixed at the corners. Where hollow sections are used with welded joints, argon-arc welding or flash butt welding shall be employed (Gas welding or brazing not to be done)only if required for specific doors or members as required by Architectural /E.I.C. In case welded joints are used, anodising shall be done after fabrication as a whole. All welding shall be on unexposed sides in order to prevent pitting/discolouration of other surface imperfections after fixing etc. Necessary allowance shall be made while manufacturing the aluminium door entrances, wall spans and glazing for receiving plaster. A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate shall be applied on the finished sections of the aluminium work by the contractor to protect the surfaces

from wet cement, lime, dirts, dust etc. during the construction activities. The size for door, window or ventilator frames shall not vary by more than (+/-) 1.5 mm.

38.5. HARDWARE :

All cut outs, recesses, mortising or milling and operations required for fixing the hardware shall be accurately made reinforced with packing plate as required to ensure adequate strength of the connection. All the hardware accessories shall be of best approved type and of anodised finish same as for the frames and other sections or as per architectural requirement. Each lock shall be supplied with two stainless steel keys and each key shall be with number stamped thereon according to the number on doors so installed. All hardware shall be free from defects, which may affect the appearance and serviceability. All hardware shall be fixed after obtaining the prior approval of the Engineer-in-Charge. Approved samples of hardware shall be kept in the custody of the Engineer-in-Charge. Working and moving parts of locksets shall be accurately fitted to smooth, close bearings and shall be free from rattle. The floor springs shall be of heavy-duty type and should allow door operation smoothly and shall conform to IS 6315. The contractor shall furnish a guarantee for all finishing and quality of hardware covered under this section and which shall remain free from defects of any kind, either materials and/or workmanship for a period of one year (unless otherwise specified) from the date of completion/handing over of work. The contractor shall repair or replace any and all defective work and damage caused, at any time or times during that period within 3 days from the written notice. This shall be done without any extra cost and to the complete satisfaction of the Engineer-in-Charge.

38.6. FIXING :

Fixing and glazing of doors, windows and ventilators shall be conforming to IS 1081, unless otherwise specified. The frames shall be accurately fixed in the flooring / brick masonry or R.C.C. works. The fixing of the frame shall be done with cadmium plated brass counter sunk screws driven on to the teak wood rough ground, or fixed to the wall with hold fasts as directed by the Engineer-in-charge, and as shown in approved drawings. All aluminium works shall be fixed in position as per relevant Indian Standard Specifications and code of practice for fixing and glazing of aluminium work. Joints between metal and masonry shall be fully caulked with mastic/ Non shrink cementitious filler / Acrylic Latex caulk /One pack elastomeric siliconised acrylic sealant /One-part, low modulus neutral cure silicone sealant /Polyurethane foam Sika boom of Sika make or approved equivalent /Low modulus Acetoxy silicone sealant / polysulphide compound (only at location specified in the drawing/ as required by E.I.C.) in order to ensure water tightness/insulation joints as directed by the Engineer-in-Charge. Joints shall be neatly painted with matching cement and excess materials shall be removed. Fixing of aluminium door entrances, hardware

etc. shall be done in best workmanship like manner true to line, level, plane, plumb etc. and all as directed by the Engineer-in-Charge. Breaking of floor for providing floor springs and restoration of the floor finishes to the original specification and finishes and minor additions and alterations to the openings shall be deemed to have been included in the quoted rates.

38.7. GLASS AND GLAZING :

38.7.1. **Glass :** The glass shall be of selected quality/special selected quality of M/s. Saint Gobain or equivalent manufacture, as specified under the chapter GLASS AND GLAZING.

38.7.2. **Glazing Clips/Beading :** The glazing clips/beading where specified in drawings for aluminium/steel doors and windows shall be anodised aluminium beading of channel section or as specified & as per sizes mentioned in the item and/or shown in the drawing.

The junction of the beadings shall be mitre jointed. Holes for glazing clips shall be drilled prior to fabrication and shall not be done at any later stage.

38.7.3. The glass shall be cut to the required sizes of panels where it is to be fitted and it shall be so cut that it fits properly in the frames without rattling. Premeasurement of each panel prior to the cutting of glass is essential.

The clips/beading shall then be fixed to glass panes and screwed at close intervals not more than 10 cm. from each corner and the intermediate not more than 20 cm. apart. When glass panes are fixed with wooden beadings having mitred joints or aluminium beading, a thin layer of glaziers putty shall be applied covering the area in contact between the glass and sash-bars and beadings. In case of louvers all the exposed edges of the glass shall be ground properly.

38.7.4. **Glazing :** The glass panes shall be fixed to the frame as mentioned above with approved Neoprene dry set glazing gasket (of best quality and approved make) with snap-in-bevelled anodised matt finished aluminium metal glazing stops inside and outside. In the fixed side and transom light, the thickness of glass or panel shall be accommodated by the screw down glazing stops. The glass panels shall be fixed firmly and truly parallel to the plane of frames. All damages or breakages during glazing shall be made good at the contractors own cost till the work is properly taken over by the Engineer-in-Charge. All wall spans glazing and entrances door, fixed glazing etc. shall be tested for water tightness. Any leakage found during testing, it is the responsibility of the contractor to rectify the same without any extra claim.

38.7.5. **General :** After the inspection is over and permitted by the Engineer-in-Charge, the glass panes shall be cleaned off any labels, paint smears and spots and shall be washed from both the side and all glazing left clear, perfect and free from rattling. The contractor shall provide all the scaffolding, tools and plants for fixing the glass panes at his own cost. In case of aluminium/steel doors/windows any hardware if fixed in position shall be removed temporarily before fixing the glass panes and which shall be re-fixed back in position all at the contractors cost.

38.8. MODE OF MEASUREMENT :

a) **Aluminium work:** The measurement of aluminium sections shall be taken only after the frames along with shutters are fixed in its final finished position in line, level and plumb. Length of each extruded section used for fabrication shall be measured **outer to outer of cut length** correct upto 1 mm

b) The weight of material used shall be calculated on the basis of actual weight of extruded sections used for fabrication and shall be compared with the weights given in the catalogue of the approved manufacturer subject to the condition that the variation in actual weight should not exceed (+ / -) 10% than the approved catalogue weights. The payment shall be made for the actual weight of the extruded section **after anodising.** The final weight shall be calculated in kgs upto two places of decimal.

c) **Glazing work:** The length and width of opening for glazing inserts shall be measured correct to a centimetre and area for payment shall be calculated in square metre nearest to 0.01 sqm.

38.9. RATE :

Unless otherwise specified, Fittings and fixtures such as window handles, hinges, peg stays, friction stays, concealed window lock, cleat angles, stiffener plates etc. shall not be measured for payment and rate quoted shall include cost of all such fittings, accessories and hardware. If in schedule of items door handles, mortise lock, dead lock, door closer, floor springs, concealed door tower bolts are to be separately paid, then payment will be paid accordingly. But if mentioned in the item of door then the rate should account for the above fittings also; all depending on the Schedule of items.

The rate quoted shall include all taxes, duties etc. tools, plants, labour involved in all the operations described above, fixing in final position including submitting shop drawings etc. and all incidentals to the job involved.

38.10. TESTING :

Aluminium sections shall be tested for its unit weight, anodic coating etc. as per relevant IS codes.

38.11. GUARANTEE :

All materials used in above work shall be **guaranteed for one year** (unless otherwise specified) from the date of handing over the work. Any defect found in the guarantee period shall be replaced/repaired to original condition/position entirely at the contractors cost.

39. ALUMINIUM WINDOWS, VENTILATORS, COMPOSITE UNIT ETC. :

39.1. SCOPE OF WORK :

The scope of work in the tender item includes fabrication, supply and installation of anodised finished aluminium windows, ventilators, composite units, glazing etc. strictly in accordance with these specifications and relevant detailed approved shop drawings.

39.2. GENERAL :

The material, fabrication and hardware shall conform to IS 1948 & 1949. The contractor shall submit six copies of shop drawings covering all types/details of work as generally shown in Architectural drawing and envisaged under these specifications before manufacture. The drawing shall show all dimensions, details of construction, installation, fixtures and relation to adjoining and related works. No fabrication work shall be under-taken prior to the approval of the shop drgs. from the Engineer-in-Charge. The tenderer shall intimate at the time of tendering, the types of sections he proposes to use on the works.

39.3. MATERIALS :

The aluminium alloy used in the manufacture for extruded window section shall correspond to I.S. 733 (or any further revision thereof). Extruded sections shall conform to I.S. designation HE9-WP and Hollow sections shall conform to I.S. Designation HV9-WP. The frame work, stiles, mullions, beadings, transoms, hinges, pegstays, handles etc. shall be of aluminium anodised sections as shown in the detailed drawings. All sections and hardware shall have minimum anodic film thickness of 0.015 mm. All sections shall

be of JINDAL or other equivalent make as per drawing. The contractor can also propose nearest alternative sections they manufacture/posses without changing the elevations and functional requirements. E.I.C reserves the right to accept the alternative sections or otherwise. The sections shall be structurally suitable to withstand all the load, the members have to sustain. Countersunk screws, nuts, bolts, washers, rivets and other miscellaneous fastening devices shall be of approved cadmium plated or stainless steel as specified in the approved drawings.

39.4. FABRICATION :

The frames shall be manufactured square and flat. The corners of the frames shall be fabricated to true right angles. All the fixed, sliding, openable frames shall be constructed from sections which have been cut to length, mitred and mechanically jointed or welded at the corners. Where hollow sections are used with welded joints, argon arc welding or flash butt welding shall be employed (Gas welding or brazing not to be done). Sub-dividing bars of units shall be tennoned and rivetted into the frames. In case welded joints are used, all welding shall be on unexposed sides in order to prevent pitting, discolouration and other surface imperfections after finishing. The dimensions shown in the drawing are overall heights and widths to the outside of frames of aluminium windows. The side hung shutters shall have projected friction type hinges of aluminium alloy. Concealed projected hinges having structural stability and of good quality will also be considered only after the inspection of the sample submitted by the tenderer. The necessary pegstays, handles, window fasteners etc. shall be of aluminium. The handle shall be mounted on a handle plate rivetted to the opening frame. The pegstays shall be 300 mm. long or as required complete with peg and locking bracket and shall have holes for keeping the shutter open in three different positions. No field fabrication of frames is permitted. The complete fabricated assembly shall be anodised in approved satin finish with minimum film thickness of 0.0 15 mm. for the entire surface. A thick layer of clear transparent lacquer based on methacrylate or cellulose butyrate shall be applied on the finished sections of the aluminium windows etc. by the supplier to protect the surfaces from wet cement, lime, dirt, dust etc. during the installation. This lacquer coating shall be removed after installation is complete, if approved by the Engineer-in-Charge and all sections of the windows shall be protected by P.V.C. film covering.

39.5. HARDWARE :

All cut outs, recesses, mortising or milling and operations required for fixing the hardware shall be accurately made, reinforced with packing plate as required to ensure adequate strength of the connection. All the hardware, accessories shall be of best approved type

and of anodised finish same as for the frame and other sections. All hardware shall be free from defects which may affect the appearance and serviceability. All hardware shall be fixed after obtaining the prior approval of the Engineer-in-Charge. Approved samples of hardware shall be kept in the custody of Engineer-in-Charge.

39.6. FIXING :

The window frames shall be accurately fixed in the brick masonry or R.C.C. work. The fixing of the frame shall be done with cadmium plated brass counter sunk screws driven on the teak wood rough grounds if required or fixed to the wall with holdfasts. All aluminium windows shall be fixed in position as per I.S. 1081 (or any revision thereof): Code of practice for fixing and glazing of aluminium windows. All joints between metal and masonry/rough ground wooden frame shall be fully caulked with mastic / Non shrink cementitious filler / Acrylic Latex caulk / One pack elastomeric siliconised acrylic sealant /One-part, low modulus neutral cure silicone sealant /Polyurethane foam Sika boom of Sika make or approved equivalent /Low modulus Acetoxy silicone sealant / polysulphide compound (only at location specified in the drawing/ as required by E.I.C.) in order to ensure water tightness/insulation joints as directed by the Engineer-in-Charge. Joints shall be neatly painted with matching cement and excess materials shall be removed. Hardware shall be fixed in workman like manner all as directed by the Engineer-in-Charge.

39.7. SAMPLES :

The samples of different windows shall be submitted to the Engineer-in-charge, for approval.

39.8. GLAZING :

The glazing shall be of Indian make plain sheet/frosted figured glass of special selected quality and size as mentioned in item description and drawings and shall be of M/S. Saint Gobain or equivalent manufacture. The specifications specified here-in-before shall hold good as far as applicable.

39.9. MODE OF MEASUREMENT :

Similar to as described under chapter “Aluminium Windows, Ventilators, Composite Unit Etc.”

39.10. GUARANTEE :

All materials and workmanship in above work shall be guaranteed for a period of one year (unless otherwise specified) from the date of handing over the work. Unqualified performance guarantee for smooth operation of the windows, doors, wall spans and precautionary measures against leakages etc. shall be furnished by the contractor on stamped paper, if so specified in schedule of quantities. Any defect found during the guarantee period shall be replaced/made good to the original conditions/positions entirely at the cost of the contractor.

39.11. TESTING :

All windows shall be tested for water tightness. Any leakage found during testing shall be rectified by the contractor without any extra charge.

NOTES-

i) The contractor shall submit 6 copies of shop drawings for each windows, ventilators showing dimension details of construction etc. for approval of the Engineer - in - charge. According to the approved shop drawing a sample of each of windows with all fittings and fixtures with locking arrangement including glass panes etc. complete as per schedule of quantities, specifications and drawings, shop drawing should be submitted for preliminary inspection for approval. After preliminary inspection and approval of the sample.

ii) All doors, windows, ventilators section shall be 15 micron anodized of approved colour extruded section of M/s Jindal / M/s Indal or or any other makes specified in the list of approved makes alongwith certificate of primary biller manufacturer of Hindalco/Jindal/Vedanta.

iii) All fittings / fixtures shall be of approved make / quality and as approved by engineer- in -charge.

iv) All dimensions mentioned in the drawing are approximate. Necessary allowance for fixing over granite frame and also necessary allowances for fixing tolerances to be considered while manufacturing. While manufacturing, actual site measurement shall be considered. Necessary planning for fixing the unit has to be carried out by the contractor without any extra cost to the department and rate quoted by the contractor shall hold good.

v) Payment shall be made per Kg basis.Aluminium sections such as shutter frames, track window / door frame/beading channel for glass adjustable louvers ,all necessary hardware etc., shall only be measured linearly as per actual / finished cutting size nearest to centimeter and multiplied with approved sectional weight of the individual section and

the total quantity of aluminum section will be arrived at for payment without any allowance for wastage.

vi) All glass panels shall be of approved makes specified in the list of approved makes. The glasses will be measured for payment separately under relevant item.

vii) Glass panes shall be fixed with approved EPDM gasket ting, beading, to be free from settling. Necessary polysulphide sealant to be provided against seepage of rain water.

viii) All top hung/side hung shutters to be provided with approved quality of stainless steel friction hinges.

ix) In case of damage of any existing work, the same has to be made good/restored to original condition by the contractor at his own cost.

x) Tenderer are required to consider while quoting the rates shall inclusive of the cost of all fittings, fixtures, locking arrangement , handles, pegstays, gaskets, screws, hinges and all necessary hardwares etc., while quoting the rate for unit weight of aluminum sections for window/sliding doors .

xi) Shall furnish guarantee of one year on a stamp paper for performance of smooth operation and leakage.

Note-For measurement Aluminum window subframe,window track are to be considered as fixed portion.

- EPDM / Neoprene purpose made beading shall be provided.

- Fixing shall be with SS screws.

- All sections shall be extruded, heavy duty and shall have minimum anodic film thickness of 0.015mm.

- All beading shall be snap on type.

- Glazing beading shall be from inside only.

- Minimum thickness of glass shall be 5.5mm when not specified.

Sliding Windows/Doors

- Anti-lifting device.

- Bottom rail shall be with self cleaning gutter section unless noted otherwise.

- Stainless steel ball bearings rollers.

- Concealed locking arrangement.

- In louvered windows, extruded sections only shall be used.

All fitting and fixtures shall be of approved make. They shall be finished in matching coating or as approved

Fitting of S.S.Mosquito net in single shutter with SS screws etc. complete. Cost of net shall be paid under relevant item.

- Supply and fixing of aluminum work shall be carried out from 'approved agency.

- Prior to start of work supplier shall submit detailed full scale Shop drawings including plan, elevation and detail of fixing with structure for approval of the EIC. Samples of each item on full scale or smaller scale as directed by the EIC shall be submitted for approval.

- Work shall proceed only on approval of shop drawing, samples of each extruded section, neoprene beading, gaskets, wool pile, fittings and fixtures by the EIC in writing.

40. ALUMINIUM CURTAIN WALL SYSTEM

40.1. General

1) Aluminium Curtain Wall System shall be designed for the following effects:

   (a) Permanent Deformation, thermal expansion.

   (b) Wind and seismic load

   (c) Air and water infilteration or leakage.

   (d) Lateral deflection per floor height

2) Unless otherwise specified the design of the system shall be prepared by the specialized firm for executing such works and submitted to the EIC for approval after detailed scrutiny and checking design calculations and drawings.

3) The work shall bear five years guarantee. It will be obligatory on the part of the contractor to execute the work systematically and conduct the necessary mock-up unit tests, before taking up the work to the satisfaction of EIC.

40.2. Specification for Materials used for Curtain Wall

1	**Glazing**	Glazing work shall be as specified in the description of the item and / or as described under the chapter Glass & Glazing of this book. The glass material should be such that it can withstand and resist a fire for at least an hour. Safety Glass - tempered / toughened glass & laminated Glass all as per architectural requirement.
2	**Framing system**	Aluminium anodized extruded sections manufactured by reputed approved manufacturers, for all types of members like brackets, mullions, transom etc.
3	**Sealant**	As specified in the item or silicon sealant; it shall be of approved make & of type for curtain/structural Glazing application, it shall be laid as per manufacturers specification.
4	**Insulation**	50 mm thick glass wool/ Rock wool of minimum density 48 kg/cum sandwiched with black polythene sheet 100 micron on one side and aluminium foil of 100 micron on the other side or as specified by manufacturer at spandrel area. The surface after fixing insulation shall be plain without any distortion
5	**Heat Reflective Toughened Glass**	(a) Saint Gobain Glass - Reflectosolar as specified (Reflective Solar Control Glass) (b) Asahi India Glass Ltd /Glaverbel / Glavermass - Super Silver or equivalent. (c) Visteon Ford Brown or Grey Colour of any shade approved by the Engineer-in-Charge.
6	**Fire sealing systems**	a) Hilti or approved equivalent

40.3. Aluminium Alloy Extruded Sections: Extruded sections to be used for fabrication of framing system for curtain walls shall be manufactured and supplied by approved reputed companies. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works. Dimensions and weights of the sections shall be as per approved drawings.

40.4. Components, General specifications, Glazing, Panelling etc. for Curtain Wall System: These shall be generally as per relevant Chapters in this book.

40.5. Scope of Work

40.5.1. Preliminary Requirements

i) The contractor shall design, test, fabricate, deliver, install and guarantee all construction necessary to provide a complete curtain wall system, all in conformity with the drawings and approval of the Engineer-in-Charge.

ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, not withstanding any omissions or inadequacies of the drawings,

iii) **The curtain wall system shall also include the following activities :**

(a) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings, metal closure, windows etc.

(b) All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.

(c) All thermal insulation associated with the system.

(d) All fire protection associated with the system.

(e) All copings and closure and metal cladding to complete the system.

(f) All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system. EPDM / Rubber Gasket to achieve water resistance joints

(g) Isolation of dissimilar metals and moving parts,

(h) Anticorrosive treatment on all metals used in the system,

(i) Polyester powder coating /anodizing aluminium sections,

(iv) The contractor shall also be responsible for providing the following :

(a) Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.

(b) Mock-ups, samples and test units.

(c) Performance testing of the curtain wall framing and glazing assembly.

(d) Co-ordination with the work of other trade.

(e) Insulation with glass wool 48 kg/cum at spandrels area.

(f) Protection.

(g) All final exterior and interior cleaning and finishing of the curtain wall system.

(h) As built record drawings and photographs.

(i) Guarantees and warranties.

(j) All hoisting, scaffolding, staging and temporary services.

(k) Conceptualising and design of a suitable maintenance system for curtain glazing,

(v) The water tightness and structural stability of the whole curtain wall system shall be the prime responsibility of the contractor. Any defect or leakage found within the guarantee period shall be sealed and made good all at the risk and cost of the contractor.

(vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details should be designed to accommodate thermal and building movements.

40.5.2. Design Requirements

(i) Curtain wall shall comply with all government codes and regulations, building bye-laws, if any.

(j) All curtain walling, individual aluminium and glass components and all completed work shall be designed and erected to comply with the following requirements.

(k) Curtain wall Glazing to comply requirement as per IS 3548, IS 16231 (Pt. 4)

(l) System shall be designed to withstand the wind pressure. The designed facade system should be able to withstand all requirements as mentioned in the specifications not limited to thermal stresses, seismic forces, wind velocity, rain, atmospheric variations and to cover any other stress occurring from natural or man made factors whatsoever condition etc. with adequate factor of safety to meet relevant IS code and international codal provisions.

40.5.2.1. Basic requirement: The basic design and architectural requirements shall consist of the size of window, net glass area, ventilator, configuration of windows and spandrels to be retained. However the contractor may propose alternatives on the construction details for approval of the Engineer-in-Charge, provided that all basic functional and architectural requirements are fulfilled.

40.5.2.2. Quality Consideration and other Activities

(j) The contractor while submitting the detailed design calculations should submit the following information on the quality of materials to be used and other aspects as detailed below:

(1) Metal quality, finishes and thickness

(2) Glass quality, coating and thickness and proposed manufacturer's brand names.

(3) Aluminium extruded sections including mullions and transoms together with structural calculations and proposed manufacturer's brand name and also the name of agency proposed for fabrication work.

(4) Arrangement and jointing of components.

(5) Field connections especially mullion to mullion and transom to mullion.

(6) Fixing and anchorage system of typical wall unit together with structural calculations.

(7) Drainage system and provision in respect of water leakage in the curtain wall system.

(8) Provisions for thermal movements.

(9) Sealant and sealing methods.

(10) Glazing Method

(11) Wind load and seismic load and any other specific load considered in the design

i) Design concept over lighting protection link-up system of the curtain wall for connection and incorporation into the lighting conductor system of the building (Lighting conductor system of the building shall be done by other approved specialized agency).

(ii) The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case these tolerances exceed those specified in the specification.

12) Provision of Smoke outlet, openable panels in case of fire. Compliance of Local Government Fire Department. Fire safing and smoke seal at gaps between the floor slab-edge and the back of the curtain wall are essential to compartmentalize between floors and slow down the passage of fire and combustion gases between floors. The materials used for perimeter containment remain in place for the specified duration of the required rating in a fire. Perimeter Fire Containment System shall be designed for safe measures of the building .

Fireman knock-out glazing panels are often required for venting and emergency access from the exterior. Knock-out panels to be fully tempered glass to allow full fracturing of the panel into small pieces and relatively safe removal from the opening. Knock-out panels are identified by a non-removable reflective dot (typically two inches in diameter) located in the lower corner of the glass and visible from the ground for the fire department.

13) The curtain wall should be designed for accessibility for maintenance.

14) window-like opening on each floor of glass-façade buildings is mandatory as access points for rescue workers. The openings must have 'Emergency exit' labels, which will help save time as fire - . fighters will not have to hunt for access points. The window should be positioned such that it is overlooks an access road. This will allow easy access to the ladder in case a fire breaks out an upper floor.

15) Spandrels to be provided with insulation or / and projections to be provided

16) Distance between external wall and glass façade shall not be more than 300 mm

40.5.2.3. Tolerances: Any parts of the curtain wall, when completed, shall be within the following tolerances:

(1) Deviation from plumb level or dimensioned angle must not exceed 3 mm per 3.5 m length of any member, or 6 mm in any total run in any line.

(2) Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle must not exceed 9mm total at any location.

(3) Change in deviation must not exceed 3mm for any 3.5 m run in any direction.

40.5.2.4. Samples : The contractor shall also submit samples of aluminium extruded sections; mullion and transom sections in lengths of 300 mm with the same finish and workmanship as per the tender proposals and 300 mm x 300 mm samples of glass for approval of the EIC. (samples to include exposed screws and other exposed securing devices if any).

40.5.2.5. Ancilary Requirements to be fulfiled by the contractor

(i) The contractor / approved specialized agency shall submit a maintenance manual for the curtain wall system inclusive of all metal parts, glass and finish etc.

(ii) During detailed design scrutiny and also during the actual execution of the work any additions and extra provisions that will have to be made as per theoretical requirements or site conditions shall be implemented and executed by the contractor at his own cost, without claiming any thing extra under any circumstances.

40.6. Execution of work –

40.6.1. Performance Testing - General Requirements

i) Mock-up units shall be constructed by the contractor and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the face of the building.

ii) After the approval of structural calculations and the drawing for construction of the curtain wall, one test unit for performance testing of the curtain wall shall be constructed by the contractor at an independent laboratory or at a laboratory approved by the Engineer-in-Charge.

iii) Erect mock-up under manufacturer's / Fabricator's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

iv) The contractor shall submit to the Engineer-in-Charge the test procedures to be adopted, test schedule and location for testing before the work of actual testing is taken up.

v) Prior to the fabrication of test units, the contractor shall submit shop drawings and design calculations of the test unit for approval of the Engineer-in-Charge.

vi) The contractor shall not start the work of erection of curtain wall on site till the approval for the successful completion of the mock up test and clear instruction in writing to start the work is received from the Engineer-in-Charge.

vii) The decision of the Engineer-in-charge in respect of the procedure to be adopted, in conducting the mock-up test and the judgment over the net results, shall be final and binding on the contractor.

40.6.2. Test of Wind Pressure

(i) The equivalent load of wind pressure or wind suction shall be given to the test unit as increasing or decreasing the inside pressure in the "pressure chamber" at which the test unit is fixed.

(ii) The static wind pressure shall be applied up to 1.5 kpa at maximum wind pressure.

(iii) The variation of dynamic pressure shall be of any approximate sine curve line.

(iv) Deflection on each observational points of the test unit shall be observed and recorded under static pressure as described above.

(v) Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

(vi) **The deflection on the main structural parts in this condition shall not exceed :**

(1) 1/175 of the span between supports or 20 mm, whichever is less for vertical elements.

(2) 1/250 of the span between supports for horizontal elements.

(3) The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

40.6.3. Test of Lateral Deflection per floor height

(i) Lateral deflection per floor height shall occur on the test unit, when the structural frame which fixes the test unit is deflected horizontally.

(ii) The deflection of every ± 2.5 mm shall be increased up to ± 13 mm on the test unit (static deflection test)

(iii) The dynamic deflection shall be applied up to ± 13 mm.

(iv) The variation of dynamic deflection shall be of an approximate sine curve line, one period of 3 seconds.

(v) The dimensions of the deflection on each observational point of the test unit shall be measured under the condition as described above and the damage shall be observed.

(vi) Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall except the damage to sealant at maximum deflection.

40.6.4. Water-tightness Test

(i) Water shall be sprinkled to the Test Unit' under wind pressure.

(ii) Pressure shall not be applied to the test unit.

(iii) The volume of the sprinkling water in one minute shall be 5 litres per sqm minimum.

(iv) All water leakage and drainage system at the joint and the openable sash of the curtain wall system shall be observed from the outside of the chamber.

(v) Hold the test two times, in sequence as described below, conforming to the above mentioned conditions.

(vi) Water leakage shall not be observed inside at all parts of the test unit during first water-tightness test.

(1) Install the test unit.

(2) Hold first water-tightness test.

(3) Hold test of wind pressure as described above.

(4) Hold second water-tightness test.

(5) Lateral deflection test.

40.6.5. Test Report: The contractor shall submit five copies of test report to the Engineer-in-charge.

40.6.6. Cost of Performance Test

(i) The contractor shall allow in his tender for the cost of the performance testing and fabrication, erection, corrections to and demolition of the test units including any special provision required in the testing laboratory for the tests mentioned above.

(ii) The contractor shall allow for amendments and adjustments to the mock-up unit as instructed and required by the Engineer-in-Charge / Architect or the consultant.

(iii) If the mock-up test unit fails to pass the initial testing, the contractor shall make the necessary corrections to the test unit and shall get the test unit retested by the testing laboratory until it passes the test.

(iv) Cost of corrections to the test unit and the cost of retesting shall be borne by the contractor.

(v) The contractor shall be allowed six calendar months time after the work is awarded to set up the test unit and conduct the required test as described above to the satisfaction of the Engineer-in-charge.

(vi) In case the contractor fails to conduct the necessary tests as described above or fails to meet the required test results, without any genuine cause within the allotted period of six months, the Engineer-in-charge shall be free to rescind the contract with all costs including the forfeiture of E.M.D. and any other securities deposited by the contractor under the condition of contract.

40.6.7. Record of Test and Drawings

(i) The testing laboratory shall keep the approved copy of the shop drawing and calculations of the test unit at testing laboratory during testing of test unit.

(ii) The testing laboratory shall accurately and nearly record on the above mentioned shop drawings all changes, revisions, modifications etc. made to test unit, which shall become the record drawing.

(iii) On completion of testing and after approval of the test reports the testing laboratory shall submit the final record drawings to the Engineer-in-charge.

40.6.8. Fabrication and Erection

(i) Frames shall be square and flat, both the fixed and openable frames shall be constructed of sections, which have been cut to length, mitred and mechanically jointed at the corners, Sub-dividing bar of units shall be tenoned and riveted into frames.

All frames shall have corners welded to true right angles. For jointing hollow sections flash butt welding, argon arc welding or mechanical jointing by inserts shall be used. (Gas welding or brazing shall not be done). Concealed screws shall be used for joining the sub-units.

(ii) The grid for the curtain wall system shall be fabricated carefully with aluminium extruded sections like mullions and transom in the exactly same pattern as per the final drawings with amendments if any received from the laboratory after conducting the mock-up unit test.

(iii) The sizes of different members of the curtain wall system shall be exactly as adopted for the mock-up unit tests and the grid shall be fixed to the building member as shown in the drawing, received after conducting the mock-up unit test.

(iv) Care should be taken to see that any gap between the frame and support and the frame **itself is sealed with silicon sealant.**

(v) Finish of grid frame shall be either anodized, organic coating, backed enamel finish or as specified in the item of work, no visual variation in anodizing / colour shall be accepted.

(vi) Care shall be taken to see that the curtain wall system is not deformed, damaged during erection and it shall be protected from direct contact with wet or intermittent wet cement concrete mortar etc.

40.7. Representative of the contractor

Full time attendance of a qualified civil engineer with sufficient experience in construction of curtain wall system shall be provided for erection of test unit, all testing and later on actual construction.

40.8. Performance Guarantee

The contractor shall provide a performance guarantee as indicated in the Schedule of Quantities for a period of five years, to provide for expenses to cover the risk and cost of

rectification of defect, noticed during the five years guarantee period. Guarantee period shall start from the date of completion and handing over of the project.

40.9. Measurements

(i) The breadth and the height of the finished work including the openable windows shall be measured in metres and cm and the net quantity for payment shall be calculated in sqm up to two places of decimal.

(ii) The area to be considered for measurement shall be the net area of the exterior face of the curtain wall as fixed including the openable windows, if any, as part of the curtain wall.

40.10. Rate

The rate shall include the cost of all operations described above including the cost of materials, labour, design, shop drawings, erection and testing, mock-up test units, fabrication, erection, finishing, scaffolding, undertaking performance guarantee etc. No other claims of any kind pertaining to this work shall be entertained.

41 STRUCTURAL GLAZING

41.1. Specification for Materials to be used In Structural Glazing

This shall be same as described for Aluminium Curtain Wall System.

41.2. Specification for Materials to be used In Structural Glazing

Aluminium extruded sections shall be from approved and reputed / renowned manufacturer. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works.

41.3. General Specification and Tolerances for Aluminium Extrusions Dimensions and weights of the sections shall be as per approved drawings.

Circumscribing Circle Diameter (CCD)

i) The product range shall be broadly as categorized below;

a) For solids upto 190mm.

b) For hollows upto 135mm

ii) Sections with higher CCD, if required, shall be produced from reputed / renowned manufacturer as approved by the Engineer-in-Charge.

Manufacturing Tolerance: Dimensional extrusions shall be normally as per IS / BSS. Special tolerances shall be mutually agreed upon.

Tolerance on cut length:

i) The standard cut length is 3.66M the tolerance on cut length shall be as follows:

Length	Upto 6 metres	Over 6 metres
Tolerance	+ 5 mm	+ 7 mm

ii) Sections shall also be acceptable in random lengths between 1500 to 5000mm depending upon actual requirements. **Tolerance in Weights:** A tolerance of ± 10% shall be acceptable on Sectional weight per metre.

41.4. Glazing:

Glazing work shall be as specified in the description of the item and / or as described under chapter: Glass & Glazing.

41.5. Scope of Work

This shall be same as described in the para “Scope of work” for Aluminium Curtain Wall System.

41.6. Execution of Work

i. This shall be similar to the Specifications for Aluminium Curtain Wall System as far as applicable.

Notes on Aluminium Curtain Wall System and structural glazing

1) Though both the systems i.e. curtain wall system and structural glazing are very much similar, still the type and shape of aluminium extruded sections, that are used in this case are totally different.

2) Another noted difference between the two systems is that in elevation the structural glazing looks as total glass surface without any beading visible externaly, whereas in case of curtain wall system the cover plate used on the surface is clearly visible in elevation.

3) A large quantity of sealant has to be used for the execution of the work of structural glazing with the result the cost per sqm. of structural glazing works out to be much on higher side.

4) There is also a slight difference in the actual fabrication of the two systems though quantity of materials required for execution in both the cases is same except the quantity of sealant.

41.7.	**Representative of the Contractor**	These shall be similar to the
41.8.	**Performance Guarantee**	Specifications for Aluminium Curtain
		Wall System as far as applicable
41.9.	**Measurements**	
41.10.	**Rate**	

42 CEMENT PLASTERING FOR WALLS & CEILINGS AND SAND FACE / ROUGH CAST PLASTERS :

42.1. SCOPE OF WORK :

The work covered under these specifications consists of supplying all materials and rendering all types of plaster/pointing finishes strictly in accordance with these specifications, applicable drawings etc. For all finishing works mentioned above, only blended cement shall be a used.

42.2. GENERAL :

Blended cement, sand and water required for the work shall conform to specifications laid down herein before under chapter 4 i.e. Plain and reinforced cement concrete, except that sand for finishing coat shall be fine sand conforming to I.S. 1542. The plastering works shall generally conform to I.S. 1661 (Code of practice for cement and cement plaster finish on walls and ceilings). All general precautions as specified in I.S. 1661 clause-8, shall be taken and preparation of the back ground shall be done as laid down in I.S. 1661 clause 12 and I.S. 2402 shall be generally followed for rough cast and sand faced plaster work. Scaffolding required for facility of working shall be provided by the contractor at his own

cost. This may be double or single according to the requirement and shall be approved by the Engineer-in-Charge. Stage scaffolding shall be erected when ceiling plastering is done. The contractor shall be responsible for accidents, if any, take place. The contractor shall co-operate with the other agencies also. Whenever electrical contractor/agency has to fix up switch boxes in walls, necessary Thiyyas, Tapanish or Dhadas shall be arranged to be given in advance of actual plastering process at these locations so that the boxes are fixed properly in line with finished plaster surface. All finishing in and around these boxes as also around the conduit boxes in ceiling shall be done by plastering contractor without any extra cost. The decision of the Engineer-in-Charge in this regard shall be final and binding on the contractor. NO DRY CEMENT TO BE USED WHILE PLASTERING IT SHOULD BE IN MIXED STAGE. **Portland Pozzolana cement (Fly Ash) shall be used for Plastering**. Ready mix cement plaster if used shall be of approved make & shall be mixed and laid as per manufacturer's specification.

Polypropylene fiber mesh at concrete and masonry joints & addition of polypropylene fiber / Glass fibers of approved make , quantity ranges from approx 125 gms Per bag of cement for polypropylene fibers / Glass fibers; dosage shall be as per manufacturers specification ; mixing into Plaster mix.

42.3. PREPARATION OF SURFACE :

The surface to be plastered shall first be thoroughly cleaned of all muck and cleaned down. All joints shall be raked out in case of brick work / stone masonry and closely hacked in case of concrete, **under the relevant masonry / concrete items. The plastering to be done on concrete surface shall be only be done on rough hacked (tacha) finished surface.** The surface to be plastered shall be well wetted for a minimum period of 6 hours before commencing the work. The mortar for all plaster work shall be blended cement mortar of mix as specified in the schedule of quantities.

After erection of scaffolding and before commencement of plastering work, top most junctions/joints/sides with beam/column shall be thoroughly packed with blended cement mortar to prevent cracks.

Before commencement of plastering operation, the contractor shall ensure that all the service pipes, electrical conduits, boxes, switch boxes etc. have been installed in position by other agencies and the plastering surface is duly approved by the Engineer-in-Charge. In order to enable other service contractors to fix the electrical conduits, conduit boxes, EDBs, pipes, outlets etc. in proper level and line with reference to the finished surface of the plaster, Thiyyas and Tapanis i.e. finished plaster patches shall be given by the main

civil contractor on walls, ceiling at regular intervals well in advance of his plaster work at no extra cost . The entire work of preparation of surface before plastering shall thus be co-ordinated by the main civil contractor with all other agencies working at site.

Just before actual plastering work is taken up in hand, all the ceilings and walls etc. shall be marked with Tapanis or Thiyyas indicating the thickness of plaster required and which shall be in true line, level and plumb. The contractor shall get these marks approved by the Engineer-in-Charge before starting the plastering work. The contractor shall also be responsible to render the final surface true to line, level and plumb etc.

All building operations like construction of walls, concreting etc. shall have been completed before plastering is taken up. The plastering operation should be taken up only after the service pipes (concealed lines with plumbing/ electrical) etc. that are to be embedded in the wall or ceiling are completed and suitably protected against erosion by other agencies and okayed by the Engineer-in-charge. Damage if caused to any of the existing fittings, fixtures, including doors and windows etc. during the plastering operation shall be made good by the contractor at his own cost.

If the surface which is to be plastered either internally or externally is out of plumb and not in line and level and if the plastering to be done is more than specified thickness to bring the plastered surface to perfect line and levels, in such specific cases, chicken wire mesh is to be provided by the contractor at his own cost and the plaster should be done to required line and level with no extra cost whatsoever.

The finished plastered surface shall be free from cracks, fissures, crevices, hair cracks, blisterings, local swellings and flakings. The finished surface shall be true to line, level, plumb & plain and durable. The adhesion of the mortar with the background surface is of prime importance as this affects durability of plaster. Preparation of surface which has to take plastering is of great importance. Before starting the plastering work the surface should be got approved by the Engineer-in-charge.

In order to avoid the formation of deep and side cracks and for dispersion of cracks at the junctions between concrete surfaces and brick masonry work as also between junction of windows/door frames and brick masonry works, cautionary measures such as fastening and lapping of chicken mesh / fibre Glass mesh over the junction areas should be carried out over which the plastering work has to be taken up as required by the Engineer-in-charge.

The minute gap between window/door frames with cills and jambs should be filled up/caulked by silicone sealants /Acrylic Latex caulk by caulking guns or by approved methods as instructed/approved by Engineer-in-Charge.

42.4. GROOVES :

The grooves shall be of required dimensions. The same shall be made to turn wherever necessary. The finish, inside, shall be of the same finish as that of the plaster. The lines of the grooves shall be well defined and rounded. The grooves are to be provided in plastering in internal and external surfaces. The groove shall be in straight line.

42.5. MIX PROPORTIONS :

The mortar for plastering shall be of proportion as specified in the schedule of Item. The mixes specified in the schedule are volumetric.

42.6. MIXING :

Cement and fine aggregates shall be mixed dry in the required proportions to obtain a uniform colour. Water shall then be added to get the required consistency for the plaster.

Mixing shall be done mechanically. However, manual mixing will be allowed only in exceptional circumstances at the discretion of the Engineer-in-Charge. Manual mixing, where adopted, shall be carried out on a clean water tight Galvanised steel side closed tray. After water is added during mixing, the mix shall be held back and forth for 10 to 15 minutes.

In machine mixing, the mixer shall run atleast five minutes after placing all the ingredients in the drum. Only so much quantity of mortar which can be used within half an hour after the addition of water shall be prepared at a time. Any mortar for plaster which is set or partially set shall be rejected & shall be removed forthwith from the site. The mix should not be laid on Ground; even if mixing is done in machine it should be collected in tray (laid below the mixer) after mixing & then transported by Ghamellas/construction trolleys or other means as per standard construction Practice.

6 / 12 / 15 /25 MM. PLASTER :

The plaster shall be laid with somewhat more than 12 mm. thickness and pressed and levelled with wooden ruler to a finished thickness of 12 mm. Straight edges shall be freely used to ensure a perfectly even surface. All exposed angles and junctions of walls, doors, windows, beams, slabs etc. shall be carefully finished so as to furnish a neat and even surface.

Note: For 6mm plaster, approved bonding agent shall be used as per manufacturer's specifications, wherever specified in the Schedule of Items.

20 MM PLASTER :

The proportions of sand and cement shall be as specified and shall cover all irregularities, undulations, depressions due to chasing etc. in the surface to be plastered. The mortar shall be applied slightly more than 20 mm. thick and pressed and levelled with wooden ruler or straight edge to finished thickness of 20 mm. Straight edges shall be freely used to ensure a perfectly even surface. The finished surface shall be true and even and present uniform texture throughout and all joining marks shall be eliminated. All corners, edges and angles shall be made perfectly to line, plane and plumb. All exposed angles and junctions of walls, doors, windows, beams, slabs etc. shall be carefully finished so as to furnish a neat and even surface.

Plastering items amongst all other things as described in various items also include:

i) Preparation of surfaces to receive the plaster, providing cement plaster of the specified average thickness and proportions with specified number of coats.

ii) All labour, materials, scaffolding, use of tools and equipment to complete the plastering work as per specifications.

iii) Curing for 10 days.

iv) Cleaning the surface of doors, windows, floors or any other surfaces where plastering might have splashed.

v) Finishing the portion of plaster left above the terrazo, plain cement tiles, Ceramic/vitrified /stone or any type of skirting work to be finished rounded or as directed by the Engineer-in-Charge, in a separate operation after laying of floor tiles skirting.

42.7. (A) NEERU FINISH :

Wherever specified, the surface rendered shall be finished smooth with good quality lime neeru class 'C' conforming to I.S. 712. The lime shall be tested in an approved testing laboratory for the chemical analysis of the lime and test certificate submitted regarding suitability of lime for plaster work. The cost of testing shall be borne by the contractor. Neeru shall be prepared at site out of best quality pure fat lime slaked at site with fresh water and slaked in accordance with the relevant I.S. code for slaking of lime. The slaked and sifted lime shall be reduced to a fine paste by grinding 150 turns in a mortar mill. Sufficient quantity, which can be used within 10 days only shall be prepared at a time.

Chopped hessian or jute fibre in the required quantity may also be added to neeru and properly ground to pure paste as per directions of the Engineer-in-Charge.

An entire unobstructed area shall be plastered in one operation. Neeru shall be applied to the prepared and partially set but somewhat plastic surface with steel trowel to a thickness slightlty exceeding 1.5 mm. (1/16") and rubbed down to 1.5 mm. It shall be polished to perfectly smooth and even finish working from top to bottom for at least 3 days. All corners shall be truly brought to desired lines and levels in the base plaster along and the thickness of neeru shall not exceed 1.5 mm., at these locations. Moistening shall be commenced as soon as the plaster has hardened sufficiently and is not susceptable to injury. The surfaces shall be kept sprinkled with water for 7 days to prevent excessive evaporation. On the sunny or wind-ward side of the building in hot dry weather, matting or gunny bags may be hung over on the outside of the plaster and kept them wet. If blow holes are observed in neeru plaster at any time during the contract period and during the defect liability period, the contractor will have to rectify the defective neeru plaster work including redoing of the white washing/colour washing/distempering work etc. as the case may be, entirely at his own cost.

It shall be the contractors responsibility to ensure that cracks do not develop during the execution or subsequently during the defect liability period and the cracks if any observed shall be rectified including finishing, white washing/painting as specified, without any extra cost, to the entire satisfaction of the Engineer-in-charge.

42.8. (B)TEROL FINISH OF TERRACO :

Wherever specified, the surface rendered shall be finished smooth with 1 to 3 mm. thick coat of TEROL of TERRACO as per manufacturers specification. It shall be ensured that the surface to be covered is free of loose particles, dust, dirt, grease, oil and paint. TERROL shall be applied on top of finished coat of plaster which should be levelled without any scratch/key marks. Adequate care should be taken that the first coat is levelled well to enable the thin layer TEROL plaster to give smooth finish, substrata/sub base should be moistened with water prior to the application of TEROL thin layer plaster.

1. Mixing : Put water into a clean empty drum. Add TEROL start stirring with paddle. Gradually add water and TEROL alternatively in the required proportion to get desired creamy consistency, convenient for application and stir continuously and ensure that no lumps remain. TEROL should not be allowed to stand without stirring for longer than 60 minutes. In normal condition let TEROL set for 5 minutes then stir and use. Where rapid drying conditions are prevalent, it is advisable to mix TEROL 20 minutes before using.

2. Application : TEROL is sprayed or hand applied and smoothened with a steel float.

Smooth finishing shall be achieved with wooden floating or troweling when TEROL has set. The float should be moistened during the smoothening operation.

Curing the surface shall be carried out after 24 hours of application at least for 4 days using light water spray.

42.9 (C) PLASTER OF PARIS (POP – CaSO4 , 1 / 2H2O) FINISH :

Wherever specified, the wall / ceiling surfaces shall be finished smooth with approved quality Plaster of Paris (POP). POP shall be mixed in water for dehydration at site. Sufficient quantity, which can be used within half an hour only, shall be prepared at a time.

POP shall be applied immediately after the under coat of cement plaster has set. An entire unobstructed area shall be finished in one operation. POP shall be applied on top of finished coat of plaster which should be levelled without any scratch/key marks to the prepared and partially set. It shall be ensured that the surface to be covered is free of loose particles, dust, dirt, grease, oil and paint.It shall be applied with steel trowel to a thickness slightly exceeding 2 mm and rubbed down to 2 mm. It shall be polished to perfectly silk smooth and even finish working from top to bottom. All corners shall be truly brought to desired lines and levels in the base plaster along and the thickness of POP shall not exceed 2 mm, at these locations.

If blow holes / cracks are observed in POP plaster at any time during the contract period and during the defects liability period, the contractor will have to rectify the same including redoing painting to match with the adjacent surface etc., all at his own cost to the entire satisfaction of the Engineer-in-charge.

42.10 (D) GYPSUM PLASTERS

1.0 Material:
Requirement of premixed light weight gypsum shall be conforming to IS: 2547, Part-I &II latest revision. Product Package shall be ISI marked and material shall be got approved prior to commencement of work.

Physical and Chemical requirement, sample testing to be carried out as per the IS: 2547 Part I & II cost of all test shall be born by contractor.

1.1. Surface Preparation for RCC: Smooth RCC surface to be hacked for bonding (50 hacks per Sq. Ft.).
1.1.1. Any mould oil (Release oil) or other agents presents should be washed.
1.1.2. Normal ballast concrete should be given sufficient time to cure prior to application of plaster.

1.1.3. Any kind of loose masonry, foreign material adhering to the surface to be removed.
1.1.4. Recommending to use bonding agents to avoid any issue of debonding.

1.2. Application Methodology: The powder should be mixed with clean water preferably in clean plastic buckets to avoid mixing with impurities.
1.2.1. Mix gypsum plaster powders to water ensure through mixing by help of mixing rod has to avoid formation of lumps and unmixed residues.
1.2.2. Material should be thoroughly mixed and free from lumps and impurities before use.
1.2.3. Water to plaster ratio should be as per manufacture recommended.
1.2.4. When the mix has begun to set it should not be further added with additional water or dry material.
1.2.5. Material should always apply above 6" from skirting level.
1.2.6. Can apply gypsum in the thickness range of 3.25 mm. However when applying gypsum plaster in thickness excess of 12-13 mm it has to be applied in layers of 10 mm each and not the whole thickness of 25-30 mm in one single layer.
1.2.7. Similar will be the application process for RCC columns and wall where it has to be applied in layers. However in ceiling it is not recommended to go beyond thickness of 13 mm even it applied on Bond IT or Hacked surface.

1.3. RATE: - Rate quoted shall be all heights and floors including cost of material, scaffolding, transporting, testing , labour and of additional thickness due to variation in plain and plumb etc.

1.4. MODE OF MEASURMENT: Mode of measurement will be as per schedule of quantities.

43 SAND FACED CEMENT PLASTER:

43.1 GENERAL : Materials and preparation of surfaces and scaffolding etc. for sand faced plaster wherever applicable shall conform to specification laid down here-in-before under section cement plastering and the following specifications are also to be complied with:

PREPARATION OF SURFACE : The surface to be plastered shall first be thoroughly cleaned down. All joints shall be raked out in case of brick work / stone masonry and closely hacked and wire brushed in case of concrete, **under the relevant masonry / concrete items.** The surface to be plastered shall be well wetted for a minimum period of 6 hours before commencing the work. The mortar for all plaster work shall be cement sand mortar of mix as specified in the schedule of quantities.

Double scaffoldings required for facility of construction shall be provided by the contractor at his own expenses wherever directed by the Engineer-in-Charge. Scaffolding shall be erected with pipes or ballies or bamboos of adequate strength so as to be safe for all the

dead, live and impact loads likely to sustain by it during construction operations. The contractor shall take all measures to ensure the safety of the work and workmen. Any instruction of the Engineer-in-Charge in this respect shall also be complied with. The contractor shall be entirely responsible for any damage to Government /Private property or injury to persons, resulting from faulty scaffolding, defective ladders and materials or otherwise arising out of his default in this respect. Proper scaffolding shall be provided to allow easy approach for workmen and supervisory staff to every part of the work. Ballies, bamboos etc. for scaffolding shall not be tied to the windows, doors, mullions, ventilators etc. Any damage done to the windows, doors etc. shall be made good by the contractor to the original conditions at his own cost. For better safety, steel pipe scaffolding is preferred.

WORKMANSHIP : The surface to be plastered shall first be dubbed out with cement mortar to cover all irregularities and faces upto proudest part. The dubbing coat which shall be of proportion as specified in schedule and a 12 mm. thick (1/2") layer shall then be applied/scored and keys shall be formed on the surface by thoroughly combing it with heavy horizontal lines about 12 mm. (1/2") apart and about 3 mm. (1/8") deep when mortar has just set.

The cement mortar for sand faced plaster shall have washed and approved sand with slightly larger proportions of coarse materials, but not exceeding 3 mm. The proportion of cement to sand shall be as specified in the schedule. The water is gradually added to make the mixture homogenous. The thickness of finishing coat excluding key shall be 8mm. (about 5/16"). After application the surface should be finished with a wooden float lined with cork closely pricked on with a wet sponge tapped gently to bring sand particles into prominence.

The chajjas and any other horizontal portions shall be cleaned and set mortar that might have been fallen at the time of plastering at higher elevation, before plastering work is taken up. Junction of wall and chajja shall be rounded off simultaneously as directed by the Engineer-in-Charge.

43.2 ROUGH CAST PLASTER :

All materials shall conform to the standards already specified for plaster described above. The preparation of the surface to received the rough cast plaster shall be as described under sand face plaster. Rough cast plaster shall be carried out in two coats. First coat shall consist of 1 part of cement to 3 parts of clean sand or as specified otherwise. The finished thickness of the first coat shall be 12mm. and shall be laid by throwing the mortar (By using strong whipping motion) on the prepared surface with a trowel in a uniform layer but shall not be smooth. The second coat consists of 1 part of cement and

3 part of 6 mm. to 10 mm. down gravel all as approved by the Engineer-in-Charge. The gravel shall thoroughly be got cleaned with water removing all dirt and other organic materials. All these ingredients shall be mixed into a paste which shall be flung upon the first coat with large trowels to form an even protective coat. The second coat must be applied while the first coat is still soft and unset. The thickness of this coat shall be 10 mm. only. Due care shall be taken to avoid concentration of either large size or small size of gravel in one place. A sample of rough cast plaster shall also be got approved by the Engineer-in-Charge as regards the texture etc. before proceeding further with the work. All subsequent work shall generally conform to the approved sample panel. The finished work shall be cured for a minimum period of seven days.

General workmanship, scaffolding, preparation of surface, curing etc. shall conform to the specification already laid down under sand faced plastering.

The contractor shall take special care at the time of plastering or pointing to keep the M.S./aluminium window/wallspan etc. fixed by other agency in correct shape, position and to cover the same with required hessian cloth/gunny bags to keep away from sprinkling of plasters/paint etc. The damage caused to the above if any, shall be made good by the contractor at his own cost.

MODE OF MEASUREMENT:

Area of plastering will be measured net and shall be paid for. The measurement of length of wall plastering shall be taken between walls or partitions (dimensions before plastering shall be taken) for the length and from top of the floor or skirting or dado as the case may be to the underside of ceiling for the height. All openings more than 0.1 sqm. shall be deducted and all jambs, soffits, sills of these openings if done, will be measured to arrive to the net area for payment. No opening less than 0.1 sqm. shall be deducted and no jambs etc. for such openings shall be measured for payment. The rate shall include the cost of finishing all the edges, corners, cost of all materials, labours, scaffolding, transport, curing etc.

The rate shall include the cost of finishing all the edges, corners, cost of all materials, labour, transport, scaffolding, curing etc. and grooves if so specified in the item of schedule of quantities.

The rate for plastering should include the cost of work towards the following items for co-ordination with electrical item:

1. Neatly plastering around DBs, junction boxes, M.S. boxes etc. should be done and made matching with the wall finish after installation of electrical equipments.

2. All DBs, service boxes, covers etc. should be covered by a plastic cloth or other suitable covering materials such that water or materials should not splash the same during brick work and plastering work. This is to be done in such a way that electrical equipments as well as painted surfaces are not spoiled.

3. For fixing M.S. boxes, DBs etc. Thiyya should be given such that the required face of the M.S. box, DB covers etc inline with final finished plastered surface.

4. The rate for the item shall also include rounding up of corner and angles making sharp corners and angles finishing around ceiling rose and electrical fittings etc. fixed by other agencies, finishing of top of dado and skirting (zad finishing), junctions of roof and wall or beam with the finish as specified in the item. Plastering of brick and concrete cornice and copings and plastering in restricted areas if any shall not be measured separately. Architectural bands and narrow widths of plaster over structural as well as non-structural and the line when prepared in the same thickness of plaster shall not be measured separately and shall be covered by respective plaster items.

ROUGH CAST PLASTER : The area of surfaces actually plastered will be measured net and shall be paid for. The measurements of length and height of wall plastered shall be correct to a centimeter taken between walls or projections including the width of corner edge strips including the areas of grooves. All the openings more than 0.1 sqm. shall be deducted and all jambs, soffits and sills of these openings, if plastered will be measured to arrive at the net area for the payment. No opening less than 0.1 sqm. shall be deducted and no jambs etc. for such openings shall be measured for payment. Corner/edges finishing will not be measured separately and the rate shall include the cost of finishing all the edges, corner strips in addition to the cost of all materials, labour, transport, scaffolding, curing etc. and grooves if so specified in the item of schedule of quantities.

44 CEMENT POINTING :

PREPARATION OF SURFACE :

The joints shall be raked out properly **under masonry item.** Dust and loose mortar shall be brushed out. Efflorescence if any, shall also be removed by brushing and scrapping. The surface shall be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

MORTAR :

Mortar mix for pointing shall be as described in the schedule of quantities. Specifications for cement, sand and water shall be as described herein before for concrete works.

APPLICATION OF MORTAR & FINISHING :

The mortar shall be pressed into the raked out joints with a pointing trowel, either flush, sunk, ruled or raised according to type of pointing specified in the schedule of quantities. The mortar shall not spread over the face of brick work or stone work, corners, edges of the masonry but restricted to the width of joints only.

The super-fluous mortar shall then the struck off and the surface of the masonry shall be cleaned off completely. The finish shall be such that the pointing is to the exact size and shape stipulated and the edges are straight, neat and clean. The pointing lines shall be straight, regular and uniform. No false joints shall be allowed.

CURING :

The pointing shall be kept wet for atleast seven days. During this period it shall be suitably protected from all damages.

TYPES :

(a) **Raised and Cut Pointing :** Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm. raised and width 10 mm. or more as directed.

(b) **Flush Pointing :** The mortar pressed into the joints shall be finished off flush and level with the edges of bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edges.

(c) **Ruled Pointing :** The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as directed shall be formed by running a forming tool straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. All vertical lines shall make true right angles at their junctions with horizontal lines and shall not project beyond the same.

MODE OF MEASUREMENT :

The area of surface actually pointed will be measured net and shall be paid for. The measurement of length and height of walls pointed shall be taken correct to a centimetre. All the openings of doors, windows, ventilators etc. shall be deducted and jambs, soffits, sills etc. if pointed will be measured to arrive at the net area for the payment. The rate shall include cost of all materials, labour, transport, scaffolding, curing etc.

45 WALL CARE PUTTY

45.1SCOPE OF WORK:

Wall care putty consists of white cement, high quality polymers and specialty chemicals and mineral fillers and is formulated to make it suitable to apply even on damp surfaces. Being cement based putty, it has better compatibility with the base plaster and forms a durable base for paints. It can be applied on both, Interior and exterior plastered surfaces. It is a water resistant base coating to the plastered surfaces to provide fine leveling and a protective base for the surfaces to be painted.

GENERAL:

Wall care putty shall have superior water resisting properties to prevent paint from flaking even if the walls are damp. It should fill-up fine pores in walls and ceilings to get the smooth and dry surface for painting. Wall care putty shall have better properties in terms of water-resistance, adhesive strength and durability as compared to the ordinary putties. The putty shall provide a breathable surface and allow any trapped moisture to move out keeping the wall dry and clean.

MATERIAL:

Wall care Putty shall be in dry free flowing powder form. Required quantity of Wall care putty shall be procured from the reputed manufacturers like M/s. Birla White Wall Care Putty / M/s. Walplast Products Pvt. Ltd. or equivalent approved manufacturers, or from their authorised dealers. The putty shall conform to the International standards (viz. HDB-Singapore Standards with Water-resistant properties).

The putty shall be procured in the form of FINE or COARSE (MATT) finish as specified in the description of the item.

PREPARATION OF SURFACE:

- Surface should be clean of loose particles, dirt, grease and traces of foreign material. Sand papering or chipping shall be done if so required.

- Loose plastered areas/defective materials shall be removed & surface re-plastered and cracks filled-up properly.

- Uneven ceiling/wall surfaces shall be made even by re-plastering.

- Surface should be pre-wetted prior to application. This helps in providing a strong bond with substrate.

MIXING:

- 12 to 16 litres of clean water shall be required for a bag of 40 kg of wall care putty. Required quantity of putty (which is required to be used at a time) shall be added to the water in right proportion. (considering pot life of the mix as 60 minutes).

- Mix shall be stirred continuously by using an electric mixer or by hand to obtain a homogeneous lump-free paste.

- The paste shall be allowed to stand for about 10 minutes for the additives to dissolve.

- The paste shall be re-mixed again for about 2 minutes.

- This mix should be used within 60 minutes.

APPLICATION:

- The plastered surface shall be dampened with clean water and excess water shall be allowed to be drained-off.

- Using a steel trowel/blade, the above mix shall be applied to a thickness of about 1 – 2 mm. Then the surface shall be levelled and smoothened. This first coat shall be cured lightly after it dries-up.

- Then second coat shall be applied after first coat is fully dried and set. Second coat shall be cured lightly for two days.

- Over plastered / Coarse putty substrate, fine wall care putty of about 1 to 1.5 mm thickness shall be applied, to smoothen the surface with a steel trowel. Finished surface of wall care putty shall not require any dressing by Emery Paper but if at all it is done, the paper should not be less than 500 number.

- The thickness of each coat should not exceed 1.5mm and total wall putty thickness

should not exceed 3mm.

- If specified in the description of item, coarse wall care putty of about 6 to 10 mm thickness shall be applied to remove the undulations and level the surface. More number of coats of coarse putty shall be applied to cover up undulations, only after approval of the Engineer-in-Charge.

- Coverage of wall care putty depends upon surface quality. However, approximate coverage for fine wall care putty shall be 20-22 Sqft/kg and for coarse wall care putty, it shall be 9-10 Sqft/kg.

- Application of primer before painting is not necessary over the surfaces finished with wall care putty.

SPECIFICATIONS

Specification of Wall care putty – For smooth Finish			
SL. NO.	**PROPERTY**	**AS PER HDB (HOUSING DEVELOPMENT BOARD), SINGAPORE**	**TEST METHOD**
	Dry Adhesion	>=0.8 N/sqmm	EN 1015-12
	Wet Adhesion	>=0.3 N/sqmm	Chinese Std.
1	Tensile Adhesion Strength (N/sqmm) @ 28 Days	>0.8 N/sqmm	EN-1348
2	Compressive Strength (N/sqmm) @ 28 Days	7-12 N/sqmm	EN 1015-11
3	Setting Time (Minutes) - Initial & Final	<360 <500	EN 196
4	Water Absorption Coefficient - Kg/M². H1/2	<=0.13 for W2 / <=0.26 for W1	EN 1015-18

5	Water Capillary Absorption (ML) @ 24 Hrs.		Karsten Tube
6	Water Retentivity %	>=95%	EN 1015-8
	PH	Alkaline	

NOTE:

Putty being white cement based, it is alkaline, and hence direct eye and skin contact should be avoided. In case of eye contact, flush the same with clean water for 15 minutes and seek medical help.

46. PAINTING :

46.1. SCOPE OF WORK :

The work covered under these specifications consist of furnishing the various types of paints and also the workmanship for these items, in strict compliance with these specifications, which are given in detail here-in-after with the item of schedule of quantities.

46.2. MATERIALS :

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Ready mixed paints as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used. Approved paints, oils or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The materials shall be brought in at a time in adequate quantities to suffice for the whole work or atleast a fortnights work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineerin-Charge.

The contractor shall associate the chemist of paint manufacturers before commencement of work, during and after the completion of work who shall certify the suitability of the surface to receive painting and the paint before use etc.

Water based flat finish Acrylic latex Paint shall be used for ceiling .

46.3. COMMENCING WORK :

Scaffolding : Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being painted.

Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

For painting of the ceiling, proper stage scaffolding shall be erected.

Painting shall not be started until and unless the Engineer-in-Charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work.

Painting, except the priming coat, shall generally be taken in hand after all other builders work, practically finished.

The rooms should be thoroughly swept out and the entire building cleaned up at least one day in advance of the paint work being started.

46.4. PREPARATION OF SURFACE :

The surface shall be thoroughly cleaned. All dirt, rust, scales, smoke and grease shall be thoroughly removed before painting is started. Minor patches if any in plastered/form finished surfaces shall be repaired and finished in line and level in C.M. 1:1 and cracks & crevices shall be filled with approved filler, by the contractor at no extra cost. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

46.5. APPLICATION :

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its containers. When applying also, the paint shall be continuously stirred in the smaller containers so that consistency is kept uniform.

The external surfaces of the buildings under reference including the R.C.C. Jalli, fins and the panels above and below the window etc. shall be finished in different colours of approved shade. The contractor will make suitable samples at site for E.I.C approvel before taking up the work in hand and they will be allowed to proceed with the work only after getting E.I.C approval for the same.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the later in the direction of the grain in case of wood. The crossing & laying off consists of covering the area with paint, brushing the surface hard for the first time and then brushing alternately in opposite directions two or three time and then finally brushing lightly in direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying will constitute one coat.

Where so stipulated, the painting shall be done with spraying. Spray machine used may be (a) a high pressure (small air aperture) type or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner. Spraying should be done only when dry condition prevails.

Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be fecilitated by thorough ventilation.

Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned of dust before the next coat is laid.

No left over paint shall be put back into the stock tins. When not in use, containers shall be kept properly closed.

The final painted surface shall present a uniform appearance and no streaks, blisters, hair marks from the brush or clogging of paint puddles in the corners of panels, angles of mouldings etc. shall be left on the work.

In case of cement based paints/primers, the absorbent surfaces shall be evenly damped so as to give even suction. In any weather, freshly painted surfaces shall be kept damp for atleast two days.

In painting doors and windows, the putty around the glass panes must also be painted, but care must be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out while painting. Perspect covers of electrical switch boxes have to be painted from inside by removing them. Care shall be taken while removing them in position after painting with respective approved paints. In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

The additional specifications for primer and other coats of paints shall be as in accordance to the detailed specifications under the respective headings.

Any damage caused during painting work to the existing works/surfaces shall be made good by the contractor at his own cost.

46.6. BRUSHES AND CONTAINERS :

After work, the brushes shall be completely cleaned off paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers, when not in use, shall be closed, kept air tight and shall be kept at a place free from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean & can be used again.

46.7. MEASUREMENT :

a) Painting, unless otherwise stated shall be measured by area in square metre. Length and breadth shall be measured correct upto two places of decimal of a metre.

b) No deduction shall be made for opening not exceeding 0.05 sqm. and no addition shall be made for painting to the beading, moulding edges, jambs, soffits, sils, architraves etc. of such openings.

c) In measuring painting, varnishing, oiling etc. of joinery and steel work etc., the co-efficients as in the following table shall be used to obtain the areas payable. The co-efficients shall be applied to the areas measured flat and not girthed in all cases.

d) In case of painting of door shutter with push plates in plastic laminate, deduction will be made for area of such laminations.

46.7.1. Table of multiplying Co-efficients to be applied over areas of different surfaces to get equivalent plain areas is given in the Appendix-"C-2" of this book.

46.7.2. Explanatory notes on the table of Co-efficients.

1. Where doors, window etc. are of composite types other than those included in para 47.7 (c), the different portions shall be measured separately with their appropriate co-efficients, the centre line of the common rail being taken as the dividing line between the two portions.

2. Measurements for doors, windows etc. shall be taken flat (and not girthed) over all including chowkhats or frames, where provided. Where chowkhats or frames are not provided, the shutter measurements shall be taken.

3. Collapsible gates shall be measured for width from outside to outside of gate in its

expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide, rails, rollers, fittings etc.

4. Rolling shutters of interlocked laths shall be measured for the actual shutter width and the height from bottom of opening to the centre of the shaft. No separate measurements shall be taken for painting guides and other exposed features within or outside the shutter area. The painting of top cover or hood shall however be measured separately.

5. Co-efficients for sliding doors shall be the same as for normal types of doors as mentioned in the table. Measurements shall be taken outside of shutters, and no separate measurements shall be taken for painting guides, rollers, fittings etc.

6. Measurement of painting of doors, windows, collapsible gates, rolling shutters etc. as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

7. The measurements as above shall be deemed to include also the painting of edges, blocks, cleats etc. for which no extra will be paid.

8. The co-efficients for doors and windows shall apply irrespective of the size of frames and shutter members.

9. When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge, and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

10. In the case where shutters are fixed on both faces of the frames, the measurements for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter area only excluding the frame.

11. Where shutters are provided with clearance at top or/and bottom, such openings shall be deducted from the over all measurements and relevant co-efficients shall be applied to obtain the area payable.

12. In case of trellis (or jaffri) work, the measurements shall include the painting of the frame member for which no separate measurements shall be taken. Trellis door or window shutters shall also be measured under terllis work.

13. Wherever air conditioning grill, lighting, fixtures etc. in false ceiling are painted along with, measurements shall be taken over all without deductions for opening in grills and no extra shall be paid for the grills. If grills, fixtures etc. are not painted, area of fixtures or grills as measured flat (not girthed) shall be deducted when it exceeds 0.05 sqm. individuals. Where walls and ceilings are painted in separate colours, the junctions of two paints shall be brought down on the walls in a straight line by about 6mm to 12mm. if so desired, if the junctions of walls and ceilings are not even. Nothing extra shall be paid to the contractor on this account. Beading wherever provided shall not be measured separately but shall be deemed to be included in the area of false ceiling etc. measured flat (not girthed).

14. For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or palisades.

15. In the case of Non asbestos Fibre reinforced cement corrugated or semi-corrugated sheeting and iron corrugated sheeting in roofs, side cladding etc., the work shall be measured flat (not girthed) as fixed.

16. For trusses, compound girders, stanchions, lattice girder and similar work, actual areas will be measured in sqm. Or as per BOQ (Schedule of quantities) under structural steel and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

17. Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

18. Measurements of wall surfaces and wood and other works not referred to already shall be recorded as per actual and opening exceeding 0.05 sqm. shall be deducted to get the net payable area. Length and breadth shall be measured correct upto two places of decimal of a metre and area so worked out shall be correct upto two places of decimal of a square metre.

19. In case the items of work requiring painting are inclusive of cost of painting, the painting carried out shall not be measured separately.

46.8. PRECAUTIONS :

All furnitures, lightings, fixtures, sanitary fittings, glazing, floors etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damage done shall be made good by the contractor at his cost.

46.9. RATES:

Rates shall include cost of all labour and materials involved on all the operations described above and in the particular specifications given under the several items.

46.10. (A) PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES :

46.10.1. Primer

1. The primer for wood work, iron work or plastered surface shall be as specified in the description of the item.

2. **Primer for Wood work / Iron & Steel / Plastered / Aluminium surfaces shall be as specified below:**

SN	SURFACES	PRIMER TO BE USED
a	Wood work (hard & soft wood):	Pink conforming to I.S.3536-
b	Resinous wood and ply wood:	Aluminium primer
c	Iron & Steel, Aluminium and galvanised Steel	Zinc chromate primer conforming to
d	Plastered surfaces, cement brick work, Asbestos	Cement Primer

3. The primer shall be ready mixed primer of approved brand and manufacture.

47.10.2 Preparation of surface :

a) **Wood work :** The wood work to be painted shall be dry and free from moisture.

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any, shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material with same shade as paint shall be used where so desired by the Engineer-in-charge.

The surface treated for knotting shall be dry before painting is applied. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glaziers putty or wood putty (for specifications for glaziers putty and wood putty- refer as mentioned here-in-before). Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in the stopping and the latter is therefore liable to crack.

b) **Iron and Steel Work :** All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

c) **Plastered Surface :** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of paris and rubbed smooth.

46.10.2. Application : The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described here-in-before.

46.10.3. Other Details : The specifications for Painting (General) shall hold good so far as it is applicable.

46.11.(B): PAINTING WITH SUPERIOR QUALITY & FLAT OIL READY MIXED PAINTS ON NEW SURFACE :

46.11.1. Paint : Ready mixed paints shall be of approved brand and manufacture and of the required shades. They shall conform in all respects to the relevant I.S. specifications.

46.11.2. <u>Preparation of Surface:</u>

(a) **Wood work :** The surface shall be cleaned and all unevenness removed as in para 47.10.2 (a). Knots if visible, shall be covered with a preparation of red lead. Holes and indentations on the surface shall be filled in with glaziers putty or wood putty and rubbed smooth before painting is done. The surface should be thoroughly dry before painting.

(b) **Iron and steel work :** The primer coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly wiped away.

(c) **Plastered surfaces :** The priming coat shall have dried up completely before painting is started. All dust or dirt that has settled on the priming coat shall be thoroughly wiped before painting is started.

46.11.3. Application : The specifications mentioned here-in-before shall hold good as far as applicable.

The number of coats to be applied will be as stipulated in the item. The painted surface shall present a uniform appearance1 and glossy/semiglossy finish, free from streaks, blisters etc.

46.11.4. Other details : The specifications for Painting (General) specified here-in-before shall hold good in so far as they are applicable.

46.12. (C) PAINTING WITH SYNTHETIC ENAMEL/SEMI GLOSSY PAINT ON NEW WORK :

1. Paint : Synthetic enamel/semi glossy paint of approved brand and manufacture and required shade shall be used for the top coat and an under coat of shade to match the top coat as recommended by the manufacturer shall be used. The paint shall be conforming to IS : 1932-1 964.

2. Preparation of Surface : This shall be as per painting with superior quality ready mixed paint as mentioned here- in- before.

3. Application : The number of coats including the under coat shall be as stipulated in the item.

3.1. Under Coat : One coat of the specified paint of shade suited to the shade of the top coat shall be applied and allowed to dry over night. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface free from brush marks and all loose particles shall be dusted off. All the cracks, crevices, roughness etc. will be filled with approved putty as per manufacturers recommendations.

3.2. Top Coat : Finishing coats of specified paint of the desired colour & shade shall be applied after the under coat is thoroughly dried. Additional finishing coats shall be applied if found necessary to ensure a proper and uniform semi glossy surface.

4. Other Details : The specifications for "Painting (General)" mentioned here-in-before shall hold good as far as they are applicable.

46.13. (D) PAINTING WITH ACRYLIC EMULSION/PLASTIC EMULSION PAINT.

1. This shall be polyvinyl based Acrylic/plastic emulsion paint of approved manufacture of the required shade, conforming to I.S.5411-1969.

2. Primer: The primer to be used for the painting with acrylic emulsion on cement concrete surfaces, plastered surfaces, A.C. sheets, timber and metal surfaces, if necessary, shall be of approved base and as per recommendations of the manufacturers.

3. Putty : Plaster filler to be used for filling up (putting) uneven surfaces, small cracks and holes etc. shall be of approved compound and as per recommendations of the manufacturers. No oil based putty shall be used. The putty should be made from a mixture of whiting and plastic emulsion paint or as per manufacturers recommendations.

4. Finishing coats : All the finishing coats shall be of matt finish or any other finish as required by the Engineerin-charge. The number of finishing coats shall be as specified in the item.

MODE OF MEASUREMENT :

All the measurements for payment shall be taken on net surface area actually painted, unless otherwise specified. Deduction will be made from the areas for fixtures, grills, ventilation, outlets, electrical boxes and such obstructions not painted, if they are individually more than 0.05 sqm.

JOB REQUIREMENTS :

i) Acrylic emulsion paint is required to be provided on plastered and concrete surfaces in portions of the building. The E.I.C shall reserve the option to delete or increase quantities in full or part from the scope of contract during progress of work.

ii) All wood surfaces are to be painted with semi glossy synthetic enamel paint with an approved primer.

iii) All shades and colours of paints shall be subjected to review and prior approval of Engineer-in-Charge shall be taken before the application.

46.14. WHITE WASHING WITH LIME

46.14.1. Preparation of Surface : Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings and foreign-matter.

In the case of old work, all loose pieces and scales shall be scrapped off and holes in plaster as well as patches of less than 0.05 sqm.area each shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer-in-charge, the entire surface of old white wash shall be thoroughly removed by scrapping and this shall be paid for separately.

46.14.2. Preparation of lime wash : The wash shall be prepared from fresh stone white lime "Katani" or equivalent. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm. of gum dissolved in hot water, shall be added to each 10 cubic decimetre of the cream. The approximate quantity of water to be added in making the cream will be 5 litres of water to one kg. of lime.

Indigo (Neel) up to 3 gm. per kg. of lime dissolved in water, shall then be added and wash stirred well. Water shall then be added at the rate of about 5 ltrs. per kg. of lime to produce a milky solution.

The lime shall be tested in a chemical laboratory and test certificate submitted, to conform the quality of lime with regard to its physical and chemical properties. The cost of testing lime shall be borne by the contractor.

46.14.3. White Washing ``: The white wash shall be applied with brushes or by spray in the specified number of coats. The operation for each coat in the case of brush application shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer-in-charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

For new work, three or more coats shall be applied till the surface present a smooth and uniform finish through which the plaster does not show. The finished dry surface shall not show any sign of cracking and peeling nor shall it come off readily on the hand when rubbed.

For old work, after the surface has been prepared as described here-in-before, a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or

more coats of white wash as stipulated in the description of the item shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patched do not appear. The washing on ceiling should be done prior to that on walls.

46.14.4. Protective Measures : Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed shall be protected from being splashed upon. Splashings and droppings, if any, shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to painted surfaces, furnitures or fittings and fixtures etc. shall be recoverable from the contractor.

46.14.5. Measurements : All measurements for payment shall be taken on net surface areas actually white washed, unless otherwise specified. Deductions will be made from the areas for fixtures, grills, ventilation, outlets, electrical boxes and such obstruction not painted if they are individually more than 0.05 sqm. Length and breadth shall be taken correct upto two places of decimal of a metre and areas so worked out shall be correct upto two places of decimals of a square metre.

Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

Corrugated asbestos cement sheets	20%
Semi-corrugated asbestos cement sheets:	10%

The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.05 sqm. each with materials similar in composition to the surface to be prepared.

46.14.6. Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

46.15. COLOUR WASHING:

In the case of colour washing, mineral colours, not affected by lime, shall be added to white wash with proper glue. No colour wash shall be done until a sample of the colour wash to the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface. If it is patchy or otherwise badly applied, it shall be redone by the contractor, at no extra cost.

For new work, the priming coat shall be of white wash lime or with whiting as specified in the description of the item. Two or three coats, shall then be applied as specified on the entire surface till it represents a smooth and uniform finish. Each coat after applying shall be got approved from the Engineer-in-Charge.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

Other specifications as detailed for Whitewashing with lime shall be applicable. Indigo (Neel) shall however, not be added.

46.16. DRY DISTEMPERING :

(a) **Distemper :** Dry distemper (IS:427-1965) of approved brand and manufacture, colour and required shade shall be used. The dry distemper shall be stirred slowly in clean water using 0.6 litre of water per kg. of distemper or as specified by the manufacturers. Warm water shall preferably be used. It shall be allowed to stand for atleast 30 minutes before use. The mixture shall be invariably well stirred before and during use to maintain an even consistency.

(b) **Preparation of surface :** This shall be as for Painting work mentioned here-in-before in so far as it is applicable.

(c) **Application :** In case of new work, the treatment shall consist of a priming coat followed by the application of two or more coats of distemper till the surface shows an even colour.

i) Priming coat : Priming coat of whiting shall be applied over the prepared surface. The whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. Two kg. of gum and 0.4 kg. of copper sulphate dissolved separately in hot water shall be added for every cum. of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use. No white washing coat shall be used as a priming coat for distempering.

ii) The application of each coat as mentioned in the specifications for painting (General) here-in-before, shall hold good, as far as it is applicable.

46.17. OIL EMULSION (OIL BOUND) DISTEMPERING :

(a) Oil bound distemper (IS:428-1969) of approved brand and manufacture, colour and required shade shall be used. The primer where used as on new work shall be cement primer or distemper primer as specified in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by manufacturer. Only sufficient quantity of distemper required for days work shall be prepared.

(b) Preparation of surfaces : The surface shall be prepared as described here- in- before for Painting work in so far as it is applicable and approved putty/filler shall be applied to the entire area to get uniform and smooth surface before application of primer.

Application: The cement primer or distemper primer shall be applied by brushing and not by spraying. Hurried priming work shall be avoided, particularly on absorbent surfaces. New plaster patches in old work before applying oil bound distemper shall be treated with cement primer/distemper primer. The surface shall be finished as uniformly as possible leaving no brush marks. priming coat shall be allowed to dry for at least 48 hours before oil bound distemper is applied. Before applying distemper,the surface shall be lightly sand prepared to make it smooth for receiving the oil bound distemper, taking care not to rub out the priming coat. A time interval of at least 24 hours shall be allowed between consecutive coats to permit the proper drying of the preceding coat. Two or more coats of distemper as are found necessary shall be applied over the priming coat to obtain an even shade.

(c) Other details : The specifications for “Painting (General)” mentioned here-in-before shall hold good as far as it is applicable.

46.18. WATER PROOFING CEMENT BASED PAINT :

a) **Material:** Cement based paint (IS:541 0-1 969) of approved manufacture, quality, shade and colour only shall be used.

b) **Preparation of surfaces :** The surface shall be thoroughly cleaned off all mortar dropping, dirt, dust, algae, grease and other foreign matter by brushing and washing the surfaces. The surface shall be thoroughly wetted with clean water before the water proof cement paint is applied. The prepared surface shall be got approved before painting is commenced.

The water proof cement paint shall be mixed in such quantities as can be used up with in an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish.

Water proof cement paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of water proof cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the water proof cement paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain liquid of workable and uniform consistency. In all cases the manufacturers instruction shall be followed meticulously.

c) **Application:** The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. To avoid direct heat of the sun during painting, the cement based paint shall be applied on the surface which is on the shady side. Cement based paint shall not be applied on the surfaces already treated with white wash, colour wash, dry or oil bound distemper, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

d) **Other details :** The specifications for Painting (General) mentioned here-in-before shall hold good as far as they are applicable.

e) **Mode of measurement for dry distemper, oil bound distemper and water proof cement paint :** All measurement for payment shall be taken on net surface area actually painted unless otherwise specified and no co-efficient shall be applied for working out areas. Deductions will be made from areas for opening/obstructions not painted, if they are individually more than 0.05 sqm. Length and breadth shall be taken correct upto two places of decimal of a meter and areas shall be worked out correct upto two places of decimal of a square meter.

Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentage to allow the girthed area: a) Corrugated asbestos cement sheets - 20%; b) Semi corrugated asbestos cement sheets - 10%.

The number of coats of each treatement shall be stated in the schedule of quantities. The whole surface shall be applied with approved putty/filler to get uniform and smooth surface at no extra cost.

Rates : The rate shall include cost of all materials and labour involved in all the operation described above.

46.19. BEES WAXING OR POLISHING WITH READY MADE WAX POLISH:(NEW WORK) :

46.19.1. Materials : The polishing shall be done with bees waxing prepared locally or

with ready made wax polish of approved brand and manufacture, as stipulated in the description of item.

a) Where bees waxing is to be prepared locally, the following specifications for the same shall apply:

Pure bees wax free from paraffin or stearing adulterants shall be used. Its specific gravity shall be 0.965 to 0.969 and melting point shall be 63o C. The polish shall be prepared from a mixture of bees wax, linseed oil, turpentine and varnish in the ratio of 2: 1 .5: 1: 0.5 by weight.

The bees wax and boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved, the mixture shall be cooled till it is just warm and turpentine and varnish added to it in the required proportions and the entire mixture shall be well stirred.

46.19.2. Preparation of surface : Preparation of surface will be as mentioned here-in-under para 47.20.2 with the exception that knotting, holes and cracks shall be stopped with a mixture of fine saw dust formed of the wood being treated, beaten up with sufficient bees wax to enhance cohesion.

46.19.3. Application : The polish shall be applied evenly with a clean soft pad of cotton cloth in such a way that the surface is completely and fully covered. The surface is then rubbed continuously for half an hour.

When the surface is quite dry, a second coat shall be applied in the same manner and rubbed continuously for one hour or until the surface is dry.

The final coat shall then be applied and rubbed for two hours (more if necessary) until the surface has assumed a uniform gloss and is dry showing no sign of stickiness.

The final polish depends largely on the amount of rubbing which should be continuous and with uniform pressure, with frequent changes in the direction.

46.19.4. Other details : The specifications for painting (General) as mentioned here-in-before shall hold good as for as they are applicable.

46.20. FRENCH SPIRIT POLISHING: (ON NEW WORK WITH A COAT OF WOOD FILLER) :

46.20.1. Polish : Pure shellac varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm. of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade.

46.20.2. Preparation of surface : The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted off. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glaziers putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1 .5 kg. of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

46.20.3. Application : The number of coats of polish to be applied shall be as described in the item.

A pad of woolen cloth covered by fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

46.20.4. Measurement, Rate and other Details : These shall be as for Painting (General) mentioned here-inbefore as far as they are applicable.

NOTE: Consumption of paint for some painting items is given in Appendix – "C-1".

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46.21. RESIN BASED THERMO PLASTIC PAINT (DECORATIVE AND PROTECTIVE FINISH) :

46.21.1. Materials : Resin based thermo plastic paint such as Sandtex Matt or other equivalent approved manufacture, colour and shade shall only be used.

46.21.2. Preparation of Surface & General : The Specifications for Painting (General)described here-in-before shall hold good as for as they are applicable.

46.21.3. Protective Coatings : On surfaces such as ferrous metals, brass, copper and phospher bronze, a protective coating of suitable bituminous compound or chromated

red oxide should be given. New wood should be treated with a leafing grade aluminium primer or a water based acrylic emulsion primer.

The surfaces with algae growth shall be thoroughly cleaned down to remove as much growth as possible and effective solution of stabilized house hold bleach (calcium hypochloride) of approved quality with approximate 35% chlorine content @ 2 kgs. per 50 ltrs. (or as per manufacturers recommendations) should be used to treat the surfaces.

On chalky or friable surfaces after removing the loose materials by stiff brushing or scraping the surface should be treated with one coat of advanced solvent based material such as snowsol stabilizing solution or other approved equivalent with white spirit.

46.21.4. Application: The ready mix Sandtex Matt or other equivalent approved resin based thermo plastic paint shall be applied on clean and wetted surfaces by means of brushes or roller. The solution shall be kept well stirred during the period of application. To avoid direct heat of the sun, the paint shall be applied on the side in shade.

On rough and textured surfaces, one under coat of cement based paint such as Snowcem or other equivalent shall be applied before application of undiluted Sandtex Matt finish coat. In case of application of two coats of Sandtex Matt at normal temperatures, the first one shall be diluted by addition of 25% water and the second coat direct. In extremely hot environs, the second coat shall be diluted @ 2.5 ltrs. of water to 20 ltrs. of paint or as directed.

Painting with resin based thermo plastic paint shall be carried out generally as per manufacturers specifications.

46.21.5. Other Details : The specification for Painting (general) mentioned here-in-before shall hold good as far as they are applicable.

Snowsol stabilized solution shall not be applied over bitumen. Snowsol stabilized solution treated surfaces shall not be left unpainted for more than 2 (two) days. Gypsum based materials shall not be used for filling of exterior cracks while preparation of surfaces.

46.21.6. Mode of Measurement : The painting unless otherwise mentioned shall be measured by area in sqm. upto two places of decimal. Length and breadth shall be measured correct upto two places of decimal of a meter. Deduction will be made from the areas of fixtures, grills, ventilation, outlets individually more than 0.05 sqm.

The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 0.1 sqm. each with materials similar in composition to the surface to be prepared.

46.21.7. Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

47. VINERATEX OR VITROBRITE DECORATIVE TEXTURE COAT :

47.1. GENERAL :

Vineratex or vitrobrite decorative treatment/coating consisting of coating the plaster finished surfaces with decorative texured coat of ready mixed mixture of approved aggregate with bonding compound/synthetic adhesive manufactured by M/s. Vinera Industries & Co. or other approved manufacturer. The vineratex or vitrobrite treatment coating shall be got done through approved agency as per manufacturers recommendations.

The vineratex or vitrobrite treatment shall be applied/coated directly over the sub-base of reasonably smooth/levelled and clean surface like plastered brick work (plaster not being raked or scratched) in-situ concrete, precast concrete units, light weight blocks, asbestos cement sheet etc. as specified.

47.2. MATERIAL :

The various aggregate and special bonding media/synthetic resin shall be strictly as per manufacturers recommendations. Only such aggregates shall be used, which are weather and corrosion resistant viz. glass, ceramic marble, chips, granite, quartz and flint, hametites, pyrites or one in natural vitrified, coloined or other processed forms as specified. The aggregate shall vary in sizes from 0.5 mm. to 2.5 mm. and shall be applied in shades as specified. The finish shall have a film thickness of 3 mm. average.

47.3. SURFACE PREPARATION :

Before commencing, the surfaces should be cleaned thoroughly to remove any grease, dirt, dust or loose particle and should be free from surface water. Extremely porous surfaces should be pre-sealed with a thin coat of suitable primer. Previous painted surfaces if any, should be prepared by thoroughly scrapping off all loose flaking paint film, washing down with a suitable detergent and rinsing thoroughly with clean water and allowed to dry.

47.4. APPLICATION :

Vineratex or vitrobrite shall be brought to site in sealed containers. Addition of thinner at site will not be permitted. The material in the containers shall be mixed thoroughly before use, to off-set the settlement occurred due to heavy vibration while transporting and during storage.

A small amount of Vineratex or vitrobrite mixture shall be placed on a spot board. The spot board shall be held against the surface on which the treatment/coating is to be applied. The mixture shall be applied to the surface evenly with the help of laying on trowel to uniform thickness of about 3 mm. on an area of about 0.18 sqm. Scrap off the excess material with the help of the steel float to obtain an even film thickness of 3 mm. This shall be achieved by using the steel float held slightly on the trailing edge, putting an even pressure and scrapping off the excess material/mixture, left on the spot board shall be immediately put back into drum and shall be mixed well before reuse.

Level of the vineratex or vitrobrite film to a smooth and even finish using the flat edge of steel float. It is important that only small areas of about 0.18 sqm. shall be treated at a time. Wherever possible, whole work should be completed without stop in one operation by engaging sufficient number of workers, so that flowing edge may be maintained without forming any joint. If this is unavoidable, a suitable natural break in the application should be chosen and the joint shall be made using a straight edge, which can be continued when application is resumed the following day. Over lap or over troweling at joints shall be avoided. This treatment shall always be carried out in shade, away from full effect of hot sun.

At all times the completed work of vineratex or vitrobrite shall be protected against rain fall until complete hardness has been obtained which takes about 24 hours.

Once the treatment/coating is completed and set hard, no other treatment like polishing, cleaning, washing with acid etc. shall be resorted to in this area. The treatment/coating shall be taken up in hand when all other construction works viz. plastering, electrical wiring, plumbing, painting etc. have been completed.

After the whole work is completed, the vineratex/vitrobrite shall be given a coat of anti-fungus gel to avoid fungus growth on surfaces. The contractor shall be responsible to protect the finished surface from any damages for whatever reason whatsoever.

47.5. MODE OF MEASUREMENT :

Mode of measurement shall be similar to sand faced/roughcast plaster items.

* * *

47.6. TUBULAR TRUSSES, PURLINS ETC.:
Structural Steel Tubes : These shall be of :

i) hot finished welded (HFW) type, or

ii) hot finished seamless (HFS) type, or

iii) electric resistance or induction butt welded (ERW), having carbon content less than 0.03%, yield stress of 21.5 kg./mm. (YST 22) type, conforming to the requirement of I.S. 1161-63. The steel tubes when analysed in accordance with the method specified in I.S. 226-1959.

Tubes shall be designated by their nominal bore. These shall be light, medium or heavy as specified, depending on the wall thickness.

Tubes shall be cleanly finished and reasonably free from scale. They shall be free from cracks, surface flaws, laminations and other defects. The ends shall be cut cleanly and square with the axis of tube, unless otherwise specified.

47.7. MINIMUM THICKNESS OF METALS : The tubular steel work shall be painted with one coat of approved epoxy steel primer after fabrication. Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm. and for construction not exposed to weather, it shall be not less than 3.2 mm., where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

47.8. FABRICATION :

47.8.1. The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are maintained.

47.8.2. Straightening : All material before being assembled shall be straightened, if necessary, unless required to be of a curvilinear form and shall be free from twist.

47.8.3. Bolting : Washers shall be specially shaped where necessary, or other means used, to give the nuts and the heads of bolts a satisfactory bearing.

In all cases where the full bearing area of the bolt is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together, and washers of appropriate thickness shall be provided to allow the nut to be completely tightened.

47.8.4. Welding : Where welding is adopted, it shall be done as per relevant I.S. 820.

47.8.5. Caps and Bases for Columns : The ends of all the tubes for columns, transmitting loads through the ends, should be true and square to the axis of the tube and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

47.8.6. Sealing of Tubes : When the end of a tube is not automatically sealed by virtue of its connection by welding to another member, **the end shall be properly and completely sealed**. Before sealing, the inside of the tube should be dry and free from loose scale.

47.8.7. Flattened Ends : In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded, rivetted or bolted connections, provided that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

47.9. HOISTING AND ERECTION :

Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workmen. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-charge. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. The contractor shall have to grout the bolts in column tops to receive the truss wall plates, hoist the trusses in position, erect it in a perfect line, level and plumb, fix it in position with nuts, bolts etc., cure the grouted portion and paint the truss with two coats of epoxy paint as per drawing of approved colour and shade over a coat of approved steel epoxy primer. Proper equipment such as derricks, lifting tackles, winches, scaffolding, propping, ropes etc. shall be used.

47.10. MODE OF MEASUREMENT : The work as fixed in place shall be measured in running metres correct to a centimetre and their weights calculated on the basis of standard tables correct to the nearest kilogram, unless otherwise specified.

Weight of cleats, brackets, packing pieces, bolts , nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

47.11. RATE : The rate shall include the cost of labour and materials involved in all the operations described above including one coat of approved steel primer and painting

as specified in the item.

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48. FALSE CEILING WITH FLEXO BOARDS / NON A.C. SHEETS :

48.1. SCOPE OF WORK :

The work envisaged under these specifications refer to supplying and fixing in position false ceiling at any floor, any location and at any height.

48.2. MATERIAL :

The plain/ Designer Non A.C. Fibre reinforced sheet or flexo board Conforming to IS 14862 -2000 shall be of the thickness as mentioned in the relevant items of the schedule of quantities and the size of panels and the arrangement of panels etc. for different area of the building shall be as indicated by the Engineer-in-Charge. Plain/ Designer Non A.C. Fibre reinforced sheet or flexo board shall be of approved quality and shall be free from cracks, bends and other defects. Samples of materials to be used on the work shall first be furnished by the contractor and got approved by the Engineer-in-Charge. All materials which are used on the works shall strictly conform to the samples, other-wise the materials shall be summarily rejected.

The plain Non A.C. sheet or flexo board shall be fixed to the angle iron frames (frame work paid separately) work by means of suitable counter sunk brass self tapping screws not more than 200 mm. centre to centre or as directed, and all holes after fixing the screws be filled with approved filler. Necessary openings in the ceiling shall be left for trap doors, ducts etc.

48.3. ERECTION :

The flexo boards/ Non A.C. sheets when brought to site shall be stacked carefully on floor over wooden sleeper supports. The boards shall be cut to required sizes either by sawing or by score and snap method. The edges shall be smoothened by wood rasp file or with emery paper. Wherever required the edges of each panel may require bevelling which also shall be done carefully to the correct line and dimensions.

The flexo boards/ Non A.C. sheets shall be fixed to ridge frames either wooden or metallic or mentioned in the item description. In case of metallic frame, the flexo boards are held

to the frame by means of self tapping screws or by the ordinary machine screws and nuts, as directed by the Engineer-in-Charge.

Teak wood or aluminium beadings if required to be fixed shall be as mentioned in the item description and shall be carried out in best workman-like manner.

Any other treatment for finishing such as gluing of wall papers, cement or oil based paint etc. shall be as specified in the item description and shall be done as per relevant specifications.

48.4. MODE OF MEASUREMENT :

Unless otherwise mentioned, the wooden or metallic-frame work shall be separately measured and paid for. The flexo board/ Non A.C. sheet false ceiling shall be measured in square metre as actually laid over the frame work. The area being worked out correct to two places of decimal with length and breadth measured correct to a centimeter. The rates shall include the cost of all materials, labour, scaffolding etc. as mentioned above and in item description, unless otherwise specified.

49. NON A.C.SHEET FALSE CEILING AND MASKING ETC. WITH PRESSED STEEL FRAME WORK/ANODIZED ALUMINIUM FRAME WORK :

49.1 GENERAL:

The work covered by these specifications shall consist of furnishing all labour, materials and equipment necessary for installation of the suspended false ceiling and vertical masking, with Non A.C. sheet on pressed steel frame work, inter locking, Aluminium frame work suspended by adjustable M.S. suspenders with necessary cut outs in the Non A.C. sheet for lighting fixtures, trap doors, A.C. grills etc., providing m.s. lighting troughs etc., erecting to proper line and level in the specified areas, floors and levels as indicated in the drawing and as directed by the Engineer-in-Charge.

49.2 MATERIALS :

All materials which are to be in-cooperated in work shall be got approval prior to bulk procurement.

49.2.1 Fabrication of Pressed Steel Frame : The frame work for “snap grid” false ceiling shall be made out of tested special springs grade steel or approved cold rolled sheets of specified gauge as per schedule, accurately formed and die cuts with identical ends in automatic machine with precision tools. All workmanship shall be best quality as followed in a modern sheet metal shops equipped with all machines such as press, dies, spot

welding machine, baking oven etc. All materials shall be done by a process approved by the Engineer-in-Charge and in a manner that will not damage the materials. All work shall be accurately formed to the required dimensions, true to line, level and plane in all directions and properly sized to suit the exact dimension within permissible tolerances. Twisted or bent sections shall not be permitted to be used on work. Main runners and cross tees shall be of sizes as specified in the schedule/shown in the drawing. The main runners shall be slotted for cross tees and punched for hangers/suspenders. Cross tees shall have identified die formed ends accurately cut for easy, correct and proper fit assembly. Shearing, cropping shall be clean, reasonably square and free from distortion. Surfaces and joints to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign materials. The surface shall be wire brushed vigorously. Welding sequence shall be followed to avoid needless distortion and minimise shrinkage stresses. Holes to be made in pressed M.S. sheet shall not be made by flame cutting. The flame cut or unfair holes are not acceptable connection of supported members with erection clearance for all members. Where for practical reasons greater clearance is necessary, suitable designed seating should be provided. Any damages done to the walls/ceiling shall be reinstated to original condition. The contractor shall not be entitled for any extra cost on this account.

49.2.2 Suspended Aluminium Grid system : Aluminium grid system shall be of BESTLOK/EEZILOCK or equivalent approved standard suspended aluminium grid system. The suspended ceiling grid shall be of self interlocking anodised aluminium T bars for main runners and cross runners of specified section and pattern as required to suit the span as per drawing.

49.2.3 Non **A.C. Sheets :** Non A.C. sheet shall be plain and of specified thickness, approved best quality and shall conform in all respect to the relevant Indian Standard Specifications.

The sheets shall be free from cracks, chipped edges or corners, twist dents, rough patches and other damages etc.

49.2.4 M.S. Works : All MS works shall conform to relevant specification mentioned under Structural Steel here-in-before.

49.2.5 Fastening : All bolts, nuts, screws, fittings & fixtures shall be of best quality and of approved manufacture.

49.2.6 FIXING :

The contractor shall take all necessary field measurements before the commencement of the frame work to ensure proper fittings of the work to actual condition of work at site.

Particular care should be taken to examine the positions of all recessed lighting, trap doors and other openings indicated on drawings or as directed by the Engineer-in-Charge. The correct panel sizes shall be decided to suit each location. The false ceiling levels shall then be marked on walls. Mark the position of the runners to suit the span of the area. Fix up the wall angles with approved metal fasteners and level then correctly. The position of suspender shall then be marked on the R.C. slab as per the sizes of the panels decided for each area with due consideration to location of air-conditioning ducts, grills etc. Suspenders of type and design fabricated as per drawing and approved by the Engineer-in-Charge, shall then be securely fixed at correct points with approved metal fasteners/expansion bolts of specified dia., as per manufacturers specifications. It shall be ensured that the hanger/suspender shall remain perpendicular and not pulled by the suspension system to any side. Fix up the runner to the suspenders and lock up the runners at the joints, complete the levelling starting from the fixed points and proceed towards the other end. Fix up the the cross tees to every runner joints to have stability while levelling. Neoprene rubber gasket shall then be fixed all along the frame work with approved type of adhesive. Approved Non A.C. sheets cut to correct sizes shall then be placed on the runner, starting from the centre of the width and work side wards. Connect all cross tees and put on the approved spring type hold down clip/pins as per drawing. Holes if required to be provided in Non A.C. sheets shall be drilled and on no account holes shall be punched. Lock the runner tees and tiles with hold down clips/pins as required. Wherever grouting for frame work, suspenders etc. is required to be done in masonry walls columns/beams etc., the same shall be done after the entire frame work is properly levelled.

The contractor shall take into consideration all wastage in the Non A.C. sheets, aluminium grid system frame work/pressed steel frame work, M.S. suspenders, screws, nuts, bolts, washers etc. required for fixing Non A.C. sheet false ceiling and vertical masking while quoting his rates. Non A.C. sheet false ceiling and vertical masking shall be fixed to pressed steel frame or Aluminium grid system by means of spring clip (brass counter sunk machine screws in case of masking) of approved size, make and at approved spacing or as shown in drawing or as instructed. After fixing the Non A.C. sheets, all holes of screws etc. shall be filled with approved putty, levelled with the Non A.C. sheets and sand papered, so that no sign of screw is visible on the Non A.C. sheets. For all the Non A.C. sheets false ceiling and vertical masking work, the Non A.C. sheet of required size and shape shall be cut as per approved panel size shown in drawing and fixed on pressed steel frame in the best workman like manner.

Trap doors/lighting recesses/troughs of approved size and shape with approved matching work, shall be provided in the false ceiling and vertical masking at the specified places.

Any damage done to the walls/columns/ceilings/plasters/floors etc. shall be made good to the original condition at his own cost. The contractor shall not be entitled for any extra cost on this account. During the execution of this work, the contractor shall take all the precautions to prevent damage to the painted surface, plaster, floor tiles, doors etc. Contractor should specifically note that the area where the false ceiling is required to be provided will be in advance stage of completion with various finishing items such as painting, floor polishing etc. Any damage to these finishes will have to be made good by him at no extra cost .

49.2.7 SAFETY PRECAUTIONS :

No person other than workman employed by the false ceiling contractor shall be permitted access to any area over which the sheeting is being laid. The contractor should take protective measures during the progress of work. Cat ladders or roof boards, scaffolding etc. should invariably be used by men working on the roof/false ceiling/masking etc.

49.2.8 WORK TO INCLUDE :

Cost of all approved Non A.C. sheets with anodized aluminium/pressed steel frame work, adjustable m.s. suspenders m.s. cleats, nuts, bolts, washers, screws, all labour, materials, tools, plants, approval scaffoldings, providing m.s. cleats and fixing them with metal fasteners/expansion bolts, nuts, washers, screws etc. to the concrete/wall surfaces and then fixing the adjustable suspenders in m.s. clamps, painting two coats of synthetic enamel paint on m.s. work as directed/as shown in drawing.

49.2.9 MODE OF MEASUREMENT :

Non A.C. Sheet false ceiling with snap grid pressed steel/anodized aluminium internal grid system frame work completed and accepted as per above specifications shall be measured in square metre upto two places of decimals. The line measurements shall be taken upto two places of decimal of a metre. The width shall be measured, from wall angle to wall angle and length shall be measured as per actual. Areas of trap doors, lighting troughs, Air conditioning diffusers, Air conditioning grills and other openings shall be deducted and net areas of false ceiling so computed shall be paid for unless other wise specified.

Areas of false ceiling with additional horizontal M.S. angle supports as per relevant drawing shall be measured separately between such additional supports. Mode of measurement for this item shall also be in square metre as described above.

49.3 LIGHTING TROUGHS / FIXTURES :

Lighting troughs/fixtures shall be fabricated out of anodized aluminium sheet or out of m.s. sheet of specified gauge and shall be free from scale, blisters, laminations, cracked edges, defects of any sort and shall conform to relevant I.S. specifications.

Lighting troughs shall be fabricated in a modern, well equipped workshop, as per the size and profile given in the drawing. The M.S. lighting trough shall be stove enamelled in the shop with approved type of colour & shade on both the surfaces. Aluminium troughs shall be anodized as per standard practice. Sample of lighting trough fabricated as per drawing shall be got approved by the Engineer-in-Charge before manufacturing on large scale. Aluminium/M.S. frame work sections and sizes, as per drawing, shall be fabricated and got approved before fixing in position.

The m.s. lighting troughs along with m.s. frame or aluminium lighting troughs with aluminium frame shall be fixed in position to correct line and level with m.s. suspenders as per drawings. One or more sample lighting troughs shall be fixed in position and got approved before fixing all the lighting troughs. The end of the lighting troughs on both sides shall be provided with m.s. covers of the same gauge as per drawings.

The materials and fabrication of lighting trough, m.s. aluminium frame and suspenders shall conform to the relevant specification given in this tender. The m.s. work shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer as per specification under relevant head.

49.3.1 MODE OF MEASUREMENT :

The lighting troughs along with m.s. or aluminium frame work, suspenders, end covers etc. duly fixed in position shall be measured along the length of the trough in running metres upto two places of decimal of a metre and paid for unless otherwise specified in schedule of work.

49.4 TRAP DOORS :

The materials viz. M.S. frame, aluminium frame and Non A.C. sheet and fabrications shall conform to the relevant specification given in this tender.

The trap doors shall be fixed in position with necessary M.S. angle frame out of M.S. angle of size 40 x 40 x 6mm. for the shutter and fixed to M.S. wall angle of size 40 x 25 x 6 mm. which is to be fixed by means of 40 x 25 x 6 mm. M.S. angle cleats, fixed to wall by means of M.S. hold fasts out of M.S. flats of size 40 x 6mm., 150 mm. long and grouted with cement concrete 1:2:4 in case of brick wall and with 100 mm. long M.S. coach screws and rawl plugs in case R.C. columns etc. M.S. angle of size 40 x 25 x 5 mm. shall be provided for receiving the lever of the locking arrangement. This angle shall be supported by 40 x

6 mm. M.S. flat suspenders from ceiling fixed with 3/8" diameter metal fasteners/expansion bolts. This angle, meant to receive the lever of the lock, shall be supported by two numbers of M.S. angle of size 40 x 25 x 5 mm. on either side. The two angles also shall be provided with M.S. flat (40 x 6 mm.) suspenders @ 800 mm. centers at all other convenient spacing as per drawing and as approved by the Engineer-in-Charge.

Sample of trap doors of single, double and multi panels shall be fabricated and fixed in position and got approved before taking up fabrication of trap doors on large scale.

All the exposed surfaces of M.S. work including the suspenders shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

49.4.1 MODE OF MEASUREMENT :

The area of trap door visible from underside of the false ceiling only shall be measured in square metres for payment. The m.s. angles to be provided for locking arrangements and supporting M.S. angles which shall not be seen from underneath shall not be measured for payment and are supposed to be included in the rate quoted for trap door, unless otherwise specified in the schedule of work.

50.0 FIBRE GLASS THERMAL INSULATION WORK AT CEILING WITH T.W. BATTENS FRAME WORK AND COVERING WITH NON A.C. SHEET :

50.1 SCOPE OF WORK :

The work envisaged under these specification covers providing and fixing fibre glass thermal insulation to ceiling at any floor, location and height as specified including T.W. battens frame work in required grid and insulation work covered with Non A.C. sheet/flexo board of specified thickness.

50.2 MATERIALS :

i) **T.W. battens for frame :** Battens required for frame work shall be as specified under chapter “Wood work in frames, shutters and panelling”.
ii) **Thermal insulation media :** The thermal insulation media shall be of fibre glass Crown 150 or equivalent approved make with K value of 0.0285 K. Cal / sqm. hr. 0C, 50 mm. thick and density of 24 kg/cum. or as specified in the description of item/ in drawing. Sample of fibre glass to be used on the work shall first be furnished by the contractor and got approved from Engineer-in-Charge before mass procurement.

iii) **NON A.C./Flexo board sheet covering :** The plain Non A.C. sheet or flexo board shall be as specified here-inbefore.

iv) **Fire resisting paint :** The fire resisting paint shall be of M/s. Garware Paints Ltd. or any other approved equivalent make and shall conform to I.S. 163. Sample of fire resisting paint to be used on work shall first be got approved from Engineer-in-Charge before bulk procurement. Ready mixed paint as received from the manufacturer without any admixture shall be used.

50-3 ERECTION / FIXING OF INSULATION :

i) **Frame work :** The workmanship shall be of best quality. All wrought timber is to be sawn, drilled or otherwise machine worked to the correct sizes and shall be as indicated in drawing or as specified. All joinery work shall fit truly and without wedging or filling. All necessary mortising, tennoning, grooving, matching, tonguing, housing rebate and other necessary work for correct jointing shall be carried out in the best workmanship like manner. The frame work shall be made in required grid as specified in schedule item and in drawing. The frame work shall be rigidly screwed to the ceiling with 100 mm. long G.I. wood screws and rawl plugs @ 300 mm. centre to centre (or as specified) both ways by drilling holes in ceiling through frame work. The wood work shall be painted all over with fire resisting paint of M/s. Garware Paints Ltd. or any other approved equivalent make before erection of the same in position as per manufacturers specifications and as directed by Engineer-in-Charge.

If after fixing the frame work in position, any shrinking or substandard material or bad workmanship is detected, the contractor shall forth with remove them and replace the same at his own cost.

ii) **Sticking of insulation material & fixing of** Non **A.C./flexo board :** After fixing of the frame work as above, a thick coat of bitumen of approved grade shall be applied as vapour barrier in the grids of frame work and then fibre glass of required thickness shall be sticked to ceiling and panel of grids as directed by the Engineer-in-Charge. The panels of fibre glass shall be cut exact to grid size and evenly pressed.

Approved Non A.C./flexo board sheets cut to correct sizes as specified in item description shall then be placed on the frame works starting from the centre of the width and work side-wards. Holes required in Non A.C. sheet/flexo board shall be drilled and on no account holes shall be punched. Non A.C. sheet shall be fixed to wooden frame work with suitable size of C.P. brass screws @ 300 mm. c/c. 4 mm. wide groove or as shown in the drawing shall be kept to correct line, level and plane at the junctions of sheets.

Any damage done to the finishes and to walls, columns, ceilings, plasters, floors etc. shall be made good to the original condition by the contractor at his own cost. The contractor should take protective measures during the progress of work. Cat ladders or roof boards scaffolding should invariably be used by men working on the thermal insulation work.

50-4 MODE OF MEASUREMENT :

This work shall be measured on square metre basis. The length and width shall be measured between plastered surfaces of walls upto two places of decimal of a metre for working out the area.

50.5 RATES :

Rates quoted by the contractor for the work shall include cost of all materials and labour required to complete the work as per item description, as per above specifications and as shown in the drawing.

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51. WATER PROOFING :

GENERAL : The guarantee of minimum 10 years for waterproofing treatment in prescribed proforma must be given by the specialised agency which shall be countersigned by the contractor in token of his over all responsibility. The guarantee for waterproofing treatment in the prescribed proforma shall also cover Horizontal expansion joint and Vertical expansion joint. Waterproofing system shall be as per approved manufacturers specification .

On cleaned surface detect pores/gaps if any & Fill all gaps /pores and inject cement slurry mixed with Sunplex of Sunanda make (Shrinkage Compensating, Expanding Grout Admixture with Plasticizer) or MC-Special DM of MC Bauchemie make. Then Apply acrylic based Polymer Modified Cementations Flexible Composite /Crystalline coating system over concrete slab.

51.1. WATER PROOFING PLASTER IN TOILET AREA :

The following specification shall be followed unless otherwise stated in schedule of quantities. This shall be 15 mm. thick plaster including an under coat not exceeding 8 mm. thick. Approved water proofing compound like CICO No. 1 or other approved equivalent shall be added @ 3% by weight of cement in cement mortar or as per manufacturers specifications in both the coats. The workmanship and material shall be same as described in plaster work in general. All exposed surfaces shall be finished smooth with a coat of neat cement as directed, except areas where tiling work is to be done, where the plaster shall be left rough / float finish..

51.2. BRICK BAT COBA WATERPROOFING ON TERRACE :

51.2.1. Materials : The aggregate for brick bat coba shall be broken from good and thoroughly well burnt bricks. These shall be strong, durable, clean and free from impurities. They shall not contain any soft or powdering materials. The aggregate shall be 20 mm. to 10 mm. size and shall be approved by the Engineer-in-Charge before use.

Lime to be used for preparing brick bat coba shall be of lime class B, conforming to I.S. 712-1959. Lime burnt from lime stone shall be used. All impurities, ashes or pieces improperly burnt shall be screened or picked out before slaking. It shall be in the form of lumps when brought to site of work and not in powder form. The lime shall not be slaked with water less than one week or more than two weeks before use.

51.2.2. Storage : The slaked lime if stored, shall be kept in a weather proof and damp proof closed shed with impervious floor and sides to protect it against rain, moisture, weather and extraneous materials mixing with it, and shall be approved by the Engineer-in-Charge.

51.2.3. Proportion : The proportion for brick bat coba shall be 0.906 cum. (about 32cft.) of brick bat to 0.34 cum. (about 12 cft.) of slaked lime.

Laying : The concrete surface shall be thoroughly rubbed, cleaned of all set mortar, all dirt and dust and slightly wetted. On cleaned surface detect pores/gaps if any & Fill all gaps /pores and inject cement slurry mixed with Sunplex of Sunanda make (Shrinkage Compensating, Expanding Grout Admixture with Plasticizer) or MC-Special DM of MC Bauchemie make. Then Apply acrylic based Polymer Modified Cementations Flexible Composite /crystalline coating system over concrete slab.

51.2.4. The brick aggregate shall be soaked in water before mixing with lime. The brick bat coba shall be laid in an even layer and to the required thickness and slope so as to form ridge, hip or valley line as may be necessary and as indicated in the drawing or as directed by the Engineer-in-Charge. The compaction shall be started immediately

with wooden beaters and during the above process, the surface shall be constantly kept wet by sprinkling water observing the following precautions:

a) Brick bat coba shall not be rammed with heavy iron rammers as brick aggregates are likely to be crushed into powder thereby, but shall be beaten lightly and rapidly with wooden beaters to get the required compaction and to obtain complete integration of brick bats and lime.

b) While beating, fresh fracture may take place which may cause absorption of water from the mortar. Additional water may be sprinkled with beating in such cases as considered necessary by the Engineer-in-Charge. The beating work shall continue for at least 7 days.

c) The average thickness of coba shall be as specified in the items and the top of the coba shall be given slope or made level and edges taken into the brick masonry parapet or rounded off at junctions as shown in the drawing and as directed by the Engineer-in-Charge.

51.2.5. MODE OF MEASUREMENT :

The length and breadth of the surface area shall be measured to two places of decimals of a metre from the finished surface of wall and parapet and cubic contents to be worked out with average thickness of coba provided. Rate shall include cost of preparation of surface, cost of materials, labour, rounding of junctions etc. complete.

51.3. CHINA MOSAIC WATER PROOFING :

51.3.1. General : This type of water proofing shall consist of setting in thick cement slurry selected colour/white glazed tile broken pieces of approved make and size over 20mm. thick bedding of cement mortar 1:4 with approved waterproofing agent or as specified in schedule of work, to the required slope and level, over brick bat coba and finishing with neat cement and cleaning to the required degree of fineness and evenness.

The different materials and workmanship shall conform to the relevant I.S. specifications and shall be got approved before incorporating in the work.

The surface of brick bat coba shall be thoroughly cleaned of dust, dirt and loose particles removed and adequately watered. Thick coat of cement slurry of the honey like consistency shall be sprayed on the base before lime mortar screening of specified thickness is laid.

51.3.2. Laying : Over the prepared surface of brick bat coba, a layer of cement

mortar, 20 mm. thick or as specified, shall be laid and cement slurry of consistency of honey, shall be spread over it using cement at a rate of not less than 0.01 cum. per 10 sqm. While the bed is fresh, broken pieces of 6 mm. thick selected white/colour glazed tiles not less than 25 mm. and not more than 50 mm. in any direction shall be set closely by hand at random. The glazed tile pieces shall be soaked in water before setting in position. The glazed surfaces shall be kept exposed and pressed with wooden mallet. Over the glazed tile pieces a neat cement slurry, using cement not less than 0.01 cum. per 10 sqm. shall be spread and the surface brushed in and lightly rolled with wooden roller, taking care that no air pocket is left between brick bat coba and china mosaic flooring.

The top surfaces shall be cleaned with saw dust and cotton waste. Finally the surface shall be cleaned with weak acid solution to remove cement marks over the white glazed tile pieces. The finished work shall be cured for at least 7 days. Care shall be taken to see that cement in joints does not get dissolved due to acid washing. At corners and junctions with parapet, the water proofing course shall be rounded off with cement mortar as per drawing and shall be included in the quoted rate.

51.3.3. MODE OF MEASUREMENT :

The length and breadth shall be measured to two places of decimal of a metre, along side the surface including rounding of junctions of walls and wall & slab etc. and area worked out in square metre. The rain water out-lets shall be finished as directed and no deduction shall be made for the same (area upto 0.02 sqm.) while arriving at the net area for payment.

51.4. TAR FELT WATER PROOFING :

51.4.1. General: All materials and workmanship for waterproofing the R.C.C. roof shall conform to I.S. 1346-1959 & 1322-1965 respectively. The tar felt shall be of type and of grade-I as specified in I.S. 1322-1965.

51.4.2. Preparation of Surfaces : The existing roof surface shall be prepared by cutting cracks if any to V section, cleaned and filled flush with cement sand slurry or a suitable grade of bitumen or both and the surface shall be allowed to set and dry. The surface of the roof and that part of the parapet and gutters drain mouths etc., over which the waterproofing treatment is to be laid shall be cleaned of all foreign matters viz. fungus, moss, dust etc. by wire brushing and dusting.

51.4.3. Laying : The felt shall be laid in lengths at right angles to run off gradient commencing at the lowest level and working upto the crest, thus providing adequate overlap of the adjacent lower felt.

The bituminous primer shall be brushed @ 0.42 ltr./sqm. (1 gallon/100 sft.) over the roof surface thus prepared and allowed to dry. The bitumen bounding material (60/70 grade) shall be prepared by heating to the correct working temperature and conveyed to the point of work in a bucket or pouring cane.

The felt shall be first cut to required length, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. Each length of the felt prepared for laying as described shall be laid in position and rolled up for a distance of half of this length. The hot bonding material shall be poured on to the roof across the full width of the rolled felt @ 1.2 kg/sqm. as the latter is steadily rolled out and pressed down. Light rollers as required on the work shall be used to even up the treatment at the contractors cost. The excess bonding material is squeezed out at the ends and is removed as the laying proceeds.

When the first half of the strip of felt has been bonded to the roof, the other half be rolled up and unrolled on to the top bonding material in the same way. Minimum overlaps of 10 and 7.5 cm. shall be allowed at the end and sides of strips of felt. All overlaps shall be firmly bonded with hot bitumen.

After the specified number of layers of felt have been laid, hot bitumen (60/70 grade) shall be applied over the top surface @ 1.2 kg/sqm. Pea size gravel as mentioned in item description shall be uniformly spread on this hot bitumen layer @ 0.0609 cum. to 0.0761 cum./10 sqm. (2 to 2.5 cft. per 100 sft.) on horizontal surfaces and over the rounded junctions, a coat of cement slurry shall be applied and grit shall be pressed into the slurry coat followed by curing.

For flashing in existing parapet walls, a groove or chase at a minimum height of 15 cm. above the roof level shall be cut in the vertical face of the wall and shall be filled with cement mortar 1:3 after water proofing compound is thoroughly set. This groove shall be of dimension 7.5 cm. wide and 6.5 cm. deep. In case of low parapet where the height does not exceed 45 cm., grooves shall be provided and water proofing treatment shall be carried right over the top.

Felt shall be laid as flashing in widths wherever junction of vertical and horizontal structures occur with minimum over lap of 10 cm. The lower edge of flashing shall overlap the felt laid on flat portion of the roof and the upper edge of the flashing shall be taken along the entire vertical face of the tucked groove made in the parapet and over the top surface so as to provide a continuous water proof layer. Each layer shall be so arranged that the joints are staggered with those of the layer beneath it.

Drain mouths, gutters, drain outlets, projections, pipes etc. shall be given the special treatment conforming to I.S. 1346 - 1959.

51.4.4. Guarantee : The contractor shall furnish guarantee as per appendix D for maintaining the roof leak proof for a minimum period of 10 (ten) years. If any defects occur during guarantee period, the contractor shall rectify the same within three days of intimation at their own cost to the satisfaction of the Engineer-in-Charge. The decision of the Engineer-in-Charge shall be final and binding.

The tenderers may, if they so desire, quote on the basis of their own patent water proofing treatment with rates and terms and conditions if any and detailed specification if their patent treatment is considered by them to be more effective and competitive. They shall also guarantee their treatment for a minimum period of 10 (ten) years.

51.4.5. MODE OF MEASUREMENT : Only plan dimensions between brick / concrete walls shall be measured in sqm. to second place of decimal for payment. Rainwater outlets shall be finished as directed and no deduction shall be made for the same (area upto 0.02 sqm.), while arriving at the net area for payment. The rate shall also include rounding of junctions between walls / wall & slab.

51.5. CEMENT BASED WATER PROOFING OF W.C. AND BATHS AREAS :

51.5.1. General : The water proofing treatment for the Bath and W.C. shall be essentially of cement based water proofing treatment with admixture of proprietary water proofing compound similar to M/s. India water proofing companys treatment or any other equivalent approved cement based water proofing treatment. The waterproofing treatment shall consist of providing cement slurry mixed with proprietary water proofing compound after preparation of surfaces, providing water proofing cement plaster, finishing smooth/rough as required to the required line, level, curing, finishing, guarantee for the water tightness of the water proofing treatment etc.

Preparation of Surface : The surface to receive water proofing treatment shall be thoroughly cleaned of scales, laitance, set mortar etc. for receiving water proofing treatment, and necessary preparation of the surface for providing water proofing treatment shall be done by the contractor. If any honey combs are observed in beams and slabs of Bath and W.C., the same shall be grouted with cement slurry mixed with water proofing compound and the cracks and crevices, filled with injection method. On cleaned surface detect pores/gaps if any & Fill all gaps /pores and inject cement slurry mixed with Sunplex of Sunanda make (Shrinkage Compensating, Expanding Grout Admixture with Plasticizer) or MC-Special DM of MC Bauchemie make. Then Apply acrylic based Polymer Modified Cementations Flexible Composite coating /crystalline system over concrete slab.

51.5.2. Sequence of Treatment : All cutting and chasing in the floor and walls for plumbing work shall be done by the plumbing agency. Water proofing agency shall then provide CETROOF or equivalent approved cement based water proofing treatment consisting of cement plaster treatment mixed with the water proofing compound according to the recommended specifications of the waterproofing agency. The thickness of water proof plaster shall be about 35 mm. on floor area of the depression and about 25 mm. thick on the vertical surface of walls/concrete surface in case of sunken slabs, upto the finished floor level. The thickness shall be about 18 mm. for the remaining wall height upto 600 mm. from finished floor level.

The plumbing agency shall then lay and fix the pipes, W.C. pans, traps etc. without disturbing the water proofing treatment. However, the joints of water supply and waste connections including holes drilled for clamps shall be treated by water proofing agency.

Waterproofing agency shall then fill-in the depression in the floor with their 'CETROOF'or equivalent approved waterproof brick bat coba with the admixture of waterproofing compound according to waterproofing agency's specification and process, which should be furnished in writing to the Engineer-in-Charge for effective supervision of completeness of the process while executing the works.

51.5.3. Finishing : The surface of the exposed plaster shall be finished smooth with neat cement. The plaster surface where tiling is to be provided as well as brick bat coba filling where flooring to be provided, shall be finished to proper line, level, plane and plumb to receive the floor/dado finish. Curing of the waterproofing treatment shall be carried out for 14 days.

51.5.4. Testing and Guarantee : The contractor shall test the surface where waterproofing treatment is provided for the bone dry condition by filling with water inside the depressed plastered portion. No wet patches or leaks shall appear on he surrounding plastered walls or at the under side of the slabs. The testing shall be carried out to the entire satisfaction of the Engineer-in-Charge. The contractor shall furnish guarantee in the Proforma as per Appendix D for the waterproofing treatment for maintaining the under side of the waterproofed surface in bone dry condition for a period of minimum ten years. During this period, contractor shall attend to all leakages, defects etc. if noticed, free of cost, starting his work of checking up and rectification with in a weeks time from the date of receipt of information about such leakages etc. by him.

The contractor shall submit the guarantee bond on appropriate stamp paper and as per the enclosed proforma.

51.5.5. MODE OF MEASUREMENT :

i. Waterproof plaster shall be computed by taking the length and breadth of the area actually plastered correct upto two decimal places of a metre. No deduction shall be made for W.C. pans, pipes etc. in the measurement.

ii. The filling with waterproof brick bat coba shall be computed by noting the levels and dimensions of the filled up depression before and after the filling, upto two decimal places of a metre and also no deductions shall be made for W.C. pans, pipes etc.

51.6. CEMENT BASED WATERPROOFING OF ROOF TERRACES :

51.6.1. General : The waterproofing treatment shall be essentially a cement based waterproofing treatment similar to that of M/s. India Waterproofing Companys CETROOF or any other equivalent approved waterproofing treatment. The waterproofing treatment shall consist of providing cement slurry mixed with waterproofing compound, at desired proportions including grouting the cracks and crevices with cement slurry mixed with waterproofing compound, laying brick bats over cement mortar bedding to the required slopes for roof drainage, filling and grouting the joints with cement mortar, finishing the surface smooth/chequered with cement plaster mixed with waterproofing compound etc. as directed.

Preparation of Surfaces : All the rubbish, debris and other materials left over by other agencies will be got removed by the Contractor through other agencies. After removal of this rubbish, debris etc., the surface to receive the waterproofing treatments shall be thoroughly cleaned with wire brushes including removing of scales and laitance, set mortar etc. by the waterproofing contractors. If any honey combing including cracks and crevices are observed at column junctions/and elsewhere, the same shall be grouted with cement slurry mixed with approved waterproofing compound. On cleaned surface detect pores/gaps if any & Fill all gaps /pores and inject cement slurry mixed with Sunplex of Sunanda make (Shrinkage Compensating, Expanding Grout Admixture with Plasticizer) or MC-Special DM of MC Bauchemie make. Then Apply acrylic based Polymer Modified Cementations Flexible Composite coating /crystalline coating system over concrete slab.

51.6.2. Treatment : The waterproofing treatment shall be generally as per manufacturers own specifications, method and procedure. A typical cross section of the waterproofing treatment shall generally consist of the following:

i) Applying cement slurry mixed with waterproofing compound for the entire surface to be treated.

ii) Laying of broken brick bat of required thickness over cement mortar bedding to give

proper roof drainage, grouted with cement mortar with waterproofing compound.

iii) Laying of jointless cement based waterproofing cement mortar layer of average thickness as specified in the item.

iv) Final rendering to give a smooth finish of cement colour with false lines at 300 x 300 mm. or nearer convenient dimensions. Tenderer shall give complete details of waterproofing treatment proposed by him, in writing viz. details including roof fill material, waterproofing compound, minimum and maximum thickness etc. for effective supervision of the EIC/Representative Engineers, while the work is executed at site.

The contractor shall ensure that sufficient slope for effective roof drainage is provided within the average thickness of waterproofing treatment proposed by the contractor. In case the average specified thickness of treatment exceeds, the fact shall be specifically brought to the notice of the Engineer-in-Charge, before adopting the extra thickness.

The rain water down take pipes if any, shall be fixed by the other agency prior to commencement of waterproofing operation. Curing of the finished surface by ponding shall be done for 7 days atleast.

51.6.3. Testing and Guarantee :

The contractor shall test the surface for the bone dry condition by ponding water over roof for minimum seven days period to the entire satisfaction of the Engineer-in-Charge. Alternately, the curing of the finished surface done by ponding of water on the entire surface for seven days, can also be used for testing water tightness. After a period of two months, once again the roof should be ponded with water to check its efficiency of waterproofing treatment against leakage. The contractor shall furnish guarantee in the proforma as per Appendix D for the waterproofing treatment provided by them, for maintaining the under side of the roof in bone dry condition for a minimum period of ten years.

During this period, the contractor shall be liable to attend all the leakages, defects etc. if noticed, free of cost, starting his work of checking and rectifications within a weeks time from the date of receipt of intimation of such leakages etc. by him.

51.6.4. MODE OF MEASUREMENT :

Net area in square metre of the roof measured in between the side walls, i.e. plan dimensions including rounded junctions, kerbs, parapets where waterproofing treatment

provided etc. shall be measured for payment. No deduction shall be made for openings upto 0.02 sqm such as rain water outlets etc., but the same shall be finished as directed by the Engineer-in-Charge. The rate shall include the cost of labour, materials, scaffolding etc. and shall cover the cost of rounding of junctions etc. which will not be measured separately. Brick bat filling done under this item will not be measured separately and is deemed to be included in the waterproofing treatment for roof with an average thickness of 115 mm.

51.7. INTERNAL WATERPROOFING FOR OVERHEAD WATER TANK / LIFT PIT / UNDERGROUND SUMP OR TANKS :

51.7.1. General : The waterproofing treatment for overhead water tanks shall be essentially a cement based waterproofing treatment similar to that of M/s. India Water Proofing Company, consisting of providing water proof cement plaster after preparing the surface, filling the cracks and crevices by means of injection and surface method, using proprietary waterproofing compound as per their own specifications and as per recommended proportions etc. and testing of watertightness of the water proofing treatment and furnishing guarantee as specified.

Preparation of Surfaces : The surface to receive the waterproofing treatment shall be thoroughly cleaned of scales, laitence, set mortar etc. The surface shall be roughened with close hacking to provide adequate key for the waterproofing treatment. All honey combs in concrete surface shall be carefully hacked and loose materials removed and all pockets plugged suitably well before commencing waterproofing treatment. On cleaned surface detect pores/gaps if any & Fill all gaps /pores and inject cement slurry mixed with Sunplex of Sunanda make (Shrinkage Compensating, Expanding Grout Admixture with Plasticizer) or MC-Special DM of MC Bauchemie make. Then Apply acrylic based Polymer Modified Cementations Flexible Composite coating system over concrete slab.

51.7.2. Treatment : Before any work of waterproofing is taken in hand, all the surface preparation mentioned above shall be got approved from the Engineer-in-charge. All plumbing work will be got completed by the contractor before commencing the treatment.

The treatment shall then be commenced with injection into RCC members wherever required by cement slurry mixed with water proofing compound of appropriate consistency to fill up all cracks and crevices if any. A layer of waterproofing plaster in the specified proportion as per manufacturers/waterproofing contractors recommendations with admixture of approved manufacture waterproofing compound, shall then be laid over floor from inside and will be continued along the sides and partition walls to their full height. The thickness of this treatment on the floor shall not be less than 50 mm. and that

on walls not less than 20 mm. The entire surface shall be finished smooth with steel trowel in cement colour. The plastered surfaces shall be kept continuously wet immediately after 24 hours so as to cure it properly for at least seven days.

51.7.3. Testing : The tank will thereafter be got filled upto the full height immediately by the Contractor as specified, and water stored for a minimum period of seven days so as to observe any leakages/defects for necessary compliance by the waterproofing contractor.

In the case of tanks whose external faces are exposed, the requirements of the test shall be deemed to be satisfied in the external faces shown no sign of leakage and remain apparently dry over the period of observation of seven days after allowing a seven days period for absorption after filling the tank for full height. If the structure does not satisfy the conditions of test, the period of test may be extended for a further period of seven days and if specified limit is then reached, the structure may be considered a satisfactory. Suitable remedial measures shall be taken by the contractor at his own cost till the test as specified above is carried out satisfactorily.

In the case of tanks whose external faces are exposed or can be left exposed prior to testing all leakages, wet patches and the like, shall be marked out on the outside of walls during test. The tank shall then be dewatered and the defects made good by grouting, waterproofing, plastering etc. as necessary to the entire satisfaction of the Engineer-in-Charge, at no extra cost . The tank shall again be tested for leakage after rectification. The work shall not be accepted unless the water tightness is established.

Back filling in case of underground sump and waterproofing the roof where specified, shall be carried out after testing and rectification of defects. The completion certificate shall not be given unless the test for water tightness as described above is carried out to the entire satisfaction of the Engineer-in-Charge. After a period of two months after the tank is left dry, once again the tank should be filled with water to check the efficiency of the waterproofing treatment done. If there is any leakage or wet patches, the same shall be rectified, with no extra cost, by the contractor.

51.7.4. Guarantee : The contractor shall furnish service guarantee in the prescribed proforma vide Annexure 'D' of the Tender for the workmanship and the materials provided and for maintaining the waterproofed surfaces of the tanks in bone dry condition for a minimum period of ten years. If any defect occur during the guarantee period, the contractor shall rectify the same at his own cost to the satisfaction of the Engineer-in-Charge, and start his work of checking and rectification within seven days after receipt of intimation by him.

51.7.5. MODE OF MEASUREMENT :

Measurement for payment of waterproofing treatment shall be as per actual area covered by waterproofing treatment including offset, overlapping, rounded junctions, haunch etc. as provided at site. The length and breadth of the surface actually treated with water proofing treatment shall be measured upto two places of decimal of a metre. No deduction shall be made for inlet, outlet, scour connection, but the same shall be finished as required. The rate quoted shall include all the cost of materials, labour, transportation, testing of water tank for water tightness, furnishing necessary guarantee for waterproofing so provided, all as detailed above.

51.8. WATER PROOFING TREATMENT OF EXPANSION JOINT AT ROOF LEVEL :

51.8.1. Treatment : The expansion joint treatment at roof level shall be provided with approved cement based waterproofing treatment of M/s. India Water proofing Company or other approved equivalent waterproofing agency. This treatment shall be 20 mm. thick waterproof plaster on top sides and ends of RCC covering hood over expansion joint as shown in the drawing.

51.8.2. Guarantee : The contractor shall carry out the test for waterproof joint provided for expansion joint at roof level by any approved method and furnish a guarantee for the watertightness of the joint in the prescribed proforma as per Appendix D and its maintenance in bone dry condition for a period of ten years. During this period the contractor shall be liable to attend to leakages, defects etc. noticed, free of cost within a weeks time from the date of intimation to him of such leakages.

51.8.3. MODE OF MEASUREMENT :

The measurement for the joints thus waterproofed, shall be made in Running Metres upto two places of decimal of a metre.

52. INTEGRAL CEMENT BASED WATER PROOFING TREATMENT OF UNDER GROUND WATER TANKS, SWIMMING POOLS, BASEMENTS ETC. FROM OUTSIDE:

52.1ON HORIZONTAL SURFACES

52.1.1. Preparing the Surface

The water proofing treatment over the lean concrete/levelling course surface should adhere to the surface firmly. The surface of levelling course should be roughened when the

concrete is still green. In case the surface is not made rough in the initial stages itself (i.e. before the concrete is set, the work of water proofing shall not be permitted till proper key is provided for the 25 mm thick base layer. This key cannot be achieved by hacking the already set concrete surface, instead a spatter-dash key should be provided without any extra cost, as it is the responsibility of the contractor to roughen the surfaces properly over which plaster or similar coat is to be laid.

52.1.2. Blending Cement/Water with Water Proofing Compound

Mixing water-proofing compound in powder or liquid form, to already prepared cement mortar shall not be allowed. **Blending Cement** with water-Proofing Compound shall be prepared as followed:

i. The required quantity of cement bags to be used for a particular portion of work should be sorted out and the contents of each bag should be emptied on a suitable dry platform. Water proofing compound in powder form manufactured by reputed approved manufacturer, bearing ISI mark, conforming to IS 2645 should be mixed with the contents of each bag. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding 3% by weight of cement.

ii. The quantity of cement (50 kg) and water-proofing compound in powder form should be mixed thoroughly, blended by employing skilled labourers and the cement thus blended should again be packed in gunny bags so that the material can be readily used for preparing mortar/slurry for the water proofing works, to achieve best results.

Note: Unless otherwise specified, all waterproofing works shall be carried out using blended / PPC cement.

52.1.3. Blending Water with Liquid Water Proofing Compound.

(i) In case the water proofing compound to be used is in liquid form then instead of blending cement with water-proofing compound the water to be used in the particular mix should be blended with water proofing compound.

(ii) This shall be done by taking just required quantity of water to be mixed in the particular batch of dry cement mortar. The required quantity of water thus collected per batch of dry cement mortar to be prepared should be mixed with liquid water-proofing compound from sealed tins with ISI mark and manufactured by reputed approved manufacturer.

(iii) The water thus mixed with water-proofing compound shall be stirred so that the water is blended with water proofing compound well.

(iv) The quantity of blended water thus prepared should only be used per batch of dry cement mortar/dry cement to make slurry to be used for water-proofing works to achieve the best results.

Note: Use of cement mixed with water-proofing compound is referred as "blended cement" in this chapter which shall mean use of water proofing compound in powder/liquid form for use in cement mortar/slurry.

52.1.4. Rough Shahabad stone:

i. The stone slabs to be used for this item shall be carefully selected for uniform thickness. Stones with varying thicknesses shall not be permitted to be used. Unless otherwise specified, the size of rough Shahabad stone shall not be less than 300x300mm and thickness 22mm (+/-) 3mm.

52.1.5: Preparation of Cement Slurry

Cement slurry normally prepared and used on general building works with just 1.50 to 2 kg of cement to cover an area of one sqm shall not be applicable for such works instead it should have thick honey like consistency. Each time only that much quantity of slurry shall be prepared which can be covered on the surface and the surface in turn would be covered with 25 mm thick cement mortar base within half an hour. Slurry prepared and remained un-used for more than half an hour shall be totally rejected.

52.1.6. Preparation of Cement Mortar

The cement mortar 1:3 (1 blended cement : 3 sand) shall be prepared with cement / water duly blended. Each time only that much quantity of cement mortar that can be consumed within half an hour, shall be prepared. Any quantity of cement mortar that is prepared and remains unused for more than half an hour shall be totally rejected.

52.1.7. Laying Water Proofing Course

1. First layer : 25 mm thick Base Course in Cement mortar 1:3

i. Before laying the first course of cement mortar 1:3 base the lean concrete surface shall be cleaned neatly with water and cement slurry shall be applied only on the area of the concrete surface, that can be covered with the cement mortar (1:3) base course within half an hour.

ii. The cement slurry should cover every spot of the surface and no place shall remain uncovered.

iii. Just after the application of cement slurry on the surface, the cement mortar should be used for laying the base course.

iv. For laying base course to a perfect level at least 3 Nos. 25mm high wooden strips with 3 legs shall be placed on the concrete surface at suitable distances and the cement mortar shall be laid to the exact level of the strips and tamped gently. The top surface should be finished neatly and later scratched when green with a suitable instrument.

v. Before the base course dries and gets hard that is just before the base course takes up initial set, the 2nd layer of Shahabad stone/slab cladding shall be taken up immediately.

Note : As far as possible work of different layers of this water proofing treatment shall be taken up in immediate succession without allowing any time gap in between the layers, otherwise it would be difficult to achieve homogenous treatment, which is the basic necessity.

2. Second layer : Shahabad stone.

i. When the 25 mm thick base course is just getting set the cement slurry should be spread over the base course up to the area that shall be covered with just two to three stone slabs.

ii. The Cement slurry shall be spread in such a way that the area of base course to be covered immediately shall be covered with slurry without any gap, or dry spots.

iii. Each time only the area that is required to clad two to three stone slabs shall be taken up for spreading the slurry and only after fixing the stone slabs over the slurry further area shall be taken up.

iv. Immediately on applying cement slurry on the base course the Shahabad stone slabs shall be laid over the base course and pressed gently so that the air gap can be removed.

v. The slurry applied on the surface which gets spread when the stone slab is pressed shall get accumulated in the joints of adjacent stone slabs and if any gap still remains between the stone slabs the same should also be filled with additional quantity of cement slurry.

vi. For laying the stone slabs in perfect level, two slabs at adjacent corners/ends shall be fixed firmly to the required level and a string stretched over the two slabs, the intermediate slabs shall then be set to the level of the string.

3. Third layer : 25 mm thick course in cement mortar 1:3

i. On filling all the joints of the Shahabad stone slabs with cement slurry and after a gap of 6 to 8 hours the area of stone slabs shall be cladded with cement mortar 1:3.

ii. The surface of stone slabs shall be cleaned and lightly watered. The cement mortar (1:3) shall be used for laying this course, no cement slurry need be used and the mortar can be laid on the slab surface directly.

iii. For laying this course in perfect level, 25mm high wooden strips with legs used for laying base course shall be used and the top surface shall be finished smooth without using additional cement or slurry.

4. Fourth Layer : Top Finish with Stone Aggregates 10 to 12 mm Size

i. Immediately after laying 3rd course and before the cladded mortar takes the initial set, stone aggregate of 10mm to 12mm nominal size shall be pressed into the finished surface @ 8 cudm/sqm.

ii. The aggregates though embedded shall be clearly visible on the surface, i.e. the stone aggregates shall not be embedded totally inside the mortar.

Note: This treatment is provided over the surfaces which are originally in slope or in level & no attempt under any circumstances shall be made to provide any slope by altering the 25 mm thickness of base course, to lay the water-proofing course in slope.

In case a slope is to be provided for the water proofing layer on a surface which is in perfect level, grading with additional cement concrete/cement mortar shall be provided and then the water-proofing layer shall be laid on the graded surface.

52.1.8. Curing

a) Water Proofing on Lean Concrete Surface

Immediately after completing the fourth layer, arrangements shall be made to lay the top RCC slab as quickly as possible and in the mean time till the top slab is concreted the water proofing treatment shall be kept wet continuously. In case the concreting of slab gets delayed for more than 2 weeks the curing can be stopped after 14 days.

b) Water Proofing on Horizontal Surface of the offset of floor slab.

The water proofing treatment done on the offset of the floor slab shall be kept wet continuously for 14 days minimum.

52.1.9. Measurement: Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm.

52.1.10. Rate: The rate shall include the cost of labour & materials involved in all the operations described above.

52.2 ON VERTICAL SURFACES

The vertical water proofing treatment either from inside or outside shall be undertaken only when the entire work is structurally complete.

52.2.1. Preparing the Surface and Providing Ancillary Arrangements.

(i) The surface of the structure to be treated shall be roughened properly either by raking joints when the mortar is still green in case of brick/stone masonry structures, or by hacking the cement concrete surface with a specially made hacking tool just after removing the shuttering.

(ii) In case the raking joints/hacking concrete surface is not done properly the only alternative method to make the surface rough by **"Spatter dash key"** (a special hacking tool), which shall be done by the contractor without any extra cost.

(iii) For doing the water proofing treatment from outside or inside, al-round scaffolding shall be erected which shall be strong enough to support the stone slabs . Also proper strong scaffold boards, strong ladders and coir ropes shall be made available for using while erecting the stone slabs. Similarly, while doing the water proofing to vertical faces from inside, a particular care shall be taken to see that the water proofing layer of floor slab is not get damaged while resting the vertical props of scaffolding. As a precaution it is advised to rest the bellies on the strong and proper size sole piece placed on the horizontal water proofing treatment of the floor slab.

(iv) Alternatively water proofing for vertical surface shall be provided before horizontal floor slab water proofing. In order to arrest any leakage through junction of vertical/horizontal water proofing, a proper haunch in cement concrete shall be provided.

(v) For the stone slabs that are used for arresting the leakages, while executing this type of water proofing treatment, the first and foremost mandatory condition is that the number of joints in the portion covered by the stone slabs shall be minimum and this condition can be achieved only by using the maximum possible size of stone slabs.

Normally the size of stone slabs used for the purpose is 600 x 600mm x 900mm each stone slab weighing approximately 16 kg and 25 kg respectively.

(vi) The Rough Stone slabs used for such works though are basically rough on the surface still that much roughness will not be sufficient for the stone slabs to remain in vertical position held by cement slurry. Therefore the grip for the stone slabs has to be increased and this can easily be done by planting 12mm to 15mm nominal size stone aggregate fixed with araldite on the face of each stone slab.

(vii) A 20mm thick clear gap has to be formed between the masonry/concrete surface and the stone slabs erected in vertical position for pouring the cement slurry. This gap can be maintained by fixing with araldite the 20mm x 20mm cover blocks made out of M50 or more Grade of concrete on the four corners of the stone slabs and also at centre.

52.2.2. Preparation of Cement Mortar (1:4)

Cement mortar shall be prepared as explained above except that the proportion shall be 1:4 (1 Blended Cement : 4 Coarse sand) instead of 1:3.

52.2.3. Fixing Water Proofing Courses on Vertical Surfaces.

Note:

(i) Normally the item of work prescribes executing the first layer as base course with Cement slurry, second layer fixing rough Shahabad stone slab, third layer as plastering the surface and the fourth layer as finishing surface with neat cement punning, but in actual execution, a gap of 20mm width has to be formed for pouring cement slurry. The 20mm wide gap can be formed by erecting the 20 mm thick Shahabad slab at a distance of 20 mm from the Masonry/concrete surface, over which the cement slurry is to be cladded and can be termed as first step for construction.

(ii) Hence for all practical purposes, chronology of layers shall be considered as per actual construction i.e. as laid in particular serial and not as actually formed later. To avoid confusion and to distinguish between the two different layers laid and the actual work executed, actual working is termed as Step I, Step II etc.

Step I: Erecting Shahabad Stone Slab forming 20mm wide gap.

(i) The Shahabad Stone slab duly fixed with 20 x 20 mm cover blocks and 12 to 15mm size stone aggregate on the surface shall be erected against the masonry/concrete surface

to be treated by abutting the 20mm thick cover block against the surface, thus forming a clear gap of 20 mm.

(ii) The stone slabs thus erected shall be supported with ballies/pipes to the scaffolding already erected for the purpose.

(iii) The joints of stone slabs shall be temporarily closed from outside with cement mortar so that the cement slurry poured in the gap does not escape through the joints. The bottom portion of the stone slabs shall also be closed with cement mortar.

(iv) While erecting the stone slabs, proper care shall be taken to see that stone slabs are of uniform size. In case similar width slabs are used, it shall be ensured that these are not fixed at the corners but the same should be at the middle portion.

(v) Interlinking of the Shahabad Stones of horizontal layer of water proofing with this vertical layer of water proofing shall be done very carefully, as per standard practice.

(vi) The Stone slabs shall be erected in perfect plumb and fixed in position and it will be considered as 2nd layer of water proofing on completion.

(vii) Further lifts of Shahabad Stone slabs up to the full height of the masonry/ concrete wall shall be erected only after filling the gap of each lift erected, with cement slurry.

Step II : Filling Cement Slurry in the gap formed by erecting Shahabad Stone Slabs:

(i) When the first lift of stone slabs are erected and checked to be in perfect plumb, cement slurry shall be poured in the gap till the gap is filled completely.

(ii) The further filling of slurry in the second lift shall be done when the second lift of stone slabs are erected in position and thus the work on 2nd and 1st layer of the item shall be completed simultaneously till the cladding over the entire height of the wall is complete.

(iii) Thus on completion of filling cement slurry and erecting stone slabs for the entire height of the wall, it can be considered that the first layer (i.e the layer of cement slurry) and the second layer (i.e. the layer of erecting Rough Shahabad Stone Slabs) is complete as per the item.

Step III : 3rd Layer: Plastering Over 2nd layer with Cement Mortar 1:4 (1 Blended Cement : 4 Sand)

i. Immediately on completion of the work of cladding the entire masonry/ concrete wall with Shahabad Stone slabs, the cement mortar applied over the joints shall be removed and the joints exposed. The entire surface shall be cleaned with water neatly to start the plastering work.

ii. Cement mortar 1:4 (1 blended cement : 4 coarse sand) shall be used for the purpose. Care shall be taken to see that the 20mm thickness of cement plaster over the entire surface is maintained correctly.

iii. The work of plastering shall be taken up immediately on completion of cladding the wall surface, rather it should be a continuous process from the day of starting the erection of stone slabs till the finishing work of plastering is done.

iv. The plastering shall be done from top to bottom without leaving any joint. As far as possible the joints in plaster shall be minimum. In case a joint has to be left to continue the work on the subsequent day, cement slurry shall be applied over the entire joint, and then only the further work of plastering shall be taken up.

Step IV: 4th Layer: Finishing with Neat Cement Punning:

(l) When the surface of plastering is still green, the cement slurry shall be applied over the plastered surface and the surface shall be finished neatly to a smooth surface with specially made semi rounded thapis. The surface should show a smooth and neat finish without any undulations.

52.2.4. Curing and Testing: On completion of water proofing course from outside, the tank shall be cleaned from inside, scaffoldings shall be removed and tank is gradually filled with water for testing, which shall commence within two or three days. The exposed faces of the water proofing course shall be kept wet for 14 days. No back filling shall be done before expiry of 14 days from the date of completing the water proofing course from outside.

52.2.5. Measurement: Length, width/height shall be measured along the finished surface correct to a cm and the area shall be worked out correct to nearest 0.01 sqm.

52.2.6. Rate: The rate shall include the cost of all labour and materials involved in all the operations described above and for all heights.

52.3 The only difference between treatment of horizontal and vertical surfaces is the thickness and the type of treatment per layer that is to be provided. The same is tabulated below for clear understanding:

Horizontal Surfaces			**Vertical Surfaces**		
Layers	**Details of Layer**	**Thicknes**	**Layers**	**Details of**	**Thicknes**
First Layer	25mm thick base course	25mm	First layer	Base course with	20mm
Second Layer	Shahabad Stone Slab	22(+/-)	Second Layer	Shahabad Stone	22(+/-)
Third Layer	Finishing with CM 1:3	25mm	Third Layer	Plastering II Layer	20MM
Fourth Layer	Embedding 10 to 12mm	----	Fourth Layer	Punning with neat	---
	Total Thickness	**72 (+/-)**		**Total Thickness**	**62 (+/-)**

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53. RAILING, BALUSTERS AND NEWELS :

53.1. SCOPE OF WORK AND GENERAL : The item refers to supplying and fixing in position composite hand railing for staircase, open area, balcony, corridor etc. at different floors, levels and locations.

53.2. MATERIALS : The class and quality of wood to be used for hand railing and workmanship shall comply with the requirements specified in wood work wrought and put up and also comply with the I.S. specifications. M.S. balusters, grills, M.S. flat frame work and runners to be used in hand railing, their quality, workmanship etc. shall comply with requirements specified in manufacture of M.S. grills, and standard practice adopted in fabrication of structural steel work and also comply with I.S. specification.

53.3. SAMPLES : Before taking up fabrication and erection on mass scale, the sample of railing materials being used etc. shall be got approved by the Engineer-in-charge.

53.4. FABRICATION : The fabrication of wooden hand rail shall follow the standard specification for wood work. The wooden handrail shall be in single piece per flight panel, moulded, shaped and finished to required dimensions as shown in drawing and as directed by the Engineer-in-charge. The hand railing shall be secured perfectly to line, slope and level to M.S. flat runners, balusters, newels and posts. M.S. grill, balusters, M.S. flat frame work fabricated as per the drawing and shall be strictly according to the specifications specified in manufacturing of M.S. grills and structural steel work. M.S. balusters, newels, M.S. flat frame work and posts as the case may be, shall be fabricated in a workman like manner.

53.5. FIXING/ERECTION : M.S. Balusters, newels, posts, M.S. flat frame work manufactured as per drawing and as per approved sample, shall be firmly fixed in the pockets left for fixing of balusters or weld to main steel of waist slab or landing slab or weld to the inserts left for fixing of balusters, posts etc. as shown in the drawing. Necessary cover plates at the base of the balusters shall be provided after grouting the balusters duly kept in position. The hand railing shall follow the inclination of stair in case of stair-case and shall be perfectly in line, level and plumb for all other railings. Any damage caused to treads/risers while fixing of balusters, posts, railings etc., the damaged tread and riser shall be removed and replaced by new ones at no extra cost. Railing shall be joined in lengths with plain butt joints, dowelled and held together by hand rails, bolts, clamps and M.S. frame work.

53.6. MODE OF MEASUREMENT : Hand railing shall be measured for payment in running meters. The length shall be measured along the top centre line of the hand rail and shall be measured between ends of balusters, newels posts as the case may be upto two places of a decimal. Rate to include fabrication, leaving suitable pockets, grouting the same, fixing, all labour, materials, transporting, painting, polishing, finishing, scaffolding if necessary and as described in the schedule of quantities.

54. RUBBER / P.V.C. WATER STOPS:

54.1. GENERAL: The corrugated Rubber/PVC water stops with centre bulb of specified width, shall be of approved manufacture and shall satisfy all the normal tests such as tensile strength, elongation etc. Swellable water bar of approved make shall be used for filling construction joint in water retaining structure .

54.2. SAMPLE : A sample of Rubber/PVC water stops shall be got approved from the Engineer-in-charge before procurement of bulk quantity.

54.3. PLACING IN POSITION : The water stops shall be provided in available maximum length and as far as possible, jointing shall be avoided. All the joints when unavoidable, shall be field jointed for water tightness as per manufacturers specifications.

The water stops shall be positioned with suitable temporary supports so as to render adequate rigidity to the water stops while concreting. The exposed surfaces of water stops revealed after first concreting shall be cleaned thoroughly of all the droppings, mortar splashing, timber scantlings sticking etc. before the next pour of concrete is taken up in hand. Any damage caused to water stops shall be made good by the contractor at his own cost.

54.4. MODE OF MEASUREMENT : The mode of measurements shall be in running meter,

of water stop actually laid without any allowance for laps, wastage etc., measured correct to one centimetre.

Rate shall include supply, transport, fixing, welding, supporting arrangements, cleaning etc. all as described above.

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55. DISMANTLING AND DEMOLITION :

55.1. SCOPE OF WORK :

The work envisaged under this sub-head is for dismantling and demolition of brick masonry in cement/lime mortar, reinforced cement concrete works, removing wooden chowkhats of doors, wooden or steel windows.

55.2. GENERAL :

The term Dismantling implies carefully taking up or down and removing without damage. This shall consist of dismantling one or more parts of the building as specified or shown on the drawings.

The term Demolition implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on drawings.

55.3. PRECAUTIONS :

Necessary propping, shoring and/or underpinning shall be provided for the safety of the adjoining work or property, which is to be left in tact, before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property.

Wherever required, temporary enclosures or partitions shall also be provided.

Necessary precautions shall be taken to keep the dust- nuisance down as and when necessary.

Dismantling shall be commenced in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roofs, masonry etc., shall be carefully dismantled first. The dismantled articles shall be passed by hand where necessary and lowered to the ground and not thrown. The materials then be properly stacked as directed by the Engineer-in-charge.

All materials obtained from dismantling or demolition shall be the property of the Government unless otherwise specified and shall be kept in safe custody until handed over to the Engineer-in-charge.

Any serviceable material, obtained during dismantling or demolition shall be separated out and stacked properly as indicated by the Engineer-in-charge within a lead of 150 m. or as specified in the item. All under serviceable materials, rubbish etc. shall be disposed off as directed by the Engineer-in-charge.

55.4. TREATMENT :

All the dismantled area shall be rendered clean off all debris, dust etc. The sides of jambs, sills, soffits etc. of the openings if any, after taking out doors and window chowkhats, unless and otherwise to be treated, shall be plastered in C.M. 1:3 with neeru finish to render true sides, corners, edges etc.

55.5. MODE OF MEASUREMENT :

55.5.1. Brick Masonry & R.C.C. Works : The measurement of brick masonry with or without plaster/painting shall be taken correct to a centimeter and volume calculated in cubic metres upto two places of decimal.

55.5.2. Doors and Windows : Dismantling of doors and windows (wooden or steel) shall be enumerated. Removal of chowkhats (frame works) shall include (unless otherwise separately mentioned for removing shutters only), the removal of shutters along with architraves, beadings, fittings and fastenings along with frames.

55.5.3. Roof Terracing : Dismantling of roof waterproofing treatment shall be measured in square metre area. .Length and breadth shall be measured correct to a centimeter between parapets. No separate measurement shall be taken for gola and khurrah etc.

55.6. RATES :

The rate shall include cost of all such operations mentioned above including necessary labour, materials, transport, scaffolding, stacking the serviceable materials, disposing the unserviceable materials within the lead specified, all as directed by the Engineer-in-charge.

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56. ROAD AND PAVEMENTS :

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

SCOPE OF WORK :

The work contemplated under these specifications refers to Earth work in Excavation, Forming Embankments, Soling, W.B.M., Bituminous Macadam, Wearing Course/Sealing Coat etc. for road and pavement works.

Concrete road shall be constructed as per IRC:15-2011 & IRC:44-2008, MORTH Specification & as per details shown in the drawing to the satisfaction of E.I.C

Approximate quantities of materials to be used in the work are listed below for reference:

SN	MATERIAL	DESCRIPTION	CONSUMPTION
i)	**Soling stone**	a) for 230 mm. thick consolidated thickness	2.65 cum./10 sqm
		b) for 150 mm. thick consolidated thickness	1.725 cum./1 0 sqm.
ii)	**Stone aggregate** 50 mm. nominal size	for 75 mm. thick consolidated W.B.M.	0.975 cum./1 0 sqm.
iii)	**Murrum**	for 75 mm. thick consolidated W.B.M	0.305 cum./10 sqm
iv)	**Bituminous macadam**	for premix carpets for 38 mm. consolidated thickness	11 sqm./mt.
v)	**Seal coat** (Bituminous concrete for wearing course)	for 12 mm. consolidated thickness	33 sqm./mt.

56.1. EARTH WORK IN EXCAVATION :

The specifications for “Earth work” under chapter - 1, specified here-in-before shall hold good as far as they are applicable.

56.2. FORMING EMBANKMENT :

The work shall include preliminaries of clearing site, setting out and preparing the ground and there after forming embankment for the roads, paths etc. with approved material available form excavations under this contract (excavation paid separately under respective items) or elsewhere, spreading in layers, watering and compacting to the required density and lines, curves, grades, camber and cross section and dimensions shown in the plan or as directed by the Engineer-in-Charge. When the embankment is to be laid on hill sides or slopes, the existing slopes are to be ploughed deeply. If the cross slopes are steeper than 1 in 3, steps with reverse slope shall be cut into the slopes to give proper hold and seating to the bank as directed by the Engineer-in-Charge. The top 15 cm. of soil shall be scarified and watered if directed and compacted to the same density as specified for the embankment before any material is laid for the embankment work.

Only the approved excavated earth shall be placed in the embankments in successive horizontal layers not exceeding 200 mm. extending to the full width of the embankment including the slopes at the level of the particular layer and 30 cm. more on both sides to allow compaction of the full specified section. The extra loose stuff at the edges shall be trimmed later after completion of the bank work without extra cost leaving the correct section fully compacted.

Keeping the width of the bank initially less and widening it later by dumping loose earth on the slopes shall not be permitted as the additional width and slopes will remain loose and uncompacted. Similar procedure to extend the embankment by dumping the material longitudinally shall also not be allowed. Each layer of the embankment shall be watered, levelled and compacted as specified here-in-after, before the succeeding layers are placed. The surface of the embankment shall at all times during construction, be maintained in such a manner so as to prevent ponding. Water to be used shall be free from all harmful elements which may cause efflorescence etc. and approved by the Engineer-in-Charge.

If the material for embankment contains moisture less than the optimum moisture, water shall be added in the 100 mm. layers of the embankment to bring moisture uniformly upto requirement. If the excavated material contain more than required moisture, it shall be allowed to dry until the moisture is reduced to required extent. If due to the wetness, the moisture content of the soil cannot be reduced to the appropriate amount by exposure, embankment work shall be suspended till suitable conditions prevail at no extra claim/compensation.

When loose layer is levelled manually or mechanically and moistened or dried to a uniform moisture content suitable for maximum compaction, it shall be compacted by 8 to 10 tonne power roller or sheep foot rollers or heavy hauling or dozing equipment to give the specified 90% of the proctor density. If on testing, the density is found to be less than 90% of the proctor density, the contractor shall do additional compaction necessary to get the

specified density after adding water if required. If the density cannot be improved by such reasonable efforts, the work may be accepted as substandard work by the Engineer-in-Charge, if he thinks it is not harmful for the purpose and paid for at a reduced rate. Test shall be made to determine the maximum density of the material to be used by the proctor method before starting the work. Density test shall be carried out for the embankment work during the progress of the work. One set of three core samples for every 1000 sqm. (about 1000 sq.yd.) area of each layer of embankment work shall be taken and tested. The average density shall not be less than 90% of the proctor density, obtained in the laboratory.

Arrangement for obtaining the samples and transporting the same to laboratory, shall be made by the contractor at his own cost.

Embankment not accessible to rollers, such as those adjoining bridges, culverts and other works shall be carried out independently of the main embankments and shall have the layers placed in 150 mm. to 200 mm. height and each layer shall be moistened and thoroughly compacted with mechanical or manual tamper. Before placing the next layer, the surface of the under layer shall be moistened and scarified so as to provide a satisfactory bond with the next layer.

The embankment shall be finished and dressed smooth and even, in conformity with the alignment levels and cross sections and dimensions shown on the drawing. On curves, section shall be provided with super elevation and increased width, as shown on the plans as directed by the Engineer-in-Charge.

Joining of old and new embankments shall be done by stepping in an overall slope of about 1 to 5.

The contractor shall be responsible for maintaining the embankment work in satisfactory conditions at his own cost till finally accepted including making good any damage.

MEASUREMENT AND RATE :

The contract rate shall be per cubic metre of the finished embankment. Measurements shall normally be taken by taking cross sections at suitable intervals. The measurements of the section shall be limited to the dimensions shown on the drawing or those ordered by the Engineer-in-Charge in writing. The sectional area shall be worked out correct upto two places of decimal of square metre and the quantity worked out to two places of decimal of cubic metre on lines similar to those specified for earth work here-in-before.

57.0 SUB GRADE :

Preparation of Sub-Grade : The surface of the formation for a width of sub-base, which shall be as per drawing shall first be cut to a depth equal to the combine depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to finished profile.

Consolidation : The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as an elastic mass (the roller shall pass a minimum of 5 runs on the sub-grade). All undulations in the surface that develop due to rolling shall be made good with fresh material or quarry spoils as the case may be and the sub-grade is rerolled.

Surface Regularity : The finished surface shall be uniform and conform to the lines, grades and typical cross sections shown in the drawings. When tested with the template and straight edge, the variation shall be within the tolerances specified in the Table below :

PERMISSIBLE TOLERANCES OF SURFACE REGULARITY

Longitudinal profile	**Cross profile**
Maximum permissible undulation when measured with a 3 metre straight edge template.	Maximum permissible variation from specified profile when measured with a camber-
24mm	**15mm**

Where the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shall be liable to rectify these with fresh material or quarry spoils as the case may be, and the sub grade rerolled to the satisfaction of the Engineer-in-charge.

Measurement & Rate : The length and width shall be measured correct to a cm. The area shall be worked out in square metre, correct to two places of decimal. The rate shall include the cost of materials and labour required for all the operations mentioned above, unless specified otherwise.

57.1 SUB-BASES :

57.1.1. Water Bound Macadam Sub-base with stone aggregate : Stone aggregate of size 90 mm to 45 mm shall be used. This consists of clean crushed coarse aggregate

mechanically interlocked by rolling using power road roller of 8 to 10 tonnes and voids thereof filled with screening and blinding material with the assistance of water, laid on a prepared sub-grade/sub-base.

SPECIFICATIONS FOR LAYING :

Quantities of Materials : Quantities of coarse aggregate, screening & blinding material required to be stacked for 100 mm appx. compacted thickness of WBM sub-base course for 10 Sqm. shall be as per table given below:

	Coarse Aggregate		**Stone Screenings**		**Blinding materials**
Classification	Size Range	Net Qty.	Grading/Classification and size	Net Qty	
Grading - I	90mm to 45mm	1.2 Cum. to 1.28 Cum	Type A 13.2 mm	0.27 Cum. to 0.30 Cum	0.08 Cum. to 0.10 Cum.

NOTE : Net Quantity = Loose Quantity measured in stack minus 7.5%

Preparation of Foundation : In the case of an existing unsurfaced road, where new materials is to be laid, the surface shall be scarified and reshaped to the required grade, camber and shape as necessary. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for W.B.M.

Spreading Aggregate : The coarse aggregate shall be spread uniformly and evenly upon the prepared base in required quantities with a twisting motion to avoid segregation. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. The aggregates shall be spread uniformly to proper profile by using templates placed across the road six metres apart. Where specified, approved mechanical devices may be used to spread the aggregates uniformly. The levels along the longitudinal direction upon which the metal shall be laid, shall be first obtained at site to the satisfaction of Engineer-incharge and these shall be adhered to.

The surface of the aggregate spread shall be carefully trued up and all high or low spots remedied by removing or adding aggregate as may be required.

The W.B.M. sub-base shall be normally constructed in layers of 115 mm compacted thickness. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall normally not be spread in lengths exceeding three days average work ahead of the rolling and blending of the proceeding section.

Rolling : Immediately following the spreading of the coarse aggregate, it shall be compacted to the full width by rolling with either a three-wheel power roller of 8 to 10 tonnes capacity or an equivalent vibratory roller. Initially, light rolling is to be done which shall be discontinued when the aggregate is partially compacted with sufficient void space in them to permit application of screenings.

The rolling shall begin from the edges with the roller running forward and backward and adding the screenings simultaneously until the edges have been firmly compacted. The roller shall then progress gradually from the edges to the centre, parallel to the centre line of the road and overlapping uniformly each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. Rolling shall continue until the road metal is thoroughly keyed with no creeping of metal ahead of the roller. Only slight sprinkling of water may be done during rolling, if required. On super elevated curves, the rolling shall proceed from the lower edge and progress gradually continuing towards the upper edge of the pavement.

Rolling shall not be done when the sub-grade is soft or yielding or when the rolling causes a wave like motion in the sub-base or sub-grade. When rolling develops irregularities that exceed 12 mm when tested with a three metre straight edge, the irregular surface shall be loosened and then aggregate added to or removed from it as required and the area rolled until it gives a uniform surface conforming to the desired cross-section and grade. The surface shall also be checked transversely by template for camber and any irregularities corrected in the manner described above. In no case shall the use of screenings to make up depressions be permitted.

Application of Screenings : After the coarse aggregate has been lightly rolled to the required true surface, screenings shall be applied gradually over the surface to completely fill the interstices. Dry rolling shall be continued while the screenings are being spread so that the jarring effect of the roller causes them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles on the coarse aggregate but shall be spread uniformly in successive thin layers either by the spreading motion of the hand, shovels or a mechanical spreader.

The screenings shall be applied at a slow rate (in three or more applications) so as to ensure filling of all voids. Rolling and brooming shall continue with the spreading of the screenings. Either mechanical brooms or hand brooms or both may be used. In no case shall the screenings be applied, so fast and thick as to form cakes, ridges on the surface making the filling of voids difficult, or to prevent the direct bearing of the roller on the coarse aggregates. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one day's operation and shall continue until no more screenings can be forced into the voids of the coarse aggregate. Damp and wet screenings shall not be used under any circumstances.

Sprinkling and Grouting : After spreading the screening and rolling, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screening into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well bonded and firmly set for the entire depth and until a grout has been formed of screenings and water that will fill all voids and form a wave of grout ahead of the wheels of the roller. The quantity of water to be used during the construction shall not be excessive so as to cause damage to the sub-base or sub-grade.

Application of Blinding Material : After the application of screenings and rolling, a suitable blinding material shall be applied at a uniform and slow rate in two or more successive thin layers. After each application of blinding material, the surface shall be copiously sprinkled with water and the resulting slurry swept-in with hand brooms or mechanical brooms or both so as to fill the voids properly. The surface shall then be rolled by a 8-10 tonne roller, water being applied to the wheels in order to wash down the blinding material that may get stuck to the wheels. The spreading of blinding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry that is formed well, after filling the voids form a wave ahead of wheels of the moving roller.

Setting and Drying : After final compaction of the course, the road shall be allowed to cure overnight. Next morning defective spots shall be filled with screenings or blinding material, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed till the macadam sets.

Surface Evenness : The surface evenness of completed W.B.M. sub-base in the longitudinal and transverse directions shall be as specified in the table given below:

Size of coarse aggregates	**Longitudinal profile**	**Cross profile**

	Max. permissible undulation when measured with a 3 M straight edge	Max. permissible undulation when measured with a camber template
45-90 mm	15 mm	12 mm

The longitudinal profile shall be checked with a 3 M long straight edge at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10 M.

Rectification of Defective Construction : Where the surface irregularity of the WBM sub-base course exceeds the tolerances specified in the table given above or where the course is otherwise defective due to sub-grade soil mixing with the aggregates, the layer to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable, and re-compacted. The area treated in the aforesaid manner shall not be less than 10 Sqm. In no case shall depressions be filled up with screenings and blinding material.

Measurements & Rate : The length and breadth shall be taken to the nearest centimetre and thickness to the nearest half centimetre. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimals. The rate shall include the cost of all labour and materials involved in all the operations described above.

57.1.2. RUBBLE SOLING :

Rubble soling for road work including foot paths, culverts, side drains etc. shall be carried out as specified here-inbefore under Chapter for Rubble stone soling, so far as they are applicable, with the following additions:

Subgrade for soling shall be prepared by cleaning of all foreign substances including rank vegetation, if any. Any ruts or soft yielding places that appear due to improper drainage conditions, traffic, hauling or from any other cause, shall be corrected by filling/cutting upto 150 mm. and compacted and the subgrade dressed off parallel to the finished profile and the same shall be approved by the Engineer-in-Charge, before laying of soling. Soling shall be laid in regular lines and staggered joints. The stones shall be laid as closely as possible and packed well. The stones shall be so laid as to have their bases and the largest area resting on the subgrade and in contact with each other.

Soling shall be laid to proper gradient and camber which shall be checked frequently to ensure accuracy. Rolling shall then be carried out by a 8 to 10 tonne power roller and

soling consolidated properly shall be lightly sprinkled during rolling, if ordered by the Engineer-in-Charge.

The surface thus prepared shall first be passed by the Engineer-in-Charge, after which 40 mm. to 50 mm. thick layer of selected hard murrum available from excavation shall be spread over the soling as directed by the Engineerin-Charge, and rolled again such that the hard murrum gets into the interstices. It shall, however, be ensured that a thin layer of murrum/grit shall remain on the finished surface of soling.

The area of soling actually done of specified consolidated thickness limiting to the dimensions as per drawing, shall be measured in square metre upto two decimal places.

57.2. WATER BOUND MACADAM / WET MIX MACADAM :

a) **Metal :** Metal required for water bound macadam surfacing shall be broken from the first sort rubble. The rubble shall be broken to required size by the contractor at his own cost. However, the metal required for water bound macadam shall conform to I.R.C. specification in all respects. It shall be hard, sound, trap stone metal free from decay and weathering and obtained from approved quarries, and shall be of 50 mm. nominal size.

b) **Collection of metal :** Metal shall be of first sort black trap stone and shall be collected in stacks on level ground and stacked on the sides of the road as directed. The metal shall be free from all earth, rubbish and vegetable matter and graded before stacking and closely packed in stacks. The metal supplied by the contractor shall be arranged in stacks for measurement. No deductions will be made for voids. The size of stack shall be 1 m. wide at top, 2.2 m. wide at bottom and 60 cm. high. The length shall be as directed by the Engineer-in-Charge. The contractor shall provide the templates required to ensure, compliance with size of stack stipulated.

c) **Supply of Murrum :** The contractor shall be permitted to excavate in the selected areas in the township/site of work, as approved by the Engineer-in-Charge, for collection of murrum. The excavation shall be done by the contractor to correct line and level, transport and stack the same at site of work as directed by the Engineer-in-Charge. Alternately, the contractor will be permitted to bring from outside, approved graded hard murrum 10 mm. down to dust (but not silt) as directed by the Engineer-in-Charge and shall also be collected in stacks on level ground along side of the road.

The stacks shall be measured in cubic metre for payment before using it for blinding. No deduction shall be made for voids.

d) Laying and preparation of water bound macadam surface :

i) After preparation of the existing surface as specified above, 50 mm size metal collected in stacks shall be spread to uniform thickness over the prepared surface and consolidated to 75 mm thickness as specified here-in-after.

ii) Templates properly made of full width and gauge or templates fitted with central plumb to each edge fixed with it must be used. The depth of the plank forming the gauge shall be the thickness of the metal layer in loose state so that when the metal has been properly spread, the gauges are buried just flush with the surface. The intermediate work shall be tested with cord stretched between the gauge. Three templates shall be provided and used with a distance of about 7.5 Metres between each but not exceeding 15 Metres. A spirit level shall invariably be used with the templates to ensure that the edges of metalling are truly levelled. The metal shall be spread and rolled with 8 to 10 tonne power roller until well compacted and there is no appreciable movement (in the metal) when walked upon, or no appreciable wave in front of the advancing roller. Rolling shall be done by roller perfectly, by a 8 to 10 tonne power roller, till proper internal packing of adjacent pieces of stones has been achieved. Excessive dry rolling shall be avoided.

iii) Rolling shall commence from the edge to the centre of the road. In case of super elevated curve, rolling shall commence from the inside edge of the centre and progress towards the outside edge. Where the gradient is steeper than 1 in 60, the roller shall run up grade, i.e. rolling shall be started from lower level to upward direction for the 1St. rolling.

iv) While rolling the surface in two or more parts, a strip of about 230 mm. to 300 mm. along the predetermined cross section shall be left unrolled while consolidating the first half. This shall be properly jointed when the metal is being spread on the second half and consolidated with it. Care must be taken to avoid the occurrence of a continuous longitudinal furrow along cross section of the road. Full width of road will be rolled at a time.

v) The metalling shall be moderately kept saturated and rolling continued until consolidation is completed. Just enough watering shall be done so as to flush the metal slurry into the interstices. Care shall be taken to avoid excess water softening the subsoil. The full consolidation stage shall be tested by (a) putting a piece of metal about the size of wal-nut on the surface and roller passed over it. If it is crushed the surface shall be deemed as well consolidated (b) there shall be no creeping of stone ahead of the roller.

vi) Until the above conditions are satisfied, no blinding or surfacing materials shall be put on the surface. No rolling shall be done where signs of metal crushing are noticed or rolling causes wave like motions in the base course of sub-grade. Over rolling shall not be done. About 20 to 30 trips of the roller shall normally suffice to make the surface well compacted. Before starting rolling, the metal shall be dressed accurately to camber. No fresh

metal shall be added once dry consolidation has commenced. The part of the road must be fully raked up so that the metal is thoroughly incorporated into the body of road.

i. **Blinding Course :** When the required consolidation has been completed, the blinding material of approved graded murrum/stone grit and dust (unscreened) as specified shall be spread over the surface and brushed backwards and forwards to fill in the surface voids and rolling and watering continued to such an extent that the blinding materials are formed into a slurry and is grouted into the interstices. After the road has been fully consolidated, the surface shall be covered with 12 mm layer of murrum/stone grit and dust (unscreened) and road opened to traffic after 4 days. The road shall be kept watered for 14 days or such other period as specified by the Engineer-in-charge. Where tracks are likely to be formed by the traffic on the road, barriers such as tree branches etc. shall be put to divert the traffic. After 15 days, light watering and rolling shall be done. For joints across the road, the end of each layer shall be given a flat slope and well consolidated together and hump formation must be avoided.

ii. **Damages to the Owners's Property :** Any damage to the **Owners's** property due to negligence of the contractor while executing the work shall be made good to the original condition by the contractor at his own cost.

iii. **MODE OF MEASUREMENT :**

The areas of water bound macadam road surfaces of required thickness actually completed as per above specifications limiting to the areas as per drawing shall be measured in square metre upto two places of decimal,for payment.

The item includes laying, spreading, watering, consolidation, blinding etc. but excluding the cost of 50 mm size I.R.C. metal and graded murrum which will be paid under relevant item. However Murrum obtained from excavation work under this contract and used as blinding material as above on instructions/approval of the Engineer-in-charge shall not be paid.

Wet mix macadam if used shall be mixed in controlled mixing plant and laid as per MORTH specification.

57.3. BITUMINOUS MACADAM & BITUMINOUS CONCRETE SURFACING FOR ROAD (GENERAL) :

SCOPE OF WORK :

The work covered under these specifications provides for bituminous treatment for roads consisting of providing 38 mm thick bituminous macadam and 12 mm thick seal coat or bituminous concrete of thickness as specified in item in the schedule of quantities.

The contractor shall make at his own cost, all the arrangements for controlling the traffic during the execution of the work. All arrangements such as proper barricading of road, diversion of road if necessary, red and green flags during the day, red lights at nights shall be made by the contractor at his own cost to control and safeguard the traffic.

57.4 BITUMINOUS MACADAM OVER WATER BOUND MACADAM :

57.4.1 Preparation of Existing Water Bound Macadam Surface : The existing water bound macadam surface shall be brushed, cleaned properly with wire brushes and coir brooms, so as to free from all loose materials, murrum, earth, silt and caked mud etc. The surface shall then be dusted clean with gunny bags etc. If during the process of cleaning the sub grade (water abound macadam), soft spots and pockets, hollows etc. are found, such spots/pockets will be filled with approved precoated bituminous chips, consolidated and finished to proper level, rolled with power roller if necessary. The pot holes shall be excavated properly in a rectangular or rhomboidal shape with vertical edges. The bottom and sides shall be cleaned as stated above. The sides and bottom shall then be thoroughly painted with heated 60/70 penetration bitumen. The pot holes shall thereafter be filled with premixed bituminous chips so that after thorough tamping and rolling, the surface is flush with surrounding road surface all as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to ensure that the subgrade is even and is finished to camber and slope as shown on the drawings or as directed by the Engineer-in-Charge.

The surface of the subgrade shall be checked for its trueness by means of the scratch template resting on side forms having scratch points placed at not less than 200 mm. apart and set to the exact profile of the base course. The template shall be drawn along the forms at right angles to the road.

Unevenness of the surfaces as indicated by the scratch points shall not exceed 10 mm. in 30 m. The area of depression shall then be painted or sprayed with 60/70 penetration bitumen at the rate of 0.75 kg. per sqm. and the leveling course applied by hand or machine to grade and camber and rolled. If the depressions are deeper than 50 mm., the levelling course shall be applied in two or more layers and rolled as directed by the Engineer-in-Charge.

The prepared surface shall be closed to traffic and maintained fully clean and no asphalting work shall be started unless this prepared surface is approved by the Engineer-in-Charge.

57.4.2 MATERIALS :

Representative samples of materials proposed to be used shall be submitted to the Engineer-in-Charge and got approved. No material shall be used unless it is approved by the Engineer-in-Charge.

57.4.3 HOT MIXED HOT LAID BITUMINOUS MACADAM :

1. Coarse Aggregate : It shall consist of crushed hard trap stone metal, free from coatings of clay, silt and any objectionable material. Metal brought by contractor for different items of work shall strictly conform to I.R.C. specifications in all respects. The aggregate shall be obtained by crushing approved stones of specified type in mechanical crusher and shall be hard, close grained, sound trap stone metal, free from decay and weathering and obtained from approved quarries.

Metal shall be collected in stacks on level ground and neatly stacked at site of mixing. The metal shall be free from all earth, rubbish, vegetation and other foreign matter and graded before stacking and closely packed in stacks.

Tests considered necessary shall be carried out in an approved laboratory when the Engineer-in-Charge considers the quality to be doubtful or there is a dispute about the quality. The cost of testing shall be borne by the contractor.

AGGREGATE GRADING : The requirements of base course shall be as under:

B.S. Sieve Designation	**Equivalent I.S. Sieves**	**Passing percentage**
32 mm. (about 1.25")	40 mm. (1.5")	100
20 mm. (about 3/4")	20 mm.	50 - 100
12 mm. (about 1/2")	12.5 mm.	30 - 60
6 mm. (about 1/4")	6.3 mm.	18 - 30
No. 10	1.7 mm.	10 - 20
No. 200	75 micron	0 - 5

The aggregate/chips shall be entirely dry at the time of mixing.

2. Bitumen : Bitumen to be used shall conform to I.S. 73-1992 for paving bitumen, with 60/70 penetration and shall be from approved manufacturers.
The contractor on demand by the Engineer, obtain and furnish a laboratory test certificate to the effect that the material conforming to the requirement of the specified grade, to the satisfaction of the Engineer-in-Charge. Bitumen (60/70 penetration) content 3.7% to 4.7% by weight of the total mix, shall be used in the mixture.

3. Tack Coat : Bitumen of the same grade as that used for premix shall be heated to a temperature of 163^{0}C to 177^{0}C (325^{0}F to 350^{0}F) in a bitumen boiler and the hot bitumen shall be applied evenly to the thoroughly cleaned and prepared road surface (as specified here-in-before) @ 7.5 kg. per 10 sqm. leaving no part of the surface unpainted. Application shall be done by a mechanical pressure sprayer or if permitted, by perforated pouring cans. The tack coat shall be applied just before the macadam is laid. Application of tack coat shall be only slightly in advance of laying premixed chips.

In case of surface already asphalted, application of tack coat is not necessary.

4. Premixing Chips : The bitumen shall be heated to 163^0 C to 177^0 C (325^0 F to 350^0 F) in boiler. The aggregate of the approved grading or as decided by the preliminary tests shall be dried and heated in an aggregate drier to a temperature of 149^0 C to 177^0 C (300^0 F to 350^0 F) and fed into a twin shaft peddle type mixer at a temperature not less than 149^{0}C (about 300^{0}F). The bitumen, the approved aggregate and the filler shall be measured separately and accurately to the proportions in which they are to be mixed and mixed intimately till all the particles are completely coated with bitumen. Asphalt/bituminous mixing plant proposed to be used by the contractor for the preparation of Asphalt/bituminous mixing shall conform to all of the requirements of the job, which shall produce uniform mixtures of the required quality, and got approved by the E.I.C before mixing.

The temperature of the premix bituminous macadam when leaving the mixer shall not be less than 130 0 C (about 280^0 F) and it shall not be less than 121^0 C (about 250^0 F) at the time of laying.

Bituminous macadam shall be transported to site of work in suitable tipping vehicle properly insulated and covered with canvas or other suitable materials to protect the mixture from weather conditions and to retain the heat. The road surface shall be suitably marked to ensure correct and uniform application. Width of macadam to be laid shall be slightly more (not exceeding 50 mm. on each side) than the required carriage way as per drawing. Excess on either side shall be neatly cut after full compaction to get final width of carriage way as per drawing. The premixed bituminous macadam shall be laid by a mechanical self powered spreader and compactor and finished to correct line, level, & final consolidation done by means of power roller not less than 10 tonne. Any irregularities shall be corrected during rolling.

5. Compaction : The base bituminous macadam course shall be compacted thoroughly and evenly with 10 to 12 tonne power roller immediately after it is laid. Compacted thickness shall be as specified in schedule of quantity.

The surface shall be checked for correct grade during and after rolling. Any irregularities shall be corrected by adding precoated chips or removing the surplus. The disturbed surface shall be well compacted again. If necessary, the roller wheel shall be coated with oil to prevent the coated chip from sticking to the wheels. Rolling shall be continued till no wheel marks are left on the surface. The speed of the roller shall be sufficiently slow to prevent any pushing under the wheels.

57.4. HOT MIXED HOT LAID BITUMINOUS CONCRETE WEARING COURSE (SEAL COAT) :

1. Bituminous concrete : shall consist of mixture of mineral aggregate, sand and filler, graded to fill the voids, mixed with bitumen binder to obtain the maximum stability and durability. It shall be spread and compacted on a prepared bituminous macadam base in conformity with lines, grades and cross section shown in the drawings. The aggregate shall be preheated the temperature specified for the bitumen and the mixture shall be prepared and laid hot.

2. Coarse Aggregate : The coarse aggregate brought by contractor shall be I.R.C. hard black trap, crushed in mechanical crushers and shall be clean, strong, tough, dense, close grained, angular but not flaky, and free from soft, decayed, weathered portion, coating of dust, dirt or other objectionable matter. Maximum size of the aggregate shall be suitable for the thickness of the seal coat (12mm./15mm. or as specified).

The aggregate grading composition and characteristics of surface (wearing course mix) shall conform to standard code of practice. The mix shall satisfy the following requirements:

Bitumen :	7.25 (+/-) 0.25% by weight of total
Voids of air in total mix :	2% by weight of mix and 4% by
Specific gravity	Not less than 2.3.
Marshall stability :	453.6 kg (1000 lb.) minimum
Flow :	1020.
Water absorption :	0.50%

3. Fine Aggregate : The fine aggregate shall be clean, natural, river bank or pit sand or quarry sand produced in a crushing plant and satisfying the requirement of the grading of aggregate for the bituminous concrete as stated above or as determined by the preliminary tests.

Filler : The filler shall be dry and clean lime stone powder hydrated lime having calcium oxide content of not less than 60% both passing B.S. sieve No.8. It shall be free from lumps and loosely bonded aggregation. When tested by laboratory sieves, 100% shall pass through B.S. sieve No.14, 80% shall pass through B.S. sieve No.8. Fillers shall be added to the aggregate to give the above grading determined by preliminary tests.

4. Bitumen : Bitumen shall be of 60/70 penetration or such other grade specified by the Engineer-in-Charge and shall conform to I.S. 73-1 961.

The tenderers shall indicate the exact grading, bitumen content, voids, specific gravity etc. which they propose to adopt for type to treatment offered by them.

5. Preparation of Base : Dirt,dust and other foreign materials if accumulated shall be cleared off leaving the surface entirely clean. The prepared surface shall be closed to traffic and so maintained fully clean till the seal coat is applied.

6. Mixing and Laying Wearing Course : Grade 60/70 bitumen shall be heated to a temperature of 163^0 C to 177^0 C (325^0 F to 350^0 F) in a boiler. The aggregate of the suitable approved grading or as decided by preliminary tests, shall be dried and heated in an aggregate drier to a temperature of 149^0 C to 177^0 C (300^0 F to 350^0 F) and fed into a twin shaft peddle type mixer at a temperature not less than 149^0 C (300^0 F). The bitumen, the aggregate and the filler shall be measured separately and accurately to the proportions in which they are to be mixed and mixed intimately till all the particles are completely coated with bitumen. The quantities of aggregate, bitumen and the filler shall be such as to obtain the percentage of each as specified above or decided after tests. Continues batching and mixing plant shall be used. Asphalt/bituminous mixing plant proposed to be used by the contractor for the preparation of asphalt/bituminous mixes shall conform to all of the requirements of the job, which shall produce uniform mixtures of the required quality.

The temperature of bituminous concrete when leaving the mixer shall not be less than 138^0 C (280^0 F) and it shall not be less than 121^0 C (250^0 F) at the time of laying.

The bituminous concrete shall be transported to the site of work in suitable tipping vehicles properly insulated and covered with canvas or other suitable materials to protect the mixture from weather conditions and to retain the heat.

The mixture shall be spread with mechanical self powered spreader. The bituminous concrete shall be laid to the specified line, curve, grade and camber. Any irregularities shall be corrected immediately before rolling is started. Before laying the mixture, the faces of the joints shall be painted with a uniform coating of hot bitumen. The bituminous

concrete shall be laid to such loose depth as to give a compacted layer of specified thickness as per item in the schedule of quantities.

7. Compaction : The bituminous concrete layers shall then be allowed to cool sufficiently such that it does not spread under wheel load of 10/12 tonne power roller. The compaction shall be done by the roller till no wheel mark are left on the surface and no further compaction is possible. The road shall be opened to traffic on cooling of the concrete to the atmospheric temperature or after a lapse of 24 to 40 hr. after laying.

GENERAL REQUIREMENTS FOR BITUMEN MACADAM & SEAL COAT:

1. Testing : The contractor shall have a well equipped testing laboratory with a competent laboratory staff. Daily tests (not less than two specimen per day) shall be made by them on the bituminous mixture produced to ensure compliance with these specification and copy of the test results duly signed by the competent authority shall be submitted to Engineer-in-Charge for record. Tests shall include water absorption, stability, filler content etc.

The contractor shall give all facilities at all times to the Engineer-in-Charge or his representative to inspect the work or testing done by him.

2. Weighing : Each lorry leaving the plant must be weighed on a weigh bridge in the presence of the representative of the E.I.C and a challan must be issued along with the lorry in duplicate showing the weight of the material loaded in the lorry. As and when required, the said lorries shall also be weighed at weigh bridge approved by the Engineer-in-Charge to check the tonnage of the material stated on the challans. In case of short fall, the same shall be made good by the contractor without extra cost.

3. Testing Surface : The completed surface when ready for acceptance shall be thoroughly compacted, smooth, true to line, grade, camber and free from irregularities when tested by means of a straight edge of 3 m. long, laid on the finished surface parallel with the centre line of the road, the surface shall in no place vary more than 6mm. from the working edge.

4. MODE OF MEASUREMENT :

i) Measurement for bituminous macadam including filling in pot holes and depressions shall be paid by weight measured in metric tonne used on the job, completed satisfactorily, measured upto second place of decimal including preparing surface, applying tack coat and compacting by roller etc. complete as specified.

ii) Measurement for bituminous concrete (seal coat) shall also be paid by weight as

measured at site of work, irrespective of the thickness laid, in Metric tonne used on the job, compacted satisfactorily, measured upto second place of decimal including all the relevant items of work specified.

58. FENCING WORK WITH BARBED WIRE, CHAIN LINK ETC. :

The work shall generally be carried out as per these specifications, relevant drawings and as directed by the Engineer-in-Charge.

58.1. M.S. POSTS AND STRUTS :

All the M.S. posts/struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the specified sections. The posts and struts shall be conforming to relevant specifications stipulated here-in-before under relevant sections. All the posts and struts shall be of sizes and lengths as specified in the tender schedule and drawing. The posts and struts shall have split ends for proper fixing and shall be embedded in the cement concrete of mix. 1:3:6 or as specified in the schedule. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

58.2. R.C.C. POSTS AND STRUTS :

All the posts and struts shall be of standard size as specified in schedule. These shall be casted on suitable places/platforms in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm. nominal size) as per relevant specifications stipulated here-in-before. The reinforcement shall be provided as shown in the drawings, as directed by Engineer-in-Charge and specified here-in-before under relevant sections. The posts and struts shall be free from honeycombing, cracks and other defects.

After casting, the posts/struts shall be left at the same place and cured for a minimum period of 7 days. After 7 days curing the same shall be shifted to a levelled ground and stacked for further curing for 14 days. After 21 days of curing only, the posts/struts shall be transported to work site without any damage, for fixing in position.

58.3. SPACING OF THE POSTS AND STRUTS :

The spacing of posts shall be 3 m. centre to centre unless otherwise specified or as directed by the Engineer-in Charge, to suit the dimensions of the area to be fenced. Every 10th posts, last but one end posts, corner posts, and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as directed by the Engineer-in-Charge. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

58.4. FIXING OF M.S./R.C.C. POSTS AND STRUTS :

Pits of size 45 x 45 x 45 cm. deep or of sizes mentioned in the drawings, shall first be excavated centrally in the direction of proposed fencing work, true to line and level to receive the posts. In case of struts, the pits shall be so excavated, as to receive minimum 15 cm. concrete cover at any point of the struts to suit its inclination or as shown in the drawing.

The pits shall be filled with a layer of 15 cm. thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position, by providing adequate supports temporarily, and cement concrete of specified mix. shall then be filled-in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for atleast 7 days to ensure proper curing.

58.5. BARBED WIRE :

The barbed wire shall be of M.S. or G.I. as specified and it shall generally conform to I.S. 278-1978.

The base metal of the line and point wire shall be of good commercial quality mild steel. The line and point wire shall be circular in section, free from scales and other defects and shall be uniformly galvanised if specified.

The line wire shall be in continuous lengths and shall generally be free from signs of welds. It shall be able to withstand Wrapping and unwrapping 8 turns round its diameter.

The barbed wire shall consist of two splices per reel. The barbed wire shall be formed by twisting two lines wires one containing the barbs.

The barbed wire and its weight shall be as given in the table below:

Type	Nominal diameter of wire				Nominal distance between two barbs in mm	Mass of complete barbed wire (in gm./m.)	
	line wire (in mm.)		point wire (in mm.)				
1.	2.50	(12 G)	2.50	(12 G)	75	146	(136-155)
2.	2.50		2.50		150	114	(108-120)
3.	2.50		2.00	(14G)	75	117	(108-125)

4.	2.50		2.00		150	96	(89-1 03)
5.	2.24	(13 G)	2.00		75	102	(97-1 06)
6.	2.24		2.00		150	82	(78- 85)

The barbs shall carry four points and shall be formed by twisting two point wires, each two turns, tightly round one line wire, making altogether 4 (four) complete turns. The barbs shall be so finished that the four points are set and locked at right angles to each other.

The barbs shall have a length of not less than 13 mm. and not more than 18 mm. The points shall be sharp and well pointed. Barbed spacings shall be as given in the above table. Wherever required for every 50 reels or part thereof, samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to conform to tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

TENSILE PROPERTIES :

Size of line wire	**Breaking load of line wire**		**Min. breaking load of**
Nominal dia (in mm)	**Min. (in Kg.)**	**Max. (in Kg.)**	**complete barbed wire (in Kg.)**
2.50 (12G)	216	302	444
2.24 (13G)	128	179	263

On the results of these additional tests, the whole or portion of the barbed wire shall be accepted or discarded as the case may be.

58.5.1. Fixing of Barbed Wire : The barbed wire shall be stretched and fixed in number of rows and two diagonals as specified. The bottom row shall be 140 mm. above ground and the rest at 125 mm or at given spacing as per drawing. The diagonals shall be stretched between adjacent posts from top wire of one post to the bottom wire of the 2nd post. The diagonal wires will be interwoven with horizontal wires by fixing the odd rows of wires, then the diagonal cross wires and lastly the even rows of wires. The jointing of the barbed wire in between the posts shall not be permitted.

Necessary holes should be tapped in the post and the barbed wire shall be fixed in position by means of 'U' clamps or bolts and nuts as specified in drawings. In case of fixing with

'U' clamps, the legs of the 'U' clamps passing through the 10 mm. dia. hole in the R.C.C. post to hold barbed wire shall be turned up and down to get an over-lap of 25 mm. on the face of RCC post. Turn buckles and straining bolts shall be used at the end posts if specified.

58.5.2. MODE OF MEASUREMENT :

The work shall be measured in running metre length of fencing correct to a centimetre for the finished work, from centre to centre of the posts.

The rate shall include the cost of labour and materials involved in all the operations described above including the cost of barbed wire, turn buckle, straining bolts, bolts and the nuts/U clamps including excavation and foundation concrete or as specified in item description for the work.

58.6. CHAIN LINK :

The chain link shall be of approved manufacture and of correct size, gauge etc. It shall be of M.S. or G.I. as specified of approved manufacture and of required size, gauge etc. The base materials of the wire shall be of good commercial quality mild steel. The wire shall be circular in section, free from rust, scale, cuts, welds and other defects and shall be uniformly galvanised if specified.

58.6.1. FIXING OF THE CHAIN LINK FENCING TO M.S. OR R.C.C. POST :

The chain link of specified height of fencing shall be fixed first to the end post with necessary G.I. approved type U clamps threaded at both the ends and G.I. nut, bolts, washers etc. and with 6 mm. dia. full height M.S./G.I. anchor bar. After fixing the chain link at the end post, it shall be stretched tightly and fixed to next post one after the other by the above mentioned clamps and bars etc. leaving 50 mm. clearance from the ground and 20 mm. clearance in the case of concrete coping at bottom to avoid rusting. The point at the change in level of the fencing top/bottom, necessary links shall be adjusted suitably as per the manufacturers specification or as directed by the Engineer-in-Charge. The entire chain link fence shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer or as specified in the item/drawing.

58.6.2. MEASUREMENT :

The work shall be measured in running metre length of fencing correct to a centimetre for the finished work from centre to centre of the posts.

The rate shall include the cost of labour and material involved in all the operation described above including the cost of barbed wire, turn buckle, straining bolts and bolts and the nuts/U clamps, 6 mm. dia. M.S./G.I. anchor bar etc. including excavation and foundation concrete or as specified in item description for the work.

CEMENT CONCRETE PAVEMENT (UNDER ORDINARY CONDITIONS)

Concrete is same as above

Compaction of Concrete

Compaction shall be carried out by electrically (or) diesel operated needle and screed vibrators as stipulated hereafter. Needle vibrator should be used all over the area for obtaining initial compaction of concrete. These should be of diameter not less than 4.5 cm. If the vibrator are pneumatic the pressure must not be below 4 kg/sq.cm. If electrically operated, they should have a minimum frequency of 3500 impulses per minute.

There should be at least three needle vibrators working in any bay. A vibrating screed consisting of a steel or timber section weighing not less than 15 kg. per metre with a tamping edge of not less than 7 cm width and having a vibrator mounted thereon shall follow needle vibrators to obtain full compaction. The face of the wooden tamping edge of the screed shall be lined with M.S. Plate rigidly fixed by means of counter sunk screw. Where screed vibrators are used for compaction, a standby unit shall always be maintained ready for use, should the other one go out of order. Where electrically driven vibrators are employed, a standby diesel pneumatic unit shall be kept ready for use in case of power failure. At the discretion of the Engineer-in-Charge, for compaction at edges and joints, vibrators may be supplemented by hand tamping and rodding for securing satisfactory results. Under no circumstances, honey combing of concrete at joints or elsewhere shall be permitted.

When using screed vibrator for compaction it should not be dragged over the concrete. During the initial passes it shall be lifted to the adjacent forward position in short steps, subsequently, it shall be slowly slided over the surface with its axis slightly tilted away from the direction of sliding and the operation repeated until a close, dense surface is obtained.

Concreting shall be carried out in one operation between the expansion joints and construction joints without any break at the dummy joints.

Concrete shall be deposited on the base as near the joints as possible without touching them.

It shall then be shoveled against the sides, maintaining equal pressure and deposited approx. 50 mm higher than the depth of the joints, care being taken that it is worked well around the joints. The concrete shall not be dumped from the bucket directly upon or against the joints.

Workmen shall not be allowed to walk on freshly laid concrete and proper cat walk shall be provided with independent supports beyond concreting bays.

Finishing of Concrete

During compaction, any low or high spots shall be made up by adding or removing concrete.

After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge. Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished. Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished.

The straight edge testing the refloating is to continue until the entire surface:

(a) is free from observable departure from the straight edge,

(b) Conforms to the required levels and across section, and

(c) Shall conform to the specified surface when the concrete has hardened.

The foregoing work is to be carried out while the concrete is still plastic and workable.

Belting

Just before concrete becomes non-plastic, the surface shall be belted with a two ply canvas belt not less than 20 cm wide and at least 1 metre longer than the width of the slab. Hand belts shall have suitable handles to permit controlled uniform manipulation. The belt shall be operated with short strokes transverse to the centre line of the pavement and with rapid advance parallel to the centre line.

Brooming

After belting and as soon as the surplus water, if any, has risen to the surface, the pavement shall be given a broom finish with an approved steel or fiber broom not less than 45 cm wide. The broom shall be pulled gently over the surface of the pavement from edge to edge.

Adjacent strokes shall be slightly overlapped. Brooming shall be perpendicular to the centre line of the pavement and so executed that the corrugations formed shall be uniform in character and width and not more than 1.5 mm deep.

Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions, and small pockets such as may be caused by accidental disturbing of particles of coarse aggregates embodied near the surface. The brooming shall be of uniform pattern all through.

Edging :

After belting/brooming has been completed but before the initial setting of concrete, the edges of the slab shall be carefully finished with an edger of 6 mm radius, and the pavement edges shall be left smooth and true to line.

Honey Combing

The side forms shall not be removed until 12 hours or such longer period as the Engineer-in-

Charge may decide after the laying of concrete.

As soon as the side forms are removed, any minor honey combed area shall be filled with mortar composed of one part of cement and two parts of fine aggregate. Major honey combing areas or segregated concrete or other defective work or areas damaged by removal of the forms or concrete damaged by rain or due to any other reason whatsoever shall be considered as defective work and shall be removed and replaced by the contractor at his own expense. The total area of honey combed surface shall not exceed 4 per cent of the area of the slab side. However, no individual honeycomb patch shall exceed 0.1 sqm. Engineer-in-Charge's decision as to whether the concrete is defective or not shall be final and binding.

Surface Accuracy

After the concrete has sufficiently hardened after about 12 hours and not later than 24 hours, the surface shall be tested again for high spots. All high spots shall be marked and those exceeding 3 mm shall be ground down immediately. Care shall be taken to see that the grinding does not in any way damage the concrete surface.

The final surface finish is to be such that when tested with a profilograh/roughness indicator/or a 3 metre long straight edge or an equivalent mechanical unevenness indicator placed anywhere within the same or adjoining slab in any direction on the surface, there shall be no variation greater than 3 mm.

If the surface irregularity exceeding 3 mm still remains despite grinding the concrete shall be removed to its full depth. The area of concrete to be removed shall be complete slab between the nearest joints, where the defective slab is less than 4.5 metres from the expansion joint, the whole area upto the expansion joint shall be removed to the full depth. The concrete so removed shall not be reused in the work. Fresh concrete shall be laid in the manner already described in above paras and shall again be subject to test for surface accuracy and other quality control measures. Nothing extra shall be paid on this account.

Every slab shall bear an impression not exceeding 3 mm in depth comprising the number allotted to the slab and the date on which it is laid. This impression shall be formed by the contractor when the concrete is green so as to leave permanent mark on setting.

Initial Curing

Immediately after completion of the finishing operations, the surface of the pavement shall be entirely covered with wetted burlap, cotton or jute mats. The mats used shall be of such length (or width) that as laid they shall extend at least 45 cm beyond the edges of the slab. The mats shall be placed so that the entire surface and both edges of the slab are completely covered. This covering shall be placed as soon as, in the judgment of the Engineer-in-Charge the concrete has set sufficiently to prevent damage to the surface prior to being placed, the mats shall be thoroughly saturated with water and shall be placed with the wettest side down. The mats shall be so placed and weighed down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained full wetted and in position for 24 hours after the concrete has been placed or until the concrete is sufficiently hard to be walked on without suffering damage. Water shall be gently sprayed so as to avoid damage to the fresh concrete. If it becomes necessary to remove a mat for any reason, the concrete slab shall not be exposed for a period of more than half an hour.

Worn burlap or burlap with holes shall not be permitted. Burlap reclaimed from previous use other than curing concrete shall be thoroughly washed prior to use for curing purposes. If burlap is obtained in strips, shall be laid to overlap by at least 150 mm.

Burlap shall be placed from suitable bridges. Walking on freshly laid concrete to facilitate placing burlap shall not be permitted.

Final Curing

Upon the removal of the burlaps, the slab shall be thoroughly wetted and then cured as follows:-

All joints shall be filled with filler in order to prevent the edges of joints from getting damaged and entry of clay materials into the joints during final curing. Exposed edges of the slab shall be banked with a substantial berm of earth. Upon the slab shall then be laid a system of transverse and longitudinal dykes of clay about 50 mm high immediately covered with a blanket of sandy soil free from stones to prevent the drying up and cracking of clay. The rest of slab shall then be covered with sufficient sandy soil so as to produce a blanket of earth not less than 40 mm deep after wetting. The earth covering shall be thoroughly wetted while it is being placed on the surface and against the sides of the slab and kept thoroughly saturated with water for 21 days and thoroughly wetted down during the morning of the 22nd day and shall thereafter remain in place until the concrete has attained the required strength and permission is given by the Engineer-in-Charge. Thereafter the covering shall be removed and the pavement cleaned and swept. If the earth covering becomes displaced during the curing period, it shall be replaced to the original depth and re saturated.

Contractor shall appoint chowkidars at his expense to prevent workmen, cattle, etc., straying on the pavement concrete.

Concrete shall not be subjected to any load or weight of any plant until at least 28 days after laying.

Construction Joints

Construction joints shall be provided as shown in the drawing and also at places where concreting is stopped due to unforeseen circumstances. The joints shall be straight and vertical through the full thickness of the slab. While concrete in adjacent bay is still green, flats of suitable size shall be drawn along the edge and a groove of size 10 mm × 25 mm deep shall be neatly formed and finished.

The edges of the groove shall be full nosed. After curing of concrete is complete, this groove shall be thoroughly cleaned of all sand dust and shall be perfectly dried and filled with hot poured sealing compound conforming to grade B of IS 1834. Before filling with sealing compound the faces of concrete of the joint shall be coated with primer of approved brand to a depth of 25 mm at the rate of 2.6 liters per 10 square meters. Bitumen emusion shall not be used as primer.

Dummy Joints

The joints shall be 10 mm wide and shall extend vertically from the surface of the slab to a depth equal to 1/3rd of the thickness of the slab but not less than 4 cm in any case. The joint may be formed by depressing into the soft but compacted concrete a high tensile M.S. or other approved Tee of flat bar of depth not less than required depth of the joint plus 25 mm. The bar used for forming the groove shall be coated with soft soap or other suitable lubricant

to facilitate its removal when the steel Tee or flat is removed joints shall be neatly formed with proper tools and mortar/fine material from the slab itself. No additional cement mortar (rich or otherwise) shall be used.

Cutting or sawing by a saw mounted on a movable frame and driven mechanically shall also be permitted as a method for making the joint. In this case the width may be reduced to 6 mm. any other method for making joints can be followed with the prior approval of the Engineer-in-Charge.

In all cases, except where cutting is done with saw, the joint edges shall be bullnosed. Care should be taken to see that the edges of the grooves are not damaged.

The grooves shall be filled with hot poured sealing compound conforming to Grade B of IS:1834. Prior to filling with sealing compound, the joints shall be cleaned by compressed air and primed with Shalijet primer or equivalent at the rate specified

All joints shall be sealed as soon as practicable after 28 days of casting of cc pavement.

Joints shall be sealed flush with the adjacent pavement surface in summer and 3-4 mm below finished concrete surface in winter. The pavement shall be opened to traffic only after joint sealing over the entire pavement. To prevent tackiness or pickup under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge, for which nothing extra shall be paid to the contractor.

In case of sudden rain or storm, the work can be concluded at the dummy joints but these will then be formed as construction joints.

Before sealing of joints, it may be ensured that the groove extends fully across the bay between consecutive longitudinal joints, in the case of transverse joints and is continuous in the case of longitudinal joints. Any concrete or other foreign matter must be removed from the groove.

Measurement

In Cubic Meter

EXPANSION JOINT

Materials

Premoulded Joint Filler in Expansion Joint:

It shall conform to IS 1838 (Pt. I). The thickness shall be 25 mm with tolerance 1.5 mm. and shall be of the maximum available standard length not less than one lane width. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within tolerance of + 10 mm from the intended line of the joint. The depth of board shall be 25 mm less than thickness of slab within a tolerance of ± 3mm so that the top of the board shall be below the surface or will not impead the passage of the finishing straight edge or oscillating beam of the paving machine.

Bitumen Hot Sealing Compound:

The joint sealing compound shall be fuel and heat resistant type complying to grade B of IS 1834. It shall be capable of adhering to the concrete without cracking, spalling and disintegration.

CONSTRUCTION PROCEDURE

Expansion joints shall be provided as shown in the drawing and as per directions of Engineer-in- Charge. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. The joint shall be 20 mm wide. The depth of the non-extruding filler pad shall be 25 mm less than the depth of the concrete slab

.Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with primer at the rate of 2.6 liters per 10 square metres. The expansion pad shall be properly cut to shape and shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The face of the pad against which the new concrete slab is to be laid shall also be painted with primer before laying the concrete, while concreting a neat groove of size 20 mm x 25 mm as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

Before the curing process is started, the top of expansion joint shall be filled with bitumen sand mixture in order to ensure that no foreign material used in curing enters into the joint. This filling shall be removed before filling the joints with sealing compound.

For sealing the joints following operations shall be carried out :—

(a) The joints are cleared of any foreign matter to the full depth upto the top of expansion pad with steel spatula.

(b) The joints are blown with compressed air.

(c) Cleaning is done with Kerosene oil.

(d) Priming is done with spray gun @ 2.6 liters per 10 sqm of the surface to be primed.

(e) The primer is allowed to dry completely before pouring the sealing compound.

(f) The sealing compound grade 'A' is heated to the required temperature ranging between 155 deg. C to 165 deg. C or to the temperature range specified by the manufacturer. Over heating shall be avoided. Pouring shall be done from vessel with spout in such a manner that the material will not get spilled on the exposed surface of the concrete, any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned.

(g) The filling shall be worked into the joints with hot flats to ensure escape of trapped air.

(h) The filling is then ironed with hot iron. It is recommended that while in summer the joints may be sealed flush with the adjacent pavement surface, in winter the sealing compound may be filled to a depth 3-4 mm below the surface.

(i) The edges of the joints are then cut and trimmed to ensure neat and straight line finish.

(j) To prevent tackiness or pick up under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge (Nothing extra shall be paid for the same).

Measurements:

The measurement of the specified depth of joint shall be recorded in metres correct to two places of decimals.

* * * *

59. M. S. CRIMPNET GATE :

59.1. MATERIALS :

All steel work, pipe frame work and crimpnet shall be of sizes and sections as per drawings. They shall generally conform to relevant I.S. specifications. The G.I. crimpnet shall be unless otherwise stated, 25 x 25 mm. x 8 g. and of approved manufacture.

59.2. INSTALLATION :

For each leaf of the gate, the crimpnet shall be fixed tightly to internal angle iron frame of required size by means of suitable welding. This internal angle iron frame is then fixed to

outer frame of 50 mm. dia. seamless pipes by means of 65 mm. long angle iron lugs welded together. Suitable cleats for the locking arrangement are welded at the height as shown in drawing. Both the leaves of the gates thus be fixed over suitable hinges provided on the side M.S. channel posts of specified sizes. The side post which shall be erected prior to fixing the gates shall be welded with m.s. plates 250 x 150 x 5 mm. at bottom. These posts shall be properly embedded in cement concrete foundations of specified sizes and allowed to set properly.

All the assembly mentioned above shall be properly erected correct to line, level, plumb and render easy and proper movement of shutters.

59.3. The shutters, channel posts and all other steel parts shall be thoroughly cleaned and painted with red oxide primer of approved make and shade. Final painting with two coats of flat oil/synthetic enamel paints of approved shade and make shall be done as directed by the Engineer-in-Charge and as per specifications.

59.4. MODE OF MEASUREMENT :

The length of the gate shall be measured clear in between the side m.s. channel posts and height between the extreme ends of pipes, correct to half centimeter and area worked out in sqm. correct to two places of decimals.

The rate shall include the cost of all materials mentioned above viz. crimpnets, m.s. angles, G.I.pipes, guide plates, channels, base plates, hinges, locking arrangement and other accessories as also necessary excavation in pits, embedding cement concrete, painting etc. all complete. The rates shall be valid for areas in variance by about (+/-) 10% in the overall size of the gate.

60. DRAINAGE WORK WITH NP2 CLASS RCC HUME PIPES :

60.1. R.C.C. SPUN PIPES :

The pipes shall be R.C.C. spun pipes NP2 class, conforming to I.S. 458-1971 and shall be approved by the Engineer-in-Charge for soundness before incorporation in the work.

60.2. LAYING R.C.C. SPUN PIPES :

The work consist of providing, laying, jointing and testing R.C.C. spun pipe storm water drain of required diameter as mentioned in the schedule to discharge storm water to the main nallah as shown in the drawing.

After the cement concrete cradle has been laid properly, if specified or as directed by the Engineer-in-Charge, the pipes shall be lowered gradually into the trenches over the concrete cradle or bed. Necessary working space/gap for collars shall be made at every joint. Laying of pipe shall proceed upgrade of a slope. The collars shall be slipped-on before the next pipe is laid.

The pipe drain shall rest on the bed at every point through its length. To ensure this the space between the underside of the pipe on the invert of the cradle shall be carefully grouted solid with cement slurry consisting of one part of cement to one part of clean washed sand in such a manner that no void is left. It shall be ensured that the load of the pipes and the super imposed load of the earth filling is evenly distributed on the cradle or bed.

The contractor shall take precautions to see that no dirt, earth or other foreign matter is allowed on the surface of the cradle or bed of the pipe resting there-on, all to the full satisfaction of the Engineer-in-Charge. After the alignment and grading of the pipes is checked by the authorised representative of the E.I.C, the grouting shall be done with specified stiff mix of cement mortar.

The cradle of concrete shall be allowed to set at least for three days before any pipe is placed on it and the contractor shall take due care in setting the pipe in the cradle so that no damage is occur to the cradle. If any damage to the cradle occurs, it shall be rectified to the satisfaction of Engineer-in-Charge and in any particular case where damage to the cradle is beyond repair in the opinion of the Engineer-in-Charge, the contractor shall cut out the damaged section of the cradle and re do the same at his own expenses to the complete satisfaction of the Engineer-in-Charge.

No pipe shall be laid or placed till the alignment of the pipe drain and its levels and gradient have been carefully checked and found correct/approved by the Engineer-in-Charge.

60.3. JOINTS :

The joints for the pipes shall be made by loose collars and the connecting space shall be as minimum as possible. The collars shall be specifically roughened inside to provide a better grip.

The two adjacent pipes will be so designed and manufactured that when butted together concentrically, a dowel is left between the two ends. In this dowel, cement mortar of (1:1) proportion or mix. as specified in the schedule be filled and then between the ends a paste of cement mortar of the same proportions will be placed. The space remaining between

the pipe ends and the collar being then caulked with cement mortar of (1:1) or other specified proportion so that an even space appears all round the external diameter of the pipes. All the joints shall be finished off smooth at an angle of 45o with the longitudinal axis of the pipe on either side of the collars.

The interior of the pipe drains shall be cleaned off all dirt, cement mortar and superfluous materials and joints shall be cured for atleast 7 days.

60.4. TESTING OF R.C.C. SPUN PIPES :

After sufficient interval has been allowed for the joints to set, the pipe drains will be tested under a water head of at least 1.2 m. and in no case under a head greater than 1.8 m. of water above the top of the pipes. In addition, the pipe drains shall be examined for leaks of land/sub-soil water making its way through the joints. The contractor shall make the pipe drains water tight against the entrance of land/sub-soil water from outside and also against the leakages of water from the inside of the pipe drains at the test heads specified above to the full satisfaction of the Engineer-in-Charge.

All defective or leaking pipes or joints shall be cut out and replaced and made good by the contractor at his own cost. In case of the joints that may be defective and cannot be made good, shall be entirely embedded/surrounded externally with cement concrete of 1:2:4 proportion to render the joint (s) water tight and this shall be allowed to set before encasing or back filling is done. A strong colour shall be added to the water used for testing of the pipes, in order to detect any leakage easily. The cost of testing of the pipe drain shall be borne by the contractor and is deemed to be included in the rates quoted by the contractor.

60.5. ENGINEER-IN-CHARGE MAY ORDER CONCRETE TO BE INCREASED OR DIMINISHED :

The Engineer-in-Charge may increase or decrease the concrete on the pipe drains as to the quantity and quality or to omit the same entirely according to the nature of the ground that may be revealed when the storm water drain trenches are excavated.

60.6. Back filling/filling Trenches :

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 20 cm. watered, rammed and consolidated, taking care that no damage is caused to the pipe below. In case of excavation of trenches in rock, the filling upto a depth of 30 cm. above the crown of pipe or barrel shall be done with fine material such as earth, murrum or

pulverised decomposed rock according to the availability at site. The remaining filling shall be done with rock filling or boulders of size not exceeding 15 cm. mixed with fine material as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30 cm.

60.7. MODE OF MEASUREMENT :

The length of pipes shall be measured in running metre nearest to a centimetre along the centre line of the pipes over all fittings such as collars, bends, junctions etc. Fittings/specials shall not be measured separately.

The rate shall include the cost of materials and labour including jointing, grouting, cutting of pipes to the required lengths, wastages etc. involved in all the operations described above.

Excavation, back filling, shoring and timbering in trenches and cement concreting wherever required shall be measured separately under relevant items of work.

61. ROUGH / NATURAL FACED SHAHABAD STONE PAVEMENT:

61.1. MATERIALS :

Hand cut rough/natural faced shahabad stone shall be of the best quality and of the specified thickness, size etc. and shall be got approved by the Engineer-in-Charge. The sizes given in schedule of quantities are tentative and can vary only slightly as per the availability in the market. At its thinnest, no stone shall be thinner than specified thickness. The stone shall be hard, sound, durable, tough, free from flaws, cracks, decay & weathering. The edges shall be hand cut and dressed true and squares. The evenness of surfaces and edges of the slabs shall not be marred by careless dressing or handling and no patching up shall be allowed for the slab. The edges shall be reasonably straight. The under face may be left as required or rough dressed. Before taking up the work, samples of stone slabs to be used and their dressing shall be got approved by the Engineer-in-Charge. The work shall be carried out strictly in accordance with the approved samples.

61.2. BEDDING/BACKING COAT :

In case of plinth protection or other pavements over concrete sub base, the mortar bedding shall be of cement mortar of thickness and mix specified in the item of tender schedule.

In case of pavement work for footpaths, approaches and other similar works, to be laid directly over levelled and consolidated ground, the bedding shall be of 150 mm. thick quarry spoil and 60 mm. thick stone grit or as specified/directed by the Engineer-in-Charge.

61.3. LAYING AND FIXING THE STONE SLABS/ TILES :

The specifications for Kotah stone flooring/skirting/facia described here-in-before shall hold good as far as it is applicable except that the joints shall be pointed with C.M. 1:3 or with other specified mix, finished flush/with grooves as specified/directed. The joints shall be raked out uniformly to a depth of not less than 12 mm. before grouting and pointing the same.

61.4. CURING :

The pavement work shall be kept well wetted for atleast seven days.

61.5. CLEANING :

When the bedding and joints have completed, set and attained required strength, the surface shall be thoroughly cleaned and handed over free from any mortar stains, dust, dirt etc.

61.6. MODE OF MEASUREMENT :

The above pavement work shall be measured in square metre correct to two places of decimal. The length and breadth shall be measured net correct to a centimetre. The pavement under skirting/dado/wall plaster, if any, shall not be measured for payment.

No deduction shall be made nor extra paid for any opening of area up to 0.10 sqm. Nothing extra shall be paid for use of cut tiles/slabs nor for laying the pavement at different levels.

NOTE : Wastage in obtaining the required sizes as specified from the commercial sizes available in market is deemed to be taken in to consideration by the contractor while quoting the rate. The work shall be measured as above and no extra claim on this account will be entertained.

62. UNDERDECK INSULATION SYSTEM

The Under deck thermal insulation shall be done with NEOPOR Board which offers greater insulating performance with low water absorption and up to 50 percent lower use of materials and 20 percent better insulating performance than conventional EPS, helping environmental conservation and saving money. Environmentally-friendly Neopor insulating materials do not contain CFCs, HCFCs, HFCs or other halogenated cell gases.

They contain air as the cell gas, which guarantees the preservation of the thermal conductivity throughout the life of the construction.

Technical Properties

Parameters	**Property**	**Code Compliance**
Colour	Silver – gray	
Dimension, Thickness	1000mm*500mm, 120mm	
Fixing Arrangement	Adhesive	
Compressive Strength @ 10% deformation	100-150 kpa	DIN EN 826
Fire Behaviour	B1	DIN 4102
Long term water absorption (28 days)	≤ 3	DIN 12087
Tensile Strength	≥ 200	DIN 1607
Thermal Conductivity @ 10 deg C mean temperature	< 0.031 W/mK	DIN 52612
Ozone depleting substance	Free of HFC,CFC,HCFC	EU Council Regulation 1005/2009
Thermal Resistance Value	21 sft.OF.hr/Btu	

The product should be manufactured by a company certified to conform to the requirements of the quality, environmental and occupational health & safety standards ISO 9001, ISO 14001 and OHSAS 18001.

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

Method Statement for Under Deck Insulation Using Neopor Boards

A. Underdeck Thermal Insulation Layer

The thermal insulation built-up would be done in a highly technical manner using the latest technologies, products and innovations. The product shall be NEOPOR of BASF of 50mm thick. The insulation boards of Neopor to be fastened to the roof slab from below using tile adhesive Mastertile 30 The high performance tile fixing adhesive shall be cementitious polymer modified powder. The adhesive shall be free from chlorides.

B. Method Statement for Underdeck Insulation

1) Surface preparation - The substrate shall be free from laitance, curing compound, oils and any foreign substance which would inhibit the bonding of the Neopor board to the substrate. The substrate shall be smooth; any undulations greater than 3 mm shall either be grinded or finished with Emaco 303. The substrate shall be lightly abraded mechanically with buffing wheel/ angle grinder/hacking. The substrate shall be saturated with water prior to application of Neopor board

2) **Markings**- Any identification points or markings left on the slab shall be transferred to the wall or the floor, which after completion of insulation shall be remarked on the insulation board. The deck slab shall be marked and divided in such a way that the edges receive at least 300 mm wide Neopor board.

3) **Application**- The surface of Neopor board which will receive Master tile 30 shall be sanded/ abraded. Mastertile 30 shall be applied on the Neopor board using 6mm notch trowel. First take a small quantity of Mastertile 30 and apply it with force pressing it against the board with a flat trowel. Take further quantity and use a 6 -8 mm notch trowel. Mastertile 30 shall be removed from the periphery of the board at least 25 mm wide. The consumption is approx. 4 - 5 kg/Sqmt.

4) **Placing-**The Neopor boards shall be placed along the marking and pressed upward using both the hands for 10 to 15 seconds and tapped lightly. Care should be taken while placing the board so that each Neopor board fits in the tong and groove arrangement. Drilling for fixing of the anchors shall be done immediately while the person is still holding the Neopor board. The depth of hole shall at least be 25 mm in the concrete. After drilling anchors shall be fixed in the drill hole at 1 anchor per board.

5) The initial markings which were transferred on the walls and the floor shall be transferred back on to the Neopor Boards.

C. Installation Of Underdeck Neopor Boards At The Site Conditions

1. Removal of Shuttering Marks - The projections of shuttering marks should be chipped and grinded. Form release agents should be removed and surface prepared as per the given method statement.

2. Suspenders for False ceiling - The suspenders for false ceiling shall be installed after the installation of Neopor Boards

3. Suspenders for Fire Hydrant - The suspenders for fire hydrant / firefighting conduits to be installed after the installation if Neopor Boards.

4. HVAC Duct - The HVAC ducts to be installed after the installation of Neopor board.

5. Pipes fixed to the Wall - The pipes fixed to the wall should be in a straight line. Groove to be cut in the Neopor board with the help of Hot knife or sharp knife and fixed on the slab.

Since 2, 3 and 4 are fixed with the help of suspenders the installation of Neopor Boards to be done first and then the suspenders shall be installed.

63. AUTOCLAVED CELLULAR (AREATED) CONCRETE BLOCK MASONRY

63.1 Scope of Work : The work covered under this specifications pertains to procurement of best quality locally available or locally manufactured precast AAC concrete solid block and workmanship in building walls of various thickness in strict compliance with the specifications and applicable drawings.

53.2 Material: Precast cement concrete solid blocks shall be of best quality locally available/ manufactured at factory and should be approved by the Engineer-in-Charge before incorporation in the work. The ingredient and the cement concrete used shall confirm to relevant I.S. as stipulated in specification for cement concrete works herein before. **Autoclaved aerated cement blocks of approved quality of Grade 1 as per IS 2185 Part III.**

Minimum crushing strength of the AAC blocks shall be 5 N/ sqmm. at 28th day after curing and dry density shall be not less than 651-750 kg/cum. The type of the bond to be adopted will be decided by the Engineer-in-Charge but vertical joints shall be staggered. The thickness of the blocks shall be 100 mm, 150 mm & 200 mm and the proportion used in making the blocks shall be as per IS code. The blocks shall be cured well at least for 14 days before incorporation in to the work. The cement mortar for concrete blocks masonry shall be 1:4 and joints shall not be more than 10 mm. thick. In cases instead of cement mortar readymade thin jointing adhesive Polymer of approved make shall be used with notch trowels for attaining uniform thickness of 3 mm consistently ; Avoid using in watery consistency (slurry form) to avoid air pockets ; surface preparation, mixing & laying shall be as per manufacturer's specification.

Workmanship and Mode of Measurement: The workmanship and mode of measurement shall be as stipulated in the specification for brick work as applicable stated earlier and AAC block masonry with 140 mm. thick block shall be measured in sqm. nearest to two places of decimals of a meter. The rate quoted shall include cost of all materials, labour including form work in casting the blocks, curing, transporting, handling, hoisting the blocks to proper level, curing masonry etc. complete.

63.2 Mode of measurement: All AAC blocks masonry walls shall be measured in Cum. All opening in AAC block work for doors, windows and ventilators shall be deducted to get the net quantity of actual work done. Opening or chases required for P.H. or electrical inserts less than 0.1 sqm. And bearing of precast concrete members shall not be deducted. No extra payment shall be made for extra work involved in making the above opening or placement.

64 . READYMIX CEMENT PLASTER (READIPLAST)

64.1 General: Readiplast is a factory made pre blended sand-cement plaster with polymers supplied in dry form. It is made of Cement (OPC), Graded processed silt free and clay free River sand, polymers and fibers. These ingredients of known quality and are blended exactly in correct ratio. It is ready to use cement based mortar for external as well as internal plaster which ensures waterproof crack free plasters of consistent quality. It is a mixer of graded inert filler, additives blinder and fiber generally meet to IS code 2250 -1981.

64.2 Mixing: Take precise quantity of water and pour into mechanically mixer or can be loaded into plastering machine and slowly add the Rediplast mortar into mixer at 0.15 W/P ratio and mix it thoroughly for application.

64.3 Application: Clean the substate take out loose particles. Wet the surface , except those of cement concrete blocks thoroughly and apply Readiplast to achieve uniform thickness and level surface. Mixed Rediplast mortar after adding water should be used within 60 minutes.

64.4 Curing: Water curing is recommended after 12 hrs. and to be continued for at least 7 days.

64.5 Mode of measurement: Mode of measurement will as per schedule of quantities

65.0 : HORTICULTURE AND LANDSCAPE

Horticultural operations shall be started on ground previously levelled and dressed to required formation levels and slopes.

In case where unsuitable soil is met with, it shall be either removed or, replaced or it shall be covered over to a thickness decided by the Engineer-in-charge with good earth.

In the course of excavation or trenching during horticultural operations, any walls, foundations, etc. met with shall not be dismantled without pre-measurement and prior to the written permission of the Engineer-in-charge.

65.1 TRENCHING IN ORDINARY SOIL

65.1.1 Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc. and to bring up the lower layer of good earth to form a proper medium for grassing, regrassing, hedging and shrubbery.

Trenching shall be done to the depth ordered by the Engineer-in-charge. The depth is generally 30 cm for grassing and 60 cm for regrassing in good soil.

65.1.2 The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good soil.

65.1.3 Weeds or other vegetation which appear on the ground are then uprooted and removed and disposed off and paid.

65.1.4 Trenching

Trenching shall consist of the following operations:

1. The whole plot shall be divided into narrow rectangular strips of about 1.5 m width or as directed by the Engineer-in-Charge.

2. These strips shall be sub-divided lengthwise into about 1 m long sections. Such sections shall be excavated serially and excavated soil deposited in the adjacent section preceding it.

3. In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.

4. The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

65.1.5 Measurements

Length and breadth of the plot shall be taken correct to 0.1 m and depths correct to cm. Cubical contents shall be calculated in cubic meters, correct to two places of decimal. No deduction shall be made nor extra paid for removing stones, brick bats and other foreign matter met with during excavation upto initial lead of 50 m and stacking the same.

65.1.6 Rate

The rate shall include the cost of all labour and material involved in the operations described above, including cost of all precautionary measures to be taken for protections and supporting all services etc. met with during trenching. It does not include the cost of mixing of earth, sludge/manure.

65.2 GOOD EARTH

65.2.1 The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.

65.2.2 Measurements: Length, breadth and height of stacks shall be measured correct to a cm. The volume of the stacks shall be reduced by 20% for voids before payment, unless otherwise described. CPWD SPECIFICATIONS 2009 1026

65.2.3 Rate: The rate shall include the cost of excavating the earth from areas lying at distance not exceeding one km. from the site, transporting the same at site breaking of clods and stacking at places indicated. The rate shall also include royalty if payable.

65.3 OIL CAKE

65.3.1 Neem/Castor: The cake shall be free from grit and any other foreign matter. It should be undecorticated and pulverized. The material shall be packed in old serviceable gunny bags of 50 kgs capacity approximately. The weight of gunny bag shall

be deducted @1 kg per bag and payment shall be made for net quantity. The quality of cake should be got approved by the Engineer-in-charge before supply.

65.3.2 Measurements

The arrangement for weighing shall be made at site of work by the department. The gunny bags shall be the property of the government.

65.3.3 Rate: The rate shall include the cost of labour and material involved in all operations described above, including carriage up to site of work with all lead and lifts, weighing etc.

65.4 SUPPLY AND STACKING OF SLUDGE

65.4.1 It shall be transported to the site in lorries with efficient arrangement to prevent spilling enroute. It shall be stacked at site. Each stack shall not be less than 50 cm height and volume not less than 3 cum.

65.4.2 Measurements

Length, breadth and depth of stacks shall be measured correct to a cm. The volume of the stack shall be reduced by 8% for looseness in stacking and to arrive at the net quantity for payment.

65.4.3 Rate

The rate shall include the cost of labour and material involved in all operations described above, including carriage up to one km. The rate shall also include royalty if payable.

65.5 SUPPLY AND STACKING OF MANURE

65.5.1 Farmyard Manure: Same as 65.4.1.

65.5.2 Measurements: Same as 65.4.2.

65.5.3 Rate : Same as 65.4.3.

66.6 ROUGH DRESSING OF THE TRENCHED GROUND

65.6.0 Rough dressing of the area shall include making kiaries for flooding.

65.6.1 The trenched ground shall be levelled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannot be so levelled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. The supply and spreading of soil in such depressions is payable separately. In rough dressing, the soil at the surface and for 75 mm depth below shall be broken down to particle size not more than 10 mm in any direction.

65.6.2 Measurements

Length, breadth of superficial area shall be measured correct to 0.1 metre. The area shall be calculated in sqm. correct to two places of decimal.

65.6.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

65.7 UPROOTING WEEDS FROM TRENCHED AREAS

65.7.1 After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

65.7.2 Measurements

Length, breadth of superficial area shall be measured correct to 0.1 meters. Superficial area of the weeded ground shall be measured for purpose of payments.

65.7.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

65.8 FINE DRESSING THE GROUND

65.8.1 Slight unevenness, ups, and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

65.8.2 Measurements

Length, breadth and depth of stacks shall be measured correct to a cm. The area shall be calculated in sqm. correct to two places of decimal.

65.8.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

65.9 SPREADING GOOD EARTH

65.9.1 Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Engineer-in-charge. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

65.9.2 Measurements: The quantity of good earth spread shall be determined by the difference in the volume of good earth in stacks before and after spreading duly reduced for looseness in stacking by 20% of good earth.

65.9.3 Rate: The rate shall include of all the labour and material involved in all the operations described above, but does not include the cost of the good earth which shall be paid for separately unless specifically described in the item.

65.10 SPREADING SLUDGE/MANURE

65.10.1 Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-Charge. The mixing shall be spread as described in 68.9.1 to the thickness ordered by the Engineer-in-Charge.

65.10.2 Measurements

The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth and sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

65.10.3 Rate

The rate shall include of all the labour and material involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

65.11 MIXING OF GOOD EARTH AND SLUDGE/MANURE

65.11.1 The stacked earth shall, before mixing be broken down top particle of sizes not exceeding 6 mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-charge.

65.11.2 Measurements

The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth, sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

65.11.3 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

65.12 GRASSING WITH SELECT GRASS NO. 1

65.12.0 The area from where the grass roots are to be obtained shall be specified by the Engineer-in-Charge at the time of execution of the work and no royalty shall be charged on this account from the contractor. Grass is to be arranged by contractor (cost of grass to be paid separately).

65.12.1 The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as described in the item. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and material (grass shall be paid separately.)

65.12.2 During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be

constantly made up to the proper levels with earth as available or brought from outside as necessary, Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

65.12.3 Measurements

Length, breadth of the lawn grassed shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

65.12.4 Rate

The rate shall include of all the labour and material involved in all the operations described above, excluding supply of the requisite quantity of good earth and grass so needed for properly maintaining the levels of the lawns. (Payment of grass to be paid separately).

65.13 RENOVATION OF LAWNS

65.13.1 The area shall be first weeded out of all undesirable growth. The entire grass shall be scrapped (cheeled) without damaging roots and level of the grounds. Slight irregularities in surface shall be levelled off and the area shall then be forked so as to aerate the roots of the grass without, however up-rooting them.

Specified quantity of sludge or manure shall than be spread uniformly with wooden straight edge (phatti) as directed by the Engineer-in-charge. The area shall then be slightly sprinkled with water so as to facilitate proper integration of the manure or sludge with the soil and later flooded. The contractor shall be responsible for watering, proper maintenance and tending of the lawn for 30 days or till the grass forms a lawn fit for mowing, whichever is later. During the above operations, all undesirable growths shall be constantly weeded out and all rubbish removed and disposed off as directed by the Engineer-in-Charge.

65.13.2 Measurements

Length, breadth of the lawn renovated shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

65.13.3 Rate

The rate shall include of all the labour and T&P (excluding RH pipe/grass) involved in all the operations described above, excluding the supply of the requisite quantity of good earth if so needed for proper maintenance of the levels of the lawns. The cost of the

sludge or manure shall be measured and paid for separately, unless its supply is specifically included in the description of the item.

65.14 UPROOTING RANK VEGETATION AND WEEDS AND PREPARING THE GROUND FOR PLANTING 'SELECT GRASS NO. 1'

65.14.1 Initially the area shall be dug up to a depth of 30 cm. and weeds and rank vegetarian with roots removed thereon by repeated forking. The whole area then shall be retrenched to a depth of 60 cm in the same manner as described in 23.1. Clods of excavated earth shall then be broken upto the size not more than 75 mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds shall be uprooted carefully. The rubbish arising from the above operations shall be removed and disposed off in a manner directed by the Engineer-in-charge, away from the site. The earth shall then be rough dressed and fine dressed as described in 65.6 & 65.8.

65.14.2 Measurements

Length, breadth of uprooted area shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

65.14.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

65.15 EXCAVATION AND TRENCHING FOR PREPARATION OF BEDS FOR HEDGE AND SHRUBBERY

65.15.1 Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to 4 meters respectively.

65.15.2 Beds for hedges and shrubbery shall be prepared in the following manner. The beds shall first be excavated to a depth of 60 cm. and the excavated soil shall be stacked on the sides of the beds. The surface of the excavated bed shall then be trenched to a further depth of 30 cm, in order to loosen the soil, in the manner described in 23.1. No flooding will be done at this stage but the top surface shall be rough dressed and levelled. The excavated soil from the top 60 cm depth of the bed stacked at the site shall then be thoroughly mixed with sludge over manner in the proportion 8:1 by ratio or other proportion described in the item. The mixed earth and manure shall be refilled over the trenched bed, levelled neatly and profusely flooded so that the water reaches even the bottom most layers of the trenched depth of the bed. The surface

after full subsidence shall again be refilled with the earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50 mm to 75 mm below the adjoining ground or as directed by the Engineer-in-Charge. Surplus earth if any, shall be disposed off as directed by the Engineer-in-charge. Any surplus earth if removed beyond initially lead shall be paid separately. Stones, bricks bats and other foreign matter if met with during excavation or trenching shall be removed and stacked within initially lead & lift, such material as is declared unserviceable by the Engineer-in-charge shall be disposed by spreading and levelling at places ordered by him. If disposed outside the initial lead & lift, then the transport for the extra leads will be paid for separately. If a large proportion of material unsuitable for the hedging and shrubbery operations is met with and earth from outsides is required to be brought in for mixing with manure and filling, the supply and stacking of such earth will be paid for separately.

65.15.3 Measurements

Length, breadth and depth of the pit excavated and trenched shall be measured correct to a cm. The cubical contents shall be calculated in cubic meter correct to two places of decimal.

65.15.4 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above. The rate shall not include the cost of supply & stacking of the manure unless the same is

specifically included in the description of the item.

65.16 DIGGING HOLES FOR PLANTING TREES

65.16.1 In ordinary soil, including refilling earth after mixing with oil cake, manure and watering.

65.16.1.1 Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately.

The tree holes shall be manured with powdered Neam/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

65.16.1.2 Measurements : Holes shall be enumerated.

65.16.1.3 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, excluding the cost of supply and stacking the requisite quantity of manure/sludge and oil cake.

65.16.2 In Soil other than Ordinary Soil

65.16.2.1 Where holes are dug in (a) Hard soil (b) Ordinary rock or (c) Hard rock, the above soils occurring independently over in conjunction with each other and /or ordinary soil in any hole, the different excavated soil shall be stacked separately. Excavation in hard rock shall be carried out by chiseling only.

65.16.2.2 The stack measurement of ordinary rock and hard rock shall be reduced by 50% and of soil by 20% to arrive at the excavated volume. This excavation shall be paid for as extra over the rate for holes dug in ordinary soil above, at rate appropriate to particular soil concerned.

65.16.2.3 Sufficient quantity of good soil to replace the solid volume of stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth, ordinary and hard stacks shall be brought and stacked at site but the supply and stacking of such shall be paid for separately.

65.16.2.4 The useless excavated stuff shall be disposed off by spreading at places as ordered by the Engineer-in-charge. If such places are outside initially leads, carriage for the extra lead shall be paid for separately.

65.16.2.5 The ordinary soil excavated from the hole and the earth brought from outside shall then be mixed with manure screened through sieve of IS designation 16 mm in the proportion specified in the description of the item and filled with the pit and the same watered and finally dressed.

65.16.2.6 Measurements: The pit shall be enumerated. The volume of excavation in soil and other than a ordinary soil shall be determined by reducing the stack volume of the relevant soil with respective percentage for voids specified in 68.14.2.2.

65.16.2.7 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, including mixing refilling, watering, dressing etc. but shall not include cost of manure over sludge (b) cost of supplying and stacking of good earth for replacement and (c) the cost of carriage beyond initial lead for disposing off useless materials. The excavation other than that of ordinary soil shall be paid extra over and above the rate if excavation in ordinary soil.

65.17 M.S. FLAT IRON TREE GUARD

65.17.1 M.S. Iron Riveted Tree Guard

65.17.1.1 The tree guard shall be 600 mm in diameter and 2 meter high above ground level and 25 cm in below ground level.

65.17.1.2 The tree guard shall be framed of 4 nos. 25 x 6 m M.S. flat 2 meter long excluding displayed outward at lower and upto an extent 10 cm and 8 nos. 25 x 3 mm vertical M.S. Flat Rivetted to 3 Nos. 25 x 6 mm Flat iron rings in two halves, bolted together 8 mm dia and 30 mm long M.S. bolts and nuts.The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade over a priming coat of ready mixed steel primer of approved brand and manufacturer. The design of tree guards shall be shown in the drawing.

65.17.1.3 Measurement : The tree guard shall be enumerated.

65.17.1.4 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

65.17.2 M.S. Flat Iron Welded Tree Guard

65.17.2.1 The tree guard shall be 600 mm in diameter and 2 meter high above ground level and 25 cm in below ground level.

65.17.2.2 The tree guard shall be framed of 4 nos. 25 x 6 mm MS. Flat 2 metres long excluding displayed outward at lower and upto an extent 10 cm and 8 Nos. 25 x 3 mm vertical M.S. Flat Riveted to 3 nos. 25 x 6 mm flat iron rings in two halves, bolted together 8 mm dia and 30 mm long M.S. Bolts & nuts. The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade brand and manufacturer of required shade over a priming coat of ready

mixed steel primer of approved brand and manufacturer. The design of tree guards shall be shown in the drawing.

65.17.2.3 Measurement : The tree guard shall be enumerated.

65.17.2.4 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

65.18 FILLING MIXTURE OF EARTH & SLUDGE OVER MANURE

65.18.0 The separately specified earth and sludge shall be broken down to particles of size not exceeding 6 mm in any directions before mixing. Good earth shall be thoroughly mixed with sludge over manure in specified proportions as directed by Officer-in-Charge. During the process of preparing the mixture as above, trenches shall be flooded with water and levelled.

65.18.1 Measurements

Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

65.18.2 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above, but do not include the good earth, sludge or manure which will be paid separately.

65.19 EXCAVATION OF DUMPED STONE OR MALBA

65.11.1 Excavation operations shall include excavation and getting out water if required. During the excavation stone, brick bats and other foreign material if met shall be removed and stacked within 50 meter leads and lifts. Such material as is declared unserviceable by the Engineer-in-Charge be disposed within 50 m. The excavated surface shall be neatly dressed and levelled.

65.19.2 Measurements

Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

65.19.3 Rate

The rate shall include the cost of all the labour and material involve in all the operations described above.

65.20 EXCAVATION IN BAJRI PATH

65.20.1 All excavated operations shall include excavation and stacking of serviceable and unserviceable material. Excavated surface of Bajri path shall be removed and stacked upto 50 meter lead and disposed material neatly dressed.

65.20.2 Measurements

Same as 65.19.2.

65.20.3 Rate

Same as 65.19.3.

65.21 EXCAVATION OF WATER BOUND MACADAM

65.21.1 All excavated operations shall include excavation, stacking of serviceable and unserviceable material. Excavation shall be straight and uniform in width. Soling stone and aggregate obtained from excavation of W.B.M. shall be stacked separately and unserviceable material disposed off with lead upto 50 meter and lift upto 1.50 meter and neatly dressed.

65.21.2 Measurements

Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

65.21.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

65.22 FLOODING THE GROUND WITH WATER AND MAKING KIARIES

65.22.1 The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in

required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

65.22.2 Measurements

Measurement shall be made in sqm. Of area.

65.22.3 Rate

The rate shall be for 100 sqm of area and include the cost of all the labour and material involved in all the operations described above.

FELLING AND REPLANTING OF TRESS

Scope

Cutting or removing of existing trees including taking permission from government authorities.

Description

While clearing jungle, growth trees above 30 cm girth (measured at a height of one metre above

ground level) to be cut, shall be approved by the Engineer-in-Charge and then marked at site. Felling trees shall include taking out roots up to 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower.

All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 20 cm layers and compacted thoroughly so that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut into suitable pieces as directed by the Engineer-in-Charge.

Wood, branches, twigs of trees and other useful material shall be the property of the Government. The serviceable materials shall be stacked in the manner as directed by the Engineer-in-Charge upto a lead of 50m. All unserviceable material, which in the opinion of Engineer-in-Charge cannot be used or auctioned shall be removed from the area and disposed off as per the directions of the Engineer-in-Charge. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

Cutting of trees above 30 cm in girth (measured at a height of one metre above level) shall be measured in numbers according to the sizes given below:

(a) Beyond 30 cm girth, upto and including 60cm girth.

(b) Beyond 60 cm girth, upto and including 120 cm girth.

(c) Beyond 120 cm girth, upto and including 240 cm girth.

(d) Above 240 cm girth.

Rate

The rate for cutting of trees will be in per number mentioning the girth.

Replanting of tree

Replanting of trees would include uprooting of trees without damaging or cutting the root.

Digging of pit of depth 2M for replanting at specified location, Spraying of chemical in pit and on the roots of the trees. Placing the tree in position with roots in the pit, backfilling with good earth and watering. The contractor to make sure that the tree is watered properly till the roots have firmed into the ground and till the tree has started growing again.

APPENDIX "A"

LIST OF APPROVED MAKE / MODEL

PREAMBLE:

1) All materials shall conform to relevant technical specifications of the Tender document. The materials shall be further subjected to tests in the recognized laboratories at the sole discretion of the Engineer-in-Charge and shall be at contractor's cost.

2) The contractor shall procure TMT bars of **Fe500/Fe550/Fe550D** grade as per structural design drawing (the grade to be procured is to be as specified) from primary steel producers such as **SAIL, Tata Steel Ltd., RINL, Jindal Steel & Power Ltd. ; Essar steel and JSW Steel Ltd .**

3) Reinforcement for work shall have relevant IS marking and every lot shall be subject to tests in the recognized laboratories and shall be at contractor's cost.

4) Cement for work shall have relevant IS marking and every lot shall be subject to tests in the recognized laboratories and shall be at contractor's cost

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

A. Civil, Interior Finish Work

S. No.	Description	Approved Makes
1	Cement (Grey)	OPC cement of Grade 43/53 (for only Concrete work) of Ultratech , A.C.C., Rajashree, Ambuja/ L & T
2	Portland Pozzolana Fly Ash based cement (for all works Other than Concrete)	Ultratech, A.C.C., Rajashree,Ambuja.
3	Cement (White)	Birla White / J.K.White
4	T.M.T. Reinforcement Steel	SAIL, Tata Steel Ltd., RINL, Jindal Steel & Power Ltd.; Essar and JSW
5	Structural steel	SAIL/TATA/RINL/IISCO
6	Ready Mixed Concrete	ACC/L&T /Ultratech/ RMC/ Godrej / TARMAC
7	Concrete Interlocking Paver Blocks, Concrete retaining / wall face /multi step /erosion control blocks/ Kerb stone	Super Tiles, Vitco , Vyara Tiles, Prayosa Buildmat
8	Antitermite Treatment	PCI, Pecopp, Godrej Hi-Care
9	Stainless Steel	Jindal/SAIL/ Mukand/ Outokumpu
10	Ceramic Tiles	Kajaria /(I)/NITCO / H.R.Johnson
11	Italian Marble	As approved by Architect
12	Factory made Concrete cover blocks	Raj cover blocks / Astra concrete products
13	Geosynthetics :- Geotextile –Non Woven , Woven ; Gabions, Geo composites ,soil improvement ; soil retaining HDPE sheet	Maccaferri Solutions; Garware wall ropes,Strata Geosystems (India)
14	External Paver Tiles Series	H. R. Johnson (I)-Endura/Vyara Tiles/ SUPER TILES/ Pavit

15	Agglomerate Composite Marble	CMC/Asian/Johnson
16	Kotah Stone	As approved by Architect
17	Granite Stone	As approved by Architect
18	Paint –Interior & Exterior – Acrylic based Epoxy Paint for structural steel Fire Resistant intumescent Paint	Asian Paints / Nerolac /Akzo Nobel (Dulux)/ Berger Special Decorative Textured /metallic Interior Paint –Royal Play series – Asian Paints Epoxy Paint for structural steel – Berger/ Asian / Akzo Nobel/Sigma Fire Resistant intumescent Paint – Nobel Paints/ Akzo Nobel Paints/Berger Paints
19	Texture Paint - External	Renova –Damani Dye Stuff / Ruff Cote -Indian Paints / Asian Paints
20	Clear Float ,frosted Translucent, Fire Rated Glass for Door & Window & Partition Reflective Solar Control Glass	Clear Float Glass –Planilux -Saint Gobain/ Asahi India Glass Ltd / Gujarat Guardian - Modiguard Frosted Translucent Glass - Satinovo Mate –Saint Gobain Fire Rated Glass- Vetrotech Saint Gobain Glass / Shakti Hormann Reflective Solar Control Glass –Saint Gobain Glass
21	Aluminium Sections For Doors, Windows	Jindal/ Hindalco

22	Steel Doors, Windows & Pressed Steel Door Frames	Godrej/ Shakti Hormann / NCL Alltek & Seccolor Ltd Steel Fire Proof Door- Promat, Shakti Hormann/Godrej
23	Anodized aluminum fittings for doors/windows	Geeta Aluminium / Crown/ Classic/ Argent
24	Flush Doors/ Moulded Panel Doors-Engineered Wood Solid Core/ Natural Wood Solid Core timbers /Block Board core Sound proof doors Radiation Protection (lead line) doors	Anchor (Indian Plywood Manufacturing) / Merino Ply / Shreeji Woodcraft / Century / Kutty Kutty's Nishabdh- sound proof doors- Kutty Kutty's lead line doors-
25	Laminate	Greenlam /Merino / Royale touche Century
26	Integral Water Proofing Compound	MC-Special DM -MC Bauchemie/ CICO No 1- CICO/BASF/ Fosroc/ STP/ Sika/ Penetron.
27	White cement based putty for concrete / plastered surfaces	Wall care putty of M/s. Birla White./J.K White/ Plasto Shine wall putty of M/s. Walplast Products Pvt.
28	Floor spring & floor lock	Dorma/Godrej/ Enox/ Sevax **/** **/**Hardwyn /Hettich
29	Water Proof cement paint	Snowcem/Shalimar Paints/Kansai Nerolac
30	Welding Rods (Electrodes) for structural steel fabrication	ADOR/ Esab India/ D& H India
31	Fastner	Hilti India/ Fischer(Bosch) / Powers
32	AAC block	Xtralite -Ultratech / Aerocon/ Siporex/ Hindustan Concrete Block

33	Thin jointing adhesive polymer material for AAC blocks	Fixoblock – Ultratech / Blokset – Weber Saint Gobain / MYK Laticrete
34	Ready mix plaster	Readiplast -Ultratech/ Superplast RMP 1 -Ashtech /Buildwell -Wal Plast products/ Sound Buildcare
35	Cement bonded particle board	Bison -NCL Industries Ltd. Cement fibre Board – Shera
36	Vitrified Tiles Heavy Duty Vitrified Tiles	RAK / Kajaria/ Restile/H.R.Johnson (I) /Nitco /Somany
37	Structural / Curtain wall Glazing	
a)	Aluminium Section	Jindal / Hindalco / Nalco/Vedanta
b)	D.G.U. Glass , Fire Rated Glass, S.G.U. Glass	Saint Gobain/Gujarat Guardian - Modiguard / Asahi India Glass Ltd
c)	Aluminium Composite Panel	Alucobond-3 A Composites/ Aludecore Lamination /Altobond-Deist Buildwell
38	Wooden Flooring - Laminated / Veneer Flooring/ Engineered hard wood	Titan "x" -Pergo/ Green ply – Floormax /Xylos Arteriors India /Armstrong
39	Commercial Plywood, Marine Plywood & Block Board	Century/Green/Kit ply/ Anchor
40	Cement Particle block board	Bison Panel –NCL
41	Veneer	Century / Durian,/ Timex/Anchor
42	Carpentry (Furniture) fittings , Panic hardware fittings	Godrej/ Hettich/ Kich Architectural Products/ Dorma/Hafele
43	Plain / Designer Acrylic Sheets	Palram India/Acrylic Sheet India/ Acry Plus

44	Plain / Designer (Non Asbestos) Fiber reinforced cement False ceiling / Flexo board Corrugated (Non Asbestos) Fiber reinforced cement roof sheets	Ramco / Everest
45	Acoustic Barrier Acrylic	Palram India
46	Bitumen	STP/ Tikitar Danosa/ IWL
47	Gypsum Putty /Plaster of Paris	Khatri India/ Gyproc Champion Putty -Saint Gobain Gyproc
48	Fibres in Plaster mix & Concrete - Polyproplylene Fibres / Alkali resistant Glass Fibres	Polyproplylene Fibres -Reliance - Recron 3S & Alkali resistant Glass Fibres- Owens Corning India- Cem-Fil
49	High Pressure Compact laminate - Cubicle Toilet Partition	Besco-Merino/ Sturdo -Greenlam /Stylam/Inner space
50	Brickbat Cementitious waterproofing	Waterproofing system as per India Water Proofing company or equivalent of :- MC Bauchemie/Chryso India/CICO
51	Terrace , Sunken Toilet Waterproofing System – elastomeric cementitious coating, Acrylic based polymer modified cementitious coating Admix for Shrinkage Compensating, Expanding Grout Admixture with Plasticizer	Mc Bauchemie / Mapei India/ Sika/ Fosroc / BASF / Dr. Fixit –Pidilite Acrylic based Polymer Modified Cementations Flexible Composite coating- CICO TAPECRETE P151- CICO / Mapelastic smart -Mapei Cement based styrene acrylic polymer based- Seal & Dry – Ultratech cement Admix for Shrinkage Compensating, Expanding Grout Admixture with Plasticizer -

52	Terrace Waterproofing Membrane Sheets :- APP , Anti root type APP membrane ; TPO ,EPDM	APP :- Sika/ STP/ Tiki Tar Danosa/ IWL EPDM , TPO: – STP/ Carlisle
53	Crystalline Waterproofing Liquid	Xypex India/ Evercrete India / Kryton India
54	Liquid applied polyster resin base, flexible, UV resistant waterproofing system	Kemperol V210 – Kemper systems
55	Polyurea waterproofing	Polyurea WH 200 -Fosroc /Chryso India
56	Solar Reflection waterproofing coating	Aquaflex Roof HR- Mapei
57	Waterproofing coating Good for Drinking water –to internal surface of Drinking water tank	Idrosilex Pronto - Mapei
58	Tape used in waterproofing systems –in Tunnels & building Terrace joints	Tape -Mapeband TPE- Mapei Waterproofing Sealant – Mapeflex PU 45- Mapei
59	DPC layer (waterproofing layer)	Liquid layer - Nitoflor DPM –Fosroc Bitumen layer –STP/Tikitar Danosa/ IWL
60	Non shrink cementitious Grout for below structural steel base plates	Sika / Fosroc / BASF
61	Hydrophilic Swellable water bar, Profiles , Sealants	Sika / BASF / Adeka India

62	Tile Bedding – Polymer modified cement based Tile adhesive Tile joint Grout – Polymer modified cement based Grout	Tile Bedding - Polymer modified cement based Tile adhesive Laticrete 335 thin set adhesive of MYK Laticrete Equivalent of Weber / Goldstar of Ardex Endura Tile Grout- polymer modified cementitious water repellant joint filler (Colour, drop effect water repellent & Mould resistance) for wet areas – Ultracolor Plus – Mapei,
63	Glass mosaic tiles –Grout & Bedding Tile Grout - three component **epoxy system** chemical resistant , Hygiene ,wet areas , fungus resistance, resistance to stains & chemical resistance Tile Grout - 2 component, 100% solid epoxy based tile/stone filler which allows light to pass through the grout itself to create an unique reflective appearance,low shrink & resistant to crack. Tile Grout (Green Product) - 2 component, 100% solid epoxy based, which provides photo luminescence during dark.	Glass mosaic tiles – Bisazza/Palladio-Piccolo mosaic/Italia Tile Grout- Stain Free Epoxy Grout Latapoxy SP-100 of MYK Laticrete Tile Bedding - thin set Laticrete 317 of MYK Laticrete Equivalent of Weber / Ardex Endura Laticrete 3701 mortar admix / Weber set Plus (white) tile adhesive Tile Grout which allows light to pass- Weber pearl armor Tile Grout – Green Product which provides photo luminescence during dark.- Weber knight armor
64	Adhesive for Granite,Marble Stone Joinery	Araldite (Standard Type) -Huntsman Advanced Material
65	Polyester , PU Coating on Veneer ,wood , Melamine coating on Veneer ,wood	MRF Corp/ ICA /Asian Paints

66	False ceiling -Gypsum Board & Moisture Resistant Gypsum Board ;Mineral Fibre Board, wood Panels; Metal Grid Ceiling; Baffle Ceiling; Silhouette Slot System	Gypsum - Saint Gobain Gyproc India/ USG Boral India Mineral Fibre,Metal ,Wood Panels- Amstrong / Saint Gobain Gyproc India/ USG Boral India Baffle ceiling – Ecophon Solo Saint Gobain/ Amstrong /USG Boral India Metal – Hunter Douglas/ Amstrong /
67	Adhesive for Wood, Laminate	Marine Fevicol-Pidilite / Euro - Jyoti Resins & Adhesive
68	Adhesive for PVC Laminate	Fevicol Probond –Pidilite/ Karigar PVC weld- Super Bond
69	Silicone Based Clear Water Repellant coating	Techrepel -Choksey chemical/ Dulux Weathershield Clear -Akzo Nobel/
70	Elastomeric Exterior Paint	Dr Fixit Rain Coat - Pidilite / Clear Seal -Apurva Make
71	Epoxy Resin Old To New Bonding Agent	Fosroc / Sika / BASF
72	Reinforcement Rust Preventive Coating	Krishna Conchem/ Sunanda / Choksey Chemicals
73	Dry Cladding (Porcelain)	Techlam-Classic./ H.R. Johnson / Kale or Equivalent as approved by Architect.
74	Structural Silicon Sealant	Dow Corning/GE-Momentive Performance Materials India/ Wacker India

75	Aluminium Facade Sun Louvers System /Sun control systems Roll formed Aluminium fins	Hunter Douglas/ Construction Specialties
76	Stainless Steel Kitchen Sink	Nirali –Jyoti India Metal/ Neelkanth- Tropical Industries/ Jayna Sinks-Jain Brothers
77	Stainless Steel Pipe For Handrailing	For Pipe-Jindal/Zenith Birla /Mukand; Fabricated Pipe Handrailing- Kich
78	Stainless Steel cladding / skirting	JSL Lifestyle Ltd / Mukand/ Outokumpu
79	Glass Fibre Reinforced Concrete Chajja/ Cornice/Fins	Birla White Cement -GRC Division/ Everest Composites
80	PVC Edge Banding	Rehau/Pegasus/Fibro
81	Aluminium /PVC Bird Net	Geeta Aluminium / Balaji Safety Nets / Nets "N" Screens/ Reach Nettings
82	SentryGlas / Laminated Glass Coloured lacquered Glass	Saint Gobain/ DuPont Coloured lacquered Glass-

83	Stepping Stone for treads & Risers Full body vitrified	H.R. Johnson Endura Series /Vyara
84	Polymer Expansion Joint Filler Board & closed cell Polymer backer Rod	Supreme Industries (Dura board & Rods)
85	Sealant Polyurethane based over Polymer board Sealant Bitumen based over	Sealant Polyurethane based over Polymer backer rod/board - Mapeflex PU 65 – Mapei
86	False ceiling -Calcium Silicate Board	Ramco Hilux/Armstrong / Danapole

87	XPS /EPS Insulation Board _Styrofill geofoam (Filler)	BASF / Owens Corning / Carlisle
88	UPVC Fins	Citadel /Everwood WPC
89	Fly Ash Bricks	Jindal Mechno Bricks/ Anjaneya /Aditi Group
90	Concrete Pipes , Precast Ready made compound walls	Spun Concrete Pipes :- Raj Concrete Products / India Hume pipe
91	Corten steel (Weathering steel facade) Copper façade	Corten steel-Vijaynath interiors/ Kingspan Copper façade – KME -Vijaynath interiors/Aludecor
92	Railing	Viva railing/Kich
93	Automatic Sliding door	DORMA/Hafele
94	Styrofill	Truepack/Infinite propack
95	Fine Aggregate	Approved Source
96	Coarse Aggregate	Approved Source
97	Galvanisation	Jenco/Steelite
98	2Hr. Fire rated glass	Pyroshield of Pilkington
99	Aluminium doors & windows	Alumi lite/Aluplex/Permisa/SP fap
100	Roch anchors	Fresinet/VSL/BBR
101	Rolling shutter	Gandhi Automation/Standard/Swastik/Avia

102	High pressure laminate	Fundermax
103	Toilet Compact Cubicle	Merino/Stylam
104	LOGO	Alpha plus/Eigma Enterprises/Motif Graphis
105	Tensile roof	Ferrari/NEHLEK/HIRAOKA
1	Cement (Grey)	OPC cement of Grade 43/53 (for only Concrete work) of Ultratech ,

APPENDIX "B"

THEORETICAL STANDARD REQUIREMENT OF CEMENT FOR VARIOUS ITEMS OF WORK

Sr.NO.	**BRIEF DESCRIPTION OF ITEM**	**UNIT**	**CEMENT IN BAGS**
1	Cement Concrete 1:5:10	Cum	2.60
2	Cement Concrete 1:4:8	Cum	3.40
3	Cement Concrete 1:3:6	Cum.	4.40*
4	Cement Concrete 1:2:4	Cum	6.40*
5	Reinforced Cement Concrete 1:2:4	Cum	6.40*
6	Reinforced Cement Concrete 1:1.5:3	Cum.	8.00*
7	Reinforced Cement Concrete 1:1:2	Cum	12.20*
* **Note :** For controlled concrete items like M-10, M-15, M-20, M-25 etc., the consumption of cement will have to be assessed by the Engineer-in-Charge on the basis of design mixes approved for individual work.			
8	Brick masonry in C.M. 1:4	Cum.	1.90
9	Brick masonry in C.M. 1:6	Cum	1.25
10	Half brick masonry in C.M. 1:4 with RCC 1:2:4 stiffeners	Sqm.	0.27

11	Half brick masonry in C.M. 1:4	Sqm	0.21
12.(a)	R.R. Masonry in C.M. 1:6	Cum.	1.65
12.(b)	C.R. Masonry in C.M. 1:6	Cum.	1.56
13.	**IPS Flooring (C.C. 1:2:4, finished smooth)**		
(a)	30mm. thick	Sqm	0.23
(b)	40mm. thick (smooth/broom finish)	Sqm	0.30
(c)	50mm. thick	Sqm	0.36
(+)	20mm. thick skirting/dado in cm.1 :3	Sqm	0.30
14	Hardonate flooring -50mm. thick (C.C. 1:2:4, finished smooth)	Sqm.	0.41
15	**Kota stone:**		
(a)	Flooring (with lime mortar bedding pointed with matching cement slurry)	Sqm	0.13
(b)	Skirting with 20mm. thick C.M. 1:3 backing	Sqm	0.27
(c)	Coping	Sqm.	0.13
16	**Terrazzo tile :**		
(a)	Flooring (with lime mortar bedding & pointed with cement slurry).	Sqm	0.18
(b)	Skirting with 20mm. thick C.M. 1:3	Sqm	0.28
(c)	Treads, hydraulically pressed with C.M. 1:3 bedding	Sqm.	0.37
(d)	Treads in one piece	Sqm	0.28
(e)	Risers, hydraulically pressed with C.M. 1:3 backing	Sqm.	0.28
(f)	Risers in one piece	Sqm	0.23
17.	**Cast-in-situ terrazzo**		

(a)	Flooring, 40mm. th. (28mm C.C. 1:2:4 + 12mm with marble chips & powder)	Sqm	0.26
(b)	Skirting, 20mm. thick (12mm CM1:3+ 8mm marble chips with cement & marble powder)	Sqm	0.25
18.	White glazed tile flooring and dado over 20mm. C.M.1 :3 bedding	Sqm	0.31
19.	**Cement tile :**		
(a)	Flooring (lime mortar bedding).	Sqm	0.18
(b)	Skirting with 20mm thick C.M. 1:3	Sqm	0.28
20	Plaster skirting, 20mm. thick in C.M.1 :3.	Sqm	0.30
21.	Cuddapah stone kitchen platform over 20mm. thick C.M. 1:4	Sqm	0.30
22	Cuddapah stone window sill over 20mm. thick C.M. 1:4	Sqm	0.27
23	Fixing hold fasts in CC 1:3:6 of size 300x100x150 mm. for doors & windows	100 Nos	2.20
24.	Cement Plaster in C.M. 1:4/1:5 with neeru finish		
(A)	**Cement Mortar 1:4**		
(a)	12 mm. thick	Sqm	0.11
(b)	15 mm. thick	Sqm	0.13
(c)	20 mm. thick.	Sqm	0.17
(B)	**Cement Mortar 1:5**		
(a)	12 mm. thick	Sqm	0.09
(b)	15 mm. thick	Sqm	0.11
(c)	20 mm. thick	Sqm	0.14

25.	**Cement plaster in C.M. 1:4 in two coats with neat cement punning**		
a)	15 mm. thick.10mm + 5mm (for ceiling	Sqm	0.18
(b)	20 mm. thick.15mm + 5mm (for internal walls	Sqm	0.22
26	Cement plaster in C.M. 1:4, 20mm. thick rough finish (for externalbrick/concrete surfaces)	Sqm.	0.17
27.	Sand faced plaster, 20mm. thick (12mm C.M. 1:4 + 8 mm C.M. 1:3)	Sqm	0.21
28.	Rough cast plaster, 25 mm thick (12mm C.M. 1:4 + 13 mm C.M.1 :3)	Sqm	0.27
(+)	(+) 10 mm wide & 18 mm thick plain or moulded cement mortar band in CM 1:4	100 R.M	0.152
29.	**Cement plaster in C.M. 1:3 with water proofing compound finished smooth with neat cement**		
(a)	12mm. thick	Sqm	0.19
(b)	20mm. thick	Sqm	0.27
30.	**Cement pointing in C.M. 1:3**		
(a)	Ruled pointing (groove pointing)	Sqm	0.02
(b)	Raised & cut pointing	Sqm	0.04
31.	**Cement based waterproofing works (Through the agency approved by the E.I.C)**		
(a)	Terrace type average 115 mm. thick	Sqm	0.45
(b)	Basement type (Box type).	Sqm	0.70
(c)	Basement type (surface).	Sqm	0.60
(d)	In sunken floor of toilets, chajjas, parapets	Sqm	0.30
(e)	Brickbat coba in toilets, extra in roof terrace	Cum	3.00

(f)	O.H. Water tanks	Sqm	0.50
(g)	Expansion joints.	R.M	0.50
32.	**Damp proof course in C.C. 1:2:4**		
(a)	25mm. thick	Sqm	0.16
(b)	38mm. thick	Sqm	0.24
33.	**Laying R.C.C. spun pipes in C.M. 1:1/1:2**		
(a)	100 mm dia.	10m	0.10
(b)	150 mm dia	10m	0.12
(c)	250 mm dia.	10m	0.18
(d)	300 mm dia	10m	0.22
(e)	450 mm dia	10m	0.48
(f)	600 mm dia	10m	0.64
34.	**Cement mortar 1:4 screed**		
(a)	20mm. thick	Sqm	0.16
(b)	50mm. thick	Sqm	0.38
35.	**Chain link fencing/barbed wire fencing - C.C. 1:2:4 pockets of 450x450x600 mm.:**		
(a)	Angle iron posts	m	0.21
(b)	Cement Concrete 1:2:4 posts	m	0.37
36	Kerb stone in CC 1:3:6 of size 125x375mm	m.	0.21
37.	Shahabad stone paving, pointed in C.M.1 :3, 15x10 mm groove.	Sqm	0.02
38	Pointing & grouting stone pitching in C.M. 1:3	Sqm	0.14

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

CONSUMPTION OF PAINT FOR SOME PAINTING ITEMS :

(PARA OF PAINTING)

Coverage Achieved Per Litre or Per Kg of Paint / Material				
Sl. No.	**Name of Paint**	**Area coverage For one coat (Old work)**	**Area coverage For two coats**	**Area coverage Per addl. coat**
1	Synthetic enamel paint	1 4m² per Ltr.	8.5m² per Ltr.	1 8m² per Ltr.
2	Plastic emulsion paint	14m² per Ltr.	8.5m² per Ltr.	18m² per Ltr.
3	Oil Bound distemper	10m² per Ltr.	6.0m² per Ltr.	12m² per Ltr.
4	Dry Distemper	10m² per kg	6.5 m² per kg	12 m² per kg
5	White wash	5m² /kg of lime	3.5m² / kg of lime	10 m² /kg of lime
	Note : Following things to be added in lime (i) Adhesive (DDL/SDL) – 5% of lime (ii) Neel (Blue) – 3 gm per kg of lime			
6	Cement based paint	4.5 m² per kg	2 m² per kg	6 m² per kg
7	Aluminium paint	20m² per Ltr.	12.5 m² / Ltr.	28 m² per Ltr.
8	Bitumen Paint/Black Japan	14 m² per Ltr.	14 m² per Ltr.	28 m² per Ltr.
9	Neeru (or lime punning with slacked lime) over	0.5 m² per kg of slacked lime		
10	Red oxide metal primer	16 m² per Ltr.		
11	Cement primer	12 m² per Ltr.		

12	Wood primer	13 m^2 per Ltr.		
13	Wax polishing of new wood work with ready	20m^2 per kg	20m^2 per kg	20m^2 per kg
14	French or spirit polish	10.5 m^2 / Ltr.		
15	Varnish	14 m^2 per Ltr.	8.5 m^2 per Ltr.	18 m^2 per Ltr.
16	**Requirement of paint per coat in Structural steel work on tonnage basis.** (i) Truss and Lattice girder work – 4.5 litres per tonne.			

APPENDIX – "C-2"

CO-EFFICIENT FOR EQUIVALENT PLAIN AREAS FOR PAINTING ITEMS :

(PARA REFERRED TO CHAPTER 47 - PAINTING)

SrNo	**DESCRIPTION OF WORK**	**MULTIPLYING CO-EFFICIENTS**
I.	**WOOD WORK : DOORS, WINDOWS ETC.**	
1	Panelled or framed and braced doors, windows etc.	
2	Ledged & battened or ledged, battened & braced doors, windows etc.	1.30 (for each side)
3	Flush doors etc	1 .20 (for each side)
4	Part panelled and part glazed or gauzed doors,windows etc.	1.00 (for each side)
5	Fully glazed or gauzed doors, windows etc.	0.80 (for each side)
6	Fully ventillated or louvered doors, windows etc.	1.80 (for each side)
7	Trellis (or Jaffri) work one way or two way.	2.00 (for painting all over)
8	Carved or enriched work:	2.00 (for each side)
9	Weather boarding:	1.20 (for each side)
10	Wood shingle roofing:	1.10 (for each side)
11	Boarding with cover fillets and match boarding.	1.05 (for each side)
12	Tile and slate battening:	0.80 (for painting all over)
II.	**STEEL WORK: DOORS, WINDOWS ETC.**	
13	Plain sheeted steel door or windows:	1.10 (for each side)
14	Fully glazed or gauzed steel doors and windows	0.50 (for each side)

15	Partly panelled and partly gauzed or glazed doors and windows.	0.80 (for each side)
16	Corrugated sheeted steel doors or windows.	1.25 (for each side)
17	Collapsible gates	1.50 (for painting all over)
18	Rolling shutters of inter locked laths.	1.10 (for each side)
III.	**GENERAL WORKS :**	
19	Expanded metal, hard drawn steel wire fabric of approved quality,grill work and gratings in guard bars,balusters, railings,partitions and m.s. bars in window frames.	1.00 (for painting all over)
20	Open palisade fencing and gates including standards, braces, rails,stays etc. in timber or steel.	1.00 (for painting all over)
NOTE: The height shall be taken from the bottom of the lowest rail, if the palisades do not go below it (or from the lower end of palisades, if they project below the lowest rail) upto the top of palisades but not upto the top of standards, if they are higher than the palisades.		

APPENDIX – "F"

7 Special conditions for steel

1) The contractor shall procure TMT bars of **Fe500D/Fe550/Fe550D** grade (the grade to procured is to be specified) from primary steel producers such as **SAIL, Tata Steel Ltd., RINL, Jindal Steel & Power Ltd.; Essar and JSW Steel Ltd.**

a) The grade of the steel such as **Fe415/Fe415D/Fe500/Fe500D/Fe550/Fe550D** or other grade to be procured is to be specified as per BIS 1786-2008.

2) The contractor shall have to obtain and furnish test certificates to the Engineer-in-Charge in respect of all supplies of steel brought by him to the site of work.

3) Samples shall also be taken and got tested by the Engineer-in-Charge as per the provisions in this regard in relevant BIS codes. In case the test results indicate that the steel arranged by the contractor does not conform to the specifications defined under para (1) above, the same shall stand rejected, and it shall be removed from the site of work by the contractor at his cost within a week time or written orders from the Engineer-in-Charge to do so.

4) The steel reinforcement bars shall be brought to the site in bulk supply of 10 tonnes or more, or as decided by the Engineer-in-Charge.

5) The steel reinforcement bars shall be stored by the contractor at site of work in such a way as to prevent their distortion and corrosion, and nothing extra shall be paid on this account. Bars of different sizes and lengths shall be stored separately to facilitate easy counting and checking.

6) For checking nominal mass, tensile strength, bend test, re-bend test etc. specimens of sufficient length shall be cut from each size of the bar at random, and at frequency not less than that specified below:

Size of bar	**For consignment below 100 tonnes**	**For consignment above 100 tonnes**

Under 10mm dia bars	One sample for each 25 tonnes or part thereof	One sample for each 40 tonnes or part there of
10mm to 16mm dia bars	One sample for each 35 tonnes or part thereof	One sample for each 45 tonnes or part there of
Over 16mm dia bars	One sample for each 45 tonnes or part thereof	One sample for each 50 tonnes or part there of

7) The contractor shall supply free of charge the steel required for testing including its transportation to testing laboratories. The cost of tests shall be borne by the contractor.

8) The actual issue and consumption of steel on work shall be regulated and proper accounts maintained as provided in clause of the contract. The theoretical consumption of steel shall be worked out as per procedure prescribed in clause of the contract and shall be governed by conditions laid therein. In case the consumption is less than theoretical consumption including permissible no adjustment need to be made.

Note:-

If the Contractor wishes to suggest minor improvements/changes in the technical parameters without changing the major Contract technical specification, then the same need to be informed to the Consultant and Client for consideration with proper justification. However the Consultant's and Client's decision will be full and final and binding on the Contractor.

1) PROGRESS OF WORK

The Contractor shall carry out the work as per the programme approved by the Department from time to time. He will also not be allowed to proceed with the work in a scattered manner.

2) FIELD LABORATORY

The Contractor shall establish a field laboratory for the various field tests for items like concrete cubes, cement, aggregates, sand, blocks for masonry, tiles, wood and for similar items as directed by the Engineer. A Site Laboratory of approximately 5.0 x 7.0 m. area with platform etc. shall be constructed for items similar as directed by the Engineer.

The Laboratory must have the following equipment ;

Slump Cone	:	6 nos. as per ISI
Cube moulds for concrete	:	24 nos.
Cube moulds for cement mortar	:	6 nos.

Cement testing equipment	:	1 set
Soundness accelerated (initial and final setting, fineness, Compressive test equipment, etc.)		
Oven	:	1 no.
Cube Testing Machine-200T	:	1 no.
Weigh Balance (Digital)	:	2 nos.
IS Sieves	:	4 sets
Glass-measuring Cylinders	:	12 nos.
Ultrasonic Equipment	:	1 no.
Micro Meter	:	2 no.
Vernier caliper	:	2 no.
Moisture Meter	:	2 no.

Equipment for measuring cover in concrete : 2 No.

Construction of Laboratory building well-equipped with equipments as listed above is incidental to the work and no separate payment will be made for this.

The Contractor shall carry out other various tests for various items and materials at IIT or VJTI laboratory or any other approved laboratory as directed by the Engineer at Contractor's own cost. At the end of each month for each category of the work, e.g. RCC work, etc. the Contractor shall give statistical analysis of all the test results in the format prescribed by the Engineer and take corrective action in the work in accordance with these results.

The Contractor shall keep all relevant IS / BIS / special publications at site lab for various items of works covered in the present Contract.

3) ENGINEER-IN-CHARGE (EIC)

Engineer-in-charge for this project shall be the Executive Engineer or the person nominated or appointed by the Managing Director, MDL, from, time to time and shall include any person duly authorised by him.

Engineer-in-charge shall be responsible for the execution of the project with regards to management and supervision. Instructions issued by the EIC to the Contractor shall be deemed to be the Employer's instructions in respect of

1.Day to day supervision including material testing using ISO formats proforma of which should be got approved from EIC.

2.Certification of measurements and bills and issue of certificates accordingly for interim and final bills.

The EIC shall coordinate works at site of all agencies appointed by the Employer.

MDL has implemented Enterprise Resource Planning (ERP) Software SAP in the organization for its various processes. The Contractor will furnish all the project related data, if an when required by EIC, in the manner and format which is compatible to Enterprise Resource Planning Software SAP R/3. Apart from the above the Contractor will make a detailed work programme on MS Project in soft and hard copy and submit the same to EIC for approval before commencement of work. All monitoring will be done on SAP R/3 as well as MS Project.

4) EXCAVATED STUFF

All the materials obtained during the process of excavation shall remain the property of the corporation and shall be disposed off as instructed by the EIC. The Contractor is supposed to use the selected materials for filling in plinth, pipe bedding, and providing embankment where required, filling the trenches and also filling low lying areas. All operations including loading, unloading, transportation of materials, payment of royalty where required with all leads and lifts and handling them and leveling at disposal site etc.

5) DEBRIS CHUTE

Disposal of moorum/building rubbish/ malba/ similar unserviceable, dismantled or waste material shall be removed by means of chute, bucket or other safe method & cleaned off the site on a regular basis.

6) AS BUILT DRAWINGS

The Contractor shall during the course of execution, prepare and keep updated a complete set of 'as- built' drawings recording all works on the blue prints, which shall be corrected daily, if necessary, to show each and every change from the Contract Drawings as a approved working drawings, shop drawings and the exact `as-built' location, sizes and kinds of work etc. This set of drawings shall be kept on the site and shall be used for record purposes. Changes recorded shall be countersigned by the Engineer and the Contractor. Copies of 'as-built' drawings shall be supplied to the Architect and the Engineer on request.

The Contractor shall submit complete 'as-built' drawings on reproducible tracings and ammonia prints 3 sets in form of hard copies and Compact Discs 2 nos. for building work and all services as directed by the Engineer within 30 days of the completion of entire work by using AutoCAD facility. In case the Contractor fails to submit complete 'as-built' drawings as aforesaid [in form of hard copies [3 (Three) sets] and Compact Discs [2 nos.], he shall be liable to pay a sum equivalent to 0.1 percent of the value of work subject to maximum of Rs.10 lakh or as may be fixed by

MDL and this decision shall be final and binding. Final Bill shall not be released until all the as-built drawings are submitted.

7) ENGINEER'S SITE OFFICE

The Contractor shall provide site office for the Engineer's use of area admeasuring about 120 Sqmt with Split Air Conditioners for entire office premises including conference hall as per the Client requirement.

Broad details about construction of office and other facilities to be provided at the minimum shall be as follows:

a) Overall size of the office shall be 15m x 8.0 m with one separate cabin for Engineer and conference hall and one room of 3.0 x 3.0 m for Computer.

b) All furniture, fittings, fixtures, specifications as per drawing including landscaping, etc. All as per drawing which will show fully furnished, furniture specifications, etc.

c) Pantry Equipment;

i)	Electrical hot plate, one burner	1 No.
ii)	Cutlery, Crockery, etc. for 12 persons	1 set
iii)	Dinner set for 12 person	1 set
iv)	Thermos, Trays	2 Set
v)	Water cooler with water purifier	1 Set

The Contractor shall arrange to maintain this office by daily sweeping the floor and keeping the premises clean. The Contractor shall also arrange to deploy two office boys for the pantry and for EIC.

Cost of all this shall be deemed to have been included in the tender as incidentals and no separate payment shall be made for providing these facilities.

8) TIME SCHEDULE FOR COMPLIANCES

The tenderers should please note the following time schedule for various compliances and follow the same:

a) The Initial Security Deposit shall be paid within 15 days of receipt of Letter of Acceptance.

b) The work order shall be signed by the Contractor within 3 days of submission of Bank guarantee/ Paying of Initial Security Deposit.

c) The Contractor should construct the site office within one month of date of work order. The site office should be as per relevant clause in the tender document.

d) The CAR policy and Labour license shall be taken by the Contractor within one month from the date of work order. All amounts / charges towards premium shall be paid entirely by the contractor.

e) The successful tenderer has to furnish Quality Assurance Manual along with programme within 15 days from the date of Work Order.

9) APPROVAL OF ENGINEER

The foundation strata as well as steel reinforcement provided in all RCC members shall be got approved from the Engineer-in-charge or his authorised representative. At every stage of work, approval of the Engineer-in-charge shall be taken by the Contractor. Before starting any work like concreting, block masonry, water proofing, concrete, etc. detailed information of the work in the prescribed proforma shall be give to the Engineer-in-charge and his approval shall be taken by the Contractor. It is the responsibility of the Contractor to get all the hidden measurements like foundation work, reinforcement, etc. recorded before covering the same. All the measurements shall be taken jointly by PMC's representative and the Contractor's authorised representative and then only the measurements will be forwarded by the Engineer-in-charge for payment.

10) WORK TO THE SATISFACTION OF THE ENGINEER

The Contractor shall execute and maintain the works in strict accordance with the contract to the satisfaction of the Engineer and shall comply with and adhere strictly to the Engineer's instructions and directions on any matter whether mentioned explicitly or otherwise.

11) CLEANING SITE

All water which may accumulate on the site during the progress of the works or in trenches and excavation, shall be removed from the site to the satisfaction of the EIC at the Contractor's cost.

Site shall be maintained free from rubbish. Proper stacking of scaffolding material, shuttering material bricks/brickbats, steel pieces, etc. needed for work on day to day basis shall be organized in proper stacks. Heaps of material lying around in unplanned manner and disorderly fashion shall not be permitted. EIC's decision in this matter shall be final.

The Contractor shall not, at any time, do cause or permit any nuisance on the site or do anything which shall cause unnecessary disturbance or inconvenience to Employer, tenants or occupiers of other properties near the site and to the public in general.

The Contractor shall install mosquito proof and accessible water storage tanks for construction and drinking water.

The Contractor shall periodically give largasidal treatment to water storage tanks, sites of water stagnation, water collection.

Any expenditure that may be incurred by MDL to ensure that the above conditions are fulfilled by the Contractor will be debitable to Contractor's account and will be recovered from the running bills of the Contractor from time to time.

12) SUPERVISORY STAFF

The Contractor shall engage on the work a qualified and experienced, Engineers, Supervisor, capable of managing and guiding the work properly. This supervisor shall be authorised by the Contractor in writing to receive the orders issued by the EIC from time to time. The Contractor shall be responsible for carrying out these orders promptly.

13) FIRE PRECAUTIONS

The Contractor shall comply with fire regulations of the controlling authority in force at the site of the works relating to the precautions to be taken against fire hazards.

14) USE OF SITE

The Contractor shall not use any portion of the site for purpose not connected with the works without the prior written approval of the EIC He shall maintain permanent and site access roads free of spillage and shall not interfere with the flow of traffic. Also same shall apply to terraces and other developed areas.

15) SAFETY ENGINEER

The Contractor shall employ and depute at site on full time basis a fully qualified Safety Engineer/s who shall be responsible to ensure observance of safety precautions and measure required to be taken at site. Further he shall make sure stipulations laid down in annexure `C' are followed.

16) QUALITY ASSURANCE MANUAL AND SAFETY MANUAL

Successful tenderers will be required to submit Quality Assurance Manual and Safety manual for various items of work and get the same approved from Engineer-in-charge before start of work and the adhere the same during actual execution of work.

Quality Assurance Manual

An quality assurance manual constituting a base document outlining quality policy of the agency, procedures, name of action, compliance, acceptance criteria and documentation etc. Shall be prepared by the successful tenderer and submitted to

the EIC for approval within 15 days from the date of receipt of work order. The document shall generally cover aspects listed below, but not limited to the same.

a) Scope of work
b) Planning for items to be executed including method statement and resource deployment both physical and financial.
c) Identification of all parties involved in QA and their inter-relationship.
d) Execution plan of Quality System giving reference – standard – frequency and acceptance criteria.
e) Levels of cross checking / verification in case of multiple verifications / controls, including systems of inspection and audit, wherever applicable.
f) Organization of personnel, responsibilities and lines reporting for QA purpose.
g) Testing and statistical analysis.
h) Inspection reports at the end and during defect liability period / maintenance period.
i) Items to be covered for maintenance manual.
j) Check list viz. Forms and formats.

17) BATCHING PLANT

The batching plant shall be erected by the contractor only on the location approved by EIC. The batching plant shall be enclosed properly with necessary acoustic material to reduce the noise pollutions upto the permissible limit. Necessary arrangement shall be made to reduce air pollution to maintain the good, healthy environment in the surrounding residential area. However if contractor request to buy RMC from other agency then they have to take proper approval from MDL.

17) QUALITY ASSURANCE SYSTEM

A quality assurance procedure covering all aspects of the work shall be adopted for this work to ensure the desired quality. Details of the procedure shall be decided by mutual consultation between the Engineer and the contractor at the start of the works.

The contractor shall submit within the time stipulated by the Engineer in writing, the details of actual methods that would be adopted by the contractor for the execution of any item as required by the Engineer at each of the locations, supported by necessary detailed drawings and sketches including those of the equipment and machinery that would be used, their locations, arrangements for conveying and handling materials etc., and obtain prior approval of Engineer well in advance of starting of such item of work.

The Engineer reserves the right to suggest modifications or make complete changes in the methods proposed by the contractor, whether accepted previously or not, at any stage of work, to obtain the desired accuracy, quality safety and progress of work which shall be binding on the contractor and no claim on account of such change in method of execution will be entertained by the Employer so long as Specifications of the items remains unaltered.

The Contractor shall furnish within the period of 15 days a detailed programme schedule using PERT/CPM technique in quadruplicate including the date of actual start, the monthly progress expected to be achieved and the anticipated completion date of each major item of work to be done by him, also indicating, plant and machinery and material procurement schedule.

The schedule is to be such as is practicable of achievement towards the completion of the whole work in the time limit and of the particular items, if any, on the due date specified in the contract and shall have the approval of the Engineer. No revised schedule shall be operative without such acceptance in wiring. The Engineer is further empowered to ask for more detailed schedule or schedules say weekly for any item or items, in any case of urgency of work as will be directed by him and the contractor shall supply the same as and when asked for.

The contractor shall furnish sufficient plant, equipment and labour as may be necessary to maintain the progress schedule. The working and shift hours for operations to be done under.

Further, the contactor shall submit the progress of work in forms and statements etc. at periodical intervals in the form of progress charts, forms, statements and / or reports as may be approved by the Engineer.

The contractor shall maintain proforma, charts, details regarding machinery, equipment, labour, materials, periodical returns thereof as may be specified by the Engineer.

18) EQUIPMENT MAINTENANCE MANUAL

The Contractor shall mention the list of machinery procured at site for the work in this manual. This manual shall also reflect the name of the manufacturer, age of machinery and the agency interested with the maintenance work of the machinery listed in the manual.

19) MINIMUM PLANTS, EQUIPMENT AND SHUTTERING

Minimum Plants and Equipment to be provided by the Contractor are

Sr.no	**Description**		**Qty**

1.	Concreting Batching plant of minimum 60 Cum/Hr Capacity equipped with		1 No.
	o Cement Silo for 2 days capacity with direct feeding and batching and feeding facility		
	a) For Grade 53		1 No.
	b) for Grade 43		1 No.
	o Fly ash Silo with screw conveyor for direct feeding and batching.		1 No.
	o Hoppers for fine and coarse aggregate		1 No. Min. As required
	o Plasticizers dozing facility		
	o Software programme compatible to make corrections to batching.		1 Minimum
2.	Concrete Pump 20 Cum / Hr.		2 Nos.
3.	Transit Mixer of 6 Cum capacity		3 Nos.
4.	M S concrete Piping system for pumping (80 m)		1 No. set per Bldg.
5.	Steel lifting Electric Winch		4 Nos.
6.	JCB		2 Nos.
7.	Excavator/Poclain		2Nos.
8.	Roller /Grader/Vibro roller		1No each
9.	Arc Welding set. (3 phase)		20 Nos.
10.	Gas Cutting Set		20 Nos.
11.	Air Compressor 100 cfm.		1 No.
12	Vibrators		
	a) Electric with low noise		10 Nos.
	b) Petrol (Stand by)		2 Nos.
	c) Needles – 20		10 nos.
	d) Needles - 40		10 Nos.
13.	Pneumatic Rock breaker		2 No.

14.	Bar bending Machine upto 40 mm dia		5 Nos.
15.	Bar cutting machine upto 40 mm dia.		5 Nos.
16.	Floor Polishing machine		4 Nos.
17.	Wall Chasing /Cutter machine		10 Nos.
18.	Mobile crane		2 Nos.
19.	Tower crane		3Nos.
20.	Material Hoist		5 Nos.
21.	Curing Pumps		10 Nos.
22.	Dewatering pump (upto sub structure)		10 Nos.
23.	Double legged tubular scaffolding system for external plaster glazing & roofing.		20,000 Sq m
24.	Sand washing machine (screw type)		2 Nos.
25.	Pan Mixer of not less than 0.5 Cu m Capacity for external plastering.		1 Nos.

Minimum Shuttering Material to be provided by the Contractor

Sr.No	Description	Unit	Qty
26.	Centering & Shuttering		
	a) 18 mm thick marine plastic coated ply backed with timber batten / runners / frame / steel frame / designed shutter system/Plates	Sq m	12,000
	b) Steel props medium duty 3 M to 4.5 M long adjustable length.	Nos.	2,000
	c) Column Tie rods	Nos.	1,000

20) COMPUTERISED BATCHING PLANT

The concrete batching plant shall be fully computerized fully automatic for addition of all ingredients. Manual addition of any material will not be allowed. In case of break down or failure of batching plant the contractor should procure concrete from RMC plants at no extra cost to corporation.

Stand-By Concrete Pump - The Contractor to provide at least one concrete pump (Static) as stand-by for concrete works.

Sand Washing

The sand shall be river sand and shall be washed mechanically in sand washing machine before use if the silt content, chloride and sulphate content are not within the permissible limit.

Location of labour camp

The labour camp shall be located away from the building as directed by the Engineer-in-charge. The Contractor should provide proper fencing to the labour camp with display board indicating the name of the contractor.

21) SUPPLY OF WATER

Water will not be supplied by MDL and the Contractor shall make his own arrangements. MDL will give recommendatory letter to the concerned authority if so requested by the Contractor for him to arrange the water supply at site, however, MDL shall be in no way responsible for obtaining permission and no claim on account of this will be entertained.

22) ELECTRIC SUPPLY

a) Electric power both for construction and lighting shall not be made available to contractor. Contractor shall arrange at his own cost power with necessary switch boards, energy meter etc. and shall be responsible for their maintenance.

(b) Further distribution by the Contractor at his cost shall be done as per approved layout. & as per their site requirement. He shall provide required clearances for overhead lines to facilitate easy movement of heavy machinery such as cranes etc. These shall be shifted and rerouted at Contractors Cost during execution of work if the same are found to obstruct any other work of any agency working at site or requires shifting due to unforeseen reasons.

(c) On completion of the work the Contractor shall remove all temporary cabling & wiring installed by him and make good to the satisfaction of EIC if any disturbance or damage is done.

(d) The Contractor shall employ a full time certified Electrician for carrying out this work.

(e)The Contractor has to keep alternative arrangement for electric supply ready at his own cost for any failure/interruption of electric power that takes place and under no circumstances can this be deemed to be reason for any consequential delay in the works.

(f)Any disputes in sharing of power obtained directly / indirectly from MSEB with other agencies shall be resolved by the contractor at his risk and cost. MDL shall not be responsible or a party for such disputes.

22) SHOP DRAWING

Contractor shall prepare and submit shop drawing(s) for Structural glazing, Aluminum windows, rolling shutter, GI Shutter, Tensile roof structure, Techlam cladding etc. for approval by the Consultant.

MDL and /CONSULTANT giving approval of shop drawings, and samples, and permission to proceed with the work does not constitute acceptance to design, method of working, testing or certificates submitted by the CONTRACTOR.

Additional Specific Conditions of Contract for "GRIHA Rating System"

The contractors are required to comply with all the stipulations for compliance with the standards specified in the GRIHA rating system, as instructed by the Architect/ Engineer-in-Charge, including aspects of Site organisation and management, Construction Practices, safety measures and worker welfare etc. As well as documentation and other relevant mandatory requirements including, but not limited to the following:

Where specific items of work as required for GRIHA Compliance have been included in the Bill of Quantities, the contractor shall ensure use of materials, systems and technologies strictly as specified. At the same time, compliance 'with other provisions and considerations as required for the purpose including activities such as Site organisation and management, Construction Practices, safety measures and worker welfare etc. As stipulated in the GRIHA requirements shall be ensured by the Contractor.

The rates quoted by the contractor shall be deemed to include all costs if any for such compliance and documentation and naming extra shall be payable over and above the quoted rates.

In support-of the-action taken by the contractor, the Contractors shall provide-adequate and complete documentation as required towards obtaining certification from GRIHA, as noted below.

Drawings as called for in support of measures taken for various criteria of GRIHA as applicable to the contractor Documents, including narratives, certificates, and manufacturer's supporting certificates etc. as called for in support of measures taken for various criteria of GRIHA as applicable to the contractor.

Records of action taken at site during construction in support of compliance with the requirements of GRIHA. The contractor shall endeavour to execute the work with the objective of achieving the mandated GRIHA rating. For this purpose the tasks to be carried out are summarised below:

The contractor shall adhere to the following during construction.

Measures to be taken shall be implemented in consultation with the

Architect and Engineer-in-Charge after obtaining prior approval:

Take measures for conservation of existing landscape and topsoil including existing trees, soil erosion control, topsoil conservation, etc. This shall include, but not be limited to: Preparation of Site Organisation Layout Plan, defining "go" and "no-go" areas, where construction related activities will or not be permitted respectively. Define areas for excavated topsoil stacking and conservation measures. Plan proper timing of construction to ensure no basement work monsoon/rainy season.

Use strategies such as wheel-washing, etc., to reduce wastage of soil from site. Provide adequate level of sanitation and safety facilities for construction workers. Reduce air and noise pollution due to storage/ use of materials and machinery, with suitable arrangement for preventing dust and debris entering duct work and working areas. Efficient use of available water including measures to minimise the water requirements for construction related activities without Compromising on construction quality.

Use of recycled materials especially post-consumer waste products shall be ensured as specified in the Bill of Quantities, especially focusing on the use of fly-ash for cement replacement in both structural and non-structural applications.

Low energy products shall be used as specified. The contractor shall provide all necessary documentation and other information as called for in this regard. Work towards reduction in waste of construction materials, proper storage and disposal of wastes. Wastes shall be disposed of in accordance with the environmental regulations for the various types of waste — inert, chemical or hazardous. Dedicated place within the site to be earmarked for storing and sorting construction wastes prior to disposal.

To meet this objective the contractor shall prepare a Construction Waste Management Plan. The plan should include where these materials will be sent to and the mode of transportation also. The Waste Management strategy shall primarily focus on reuse and recycling of all possible waste generated during construction. Typical items would include land clearing debris, concrete, steel, duct work, clean dimensional wood, paperboard and plastic used in packing, etc. The contractor should have a system to document the disposal of construction waste.

Implement recycling program as far as possible to recycle construction waste materials during construction. Waste that cannot be reused at site but is recyclable shall be collected and sent to third party recyclers.

Ensure use of low VOC emitting materials for paints, adhesives, sealants and composite wood products.

The contractor shall maintain proper record of all the materials procured

and used, and submit details including specifications, manufacturer's.

Literature, cut-sheets etc. along with all supporting documents to-the-

Engineer-In-Charge.

Appendix I

Criteria-Specific Considerations for execution of work at site

In accordance with the requirement for GRIHA Certification (4-Star Rating)

A. Commitment by Contractor

Criterion 2:

• Select proper timing for the construction activity to minimize site disturbance such as Soil pollution due to spilling of the construction

material and its mixing with rainwater.

• Site activity and construction to include staging and spill prevention and control plan to restrict the spilling of the contaminated material on site.

•Protect the top soil from erosion. Use collection storage and reapplication of the top soil, sediment basin, contour trenching, mulching, soil stabilization methods to protect the top soil from erosion during construction.

•Specify and limit construction activity in pre-planned/designated areas. Care must be taken to preserve existing mature trees on-site during the course of construction by preserving and transplanting them.

Criterion 3:

• Ensure adequate topsoil laying for vegetative growth.

• Ensure stabilization of soil in the area where the topsoil is vulnerable to erosion.

Criterion 8:

• Comply with the safety procedures, norms and guidelines (as applicable) as outlined in

NBC 2005 (BIS 2005c): Part 7: Constructional Practices and Safety.

• Adopt additional best practices and prescribed norms as in NBC

2005 (BIS 2005c).

• Provide clean drinking water to all workers.

• Provide adequate number of decentralized latrines and urinals to

construction workers.

Criterion 9:

• Adopt measures to prevent air pollution in the vicinity of the site due to construction activities. There is no standard reference for this. The best practices should be followed (as adopted from international best practice documents and codes).

• Provision in the contract document that the contractor will

undertake the responsibility to prevent air pollution (dust and smoke); ensure that there will be adequate water supply/ storage for dust suppression; devise and arrange methods of working and carrying out the work in such a manner so as to minimize the impact of dust on the surrounding environment; and provide experienced personnel with suitable training to ensure that these methods are implemented. Prior to the commencement of any work, the methods of working, plant equipment, and air-

pollution-control system to be used on-site should be made available for the inspection and approval of the engineer-in- charge to ensure that these are suitable for the project.

Criterion 12:

•Use materials such as pre-mixed concrete for preventing water loss during mixing.

•Use recycled treated water.

•Control the wasting of curing water by adopting appropriate measures.

Criterion 15:

•Reinforced concrete, including ready-mix concrete shall make use of fly-ash conforming to IS: 3812(Part1), by using PPC (Portland pozzolana cement) conforming to IS: 1489 (Part 1). A minimum of 15% replacement of cement with fly-ash in PPC (by weight of the cement used) in the overall Reinforced Concrete shall be used for meeting the equivalent strength requirements. Higher fly-ash content over 30% shall be provided if called for by the Engineer-in-Charge, with the equivalent strength requirements.

•Use fly ash in building blocks for the walls with 40% fly-ash content.

•Use fly-ash in Plaster/masonry mortar by employing PPC. Additional fly-ash shall be added to achieve. A minimum 30% of fly-ash after obtaining approval of the Engineer-in- Charge for all wall/ceiling finishes and wall construction, meeting the required structural properties.

Criterion 22:

• Employ measures to segregate the waste on-site into inert, chemical hazardous wastes.

• Recycle the unused chemical/ hazardous wastes such as oil, paint, batteries, and asbestos.

• Inert waste shall be disposed of by municipal corporation/local bodies at approved landfill sites.

Criterion 26:

•Use only zero/low VOC paints. All plinths used in the interior of the

building must be certified-to-contain-zero VOC or less than the limits

specified as follows.

•Prefer water- based acrylics over solvent-based oil paints.

•Ensure all the sealants and adhesives used are water based rather than solvent based or have a low solvent content. Most construction adhesives offer adequate bond strengths in water-based varieties.

Acrylics, silicones, and silicones acrylics are the safest sealants for use in the interiors and have the lowest solvent content. While solvent- based products, such as urethanes and butyls, should preferably not be used indoors, sealants used for exterior do not pose any concern.

• Adhesive usually has a high-VOC emission potential. Hence, use adhesives with low-VOC or no — VOC emissions such as acrylics or phenol resins (phenol formaldehydes indoors).

•Ensure all composite wood products/agro fiber products do not contain any added urea formaldehyde resin.

•Refer Appendix 2 for VOC Limits applicable for this Building.

Criterion 27:

• Use insulation with zero-ODP (ozone depletion potential) such as HCFC-free rigid foam insulation, mineral fiber cellulose insulation, glass fiber, wood fiber board, cork wool, expanded (bead) polystyrene, recycled newspaper, and jute and cotton. Avoid materials that do not inherently have a zero-ODP, such as polyurethane foams and polyester fibre

• Install CFC-free equipment for refrigeration and air conditioning.

• Install halon-free fire suppression systems and fire extinguishers in the

building.

B. Documentation required from Contractor for Compliance

Criterion 2:

•Drawings:

Site Plan showing staging and spill prevention, demarcation of topsoil collection area and designated stacking area.

•Documents:

Description of Erosion control and sedimentation control measures

•Records:

Photographs of: Undisturbed non-construction' areas, erosion control, topsoil conservation measures

Criterion 3:

• Drawings.

Topsoil stacking and protection plan.

•Documents:

Narrative description of topsoil stabilisation and protection

Criterion-8.

•Documents:

Letter certifying Compliance with National Building Code 2005 on safety standards accepted.

Narrative description on safe drinking water provisions and sanitation

•Records

Photographic evidence depicting compliance with the NBC 2005.

Criterion 9:

•Documents:

Narrative describing the air pollution preventive measures

adopted at site during construction.

•Records

Photographic record at different stages of construction indicating

compliance

Criterion 12:

•Documents:

Narrative description of water use minimisation during construction

•Records

Photographs of measures taken to conserve water

Criterion 15:

• Documents:

Certificate from Cement Manufacturer for compliance with minimum fly-ash content stipulations in PPC used Certificate from Precast Building Block Manufacturer for compliance with minimum cement content stipulations in PPC used Certificate from Contractor indicating fly-ash content in plaster and mortar

Criterion 22:

Drawings:

Layout Plan of Waste Storage Facility

Documents:

Narrative of Waste quantum and description of storage facility

Records

Photographs of storage measures

Criterion 26:

Documents:

Certificate indicating specifications of paints, adhesives, sealants,

composite wood products etc. used in construction for compliance with

low or zero VOC content

Cut-sheets

Manufacturer's specifications

Records

Photographs of: Undisturbed non-construction areas, erosion control, topsoil conservation measures

Criterion 27:

Documents:

 A certificate from_ the manufacturer/supplier, stating that 100% of

the insulation used in the building is free of CFCs and HC.FCs.

 A list showing each type of HVAC and refrigeration equipment/systems, their numbers and- type of refrigerant used along with the manufacturer brochure clearly stating the type of refrigerant being used in their products.

 A certificate from the fire-fighting-service equipment supplier, stating that the fire suppression systems and fire extinguishers installed in the building are free of halon.

Appendix II

VOC Limits for Paints, Adhesives and Sealants

(Ref. CPWD Technical circular QACW/03/2011)

Table-4.1

Total -4.1 VOC limits for paints

Paint applications VOC limits (grams of VOC per litre)

Interior coatings Flat <50

on-flat<150

Exterior coatings Flat <200

Non-flat100

Anti corrosive Gloss, semi gloss, flat <250

Table- 4.2

Table 4.2 C content limit for adhesives •

Architectural adhesive application VOC content limit (g of

VOC per litre)

Wood flooring 100

Industrial/rubber-flooring 60

Ceramic tile 65

Structure glazing

100

Multi-purpose-construction 70_

Sub-floor 50

Wall Boards/panel 50

PVC welding' 285

Adhesive-primer-for plastic 2

Structural-member 140

Sub-specific use metal to metal 30

Wood 30

Fibre glass 80

6

Plastic foams/porous materials (except wood) 50

Table- 4.3

Table 4.3 VOC content limit for sealants Sealant application

VOC content Limit (grams of VOC per litre)

Architectural/roadways 250

Single-ply roof material installation/repair 450

Others 420

Sealant primer applications architectural non-porous 250

Sealant primer applications architectural porous 775

Other sealant primer applications architectural 750

PLUMBING WORKS

ENCLOSURE 21 – TECHNICAL SPECIFICATIONS
Sub -Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai.
Tender No:1900000248.

PUBLIC HEALTH SERVICES

General

General conditions of contract, particular specifications and special conditions of contract will apply in addition to this section.

BASIS OF TENDERING :-

The tender shall be complete covering the entire work of plumbing system and ancillary services including all building system and outside utilities as shown and specified.

The contractor shall consult specifications, drawings and the schedule of quantities which are instruction on this system.

DRAWING :-

The drawings accompanying these specifications are design drawings and generally are schematic. They do not show every offset, T, Cross, Y, junction coupling/flanges etc., which are required for installation in the space provided.

The contractor shall prepare detailed shop drawings by following these drawings, as closely as is practicable, with necessary additional bends, elbows or junctions etc., where required to suit local site conditions, from actual site measurement taken, get the same approved from the Consultants in good time & follow then at site, without additional cost to the Owner.

The Owners reserve the right to make any reasonable change in outlet location prior to roughing in. All connections and appurtenances, shown in the various diagrams, shall be included in the finished job. The contractor shall visit the site prior to bidding, to familiarize himself with all conditions.

It shall be the contractor's responsibility to co-ordinate with all others for proper and adequate installation clearances.

ORDINANCE, CODE AND REGULATIONS:-

It shall be the Contractor's responsibility to provide complete system, as indicated and as required by applicable code. Unless, otherwise approved the product shall bear the mark of approval of ISI as required by the Governing bodies, code and ordinances and local authorities, whose permission are required for occupation of the building on completion.

MEASUREMENT LINES & LEVELS :-

Check dimension at the building site and establish lines and levels for the work specified.

All inverts, slopes and manhole elevations shall be established by instruments, working from an established datum point. Elevation markers and lines shall be provided for Owner's use, to determine that slopes and elevations are in accordance with the drawings and specifications and local bylaws.

Established grid and area lines shall be used for location of trenches in relation to building and boundaries. Trenches shall be carried out to the true alignment and to required levels. No refilling will be allowed for the purpose of making up the bed of trenches,

but, to make up the same with lean concrete mix 1:4:8 (at contractors cost including cost of cement).

Use of sight rails, boning rods shall be adopted during the whole process of excavation and laying of the pipes

Sight rails shall be fixed at suitable intervals which shall not exceed twenty meters before the excavation is begun. No extra charges will be paid for excess excavation.

Sufficient width shall be provided to the trenches to allow a space of minimum 150 mm on either side of the body of drain to facilitate laying of the drains and jointing. Extra width shall be provided at the joints.

When the trenches are in deep or in bad ground, the sides of the trenches shall be supported with suitable timbering.

All pipes, water mains, or gas mains, telephone and electric cables etc., met within the course of excavation, shall be carefully protected and supported without any extra charge.

EXCAVATION & BACKFILL:-

General

Perform all necessary excavation and backfill required for installation of plumbing work, excavation shall confirm to the limits indicated on the drawings.
All the material shall be new of best quality conforming to specifications and subject to the approval of the Architects. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes, catch basins etc.

Shall be finalized and shown in approved shop drawings before the actual execution of work at site. All work shall be executed as directed by the Project Manager.

Alignment & Grade

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Architects from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed in the trench for its length and places shall be excavated to receive collar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Architect. All pipes shall be laid at least 60cms below the finished ground level or as called for on the drawings.

Setting out Trenches

The contractor shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary

instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings. The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by the Project Manager.

Excavation

Excavate trenches to the necessary depths and width, removing rocks, roots stumps and shrubs existing old foundations etc. Cost of additional excavation to facilitate utility cross over, additional offsets, etc., shall be not be paid extra.Excavation material is unclassified except rock which will be treated as per tender condition given separately. Width of trench shall be adequate for proper installation of piping.

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the Project Manager. In soft and filled in ground, the Project Manager may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by the Project Manager. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities are adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Architect. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations. All excavated earth shall be kept clear of the trenches to a distance equal to 75 cm.

Timbering of Sewer and Trenches

The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and shall be accountable for the sufficiency of all timbering, bracings, sheeting and piling used and also for, all damage to persons and property resulting from improper quality strength placing, maintaining or removing of the same.

Obstruction Road

The contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Project Manager in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

Protection of Pipes

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the contractor with the written consent from the Project Manager.

- ***Removal of Filth***

All night soil, filth or any other offensive mater met with during the execution of the works, shall not be deposited on the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be immediately, after it is taken out of any trench, sewer or cess pool, put into the carts and removed to a suitable place to be provided by the Contractor.

- ***Water: -***

Keep all excavation free of stagnant subsoil water. Excavation damaged or softened by water shall be re-excavated and filled back to original level with approved selected natural fill material placed and compacted as specified herein below under item 6.5 at no expenses to the Owners. Provisions for shoring, pumping, bailing out, draining out, dredging and disposal of subsoil water or rain water shall be made at no expense to the Owners.

- ***Bedding: -***

Concrete bedding for drain shall be cement concrete having a mix proportioned in parts by volume of 1:3:6. Lay the drains on a bed of concrete 150 mm thick and of specified width benched halfway up on both sides to the crown of the pipe.

- ***Backfill: -***

The trenches shall be backfilled using selected excavated materials in 200 mm layers and carefully rammed well and consolidated with the addition of water and compacted to 95% of maximum density at optimum moisture content as determined by the standard penetration tests. For 150 mm all-round the pipe only selected material or in its absence sand or pea gravel will be allowed for backfilling.

WIDTH OF TRENCH:-

The Project Manager shall have power by giving an order in writing to the Contractor to increase the maximum width/depth for excavation and backfilling in trenches for various classes of sewer, manholes and other works in certain length to be specifically laid down by him, where on account of bad ground on other unusual conditions, he considers that such increased width/depths are necessary in view of the site conditions.

Grading: - Following backfilling, grade all trenches to the level of surrounding soil. Surplus earth shall be carried away or dumped at site as directed.

Tests:- During the progress of the work for compacted fill, the Owners reserves the right to provide compaction tests made under direction of an independent testing agency.

Contractor to restore settlement and Damages

The contractor shall at his own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths, gardens, open spaces etc. in the public or private areas caused by

his trenches or by his other excavations and he shall be liable for any accident caused thereby. He shall also, at his own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion of the Project Manager he fails to make good such works with all practicable dispatch, the Project Manager shall be at his liberty to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

The contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled, surplus soil shall be immediately removed, the surface shall be properly restored and roadways and sides shall be left clear.

STONEWARE PIPES, BENDS, JUNCTIONS, JOINTING AND TESTING:-

All stoneware pipes, bends, junctions gully traps, intercepting traps shall be salt glazed inside and outside and shall fulfil the conditions of IS 651-1980. Acid resisting stoneware pipes, bends, junctions, gully traps, etc. shall be manufactured by approved agency.

The pipes shall be hard, sound, truly circular in cross section, perfectly straight, free from all flaws and projections.

Before being laid, the pipes shall be thoroughly cleaned specially from the inside. Cracked or chipped pipes shall not be used on the work.

Tarred gasket or hemp yarn soaked in thick cement shall first be placed round the spigot of each pipe and the spigot then be placed well home into the socket of the pipe previously laid.

The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly home so as to fill more than ¼ of the total depth (12 mm in depth) of the socket.

The remaining space in the socket shall then be tightly and completely filled with cement Mortar composed of one part of cement and two parts of sand, and shall be neatly levelled off outside the socket of the pipe at an angle of 45 degree. A wooden caulking tool shall be used for forcing the mortar home into the socket. The inside of each pipe shall then be carefully wiped with a mop or scraper, sufficiently long pass two joints from the end of each pipe and any projecting or extra cement shall be removed to leave the inside of the pipe clean as the wok proceeds. All the joints shall be kept moist by means of wet Hessian bags to protect them from the sun or wind. All pipes entering manholes shall be set in cement mortar to affect a complete watertight junction. For a width of 12 mm all round the pipe, there shall be a joint of cement mortar between it and the bricks. The end of all pipes shall be properly built in and neatly finished off with cement mortar with the manhole/ancillary structure.

After sufficient interval has been allowed for the joints to set and before filling the trench, the joints of the pipes and drains shall be proved watertight by filling the pipes with water to a level above the top of the highest pipe in the length to be tested, closing the ends of the sections and maintaining the water level for a period of one hour with a water head of 1.2 Meter.

All such testing shall be done wholly at the Contractor's expense, inclusive of apparatus, provision of water etc. and the rate covers all the above work including c.c. bedding etc.

The pipes shall be laid to the alignment and gradient shown on the plan. The maximum permissible slopes to be various diameters of pipes are as follows:-

100 mm dia pipe	1 in 60
150 mm dia pipe	1 in 100

200 mm dia pipe	1 in 145

Pipes shall be laid on a bed of plain cement concrete 1:3:6 and minimum 150 mm thick, and shall be protected by providing hunching upto half the diameter of the pipes. The width of the concrete bed for various diameters shall be as follows:-

100 mm dia pipe	300 mm wide
150 mm dia pipe	350 mm wide
200 mm dia pipe	450 mm wide

CONCRETE HUME PIPE DRAINS, LAYING, JOINTING AND TESTING:-

Cement concrete pipes where called for on the drawings, shall be centrifugally spun reinforced cement concrete pipes of an approved manufacture. Pipes shall be true, perfectly sound, free from cracks, cylindrical, straight with a uniform bore throughout. Cracked or warped pipes with uneven texture shall not be used.Pipes shall be `Hume' pipes or equivalent these pipes shall confirm to Indian Standard IS 458-1971 NP2 class.

The pipes shall be straight and free from cracks excepting craze cracks. The end of the pipe shall be square to their longitudinal axis, so that when placed in a straight line, the opening between ends in contact shall not exceed 1/8" (3mm), for pipes upto 150 mm dia..

The outside and inside surface of the pipes shall be smooth dense and hard, and shall not be coated with cement wash or other preparation. The pipes shall be free from local dents and bulges greater than 1/8" (3mm) in depth and extending over a length in any direction greater than twice the thickness of the barrel.

The pipes, before being laid, shall be brushed throughout to remove any soil or stone, that they may have accumulated therein the inside of the socket and outside of the spigot being carefully cleaned. For small pipes, they should be tilted up to remove any accumulations.

The pipes shall then be carefully laid in position.

Laying

RCC spun pipes shall be laid on cement concrete bed of cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods, etc. Cradles or concrete bed may be omitted, if directed by the Project Manager.

Jointing

Semi flexible type collar joint.

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and two part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the collar and more cement mortar added until the space of the collar has been filled completely with tightly caulked mortar. Provision of rubber sealing ring in the collar joint shall also be made. The joint shall then be finished off neatly outside the socket at an angle of 45 deg.

Curing:

The joint shall be cured for at least seven days. Refilling at joints will be permitted only on satisfactory completion of curing period.

Concrete pipes**:-**

Shall be jointed as described in IS 783-1959. After setting out the pipes, the collar shall be centred over the joint and filled in with tarred gasket till sufficient space is left on either side of the collar to receive the mortar. This space shall then be filled with cement mortar 1:2 (1cement and 2 washed coarse sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 to the longitudinal axis of the pipe on both side of the collar. The joint shall be cured for at least 4 days with wet hessian bags.

S.W. Gully Trap:-

Gully trap shall be stoneware conforming to IS:651. These shall be sound and free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from cracks. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions a per BOQ (300 x 300mm) the cover weighing not less than 4.5 kg and the frame not less than 2.7kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

Fixing of S.W. Gully Trap

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Project Manager /Consultant / Architect. The gully traps shall be fixed on cement concrete foundation 65cm square and not less than 10cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done similar to the jointing of S.W. Pipes described earlier. After fixing and testing gully and branch drain, a brick work of specified class in cement mortar 1:5 shall be built with a half brick masonry work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber and trap shall be filled in with cement concrete 1:3:6. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finish with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.
CI cover with frames (per BOQ, 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

Inspection chamber

Brick masonry inspection chamber of the following sizes in brick work in cement mortar 1:5 (1 cement:5 fine sand), With heavy duty cast iron cover and frame embedded in RCC coping on top, RCC foundation slab. 1:2:4 mix both inside and outside of plastering 12 mm thick with cement mortar 1:3 with a floating coat of neat cement on inside face, proper water proofing to ensure no ground water seepage in the manhole.

Excavation, in all kind of soil, dewatering, refilling, watering, ramming and removing the surplus excavated earth, making good the same complete as required.

Size and cover to be as per BOQ.

Measurements

Gully traps & Inspection Chamber shall be measured by the number and rate which shall include all excavation, foundation, concrete, brick masonry, cement plaster inside and outside, CI grating and sealed cover and frame.

Soil, Waste, Rain Water, Vent and Anti-Siphonage Pipes and Fittings:-

All soil, waste and anti-siphon age pipes and fittings used shall be UPVC-SWR pipes conforming to IS 13592. All pipes and fittings shall be of the best approved Indian make of soil variety They shall not be brittle but shall allow for heavy cutting, chipping and drilling and shall be of the diameter mentioned in the schedule of quantities and shall be of the largest length available and shall be fixed against the wall on `U' clamps.

Jointing shall be carried out with molten lead. The spigot of the pipe must be forced well home into its socket and must be entered, so that the joint may be of even thickness all rounding. At least, one complete lap of clean white hemp spun yarn shall be drawn into the bottom of the socket without being forced through the joint into. As many laps as may be needed to leave the space of not less than 25 mm. The lead shall then be poured into the joint and caulked tight. The joints shall then be poured into the joint and caulked tight. The joints shall be run with molten lead in sufficient quantity so that after being caulked solid the lead may project 1/8" (3mm) beyond the face of the socket against the outside of the spigot but must be flush with the outside edge of the socket. Lead wool joints wherever required will not be paid extra.

Cleanouts at the head horizontal pipes running under the floor shall be of UPVC. Floor and wall cleanouts shall be of UPVC. Cleanout shall be included in the item & will not be paid separately.

Inspection chamber, gully traps, etc., within the building shall be in cast iron with bolts, nuts to close the cover, all to be fabricated as per actual requirement and as per drawing, where indicated.

Supports, pedestals, and base for inspection chambers, gully traps and pipes shall be in 1:2:4 cement concrete mix.

Pipe sleeves and inserts, etc. through RCC walls either external or internal shall be of CI of MS provided with water bar flange.

During installation open ends of pipes shall be plugged with wood cut into required shape and gunny bags to be maintained free from dirt.

GI waste pipe and fittings shall be of heavy quality with GI unions, tail piece, reducers and connections to be provided between joints to either lead or CI pipes.

WC Pan Connectors shall be to suit the requirements as per drawing, with 40 mm vent horn for connection to the anti - siphonage pipe with pan connector.

Connection to the sewage or storm water collection sumps shall be perfectly watertight and end of the pipe which shall then the screwed home in the socket with a pipe wrench. Care must be taken that all pipes and fittings are kept at all times free from dust and dirt.
Rain water flashing shall be 150 x 100 mm or 230 x 150 mm with CI dome shape grating and extension pieces.

All rain water pipes UPVC SWR pipe vertical in shafts shall be soil pipe variety

conforming to IS 13592 or equivalent. This shall apply to pipe outside buildings or within the building or separate shafts.

The UPVC Floor trap for toilet blocks shall have SS grating & of bolted down design - if instructed.

Bathroom grating shall be having bolted down design out of heavy SS construction of the approved standard.

SS grating gratings shall be flat with perfect edges of the best quality procurable of the specified width end thickness and in the available lengths.

Spigotted and socketed 80 mm, 100 mm and 150mm C.I. Pipes shall be of heavy pattern for the portion below the floor and embedded and laid over 150 mm cement concrete 1:3:6, the width of the concrete being:-

80 mm dia	320 mm wide
100 mm dia	400 mm wide
150 mm dia	450 mm wide
200 mm dia	500 mm wide

The pipes shall be laid to a slope and connected to the drain. On no account should lime or lime concrete come in direct contact.

UPVC SWR Pipes:-

The waste and vent pipe system shall be of one make as far as possible. The material should be of best grade PVC, ultra violet stabilized, conforming to IS 13592. Pipes and fittings shall be with push fit rubber ring (with special lubricant) joints as far as possible. Where this is not available, solvent cement joint will be permitted. Suitable connection pieces (such as WC connector, special connector to metal fittings) shall be provided. Fittings shall have inspection doors at all junctions and turning points and as shown on drawings.

Pipes shall be so fixed that they are minimum 20 mm clear off the finished walls and all joint socket (entry) clear of walls. Supports shall be provided (clamps, hangers etc.) at maximum 1.2M in horizontal runs and maximum 1.8M on vertical runs.

Joints shall be made as per manufacturer's instructions using specified rings, lubricants and solvents only. At rubber ring joints, after pushing the pipe to the maximum extent, the same shall be pulled out to the respective marking on the end or in its absence by 2 mm. After completing the installation, the line should be on the true alignment. Standard smoke test shall be performed to check water tightness of the line. The cost of spacer clamps, hangers etc. out of 20 mm x 3 MS flats with holes for fixing clips etc. fixing clamps to walls and painting them with two coats of oil paint over a base coat should be included in the item.

Where pipes are laid below the floor slab, all openings in slabs, beams etc. after testing, be filled with suitable material as required by waterproofing considerations. Special deep seal nahani traps shall be provided where required.

All samples shall be got approved before ordering material. Pipes and fittings shall of "Supreme" or equal make. Mock-up of various types should also be got approved from the Architects from time to time

CPVC Pipes:-

The material should be of best grade PVC, conforming to CTS-SDR 11 Pipes and fittings shall be with push fit rubber ring (with special lubricant) joints as far as possible. Where this is not available, solvent cement joint will be permitted. Suitable connection pieces (such as WC connector, special connector to metal fittings) shall be provided. Fittings shall have inspection doors at all junctions and turning points and as shown on drawings.

Pipes shall be so fixed that they are minimum 20 mm clear off the finished walls and all joint socket (entry) clear of walls. Supports shall be provided (clamps, hangers etc.) at maximum 1.2M in horizontal runs and maximum 1.8M on vertical runs.

Joints shall be made as per manufacturer's instructions using specified rings, lubricants and solvents only. At rubber ring joints, after pushing the pipe to the maximum extent, the same shall be pulled out to the respective marking on the end or in its absence by 2 mm. After completing the installation, the line should be on the true alignment. Standard smoke test shall be performed to check water tightness of the line. The cost of spacer clamps, hangers etc. out of 20 mm x 3 MS flats with holes for fixing clips etc. fixing clamps to walls and painting them with two coats of oil paint over a base coat should be included in the item.

Where pipes are laid below the floor slab, all openings in slabs, beams etc. after testing, be filled with suitable material as required by waterproofing considerations. Special deep seal nahani traps shall be provided where required.

All samples shall be got approved before ordering material. Mock-up of various types should also be got approved from the Architects from time to time.

Disinfection of Piping System and Storage Tanks:

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 litres of water. The power shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks are full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipe work shall be thoroughly flushed before supply is restored.

All water fittings shall in all respects comply with the latest Indian Standard Specifications IS 1239 (part II) 1982. The brass fittings shall be fixed in the pipe line

in a workman like manner. Care shall be taken to see that joints shall be tested to a pressure of 10 kg/sq.cm unless otherwise specified. The defective fittings and the joints shall be repaired, redone or replaced.

Wherever a G.I. pipe crosses a floor then a C.I. sleeve with 12 mm all round clearance and projecting by 80 mm above and below the floor should be provided. On no account should lime or lime concrete come in direct contact with G.I. pipe and fittings.

Pressure Gauges And Recorders :

The gauges are an aid for the engineer incharge of maintenance to know whether the system is working normally or not. For regular record, pressure recorders having daily or weekly charts are needed to be provided. It is important that the range of the service pressure to the instrument selected shall be between 40 to 60 per cent only, at it is in this range, that the instrument is more accurate. This also leaves margin for indicating abnormal rise of fall in the pressure due to some fault in the system. These gauges are available in dials 50 mm, 63 mm, 101 mm, 203 mm, 254 mm and 304 mm upto 10,000 lbs. per square inch or equivalent Kg/cm2 in imported and indigenous makes.

Valves

All ball valve, butterfly valve and check valves and shall have working parts suitable for cold & hot water. Valves shall be tagged with permanent label of approved design under hand-wheel, indicating type of duty.

The duty and design of all valves shall be as specified in Bill of quantities. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS:776 and non-return valves and swing check type reflux to IS:5312.

Ball valve

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon.

The handle shall be provided with PVC jacket. The handle shall also indicate the direction of ‘open’ and ‘closed’ situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

- Valves shall be of screwed end type of approved make to IS 778, 781 complete
- With PTFE seating & gland packing.
- Maximum working pressure shall be 16 bar.
- Size To be provided of as per BOQ

Measurement-

To be measure as per unit number.

Butterfly valve

The butterfly valve shall be suitable for waterworks and rated for 300 P.S.I for Pressure requirement/ shall be suitable for PN16 bar rating with necessary fittings to be installed in the tank sump.

The body shall be of Cast Iron to GG 250 with Epoxy Coated for better resistance to corrosion, with ISO 5211 top connection. The Disc should be of heavy duty Ductile Iron grade GG 400 with Polyamide Coated to prevent corrosion, floating design to allow self centring.

The Shaft shall be of SS 420. Single piece, Spline design shaft mounted between Antifriction bearing to reduce the torque & blowout proof design. The valve liner shall be of High grade Elastomeric EPDM with replaceable feature & Tongue & Groove design to allow perfect tightness. Flow Control Lever with temper proof feature.

The valve shall be fitted between two flanges o either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged with the pipe flanges to prevent leakages.

Size as per BOQ or design drawing.

Measurement-

To be measure as per unit number.

Float Valve

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Non-return valve

Non-Return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS: 5312.

Measurement-

To be measure as per unit number.

Air Release Valves (at main ring main on terrace)

Air release valve consisting of following specification. Steel spring (EN 47Gr.B) actuated with necessary fittings to be installed in the tank sump / on water supply ring main

- Shall confirm IS318 Gr.LTB2

- Steel spring chrome plated (EN 47Gr.B) actuated with necessary fittings.
- Stem:-Forged brass(IS 6912 Gr.FLB)
- Size as per BOQ or design drawing.

Measurement-

To be measure as per unit number.

UPVC Nahani Traps

- Short type UPVC NAHNI TRAPS of approved make with water seal(10) along with cover including making holes in RCC /masonry work,
- Including if required extension pipe, fixing NT to correct level & line, sealant clamps etc complete.
- Fixing of grating circular type in SS

Measurement-

To be measure as per unit number.

Sanitary Fittings:-

All sanitary fittings shall be as specified in Schedule of Quantities and approved by the Owner.

All sanitary ware and CP fittings shall be new and of approved make, type and colour. All samples of materials with catalogues shall be submitted and got prior approved before use. Approved samples along with other approved materials shall be neatly displayed on a board and such a display board of samples shall always be in exhibition in the site office.

In cases where the materials are supplied by the clients, all such materials shall be inspected and received in good condition and thereafter, it will be totally under the safe custody of the contractor till they are handed over satisfactorily after installation, testing and commissioning.

Wherever multiple choices of fixtures are mentioned, the final choice will be as per the joint decision taken by the client and the architect.

- **Indian W.C**

Indian W.C pan shall be Madurai / Orissa pattern in white vitreous chinaware size as specified in the schedule of work. Each W.C shall be provided with a 100 mm dia vitreous chinaware P or S trap with or without vent horn, as required.

The water closet shall be provided with an exposed or concealed type C.P brass flush valve or flushing cistern as specified in the schedule of work. Flush valves shall have a suitable flow regulating facility. Discharge connection to the W.C shall be by means of approved type of flush bend.

- **Foot rests**

Indian W.C shall be provided wherever specified, with a pair of vitreous china foot rests at proper distance (where specified) on either side of the W.C.

Foot rests shall be set in cement mortar 1:2 mix. Edges shall be finished neatly with white cement.

- **Orissa W.C**

Orissa W.C shall be in white glazed vitreous chinaware of size specified. The W.C shall be provided with a 100 mm white vitreous chinaware P or S trap with or without vents as required.

Each W.C shall be provided with an exposed or concealed type brass flush valve or flushing cistern generally as for Indian W.C.

- **European W.C**

European W.C shall be wash down or symphonic, floor or wall mounted White Vitreous Chinaware Water Closet with ('P' / 'S' Trap), complete with

1. concealed flushing cistern,
2. CP bolts,
3. white seat cover,
4. CP Elbow,
5. CP wall flange,
6. Angular stop cocks with flange (for flushing cistern and health faucet),
7. health faucet with necessary CP flexible hose nozzle,
8. C I brackets,
9. Making necessary connection to GI flush / inlet pipe etc. completed & approved make & approved by the architect.

- **Urinals**

Urinals shall be as specified in the BOQ / drawings in white glazed vitreous chinaware of size as per the approved product number of approved make / brand.

Including with fittings, standard size C.P. brass flush pipe, spreaders with unions and clamps (all in C.P. brass) with waste fitting as per IS : 2556, C.I. trap with outlet grating and other couplings in C.P. brass, Including urinal push cock and CP pipe for connection to push cock and including painting of fittings and cutting and making good the walls and floors wherever required.

- **Lavatory Basin**

Lavatory basins shall be ivory glazed vitreous china or poly marble or any other material and of size, shape and type specified in the schedule of work.

Each basin shall be complete with:

1) C.I or galvanized steel supporting brackets and clips as required.

2) CP waste and overflow.

3) Pop-up waste or rubber plug with CP chain as specified.

4) CP P-trap with cleanout, unions, CP pipe to wall and wall flange

5) CP control angle valve/s with CP connections.

6) Mixing or CP fittings as specified.

Including 15mm dia - 450mm long PVC connection pipe, one no 15mm dia CP angle stop cock with wall flange, 32 mm dia CP waste coupling, 32 mm dia CP brass bottle trap.

The works shall include cutting and making good the walls and floors. Approved by client.

- **Sinks**

The sink shall be of size specified in with glazed vitreous chinaware or stainless steel

AISC 304 as specified.

Each sink shall be complete with:

1) C.I or galvanized steel brackets and clips as required.

2) Waste fitting with brass / rubber plug and chain.

3) P-trap with clean out, unions, CP pipe to wall and wall flange.

4) CP control valve/s with CP connections.

5) Mixing or CP fittings with spout as specified.

S.S KITCHEN SINK would be as specified in the schedule of work.

- **Towel rods and racks**

They shall be of approved make and size as specified in schedule. The towel rod shall be provided with a pair of CP brass brackets fixed to the wall with CP brass screws with round head, using cup washers, screwed on to fill-plugs embedded in wall. The brackets shall be of concealed type.

- **Soap Solution dispensers**

They shall be plastic push button type.

They shall be of approved make. They shall be fixed to the wall with CP brass screws, screwed on to fill-plugs embedded in wall.

- **Toilet paper roll holder**

Toilet paper roll holder shall be of stainless steel of size specified in schedule. It shall be of recessed type with wooden rod with spring at one end for holding the paper roll. The rate shall include cutting recess in the wall, fixing the holder with cement mortar 1:2 and rectifying the wall surface to original conditions.

- **Hand Dryer**

Hand dryer fixed on wooden cleats with CP brass screws & washers including drilling hole in walls with drill gun and making good the walls. Hand Drier shall be as approved by the architect.

- **Geyser**

Installation, Testing, Commissioning of storage water heater (Geyser) for toilets including the following. Make to be racold or equivalent

1) C.P. Connectors
2) Angular stop cock with wall flange
3) All accessories required to complete the installation

Measurements for Sanitary Fixtures-

To be measured as per unit number, unless specified different in BOQ.

Installation of Sanitary ware:-

All sanitary ware and CP fittings shall be installed in accordance with the interior requirements. Neat workmanship and maintaining exact position and level of each fixture shall be the sole objective of the installation. Care shall be taken to fix inlet and outlet pipes at correct positions. Faulty positioning shall be made good without any damage to the finished floor or wall tiling and any damage to the finished surfaces shall be made good at the contractor' s cost.

In order to ensure quality of workmanship and compliance with interior requirements, one or two mock-up installations shall be done and got approved. Fixtures used in the mock-up may be reused with the approval of the Consultant.

All fixing accessories like bolts, nuts, brackets etc. may be supplied along with the ware as defined in the mode of measurement and schedule of work. All such accessories shall be CP brass or galvanized or stainless steel as approved by the Architect. All exposed pipes and bends shall be of CP brass.

The Indian W.C shall be fixed in level in a neat manner. The W.C and trap shall be set in brick bat 1:2:4 concrete mix. Joints between W.C and flush pipe shall be made with a putty or white lead and linseed oil and caulked well or with approved rubber joints. The joint between W.C and trap shall be made with 1:1 cement mortar and shall be rendered leak proof.

The Orissa W.C shall be fixed in level in a neat manner. The W.C and trap shall be set in brick bat concrete 1:2:4. Joint between W.C and flush pipe shall be made with putty of white lead in linseed oil and caulked well or with approved rubber joint. Joint between W.C and trap shall be made with 1:1 cement sand mortar and shall be rendered leak proof.

Wall-hung European W.C shall be mounted on C.I chairs which are fixed to the wall and floor using Anchor fasteners. The bolts and nuts used for fixing the chairs shall be stainless steel and the fixing bolts for the W.C and chairs could be CP brass or stainless steel. Floor-mounted W.C shall be fixed with Anchor fasteners using stainless steel bolts and nuts. The gap between the WC and floor or wall shall be neatly sealed with water proof non-hardening sealant of approved colour. The sealant should not extrude beyond the foot print or WC outline.

All W.C's shall be aligned and levelled with the floor and wall tiles so as to present an integrated look. Utmost care and skill shall be exercised to achieve a good installation in keeping with the interior designs.

Urinals shall be fixed to the wall using Anchor fasteners and stainless steel bolts and nuts. The urinals shall be held in line and level according to the interior designs and tile modules. Partitions, wherever required shall be provided, shall also maintain line and level as shown on drawings. Supply spreader and drain piping and P-trap shall be of CP brass and installed in a neat manner. No unseemly bends or wooden support pieces shall be permitted.

Wall-mounted lavatory basins and sinks shall maintain line and level as specified by the interior drawings and also with the tile modules. The supply connections shall be of CP brass from the angle stop valves to the pillar taps or single level fixture and shall display good workmanship. Drain connections shall have a CP P-trap with unions and exposed CP drain pipe and a wall flange. In the case of counter mounted basins and sinks, extreme care shall be taken to provide independent and adequate support for the basin and aligning it with the opening in the counter slab. Supply and drain connections shall be same as that for the wall mounted basins. The crevices between basin and wall or counter shall be neatly sealed with a non-hardening sealant of approved colour.

All accessories like the mirror, soap trays etc shall be neatly fixed as per interior designs. Good workmanship is the essence of all sanitary installation for achieving the interior design objectives.

All sanitary fittings shall be as specified in Schedule of Quantities and approved by the Owner.

Hangers & Supports:-

General:-

Provide proper solid angle iron/channel section, supports for all pipes complete with clamps. Wherever insulation comes, to provide wooden guide to support pipe on the angle iron hangers/supports. In general where a bunch of pipes run, as far as possible M.S. Plat inserts are provided in the beams/slabs to facilitate welding of angle iron supports. For attachment in concrete, use 'Dash" fasteners or Anchor plug type inserts or equivalent. Provide hangers within 0.9M of all changes in directions of mains and minimum of three hangers per expansion bend wherever shown in drawing. Provide all additional structural steel angels , channels or other members not specifically shown but are required for proper support. All hangars/supports to have primer coat (epoxy) on fabrication & one more coat on erection & testing.

Wherever necessary additional hangers shall be provided to arrest water hammers or hydraulic resonance with proper rubber padding.

Space hangers, as noted below, except on all soil pipe which shall have a hanger of multiple fittings, sufficient hangers shall be provided to maintain proper slope without sagging; in case of angle suspended line, the following is suggested :-

Pipe sizes	Hanger Rod Dia
20 mm through 50 mm	10 mm
65 mm through 125 mm	12 mm

150 mm and over	16 mm

Provide floor stands, wall brackets pr, as masonry piers, etc. for all lines running near the floor or near walls for these lines can be properly supported or suspended from the walls or floors. Pipe lines, near concrete or masonry walls may be hung also by hangers carried from wall brackets at a higher level than pipe. Hanging of any pipe from another is prohibited.

Hangers:-

Cleats or band type hangers shall be provided. Hot water piping are to be provided with suspended supports as far as possible. Note that strap hangers are not permitted and clamps should be removable type.

Equipment Protection :-

Keep all pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect all piping, conduit, fixtures, equipment or apparatus. Any such items damaged prior to final completion or work shall be replaced at no expense to the Owner.

Accessibility:-

The installation of valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspections, repairs, removal or replacement, shall be conveniently and accessibly located with reference to the finished buildings. Thermometers and gauges shall be installed so as to be easily read from the floor.

Inserts And Sleeves:-

General:-

Layout work in advance of placing of concrete slabs or construction of walls; furnish and set insets and sleeves necessary to complete the work. Cost of cutting or patching made necessary as a result of this operation shall be at no expense to the Owner. Openings shall be as per structural consultant's approval.

Wall sleeves:-

C.I. wall sleeves in cold water store and black pipe `A' class for cable, conduits gas pipes, etc. are to be inside flush with wall on both sides. Sleeves shall be large enough in diameter to provide 12 mm clearance around pipe for insulation. Exterior wall sleeves for cable entry/pipe/earthing strips etc., shall be cast iron, flush with wall on both sides. Sleeves shall be large enough to allow caulking from outside using lead wool.

Floor Sleeves:-

Interior floor sleeves for

NB Pipe Sizes	**Spacing Of Supports**
12 mm To 20 mm	1.5 M Apart
25 mm To 40 mm	1.8 M Apart
50 mm And above	1.8 M Apart Or As Per

Cleaning, Operation & Tests:-

Plumbing equipment fixtures, piping, etc., shall be free of stampings, marking, (except these required by codes), iron cuttings and other foreign materials.

Hot, Cold and drinking water systems shall be cleaned thoroughly filled and flushed with water.

The entire mechanical apparatus shall operate at full capacity without objectionable noise or vibration.

Test all plumbing systems in the presence of the site Engineer/Supervisor and the Architect as herein specified. Provide ample advance notice of test dates. Provide all equipment materials and labour necessary for inspection and tests and repair all work, not passing the tests. After repairs are made, repeat tests until test systems in found satisfactory to the above authorities. Carryout all tests prior to concealing insulating or backfilling over any piping. No exception will be made.

Test entire system of soil, waste and vent piping by water after the roughing-in is completed and before the fixtures are set. After setting the fixtures, provide smoke test after sealing all traps.

Water test: -Test entire system or section of system by closing all opening in piping except the highest opening and filling system with water to the point of overflow. If the system is tested in sections, plug each opening except the highest opening of the section filled with water. Keep the water in system or in portion under test of or at least 45 minutes before inspection starts with test pressure head lasting for two hours. The system must be tight at all joints.

All water piping: - Hydro-static test 10 kg/cm2 for a minimum of 8 hours without drop in pressure as required.

All tests on below grade lines shall be continued until backfill on such line is completed to disclose any damages caused by backfilling.

All systems shall be tested in sections as required to expedite the work or other trades and meet construction schedules and final test on completion.

On completion of the works, the following tests shall be performed to the satisfaction of the Consultants Clients' representative before issue of Virtual Completion Certificate if so required:-

- ***Hydraulic test***
- ***Self inducted test for fixtures***
- ***Tests for anti-Siphonage system***
- ***Inspection of all units and fixture***

The contractor shall arrange on his own initiative for similar tests during the progress of works, to ensure that there are no defects in material/workmanship in portions of work to the concealed or embedded under the floor or walls in ceiling.

Painting:-

Piping:-

After all the piping has been installed and tested, the piping including all MS hangars/ supports shall be given one final coat of anti-corrosive paint followed by

two coats of paint as per colour code / flow direction marking etc as required by the Owners.

Equipment & Piping Identification:-

Pipe Markers

Each piping system shall be provided with a name plate properly clamped or stencilled. Letters are to be 80 mm. Plates on parallel groups of pipes etc. shall be neatly lined up. Wording of lettering shall correspond to the equipment designations used in piping legend and shall be as approved. Name plate to be of G.I. sheets (1 mm thick on 25 x 25 x 3M angle) secured on to sheet metal and angle iron to be welded on main pipes. In case o f insulated pipe, the 25 x 25 mm angle bracket should be projecting beyond insulation thickness. CI markers to be fixed as directed in ground to indicate location of underground services.

Valve Register:-

To be submitted in six copies along with location and identification number in final drawing to be furnished by contractor.

Mode Of Measurement

All drain pipes shall be measured in linear lengths along the centre line of the drainage laid. Deduction shall be made for chambers. The rate shall include all work as specified in the respective items.

Stoneware of cast iron gully traps, bends, junctions, sewer traps etc., shall be measured in numbers as in above. All pipes passing through sleeves shall be caulked with asbestos rope and finish with cement mortar. Insulated pipes shall have insulation butted to floor sleeve and sealed with insulating cement on both sides.

Interior floor sleeves for kitchen areas shall be C.I. steel pipe extending 50 mm above finished floor. Caulking shall be the same for general areas.

Floor on grade sleeves shall be the same as exterior wall sleeves, caulked and made watertight.

All cast iron spigot and socket or flanged pipes shall be measured in linear length along the centre line is completed. Fittings and specials shall be measured in position as a part of the pipe. The rate shall include lead caulking or nut and bolt joints, etc., complete as specified in the respective items.

Same rate shall be applicable for pipes of same size and materials lay in building at any level or floor.

The rock only where specified cutting shall be measured in cu.m. of the stacks of excavated rock, the deduction for voids being 25% of the stack measurement. On the rock which removed by chiselling or blasting etc.shall be measured for this item or work. Boulders shall not be considered as a rock. The excavated rock will become the Owners property.

All cast iron pipes, such as soil, waste, vent and rainwater shall be measured in linear lengths along the center line, as completed, excluding length over fittings. The rates shall include all joints and clamps etc. as specified in the respective items.

Inspection chambers shall be measured in numbers, complete as specified in the respective items in the schedule of quantities and specifications for sanitary installation work.

Lead pipes shall be measured in linear length and shall be of weights as per specifications of the respective item in installation work. The rates shall include making of necessary offsets and bends, etc.

All sanitary fittings and fixtures shall be measured in numbers and the rate shall include all the work specified in the respective item.

All G.I. pipes shall be measured in linear lengths along the center line of the pipe, including G.I. fitting. The rate for pipe line shall be inclusive of all G.I. fittings.
All gate valves, ball valves, non-return valves, sluice valves etc. shall be measured in numbers after excluding them from linear measurements.
The diameter of pipes and fittings mentioned in the specifications are the normal diameter in all cases unless otherwise stated

Tools & Materials & Storage:-

Surplus materials from the site shall be carted away by the Contractor without any cost to the Employer and the storage space provided to the Contractor shall be handed over to the employer clean and ready for occupation.

a) General Services:-

Any materials brought at site shall not be removed without the written authority of the Owner and when the Contractor shall have received payment in respect of any certificate in which it is stated that the valve of any unfixed materials on the works has been taken into account, such materials shall become the property of the Employer and the Contractor shall be liable for any loss or damage thereto.

b) Monoblock Centrifugal Pumps

Monoblock centrifugal pump shall in horizontal position high efficiency for supply of water from UG tank to overhead head tank.

Pumps motor shall be directly coupled to the suitable T.E.F.C. induction motor and starter along with necessary electrical work .Scope include the cabling and starter panel starters, expansion bellows, flanges and water flow sensor to indicate low and high level of water in OH tank.

The pump shall be suitable for auto / manual operation.

It should be supplied along with complete (Skid mounted wall mounted / floor mounted) electrical control panel comprising of all accessories such as PLCs, pressure switches, pressure transducers, control wiring and any other necessary imports etc. (list to be provided by the vendor).

The pump shall be IE3 or above Ratting.

The pump shall be suitable for auto / manual operation.

The item shall include the necessary electrical cables and starter panels for operating the pumps.

The efficiency of pumps shall not be less than 75%.

Construction Material for Pump
1) Impeller : Stainless Steel (AISI 316)
2) Pump Body : CI
3) Diffuser Casing : CI
4) Protection : Ip55
5) Class of Insulation: F
6) Sealing: Mechanical seal
7) Shaft : Stainless Steel (AISI 410)

c) Motor Design

The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oil filled motors are not acceptable. The stator windings shall be Class "F" insulation (155 degree C or 311 degree F) for general usage and class `H' insulation (180 degree C or 317-8 grade 2) for submersible type.

The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel.

The motors shall be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour.

Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage. Both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face.

The pump motor shall be IE3 or above rating.

SANITARY FIXTURES - MAKE LIST		
Sr. No.	**Item**	**Make**
1	Wall hung Vitreous European Water Closet of pure white along with Seat Cover	Hindware , Jaquar
2	Wall hung Vitreous European Water Closet of pure white along with Seat Cover	Hindware , Jaquar
3	Water closet squatting pan	Hindware , Jaquar
4	Dual Flow Flush Valve	Hindware , Jaquar
5	Slim concealed cistern (Flushing 3/6 liters) with Thermacol protection	Hindware , Jaquar
6	Health faucet with long flexible tube having wall hook	Hindware , Jaquar
7	C.P.BIB cock with wall flange	Hindware , Jaquar
8	Two way Bib cock with wall flanges	Hindware , Jaquar

9	White glazed Vitreous Semi recessed Wash Basin	Hindware , Jaquar
10	White glazed Vitreous wall hung Wash Basin	Hindware , Jaquar
11	C.P brass Pillar Cock for Semi recessed type basin	Hindware , Jaquar
12	C.P brass Pillar Cock for wall hung Wash basin	Hindware , Jaquar
13	Stainless Steel kitchen sink of Size Super 585 mm x 485 mm	Nirali
14	Stainless Steel kitchen sink of Size BIG 510 mm x 432 mm	Nirali
15	Stainless Steel kitchen sink of Size SMALL 1370 x 457 mm	Nirali
16	Sink Cock with Regular Swinging Spout	Hindware , Jaquar
17	C.P brass Angular Stop Cock	Hindware , Jaquar
18	Waste Coupling	Hindware , Jaquar
19	Bottle Trap	Parryware , Jaquar
20	White vitreous flat back lipped front urinal basin	Hindware , Jaquar
21	Push cock (Self closing tap) wall flange	Hindware , Jaquar
22	Toilet Roll Holder	Hindware , Jaquar
23	Liquid soap container with bracket	Hindware , Jaquar
24	Hand Dryer	Hindware , Jaquar
25	L Shape Disabled Grab Bar	Hindware , Jaquar
26	Disabled Grab Bar (Straight)	Hindware , Jaquar
27	Swing handicap Grab Bar	Hindware , Jaquar
28	Towel Ring Round With Round Flange	Hindware , Jaquar
29	Single Towel Rail 600mm Long	Hindware , Jaquar
30	Fixing Soap Dish Holder	Hindware , Jaquar
31	Double Coat Hook	Hindware , Jaquar
32	Single Lever High Flow Bath & Shower Mixer(Concealed Body) Wall Mounted Model with Button Spout (Composite One Piece Body)	Hindware , Jaquar
33	Overhead Shower	Hindware , Jaquar
34	3 stage cooler cum purifire of size 750mm x 570mm x 1350mm with water storage capacity of 120 Ltr./hr capacity	Hindware , Jaquar or Elena Digital

LIST OF APPROVED MAKES :-

(Note: - MECHANICAL EQUIPMENT & VALVES)

Sr. No.	**Description**	**Approved Manufacturer / Suppliers**
1.	GM gate, check, globe valves	Leader, Zoloto with IS Mark or equivalent
2.	CI foot valve & Strainer	NECO or equivalent
3.	CI NR valves	NECO or equivalent

Sr. No.	Description	Approved Manufacturer / Suppliers
4.	Ball / Butterfly Valve	Zoloto,Audco, C & R, Kitz or equivalent
5.	Pressure Regulating Valves	Danfoss, Zoloto or equivalent
6.	ARV	Jain, crispin, Valmatics or equivalent
7.	CP brass ware fittings (Cocks, mixers etc)	Parryware,Kohler,Jaquar or equivalent
8.	CP Flush valve	Nelson, Jaguar or equivalent
9.	GI pipes	Tata, Zeniths ,Birla, Jindal or equivalent
10.	CPVC pipes & fittings	Astral, Supreme, Prince (SMARTFIT, EASYFIR), Finolex. or equivalent
11.	UPVC -SWR pipes & fittings	Astral, Supreme, Prince (SMARTFIT, EASYFIR), Finolex or equivalent
12.	GSW pipes	Perfect or equivalent
13.	Water pump	DAF, Kirloskar, Crompton, or equivalent
14.	De -watering pump	Kirloskar or equivalent
15.	Electric Motors	Siemens, Kirloskar, Crompton or equivalent
16.	Electric panel components	Siemens, LT/LK or equivalent
17.	Pressure Gauge	Ficbig, H. Guru, Staneo or equivalent
18.	CI surface box	IS Mark
19.	Cables	Polycab,KEI or equivalent

Other materials should be of good quality, with IS mark if available, to be got approved beforehand.

SECTION PS - Particular Specifications

SCOPE

The scope of work covered broadly by various items is given in the bill of quantities. The scope of work is not limited to the description given - all minor work involved to make the item complete are deemed to be include in the item. The stipulations in the enclosed Standard Specifications & these Particular Specifications also hold good so long as they do not contradict each other. Normally the BOQ description followed by the Particular Specifications & by the Standard Specifications will have precedence in that order where any of them tare conflicting.

The particular specifications give more particularly the requirements applicable for this work.

The stipulations given in other sections will also hold good.

EXCAVATION

All items in the bill of quantities are including (unless otherwise specifically mentioned) all excavation and backfill. Excavation includes work in all strata, fencing, guarding the excavation, shoring, de-watering, pumping as required, backfilling in layers with consolidation, watering, carting away surplus etc complete. Black cotton soil will not be allowed in backfilling for 150 mm from any masonry, piping etc and only approved soil, excavated or brought from outside will be allowed to be used. Cost of such soil brought from outside should be included in the quoted rates.

Standard Specifications for civil work will apply wherever such items are involved.

Unless otherwise specified the following items/mixes will apply.

Bed concrete	1:3:6 nominal mix
Encasing concrete	1:2:4 nominal mix
Brick masonry	in good 2nd class brick in CM 1:4

Plaster CM 1:3, 12 to 15 mm thick Extra thickness on curved surface. In case of manholes etc for areas in contact with water, plaster will be 20mm thick in C.M 1:3 finished smooth in cement.

MATERIAL

Enclosure PS. gives the specification for main items of work.

Other material shall be to IS and with IS marking. If material with IS marking is not available, the Engineer will allow other make manufactured to IS (Bureau of Indian Standards).

LABOUR

Workmen approved, by the Engineer for a particular trade only will be allowed to do that work. Each worker will have an identity card issued by the Contractor/Engineer with his photograph. While on duty he shall punch the card. Daily list of workers & the jobs done by them will be submitted to the Engineer. A person approved to do a particular job alone will be allowed to work on it.

The contractor will have to get alignments of lines & locations of fittings approved from the Engineer. He will have to do mock-ups (rough assembly & sample assembly) well in time and get it approved from the Engineer. Main work should be executed as per the finally approved mock-up. Cost of mock-ups should be included in the quoted rates.

Regular record of testing of systems should be maintained & all measurements got checked before covering up. No item shall be covered without the written confirmation of the Site Engineer.

III- ELECTRICAL & ELV

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS

PREFACE

Actual work shall be carried out by persons holding valid PWD Wireman License. The electrification work shall be supervised by persons holding PWD Supervisors License / Degree / Diploma Holder.

All the Electrical Work shall be carried out as per The relevant Indian standards formulated by Bureau of Indian Standards

Indian Electricity Rules 1956 amended time to time.

National Electrical Code

Chapter 16 of PWD Hand Book Government of Maharashtra

Bombay Lift Act and Rules amended time to time.

Maharashtra Fire prevention and life safety measure Act 2007.

National Building Code 2016.

1.1 Preamble

The technical specification for electrical services to be provided for Work of Development of Gavan Land, Plot No 12A, Sector No-8, Node – Ulwe, Raigad, Navi Mumbai. is detailed out in this particular document. These are to be read in conjunction with the Drawing Volumes & Bill of Quantities.

SCOPE OF WORK

Scope of work covers under this tender are as below

Internal Electrical Installation along with UPS system etc.

External Electrical Installation consisting of Service connection to all buildings, Street lights, Land scaping Lighting etc.

Supplying, erecting and commissioning of lifts.

Supplying ,erecting and commissioning of Transformers along with all accessories mentioned in Schedule-B.

Supplying ,erecting and commissioning of DG Sets along with all accessories mentioned in Schedule-B

Supplying, erecting ,testing and commissioning of Fire fighting system.

Supplying ,erecting, testing and commissioning of Low voltage system consisting of Fire alarm system,C.C.T.V. system, Lan/Van ,P.A. system etc.

Supplying ,erecting, testing and commissioning H.V.A.C. System.

Supplying ,erecting, testing and commissioning of Solar P.V. System

NOTE :-

All codes and standards mean the latest where not specified otherwise installation shall generally follow the Indian Standard codes of practice in the absence of corresponding Indian Standards.

1.2 ELECTRIFICATION WORK

SCOPE

The scope of work generally comprises of supply, installation, testing & commissioning of all Internal Electrification works viz Point wiring, Distribution boards, Cabling, Cable trays, Earthing, Telephone System, Data networking, Television system, fans, and allied electrical equipment's.

The agency shall work in coordination with other agencies. Any damagdone to the work of others shall be made good by the agency without any extra cost.

General:

All material shall be conforming to relevant standard as per BIS and shall carry ISI mark. If any particular category of material for which ISI mark is not available in market, it shall either carry valid 'Quality Control' certificate issued by the Chief Engineer (Elect), P.W. Dept. Maharashtra State Govt. as included in approved list.

Work shall be carried out as per the Method of Construction specified by BIS. If there is no reference for particular Method of Construction in IS, such work shall be carried out as per the approved Method of Construction specified in chapter 16 of P.W. Dept. Handbook.

Material and Work not qualifying to any provision mentioned above shall be to the satisfaction of the Engineer in Charge.

Material shall be tested in approved Testing Laboratory and shall qualify the relevant tests as and when directed by Engineer In-Charge.

Seven copies of all submittals shall be submitted (PWD- 3set, Client- 1set, Design consultant- 1set, Architect- 1 set and Contractor- 1 set) for review.

Recommended Standards:

The following list is showing Indian Standards, which are acceptable as good practice, and

accepted standards.

IS 732: 1989 Code of Practice for Electrical Wiring Installations.

IS 4648: 1968 Guide for Electrical Layout in residential buildings

IS 9537 (Part 1): 1980 Conduits for Electrical Installations: General requirements

IS 9537 (Part 2): 1981 Rigid Steel Conduits

IS 9537 (Part 3): 1983 Rigid Plain Conduits of insulating material

IS 3419: 1989 Specifications for fittings for rigid non metallic conduits

IS 694: PVC insulated cables for working voltages up to and including 1100V

IS 1554 (Part 1): 1988 PVC insulated (heavy-duty) electric cables for working voltages up to and including 1100V

IS 3961 (Part 5): 1968 Recommended current ratings for cables: PVC insulated light duty cables.

IS 4288: 1988 PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages up to and including 1100V

IS 14772: 2000 Specifications for Accessories for household and similar fixed Electrical Installations

IS 3043: 1987 Code of practice for Earthing

SP 30: 1984 National Electrical Code

SP 7 (Group 4): 2005 National Building Code

IS 14927(Part 1): 2001 Cable Trunking and Ducting systems for electrical installations.

IEC 61439 Low voltage switchgear and controlgear assemblies

Hybrid Point Wiring

The hybrid point wiring shall be Surface type under false ceiling and concealed type for drops & switch boards on walls in required size of PVC conduit. Other specifications shall be as per point point wiring specifications.

Conduits / Trunking (Casing Capping) (Surface type)

PVC Conduits

Specification No (WG-MA/CON)

Scope:

PVC Conduits: Surface

Providing specified PVC Conduits and erecting as per approved Method of Construction; on surface of wall / ceiling, etc. including entries through walls / slabs / flooring as per requirement, and with all necessary hardware, accessories such as Spacers, Saddles, Bends, Tees, Junction boxes, Check-nuts, etc.; making conduits erection work rigid and duly finishing, removing debris from site.

Material:

PVC Conduit:

PVC pipe minimum 20mm dia and above depending on No. of wires to be drawn (refer Table No. 1/2) ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; such as Spacers & Saddles, Couplers, Bends, inspection or non inspection type Elbows, Tees, Junction boxes of required ways and resin / adhesive to make all joints rigid. Black pipe shall not be used for surface type wiring.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs, wooden gutties, etc.

Method of Construction:

Erection PVC Conduits for Surface type wiring:

General:

Erection shall be done as per the final approved layout, in perfect level and plumb. Conduits shall be firmly fixed on spacers with saddles. Fixing of spacers shall be equidistant and at ends, bends, elbows, junction boxes, couplings, boards. CSK screws of minimum 35x8 mm and suitable plugs shall be used for fixing spacers and 12x5 mm, round headed screws for fixing saddles on spacers. In case of stonewalls wooden gutties shall be grouted in wall for fixing of spacers. Distance between 2 spacers shall not be more than 600mm. Size of conduit shall be correct depending on number of wires to be drawn (as per Table No. 1/2 for PVC conduits). Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution. Also for wiring for other utilities like data, telephone, TV cabling distance between pipes shall not be less than 300 mm. or ant electrostatic partition/separate pipe should be used. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of surface and with colour coding conduit (For visual identification) as per Table No. 1/4. Flexible conduits shall be used at expansion joints.

Especially for PVC Conduits of surface type wiring:

In addition to general instructions above, all joints shall be made rigid with resin / adhesive. Wherever offsets are necessary, it shall be done with bending spring. Size of conduit shall be as per Table No. ½ for number of wires to be drawn through the conduit.

PVC Trunking (Casing capping)

Specification No (WG-MA/CON)

Scope:

PVC Trunking:

Providing specified PVC Trunking (Casing capping) and erecting as per approved Method of Construction, on surface of wall / ceiling, etc. including entries made with PVC conduit through walls / slabs / flooring as per requirement with all necessary hardware, accessories such as inner / outer Elbows, Tees, Junction boxes, etc. and duly finishing, removing debris from site.

Material:

PVC Trunking (casing capping):

PVC Trunking (casing capping) ISI mark, 1.2 mm thick, minimum 20 mm width and above depending on No. of wires to be drawn (Refer Table No 1/3 for the size of trunking and number of wires to be drawn); with double locking arrangement, 1.8mm thick push-fit joints/ accessories for PVC trunking such as couplers, elbows, internal / external angles, junction boxes of required ways of the same make.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs, wooden gutties, etc.

Method of Construction:

Erection of PVC Trunking for surface type wiring:

Erection shall be done as per the final approved layout. The Trunking shall be in perfect level and plumb. Screws of minimum 35x8 mm and suitable plugs shall be used for fixing. In case of stonewalls wooden gutties shall be grouted in wall for fixing of screws of Trunking. Distance between 2 screws shall not be more than 600 mm. Size of Trunking shall be correct depending on number of wires to be drawn as per Table No 1/3 but not less than 20mm. Separate Trunking shall be used for each phase in single phase distribution and for power and light distribution and also for wiring of other utilities like data, telephone, TV cabling and distance of 300 mm shall be maintained between the Trunking or anti electrostatic partition to be provided. Double locking shall be checked while fixing capping. Adequate use of accessories shall be made at joints and at required locations.

Conduits (Concealed type)

Specification No (WG-MA/CC)

Concealing PVC Conduits in RCC work

Scope:

Providing specified PVC conduit and laying / erecting in RCC work, such as slab, beam, column before casting as per approved Method of Construction along with of all required material including hardware, binding wire, fish wire; accessories such as deep / long neck PVC junction boxes, PVC / MS junction / draw-in boxes, check-nuts, flexible PVC pipe, drawing fish-wires and making all piping rigid, removing debris from site and supervising the work during casting to confirm rigidity, continuity and avoid damages.

Material:

PVC Conduit:

PVC pipe of minimum 20mm dia and above depending on No. of wires to be drawn (refer Table No.1/2); ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; Couplers, long Bends, deep Junction boxes of required ways and resin / adhesive to make all joints rigid.

Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate and of suitable size to accommodate No. of entries; PVC or fabricated from 16g CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix cover plates on it.

Hardware:

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire, steel fish wire etc.

Method of Construction:

Concealing of PVC conduits:

General:

Work shall be done in co-ordination with civil work and to suite final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No 1/2 for PVC conduits) Separate pipe shall be used for each phase in single phase distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc. The distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No. 1/4. (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout finalized, with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25m, in such manner so as to facilitate drawing of wires. All PVC conduit bending shall be done with Bending Spring. All joints shall be made rigid with resin.

Concealing of PVC conduits:

In RCC work:

Work shall be commenced after fixing of steel re-enforcement on centering material. Conduits shall be firmly fixed on steel of RCC work by binding wire. Fixing of conduits shall be such that it will remain rigid during casting of slab, beam, and column even after use of vibrator. Deep junction boxes and other draw-in boxes shall be such that their open end and centering material will not have gap in between so as to avoid concrete entering inside even after fixing covers to steel re-enforcement; and be filled with dry sand. Open ends of conduits; to be concealed in walls, shall be provided with couplers / sockets at ends and be flush with bottom of beam, and located at the center of the beam. As far as possible bunching / grouping of conduits shall be avoided so that it will not affect strength of RCC work especially in beams. Suitable steel fish wire shall be drawn through in the conduits for drawing of wires later on.

Concealing PVC Conduits in walls / flooring

Scope:

Providing specified PVC conduit and erecting / laying in wall, flooring by making chases / grooves / entries as per approved Method of Construction along with of all required material including hardware such as 'U' nails, binding wire, fish wire; accessories such as PVC / MS junction boxes / inspection boxes, check-nuts, flexible PVC pipe, glands, drawing fish-wires and making all piping rigid, refinishing the surface with cement mortar, removing debris from site.

Material:

PVC Conduit:

PVC pipe minimum 20mm dia and above depending on No. of wires to be drawn (refer Table No.1/2), ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; Couplers, long Bends, Junction boxes of required ways, type and resin / adhesive to make all joints rigid.

Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate and of suitable size to accommodate No. of entries; PVC or fabricated from 16g CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix cover plate on it.

Hardware:

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire 20g, steel fish wire, etc.

Other material for Surface finishing: Cement, sand, putty, and water.

Method of Construction:

Concealing of PVC conduits: (General)

Work shall be done in co-ordination with civil work to suite final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No 1/2 for PVC conduits) Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc. for which the distance between pipes shall not be less than 300 mm or anti electrostatic partition is be provided. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No.1/4. (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout finalized, with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25m, in such manner so as to facilitate drawing of wires. All bending of conduits shall be done with Bending Spring. All joints shall be made rigid with resin.

Concealing of PVC Conduits In walls / flooring:

Chases shall be made in walls of adequate width, with cutter and chiseling through it. Necessary finishing of the wall surface shall be done. Work in flooring shall not disturb RCC work, Conduits of adequate size shall be erected with use of appropriate accessories, and 'U' nails. All joints shall be made rigid with resin. Draw-in / inspection boxes shall be fixed with check-nut, flush with surrounding surface and earthed.

Bunch of wires:

Specification No (WG-MA/BW)

Scope:

Bunch of wires:

Providing specified wires and drawing them through provided conduits / trunking and / or as directed; with coded ferrules, harnessing the bunch of wires with necessary material when used in panel boards, duly connecting / terminating with lugs, and testing for safety and beneficial use.

Material:

Wires: in conduits / trunking / panel boards

Mains / Sub-mains / Circuit mains (comprising phase and neutral wires):

PVC insulated wire of specified size, minimum FR grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked, of required colour coding as per Table No 1/5.

Wires: open

PVC insulated and PVC sheathed wire of specified size, minimum FR grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked, of required colour coding as per Table No 1/5.

Earth Continuity Wire:

PVC insulated wire minimum FR grade insulation copper conductor of electrolytic grade, having insulation of 1.1 kV grade, of green / green yellow colour, ISI marked, of specified size but not less than 2.5 Sqmm as per Table No 1/5.

Lugs: Copper lugs of appropriate size & type

Other material: Rubber grommet, bush, harnessing material, flexible conduit etc.

Method of Construction:

Bunch of wires:

Drawing of wires: General

Specified wires shall be drawn with adequate care. Correct colour coding as per Table No. 1/5, shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) may be looped only within circuit. For lighting load or single-phase distribution wires of two different phases shall not be drawn in single pipe. Wires shall be terminated in the terminals of accessories only, with appropriate type and size of lugs.

Drawing of wires: through PVC conduits

Bush shall be used at pipe opening to protect wire insulation from getting damaged due to sharp edges. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/2.

Drawing of wires: through Rigid Steel conduits

Bush shall be used at pipe opening to protect wire insulation from getting damaged due to burrs / sharp edges. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/1.

Open Wire bunch: Open wires shall be erected with due care so as to avoid chances of any mechanical injury. Harnessing shall be done with required material in an approved manner in panel boards or where ever necessary. For covering lead wires flexible conduit shall be used with gland as per necessity.

Testing:

Insulation resistance test:

All wiring shall be tested with 500V Meggar between phases, phase – neutral and to Earth. IR value shall not be less than 1M-ohm.

Earth continuity:

Earth continuity shall be ensured between termination points of Earth wire.

Polarity Test:

Test shall be carried out for ensuring the correct polarity in switch and plug.

Mode of Measurement:

Measurement shall be carried out on the basis per running meter length of single wire or bunch as specified.

Mains (surface type)

Mains in surface PVC conduit

Specification No (WG-MA/PC)

Scope:

Mains in surface PVC conduit:

Providing specified PVC Conduits, Wires and erecting the conduits as per approved Method of Construction; on surface of wall / ceiling, etc. including entries through walls / slabs / flooring as per requirement, and with all necessary hardware, accessories such as Spacers, Saddles, Bends, Tees, Junction boxes, Check-nuts / glands, etc.; making conduits erection work rigid; and drawing the specified wires through these conduits and duly connecting / terminating with lugs, complete finishing, removing debris from site; testing for safety and beneficial use.

Material:

PVC Conduit:

PVC pipe of minimum 20mm dia and above depending on No. of wires to be drawn (refer Table No 1/2); ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; such as Spacers & Saddles, Couplers, Bends, inspection or non inspection type Elbows, Tees, Junction boxes of required ways and resin / adhesive to make all joints rigid. Black pipe shall not be used for surface type wiring.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs, wooden gutties, etc.

Wires: Mains / Sub-mains / Circuit mains (comprising phase and neutral wires)

PVC insulated wire of specified size, minimum FR grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked, of appropriate colour coding as per Table No 1/5

Earth Continuity Wire:

PVC insulated wire minimum FR grade insulation copper conductor of electrolytic grade, having insulation of 1.1 kV grade, of green or green yellow colour, ISI marked, of specified size but not less than 2.5 Sqmm as per Table No 1/5

Lugs: Copper lugs of appropriate type and size.

Other material: Rubber grommet, bush, flexible PVC conduit, gland etc.

Method of Construction:

Erection PVC Conduits for Surface type wiring:

General:

Erection shall be done as per the final approved layout, in perfect level and plumb. Conduits shall be firmly fixed on spacers with saddles. Fixing of spacers shall be equidistant and at ends, bends, elbows, junction boxes, couplings, boards. CSK screws of minimum 35x8 mm and suitable plugs shall be used for fixing spacers and 12x5 mm, round headed screws for fixing saddles on spacers. In case of stonewalls wooden gutties shall be grouted in wall for fixing of spacers. Distance between 2 spacers shall not be more than 600 mm. Size of conduit shall be correct depending on number of wires to be drawn (as per Table No. ½ for PVC conduits). Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution. Also for wiring for other utilities like data, telephone, TV cabling distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of surface conduit with colour coding (For Visual identification) as per Table No. 1/4. Flexible conduits shall be used at expansion joints.

Especially for PVC Conduits of surface type wiring:

In addition to general instructions above, all joints shall be made rigid with resin / adhesive. Wherever offsets are necessary, it shall be done with bending spring. Size of conduit shall be as per Table No. 1/2 for number of wires to be drawn through the conduit.

Drawing of wires: General

Wires shall be drawn with adequate care. Correct colour coding as per Table No. 1/5, shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) may be looped only within circuit. For lighting load or single-phase distribution wires of two different phases shall not be drawn in single pipe. Lead wires of sufficient extra length shall be provided and shall be terminated in the terminals of accessories only, with appropriate type and size of lugs.

Drawing of wires: through PVC conduits for surface type wiring

Insulated Earth wire of green or green-yellow colour of minimum 2.5 sq mm or as per specified shall be drawn through conduit. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/2. At the termination end flexible PVC conduit shall be used with gland as per required.

Mains in PVC Trunking (casing capping)

Specification No (WG-MA/PC)

Scope:

Surface type Mains in PVC Trunking (casing capping)

Providing specified PVC Trunking, Wires and erecting the Trunking as per approved Method of Construction; on surface of wall / ceiling, etc. including entries made with PVC conduit through walls / slabs / flooring as per requirement with all necessary hardware, accessories such as inner / outer Elbows, Tees, Junction boxes, etc; including erection of specified wires in PVC trunking, with coded ferrules and duly connecting with lugs, and finishing, removing debris from site; testing for safety and beneficial use.

Material:

PVC Trunking:

PVC Trunking (casing capping) ISI mark, 1.2 mm thick, minimum 20 mm width and above depending on No. of wires to be drawn (Refer Table No 1/2 for the size of trunking and number of wires to be drawn); with double locking arrangement, 1.8mm thick push-fit joints/ accessories for PVC trunking such as couplers, elbows, internal / external angles, junction boxes of required ways of the same make.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs, wooden gutties, etc.

Wires: Mains / Sub-mains / Circuit mains (comprising phase and neutral wires)

PVC insulated wire of specified size, minimum FR grade insulation, copper conductor of electrolytic grade, having insulation of 1.1 kV grade, ISI marked, of required colour coding as per Table No 1/5

Earth Continuity Wire: PVC insulated wire minimum FR grade insulation copper conductor of electrolytic grade, having insulation of 1.1 kV grade, of green colour, ISI marked, of specified size but not less than 1.5 Sqmm as per Table No 1/5

Lugs: Copper lugs of appropriate type and size.

Other material: Flexible PVC conduit, gland coded ferrules, etc.

Method of Construction:

Erection of PVC Trunking for surface type wiring

Erection shall be done as per the final approved layout. The Trunking shall be in perfect level and plumb. Screws of minimum 35x8 mm and suitable plugs shall be used for fixing. In case of unleveled surface number and size of screws shall be changed to higher size as per requirement and in case of stonewalls wooden gutties shall be grouted in wall for fixing of screws of Trunking. Distance between 2 screws shall not be more than 600 mm. Size of Trunking shall be correct depending on number of wires to be drawn as per Table No 1/3 but not less than 20mm. Separate Trunking shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring of other utilities like data, telephone, TV cabling and distance of 300 mm shall be maintained between the Trunking or anti electrostatic partition is to be provided. Double locking shall be checked while fixing capping. Adequate use of accessories shall be made at joints and required locations.

Erecting wires in Trunking:

Wires shall be erected within Trunking with adequate care. Correct colour coding as per Table No. 1/5 shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) may be looped only within circuit. For lighting load or single-phase distribution wires of two different phases shall not be erected in single Trunking. Wires shall be terminated in the terminals of accessories only, with appropriate type and size of lugs. Insulated Earth wire of green or green-yellow colour of minimum 2.5 sq mm or as per specified shall be erected through Trunking. Number of wires shall not exceed with respect to size of Trunking as per Table No. 1/3. After erection of wires double locking shall be checked while fixing capping. At the termination end flexible PVC conduit shall be used with gland as per requ

Earth continuity shall be ensured at all earth terminals and at earth terminals of metal enclosures.

Polarity test:

Polarity test shall be carried out for ensuring polarity in switch and plug.

Mains (Concealed type)

Mains in PVC Conduits in RCC work

Specification No (WG-MA/CC, WG-MA/BW)

Scope:

Concealed Mains in PVC Conduits in RCC work:

Providing specified PVC conduit, wires and laying / erecting Conduits in RCC work, such as slab, beam, column before casting as per approved Method of Construction along with of all required material including hardware, binding wire, fish wire; accessories such as deep PVC junction boxes, PVC / MS junction boxes / inspection boxes, check-nuts, flexible PVC pipe, drawing fish-wires and making all piping rigid, removing debris from site and supervising the work during casting to confirm rigidity, continuity and avoid

damages and as and when directed drawing of specified wires through these conduits with fish wire, tagging with coded ferrules and duly connecting with lugs, complete testing the installation for safety and beneficial use.

Material:

PVC Conduit:

PVC pipe of minimum 20mm dia and above, depending on number of wires to be drawn (refer Table No 1/2, ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; Couplers, long Bends, deep Junction boxes of required ways and resin / adhesive to make all joints rigid.

Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate and of suitable size to accommodate No. of entries; PVC or fabricated from 16 SWG CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix cover plates on it.

Hardware:

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire 20g, GI fish wire, etc.

Wires: Mains / Sub-mains / Circuit mains (comprising phase and neutral wires):

PVC insulated wire of specified size, minimum FR grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked, of required colour coding as per Table No 1/5

Earth Continuity Wire: PVC insulated wire minimum FR grade insulation copper conductor of electrolytic grade, having insulation of 1.1 kV grade, of green / green-yellow colour, ISI marked, of specified size but not less than 1.5 Sqmm as per Table No 1/5

Lugs: Copper lugs of required size & type

Other material: Rubber grommet, bush, harnessing material, flexible conduit etc.

Method of Construction:

Concealing of PVC conduits:

General:

Work shall be done in co-ordination with civil work and to suite final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No. 1/1 for Steel conduits & Table No 1/2 for PVC conduits) Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc. The distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No. 1/4. (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the

layout finalized, with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25m, in such manner so as to facilitate drawing of wires. All PVC conduit bending shall be done with Bending Spring. All joints shall be made rigid with resin.

Concealing of PVC conduits:

In RCC work:

Work shall be commenced after fixing of steel (re-enforcement) on centering material. Conduits shall be firmly fixed on steel of RCC work by binding wire. Fixing of conduits shall be such that it will remain rigid during casting of slab, beam, and column even after use of vibrator. Deep junction boxes and other draw-in boxes shall be such that their open end and centering material will not have gap in between so as to avoid concrete entering inside even after fixing covers to steel re-enforcement; and be filled with dry sand. Open ends of conduits; to be concealed in walls, shall be provided with couplers / sockets at ends and be flush with bottom of beam, and at located at the center of the beam. As far as possible bunching / grouping of conduits shall be avoided so that it will not affect strength of RCC work especially in beams. Suitable steel fish wire shall be drawn through in the conduits for drawing of wires later on.

Drawing of wires:

General:

Wires shall be drawn with adequate care. Correct colour coding as per Table No. 1/5 shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) may be looped only within circuit. For lighting load or single-phase distribution wires of two different phases shall not be drawn in single pipe. Lead wires of sufficient extra length shall be provided and shall be terminated in the terminals of accessories only, with appropriate type and size of lugs.

Drawing of wires: Through PVC conduits:

Insulated Earth wire of green or green-yellow colour of minimum 2.5 sq mm or as per specified shall be drawn through pipe. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/2.

Concealed Mains in PVC Conduits in walls / flooring:

Specification No (WG-MA/CC)

Scope:

Concealed Mains in PVC Conduits in walls / flooring:

Providing specified PVC conduit, Wires and laying / erecting the conduits in wall, flooring by making chases / grooves / entries as per approved Method of Construction along with of all required material including hardware such as 'U' nails, binding wire, fish wire; accessories such as PVC / MS junction boxes / inspection boxes, check-nuts, flexible PVC pipe, drawing fish-wires and making all piping rigid, refinishing the surface with cement

mortar, removing debris from site and as and when directed drawing of specified wires through these conduits with fish help of wire, tagging by coded ferrules and duly connecting / terminating with lugs, complete testing the installation for safety and beneficial use.

Material:

PVC Conduit:

PVC pipe minimum 20mm dia and above depending No. of wires to be drawn (refer Table No1/2, ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; Couplers, long Bends, Junction boxes of required ways and resin / adhesive to make all joints rigid.

Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate and of suitable size to accommodate No. of entries; PVC or fabricated from 16g CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix cover plate on it.

Hardware:

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire 20g, steel fish wire, etc.

Other material for Surface finishing: Cement, sand, putty and water.

Wires: Mains / Sub-mains / Circuit mains (comprising phase and neutral wires):

PVC insulated wire of specified size, minimum FR grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked, of required colour coding as per Table No 1/5

Earth Continuity Wire: PVC insulated wire minimum FR grade insulation copper conductor of electrolytic grade, having insulation of 1.1 kV grade, of green / green-yellow colour, ISI marked, of specified size but not less than 2.5 Sqmm as per Table No 1/5

Lugs: Copper lugs of appropriate size & type

Other material for wire drawing: Rubber grommet, bush, harnessing material, flexible conduit etc.

Method of Construction:

Concealing of PVC conduits:

General:

Work shall be done in co-ordination with civil work and to suite final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No. 1/1

for Steel conduits & Table No 1/2 for PVC conduits) Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc. The distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No. 1/4. (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout finalized, with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25m, in such manner so as to facilitate drawing of wires. All bending of conduits shall be done with Bending Spring. All joints shall be made rigid with resin.

Concealing of PVC Conduits In walls / flooring:

Chases shall be made in walls of adequate width, with cutter and chiseling through it. Necessary finishing of the wall surface shall be done. Work in flooring shall not disturb RCC work, Conduits of adequate size shall be erected with use of appropriate accessories, and 'U' nails. All joints shall be made rigid with resin. Draw-in / inspection boxes shall be fixed with check-nut, flush with surrounding surface and earthed.

Drawing of wires:

General:

Wires shall be drawn with adequate care. Correct colour coding as per Table No. 1/5 shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) may be looped only within circuit. For lighting load or single-phase distribution wires of two different phases shall not be drawn in single pipe. Lead wires of sufficient extra length shall be provided and shall be terminated in the terminals of accessories only, with correct type of and correct size of lugs.

Drawing of wires: Through PVC conduits:

Insulated Earth wire of green or green-yellow colour of minimum 2.5 sq mm or as per specified shall be drawn through pipe. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/2. At the termination end flexible PVC conduit shall be used with gland as per necessity.1.6 Point wiring (Surface type)

Point Wiring (Surface Type)

Specification No (WG-PW/SW)

Scope:

Point wiring (Surface type):

Providing all required approved specified material including hardware and erecting wiring on surface of wall, ceiling from switch board to outlet for light / fan / bell / independent plug point, in rigid steel / PVC conduit or PVC trunking as specified; fixing one board with

a 1 way switch for one way point or two boards with a 2 way switch on each board, in case of 2 way point; for controlling power supply and one board / block with accessory for outlet of light / fan / plug and terminating wires within as per approved Method of Construction; removing all debris and testing the installation for safety and beneficial use.

Material:

Point wiring (Surface)

PVC conduit:

PVC pipe of minimum 20mm dia and above depending No. of wires to be drawn (refer Table No 1/2); ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; such as Spacers & Saddles, Couplers, Bends, inspection or non inspection type Elbows, Tees, Junction boxes of required ways and resin / adhesive to make all joints rigid. Black pipe shall not be used for surface type wiring.

PVC Trunking:

PVC Trunking (casing capping) ISI mark, 1.2 mm thick, minimum 20 mm width and above depending on No. of wires to be drawn (Refer Table No 1/2 for the size of trunking and number of wires to be drawn); with double locking arrangement, 1.8 mm thick push-fit joints / accessories for PVC trunking such as couplers, elbows, internal / external angles, junction boxes of required ways of the same make.

Rigid Steel conduit:

Rigid steel screwed conduit minimum 20mm dia. and higher depending on No. of wires to be drawn as per Table No. 1/1, 16 gauge, ISI mark, ERW grade duly processed for anti-rust treatment and painted with black enamel paint, accessories for rigid steel conduits such as 5mm thick 20mm width spacers and G.I. saddles for individual pipe or GI strip for bunch of pipes, sockets, inspection type or normal; open bends, junction boxes of required ways all of the same make.

Wires: Phase and Neutral

PVC insulated wires of specified size, 1.1 kV, & minimum FR grade insulation, electrolytic tough pitch (ETP) copper conductor, ISI marked, of required colour coding as per Table No 1/5

Earth Wire:

PVC insulated minimum FR grade copper wires of electrolytic grade, having insulation of 1.1 kV grade, of green / green-yellow colour, ISI marked, 2.5 Sqmm or bare copper wire of 14g

Accessories:

Switch: 1 or 2 way Piano type 6/10 A, 1 or 2 way Modular type switch 6/10A.

Outlet: 6A angle / batten lamp holder or 3 plate ceiling-rose or Bakelite / porcelain three way connector or if plug point, 6A, 3-pin plug socket.

Boards:

Switchboards shall be double walled (back and front) of suitable size, to accommodate independent slot for each switch, socket, fan regulator. Boards shall be made up of 4mm

thick marine grade plywood for back and front fixed on wooden frame with 0.8mm thick laminate pasted on exposed portion of front ply, totally varnished and with either brass hinged door or screwed top.

Or

As above with 3mm thick Bakelite/Hylam top instead of laminated front ply.

Or

Board made from Filled polypropylene.

Round/Square double wooden block or PVC board for mounting light / fan outlet accessory.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs, wooden gutties, PVC/ rubber bushings etc.

Method of Construction:

Point wiring (Surface)

Erection of conduits:

General:

Erection shall be done as per the final approved layout, in perfect level and plumb. Conduits shall be duly screwed and firmly fixed on spacers with saddles. Fixing of spacers shall be equidistant and at ends, bends, elbows, junction boxes, couplings, boards. CSK screws of minimum 35x8 mm and suitable plugs shall be used for fixing spacers and 12x5 mm round headed for fixing saddles on spacers. In case of stonewalls wooden gutties shall be grouted in wall for fixing of spacers and saddles. Distance between 2 spacers shall not be more than 600mm. Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution. Also for wiring for other utilities like data, telephone, TV cabling distance between pipes shall not be less than 300 mm. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of surface conduit with colour coding (For Visual identification) as per Table No 1/4. Flexible conduits shall be used at expansion joints. Bushing shall be provided at open ends.

Erection of conduits:

PVC pipes for surface type wiring:

In addition to General conditions above, all joints shall be made rigid with resin / adhesive. Wherever offsets are necessary, same shall be done with bending spring. Size of conduit shall be correct depending on number of wires to be drawn as per Table No. 1/2.

Or

Specially for Rigid Steel Conduit of surface type wiring:

In addition to general conditions above, Size of conduit shall be correct depending on number of wires to be drawn (as per Table No. 1/1 for steel conduits). All exposed threaded portion of Rigid Steel Conduits shall be painted with anti corrosive paint. Sharp edges and burr at cut ends shall be made smooth. Inspection type conduits accessories shall be used as per requirement in accessible position to facilitate drawing or withdrawing of wires. All conduits piping work shall be properly earthed with 2.5 sq. mm G.I Earth wire fixed to conduit and made continuous with Earth clips at every 1m and at ends and joints viz. bends, junction boxes.

Or

Erection of PVC Trunking for surface type wiring:

Erection shall be done as per the final approved layout. The Trunking shall be in perfect level and plumb. Screws of minimum 35x8 mm and suitable plugs shall be used for fixing. In case of unleveled surface number and size of screws shall be changed to higher size as per requirement and in case of stonewalls wooden gutties shall be grouted in wall for fixing of screws of Trunking. Distance between 2 screws shall not be more than 600 mm. Size of Trunking shall be correct depending on number of wires to be drawn as per Table No 1/3 but not less than 20mm. Separate Trunking shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring of other utilities like data, telephone, TV cabling and distance of 300 mm shall be maintained between the Trunking. Double locking shall be checked while fixing capping. Adequate use of accessories shall be made at joints and required locations.

Drawing of wires: General

Wires shall be drawn with adequate care. Correct colour coding as per Table No 1/5 shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) may be looped within circuit. For lighting load distribution wires of two different phases shall not be drawn in single pipe. Wires shall be terminated in the terminals of accessories only. Insulated Earth wire of green or green-yellow colour of minimum 2.5 sq mm or as per specified shall be erected wherever necessary. In case of 2-way point wiring additional wires of phase conductor shall be provided between the 2-way switches.

Drawing of wires: through PVC conduits for surface type wiring

Insulated Earth wire of green or green-yellow colour of minimum 2.5 sq mm shall be drawn through pipe. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/2.

Or

Drawing of wires: through Rigid Steel conduits for surface type wiring

Bush shall be used at pipe opening to protect wire insulation from getting damaged due to burrs / sharp edges. Number of wires shall not exceed with respect to size of pipe as per Table No. 1/1.

Or

Erecting wires in Trunking:

Wires shall be erected within Trunking with adequate care. Number of wires shall not exceed with respect to size of Trunking as per Table No. 1/3. After erection of wires double locking shall be checked while fixing capping.

Fixing Switchboards and accessories:

Control switchboards shall generally be erected at 1.35m height or as specified and fixed with minimum 2 Nos. (and more as per size of board) of screws of length not less than 50mm, termination of wires shall be done with lugs on switch and other accessories only by carefully inserting all strands in lugs, terminals and proper tightening. Switches shall be provided on phase wire only. Bare wire shall not be used for looping incoming supply to switches and for earthing inside switchboards. For plug socket phase wire shall be connected in right side terminal when seen from front. Proper termination of earth wire in Earth terminal shall be ensured.

Testing:

Insulation resistance test:

All wiring shall be tested with 500V Meggar between phases, phase – neutral and to Earth. IR value shall not be less than 1M-ohm.

Earth continuity:

Earth continuity shall be ensured at all earth terminals of plug outlets and at earth terminals of metal enclosures.

Polarity test:

Polarity test shall be carried out for ensuing the correct polarity in switch and plug.

Mode of Measurement:

Measurement shall be carried out on the basis per number of points, for the point length up to 6 metre between switch and outlet. For the length exceeding 6 metre 10% of overall rate shall be added for every 1m.

Point wiring (Concealed type)

Specification No (WG-PW/CW)

Scope:

Point wiring (Concealed type):

Providing all required approved specified material including hardware and erecting rigid steel / PVC conduits, junction boxes, provided fan boxes, along with required accessories in RCC slabs before casting and in walls, flooring by making chases, and refilling the same after erection of conduits, fixing concealed type boxes for switch boards in walls, drawing wires through conduits, from switch board to outlet for light / fan / bell / independent plug point fixing modular type switch for controlling power supply and an

accessory for outlet of light / fan / bell / plug at other end, with mounting plate, and terminating wires within at both ends, as per approved Method of Construction, closing all junction boxes with plates; removing all debris and testing the installation for safety and beneficial use.

Material:

Point wiring (Concealed):

PVC conduit:

PVC pipe of minimum 20mm dia and above depending No. of wires to be drawn (refer Table No 1 / 2); ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; such as Spacers & Saddles, Couplers, Bends, deep / normal Junction boxes of required ways and resin / adhesive to make all joints rigid. Black pipe shall not be used for surface type wiring.

Rigid Steel conduit:

Rigid steel screwed conduit minimum 20mm dia. and higher depending on No. of wires to be drawn as per Table No.1/1, 16 gauge, ISI mark, ERW grade duly processed for anti-rust treatment and painted with black enamel paint, accessories for rigid steel conduits such as sockets, bends, deep / normal junction boxes of required ways all of the same make.

Sheet metal Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate, fabricated from 16g CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix surface cover plate on it. Cover plate shall be made up of fire resistant PVC material / 3mm thick laminate / Bakelite / Hylam / transparent acrylic sheet painted from inside to match colour of wall with duly tapered edges.

Wires: phase and neutral wires

PVC insulated wires of specified size, 1.1 kV, & minimum FR grade insulation, electrolytic tough pitch (ETP) copper conductor, ISI marked, of required colour coding as per Table No 1/5

Earth Continuity Wire:

PVC insulated minimum FR grade copper wires of electrolytic grade, having insulation of 1.1 kV grade, of green colour, ISI marked, 2.5 Sqmm or bare copper wire of 14g

Lugs: Pin type Copper lugs.

Accessories:

Switch: 1 or 2 way Modular type switch 6/10A.

Outlet:

Modular type 6A angle / batten lamp holder or 3 plate ceiling-rose or Bakelite / porcelain 3 way connector or if plug point, 6A, 3-pin plug shuttered socket.

Boards:

Switchboards shall comprise of; concealed type box of required modules made of sheet metal or Polypropylene material, mounting plate and cover plate. The required modules shall be worked out on the basis of points, plug socket/sockets, step type fan regulator, etc are to be fixed. For every blank module, 1 way blank plate shall be fixed. All the above accessories shall be of same make, as that of switch.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs / wooden gutties, 'U' nails, plumbing nails, steel binding wire, fish wire 20g, rubber / PVC bushes etc.

Other material for Surface finishing: Sand, Cement, water etc.

Method of Construction:

Point wiring (Concealed):

Concealing of conduits:

General:

Work shall be done in co-ordination with civil work and to suite final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No. 1/1 for Steel conduits & Table No 1/2 for PVC conduits) Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc. The distance between pipes shall not be less than 300 mm. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No. 1/4. (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout finalized, with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25m, in such manner so as to facilitate drawing of wires. All the bends shall be done with Bending Spring.

Concealing of conduits: In RCC work

Work shall be commenced after fixing of steel (re-enforcement) on centering material. Conduits shall be firmly fixed on steel of RCC work by binding wire. Fixing of conduits shall be such that it will remain rigid during casting of slab, beam, and column even after use of vibrator. Deep junction boxes and other draw-in boxes shall be such that their open end and centering material will not have gap in between so as to avoid concrete entering inside even after fixing covers to steel re-enforcement; and be filled with dry sand. Open ends of conduits; to be concealed in walls, shall be provided with couplers / sockets at ends and be flush with bottom of beam, and at located at the center of the beam. As far as possible bunching / grouping of conduits shall be avoided so that it will not affect strength of RCC work especially in beams. Suitable steel fish wire shall be drawn through in the conduits for drawing of wires later on.

Concealing of Conduits: In walls

Chases shall be made in walls of adequate width, with cutter and chiseling through it. Necessary finishing of the surface shall be done. Conduits of adequate size shall be erected with use of appropriate accessories and 'U' nails.

Drawing of wires:

Use of Steel fish wire shall be made for drawing of wires. Wires shall be drawn with adequate care. Correct colour coding shall be used for phase, neutral and earth. Wires shall not have intermediate joint in between terminals of the accessories. Earth-wire and Return wire (neutral) may be looped within circuit only. For lighting load distribution, wires of two different phases shall not be drawn in single pipe. Wires shall be terminated in the terminals of accessories only. Adequate extra length shall be left at termination points. In case of 2-way point wiring additional wires of phase conductor shall be provided between the 2-way switches.

Fixing Switchboards and accessories:

Control switchboards shall generally be erected at 1.35m height or as specified and fixed with minimum 2 Nos. of screws of length not less than 50 x 8mm, Boards shall be in line and plum and shall be in level with wall surface so as to fix mounting plate flush with wall, Termination of wires shall be done in switch and other accessories only by carefully inserting all strands in terminals and proper tightening. Switches shall be provided on phase wire only. Bare wire shall not be used for looping incoming supply to switches. Phase wire shall be routed through switch only. For plug socket phase wire shall be connected in right side terminal when seen from front. Proper termination of earth wire in Earth terminal shall be ensured. All blank modules shall be plugged with blanking plates.

Testing:

Insulation resistance test:

All wiring shall be tested with 500V Meggar between phases, phase – neutral and to Earth. IR value shall not be less than 1M-ohm.

Earth continuity:

Earth continuity shall be ensured at all earth terminals of plug outlets and at earth terminals of metal enclosures.

Polarity test:

Polarity test shall be carried out for ensuring the correct polarity in the plug.

Mode of Measurement:

Measurement shall be carried out on the basis per number of points, for the point length up to 6 metre between switch and outlet. For the length exceeding 6 metre 10% of overall rate shall be added for every 1metre.

Table No. 1/1

Maximum Number Of Single Core 1.1 kV Cables That Can Be Drawn In Rigid Steel Conduits

Size of cable mm2		Size of conduit mm													
Nominal Cross sectional area	No. and dia. of wires	16		20		25		32		40		50		63	
		S	B	S	B	S	B	S	B	S	B	S	B	S	B
1.0	1 / 1.12 Cu	5	4	7	5	13	10	20	14						
1.5	1 / 1.4	4	3	7	5	12	10	20	14						
2.5	1 / 1.8 3 / 1.06 Cu	3	2	0	5	10	8	18	12						
4.0	1 / 2.24 7 / 0.85 Cu	3	2	4	3	7	8	12	10						
6	1 / 2.80 7 / 1.06 Cu	2		3	2	6	5	10	8						
10	11 / 3.55 Al 7 / 1.40 Cu			2 2		5 4	4 3	8 6	7 5						
16	7 / 1.70					2		4	3	7	6				
25	7 / 2.24							3	2	5	4	8	6	9	7
35	7 / 2.50							2		4	3	7	5	8	6
50	7 / 3.0 Al 19 / 1.80									2		5	4	6	5

Note 1: Cu- applicable to only copper cable; Al- applicable to only Aluminium cable

Note 2: The table shows maximum capacity of conduits for the simultaneous drawing of cables. The columns headed 'S' apply to straight runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from straight by an angle more than 150. The columns headed 'B' apply to bent runs of conduit, which deflect from the straight by an angle of more than 150.

Note 3: In case of inspection type draw in box has been provided and if the cable is first drawn through one straight conduit, then through the draw in box and then through the second straight conduit such system may be considered as that of straight conduit even if the conduit deflects through the straight by more than 150.

Table No. 1/2

Maximum Number of Single Core 1.1 kV Cables That Can Be Drawn In Rigid Non-Metallic Conduits

Size of cable mm2		Size of conduit mm					
Nominal Cross sectional area	No. and dia. of wires	16	20	25	32	40	50
1.0	1 / 1.12 Cu	5	7	13	20		
1.5	1 / 1.4	4	6	10	14		
2.5	1 / 1.8 3 / 1.06 Cu	3	5	10	14		
4.0	1 / 2.24 7 / 0.85 Cu	2	3	6	10	14	
6	1 / 2.80 7 / 1.06 Cu		2	5	9	11	
10	11 / 3.55 Al 7 / 1.40 Cu			4	7	9	
16	7 / 1.70			2	4	5	12
25	7 / 2.24				2	2	6
35	7 / 2.50					2	5

50	7 / 3.0 Al 19 / 1.80					2 2	5 3

Note 1: Cu- applicable to only copper cable; Al- applicable to only Aluminium cable

Table No 1/5

Colour Code for Wires

Table No. 1/3

Maximum Number of Single Core 1.1 kV Cables in Cable Trunking (Casing and Capping)

Size of cable mm2		Size of Trunking mm				
Nominal Cross sectional area	12/16 x 12 mm	20 x 12 mm	25 x12 mm	32 x 12 mm	40 x 20 mm	50 x 20 mm
1.0						
1.5	3	5	6	8	12	18
2.5	2	4	5	6	9	15
4.0	2	3	4	5	8	12
6		2	3	4	6	9
10		1	2	3	5	8
16			1	2	4	6
25				1	3	5
35					2	4
50					1	3

Note 1: Cu- applicable to only copper cable; Al- applicable to only Aluminium cable

Telephone wiring (TW)

1. General

All material shall conform to relevant standard as per BIS and shall carry ISI mark. If any particular category of material for which PSI mark is not available in market, it shall be approved either by ITD I DOT of Govt. of India. Work shall be carried out as per the Method of Construction specified by BIS and as specified by DOT (Department of Telephone), Govt. of India. Material and Work not qualifying to any provision mentioned above shall be to the satisfaction of Engineer in Charge.

2. Scope:

Specification No: (WG-TW)

To provide wiring for telephone on surface of wall or ceiling concealed in slab, wall, under flooring, etc, through existing metallic conduits, rigid PVC conduits, PVC trunking, with all necessary hardware, material, etc. as specified.

To provide, install, test & commission the instruments / equipments and accessories used in telephone system, such as; Main Distribution Frames (MDF), Krone Modules, Over Voltage Magazine, PBX / EPABX, CO-axial cable, Rosette box, Jumper wire, etc.

3. Material:

PVC Telephone cable: PVC insulated Tinned copper solid conductor with minimum 0.5 mm dia. (Single & Multi pair) properly paired and colour coded, shall be terminated on KRONE module with suitable tool.

Jelly filled Armoured Telephone cable: PVC insulated, PVC sheathed with steel

armouring, Tinned copper solid conductor with minimum 0.5 mm dia multi pair, with

Jelly, properly paired and colour coded.

Saddles: Saddles fabricated from G I sheet of required gauge (16/18 gauge) either galvanized finish or painted with superior quality enamel black paint, with necessary shearing for mechanical strength, semi circular shaped with extended piece having suitable

holes for fixing on spacer.

Hardware: Sheet Metal (SM) screws of required sizes, plugs, wooden gutties, etc.

MDF: Manufactured by reputed manufacturer of specified capacity, facility for wall mounting, with door & lock, aluminium frame for fixing of KRONE, duly enclosed in cabinet made from 18 SWG CRCA sheet with powder coating of required colour.

Junction box: Manufactured by reputed manufacturer of specified capacity, facility for + wall mounting, with door & lock, aluminium frame for fixing of Krone, duly enclosed in cabinet made from 18 SWG CRCA sheet with powder coating of required colour. The depth of the box should consider the height of KRONE module plus protection magazine.

Over Voltage protection Magazine: Manufactured by reputed manufacturer of 10 pair capacity, with 3 pole gas discharge tube should be properly fitted on KRONE module in MDF / Junction box.

Rosette box: PVC I Bakelite box with LED indicator, RJ 11 jack, facility for fixing on wall.
Jumper wire: Twin twisted PVC insulated with Tinned copper solid conductor minimum 0.5 mm dia.

KRONE Module: Disconnection type KRONE module having capacity to connect 10 pairs with silver-plated terminal contacts.

RG-11 Co-axial low voltage grade cable: PVC insulated with Tinned copper solid conductor minimum 0.5 mm dia, with connector at both ends suitable for termination in RJ

type socket.

PBX (Analogue type): Manufactured by reputed manufacturer and approved by Telephone Engineering Certificate (TEC) of specified extensions, having following features:

Direct Inward dialling (DID) with voice guidance facility.

Caller line Identification (CLI) on Analog as well as digital extension.

Call Billing software (CB)

Dynamic STD locking

Conferencing facility for specified extensions.

EPABX (Digital type): Manufactured by reputed manufacturer and approved by Telephone Engineering Certificate (TEC) of specified extensions, having following features:

Direct Inward dialling (DID) with voice guidance facility.

Caller line Identification (CLI) on Analog as well as digital extension.

Call Billing software (CB)

Dynamic STD locking

Conferencing facility for specified extensions.

Provision of battery back-up and power failure line transfer.

4. Method of Construction:

4.1 Drawing of telephone wire through Steel conduit I PVC conduit I PVC Trunking:

As specified in Chapter for Point Wiring.

4.2 Erection of Jelly filled armoured Telephone cable:

Erection shall be done as per the layout finalized, in perfect level and plum. Before fixing the cable shall be straightened as far as possible for good aesthetics look. Cable shall be fixed with saddles firmly clipped on cable. Saddles shall be fixed to wall with minimum 50x8

mm SM screws with plugs/wooden gutties (Distance between two saddles shall be

minimum 600 mm). Wooden gutties shall be used wherever required (Especially for stone wall). The entries made in wall, floor slab, etc for laying the cable shall be made good by filling and finishing with plastering the same.

4.3 Erection of MDF Junction box / Rosette box / PBX / EPABX, etc:

Specified equipment shall be fixed to wall with minimum 50x8 mm SM screws, with necessary plugs, wooden gutties, etc. or may be fixed on Table Top if required.

5. Mode of Measurement:

Work done for telephone in Steel I PVC conduit I PVC Trunking will be measured on running meter basis, (i.e. per running meter) for each single run. For the other accessories / equipments shall be done as per unit specified. (I.e. Job / each)

1.12 Computer Cabling (COC)

A) UTP Networking Cable

General:

All material shall conform to relevant standard as per ISO/IEC11801, CENELEC EN50173

& TIA/EIA 568-B2-1; CUL listed & ETL verified.

Material and Work not qualifying to any provision mentioned above shall be to the satisfaction of Engineer in Charge.

Scope:

Specification No (WG-COC/NC)

To lay the cables for Computers on surface of wall or ceiling concealed in slab, wall, under flooring etc, through existing metallic conduits, rigid PVC conduits, PVC trunking, with all necessary hardware, material, etc. as specified. The cable shall be used only for connections between Information Outlet & Patch/ Multimax Panel. (Exception: For making MDIX patch cord)

Material:

UTP cable:

4 pairs,100 ohms, unshielded twisted pair (UTP), each pair separated by a PE former (Star shaped) solid 23AWG tinned copper conductor rated for temperature of 750 C, PVC insulated grey colour with following types as in the table 1.12/1

Table 1.12/1

Sr. No.	Type	Class	Tested frequency
1	Cat 6	E	350MHz
2	Cat 6+	E	500MHz

The Category 6 cable and Category 6 channel components shall be manufactured by a

single manufacturer. The manufacturer shall warrant the Category 6 channel cable, components, and applications for a period of 20 years.

The Delay Skew on the 100 meter channel shall not exceed 30 ns

The 20 year warranty shall be a transferable warranty and has component replacement policy in case of manufacturing defect

Category 6, 100mtr channel, 4-connection model should guarantee 400% margin over standard NEXT specification across swept frequency

Category 6, 100mtr channel, 6-connection model should guarantee +4dB margin over standard NEXT Specification across swept frequency (1~250MHZ)

The high performance Category 6 UTP cable 23AWG shall be of the traditional round design with Mylar bisector tape Non-Plenum rated.

The cable shall support Voice, Analog Baseband Video/Audio, Fax, Modem,Switched- 56, T-1, ISDN,RS-232, RS422, RS-485, 10BASE – T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet, 155 Mbps ATM, AES/EBU Digital Audio, 270 Mbps Digital Video, 622 Mbps 64-CAP ATM and emerging high-bandwidth applications including 1 Gbps Ethernet, gigabit ATM, IEEE 1394B S100 and S400, as well as all 77 channels (550 MHz) of analog broadband video.

The cable jacket shall comply with Article 800 NEC for use as a non-plenum cable.

The 4 pair UTP cable shall be UL® and c (UL®) Listed Type CM.

Performance shall be characterized to 550 MHz to support high-bandwidth video applications

Non Plenum CAT6 UTP Cable

Weight=25.3 lb (1000 ft)

Jacket Thickness=.022 in

Outside Diameter=0.232 in

Conductor Diameter=.022 in

Insulation Type=High density Polyethylene

Jacket Material=PVC

Maximum Pulling Tension=25 lbs

Nom. Velocity of Propagation=0.69

Max DC Resistance=9.83 Ohms/100m

Mutual Capacitance @ 1 kHz = 4.95 nF/100m

Operating Temperature= -20 to 60° C

The high performance Category 6 UTP cable shall be of the traditional round design with Mylar bisector tape.

The 4 pair UTP cable shall be UL Type CM (non-plenum)

Performance shall be characterized to 550 MHz to support high-bandwidth video applications

Method of Construction:

The cable shall be laid in provided separate casing n capping/ PVC conduit/ trunking 400mm away from electrical cables wherever required without sharp bends. The cable shall be spliced at both the ends for punching/ crimping at keystone jacks/ UTP connectors.

Mode of measurement: Executed quantity shall be measured on running metre basis.

B) UTP Patch cord

Scope:

Specification No (WG-COC/PC)

Structured cabling, to make connections from switch to patch panel or information outlet to computer

Material:

UTP Patch Cord:

Assembly (conforming to EIA/TIA 568B-2-1) of Cat 6 type 4 unshielded twisted pair 24-26AWG (0.51mm-0.40mm), each pair separated by a PE former (Star shaped) 100 ohms stranded wire PVC insulated cables with modular RJ-45 polycarbonate UL94V housing 15milliohms gold over ~~nickel contacts (superior three piece connector) cr~~imped on both ends with T568A & T568B wiring schemes with 8P8C connection The cord shall be branded. The cords shall be used in structured cabling in accordance with following table 1.12/2.

Table 1.12/2

Sr. No.	Length	Use in
1	1m	from switch to patch panel
2	3m	from computer to information

All patch cords shall exceed TIA/EIA and ISO/IEC Category 6/Classs E specifications.

All patch cords shall be backward compatible with Category 5 and Category 5E systems.

The patch cords shall incorporate an anti-snag feature that provides maximum protection from snagging during moves and re-arrangements.

Patch cords shall be UL listed, UL-C certified and AUSTEL approved.

Patch cords shall support network line speeds in excess of 1 gigabit per second.

Physical Specifications:

Contact Material: Phosphor Bronze

Contact Plating: Gold 50 micro-inch (1.27 microns) Nickel

100 micro –inch (2.54 microns)

Insertion Life: 750 minimum

Plug Material: Polycarbonate UL-rated 94 V-O

Operating Temperature: 14°F to 140°F (-10°C to 60°C)

Method of construction:

The patch cord shall be erected for making connections from switch to patch panel or from computer to information outlet.

Mode of measurement: Executed quantity shall be counted on number basis

BACKBONE (Fibre Network)

C) PVC Armoured Optical Fibre Cable (OFC)

General:

All material shall conform to relevant standard as per IEEE, EIA/TIA 568-B.3

Scope:

Specification No (WG-COC/OFC)

Optical fibre cable is used for connecting remote places networks by means of fibre switch or fibre module without much loss of signal.

Material:

Optical Fibre Cable:

Dielectric & metallic sheath armoured multimode optical fibre cable for underground/ aerial applications, fibres separated into binder groups inside a Industry standard 3mm gel filled buffer tubes standard around a central strength member; water blocked with dry water

blocking material, making access & handling individual tubes easier & craft-friendly cable core; operating temperature of 40 - 700 C, crush resistance of 44N/m, as per table 1.12/3.

Table 1.12/3

Fiber Count	Sub Units	Outer Diameter in. (mm)	Weight lbs/kit kg/km	Minimum Bend Radius In. (cm)		Max. Tensile Load lbs.		Max. Vertical Rise Feet (Meter)
				Loaded	Unloaded	Short Term	Long Term	
Apr-48	5	0.46 (11.7)	63 (94)	9.2 (23.4)	4.6 (11.7)	607	180	
							-800	
72	6	0.50 (12.7)	72 (107)	10.0 (25.4)	5.0 (12.7)	607 (2700)	180 (800)	2509 765)
				11.5 (29.4)			180 (800)	
96	8	0.58 (14.7)	95 (141)	14.8	5.8 (14.7)	607 (2700)	180	1904 (580)
				-37.8			-800	
144	12	0.74 (18.9)	146 (217)	17.2 (43.8)	7.4 (18.9)	607 (2700)	180 (800)	1237 (377)
			211 (315)					

288	24	0.86 (21.9)			8.6 (21.9)	607 (2700)		852 (260)

Note* There are 12 fibres per tube

04/ 06/ 12/ 24 fibres				
Sr. No.	Grade	Core dia	1Gbps Distance at	
			850nm	1300nm
1	FR	62.5	3000m	550m
2	FR	50 µm	1100m	600m
3	FRLS	62.5	3000m	550m
4	FRLS	50 µm	1100m	600m

The cable shall support Gigabit Ethernet and legacy applications including Ethernet, Fast Ethernet, Token Ring, ATM and FDDI.

The loose tube dielectric OSP cable shall be armored with a corrugated polymer coated steel tape and constructed with industry standard 3mm buffer tubes, stranded around a central strength member

The armor layer shall provide crush protection meeting the Telcordia requirements for Superior Armored cable.

The buffer tubes shall compatible with standard hardware, cable routing and fan-out kits.

The cable core shall be water blocked with dry water-blocking materials, making access and handling of individual tubes easier and craft-friendly.

The cables shall be designed for point-to point applications as well as mid-span access, and provide a high-level of protection for fiber installed in the outside plant environment.

SR No	Features
1	Support 10 Gbps up to 300 meters
2	Meets and exceeds the next generation multimode fiber (OM3) specifications in
3	Gigabit Ethernet is supported up to over 1.0 kilometre for 1000BASE-SX.
4	Supports very high speed data transmission by controlling DMD
5	Differential Mode Delay Exceeds TIA-492AAAC-A (IEC-60793-2-10ed2)@ 850nm
6	> 2,000 MHz-km laser bandwidth at 850 nm
7	Core Diameter should be 50.0 ± 3.0 µm
8	Cladding Diameter should be 125.0 ± 1.0 µm
9	Max. Attenuation, Loose Tube Cable 3.0 dB/km
10	Coating/Cladding Concentricity Error should be =< 6 µm
11	Clad Non-Circularity ≤ 1%
12	Zero Dispersion Wavelength 1297-1316 nm
13	Water Immersion, 73.4°F (23°C) should be ≤ 0.20 dB

Environmental and Mechanical

	Specification	Test Method
Operating Temperature	-40°to +70°C	FOTP - 3
Installation Temperature	20°to +70°C	N/A
Storage Temperature	-40°to +70°C	N/A
Crush Resistance	44 N/mm	FOTP - 41
Impact Resistance	Exceeds	FOTP - 25
Flexing	Exceeds	FOTP - 104
Twist Bend	Exceeds	FOTP - 85

Cable Identification:Buffer Tubes and Fibres are identified with standard color coding:

1 - Blue	5 - Slate	9 - Yellow
2 - Orange	6 - White	10 - Violet
3 - Green	7 - Red	11 - Rose
4 - Brown	8 - Black	12 - Aqua

Hardware:

Sheet Metal (SM) screws of required sizes, plugs, wooden gitties, clips etc.

Method of Construction:

As per the method of construction of PVC armoured cable. But these cables shall be tagged as “OFC” every metre length & can be laid in trench side by side. For underground cable laying cable indicator mentioning “Optical Fibre Cable” is a must.

Mode of measurement:

Executed quantity shall be measured on running meter basis.

D) Fibre Patch Cord (FPC)

General:

All material shall conform to relevant standard as per IEEE, EIA/TIA, CENELEC

Scope:

Specification No (WG-COC/FPC)

The cord is to be used to connect fibre optic equipment to fibre optic cross-connects, interconnects & information outlets. (e.g. Remote Ethernet switch with fibre optic module can be connected to another same type of switch or Fibre Optic Switch.)

Material:

FRLS duplex fibre patch cord/ pigtails 1mtr in length with LC/ SC/ ST termination consisting of 1.6mm/ 3.0mm dia. 62.5um fibre with minimum bandwidth of 200MHz-

km at 850nm & 500MHz at 1300nm with following specifications, as per table 1.12/4.

Table 1.12/4

SR No.	Outside dia.	Cable retention strength	Minimum Bend Radius	Maximum Cordage Tensile Load
1	1.6mm: 1.6mm x 3.3mm	50 Newton	Loaded: 5.1cm Unloaded: 3.5cm	Short Term : 3111 Newton Long Term: 93 Newton
2	3.0mm: 3.0mm x 5.9mm	50 Newton	Loaded: 5.8cm Unloaded: 3.5cm	Short Term : 400 Newton Long Term: 120 Newton

The fiber-optic patch cord shall be configurable with standard LC, SC, and ST terminations, and shall be available in either 1.6 mm or 3.0 mm duplex zip cord.

The 1.6 mm cordage shall exceed the requirements for larger diameter cordage and allows at least twice as many fibers to be installed in a cabinet.

The duplex cordage shall be 1.6 mm by 3.5 mm and have two single fiber cords joined together with a web.

The connector shall have a pull-proof design that helps prevent accidental disconnects and helps to assure optimal performance of equipment.

Custom hybrid patch cords shall also be available, to simplify migration to industry-leading connectors.

All fibers shall be Differential Mode Delay (DMD) tested by using a high-resolution test bench that exceeds the FOTP-220 standards and shall be independently certified by UL®.

All patch cords shall be a distinctive aqua color for positive identification.

Physical Specifications

Minimum Bandwidth	At @ 850 nm: 4700 MHz-km (laser), 3500 MHz-km (OFL) At @ 1300 nm: 500 MHz-km (laser), 500 MHz-km (OFL)
Attenuation:	3.0 dB/Km @ 850 nm, 1.0dB/Km @ 1300 nm
Cable Outside Diameter	: Duplex: 1.6 x 3.7 mm
Min. Bend Radius:	2.5 cm
Operating Temperature Range:	At -20 to 70 ºC
Average Connection Loss:	LC = 0.1 dB
Tip Material:	Ceramic
Return Loss Minimum:	At -20 dB
Mating Durability for:	500 Reconnects
Insertion Loss Change:	<0.2 dB
Temperature Stability	At -40 to + 75 ºC
Insertion Loss Change:	<0.3 dB

Method of Construction:

Supplying & plugging FRLS duplex fibre patch cord/ pigtails into the LC/ SC/ ST termination of LIU & fibre module/ fibre switch port complete.

Mode of Measurement: Executed quantity shall be counted on number basis

1.13. Networking Components (NWC) Switches/ Routers

A) Web Smart Power Over Ethernet Switch (ENS)

General:

All material shall conform to relevant standard as per IEEE802.3af PoE

Scope:

Specification No (WG-NWC/ENS)

Preferred in Wireless LAN obviating the use of external power supply for Access Points

Material:

Ethernet Switch:

Ethernet Switch with PoE: 24 ports PoE (Power Over Ethernet) with IEEE 802.3af PoE protocol, each PoE to supply up to 15.4 Watts for connecting devices such as Access Point needing additional power, 10/100Base-Tx 24 Fast Ethernet ports, 1000 Base-T 4 ports, 2 combo ports for flexible copper/fibre Gigabit connections, VLAN web manageable switch with rack mountable clips, screws, console utility software, mechanisms to detect an attack against the central processing unit of the switch and to take corrective action on attacking interface.

Feature-rich solution with functionality enabling by Secure Always On access to mission critical applications

High performance switch architecture and stacking performance delivering 320Gbps

High-density 10/100 ports for edge connectivity

Two combo 10/100/1000/SFP uplinks ports per switch for high speed gigabit or low speed connections such as 100FX

Simplified converged network deployments through support for Power over Ethernet (PoE), advanced Quality of Service (Quos), and auto-configuration of ports with IP Handsets & Wireless Access Points

Technical Specifications:

10/100 Power over Ethernet ports: 24 per switch

10/100/1000/SFP Gigabit ports: 2 per switch

SFP support: SX, LX, XD, ZX, CWDM, 100FX,& T1

Resilient Stacking: up to 8 units / 192 ports per stack

Stacking ports: 2 built-in stacking ports per switch

Total stacking capacity: 320 Gbps

Individual switch packet throughput: 6.6 Mpps

Individual switch capacity: 48.8Gbps

Concurrent VLANs: 256

Jumbo Frame Support on Gigabit ports

Maximum MAC addresses: 8,000

Standards Compliance:

IEEE 802.3 10BASE-T Ethernet

IEEE 802.3u 100BASE-TX Fast Ethernet

IEEE (ANSI) 802.3 Auto-negotiation

IEEE 802.3z Gigabit Ethernet

IEEE 802.3x Flow Control

IEEE 802.1Q VLANs

IEEE 802.1p Priority Queues

IEEE 802.1D Spanning Tree

IEEE 802.1w Rapid Spanning Tree

IEEE 802.1s Multiple Spanning Tree Groups

IEEE 802.3ad Link Aggregation

IEEE 802.1X Ethernet Authentication Protocol

IEEE 802.3AB Link Layer Discovery Protocol

RFC 783 Trivial File Transfer Protocol (TFTP)

RFC 791/950 Internet Protocol (IP)

RFC 792 Internet Control Message Protocol (ICMP)

RFC 826 Address Resolution Protocol (ARP)

RFC 854 Telnet Server and Client

RFC 951 / 1542 BOOTP

RFC 1112 Internet Group Management Protocol v1

RFC 1215 SNMP Traps Definition

RFC 1271 / 1757 / 2819 RMON

RFC 1361 / 1769 Simple Network Time Protocol (SNTP)

RFC 1493 Bridge MIB

RFC 1573 / 2863 Interface MIB

RFC 1643 / 2665 Ethernet MIB

RFC 1905 / 3416 SNMP

RFC 1906 / 3417 SNMP Transport Mappings

RFC 1907 / 3418 SNMP MIB

RFC 1945 HTTP v1.0

RFC 2011 SNMP v2 MIB for IP

RFC 2012 SNMP v2 MIB for TCP

RFC 2013 SNMP v2 MIB for UDP

RFC 2138 RADIUS

RFC 2236 Internet Group Management Protocol v2

RFC 2474 Differentiated Services Support

RFC 2570 / 3410 SNMPv3

RFC 2571 / 3411 SNMP Frameworks

RFC 2572 / 3412 SNMP Message Processing

RFC 2573 / 3413 SNMPv3 Applications

RFC 2574 / 3414 SNMPv3 USM

RFC 2575 / 3415 SNMPv3 VACM

RFC 2576 / 3584 Co-existence of SNMP v1/v2/v3

RFC 2660 HTTPS (Secure Web Server)

RFC 2665 Ethernet MIB

RFC 2863 Interfaces Group MIB

RFC 2674 Q-Bridge MIB

RFC 2737 Entity MIBv2

RFC 2819 RMON MIB

Additional features:

Customizable Auto-negotiation Advertisements (CANA)

Distributed Link Aggregation Groups

Virtual Link Aggregation Control Protocol (VLACP)

Single IP address for stack management

Resilient fail-safe stacking

Automatic Unit Replacement (Configuration and Software)

Automatic Detection Automatic Configuration (ADAC)

802.1X Single Host Single Authentication

802.1X Single Host Multiple Authentication

802.1X Multiple Host Multiple Authentication

802.1X Guest VLAN

802.1X Non-EAP (NEAP) access

DSCP-based Recognition, Marking and Recolouring

Ingress and Egress Port Mirroring

Broadcast and Multicast Rate limiting per port

ASCII Configuration File

Web, NNCLI, JDM

SSHv2 and SNMPv3 secure management support

Secure Network Access (NSNA) support

BPDU Filter

Stack Monitor

USB software and ASCII configure upload

New unit quick to configure

Resiliency Features:

- Should support a technology which will allow multiple physical network links between two network switches and another device (which could be another switch or a network device such as a server) to be treated as a single logical link and load balance the traffic across all available links

- Generally all the physical ports in the link aggregation group must reside on the same switch. It should also support protocols remove this limitation by allowing the physical ports to be split between two switches.

- Load balancing mechanism should not be round robin or dynamic which may not work with applications like Voice & Video, where session persistence is must.

Main Objective of above features is to achieve Active-Active Cluster Switching. And achieve sub second fail over in case of Link failure & Device Failure, which will result in

99.999% uptime.

Power over Ethernet specifications:

802.3af compliant with Power classification support

Signal pair power delivery

Maximum 15.4 watts per port

Maximum DTE Power AC 320 watts

Maximum DTE Power AC + RPS 740 watts

Electrical specifications:

Power supply: AC 100-240V, 50-60Hz

Input current at 110v: 7.1A

Input current at 220v: 3.6A

Max power consumption: 470W

Dimensions:

Width: 438.2mm (17.25 in)

Height: 1RU 43.7mm (1.72 in)

Depth: 368.3mm (14.5 in)

Environmental specifications:

Operating temperature: 0 to 50 degrees C

Storage temperature: -25 to 55 degrees C

Relative humidity: 10% - 90%vnon-condensing

Peak noise level: 42.3 dB

Thermal rating: 375 BTU/hr

Calculated MTBF: 242,552 hrs

Safety Agency Approvals:

IEC 60950 International CB Certification

EN 60950 European Certification

UL60950 US certification

CSA22.2, #60950 Canadian Certification

NOM Mexican Certification

Electromagnetic Emissions and Immunity:

CISPR22, Class A/CISPR24 International

EN55022, Class A/EN55024 European

FCC, Past 15, Class A US Certification

ICES-003, Class A Canadian Certification

AN/NZS 3548 Australian/NZ Certification

BSMI - Taiwan - CNS 13438, Class A

MIC - Korea - MIC, No. 2001-116

VCCI Class A Japanese Certification

Hardware: Chromium plated brass nuts & bolts with special type of U shaped square washers of required sizes.

Method of construction:

The Ethernet switch fitted with rack mountable clips shall be fixed in U Rack (Networking

Cabinet) with 4 nos. of chromium plated brass nuts & bolts. The switch shall be configured for TCP/IP addresses for switch IP & Gateway.

Mode of measurement: Executed quantity shall be counted on number basis

B) **Enterprise class** 24 Port Gigabit Switch (GBS) Scope:

Specification No (WG-NWC/GBS)

To be used in wired LAN connections.

Material:

Gigabit Ethernet Switch:

24 nos. of 10/100/1000 Base-T Gigabit ports, 2 or 4 combo SFP slots for flexible fibre backbone, VLAN, manageable, 19”standard rack mountable, auto detection of MDI/MDIX,

Layer 2, Safeguard Engine to protect against traffic flooding caused by virus/worm outbreaks with rack mountable clips, screws, console utility software.

Feature-rich solution with functionality enabling by Secure Always On access to mission critical applications

High performance switch architecture and stacking performance delivering 320Gbps

High-density 10/100/1000 ports for edge connectivity

Shared SFP uplinks ports per switch for gigabit fibre connectivity

Technical Specifications:

10/100/1000 Ethernet ports: 24 per switch

SFP Gigabit ports: 4 per switch

SFP support: SX, LX, XD, ZX, CWDM, 100FX & T1

Resilient Stacking: up to 8 units

Stacking ports: 2 built-in ports per switch

Total stacking capacity: 320 Gbps

Individual switch packet throughput: 36 Mpps

Individual switch capacity: 88 Gbps

Concurrent VLANs: 256

Jumbo Frame Support on Gigabit ports

Maximum MAC addresses: 8,000

Standards compliance:

IEEE 802.3 10BASE-T Ethernet

IEEE 802.3u 100BASE-TX Fast Ethernet

IEEE (ANSI) 802.3 Auto-negotiation

IEEE 802.3z Gigabit Ethernet

IEEE 802.3x Flow Control

IEEE 802.1Q VLANs

IEEE 802.1p Priority Queues

IEEE 802.1D Spanning Tree

IEEE 802.1w Rapid Spanning Tree

IEEE 802.1s Multiple Spanning Tree Groups

IEEE 802.3ad Link Aggregation

IEEE 802.1X Ethernet Authentication Protocol

IEEE 802.3AB Link Layer Discovery Protocol

RFC 783 Trivial File Transfer Protocol (TFTP)

RFC 791/950 Internet Protocol (IP)

RFC 792 Internet Control Message Protocol (ICMP)

RFC 826 Address Resolution Protocol (ARP)

RFC 854 Telnet Server and Client

RFC 951 / 1542 BOOTP

RFC 1112 Internet Group Management Protocol v1

RFC 1215 SNMP Traps Definition

RFC 1271 / 1757 / 2819 RMON

RFC 1361 / 1769 Simple Network Time Protocol (SNTP)

RFC 1493 Bridge MIB

RFC 1573 / 2863 Interface MIB

RFC 1643 / 2665 Ethernet MIB

RFC 1905 / 3416 SNMP

RFC 1906 / 3417 SNMP Transport Mappings

RFC 1907 / 3418 SNMP MIB

RFC 1945 HTTP v1.0

RFC 2011 SNMP v2 MIB for IP

RFC 2012 SNMP v2 MIB for TCP

RFC 2013 SNMP v2 MIB for UDP

RFC 2138 RADIUS

RFC 2236 Internet Group Management Protocol v2

RFC 2474 Differentiated Services Support

RFC 2570 / 3410 SNMPv3

RFC 2571 / 3411 SNMP Frameworks

RFC 2572 / 3412 SNMP Message Processing

RFC 2573 / 3413 SNMPv3 Applications

RFC 2574 / 3414 SNMPv3 USM

RFC 2575 / 3415 SNMPv3 VACM

RFC 2576 / 3584 Co-existence of SNMP v1/v2/v3

RFC 2660 HTTPS (Secure Web Server)

RFC 2665 Ethernet MIB

RFC 2863 Interfaces Group MIB

RFC 2674 Q-Bridge MIB

RFC 2737 Entity MIBv2

RFC 2819 RMON MIB

Additional features:

Customizable Auto-negotiation Advertisements (CANA)

Distributed Link Aggregation Groups

Virtual Link Aggregation Control Protocol (VLACP)

Nortel Multiple Spanning Tree groups

Single IP address for stack management

Resilient fail-safe stacking

Automatic Unit Replacement (Configuration and Software)

Automatic Detection Automatic Configuration (ADAC)

802.1X Single Host Single Authentication

802.1X Single Host Multiple Authentication

802.1X Multiple Host Multiple Authentication

802.1X Guest VLAN

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DSCP-based Recognition, Marking and Recolouring

Ingress and Egress Port Mirroring

Broadcast and Multicast Rate limiting per port

ASCII Configuration File

Web, NNCLI, JDM

SSHv2 and SNMPv3 secure management support

Nortel Secure Network Access (NSNA) support

BPDU Filter

Stack Monitor

USB software and ASCII configure upload

New unit quick to configure

Resiliency Features:

- Should support a technology which will allow multiple physical network links between two network switches and another device (which could be another switch or a network device such as a server) to be treated as a single logical link and load balance the traffic across all available links

- Generally all the physical ports in the link aggregation group must reside on the same switch. It should also support protocols remove this limitation by allowing the physical ports to be split between two switches.

- Load balancing mechanism should not be round robin or dynamic which may not work with applications like Voice & Video, where session persistence is must.

- Main Objective of above features is to achieve Active-Active Cluster Switching .And achieve sub second failover in case of Link failure & Device Failure which will result in

99.999% uptime

Electrical specifications:

Power supply: AC 100-240V, 50-60Hz

Input current at 110v: 1.3A

Input current at 220v: 0.7A

Max power consumption: 150W

Dimensions:

Width: 438.2mm (17.25 in)

Height: 1RU 43.7mm (1.72 in)

Depth: 368.3mm (14.5 in)

•

Environmental specifications:

Operating temperature: 0 to 50 degrees C

Storage temperature: -25 to 55 degrees C

Relative humidity10% - 90% non-condensing

Peak noise level: 42.4 dB

Thermal rating: 290 BTU/hr

Calculated MTBF: 312,001 hrs

Safety Agency Approvals:

IEC 60950 International CB Certification

EN 60950 European Certification

UL60950 US certification

CSA22.2, #60950 Canadian Certification

NOM Mexican Certification

Electromagnetic Emissions and Immunity:

CISPR22, Class A/CISPR24 International

EN55022, Class A/EN55024 European

FCC, Past 15, Class A US Certification

ICES-003, Class A Canadian Certification

AN/NZS 3548 Australian/NZ Certification

BSMI - Taiwan - CNS 13438, Class A

MIC - Korea - MIC, No. 2001-116

VCCI Class A Japanese Certification

Hardware:

Chromium plated brass nuts & bolts with special type of U shaped square washers of required sizes.

Method of construction:

The Ethernet switch fitted with rack mountable clips shall be fixed in U Rack (Networking Cabinet) with 4 nos. of chromium plated brass nuts & bolts. The switch shall be configured for TCP/IP addresses for switch IP & Gateway.

Mode of measurement: Executed quantity shall be counted on number basis

C) Broadband ADSL Router (ADSL)

General:

All material shall conform to relevant standard as per ITU G.992.2 & RFC

Scope:

Specification No (WG-NWC/ADSL)

For broadband internet connections to individual computer or Wired LAN/ Wireless LAN.

Material:

Broadband ADSL Router:

ADSL2+ broadband router with PPP(Point-to-Point Protocol), DHCP support, TCP/IP, downstream up to 24Mbps, upstream up to 1Mbps, RJ-11 for ADSL line, RJ-11 for phone line with Patch cord 3 metre in length, 10/100 Base-T port, USB 1.1 & 9V adaptor with UTP(Ethernet) Patch Cord, USB 2.0 patch cord, USB driver software

- Designed for the small to medium business - Simpler than enterprise class routers but more robust than consumer grade routers
- Secure - Good security and heavy encryption, but easy to implement; simple yet statefull firewall with simple filters
- Simplified architecture - Has a smaller processor that does not require a noisy fan, making it small and attractive for in-office or desk top installation

Note: Provision of Network Interface Card (NIC) shall be made for computer without built in NIC.

Input/Output Requirements:

WAN 1- 10/100 Base-T Auto-sensing - RJ-45

LAN -4 Port Ethernet 10/100 Base-T Auto-sensing switch – RJ- 45 (fifth port for internal connection)

VPN Services:

Minimum 10 IPSec tunnels

IKEv1 Main Mode

IKEv1 Aggressive Mode

Up to 3 IP pools for Client

16 Split networks configured

64 Subnets specified for Split (inverse) network

Diffie-Hellman Group 1, 2

IPSec Tunnel Mode

ESP

Support for Dynamically addressed peers – ABOT

NAT Traversal

IPSec Transport Mode

Keep Alive – For branch office and client tunnels

VPN Router Client termination

Cryptographic Services:

DES

3DES

Data authentication SHA-1

Data authentication MD-5

AES -128

AES – 192, 256 – Branch Office

Authentication Services:

Pre-shared secrets

External RADIUS support

802.1x/EAP support

Firewall:

Statefull Packet Inspection

IP application Inspection (FTP, SMTP, HTTP, Telnet, SSL, DNS, etc.)

Denial of Service (DoS) detection and prevention

URL Filtering

Content filtering

ALG's:

CU-SeeME

FTP

SIP

H.323

IPSEC

VDiLive

RealAudio

IP Services: NAT:

NAT, Many to One, Static, Many to Many, Many One-to-One

Port Forwarding

IPSec pass-through

SIP and H.323 ALG's

Cone NAT

NAT support for tunnel Mode IPSec tunnels

IP Services: Routing:

Clear text routing

Static

RIP v1

RIP v2

IP Services: DHCP:

Client

Server

Relay

Static mapping – 8 IP address lease mapping

IP Services: DNS:

DNS Proxy

Dynamic DNS

IP Services: NTP:

RFC-867, 868, 1305

Layer Two Protocols:

PPPoE

IP masquerade/ alias – Configurable MAC address

Performance and Scaling:

20 Mbps 3DES throughput w/ 1500 byte packets

10 IPSec tunnels

Management:

TFTP/FTP firmware upload

RS232 console port

Built-in Diagnostic tool

SNMP

Web GUI

CLI (Command Line Interpreter)

Remote management (FTP, Telnet, Web)

Backup and restore configuration via FTP and Web

WAN and LAN Ports:

The WAN and LAN ports are 10/100-base T Ethernet ports, without PoE

Two-Port Router:

The router is based on the Intel IXP-425 network processor, running at 266 MHz. It will have 64 Mbytes of FLASH, and 32 Mbytes of RAM.

5-Port Switch:

The 5-port layer-2 switch uses the Infineon 6996i chip

Serial Port:

The serial port provides a DCE connection that can be used for either WAN back-up or for installing software into a router that has a corrupted software load

Power Supply:

The router will be powered by 19 volts DC. The power supply circuit block will convert this supply to the supply voltages needed by the rest of the circuitry. The Business Secure Router 222 uses a universal wall-mount power supply.

Method of construction:

The ADSL Router shall be connected directly to the incoming phone line without any parallel telephone, then to telephone to avoid breaks in Internet connection, 9V DC

adaptor connected to provide power supply, UTP patch cord for connections between router Ethernet port to computer/ switch. The router shall be configured as per the

requirements of Broadband Internet Service Provider. As far as possible use of USB

port shall be avoided.

Mode of measurement: Executed quantity shall be counted on number basis

Wireless LAN

D) Indoor LAN Dipole Antenna (DPA)

General:

All material shall conform to relevant standard as per IEEE.

Scope:

Specification No (WG-NWC/DPA)

To enhance the signal strength of Access Point & Wireless PCI adaptor/ Router up to 500 metres.

Material:

Indoor LAN Dipole Antenna:

2.4 GHz, 5dBi gain, 50 ohms Omni-Directional Indoor Antenna outer covering made from polyurethane, polycarbonate swivel mechanism with built-in connector (RP-SMA &

Reverse SMA/ TNC) for 802.11b/g wireless network

Method of Construction:

Supplying & erecting 2.4 GHz, 5dBi Omni-Directional Antenna to be screwed to Access point/ wireless PCI adaptor complete.

Mode of Measurement: Executed quantity shall be counted on number basis.

E) Omni Directional Antenna (ODA)

Scope:

Specification No (WG-NWC/ODA)

To enhance the signal strength of Access Point & Wireless PCI adaptor/ Router at difficult to reach or far places.

Material:

Omni Directional Antenna:

2.4 GHz, 4dBi gain, Collinear, 50 ohms Omni-Directional Indoor Antenna covering horizontal 360 deg. vertical 36 deg. with 1.5m ULA-316 fixed cable, connectors (RP-SMA & Reverse SMA/ TNC), sturdy magnetic base stand to place it on flat surfaces & can be mounted on wall for 802.11b/g wireless network

Method of Construction:

Supplying & erecting 2.4 GHz, 4dBi Omni-Directional Antenna on wall or on the desktop

or suitable place which shall be at least 150mm away from electronic devices such as computers, TV, video equipment & audio/video tapes.

Mode of Measurement: Executed quantity shall be counted on number basis.

F) Aesthetic Omni Directional Antenna (AODA)

Scope:

Specification No (WG-NWC/AODA)

To enhance the signal strength of Access Point & Wireless PCI adaptor/ Router at difficult to reach or far places.

Material:

Aesthetic Omni Directional Antenna:

2.4 GHz, 20W (cw) power handling, 40 deg down tilt, 50 ohms Omni-Directional Aesthetic Indoor Ceiling Antenna with ULA-316 fixed cable, connectors (RP-SMA & Reverse SMA/ TNC) for 802.11b/g wireless network.

S No.	Type	Colour	Gain (dBi)	Coverage (deg)			
				Horizont	Vertical		
1	Glob	White	4	360	63	2.0	Places with false
2	Rod	Gray-White	5	360	32	3.0	Any other place

Hardware: Sheet Metal (SM) screws of required sizes, plugs, wooden gitties, etc.

Method of Construction

Supplying & erecting 2.4 GHz, Omni-Directional Indoor Aesthetic Ceiling Antenna on ceiling at suitable place fixed with required size of SM screws, plugs/ gitties etc. complete.

Mode of Measurement: Executed quantity shall be counted on number basis.

1.13 Networking Accessories (NAS) LAN Accessories

A) UTP connector (RJ-45) (UTPC)

General:

All material shall conform to relevant standard as per TIA/EIA 568-B2-1.

Scope:

Specification No (WG-NAS/UTPC)

To make MDIX (Cross) patch cord required for cascade connections of switches & routers.

Material:

UTP connector:

Assembly of Gold over nickel contacts with 1.5A current carrying capacity, 30V with

15milli ohms contact resistance, 8P8C connection easy to crimp with crimping tool in polycarbonate UL94V housing.

Method of construction:

The UTP cable shall be spliced, untwisted not more than 12mm, inserted into the connector with sequence as shown in the diagram crimped firmly with crimping tool. as per EIA/TIA 568 B.2-1 &

Mode of Measurement: Executed quantity shall be counted on number basis.

B) Information Outlet (Ethernet) (IO)

General:

All material shall conform to relevant standard as per TIA/EIA 568-B2-1.

Scope:

Specification No (WG-NAS/IO)

For connecting computers to wired LAN or external wireless Ethernet interface in Wireless LAN.

Material:

Information Outlet Flush/ Surface type:

Spring shuttered front access, high impact plastic body FR grade with high performance unshielded RJ-45 keystone jack (conforming to EIA/TIA 568-B.2-1 Cat 6, 15 milliohms contact resistance, gold over nickel spring contact, 1.5A current carrying capacity, with T568A/T568B wiring option, insulation displacement connector for cable crimping to accept 22-26AWG solid wire for connections up to Gigabit Ethernet.

All Category 6 outlets shall meet or exceed Category 6 transmission requirements for connecting hardware, as specified in TIA/EIA 568-B.2-1 Commercial Building Telecommunications Cabling Standard and ISO/IEC 11801:2002 Second Edition.

The Category 6 outlets shall be backward compatible with Category 5E, 5 and 3 cords and cables.

The Category 6 outlets shall be of a universal design supporting T568 A & B wiring.

The Category 6 outlets shall be capable of being in a modular patching situation or as a modular telecommunication outlet (TO) supporting current 10BASE-T, Token Ring, 100 Mbps TP-PMD, 155 Mbps ATM, 622 Mbps ATM using parallel transmission schemes and evolving high-speed, high-bandwidth applications, including Ethernet, 1000BASE-T and 1.2 Gbps ATM

The Category 6 outlets shall be capable of being installed at either a 45□ or a 90□ angle in any M-series modular faceplate, frame, or surface-mounted box avoiding the need for special faceplates.

The Category 6 outlets shall have improved pair splitters and wider channel for enhanced conductor placement. The outlet shall also have a low-profile wire cap, which protects against contamination and secures the connection. Multicolored identification labels shall be available to assure accurate installation.

Hardware:

Sheet Metal (SM) screws of required sizes, plugs, wooden gitties, etc.

Method of construction:

The Information outlet shall be fixed on the wall with sheet metal (SM) screws, rawl plugs/wooden gitties and making due connections as per EIA/TIA 568 B.2-1 by splicing the UTP cable, untwisted up to 12mm & punching the 4 pairs in the keystone jack with the help of punching tool. Not a single wire shall be left without connections.

Mode of Measurement: Executed quantity shall be counted on number basis.

C) Keystone jack (RJ-45) (KJ) Scope:

Specification No (WG-NAS/KJ)

Structured cabling, to provide connections to switch/ server from desktop computers/ Wireless devices in the patch panel

Material:

Keystone jack:

High impact plastic body FR grade with high performance unshielded RJ-45 keystone jack (conforming to EIA/TIA 568-B.2-1 Cat 6) , 20milli ohms contact resistance, gold over nickel spring contact ,1.5A current carrying capacity, with T568A/T568B wiring option, insulation displacement connector for cable crimping to accept 22-26AWG solid wire for connections up to Gigabit Ethernet

Method of construction:

The keystone jack shall be fixed with the help of its self-locking arrangement in provided patch panel before making due connection as per EIA/TIA 568 B.2-1 by splicing UTP cable, untwisted up to 12mm & punching the 4 pairs in the keystone jack with the help of punching tool. Not a single wire shall be left without connections.

Mode of Measurement: Executed quantity shall be counted on number basis.

Patch Panel (PP)

Scope:

Specification No (WG-NAS/PP)

Structured cabling for the installation of keystone jacks

Material:

Patch Panel:

Three piece structure including front panel, cable management plate with pre-fitted B-clip to help in routing cables & metal case of 1.6mm thick Mild Steel powder coated

panel of size 442.6mm X 44.5mm with the provision for 1 to 24 high density keystone jacks

24 and 48 port patch panels with 110 IDC connector terminations on rear

The patch shall have electrical performance guaranteed to meet or exceed TIA/EIA 568-B.2-1 Category 6 and ISO/IEC Category 6/Class E specifications.

The panel shall have vertical and horizontal cord organizers available as to improve patch cord management.

The panel shall be available in 24-port and 48-port configurations with universal A/B labeling and 110 connector terminations on rear of panel allowing for quick and easy installation of 22 to 24 AWG cable.

The patch panel shall have a black powder finish over high-strength steel.

The panel shall be equipped with a removable rear mounted cable management bar and front and rear labels.

The panel shall be UL listed, UL-C certified and ACA approved.

The panel shall support network line speeds in excess of 1 gigabit per second and be backward compatible with Category 5e, 5 and 3 cords and cables.

The Category 6 modular jack panels shall meet or exceed the Category 6/Class E standards requirements in ISO/IEC 11801, CENLEC EN 50173 and TIA/EIA and shall be UL Listed.

The panels shall be either wall or 19-inch rack mountable.The panels shall meet the following specifications:

Performance Specifications:

Category 6 Channel

(4 Connectors)

	Typical Worst Pair Margin*	Guaranteed Margin**	Guaranteed Margin**
Insertion Loss	64.3%	5.0%	7.5%
NEXT	6.6 dB	6.0 dB	7.0 dB
PSNEXT	7.3 dB	7.5 dB	8.5 dB
ELFEXT	6.4 dB	6.0 dB	8.0 dB
PSELFEXT	6.1 dB	8.0 dB	10.0 dB
Return Loss	6.6 dB	4.0 dB	4.0 dB
Frequency Range	1-250 MHz	1-250 MHz	1-250 MHz

Operational Specifications:

Operating Temperature Range: 14°F to 140°F (-10°C to 60°C) Storage Temperature Range: -40°F to 158°F (-40°C to 70°C) Humidity: 95% (non-condensing)

Nominal Solid Conductor

Diameter: 0.025 to 0.020 in (0.64 to 0.51 mm) (22 to 24 AWG)

Nominal Stranded Conductor

Diameter: 0.025 to 0.020 in (0.64 to 0.51 mm (22 to 24 AWG)

Insulation Size: 0.042 in (1.08 mm) (22 to 24 AWG) Maximum DOD Insulation Types: All plastic insulates (including PVC, irradiated PVC,

Polyethylene, Polypropylene,

PTF Polyurethane, Nylon, and FEP)

Insertion Life: 750 minimum insertions of an FCC 8-Position Telecommunications Plug

Front Panel: Black powder painted steel.

Plastic: High-impact, flame retardant, UL-rated 94V-0

thermoplastic

Hardware:

Chromium plated brass nuts & bolts with special type of U shaped square washers of required sizes.

Method of construction

The Patch Panel shall be firmly secured in U Rack (Networking Cabinet) with 4 nos. of chromium plated brass nuts & bolts.

Mode of Measurement: Executed quantity shall be counted on number basis.

E) Lightguide Interconnect Unit (LIU) General:

All material shall conform to relevant standard as per IEEE, EIA/TIA, CENELEC

Scope:

Specification No (WG-NAS/LIU)

To terminate the fibre backbone cables & the equipment cables.

Material:

Lightguide Interconnect Unit:

Wall mount type Lightguide Interconnect Unit with dimensions shown in the table, an interfacing unit for fibre cables coming in from field & those originating from the equipments. consisting of fibre spools to provide minimum bending radius & splice trays as splice cover for pigtail splicing, two compartment design with adaptor panel in the centre, compartmentalizing the box, complete aluminium housing, fully powder coated, two doors enclosure with lock & key, rubber grommets at the cable entry points for tight sealing; Splice trays of 140 x125 x 10mm complete aluminium body fully powder coated with provision for fibre splices fully cushioned splice holder containing grooves for fixing splice protective sleeves; FR grade high impact resistance plastic two halves design stackable sufficient room for excess cable.

1	12	300 x 300 x 80mm	6
2	24	370 x 350 x 80mm	12

Hardware:

Sheet Metal (SM) screws of required sizes, plugs, wooden gitties, etc.

Method of Construction:

Supplying & erecting Lightguide Interconnect Unit (LIU) on wall with cable termination complete with sheet metal screws of required size, plugs/ wooden gitties.

Mode of Measurement: Executed quantity shall be counted on number basis.

Fibre Accessories

F)ST “D" type Multimode Adaptor (MMA)

General:

All material shall conform to relevant standard as per IEEE, EIA/TIA 568-B.3

Scope:

Specification No (WG-NAS/MMA)

To couple two connectors together i.e. to provide optical connectivity between fibre cable & fibre switch/ fibre module.

Material:

ST "D" type multimode adaptor consists of Die cast zinc alloy housing Nickel plated, thread type mounting, washer, nut, 2 nos. of rubber plugs, high precision mechanical design Zirconium/ Phosphor Bronze sleeve having insertion loss < 0.3dB max, return loss < -40dB.

Method of Construction:

Supplying & fixing ST " D" type with threads in provided Lightguide Interconnect Unit on adaptor panel with nut & washer. The adaptor which is not in use shall be plugged with rubber plugs on both the sides to avoid dust accumulation in the adaptor.

Mode of Measurement: Executed quantity shall be counted on number basis.

G) ST “D" type Multimode Connector for LIU (MMA-LIU1)

General

All material shall conform to relevant standard as per IEEE, EIA/TIA 568-B.3

Scope:

Specification No(WG-NAS/MMA-LIU1)

To terminate the optical fibre cables in Lightguide Interconnect Unit (LIU)

Material:

ST "D" type Multimode connector consists of bayonet coupling, 2.5mm Zirconium Ferrule, wide range of Ferrule selection, pre-radiused ferrule to provide fast physical contact polishing, insertion loss < 0.5dB.

Distilled water (as lubricant & flushing agent between each polishing process).

Epoxy or Anaerobic adhesive (to bond the fibre inside the ferrule).

Tools to be used:

Carbide cleaving tool with 30 deg tip (to cut off the fibre to the desired height above the ferrule) Portable Microscope (200X minimum)

Polishing kit (includes a polishing puck, pads & an assortment of diamond, aluminium oxide & silica films)

Method of Construction:

The fibre shall be stripped & cleaved. Epoxy and polish connectors field-installed to terminate backbone and distribution cables. Epoxy and polish fibre termination include

the following steps: injecting the connector ferrule with scribing protruding fibre(s) from the ferrule, and polishing the ferrule end-face. The correct amount epoxy must be injected into the ferrule and cured for the specified time and temperature before the ferrule end-face is scribed and polished. Air bubbles shall be avoided in the epoxy to avoid micro-bending and increased loss. The cured epoxy securely bonds the fibre to the ferrule over the operating temperature minimizing relative fibre movement. The connectors with fibre cable shall be tested for loss test with Optical Time Domain Reflectometer (OTDR) & recording the results.

Mode of Measurement: Executed quantity shall be counted on number basis.

H) No Epoxy No polish ST “D" type Multimode Connector (MMA-LIU2)

Scope:

Specification No (WG-NAS/MMA-LIU2)

To terminate the optical fibre cables in Lightguide Interconnect Unit (LIU)

Material:

ST "D" type Multimode connector with Factory pre-polished fibre stub end face consists of bayonet coupling, 2.5mm Zirconium Ferrule, insertion loss < 0.5dB

Tools to be used:

Carbide cleaving tool with 30 deg tip (to cut off the fibre to the desired height above the ferrule)

Method of Construction:

The no Epoxy no polish connectors field-installed to terminate backbone and distribution cables. The fibre shall be striped, cleaved, inserted into the connector &

mechanically secured. The connectors with fibre cable shall be tested for loss test

with Optical Time Domain Reflectometer (OTDR) & recording the results.

Mode of Measurement: Executed quantity shall be counted on number basis.

Power over Ethernet Adaptor (PoEA)

General:

All material shall conform to relevant standard as per IEEE, TIA/EIA.

Scope:

Specification No (WG-NAS/PoEA)

To provide DC power supply to Ethernet devices, which do not have external/ built-in power supply.

Material:

Power over Ethernet Adaptor with output voltage of 5V DC or 12V DC (selectable)

with input of 48V DC consists of Power over Ethernet base unit, Power over terminal unit, AC to DC power adaptor, DC power cable & Ethernet cable.

Method of Construction:

Supplying & connecting Power over Ethernet Adaptor with all its connections of base unit, terminal unit & AC to DC power adaptor for supplying power to Access Point,

Router or Wireless Ethernet Transceiver complete.

Mode of Measurement: Executed quantity shall be counted on number basis.

J) Tri-Mode Dual band Wireless PCI LAN Card (LANC1)

General:

All material shall conform to relevant standard as per IEEE 802.11 xs.

Scope:

Specification No (WG-NAS/LANC1)

Making provision of Wireless LAN connectivity for desktop PCs in difficult places where signal strength is low.

Material:

Wireless PCI 32 bit interface LAN card covering 100 metres (indoor) transmission speed of 108Mbps to connect 802.11b, 802.11g & 802.11a networks operating in two non-interfering bands 2.4 GHz & 5GHz with 4dBi to 5dBi gain Omni directional dipole antenna & driver.

Method of Construction:

Supplying & fixing Tri-mode dual band wireless PCI LAN card in desktop computer with installation of driver & configuration for TCP/IP address complete.

Mode of Measurement: Executed quantity shall be counted on number basis.

K) Wireless PCI LAN Card (LANC2)

General:

All material shall conform to relevant standard as per IEEE 802.11g.

Scope:

Specification No (WG-NAS/LANC2)

Making provision of Wireless LAN connectivity for desktop PCs

Material:

Wireless PCI 32 bit interface LAN card to connect 802.11g networks operating in 2.4 GHz band covering 100 metres range (indoor), transmission speed of 54Mbps with external dipole antenna, detachable reverse SMA connector & driver.

Method of Construction:

Supplying & fixing Wireless PCI LAN card in desktop computer with installation of driver & configuration for TCP/IP address complete.

Mode of Measurement: Executed quantity shall be counted on number basis.

L) Manageable Wireless LAN Access Point (LAP1)

General:

All material shall conform to relevant standard as per IEEE 802.11b/g & IEEE802.3/u

Scope:

Specification No (WG-NAS/LAP1)

To provide wireless access to the WLAN network

Material:

Wireless Access Point consists of 108Mbps turbo mode handling heavy data payloads, 2dBi gain detachable dipole antenna with reverse SMA connector, external AC to DC\5V adaptor.

Method of Construction:

Supplying & connecting Wireless Access Point with AC to DC adaptor to Ethernet switch with due configuration for TCP/IP address complete.

Mode of Measurement: Executed quantity shall be counted on number basis.

M) High Performance Manageable Wireless LAN Access Point with PoE (Power over Ethernet) (LAP2)

General:

All material shall conform to relevant standard as per IEEE 802.11b/g, IEEE 802.3/u & IEEE 802.3af

Scope:

Specification No (WG-NAS/LAP2)

To provide high performance wireless access to the WLAN networkMaterial:

Wireless Access Point consists of 108Mbps turbo mode handling heavy data payloads, dual 5dBi gain detachable dipole antenna with reverse SMA connectors, Power over Ethernet 10/100 Base-Tx port.

Note:To connect the Access Point, availability of PoE Ethernet Switch or PoE adaptor is essential.

Method of Construction:

Supplying & connecting Wireless Access Point to PoE Ethernet switch or Ethernet Switch through PoE Adaptor with due configuration for TCP/IP address complete.

Mode of Measurement: Executed quantity shall be counted on number basis.

N) Dual Band High Performance Manageable Wireless LAN Access Point with PoE (Power over Ethernet) (LAN3)

Scope:

Specification No (WG-NAS/LAP3)

To provide high performance wireless access to the WLAN network

Material:

Wireless Access Point consists of 108Mbps turbo mode handling heavy data payloads operating in 2.4 GHz & 5 GHz bands, dual 5dBi gain detachable dipole antenna with reverse SMA connectors, Power over Ethernet 10/100 Base- Tx port.

Note: To connect the Access Point, availability of PoE Ethernet Switch or PoE adaptor is essential.

Method of Construction:

Supplying & connecting Wireless Access Point to PoE Ethernet switch or Ethernet Switch through PoE Adaptor with due configuration for TCP/IP address complete.

Mode of Measurement: Executed quantity shall be counted on number basis

LED Fittings (ESD-LED)

A) Surface / Recessed Mounting LED Luminaries

Scope:

Specification No (ESD-LED/IDF)

Supplying & erecting approved make, Surface / recessed mounting indoor fitting of specified wattage to provide specified lux level at specified height with p.f. > 0.95, complete as per manufacturer's specification, with appropriate driver.

Material:

Fitting: Scientifically designed highly polished & anodized Aluminum reflector ensures precise light control with optimum light utilization either with clear glass / frosted glass cover with ring or as per manufacturer's specification, leading to substantial savings in energy cost and excellent ambient conditions. Frame is fabricated from CRCA/MS sheet and epoxy powder coated white. Percolated frame ensure corrosion free life. Retaining clips for recess mounting fittings to facilitate mounting in false ceilings. Luminaries comprises of a deep drawn MS sheet canopy along with LED's with 100 lumens per watt mounted on top of aluminum heat sink of appropriate size for excellent thermal dissipation. The constant current driver circuit should be inside the luminary and can be driven between 80V to 260V AC. It should conform to class 1 of IS: 10322. Fitting shall be wired with multi stranded copper wire terminating on suitable connectors.

Driver: The constant current driver driven at 600mA of constant current should have short circuit protection, thermal protection & should work in the range of 80V to 260Volts.

LED's: The LED's of approved make having life of minimum 50000 burning hours, must have a color temperature between 5000 - 7000 and of 100 lumens per watt.

Metal Core PCB's: The PCB should be of metal core, copper clad laminate composed of 1 oz Electro deposit copper and 1.5mm 5052 Aluminum Alloy Laminated by 60 um high thermal conductive adhesive of modified epoxy.

Hardware: Sheet Metal (SM) screws, washers, plugs / wooden gutties, etc.
Method of Construction:

The fitting shall be fixed firmly in the designated place (False ceiling / unspecified ceiling) with the help of swinging bracket, and making the connection. In case where fittings are to be installed flush with /on false ceiling; layout shall be given to civil wing and work shall be done in co-ordination with civil wing e.g. making recesses in false ceiling.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e each)

B) Bulk Head type LED Luminaries

Scope:

Specification No (ESD-LED/BHF)

Supplying & Erecting LED bulkhead Fitting of appropriate size with 8 W with minimum 50-70 lux level at ground level with p.f. > 0.95 with frosted glass.

Material:

Fitting:

Luminaries comprises of a deep drawn MS sheet body with clear acrylic cover of 3mm thickness or as per manufacturer's specification, along with LED's with 100 lumens per watt mounted on top of aluminum heat sink of appropriate size for excellent thermal dissipation. The constant current driver circuit should be inside the luminary and can be driven between 80V to 260V AC. It should conform to class 1 of IS: 10322The surface of the canopy should be powder coated / stove enameled. Fitting shall be wired with multi stranded copper wire terminating on suitable connectors.

Driver:

The constant current driver driven at 600mA of constant current should have short circuit protection, thermal protection & should work in the range of 80V to 260Volts.

LED's:

The LED's of approved make having life of minimum 50000 burning hours, must have a color temperature between 5000 - 7000 and of 100 lumens per watt. The angle of illumination of each LED should be 90degrees and should be mounted on star type of metal core PCB's.

Metal Core PCB's: The PCB should be a metal core, copper clad laminate composed of 1 oz Electro deposit copper and 1.5mm 5052 Aluminum Alloy Laminated by 60 um high thermal conductive adhesive of modified epoxy.

Wooden board: As per (WG-PW/PW) 1.6 specified in chapter for Point wiring.

Hardware: Sheet Metal (SM) screws, washers, plugs / wooden gutties, etc.

Method of Construction:

The complete fitting with all the above accessories shall be erected as directed by Site engineer, duly connected and giving necessary testing.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e each)

C) LED Street Light / Flood Light Luminaires

Scope:

Specification No (ESD-LED/ODF)

Supplying & erecting Street Light fitting of specified wattage to provide specified lux level at specified height, complete with acrylic cover and gaskets, with appropriate driver circuit and erected on provided bracket.

Material:

Fitting: Luminaries comprises of a deep drawn MS sheet canopy with clear acrylic cover of 3mm thickness, along with LED's with 100 lumens per watt mounted on top of aluminum heat sink of appropriate size for excellent thermal dissipation. The constant current driver circuit should be inside the luminary and can be driven between 80V to 260V AC. It should conform to class 1 of IS: 10322 and Ingress Protection IP-55. The surface of the canopy should be powder coated / stove enameled. Fitting shall be wired with multi stranded copper wire terminating on suitable connectors.

Driver: The constant current driver driven at 600mA of constant current should have short circuit protection, thermal protection & should work in the range of 80V to 260Volts.

LED's: The LED's of approved make having life of minimum 50000 burning hours, must have a color temperature between 5000 - 7000 and of 100 lumens per watt. The angle of illumination of each LED should be 90degrees and should be mounted on star type of metal core PCB's.

Metal Core PCB's: The PCB should be a metal core, copper clad laminate composed of 1 oz Electro deposit copper and 1.5mm 5052 Aluminum Alloy Laminated by 60 um high thermal conductive adhesive of modified epoxy.

Method of Construction:

The complete fitting with all the above accessories shall be erected with provided bracket, on wall/street light pole or at any place as directed by Site engineer, duly connected and giving necessary testing.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e each)

Fans (FG/FN)

A) Ceiling Fans

Scope:

Specification No (FG-FN/CF)

Supplying and erecting Ceiling fan of specified sweep with all accessories and necessary materials, erected in provided hook/clamp.

Material:

Ceiling Fan:

Electric Ceiling fan capacitor type with double ball bearing complete with capacitor, 300 mm down rod, canopies, shackles, reel insulator, half threaded bolts of 9.53 mm (3/8") dia 62.5 mm (2-1/2") to 88 mm (3-1/2") long and 7.94 mm (5/16") dia 44.5 mm (1-3/4") to 57 mm (2-1/4") long with nuts, with lock type split pin, spring & plate washers, etc.; three number blade made of Aluminium alloy, suitable for single phase, AC 210 volts, 50 Hz supply and conforming to class I of IS : 374/1979 with amendment no 1 to 6 except for performance parameters to the extent modified as details in general requirements. The down rod shall be capable to withstand a tensile load of 1000 kg without breakdown and a torsion load of 500 kg.cm without breakage as per Clause 10.14.1 of IS: 374/1979 with amendment no.1 to 6. Electrical motor should be single phase permanent capacitor type with no. of poles 12/14/16/18 (As per sweep), Class-I with basic insulation. Class of insulation shall be B class. The winding wire used for fan should be synthetic enamelled of 30 to 38 SWG.

Connection wire: Flat / round Two core flexible stranded copper wire cord 24/0.2mm ISI marked.

Paint: Superior quality enamel paint of specified colour for marking Sr. No and date of rection.

Table 2.6/1

Performance Parameters for Fans suitable for Rated Voltage

S.No.	Sweep	Maximum Input Power in watts	Air delivery in m3/minute	Minimum Service Value
			at Rated Voltage	at 180 V
1	900 mm	42	140	3.4
2	1200 mm	50	215	4.3
3	1400 mm	60	270	4.5

Method of Construction:

Blades of ceiling fan shall be properly fixed. Down rod, clamp shall be carefully fixed with nut bolt and split pin. Canopies shall be tightened on down rod keeping sufficient clearance.Wiring connections shall be made with required wire leads. Regulator of fan shall be erected on provided switchboard with required wire leads.

Testing:

After erection fan shall be tested by connecting to supply at all positions of regulator. Also steadiness of fan shall be checked at full speed, so that there is no wobbling.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e. each)

B) Exhaust Fans

Scope:

Specification No (FG-FN/EXF)

Supplying and erecting Exhaust fan of specified sweep and speed, with all accessories and necessary materials, suitable to work on 230 V / 415 V, AC Supply 50 Hz, erected in position.

Material:

Exhaust Fan:

ISI marked Exhaust fan suitable for Single/Three phase AC 230/415 Volts 50 Hz, capacitor run with mounting ring, four numbers of fixing hole without regulator and louvers. The weep and speed shall be as per table below. Fan motor with moisture proof treatment and E class insulation, ISI marked, conforming to IS: 2312/67 with amendments 1 to 8. The fan mounting rings shall be proper pre-treatment followed with at least two coats of primer; final finish shall be with two coats of grey colour paint duly baked. The connecting leads shall be brought out for making connections.

Paint: Superior quality enamel paint of specified colour.

Table 2.6/2 Corresponding Speed with Sweep

S.No.	Sweep	Speed in RPM	Voltage level	CFM in m3/hr
1	375 mm	900	230 V	2460
2	375 mm	1400	230 V	4000
3	450 mm	1400	230 V	6800
4	450 mm	900	230 V	4350
5	375 mm	900	415 V	2460

Method of Construction:

The Exhaust fan complete with all above accessories and duly wired shall be erected at specified position, connected to the supply and tested.

Testing:

After erection fan shall be tested by connecting to supply. Also steadiness and vibrations if any, of fan shall be checked at full speed, so that there is no wobbling.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e each)

Water Coolers, Refrigerators (WCR)

A) Water Coolers (WC)

Scope:

Specification No (AP-WCR/WC)

Supplying, erecting, testing and commissioning self contained water cooler with specified storage capacity & cooling capacity, and marking S No and date of erection.

Material:

Water Cooler:

The water cooler shall be suitable for operation on 230 V +/- 10% , 50 Hz, single phase AC supply with hermetically sealed type suction cooled compressor with overload protection conforming to IS :-10617(part I) : 1983 with amendment no 1&2.

Tank:

Tank shall be fabricated from SS sheet of 0.8 mm min. thickness as per ISI 304 and shall be made by electrically seam welded lap joints or alternatively from 0.63 mm thickness stainless steel sheet with PUF insulation, with required number of Taps. However tank fabricated by double seam jointing is also acceptable if the same is reinforced and sealed by lead free solder material. Use of lead soldering material for sealing the joints of water tank is not permitted. Water tank cover and lid bottom shall be made of 1.25 mm aluminum sheet duly anodized / epoxy painted / high impact polystyrene (HIP) of 1.5 mm thickness. Positive locking of the lead is to be provided (lock with two keys). A drain valve at the bottom of the storage tank to be provided to draw out water while cleaning.

Cabinet (Body):

The cabinet of the water cooler shall be made of GS or SS sheet of 1.0 mm. The front panel, below the water outlets in the storage type water coolers shall be made of stainless steel of 0.8 mm. The drain pan for storage type water coolers shall be made of stainless steel sheet of 0.63 mm upto size 40 liters/hour and beyond 40 liters/hour of 0.8 mm thickness. The bottom pedestal shall be made of 2.65 mm minimum thick stainless steel sheet. Pedestal shall have a minimum ground clearance of 100 mm for ease of cleaning. Pedestal shall be strong enough to withstand weight with storage tank full and shall be reinforced to prevent skewing. The body shall be held securely with the pedestal with stainless steel nuts and bolts. The drain size should be 25 mm or above. In case water outlets are provided on three sides then all the three lower panels should be made of aluminium sheet or stainless steel sheet.

The mild steel components used in the manufacture of the cabinet shall be individually degreased, pickled, scrubbed and rinsed to remove grease, rust, scale or any other foreign elements. Immediately after pickling the MS parts shall be given phosphate treatment. The components along with the front panels shall then be given a primer coat with a finish coat of stove with a finish coat of stove enamel paint. The finish shall be smooth and uniform with hard tough film of the enamel adhering to the surface. The finish shall be free from all the visible defects and shall not chip when tapped lightly with a dull pointed instrument. Alternatively method of corrosion protection like plastic powder coating, electrostatic painting shall be permitted

Refrigeration coils to be fully soldered to the outside of the tank for good thermal contact and not merely tack welded.

There shall not be any gap between water tank cover (mask) and water tank to prevent rodent/ insect/ dust entry.

Water tank overflow should be adequately covered with strainer such as wire mesh etc to avoid rodent/ insect/ dust entry.

Condenser Fan Motor: The condenser fan motor shall be capacitor start and capacitor run (CSR) or permanently split capacitor (PSC) or alternatively permanently lubricated motor may be provided.

Thermostat: The thermostat shall conform to IS: 11338-1985. The position of the thermostat shall be adjustable through a rotary switch mounted on the front or side panels. Min and max of the thermostat setting shall be from 0 degree Celsius and 25 degree Celsius which shall be marked.

Method of Construction:

The water cooler shall be fixed at designated place or as directed by the site engineer, duly connected with inlet and drain by leak proof joints. The water cooler is to be erected on stand and tested.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e. each)

13) Bus Riser

Range Aluminum Busduct

Sandwich busduct – 400A – For Power Load

Specification for Sandwich busduct:

General

The busbar trunking system shall be sandwich construction 3P+100% Neutral +50% Integral Earth Aluminum.

Busbars shall be of hard drawn Aluminum with Copper/Tin Contacts at Joints

The degree of protection of the busbar trunking system shall be IP54 for Indoor.

The neutral conductor should have the same cross-sectional area as the phase conductor.

The Earthing must be of Aluminum same material and grade as that of phase conductor one continuous piece integral earth rated at min 50% of phase. Earthing shall be factory fitted factory tested and Icw rating rating for the earthing shall also be declared on Type Test Certificate produced by manufacturer.

The measurement of total length for the busway will be made end to end: Straight Lengths

Certificate

The busbar, of full range and each rating, should pass full type tests specified in latest IEC 61439:2012 The certificate shall be issued by an international independent testing authority (e.g. DEKRA , ASTA, KEMA, UL). Product should be KEMA/ KEMA KEUR / ASTA Diamond Certified.

Along with certification a product safety mark (KEMA-KEUR/ ASTA DIAMOND,) should be on the physical product offering a visible assurance for full product safety testing, factory inspection and ongoing surveillance under independent 3rd party authority to ensure conformity of the manufactured product in line with Sample tested during Type test .

Product Type test Certificate should be from same factory where product is being Manufactured.

Type Tests Certificate shall be furnished by vendor in Line with latest IEC 61439-6 for bus duct having passed below tests as per IEC

Clause 10.3. Degree of protection of assembly

Clause 10.4 Creepage and Clearance Distance

Clause 10.5 Protection against electrical Shock and integrity of Protective Circuit

Clause10.7 Internal Electrical Circuit and Connections

Clause 10.8 Terminals for External Conductors

Clause 10.9 Dielectric Properties

Clause 10.10 Temperature rise

Clause 10.11 Short Circuit Withstand

Clause 10.101 Resistance to Flame propagation

Clause 10.102 Fire Resistance

Clause 5.101 Strength of Power Frequency Magnetic Field

Clause 10.2.2 Resistance to Corrosion

Clause 10.2.3 Properties of Insulation Material

Clause 10.2.5 Lifting

Clause 10.2.6 Mechanical Impact

Routine tests as manufacturers factory: Busduct manufacturer shall conduct below routine tests at its factory.

Dielectric Test

Insulating Resistance Test

Ground Resistance Test

Visual Inspection

The busbar trunking system should pass seismic tests and being certified complying with seismic Zone IV Certified by a reputed international Agency.

Short Circuit Ratings and Tests

The whole busbar trunking system shall be capable of withstanding the short circuit of the electrical installation without damaging the electrical, mechanical and thermal stress under fault condition at a service voltage of 690V. The minimum rated insulation voltage shall be 690V.

The minimum certified short circuit ratings of the busbar trunking shall be as follows

For Phase:

400A - Icw for 1 sec shall be 40kA

For earth

800A – 60% phase capacity (24kA)

Housing

The busbar trunking housing shall be constructed of electro galvanized steel and aluminum to reduce hysteresis and eddy current loses and shall be provided with a suitable protective finish of ANSI 49 gray epoxy paint.

The busbar trunking housing shall pass at least 1000 hours salt spray test to ensure the anticorrosion ability.

Busbars

Busbars shall be of aluminum with copper cladding utilized Molecular Fusion technology.

There shall be no bolts passing through the busbars of the busway.

Each busbar shall be insulated with 2 Layers of Class B DuPont Mylar insulation or equivalent insulation, subject to clearance of all the type test as per IEC 61439-6

Joint

The busbar trunking joint shall be of the one-bolt type which utilizes a high strength steel bolt(s) and Belleville washers to maintain proper pressure over a large contact surface area.

The bolt shall be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.

It shall be possible to remove any joint connection assembly to allow electrical isolation or physical removal of a busbar trunking length without disturbing adjacent busbar trunking lengths.

Plug-in Holes provision

The connecting jaw of the plug-in unit shall plug directly onto the busbar and have full contact with busbar itself. Welded tab at plug-in busbar is not allowed.

All contact on joint and plug-in opening preferably of silver plated copper.

Shall have plug in provision of 2 no per floors to connect 2 nos of 250A tap of units.

Plug-in Units

The plug-in jaw shall be spring design composed of different metal to ensure the firm and tight contact with the busbar

The earthing contact of the plug-in unit shall always be made before that of the live conductors and the last to break during removal. And it must connect to the earth bar of busway to ensure the safety.

Covers of all plug-in units must have interlocks to prevent the cover from being opened when the switch is in the ON position.

Plug-in units shall be operated with visible blade quick-make and quick-break mechanism with 250A FP MCCB.

Presence of Transparent shield shall be inside to avoid direct contact of human

The plug-in units shall be equipped with internal barriers to prevent accidental contact of fish tape and conductors with live parts on the line side of the protective device during time of wire pulling.

Termination:

Termination units at transformer, DG set and Panel shall inclusive of Flange end, Copper flexible, adopter box, solid aluminum links, earthing connection, required hardware, any other accessories required if any. It shall be as per manufacturer's recommendations. Co-ordination with other vendors to be done in order to minimize the joints, and to have proper termination.

To avoid phase transposition unit, coordination to be done with panel vendor. Required phase sequence to be communicated to client/ Panel vendor.

Phase transposition unit to be quoted with unit rate and quantity to be considered during detailed engineering, if it is not possible to get the change in phase sequence from panel vendor.

Confirmation of Spares: Manufacturer of busway shall give minimum assured written declaration for availability of spares for min 10 Years after product commissioning.

Air Insulated Busbar Trunking System Specifications – 160A

General

The busbar trunking system shall be of low impedance and air insulated typed technology.

It shall be totally enclosed galvanised steel sheet with aluminium conductors; suitable for a 3 phase 4 wire 415 volts system with 100% neutral and continuous internal earth conductor of half size.

The system shall be complete with all necessary fittings, tap-off unit brackets, etc. and tap-off point on both sides of the busbar trunking system.

The busbar trunking system shall be capable of being mounted in any position without derating. Plug-in and feeder sections shall be interchangeable without the use of special adapter joint covers.

Integral continuous internal AL/copper conductor of cross-section area equal to 50% that of the corresponding phase conductor shall be provided.

The complete installation shall be coordinated throughout and where possible, shall consist of standard 5m or 3m sections with special sections and fittings provided to suit the installation.

Conformity to Standard: It shall be constructed in accordance with the applicable requirements of the latest IEC 61439 Part 1 and Part 6.

Conductors

Conductors shall be of laminated bimetal. Live conductors shall be air insulated and supported on fibreglass reinforced polyester isolators.

The busbar trunking system shall have the following characteristics:

Rated Insulation Voltage (A/C)	:	660 Volts
Rated current (Amp, AC)	:	160A

Rated Operating Voltage (A/C) : 415 Volts

Frequency : 50Hz +/- 10%

Short Circuit Capacity

The whole busbar trunking system shall be capable of withstanding the short circuit capacity of the electrical installation without damaging the electrical, mechanical and thermal stress under fault condition at a service voltage of 415V 50Hz. Minimum of 4.4KA for 1 sec. Co-ordination of the distribution should be guaranteed such that the Circuit breaker / trunking combination will limit the peak current to a value less than the rated peak current of the busbar trunking.

Joints

Electrical connection shall be via a joint with spring and silver graphite contacts.

This joint shall absorb the differential conductor/casing expansion of each length equally.

The joints shall be so designed as to allow removal of any length without disturbing adjacent lengths.

Enclosure

The metal enclosure of the busbar trunking system shall be of hot dip galvanised steel to provide high protection and mechanical resistance for the phase conductors along the entire length. Or equivalent, as per OEM design.

Tap-Off Outlets

Tap-off outlets on both sides of the trunking shall be at no more than 1m interval. It shall be possible to use them simultaneously.

Tap-off outlets shall be connected to the isolators to form a block, holding the bars. They shall have a shuttered outlet which is opened and closed automatically when tap-off units are plugged in or remove.

Tap-off unit

Tap-off units shall be from the same manufacturer as the busbar trunking system and shall be provided with 63A FP MCB.

All circuit breakers used shall be able to operate normally when mounted upside down or at any angles.

Tap-off units shall be of dust and damp proof version, degree of protection IP 54 with silver plated contacts suitable for all ratings of busbar and shall be suitably earthed.

The earthing contact of the tap-off unit shall always be made before that of the live conductors and the last to break during removal.

PVC/XLPE Cables (CB)

Armoured Cables (HT & LT)

General

All material shall conform to relevant standard as per BIS and shall carry ISI mark. If any particular category of material for which ISI mark is not available in market, it shall be as included in approved list.

Work shall be carried out as per the method of construction specified by BIS. If there is no reference for particular method of construction in IS, such work shall be carried out as per the approved method of construction specified in chapter 16 of P.W. Dept. Handbook.

Material and Work not qualifying to any provision mentioned above shall be to the satisfaction of the Engineer in Charge.

Cables: (Armoured)

The following list records those Indian Standards in force, which are acceptable as good practice, and accepted standards.

SP 30: 1984 : National Electrical Code

SP 7 (Group 4): 2005 : National Building Code

IS 1255: 1983 Code of practice of Installation & Maintenance of armoured cables up to 33 kV.

IS 3961: Part 2: 1967 : Recommended current ratings of PVC cables.

IS 1554: Part 1; 1988 : PVC Insulated (Heavy duty) Electric Cables; Part 1 for working voltages up to and including 1100 Volts.

IS 1554: Part 2; 1988 : PVC Insulated (Heavy duty) Electric Cables; Part 1 for working voltages up to and including 3.3 kV to 11 kV.

IS 10810: Part 63; 1993 : Method for Test of cables, Part 63 Smoke density of electric cables under fire condition.

Scope: (Armoured cables)

Specification No. (CB-LT/AL, CB-LT/CU, CB-HT)

Providing armoured cable of specified voltage level, size & specified conducting material (Aluminum / Copper) as per Table no. 7/3 including required material, hardware's for erection and erecting on wall, ceiling, RCC slab or drawing the same through pole, pipe, laying in provided conduit, trench, ducts, trays as per approved method of construction including glands, lugs, etc.

Material:

Cables:

Cables shall be XLPE for LT/MP and XLPE for HT as per Table no. 7/3 and of required construction, colour, shall carry ISI mark, IS No, manufacturer's name, size, duly embossed / screen printed at every metre and having the total count of progressive length in meter at each mark.

Earth wire: Galvanized Iron (G I) wire of appropriate gauge as per Table No 7/1.

Glands: As per specification (CB-GL)

Lugs: As per specification (CB-CL/AL, CB-CL/CU)

Saddles: Saddles fabricated from GI sheet of required gauge and size depending on dia of cable either galvanized or painted with superior quality enamel black paint with necessary shearing mechanical strength, semi circular shaped with extended piece having suitable holes for fixing.

G I Strip: 22 g x 25 mm width G I Strip.

Clamps: MS Clamps fabricated of required length and shape, having the size of 3/6 mm thick mild steel having 25/50 mm width (as per size of cable), rounded ends with wooden / resin cast grip for holding the cable.

Identification tags: For identifying root, connection position GI strip with identification mark / name embossed / painted with arrangement to tie should be fix on cable or arrangement of ferrules to be done.

Hardware: Sheet Metal (SM) screws of required sizes, plugs / wooden gutties, etc.

Method of Construction:

General:

Irrespective of method of construction the cable ends shall be terminated with appropriate size & type of glands with lugs duly crimped, as directed by Site engineer.

Wherever the cable has to be bent, the turning radius shall be as mentioned in Table No 7/2. Grouping of cables shall be done with adequate distance between cables as mentioned in IS so as to minimize de-rating. Cables shall be tagged/ferruled with identification name / mark at the point from where distribution starts and at ends. Bare

earth wire of appropriate size as per Table no. 7/1 shall run along with the cable. Earth wire running with the cable shall be terminated at the earth terminal nearest to cable termination.

Erection of Cable on Surface:

Erection shall be done as per the routes and layout finalized, in perfect level and in plumb. Before fixing the cable shall be straightened as far as possible for good aesthetics look, continuous bare GI earth wire of required gauge as per Table No 7/1 shall be run. Cable with G I wire shall be fixed by saddles firmly clipped on cable and shall be fixed to wall with minimum 50 x 8 mm SM screws with plugs/wooden gutties, etc. (Distance between two supports / saddles shall be maximum 450 mm). Wooden gutties shall be used wherever required (Especially for stone wall). The entries made in wall, floor slab, etc for laying the cable shall be made good by filling and finishing with plastering the same.

Erection of Cable on Trusses:

Cable along with bare GI earth wire, while erecting on trusses, shall be firmly clamped by wrapping GI strip of 22 g, 25 mm width of required length fixed to truss with nuts and bolts.

Erection of Cable on Pole:

Cable along with bare GI earth wire, while erecting on pole, shall be firmly clipped by suitable wooden / epoxy resin cast grips, clamped with 25 x 3 mm or50x6 mm MS strip of required length and fixed to pole with nuts and bolts.

Laying of Cable in provided Trench/Pole:

While laying Cable along with bare GI earth wire, utmost care shall be taken to prevent damage to the insulation of the cable and to the open end. Cable shall be brought out from trench vertically straight (minimum 1.0 metre above G L). Care shall be taken to inspect the trench so that depth of cable shall not be less than as shown in Table No 7/4. Suitable size of cable loops shall be provided near termination point at adequate depth.

Erecting cable in constructed Trench / duct:

Erection of cable/s in constructed trench / duct, shall be as per guide lines of IS 1255.

Erection of cable/s on trays:

Cable/s shall be tied with PVC tags on GI trays. At bending point care shall be taken so that sharp edges of sheet will not damage insulation of cable.

Mode of Measurement: Executed quantity shall be measured on the basis of running metre per run of cable.

Dismantling

Cable laid underground, or fixed on any surface shall be dismantled carefully without damaging complete with all its accessories, making coil and stored as directed. The surface of the dismantled cable shall be made clear by removing of unwanted material,

cement mortar, etc. When cable is dismantled from trench refill back the trench and making the surface proper.

Mode of Measurement: Executed quantity shall be measured on the basis of running metre per run of cable.

Table No 7/1

Size of Bare GI Earth wire to be used with LT Cables upto 1.1 kV

S.No.	Size of cable	Size of bare GI Earth wire to be used with cable
1	2.5 Sqmm to 50 Sqmm of all cores.	12 SWG
2	70 Sqmm to 95 Sqmm of all cores.	10 SWG
3	120 Sqmm and above of all cores.	8 SWG

Table No 7/2

Minimum bending Radius for Cables

S.No.	Voltage level of cables	Single core	Multi core Unarmoured	Multi core Armoured
1	Up to 11 kV	20 D	15 D	12 D
2	Up to 22 kV	25 D	20 D	15 D
3	Up to 33 kV	30 D	25 D	20 D

Note: D diameter of cable.

Wherever possible, 25 percent larger radii than the specified above should be used.

Table No 7/3

Current Rating (In Ground) for PVC/ XLPE Insulated 1.1 kV Grade Cables

Nominal area of conductor	Aluminum Conductor		Copper Conductor	
	Single Core	Multi Core	Single Core	Multi Core

Sqmm	PVC	XLPE	PVC	XLPE	PVC	XLPE	PVC	XLPE
10	51	55	46	50	65	71	60	65
16	66	74	60	68	85	95	77	87
25	86	98	76	90	110	125	99	115
35	100	118	92	108	130	150	120	138
50	120	137	110	126	155	175	145	161
70	140	172	135	158	190	220	175	202
95	175	204	165	187	220	260	210	239
120	195	234	185	215	250	301	240	276
150	220	262	210	240	280	336	270	308
185	240	298	235	273	305	381	300	350
240	270	344	275	316	345	441	345	405
300	295	387	305	355	375	496	385	455
400	325	458	335	420	400	586	425	538
500	345	495	-	-	425	635	-	-
630	390	555	-		470	710	-	-
800	440	625	-	-	-	-	-	-
1000	490	685	-	-	-	-	-	-

Rating Factors for Variation in Ambient Air Temperature			
Air Temperature (oC)	40	45	50
Rating Factor (XLPE)	1.00	0.94	0.88
Rating Factor (PVC)	1.00	0.90	0.81

Table No 7/4

Minimum laying Depth of cables (IS: 1255)

S.No.	Voltage level of cables	Minimum depth from top of the cable
1	Up to 1.1 kV	750 mm

2	3.3 kV to 11 kV	900 mm
3	22 kV to 33 kV	1050 mm
4	At road crossing	1000 mm
5	At railway crossing (from Bottom of sleepers to Top of pipe)	1000 mm

Notes below Table No 7/4:

1.	PVC Insulated electrical cable for voltage grade up to 1.1 kV is based on 8 volts drop.
2.	The distances are given in meters and after rounding.
3.	The distances are given in meters and after rounding.

For Temperature Correction please see as detailed below:				
Ground temp.	20 degree C	25 degree C	30 degree C	35 degree C
Rating factors:	0.95	0.90	0.85	0.80

Table No 7/5

Distance up to which different sizes of UG Aluminum Conductor Cables 1.1 kV grade, can be used for different current ratings of 8 Volts drop. (PVC insulated, PVC Sheathed, 3 cores or 4 cores)

Maximum Conductor temperature – 70 degree C														
S. No	Current	Distance in meters for the following cable sizes in Sqmm												
	Amp	6	10	16	25	35	50	70	95	120	150	185	240	300
1	5	165	260	415	725	895	1300	1925	2360	3065	3555	4300	5770	6460
2	10	80	130	205	360	450	650	960	1180	1530	1775	2150	2885	3230
3	15	55	85	140	240	300	430	640	785	1020	1185	1430	1920	2155

4	20	40	65	100	180	225	325	480	590	765	890	1075	1440	1615
5	25	30	50	80	145	180	260	385	470	610	710	860	1150	1290
6	30	25	40	70	120	150	215	320	390	570	590	715	960	1075
7	40	20	30	50	90	110	160	240	295	380	445	535	720	805
8	50	-	25	40	70	90	130	190	235	305	355	430	575	645
9	60	-	-	35	60	75	110	160	195	255	295	355	480	535
10	70	-	-	30	50	65	90	135	165	215	255	305	410	460
11	80	-	-	-	45	55	80	120	145	190	220	265	360	405
12	90	-	-	-	40	50	70	105	130	170	195	235	320	360
13	100	-	-	-	35	45	65	95	115	150	175	215	290	320
14	110	-	-	-	-	40	60	85	105	140	160	195	260	290
15	120	-	-	-	-	35	55	80	95	125	145	180	240	270
16	130	-	-	-	-	-	50	75	90	115	135	165	220	250
17	140	-	-	-	-	-	45	70	80	110	125	150	205	230
18	150	-	-	-	-	-	-	65	75	100	115	140	190	215
19	160	-	-	-	-	-	-	60	70	95	110	130	180	200
20	170	-	-	-	-	-	-	55	70	90	105	125	170	190
21	180	-	-	-	-	-	-	50	65	85	100	120	160	180

22	190	-	-	-	-	-	-	-	60	80	90	110	150	170
23	200	-	-	-	-	-	-	-	60	75	90	105	145	160
24	225	-	-	-	-	-	-	-	-	65	80	95	125	145
25	250	-	-	-	-	-	-	-	-	-	70	85	115	130
26	275	-	-	-	-	-	-	-	-	-	-	80	105	115
27	300	-	-	-	-	-	-	-	-	-	-	70	95	105

Cable Joints & End Termination Kits (LT/HT Cables)(JT/LT/HT)

Scope:

Specification No (CB-JT/LT/HT)

Providing straight through cable jointing kit of approved make and jointing cable as per the manufacturer's instructions and duly marking name of jointer and date.

Material:

Joint kit: Kit manufactured by reputed manufacturer with PVC moulds made in two parts, with epoxy compound, earth continuity lead of appropriate cross section having lugs at both ends, aluminum ferrules of the size of the cable, cross shaped epoxy spacer, MS clips for holding the moulds, adhesive for pasting the moulds.

Method of Construction:

Straight through joint Kit: LT/HT Cables

Before providing joint to the cable, the cable ends of the equivalent length of the joint moulds, shall be prepared by removing the outer PVC insulation along with the steel armouring. The ferrule shall then be inserted over the bare core of the cable, and shall be crimped with hydraulic / mechanical type heavy duty crimping tool. The crimped portion shall be wrapped first with the PVC insulation tape and then with the insulation tape used for wrapping HT conductor. The above method shall be carried out for all the cores strictly following the colour code. The leads of the both the cables now shall be placed into the mould by using the epoxy spacer, for having sufficient gap in-between the leads. The earth continuity lead shall be clamped

to the both ends of the cable. After covering the cable leads with the PVC moulds, the edges shall be clipped after applying the adhesive on the inside face of the moulds. The pasting of moulds shall be rigid and as far as possible leak proof, so that the epoxy compound shall not spill out. Now the duly stirred epoxy compound shall be poured and fill till the compound rises through the risers provided on the moulds.

After completing the above procedure, the joint shall be allowed to dry out for at least 8 to 10 hours (for epoxy compound to get hardened) depending upon the size of cable. Before connecting to supply, the dry and hardened joint shall be tested for its insulation level with 1000 V/ 5000 V Meggar.

The cable should be fixed or laid in such manner that there should not be pressure on end of moulds or on jointing position of cables

Outdoor/Indoor end termination Kit: LT/HT Cables

Before providing end termination kit to the cable, the cable end of the equivalent length of the moulds, shall be prepared by removing the outer PVC insulation along with the steel armouring. The ferrule shall then be inserted over the bare core of the cable, and shall be crimped with hydraulic / mechanical type heavy duty crimping tool. The crimping shall be done in such a manner that there shall be no air gap. Then the crimped portion shall be wrapped first with the PVC insulation tape and then with the insulation tape used for wrapping HT conductor. The above method shall be carried out for all the cores strictly following the colour code. The leads of the cable now shall be placed into the mould by using the epoxy spacer, for having sufficient gap in-between the leads. The earth continuity lead shall be clamped to theends of the cable. After covering the cable leads with the PVC moulds, the edges shall be clipped after applying the adhesive on the inside face of the moulds. The pasting of moulds shall be rigid and as far as possible leak proof, so that the epoxy compound shall not spill out. Now the duly stirred epoxy compound shall be poured and fill till the compound rises through the risers provided on the moulds.

After completing the above procedure, the joint shall be allowed to dry out for at least 8 to 10 hours (for epoxy compound to get hardened) depending upon the size of cable. Before connecting to supply, the dry and hardened joint shall be tested for its insulation level with 1000 V/ 5000 V Meggar.

Mode of Measurement:

Executed quantity will be measured on number basis. (i.e. each).

Cable Glands (GL)

Scope:

Specification Nos (CB-GL)

Termination of cable ends with cable glands for preparing and fixing the cable leads

for connection. Cable glands shall be of Flange type.

Material:

Cable glands: Flange type heavy duty. Made of high purity brass metal, with brass washers, rubber rings, threaded stud with washers and nuts.

Method of Construction

Before erection of gland, the cable end shall be prepared by removing the outer PVC insulation up to the point where gland to be fixed, by assessing the length of leads required. Bottom portion of gland shall be inserted over the steel armouring, and then armour strips shall be bent for the length of collar of gland, remaining length of armoring shall be cut. The cable end shall then be, inserted through the entry of plate where the cable is to be terminated. The top portion of gland with washer shall be then inserted in such a manner that the bent armour strip should be touching the surface of the entry. The nuts shall be tightened with spring washers over the projected stud portion. Fixing of gland shall be at right angle to the gland plate. Tightening shall assure continuity of earth. Hole to the gland plate shall be punched / knocked out, of correct diameter with respect to gland size.

Mode of Measurement:

Executed quantity will be measured on number basis. (i.e. each).

Cable Indicator Plate (CIP)

Scope:

Specification No (CB-CIP)

Providing and fixing of cable indicator plate along the route of under ground cable.

Material:

Cable indicator plate: Circular plate made of cast iron having 100 mm dia. and 6 mm thick.

Iron rod for fixing of cable indicator plate: 700 mm long galvanized iron rod of 12 mm dia., and 150 mm long cross bar welded at bottom or hook to be made with same continuous bar.

Method of Construction:

Cable indicator plate fixed/welded to the 700 mm long iron rod or angle, with 150 mm cross bars welded at bottom as fasteners or bent in 'J' shape to hook the cable in the bent portion, shall be buried along the route of cable in the trench made for laying the cable. For clear visibility, the Cable indicator plate shall be buried in such a manner that the

plate should be minimum 200 mm above the ground level and shall be provided at every 15-25 metre in straight run, at both ends of road crossing and immediate before and after turning point of cable.

Mode of Measurement:

Executed quantity will be measured on number basis. (I.e. each).

Street Light Boxes (SB) Cable Lugs (Aluminum & Copper)

Scope

Specification Nos (CB-CL/AL, CB-CL/CU)

Crimping of lugs, and fixing to the terminals with nuts and bolts, etc.

Material:

Lug: Lug shall be of high purity aluminum / copper / bimetallic of required type, with required size of hole and smooth finished both from inside and outside.

Hardware: Brass or Cadmium plated mild steel nuts and bolts, bimetallic washers.

Anti-Oxide paste: Paste of superior quality manufactured by reputed manufacturer.

Method of Construction:

Before fixing of lugs to the cable end, the cable end to the equivalent length of the lug shall be prepared by removing the outer PVC insulation along with the steel armouring and then, the inner PVC insulation. The paste shall be applied to the cable lead and inside the lug prior to the inserting of lug on the cable lead. The lug shall then be crimped with hydraulic / mechanical type heavy duty crimping tool. The crimping shall be done in such a manner that there shall be no air gap. Then the crimped portion shall be wrapped with the PVC insulation tape. (Colour of tape shall be of that of cable lead)

The above method shall be carried out for all the cores. The cable end with lug shall then be terminated into the terminal and then be tightened with either brass nuts or Cadmium plated nuts as directed by Engineer in-charge.

Mode of Measurement:

Executed quantity will be measured on number basis. (i.e. each).

CABLE TRAY & ACCESSORIES

Scope

Scope of these specifications covers the design, material selection, fabrication, testing at manufacturer's works, insurance, packing, transportation, loading/unloading, supply at site and installation of cable trays, trunking(Raceway) and accessories covered herein.

Material and construction (Cable tray)

Cable trays and accessories shall be manufactured to comply with the specifications of

National Electrical Code (NEC) and National Electrical Manufacturers' Association (NEMA).

Cable trays and accessories shall be fabricated using mild steel sheets and hot dip galvanized in accordance with B.S.729 after fabrication. All bolts, nuts and washers shall also be galvanized. The zinc coating shall be uniform, smooth and free from imperfections such as flux & ash, black spots, blisters etc. Cable trays and accessories shall undergo a process of degreasing, pickling in acid & cold rinsing prior to galvanisation.

Cable trays shall be of the following type:

i. Ladder type with rungs

ii. Perforated type.

Perforated cable trays shall be generally of channel type and the perforations shall be

10x30 mm oval holes. Perforated cable trays shall also be galvanised. Galvanising shall be in accordance with that specified above for ladder type cable tray.

Ladder type cable trays shall be made from min 1.6mm thick sheet formed in `C' section of

75/100mm height and inward flanges of 15mm as side runners and 30mm wide x 10mm high rungs (`C' shaped) from a 1.5mm thick sheet. Perforations as mentioned above shall be provided in the width of the rungs. Pitch of the rungs shall not exceed 250 mm center to centre. Rungs shall be tack welded to the side members.

The thickness of sheet steel for perforated trays shall be 1.2 mm and they shall be of the formed channel shape.

Cable trays shall be of following dimensions as specified in BOQ.

Accessories

Following accessories and hardware, as required, shall be supplied with cable trays :

¾ Coupler plates

¾ bends

¾ Tees

¾ Reducers

¾ 4-way cross

¾ Fasteners (Hardware)

Testing at manufacturers work

The material for cable trays and accessories shall be offered for stage inspection by the Owner as follows:

¾ Prior to fabrication and galvanising.

¾ After fabrication but before galvanising.

¾ After galvanising but prior to dispatch.

During inspection, thickness of sheets, dimensions and weight of zinc coating will be measured. Items not conforming to specifications shall be rejected.

Octagonal Poles (OPL)

Scope:

Specification No (OH-PL/OPL)

Supplying and erecting 3 m high galvanised octagonal pole details are as specified below.

Material:

3 m high galvanised Octagonal pole with details of given below.

Particulars	
Material	Galvanised as per specification
Top and bottom Dia. Thickness	100 mm A/F and 200 mm A/F thickness 3mm HT plate

Bracket	1500 mm long decorative sword type single / double arm bracket

Method of construction:

The pole shall be erected in provided cement concrete foundation specially designed. Erection shall be in plum.

Mode of Measurement:

Executed quantity will be measured on number basis (i.e. each)

Brackets (BKT) Pole Bracket (Cross arm) (OH-PL/BKT)

Scope:

Specification No (OH-PL/BKT)

Supply and erection of MS Pole Bracket for erection of L T insulators on provided pole.

Material:

Pole Bracket: MS pole bracket fabricated as per specifications in Table 8.4/1. Thickness and size of channel is to be checked from the steel table.

Table No 8.4/1

Details of Pole Brackets

Item No	Material of bracket	Length	No of insulator	No of insulat	Guarding Extension	Remark

8-4-1	Angle iron 50x50x6 mm	550 mm	2	2		For LT guarding for vertical formation
8-4-2	Angle iron 50x50x6 mm	750 mm	2	2		For LT guarding for horizontal formation
8-4-3	ISMC Channel 75x40x 6.8 mm	550 mm	4	4		For LT 3 phase 4 wire vertical formation
8-4-4	ISMC Channel 75x40x 6.8 mm	750 mm	5	5		For LT 3 phase 5 wire vertical formation
8-4-5	ISMC Channel	550 mm	2	2		
8-4-6	ISMC Channel	1100 mm	4	4		
8-4-7	ISMC Channel 75	550 mm	2	2	300mm of	
8-4-8	ISMC Channel 75	1100 mm	4	4	300mm of same channel	

D' type Clamps: MS Flat of 50x6mm, 15 mm MS nut bolts

Paint: Silver paint, Red oxide paint

Method of construction:

The cross arm shall be made up of size of channel mentioned in above table. The length shall be as stated above table. The cross arm shall be complete with pole

clamp of size 50X6 mm MS flat and holes required for pin / shackle insulator. For MS

pole bracket with guarding extension, an extension piece of same size of length 300 mm shall be welded to bracket as per drawing attached herewith. The cross arm and pole clamp shall be painted with one coat of red oxide and two coat silver enamel paint any other colour paint (as per the instructions of engineer in-charge).

Cross arm shall be fabricated

.

Mode of Measurement: Executed quantity will be measured on number basis. (i.e. Each)

Plate / Pipe type Earthing

Plate type Earthing (With or Without CI Cover, Funnel, etc) (EA-EP)

Scope:

Specification No (EA-EP)

Supplying and erecting galvanised cast iron / copper earth plate type / G.I. pipe type earthing with / without C.I. cover as per instructions from the site engineer.

Material:

Earth Plate: Galvanised cast iron / Copper earth plate or G.I. pipe as per specifications given in Table No 9.1/1.

CI Cover: As per specifications given in Table No 9.1/1.

Earthing Conductor: Copper/G.I strip/Annealed bare copper wire/G.l. earth wire of size as per specifications given in Table No 9.1/1.

GI Pipe: As per specification (CW-PLB/GP) mentioned chapter no. 17.5 for watering, and as enclosure for Earth wire, refer specifications given in Table No 9.1/1.

Hardware: Screw / nut bolts with required washer of dimensions, Rawl plug / clip/ 'U' nails and material as per specifications given in Table No 9.1/1.

Filling material: Coal /Charcoal/ salt as per specifications given in Table No 9.1/1.

as per specifications given in Table No 9.1/1.

Lugs: As per specification (CB-LG/AL, CB-LG/CU) mentioned chapter 7.9 & 7.10 Copper/ Aluminium lugs as per specifications given in Table No 9.1/1.

Method of construction:

Pit is to be dug of required dimension and depth for the earthing at site, and laying of Galvanised cast iron / Copper earth plate or G.I. pipe shall be as per Table No 9.1/1. The earth connection to equipment/ switch gear and earthing electrode shall be connected as shown in the diagram and as per IS 3043 amended up to-date. The connections shall be made either by strip or double run of earth wire with drilling, welding, riveting, brazing and nut bolting to plate or pipe, where ever required in an approved manner. As far as possible continuous strip shall be used, but where ever jointing of strip is unavoidable, the overlap portion must not be less than 21/2 times the width of the strip either welded/ brazed/soldered by all sides or 6 inches overlap with two nut bolts/ riveting of adequate size with required washer and covered by anti-corrosive paint as per approved jointing practice in the industry and as per directives from site engineer in charge.

Pit shall then be filled with screened soil with alternate layer of coal and salt, and if, necessary brick masonry work (Where ever applicable) shall be done as specified in IS: 3043, with laying wires in PVC/ G.I. pipe and watering arrangement as per and covered with C.I. Cover (Where ever applicable).

Where ever requires or as specified by Site Engineer, a Test link shall be provided for facilitating the testing of resistance of earth electrode.

Testing:

The value of each earth electrode shall be measured by earth tester in presence of site Engineer and record to be submitted.

Mode of Measurement:

Executed quantity will be measured on number basis (i.e. each

Table No 9.1/1

Detailed Specifications of various types of Earthing

Type of earthing ---------->		Galvanised cast iron earth plate type without C.I cover	Copper earth plate type with C.I cover	Galvanised cast iron earth plate type with C.I cover	Pipe type earthing with out C.I cover
S.No.	Particulars				
1	Depth from top of plate Up to Ground level	1.5 m	1.5 m	1.5 m	1.5 m
2	Size & type of material for pipe / Plate type earthing.	Cast iron earth plate size 60x60x0.6 cms	Copper earth plate size 60x60x0.6 cms	cast iron earth plate size 60x60x0.6 cms	'B' grade G.l. pipe 40mm. dia. 2.5 mtr. Long or 20 mm dia. G.l. Rod
3	Salt/charcoal	30 Kg. charcoal and salt each	30 Kg. charcoal and salt each	40 Kg. charcoal and salt each	N A
5	Type of Wire	Double G.l. wire 8 SWG	Double G.l. 8 SWG	Double G.l. 6 SWG	double G.l. 8 SWG
	Wire enclosure	12mm. dia. G. l.	12mm. dia. G. l. pipe 2	12mm. dia. G. l.	N A

		pipe 2 mtr. Long	mtr. Long	pipe 2.5 mtr. Long	
7	Nut bolts	12 mm dia. Cadmium / GI	12 mm dia. Cadmium / GI	12 mm dia. Cadmium / GI	N A
8	Washers	GI	GI	GI	N A
9	Watering pipe	19mm. dia. G.l. pipe	19mm. dia. G.l. pipe	19mm. dia. G.l. pipe	N A
10	Lugs	Yes	Yes	Yes	Yes
11	funnel	No	yes	yes	N A
12		No	yes	yes	N A

Low Impedance Earthing (Pipe in pipe technology) (EA-EPP)

Scope:

Specification No (EA-EPP)

Supplying and erecting approved type earthing system with Pipe in pipe technology with necessary ancillary materials and complete erection as per instructions from the site engineer

Material:

GI Pipe: As per specification no. (CW-PLB/GP) mentioned chapter 17.5;

50 mm dia x 3 meter long (In place of traditional GI pipe Earthing), for LV / MV applications.

Or

80 mm x 3 meter long (In place of traditional copper plate Earthing), for HV/EHV applications.

Earthing Conductor: G.I strip/GI earth wire of size as per specifications given in Table No 9.1/1.

GI Pipe: As per specification no. (CW-PLB/GP) mentioned chapter 17.5 for watering and as enclosure for Earth wire, as per specifications given in Table No 9.1/1.

Hardware: Screw / nut bolts with required washer of dimensions, Rawl plug / clip/ 'U' Nails and material as per specifications given in Table No 9.1/1.

Filling material: Coal /Charcoal/ salt as per specifications given in Table No 9.1/1.

as per specifications given in Table No 9.1/1.

Lugs: As per specification no. (CB-LG/AL, CB-LG/CU) mentioned in chapter 7.9 & 7.10 for Copper/ Aluminium lugs and as per specifications given in Table No 9.1/1.

Method of construction:

Earthing Pipe in pipe technology with ancillary materials shall be done by digging an 8" / 10" dia hand bore 10.5' deep sufficient to install the electrode in normal soil conditions. The space between the soil and the electrode is filled up with electrolyte material mixed with the dug out mother soil, along with water and tightly packed up to the base of the terminal. In rocky areas and under hard soil and sandy soil conditions the method of installation will be as specified by manufacturer. Installation shall include drilling, welding, reverting, brazing and nut bolting pipe when ever required in an approved manner with required material such as nut bolts and washer etc. and with necessary brick masonry work as per the specification. (As per IS 3043 amended up to-date). As far as possible continuous GI strip shall be used but when ever jointing of strip is un avoidable, the jointing over lap portion must not be less than 21/2 times the width of the strip either welded/ brazed/soldered by all sides or overlap of 6 inch with two nut bolts/ riveting of adequate size with required washer and covered by anti corrosive paint as per approved jointing practice in the industry and as per directives from site engineer in-charge.

Testing:

The value of each earth electrode shall be measured by earth tester and record to be submitted.

Mode of Measurement: Executed quantity will be measured on number basis i.e. each

Diesel Generator (DG)

Scope:

Specification No (GEN-DG)

Providing D.G. Set at site, carrying out all preparatory works, assembling, installing, making adjustments, confirming all pre-commissioning requirement as per manufacturer's instructions, commissioning, final testing, putting in to operation and handing over of the complete system of D.G. set including inspection from inspectorate office. The work include necessary minor Civil works including opening on wall/Slab/floor and making good as it was etc. & comprehensive maintenance of the DG set for 1 year from date of commissioning.

Material:

Diesel Generator set with continuous rating, 3 Phase, 415 V., 50 Cycles A.C. supply

of specified capacity, comprising of totally enclosed air/water cooled diesel engine

with standard control panel & tool kit

Diesel Engine:

The engine shall be of standard design of original manufacturers. It should be a totally enclosed air/water cooled Diesel engine with 4 stroke multi cylinders developing suitable BHP (As per Table 11/3) for giving power rating of (As per table 11/3) at the load terminals of alternator at 1500 R.P.M., at armature temperature of 400 C for height at 1000 Meter above M.S.L. at 50% R.H. The engine shall be capable of delivering specified power at variable loads for P.F. of 0.8 (lag) with 10% over load available in excess of specified output for one hour in every 12 hours. The average load factor of the engine over period of 24 hours shall be 0.85 for power output. The engine shall confirm to IS: 10000 and Amended up to date.

The engine shall be fitted with following accessories:-

1) Dynamically balanced fly wheel.

2) Necessary flexible coupling and guard for alternator and engine applicable

3) Lubricating oil cooler

4) Air cleaner Dry/Bath type

5) Lubricating oil pressure gauge

6) Lubricating oil filter with replicable element

7) Dry exhaust manifold with suitable exhausts heavy duty residential type exhaust silencer and vertical hot air duct both logged with asbestos rope exhaust piping of required length to reduce noise level.

8) 12/24 V. Electric starting equipment complete with standard batteries, dynamo, cut-out, ammeter, necessary wiring, self starter etc. The system shall be capable of starting D.G. set within 20 to 30 second even in winter condition with an ambient temperature down to 00 C.

9) Mechanical Governor of Class A2 for up to and including 200 KVA capacity and electronic governor of Class A1 for capacity above 200 KVA shall be provided as per standard design of manufacturer. Governor shall be a self contained unit capable of monitoring speed.

10) Radiator

11) Daily fuel Tank

Daily fuel service tank of minimum capacity as per Table 11/1, below, fabricated from M.S. sheet with inlet, outlet connections air vent tap, drain plug and level indicator (gauge) M.S. fuel piping from tank to engine with valves, unions, reducers, flexible hose connection and floor mounting pedestals, twin fuel filter. The location of the tank shall depend on standard manufactures design.

Table 11/1

Sr. No	Capacity of D.G. set	Minimum Fuel Tank Capacity
1	100 KVA	225 Ltrs.
2	320 KVA	500 Ltrs.

Minimum capacity of Daily fuel tank for Generators

Engine Control Panel:

Engine control panel should be fitted with following accessories/indicators and shall have display:-

Start/stop key switch

Lube oil pressure indication

Water temperature indication

RPM indication

Engine Hours indications

Battery charging indication

Low lube oil trip indication

High water temperature indication

Over speed indication

Battery Charger:

The battery charger shall be of Trickle & Boost type, and suitable to charge required numbers of batteries at 12V/ 24 Volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter, voltmeter, battery over charging protection with audible alarm. Connections between the battery charger & batteries shall be provided with suitable copper leads with lugs.

Battery:

Battery capacity and copper cable sizes for various engine capacities shall be as per the details given in Table No 11/2. Cable sizes shown are for maximum length of 2m length, if higher size of cable is required, it shall be selected in such a way that voltage drop does not exceed 2 V.

Stack Pipe & Exhaust system:

The DG exhaust pipe of required size & height shall include all required MS supports with 2 coats of primer & 2 coats of non-flammable paint, accessories & civil foundation. The DG exhaust pipe shall have height: min 52mtr, Material: ERW B Class with Aluminium

cladding of 0.6mm thick as per IS to avoid heat input to the room, Density: not less than 120kG/m3. Pipe should avoid any load & stress on turbo charger & Should be able to create minimum pressure with necessary supports. 45 deg down ward cut shall be given at the end of the pipe if tail end is horizontal. Rain trap shall be given at the end of the pipe if the tail end is vertical. The civil foundation & structure shall be verified & approved from liasoned Structural Engineer before & after execution. It shall comprise of following parameters: Exhaust system should create minimum back Pressure, Smooth bends shall be used for minimizing the back pressure, Minimum number of bends shall be used for minimizing the back pressure. Pipe sleeve of larger diameter should be used while passing the pipe through concrete wall & gap shall be filled with felt lining. Exhaust piping inside the Acoustic enclosure / Generating set room should be lagged with asbestos rope and covered with aluminum sheet cladding to avoid heating of the area. The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet / windows, etc.

Table 11/2

Battery Capacity and Copper Cable Sizes for Various Engine Capacities

S.No.	D G Set Capacity	Battery Capacity (AH)	Copper Cable size in mm2	Electrical System (Voltage)
	Upto 25 kVA	88	35	12
	Above 25 kVA upto 62.5 kVA	120	50	12
	Above 62.5 kVA upto 82.5 kVA	150	50	12
	Above 82.5 kVA upto 125 kVA	180	50	24
	Above 125 kVA upto 500 kVA	180	70	24

For AMF applications, a static battery charger working on mains supply recommended to keep the batteries charged at all times.

Alternator:

Alternator of specified rating, 415 Volts, 1500 RPM, 3 Ph, 50 HZ, A/c Supply with P.F 0.8 lagging at 400 C armature temperature for height 1000 mtr. Above MSL at 50 % R.H.

alternator shall be brush less type self regulated having static excitation system having capacity of desired output confirming to IS: 4722-1968 with automatic voltage Regulation + 5% operated voltage from no load to full load, two numbers of earth terminal on opposite sides. Terminal box shall be suitable for underground cables and

same shall be with stand mechanical and thermal stresses developed due to any short circuit at the terminals. The alternator shall be in accordance with following standards:-

IS: 4722 The performance of rotating electrical machines

IS: 4889 Rules for method of declaring efficiency of electrical machines

IS: 13364 Part I 1992 Alternator-voltage Regulation up to 20 KVA

IS: 13364 Part II 1992 Alternator Voltage regulation above 20 KVA to 80 KVA

Performance:

Voltage dip shall not exceed 20 % of the rated voltage for any step load or transient load as per IS: 8528 (Part I). The winding shall not develop hot spots exceeding safe limits due to unbalance of 20% between any two phases from no load to full load.

The performance characteristics of the alternator shall be as below:-

(a) Efficiency at full load o.8 P.F.

(i) Up to 25 KVA- not less than 82 %
(ii) Above 25 KVA and up to 62.5 KVA- not n 86 %
(iii) Above 62.5 KVA/upto 250 KVA- not less than 90 %
(iv) Above 250 KVA- not less than 93 %

(b) Total Distortion factor Less than 3 %

(i) 10 % Overload One Hour in every 12 hrs of continuous operation
(ii) 50% overload 15 seconds.

Common Base Plate:

Engine and alternator shall be coupled by means of flex plate/flexible coupling as per manufacturer standard design and both units shall be mounted on a common base plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The base plate shall be suitable for installation on suitable anti-vibration mounting system comprising of 6 anti-vibration pads duly provided.

Control Panel:

Floor/wall mounted control panel Box comprising of voltmeter, ammeter, selector switches MCCB/MCB of adequate capacity, indicator lamp duly wired with HRC fuses. Alternator & control panel shall be connected with provided suitable capacity armored cable with necessary cable glands & lugs etc.

Factory Testing:

DG set shall be tested in presence of Engineer in charge or his authorized representative in the factory for following before dispatch;

Full load trial for 12 hour. Fuel, lubricating oil, etc shall be arranged by the agency.

10% overload trial for one hour within 12 hrs test.

Certificates:

Manufacturer's test certificates for Engine, Alternator and of the set.

Necessary certificate for the engine model so selected along with compliance of noise and emission norms as per latest CPCB guidelines for D.G. set should be furnished from the manufacturer along with manufacturer's technical details.

Permission from Electrical Inspector.

Method of Construction:

The DG Set with canopy shall be erected with due care and ensuring the perfect level with the help of Sprit level, on provided cement concrete foundation and connecting the provided earthing connections. The exhaust system shall be connected to the exhaust manifold. After ensuring the filling of fuel, lubricating oil and medium of coolant, the set shall be commissioned, with giving necessary full load trials or with the available load at site. The set shall then be handed over to the department along with the installation report given by the manufacturer and with all the necessary certificates and permissions obtained.

Mode of Measurement: Executed quantity will be counted on number basis. (i.e. each)

Excavation (EXN)

A) Cable Trench(CTR)

General

This part of specification deals with the preparation of trenches in soft soil, hard murum, BT road, and laying of cables inside the trench, etc as per IS: 1255.

Scope:

Specification No (CW-EXN/CTR)

Excavating in all types of soil strata and making trench for laying cable/cables, providing sand bed for laying the cable, covering cable with specified material as per requirement, and finishing the same by making the surface proper with crown on top of the trench.

The following list shows Indian Standards, which are acceptable as good practice, and accepted standards.

SP 30: 1984 : National Electrical Code

SP 7 (Group 4): 2005 : National Building Code

IS 1255: 1967 : Code of practice of Installation & Maintenance of armoured cables up to 33 kV.

Material:

Bricks: Solid Clay bricks of minimum size 225x110x62.5 mm (L x B x H), burnt in the kiln, of good quality.

Sand: Screened sand of good quality.

Method of Construction:

Trench in Soft soil / Hard Murum / Tar road: Single run of cable

Before excavating the soil for preparing trench, route of cable laying shall be got finalized from the site in-charge. Trench of minimum 300 mm width shall be excavated up to minimum depth below the ground surface as per Table No 17.1/1 Bottom of the trench should be carefully levelled and freed from stones. Cable duly straightened shall be laid flat and embedded in the 200 mm layer of screened sand at the bottom of the trench. Bricks shall be laid all over the run of cable as specified below:

Lengthwise for cable up to and including 10 Sqmm of all cores.

Width wise for cable above 10 Sqmm of all cores.

Remaining portion of the trench shall be back filled with the excavated material after removing stones and sharp / hard material, and making the surface proper. Crown of 150 mm shall be provided over the trench. The remaining excavated material shall be removed from site and dumped in scrap yard of Local authorities or at suitable place.

Trench in Soft soil / Hard Murum / Tar road: Two or more cables run of cable

Before excavating the soil for preparing trench, route of cable laying shall be got finalized from the site in-charge. Trench of minimum required width more than 300mm. shall be excavated up to minimum depth as per Table No 5, below the ground surface. Bottom of the trench should be carefully levelled and freed from stones. Cables duly straightened shall be laid flat and embedded in the 200 mm layer of screened sand. The inter-axial

distance between two cables shall be between 230 and 400 mm. at the bottom of the trench. Bricks shall be laid all over the run of cable as specified below:

Lengthwise for cable up to and including 10 Sqmm of all cores.

Width wise for cable above 10 Sqmm of all cores.

Remaining portion of the trench shall be back filled with the excavated material after removing stones and sharp / hard material, and making the surface proper. Crown of 150 mm shall be provided over the trench. The remaining excavated material shall be removed from site and dumped in scrap yard of Local authorities or at suitable place.

Trench in Soft soil/Hard Murum/Tar road with half round Hume pipe:

(For cables of size 25 Sqmm. and above shall be covered by min. 150 mm. dia. of RCC Hume pipe)

Before excavating the soil for preparing trench, route of cable laying shall be got finalized from the site in-charge. Trench of minimum required width more than 300mm. shall be excavated up to minimum depth as per Table No 5, below the ground surface. Bottom of the trench should be carefully levelled and freed from stones. Cables duly straightened shall be laid flat and embedded in the 200 mm layer of screened sand. The inter-axial distance between two cables shall be between 230 and 400 mm. at the bottom of the trench. Inverted 150mm. dia. Half round RCC Hume pipe shall be laid above full length of cable. For more than one cable higher size or more number of Hume pipes are to be provided.

Remaining portion of the trench shall be back filled with the excavated material after removing stones and sharp / hard material, and making the surface proper. Crown of 150 mm shall be provided over the trench. The remaining excavated material shall be removed from site and dumped in scrap yard of Local authorities or at suitable place.

As per 3.1 above, in place of bricks, the cable of size 25 sq.mm and above shall be covered with 150 mm dia. half round Hume pipe.

Mode of Measurement:

Executed quantity shall be measured on the basis of running meter per run of cable.

Table No 17.1/1

Minimum laying Depth of cables (IS: 1255)

S.No	Voltage level of cables	Minimum depth from top of the cable
1	Up to 1.1 kV	750 mm
2	3.3 kV to 11 kV	900 mm

3	22 kV to 33 kV	1050 mm
4	At road crossing	1000 mm
5	At railway crossing (from Bottom of sleepers to Top of pipe)	1000 mm

TECHNICAL SPECIFICATIONS FOR UNINTERRUPTABLE POWER SUPPLY SYSTEM (10-80 KVA UPS) :

GENERAL:

This section includes specifications and description of requirements of 3 phase uninterruptible supply (UPS) for providing high quality A.C. power for Computers, Servers & lighting loads.

SCOPE :

The scope shall include design, supply, installation, testing and commissioning of the complete UPS system and related accessories including

i) Supply of complete UPS system as per specifications.

Supply of Load and Battery sharing panels / Battery circuit breakers as required.

Supply of sealed maintenance free Batteries (VRLA) with Battery racks for 15 minutes Backup with necessary Battery Racks.

Complete shop testing of all systems including harmonic analysis, UPS operation under linear and non-linear load condition etc.

Delivery at site, handling, installation of complete system including interconnection from the UPS system to batteries and to input / output panels switches. All interconnections shall be done using multistrand ZHLS/FRLS flexible Cu. conductor cables of appropriate sizes. Outgoing neutral cables shall be of double capacity.

Complete testing of system on load.

Service backup by engineer till system is fully operational as and when required.

Supply & installation of cable trays with supports for cable laying in scope.

Working drg. & As built Drawing submission.

FUNCTIONAL & STATUTORY REQUIREMENTS :

The system shall be 3 phase Input, combined 3 phase Output, static ON LINE double conversion configuration UPS with all latest functional facilities.

The system shall comply all IEC regulation minimum for installation and relevant IS standards, statutory requirements.

Complete Electronic and switching assemblies shall be mounted in one single metal cabinet 14SWG CRCA sheet fabricated and powder coated (RAL 7032) finish with due ventilation. The degree of protection unless otherwise specified shall be IP 52.

The operating height for UPS should not be more than 1800 mm from finished floor level.

SYSTEM SPECIFICATION :

UPS Configuration:

The system requirement are as follows:

25/40 KVA, 3 phase input - 3 phase combined output with 15 Minutes Battery backup.

UPS systems shall be IGBT based with latest facilities and RS 232 /RS 485 interface card with potential free contacts for attaching it to BMS system for central monitoring. Necessary software shall be provided for monitory of UPS from central BMS system.

Each UPS module shall have Two input main connection with a single output connection, Mains 1 shall consist of an IGBT rectifier, DC Booster converter, IGBT Inverter and DC Battery connection passing to output. Mains 2 shall consist of a connection to the output through no break static switch.

Each UPS module shall have its own dedicated battery capable & delivering constant UPS output power to match KVA at 0.9 leading or 0.9 lagging power factor.

Configuration: The system shall have following operation features.

Normal Condition: Mains supply the load with power flowing from the normal A.C. source through rectifier and inverter with battery-connected parallel with rectifier output. With no difference in phase angle between input & output.

Abnormal Condition: Whenever supply deviates on voltage, frequency or waveform beyond the specific limits, the battery bank supplies constant output for load through inverter.

The output supplied to the loads shall be constant without switching or disturbance, when the main A.C. Supply fails.

The same way when normal supply returns the inverter is synchronized with external source and load is transferred.

The rectifier shall also charge the discharged batteries on return of normal supply and shall automatically shift to float charge when batteries are fully charged.

When any UPS element fails and normal supply is available the static by pass switch shall switch the load directly.

The bypass switch operates in same way as above in case of UPS system fault and returns load to UPS system once fault is cleared.

Generator supply: The Ups system shall be suitable for continuous operation with the input supply delivered either from Electrical distribution Co. or Generator supply.

SYSTEM

Service Conditions: System should be able to operate in following environmental conditions without derating or damage.

Ambient temperature : O0 C to 500. C

Humidity : O to 95% relative.

Altitude : Upto 1000 mtr above mean sea level.

ii. Characteristics:

Input voltage shall be, 415 V 4 wire + Earth 3 Phase 50 Hzs.

Output voltage, 415 V 3 phase, 4 wire + Earth, 50 Hz.

iii. The system performance under steady state and transient load conditions shall remain within specified limits for entire backup period when supplied through batteries.

iv. The system performance under steady state and transient load conditions shall remain within specified limit for steady AC input voltage and frequency variations of ± 10% and 5% of rated values and harmonic contents upto 5% (max.) for nonlinear loads.

LOADS COMPATIBILITY

The UPS system shall be compatible with following loads and load characteristics.

a) Lighting : High intensity discharge and fluorescent lighting consisting 10% of UPS rating.

Computer & electronic Load with high harmonics upto 15% individual harmonics 5% of fundamental with aggregate load consisting 90% of UPS capacity.

PERFORMANCE :

i) Overall system efficiency shall be as follows.

At 100% Load : 92% or more

At 75% Load : 90% or more

At 50% Load : 86% or more

ii) Noise level: The normal noise level emanating from machine when measured at 1 mtrs under normal conditions shall be less than 60 Db.

iii) Maximum lnrush: Maximum inrush charging current shall be 6 times full load current.

Output voltage regulation for 50% unbalanced loads shall be 12% over full range of battery voltage. Out put frequency shall be 50 Hz ± 0.5%.

v) Maximum Harmonic contents shall be 5% of RMS total and 3% of RMS for single Harmonic.

Overload Capacity:

110% of full load for 60 min.

125% of full load for 10 minutes

150% for 60 seconds.

SYSTEM COMPONENTS

i) The device shall include solid-state rectifier / Battery Charger, Inverter, Static bypass, system controls with Hermetically sealed components. These components shall have suitable independent housing in cabinet.

ii) All assemblies shall be arranged for easy maintenance & plug-in modules & shall have adequate supports.

Transient voltage surge suppressors shall be provided for protection of components from transient & switching surges.

RECTIFIER CHARGE:

i) The IGBT rectifier shall be of adequate capacity to supply inverter output under full load conditions as well as overload condition & simultaneously charge the batteries from full discharged state.

ii) Inherent harmonics suppressions in the Rectifier design shall reduce the harmonic to less than 10% under all load conditions.

iii) Float charging requirements for battery bank as per manufacturer's recommendations for voltage & charging current shall be fulfilled.

iv) 3 phase self-cooled double winding dry type transformer with grounded electrostatic insulated shield between the windings shall be provided.

Input power factor : Input power factor shall be near to unity.

BATTERIES :

Batteries shall be Sealed maintenance free valve regulated lead acid (VRLA) Battery with life expectancy of minimum 8 Years, mounted on racks with battery disconnect & intercell connectors. Scope includes battery bank connections and providing safety Barriers for all busbars and cable connection leads on battery racks. The all capacity to provide the rated output for the specified time of 10 min for each module ageing factor applied i.e. 30 min autonomy of the end of life (8 years) (PTO). Each UPS battery shall be supplied with a separate circuit breaker in steel enclosing to provide battery isolator.

BATTERY CHARGER

Each UPS modules batteries shall have its own IGBI booster charger from its respective UPS module. Capable of recharging the batteries to full capacity within 8 hours on boost & 72 Hrs on trickle charger

INVERTER :

Pulse - width modulated with sinusoidal output.

The conversion from DC to AC shall be accomplished by a power transistor of the IGBT type.

Failure & any component or power stage shall not interrupt the AC output instead it shall disconnect itself from the configuration while transpiring the load to the static transfer switch and activate on alarm.

Static bypass switch shall be full rated continuous duty rated switch.

Maintenance bypass : The switch shall be located behind lockable door. Key interlock shall be provided for the bypass with the static bypass such that it can be operated only when SBS is in service.

PROTECTION & SHORT CIRCUIT:

The UPS module shall have built in protection against over & under voltage & power line surges fast acting current limiting device shall be used to protect against failure of solid state devices.

INDICATIONS & CONTROL:

All displays, indications, & basic system controls shall be provided on common control panel on front UPS cabinet, as listed below & shall be supported by sensors, transducers, Relays, wiring terminals as required. All indications shall be labeled with LED displays or plain language / LCD displays.

Quantity Indications :

Input voltage phase & line.

Input current phase & line.

Bypass input Voltage & frequency.

System output voltage phase & line.

System output current phase & frequency.

D.C. Bus voltage.

Battery current & direction.

Battery discharge elapsed time.

Visual Indications :

a) Normal operation.

Load on battery.

c) Inverter OFF.

d) Alarm condition.

Alarm Indications :

a) Input & Bypass A/C under voltage, over voltage, under frequency & over frequency.

b) Input / bypass input & inverter out of Synchronization.

c) Input & Bypass single phasing.

d) Input & Bypass reverse phase sequence.

e) Battery system alarm.

f) Control power failure.

g) Fan failure.

h) UPS overload.

i) Battery Operation end.

j) Battery under voltage shut down.

k) Battery charging control fault.

l) Isolation Transformer overheat.

Inverter overload.

Static bypass overheat.

Inverter fuse blow.

Inverter power supply fault.

Inverter O/P under voltage / over voltage.

Inverter contactor open.

Inverter sensor fault.

Control on front board.

a) Inverter ON - OFF.

b) UPS start.

c) Battery test - On line.

d) Alarm accept / reset.

e) Output voltage adjustment.

Complete mimic including single line diagram of UPS shall be provided on front board.

The metering instruments used shall be digital with 1 class accuracy.

On line battery-testing facility shall be provided as a feature when UPS is operating on normal mode. If the battery bank fails on test the load shall be automatically transferred to static bypass with alarm.

REMOTE MONITORING & CONTROL :

Facility & interface with modem & connectors for data transmission via RS 232 or equivalent link upto computer & BMS. Any software required for this shall be also be in scope along with training to clients system Engineers.

Interface card with potential free card shall also be provided as part of supply.

MECHANICAL FEATURES :

The enclosures shall be 14 SWG CRCA sheet treated & powder coated pertaing to IS 8623 and the colour shall be RAL 7032 unless otherwise specified.

Also redundant fans & blowers shall be provided such that fresh air is drawn from bottom & let out from top rear.

EARTHING : A copper earth bar should be filled along the full length of equipment. All part of the metal enclosed, gland plate shall be effectively connected to common earthbar braided bonding shall be provided across all hinges.

QUALITY TESTS :

Entire system shall be completely checked & tested for all functions, displays including;

Full load test.

Transient Analysis.

Over voltage test.

Power failure test.

Efficiency at 25%, 50%, 75% & 100% loads.

EXECUTION :

INSTALLATION :

The entire system shall be installed as per manufacturers recommendations & instructions including all interconnections for supply & control circuits.

A minimum working space shall be maintained around the equipment as per shop drawings, Consultant's reference drawings & relevant standards.

All components shall be clearly identified using labels including battery cells individually.

Services of authorized representative or manufacturer for supervision of installation, connections, testing, & adjustments shall be provided.

TESTING & COMMISSIONING:

Under supervision of manufacturer's representative all system functions, operations, protective features shall be checked & preset to ensure compliance or specifications.

Test the system as per recommendations & test listed below using precalibrated instruments preferably by third party inspection agency.

Load simulation.

Simulation of malfunctions to verify protective device operations.

Duration of supply on emergency. Low battery voltage alarm & shutdown, transfer & restoration of normal supply.

Harmonic contents of input & output current under all load conditions.

Remote status & alarm tests.

In case of test any shortfalls / faults, the same shall be rectified & test procedure shall be again repeated to establish satisfactory performance.

d) Record individual cell voltage & equalize the charging of the cells as per manufacture's recommendations.

CLEANING :

On completion of installation, testing of the system all components, cabinets etc. shall be cleaned & unwanted material, debris shall be removed from site. Scratches dents if any shall be cleaned & touched up to match the original finish.

DRAWINGS & MANUALS :

Following drawings & manuals / information shall be submitted in atleast THREE copies at appropriate stages & for handing over the system.

Manufacturer's data for product, features, components & performance along with the offer.

Operation & maintenance manual with;

List of recommended spares & replacement components.

Detail operating instructions covering operations in normal & abnormal conditions.

Shop drawings showing detail fabrication, assembly of components, internal & interconnecting wiring, dimensions, plans & views, installation details access & clearance eta for approval.

Product certificates for Brought out items.

Factory test certificates & Inspection report.

Field test reports.

AFTER SALES SERVICE :

Round the clock Service shall be guaranteed by supplier during defect liability period / guarantee period.

A certain minimum stock of spares shall be maintained by supplier at site.

Supplier shall also quote for 24 x 7 service through their authorized service engineer for a period of at least 3 years after guarantee period.

Supplier shall offer an unconditional guarantee of equipment for a

Period of 24 months against any failure.

DATA SHEET

FOR UPS SYSTEM

1	UPS Capacity & Configuration	:	30/80kVA, system with 30min. Battery Backup
2	Application	:	For Machine load
3	Input (Voltage & Freq.) Input Power Factor	:	415V, AC 3Ø & Neutral (± 10%), 50Hz (± 5%) >0.99
4	Output (Voltage & Freq.)	:	415V, AC, 3Ø & N, 50Hz
5	Output voltage regulation	:	For 50% unbalanced loads shall be 12% over full range of battery voltage. Output frequency shall be 50Hz ± 0.5%
6	Harmonic content	:	< 5% of RMS Total for non linear load & < 3% of RMS for single Harmonic
7	Crest Factor	:	3:1
8	Overall System efficiently	:	At 100% Load : 94% or more At 75% Load : 92% or more At 50% Load : 88% or more
9.	% Over load Capacity	:	125% of full load for 10 min & 150 % for 30 seconds

TECHNICAL SPECIFICATIONS FOR UNINTERRUPTABLE POWER SUPPLY SYSTEM (UPTO 5 KVA UPS) :

This part of the specifications covers the technical aspects of the Online UPS system for 1 to 10 kVA capacity.

Scope:

Specification No (AP-UPS)

Supplying, erecting, testing & commissioning of Online UPS with necessary safeties, etc.

Material:

Equipment manufactured as per standard manufacturer's specification and as tabulated in Table No. 3.7/2. The unit housed in powder coated CRCA sheet enclosure with following

fault protection on mains / UPS mode:

Under voltage on mains mode

Over voltage on mains mode

Charger protection on mains mode

Overload on UPS mode

Short circuit on UPS mode

Low battery on UPS mode

Battery reverse on UPS mode

Under voltage on UPS mode

Over voltage on UPS mode

LED & LCD display for above fault protection

Alarm for above fault protection

Batteries shall be of Sealed Maintenance Free type (Tubular). The selection of number of batteries required shall be as per Table No 3.7/1

Table No. 3.7/1

Details of Batteries required for the UPS in respect to the Backup Period.

kVA	DC Voltag e	Output	No of SMF Batteries	Back Up Period 15				
1kVA	36V	0.7	3	17AH	2 X 17AH	42AH	65AH	100AH
2kVA	96V	0.7	8	17AH	26AH	42AH	65AH	100AH
3kVA	192V	0.8	16	17AH	17AH	26AH	42AH	65AH
5/6	192V	0.8	16	17AH	26AH	42AH	65AH	100AH
8kVA	240V	0.8	20	17AH	26AH	42AH	100AH	2X 65AH
10kVA	240V	0.8	20	26AH	42AH	65AH	2X 65AH	2X 100AH
A)	The Batteries considered are Sealed Maintenance Free Batteries							
	The Batteries need to be placed in Ambient Temperature of 20Deg C -							
C)	The UPS is considered to be working @ 90% Load of its capacity							

Table No. 3.7/2

Specifications & Standard Parameters of On Line UPS

The UPS shall comply with specifications as indicated in the following table:

S.No.	Specifications / Features	Standard Parameters
1	Technology	True online Double Conversion design
2	Input voltage range	160 V to 270 V for 1 Phase Input
3	Input power factor	Near unity Power factor
4	Generator compatibility	Yes (1.2 times the UPS rating)
5	Nominal input frequency	50 Hz +/- 6 %
6	Rectifier type	Advance Rectifier with inbuilt APFC (Advance Power Factor Compensated) for 1 Phase.
7	Output Voltage	230 V AC +/- 1 % for 1 Phase Output. 400 V AC (380/415 selectable) for 3 Phase & Neutral
8	Total Harmonic distortion	1 Phase Output < 3 % for Linear load < 5 % for Non-linear load
9	Overload Capacity	110 % for 10 Seconds & 130 % for 2 Seconds for 1 & 2 kVA UPS
10	Inverter	IGBT based PWM with Digital control
11	Crest Factor	3: 1 for 1 & 2 kVA UPS.
12	Static Bypass	Automatic bypass switch facility
13	Display	Should be User friendly with LED & LCD display
14	Output Power factor	0.7 lag to Unity within kVA & kW rating.
15	Load in terms of PC per kVA. (PC with 15" CRT	3 PC's per kVA (for 1 & 2 kVA UPS) 5 PC's per kVA (for 3 to 10 kVA UPS)
16	Battery type	SMF / Thick plate / Tubular
17	DC Voltage	1 kVA – 36 V, 2 kVA – 96 V, 3 & 5 kVA – 192 V
18	Battery charger current limit	1 & 2 kVA – 6 A, 3 & 5 kVA – 4 & 6 A,
19	Ambient temperature	450 C
20	Noise level	< 50 db @ 3 metres
21	Testing standards	IEC 62040 Part III
22	Isolation Galvanic	Isolation transformer from 3 to 10 kVA

Mode of Measurement: Executed quantity will be measured on number basis. (I.e. each

LV PANEL BOARD

Rated Insulation Voltage Ui	:	Upto 1000 V
Frequency	:	50 Hz
Frequency variation	:	±3% of the nominal value
System design fault level (sym.)	:	50KA for 1 sec
System earthing	:	Solidly Earthed
Rated Impulse Withstand voltage Uimp :	:	12kV/8kV
Degree of Protection	:	IP54

Applicable standards

The equipment proposed in this offer has been designed, manufactured, and tested according to the relevant IEC recommendations.

IEC 61921 / IS 16636 – 2017 - Low-voltage power factor correction banks

IEC 61439-1/2 Low voltage switchgear &controlgear assemblies – Part 2Power switchgear and controlgear assemblies

IEC61641-ed 3 Enclosed low voltage switchgear and controlgear assemblies Guide for testing under conditions of arcing due to internal fault

IEC 60529 Degrees of protection provided by enclosures

IEC 60947-2 Low voltage switchgear &control gear – part 2 Circuit breakers

IEC 60947-3 Low voltage switchgear &control gear – Part 3 Switches, disconnectors, switch-disconnectors & fuse combination units

IEC 60068 Environmental testing

IEC 61140 Protection against electric shock – Common aspects for installation and equipment – Basic safety publication

IEC 60947-4-1 Contactors and motor starters LV Equipment Mandatory Specifications

Mandatory Safety Standards and tests

To ensure safety of the persons and equipment, each rating of the switchboard must be type tested recently in accordance with IEC 61921, IS 16636 : 2017, IEC 61439 - 1 & 2. The testing must have been performed in the independent laboratories witnessed by competent authorities of international repute.

All the performance type tests must be done with the device mounted inside the switchboards and shall be considered applicable for that particular make only. In case the make is changed separate test must be conducted. Test certificates must be available for inspection before the quotation is made

This is a Mandatory specification for low voltage switchboard dedicated for large installations comprising of LV Main distribution boards and Sub - distribution applications and motor control Centers. The specifics of site conditions and special applications are mentioned separately in the annexures This equipment is desired to be installed indoors in the substation or the specific rooms or shop floor. The LV Equipment shall be flexible, made of several type of panels to be coupled with each other for various applications with specifically rated horizontal busbars and vertical busbars for particular vertical section. For personal and equipment safety against accidental touch, each feeder must have Pre-designed finger proof metallic or molded barriers.FRP/Hyles shrouds will not be acceptable under any circumstances.

Pre-designed Metallic barriers between feeder chambers, Busbar chambers and cable compartment. All the openings between these compartments must be properly sealed and shrouded.

As per IEC 61921, IS 16636:2017 type tested design metallic partitioning in ensure safety of during operation and maintenance. Metallic partitions on the cable termination must be designed for easy termination of the cable sizes mentioned in the BOQ/ SLD. It should easily possible to reassemble the form partitions after terminations of the cable.

Differentiated locks (& Keys) for Feeder compartment, Cable compartment and Busbar compartment.

Several interlocking systems as mentioned elsewhere in this specification or special requirement to prevent inadvertent operation.

If, specific environmental conditions are mentioned (e.g. Corrosive, conductive, highly humid or outdoor), supplier must submit the processes to be followed to avoid adverse effect on the working of the switchboard.

Manufacturing Unit - Systems, Safety and Green Initiatives. The Supplier manufacturing unit must have statutory and quality system standards certification

ISO 9001 Quality Management Systems (QMS)

ISO 14001 Environment Management Systems (EMS)

OHAS18001 Certification for occupational health and safety.

LV equipment shall be modular, metal enclosed pre-engineered, comprehensively type tested as per IEC 61921, IS16636:2017, IEC61439-&2, to house switchgear devices of reputed makes as specified and as per the BOQ/SLD.

General

The switchboard shall be metal enclosed, free standing, floor mounting, compartmentalized, extendable on both sides, modular type, suitable for indoor installation with dust & vermin protected.

The switchboard shall complies to latest edition of IEC 61439-1&2, Test certificate shall be issued by a reputed authority.

The equipment shall be suitably constructed for safe, proper and reliable operation without undue wear, corrosion, heating or other operating trouble.

Panel builder shall produce valid licensed agreement made with original manufacturer.

The weatherproof housing shall be manufactured from Hot Galvanized Iron confirming to international specification and suitable for mounting on a flat concrete base or pier 300 mm above ground level.

The enclosure frame shall be from OEM. The frame shall be of bolted design made of Galvanized iron with 9 fold structure for better rigidity and strength with 275GSM. No welding frame to be considered.

All the load bearing members shall be made of GI sheet steel and it shall be of a totally enclosed design with cables entering from the Top/bottom and secured by cable cleats or glands and maintains equipotentiality of the switchgear.

The housing shall be arranged for front access/Rear access by means of hinged doors which shall be screwed to secure them.

All openings/corners shall be smooth without burrs, smooth. The openings for passing control wires and cables shall be smoothened or provided with suitable rubber gaskets. Doors and covers shall be provided with gasket to ensure specified IP degree.

All hardware shall be treated to achieve resistance to corrosion. Joints and connections shall be made using high quality 8.8 grade steel bolts, nuts & washers. Specific washers shall be used to ensure effective continuity.

The switchboards shall be formed using distinct vertical panels comprising of different compartments

Full metal sheet shall be provided between two adjacent vertical panels running up to full height of the switchboards.

All the meters,CTs, auxiliaries pertaining the feeders will be housed together in the same compartment respecting the connection rules, clearances recommended by standards and the manufacturers guidelines. For the ACB feeders however, the protection relays, other auxiliaries like control/selector switches, meters etc. shall be mounted in a separate compartment near to the breaker compartment with proper labelling

The rated impulse withstand voltage of the system shall be 8kV for ACB & MCCB feeders for total panel.

The Electrical Panel shall have a rated short time withstand current of 50 kA for 1 second

The busbar will be designed for mounting on insulated supports that are sufficient in number to accept the flow of peak short circuit current upto 254kA.

The switchboard Main distribution panel shall restrict the internal arcs faults within the compartment to ensure maximum safety to the operating personnel and also to minimize the downtime for replacement and repairs. Type test certificate shall be carried out to verify the arc containment within the compartment for 50kA, 0.3sec as per IEC 61641.

The Switchboard shall have Seismic withstand of Zone –IV.

Even under extreme condition of short circuit or Mal-operation there will be no danger in the vicinity of the assembly.

The switchboard shall be with Outer glass door with gasket to prevent from accidental / unauthorized operation of switchgears.

The glass should be of minimum 4mm thick which should comply Mechanical impact of IK-09.

The doors should be with pre-assembled handle (reversible) with 4 closing points must be used, double tongue standard type with locking system must be chosen.

No hylam sheets to be used for segregation, GI sheet is preferable.

KIOSK arrangement

The KIOSK should comply minimum IP55 with rear accessibility.

The KIOSK shall be equipped with breather without defeating the Ingress protection for better air ventilation inside the KIOSK. And shall be provided with rain canopy

Rear accessible is required (i.e) Rear cover can be opened for accessing the panel. The panel KIOSK door & Panel door should match in order not collide each other while opening the doors.

The thickness of the sheet shall be 1.6mm.

The panel shipping section & Kiosk should not be problem during erection of the panels at site. Also ease during cable termination

The KIOSK door shall be fitted with door stiffeners.

Quality assurance

The panel manufacturer should have ISO 9001certification. And shall have a minimum experience of 10years in the field of switchgear assembly. Enclosure system and switchgear components shall be from the same manufacturer

The entire switchboard shall be of bolted design to avoid welding cracks in case of welded design.

The switchboard shall be of modular kit design for easy transportation and assembling at site by which Quick and error free assembly can be achieved.

Finger touch proof design ensures highest safety to maintenance personnel.

Enclosure manufacturing

The switchboard shall be factory manufactured by OEM or manufactured by authorized Franchisee of OEM based on design given by OEM.

The switchboard shall be complete design verified assemble as per IEC 61439-1&2.

The enclosure protection shall not be less than IP-52 unless other specified in BOQ.

The switchboard shall be modular, extendable cubicle, fully compartmentalized and floor mounting.

The form of separation shall be Form-4, a modular individual mounting arrangement shall be used and the internal separation shall be carried out using GI sheets with 275GSM.

The switchboard frame (Uprights) shall be pre-punched and bent with minimum 1.5mm thickness and fitted with a multipurpose hinge, used to assemble the door and to couple the structures, both laterally and rear.

Base/top steel sheet painted (epoxypolyester RAL 7035 orange peel), with inlet/outlet for cables. They are supplied pre-mounted by means of a three-way joint, which is able to provide considerable structural rigidity.

The switchboard construction should be with universal width which can be used for both Incoming vertical as well as outgoing feeder vertical.

Zinc coating will be provided on the sheets which will prevent rust formation during storage and handling for processing, in addition to giving corrosion protection to the finished product.

The GI sheet used in the enclosure shall be 275gsm.

The sheet steel used for the enclosure manufacturing will pass through the pretreatment process for surface treatment.

The outer doors and cover shall be Poly urethane gasket to prevent from ingress of duct.

The glass should be of Tempered glass to avoid sharp edges in case of damage.

External and internal painting with electrostatic application of thermosetting powder enamel with epoxy polyester binders. Grey orange peel RAL 7035 colour, total thickness of min 80 micron.

The painting should pass the resistance test to saline fog (min 193 hours)

The switchboard shall have integral base frame.

The doors and covers shall be made of CRCA sheet steel of thickness as per OEM standard

Switchboard Configuration

The switchboard shall be configured with Air Circuit Breaker, Moulded case circuit breaker, MPCB, MCB, Contactors and other equipment's as per BOQ.

The MCCBs shall be arranged in multi-tier formation. The incoming Air Circuit breaker shall be arranged in single tier formation only but double tier formation can be arranged to facilitate operation and maintenance which is applicable to only outgoing ACBs only.

The switchboards shall be adequate size with a provision of spare space to accommodate possible future additional switchgear.

Special care has to be taken to ensure effective earthing of the frame and doors if the switchboard.

All panels and covers shall be properly fitted. The unused holes in the panel shall be closed with suitable grommet.

The panel has to be provided with “Danger” label confirming to relevant standard.

Switchboard Compartmentalization

The switchboard shall have separate totally enclosed compartment for main horizontal busbar, vertical busbars, ACBs, MCCBs and Cable chamber.

The switchboard shall be with Form 4b construction.

Insulated shutters shall be provided between drawout and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be atleast IP 2X.

Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker “ON” and “OFF” position.

For incoming vertical separate and adequate compartments shall be provided for accommodation instruments, indicating lamps, control contactors and control MCB etc.

Outgoing MCCBs “ON” and “OFF” operation can be performed only after opening the door.

Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only.

A suitable wire wat with cover shall be provided to take interconnecting control wiring between vertical section.

Incase of dead front access panel separate cable chamber and vertical chamber to be provided for easy maintenance.

In case of rear access panel cable compartment can be provided in the rear only for outgoing vertical with sufficient space for easy termination. The incoming and outgoing cables can either entering from bottom or top depending on the site requirement.

Proper cable support shall be provided in cable compartment to support and clamping the cable.

Switchboard Busbar

Busbar shall be made of high conductivity Aluminium of ETP grade busbar and shall be of rectangular cross section.

The busbar shall be suitable for full load current for phase busbar and half/full rated current for neutral busbar or as stipulated in BOQ.

The busbar system shall be designed as per the pre-defined guidelines provided by the

original manufacturer.

The fault level rating ofthe busbar system shall be as per the drawings however the minimum short circuit withstand capacity shall be 50KA RMS for 1second.

The busbar system shall be type tested by the manufacturer at reputed laboratory for short circuit withstand capacity. The neutral and earth busbars shall also be type tested for the short circuit withstand capacity.

The busbar system shall be supported adequately at regular intervals as per OEM guidelines based on the type test results on a specially designed busbar supports. The supports shall be independently fixed to structure to strengthen the busbar arrangement. Wherever required additional intermediate supports shall be provided between the busbars.

All vertical droppers shall also be adequately supported as per the manufacturer guidelines and the test results. The Vertical busbars shall be connected to the main busbars by suitable sized and graded bolt & nut and contact washers.

The busbar shall be supported on Non-breakable, glass reinforced polyamide 6.6 insulated supports able to withstand operating temperature of 140OC.

The busbar support should qualify glow wire test of 690OC.

The supports shall comply UL 94 safety of Flammability Plastic Materials for Parts.

The busbar support should withstand the impulse voltage of 12kV.

The material and busbar support spacing should be same as per the type tested assembly.

The minimum clearance to be maintained for enclosed indoor air insulated busbar shall be as per IEC guidelines.

The dimensioning of the busbar system shall be as per the rated current of the mainswitching device, the short circuit current, the maximum rated permissible temperatureat permanent operation and the ambient temperature around the busbars. The selection of busbars shall be supported by calculations and recommendations from the OEM.

The neutral busbar shall run along with the phase busbars. Neutral busbar running at bottom or in the cable chamber/alley will notbe accepted in case of Form-4 construction.

Earth busbar shall be running throughout the panel fitted directly on to the structure for

connection of the protective conductors to provide equipotential bonding of exposedconductive parts. Earth busbar shall be located at the bottom of the panel incase of bottom entry and top of the panel incase of Top entry.

All non-current carrying metallic components shall be permanently connected to earth.

Hardware used for busbar connections shall be zinc plated, yellow passivated / bichromated steel of 8.8grade. Tightening of busbar bolts shall be done as permanufacturer recommendations and pre-defined guidelines using calibrated torque wrenches.

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirement. The material for auxiliary supply bus will be insulated electrolytic copper. Wires.

With aluminium bus bars, only aluminium wire/solid bar connections shall be made for incoming/outgoing mountings on the switchboards.

With copper bus bars, only copper wire/solid bar connections shall be made for incoming/outgoing mountings on the switchboards.

The cross section of the neutral bus bar shall be the same as that of the phase bus bar for bus bars of capacities upto 200A; for higher capacities, the neutral bus bar must not be less than half the cross-section of that of the phase bus bar.

Each bus bar shall be suitably insulated with PVC sleeves/tapes.The insulation of the rising mains shall be capable of withstanding the voltage of 660V of A.C

Bus bar has to be as per TTA design of OEM .

Bus bar support insulators shall be class *F insulators made of non- hygroscopic, non-combustible, track resistant and high strength FRJP/ SMC/DMC material, and shall be of suitable size and spacing to with stand the dynamic stresses due to short circuit currents. The spacing between two insulators should not exceed 250 mm.

The minimum clearance to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as follows:

Between Min. Clearances

Phase to earth 26mm

Phase to phase 32mm

For strip connection from bus bars to switchgear, the above clearances don't apply.

Bus bar joints shall be thoroughly cleaned and suitable oxidizing grease shall be applied before making the joint.

High tensile bolts, plain and spring washers shall be pro-vided to ensure good contact at the joints.

The overlap of the bus bars at trie joints shall be not less than the area of the cross section of the bus bars.

Bus bars and main connections shall be marked by color or letter as per table shown below.

Sr. No			
i)	ThreePhase	Red,Yellow,Blue	RY.B.
	TwoPhase	Red,Blue	R.B.

Sr. No			
	SinglePhase	Red	R
ii)	Neutralconnection	Black	N
iii)	Connectiontoearth	Green	E
iv)	Phase variable (such as	Grey	Gy.

Instruments

Instruments shall be digital flush mounting type. Digital Load Managers shall be provided for the parameters as indicated in the SLD and B.O.Q. Energy meters shall be suitable for 3 phase 4 wire unbalanced load. Energy meters shall be mounted flush and gaskets shall be used for making the door cut-out dust tight.

All meters unless otherwise specified shall be with RS485 port and necessary software for parameter display at remote PC shall be provided by vendor along with the panels/meters.

Electrical indicating / measuring instruments shall be of 96 x 96 mm Digital MFM unless otherwise specified. These shall be mounted semi-flush with only flanges projecting. All meters shall be 1 accuracy class unless otherwise specified.

Current Transformer

Current transformers as specified in drawing shall be provided for each circuit conforming to relevant IS : 2705. CTs shall be epoxy resin cast with bar primary or ring type and shall be mounted on fixed portion of the switchgear cubicle. Facilities shall provided for short circuiting and earthing of CT secondary leads at the terminal blocks. Also test links, shall be provided in CT secondary leads to carry out current and phase angle measurement tests with CTs. in service.

Class I accuracy for metering and Class 1 and 5P10 for protection with rated burden of 15/30 VA on secondary.

Error limit to specific class of accuracy.

Current transformers shall be designed to withstand the thermal and mechanical stresses resulting from fault currents equal to the maximum interrupting and momentary current ratings respectively of the circuit breakers.

Insulation level of the CTs shall correspond to the voltage level of the switchgear. CTs shall have polarity marks indelibly marked on CT terminals and at the associated terminal blocks.

The arrangement of mounting and supporting the CTs shall be such as to take care that tracking along insulator surface from busbars to CT supporting metal clamps, cleats and bolts resulting - over shall be avoided.

Meters and Indicators

The meters and relays shall comply the following: -

MISC type with Class – I accuracy.

Ammeters, Voltmeters, with 96 x 96 mm size flush mounting type with selector switches and back up fuses

Maximum Demand electronic meters with integration time of 30 minutes, wherever specified.

Indicating lamps shall be LED type with control MCB. All indicating lamps shall be colour coded.

Relays

Relays shall conform to IS: 3231 and shall be mounted semi flush with only flanges projecting on the front. All protective relays shall be in drawout cases with built - in test facilities. Necessary test plugs shall be the contractor. Test blocks and switches when supplied separately, shall be located immediately below each relay for testing. Auxiliary relays and timers shall be in non-drawout cases. All protective relays shall be provided with externally hand reset, positive action, and operation indicators.

Wherever the relays external to ACBs are specified, they shall comply the following features:

Inverse time characteristic with minimum time over current having 50 – 200% setting.

Instantaneous earth fault having 20-80% setting.

Direct acting trip coil to suit 5A CT secondary and with time delay dash pot or TC fuses.

Shut trip coils to have necessary DC power source with associated charger.

Discrimination of operating characteristics for trips and delay elements with up and down streams switchgear.

Testing of relays by primary injection and secondary injection.

Enclosed in dust proof flush mounting drawout type cases.

Accessible for setting and resetting from the front.

Provided with positive acting hand-reset flag indicators visible from the front.

Access to setting devices shall be possible only after the front covers are removed. Access to resetting shall be external to the case.

Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage.

Each relay shall be provided with at least two separate voltages from contacts. Make and type of relays shall be as approved by the Engineer.

Control & Selector Switches

Control and instrument switches shall be of the rotary type provided with plates engraved with switch operating positions and suitable for semi - flush mounting with only the switch front plate and operating handle projecting out. The contact assembly at the back of the switch shall be fixed and accessible from the back.

Control switches shall have momentary contacts, spring return to center with pistol grip handles. Instrument and selector switches shall have stay put contacts with oval knurled handles. Three number of contacts, their rating and their operation in each switch shall be as per the requirement of the connected circuit and the control schematics. Controls supply 240 V, 1Ø A.C. for vacuum contactor and control circuit shall be tapped after main

switch but before power fuses and P. T. shall be provided for each meter feeder with necessary protection.

Annunciators

Annunciators when specified shall have audible alarm and visual display through translucent plastic window of 50mm x 65mm (minimum) size engraved with appropriate function in block letters on each windows. “Acknowledge” “Reset” and “Lamp Test” pushbuttons with alarm buzzer shall be provided common for the annunciation system in the relay compartment of switchgear.

On receipt of an alarm impulse, audible alarm shall be sounded and lamps inside appropriate window shall start flickering. On pressing of “Acknowledge” button the audible alarm shall stop sounding and lamp shall glow steady. By pressing the “Reset” button, the trouble lamp shall not reset unless the alarm condition has disappeared. Annunciator shall provide sealed in lamp indication and audible alarm shall be ready to operate for any new alarm condition immediately after audible alarm is reset for a previous alarm condition.

Cable Termination

For power cables, cable boxes with cable pot heads/sealing ends shall be provided in the switchgear in a separate compartment to suit the types, sizes of cables shown in cable schedule. Connecting leads of adequate size with terminal clamps/lugs, shall be supplied for connecting cable box terminals to switchgear power terminals.

For control cable entry to each switchgear cubicle, separate removable type gland plate shall be provided with cable through to lead these cables upto the control terminals. Gland plate and control cable through shall be adequately sized for the number of control and instrument cables emanating from the cubicles.

Space Heater & Receptacle

Each switchgear cubicle shall be provided with space heater rated for 230 V, single phase, A.C. Supply. The capacity and location of these space heater inside switchgear cubicles shall be such that temperature through out the cubicle section is maintained at least 5 deg. C above dew point by common thermostats to prevent any moisture condensation. MCB shall be provided inside each switchgear cubicle to control the power supply to the space heaters.

Each switchgear cubicle shall be provided with one, 3pin receptacle - plug with on-off switch rated for 5 Amps, 240V, 1 phase A.C. supply along with 10W lamp

Internal Wiring

Switchgear shall be supplied completely wired internally to equipment and terminals and ready for external cable connection at the terminal blocks. All wiring for controls and instruments shall be carried with 1100/660 volts grade PVC insulated copper conductor wires of minimum size 2.5 Sq.mm. Wire terminations shall be made with solder less, crimping type & copper lugs which firmly grip the conductor and insulation. Engraved

core identification yellow colour plastic ferrules marked to correspond with switchgear wiring diagram shall be fitted at both end - terminations of all the cubicle internal wiring.

Spare contacts of relays, control switches, auxiliary contacts of circuit breakers etc. Shall be wired to terminal blocks. At least 10% of the terminals shall be provided as spare for future use. Terminal blocks shall be 650 V grade, rated for minimum 15 Amps and complete with insulating barriers, terminal stud, washers, nuts and lock nuts and identification marks. Each terminal shall be suitable to receive 6.0 sq.mm. conductor.

Control and space heater supplies will be provided at one point in switchgear cubicle for each line up to switchgear. In each cubicle and running the entire length of line up of switchgear, control wiring through shall be provided to carry the interconnecting wires between cubicles and the common control and space heater buses. Also inter-cubicle wiring for interlocks and controls shall be carried out through this wiring through. These wires shall be suitable terminated and tagged between transport sections.

Potential free contacts shall be provided for each breaker for ON / OFF Trip signal for IBMS system as standard.

Earthing

All vertical panels shall be connected to a copper /GI earth bus bar running throughout the length of the switchboard.The minimum earth bus size shall be50x6 mm. All doors and movable parts shall be earth educing flexible copper connections to the fixed frame of the switchboard. Provision shall be made to connect the earthing busbar to the platform earthing grid at two ends.All non-current carrying metallic parts of the mounted equipment shall be earthed.The washer used for earthing connection shall be specific type to ensure &goodearthing connection.

Name Plate

Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

Painting

All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Pre-treatment shall be doneusine 9-11 tank process. The content of the tank shall be regularly checked for concentration and phvaluerecords of this shall be subject to inspection. After pretreatment sheet shall undergo Powder coating to achieve Uniform thickness of 70-120 microns.

Interlocks

It shall not be possible to push "in " a drawn out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.

It shall be possible to operate a circuit breaker only in the defined “Full in” or "Service" and "Test' position inside the panel. It shall not be possible to operate the breaker in intermediate positions while inserting or withdrawing circuit breaker.

Tests

Inspection and shop testing for all panels as per IS Standard shall be offered to consultant/owner's representatives. The tests to be done shall include: Physical checking, Megger/insulation resistance, (1000V Megger), H.V. test Functional tests including control and interlock functions, Automatic operation simulation etc. Any such tests required by local authorities, Electricity Boards and for complying statutory requirements.

AIR CIRCUIT BREAKER

General:

The air circuit-breakers are constructed and tested in accordance with the international IEC/EN 60947-2 standards. The breaker shall provide the class II insulation between front panel and internal power circuits to avoid an accidental contact with the live main current carrying path with the front cover open.

The circuit-breakers shall have a rated service voltage of 690 V AC and a rated insulation voltage and impulse withstand voltage 1000 V & 12 kV respectively;

The short-circuit capacity shall be ICU=Ics=Icw=100% and Icw value shall be declared for 1 sec and circuit breakers are of category B.

The mechanical life shall be at least 12000 operations and tested as per IEC 60947-2 standard requirements.

The electrical life of air circuit breaker shall be at least 8000 operations up to 2500 A & at least 5000 operations up to 4000 A and are tested in accordance with IEC 60947-2 standard requirements.

The air circuit breaker shall have operating temperature from -25 °C ...+70 °C and shall not have any derating up to 50°C in free air when tested as per product standard.

Construction characteristics

ACBs shall be available in the 3 & 4 pole versions in withdrawable versions and shall be capable of providing short-circuit, overload and earth fault protection through microprocessor-based unit.

The circuit breaker shall have double insulation and suitable for isolation with marking so as to guarantee maximum operator safety;

Minimum degree of protection shall be offered IP30 shall be guaranteed on the front when mounted on the switchboard

The circuit breaker cradle shall be designed and constructed to permit smooth withdrawable and insertion. The movement shall be free of jerks, easy to operate and positive.

It shall be possible to signal at least with 4 electrical contacts mounted on the circuit breaker the status of the circuit breaker or information related to the trip unit. In addition digital input shall be available to command specific actions on the breaker up to 15 auxiliary contacts.

For withdrawable breakers the positions (connected, test, isolated) of the moving part shall be clearly indicated. It shall be possible to fit the circuit breaker with

A device which permits the opening of the compartment door only when the mobile part is in racked-out position or test;

A device which permits to freeze the mobile position when the door is open

All terminals shall be changeable from horizontal to vertical position and the vice versa at site to suit the bus bar orientation if required

All Acbs, control wiring shall be accessible from the front along with all accessories and the terminal box shall offer spring clamps which helps user to make the wiring easier and safer.

It shall be possible to install the electrical accessories without removing the cover shielding the command;

There shall be a provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of ACB.

It shall not be possible for the breaker to be withdrawn from the cubicle when in the ON position and to achieve the same suitable mechanism shall be provided to lock the breaker in the tripped position before the breaker is isolated.

It shall not be possible for the breaker to be switched ON until it is in the fully inserted position.

It shall not possible for the circuit breaker to be plugged in unless it is in the OFF position

Key lock and padlock shall be provided in the open position of circuit breaker, racked in/ test/ racked out position.

The circuit breakers provided with special locks that allow the moving part to be inserted into the corresponding fixed part.

A safety latch shall be provided to ensure that movement of the breaker as it is withdrawn, is checked before it is completely out of the cubicle, thus preventing its accidental fall due to its weight.

All EDO ACB's shall have ready to close contact to ensure that ACB gets a command only when it is ready to close for applications of remote control, AMF, synchronization and auto source change over systems/

Operator safety

Operating Mechanism

The circuit breaker shall trip free with in dependent manual spring operated or motor wound spring operate mechanism with mechanical ON/OFF indication.

The circuit breaker shall provide with in-built mechanical and electrical anti-pumping mechanism.

The closing time shall be less than or equal to 40ms to ensure faster closing of the breaker.

The operating handle and mechanical trip push button shall at the front of and integral with the circuit breaker. The handle shall be placed within the breaker itself in order to have access whenever required in case of emergency

The circuit breaker shall have the following distinct and separate positions which shall be indicated on the face of the circuit breaker

Service – Both main and secondary isolating contacts closed

Test – Main isolating contacts open and secondary isolating contacts closed

Isolated – Both main and secondary isolating contacts open

The operating mechanism remains untouched/segregated and protected whenever accessories are installing inside the breaker from the front side of the breaker.

Protection Releases

The microprocessor release shall provide on the breaker for against overload (L) (40 to 100% of In), Selective short-circuit (0.6 to 10 times In), and earth (10% to 100% of In) fault with adjustable setting and time delays with inverse and definite time charactestics along with instantaneous short-circuit protection (1.5 to 15 times In) and release shall be true RMS sensing with EMC/EMI capability.

The release shall not require auxiliary power supply for the protection function or fort the alarm indication.

The release shall have in-built battery that enable indication of the cause of the fault to be view for an unlimited time after tripping.

The release shall have wide touch screen display with possibility to view the maximum parameters. It shall also have bar graph with touch screen to indicate individual phase loading and identify whether all phases are evenly loaded.

Incomer feeder breaker

Protection, measurement & diagnostic function

Protection function	Measurement data	Maintenance data
The releases shall be suitable for zone selectivity without any external device and shall be part of breaker protection unit. Thermal memory for functions L and S shall be available by default. The additional protections shall be provided in addition to the basic protection as follows Under and over voltage protection Under and over frequency Restricted earth fault protection Load shedding and insertion through programmable contacts Reverse power, undercurrent and phase sequence reversal protection etc.. The protection release shall have self-monitoring system with LED indication (in case of malfunction) within the release itself.	The release should have the following measurement functions such as - Current (class 1), - Voltage (Class 0.5), - Power (Class 2) and Energy - Power factor, frequency and peak factor, Harmonics (up to 50th order) includes current and voltage both. • Maximum values and value log; • Data logger; The Network Analyzer function performs continuous monitoring of the energy quality, and shows all results via a display or communication module. In particular: Hourly average voltage value Interruptions / short dips in voltage Short voltage spikes Slow-voltage sags and swells Voltage unbalances: Harmonic analysis:	Information on trip and opening data If a trip occurs, protection unit stores all the information that is required for rapid identification and elimination of the causes: • Protection tripped • Opening data (current, voltage or frequency) • Time-stamping (data, time and consecutive opening number) Maintenance indicators A complete set of information about the circuit breaker and its operation is available for effective fault analysis and preventive scheduling of maintenance. All the information can be seen from the display or from a PC using a communication unit. In particular: • Date, time, fault current by phase and type of protection tripped over the last 30 trips; • Date, time and type of operation of the last 200 events (example: opening/closing of circuitbreaker, pre-alarms, editing of settings, ect.); • Number of operations of the circuit breaker: divided into

		mechanical operations (no current), electrical operations (with current) and protection function (trip); • Contact wear estimated as a function of the number and type of openings; • Total operating time of the circuit breaker with circulating current; • Date and time of the last maintenance session, scheduling of the next maintenance session; • Circuit-breaker identifying data: type, serial number, firmware version, device name assigned by the user.

Outgoing circuit breaker

Protection, measurement & diagnostic function

Protection function	Measurement data	Maintenance data

Basic protection function of LSIG The releases shall be suitable for zone selectivity without any external device and shall be part of breaker protection unit. Thermal memory for functions L and S shall be available by default.	The release should have the following measurement functions such as - Current (class 1), - Voltage (Class 0.5), - Power (Class 2) and Energy • Maximum values and value log; • Data logger;	Information on trip and opening data If a trip occurs, protection unit stores all the information that is required for rapid identification and elimination of the causes: • Protection tripped • Opening data (current, voltage or frequency) • Time-stamping (data, time and consecutive opening number) Maintenance indicators A complete set of information about the circuit breaker and its operation is available for effective fault analysis and preventive scheduling of maintenance. All the information can be seen from the display or from a PC using a communication unit. In particular: • Date, time, fault current by phase and type of protection tripped over the last 30 trips; • Date, time and type of operation of the last 200 events (example: opening/closing of circuit breaker, pre-alarms, editing of settings, ect.); • Number of operations of the circuit breaker: divided

		into mechanical operations (no current), electrical operations (with current) and protection function (trip); • Contact wear estimated as a function of the number and type of openings; • Total operating time of the circuit breaker with circulating current; • Date and time of the last maintenance session, scheduling of the next maintenance session; • Circuit-breaker identifying data: type, serial number, firmware version, device name assigned by the user.

Auxiliary switch shall consist of min 4NO &4NC contacts. The total Auxiliary switch block shall have minimum six auxiliary. In case of draw out breakers two sliding contacts should be provided.

Shunt trips are used for remote control. Shunt trip coil should operate though an auxiliary switch. The operating ranges should be normally 50-110 % of the rated voltage.

Under voltage release must be energized before closing breaker. This should be provided for remote control.

Over current release shall consist of Current Transformer with slides on each current carrying path of a bi-metal relay common to all transformers. The transformer shall have a fix ratio suited to particular setting range.

Overload releases shall be thermal time lagged. Overload relay range shall be 50 % to 100 % of CT ratio. Frame shall facilitate site adjustment from 25-100% of ACB rating to match the load requirement.

RA unit - given for 0-110% operating range of SHT-ensures supply available to shunt trip from same AC source in short circuit condition.

RC unit – for up to 3secs. Time delay with U/V trip. Ideal for protection against transient voltage dips and nuisance tripping continuously adjustable time delay range of 40-500 ms with S/c trip ideal for selective interruption co-ordination of ACB's.

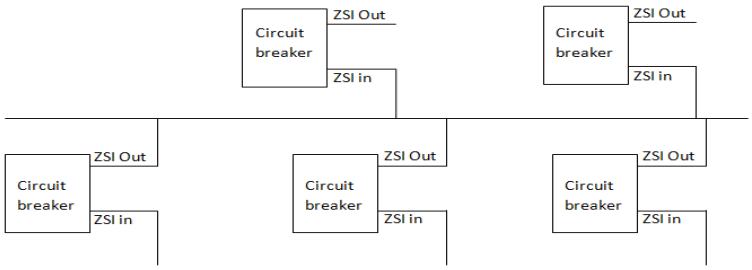
Contacts made of electrolytic copper of 99.9 % purity, of ACB shall be totally shrouded, for eliminating access to live parts.

Short Circuit release pick up shall be adjustable for closer protection.

Breaker shall be compact in size, for saving space in the cubicle & as far as possible shall be lightweight for easy handling.

Thermal over load and magnetic short circuit protection shall be provided.

ZSI Interlocking - Zone selective interlocking (ZSI) wiring ready. All ACBs in main LT panel shall surely be provided with zone selective interlocking which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate between incomer breaker and outgoing breakers enabling zone selective interlocking. The manufacturer shall supply all equipment required for ZSI viz. ZSI module, power supply and wiring connectors to implement ZSI etc. ZSI Wiring shall be done as shown below by Panel Builder.



Digital connectivity

The protection release shall be suitable for communication via Modbus TCP for incomer breaker and Modbus RTU for outgoing breaker. without using any additional external device or protocol converter. It shall be compatible for integration into SCADA system. The user should be able to integrate all LV devices and shall be able to control and monitor in the system remotely without accessing the devices manually. To guarantee the maximum safety, a redundant communication profile shall be provided. In case of switchboard monitoring, switchgear manufacturer shall able to provide cloud based compatible devices which make data enablement easy and provide asset monitoring.

Accessories

All suitable electrical accessories like coils, aux contacts, electrical interlock accessories shall be available for meeting the requirement for different purpose of logic of interlocks.

Mechanical accessories such as Key lock in open in position, locks for enabling racked in/racked out operations, Mechanical operation counter, compartment door interlock, Protection for opening and closing push button common for all frames as and when needed based on the design/project scope.

In case of switching between 2 sources or 3 sources or 2 incomes with bus coupler scenario, the manufacturer shall have cabled based interlock between the circuit breakers.

Following interlocks and features shall be incorporated for equipment protection and personnel safety:

Door interlocks to prevent opening of the door unless circuit breaker is in test or isolated position.

DATA SHEET

Description	MLTP Incomer & Breaker in Synchronising Panel.	MLTP Outgoing Feeder	Other Panel Incomer	Other Panel Outgoing Feeder
Release Type	Microprocessor Based	Microprocessor Based	Microprocessor Based	Microprocessor Based
Breaking Capacity	Ics=100% of Icu, Icw should be for 1 sec	Ics=100% of Icu, Icw should be for 1 sec	Ics=100% of Icu, Icw should be for 1 sec	Ics=100% of Icu, Icw should be for 1 sec
Method of Installation	Draw Out Type	Draw Out Type	Draw Out Type	Draw Out Type

Draw out Mechanism	EDO	EDO	EDO	EDO/
Nos. of Pole	4 Pole (100 % neutral)	4 Pole (100 % neutral)	4 Pole (100 % neutral)	4 Pole (100 % neutral)
	Note: Neutral CT should be provided in case of Ground Protection			
Protection	LSIG	LSIG	LSIG	LSIG
ZSI interlocking feature	Required	Required	Required	Required
Communication Module over Modbus TCP/IP	RS-485 / Modbus TCP/IP Port for following	RS-485 Port for following	RS-485 Port for following	RS-485 Port for following 1. Cause of Triping and interrupted fault current 2. Mech. Cycle 3. Electrical Cycle 4. Trip History20 no
	1. Cause of Triping and interrupted fault current	1. Cause of Triping and interrupted fault current	1. Cause of Triping and interrupted fault current	
	2. Mech. Cycle	2. Mech. Cycle	2. Mech. Cycle	
	3. Electrical Cycle	3. Electrical Cycle	3. Electrical Cycle	
	4. Trip History20no	4. Trip History20 no	4. Trip History20 no	
	5 - Contact Wear and tear (%)	5 - Contact Wear and tear (%)	5 - Contact Wear and tear (%)	5 - Contact Wear and tear (%)
Other	PFC for ON/OFF/Trip	PFC for ON/OFF/Trip	PFC for ON/OFF/Trip	PFC for ON/OFF/Trip
Utilisation Category	Class B	Class B	Class B	Class B
Circuit Breakers shall confirm to Electrical Standards	IEC60947-I &II, IS 13947	IEC60947-I &II, IS 13947	IEC60947-I &II, IS 13947	IEC60947-I &II, IS 13947
Rated Operational Voltage: Ue	690V, +10%	690V, +10%	690V, +10%	690V, +10%
Current Rating(In) of Circuit Breaker shall be declared at	50OC	50OC	50OC	50OC
Suitable for Isolation	Yes	Yes	Yes	Yes
Rated Insulation Voltage: Ui at 50 Hz	1000	1000	1000	1000

Rated Impulse withstand Voltage at Main Circuits	12 kV (Minimum)	12 kV (Minimum)	12 kV (Minimum)	12 kV (Minimum)
Rated Impulse withstand Voltage at Aux. circuits	4 kV (Minimum)	4 kV (Minimum)	4 kV (Minimum)	4 kV (Minimum)
Short Circuit Making Capacity-Max. Prospective Peak Current	Shall be equal to (Icu X 2.2)	Shall be equal to (Icu X 2.2)	Shall be equal to (Icu X 2.2)	Shall be equal to (Icu X 2.2)

Mechanical Feature				
ON/OFF Indication on ACB	Yes	Yes	Yes	Yes
Spring Charge Indication on ACB	Yes	Yes	Yes	Yes
Ready to Close Interlock on ACB	Yes	Yes	Yes	Yes
Contact Erosion Indicator on ACB	Yes	Yes	Yes	Yes
Position Indicators-Connected, Test, Isolated on ACB	Yes	Yes	Yes	Yes
Safety Shutters	Yes	Yes	Yes	Yes
Door Interlock	Yes	Yes	Yes	Yes
Microprocessor Based Release Functions				
True RMS Sensing	Required	Required	Required	Required
Overload (L) Protection With Setting	Ir=(0.4-1) X Inin steps of 2.5 % of In	Ir=(0.4-1) X Inin steps of 2.5 % of In	Ir=(0.4-1) X In in steps of 2.5 % of In	Ir=(0.4-1) X In in steps of 2.5 % of In
Short Circuit (S) with Time Delay setting	Isd=(1.25-12) X Ir and tsd=(0-0.8)sec.	Isd=(1.25-12) X Ir and tsd=(0-0.8)sec.	Isd=(1.25-12) X Ir and tsd=(0-0.8)sec.	Isd=(1.25-12) X Ir and tsd=(0-0.8)sec.
Instantaneous Protection (I)	Ii=Minimum 12In.	Ii=Minimum 12In.	Ii=Minimum 12In.	Ii=Minimum 12In.

Ground Fault (G) Protection with Alarm/Trip	Ig=(0.2-1) X In and tg=(0.1-0.5)sec.	Ig=(0.2-1) X In and tg=(0.1-0.5)sec.	Ig=(0.2-1) X In and tg=(0.1-0.5)sec.	Ig=(0.2-1) X In and tg=(0.1-0.5)sec.
Separate Fault Indication on Release	Required for L,S,I,G and Neutral	Required for L,S,I, and Neutral	Required for L,S,I, and Neutral	Required for L,S,I, and Neutral
Neutral Protection in 3 Pole ACBs	Required with the help of neutral CT.	Required with the help of neutral CT.	Required with the help of neutral CT.	Required with the help of neutral CT.
Neutral Protection in 4 Pole ACBs	Required with the help of neutral CT.	Required with the help of neutral CT.	Required with the help of neutral CT.	Required with the help of neutral CT.
Integral Test facility for testing healthiness of Release	Required	Required	Required	Required
LED Indication to show healthiness of Release	Required	Required	Required	Required
In Case of Failure of Release	LED Indication	LED Indication	LED Indication	LED Indication
Bypass circuit with Short Circuit protection in Case of release failure	Required	Required	Required	Required
Interlock	As specified in SLD	As specified in SLD	As specified in SLD	As specified in SLD
a) Bowden Wire	Yes	Yes	Yes	Yes
b) Castel lock provision	Yes	Yes	Yes	Yes
Under Voltage Coil with Continuous Rating and front Accessible	Yes	Yes	Yes	Yes
Shunt trip Coil with Continuous Rating and front Accessible	Yes	Yes	Yes	Yes
Closing Coil, front Accessible	In Case of EDO ACBs.	In Case of EDO ACBs.	In Case of EDO ACBs.	In Case of EDO ACBs.

MCCB

MCCBs shall be of micro processor based with RS 485 port or thermal magnetic as per SLD

All MCCB's shall be universal mounting line load interchangeable and with door interlock & handle. All MCCB's on Distribution Panels shall be provided with variable setting.

Door handles will be provided with pad locking arrangement.

All MCCB's on Main panel shall be provided with shunt release and 2No. + 2NC Auxiliary contact block. All MCCB's shall be provided with suitable spreader links on both sided for bus bar and cable connections.

All MCCB's shall have clear ON, OFF & TRIP positions.

MCCB's should comply with IS 13947 part -2, IEC (6094) and IEC 60947-3 & IEC 60947 part – 2.

The MCCB shall be suitable for universal mounting i.e. the load/line shall be interchangeable with shrouded incoming contacts.

The MCCB shall be suitable for minimum operating voltage of 415V.

The thermal setting shall be adjustable from 64 % to 100% of its normal current.

The magnetic setting shall be adjustable from 3.5 to 10 In (normal current).

Trip reset should be available Manual / Automatic.

Isolator switches for electronic circuits to open the MCCB automatically.

The MCCB's must house transparent label holder to ensure circuit identification.

The MCCB's must have fully insulated safety shutters.

Overload Zone adjustable from 0.4 to 1 in with line (For 630 amp & above MCCB)

Short circuit Zone adjustable from 1.5 to 10 In with time.

MCCBs encapsulated poles double roto active mechanism to lower the thermal dynamic stresses in the installation.

DATA SHEET (MCCB)

	MLTP Incomer & Breaker in Synchroniising Panel.	MLTP Outgoing Feeder	Other Panel Incomer	Other Panel Outgoing Feeder
Release Type	Microprocessor Based	Based / Thermal	Microprocess or Based	Microprocessor Based / Thermal Magnetic

		Magnetic Based (as per SLD)		Based (as per SLD)
	Microprocessor Based	Microprocessor Based	Microprocessor Based (315A to 800A)	TMD
Breaking Capacity	Ics=100% of Icu,	Ics=100% of Icu,	Ics=100% of Icu,	Ics=100% of Icu,
Nos. of Pole	4 Pole (100 % neutral)	4 Pole (100 % neutral) / 3 Pole (With Neutral CT) as specified SLD	4 Pole (100 % neutral)	4 Pole (100 % neutral) / 3 Pole (With Neutral CT) as specified SLD
	Note: Neutral CT should be provided in case of Ground Protection			
Protection	LSIG	LSIG / TMD as specified SLD	LSIG	LSIG / TMD as specified SLD
Communication Module over Modbus TCP/IP.	RS-485/Modbus TCP/IP Port to monitor	RS-485/Modbus TCP/IP Port to monitor	RS-485/Modbus TCP/IP Port to monitor	RS-485/Modbus TCP/IP Port to monitor (IF REQUIRED)
	1. Cause of Triping	1. Cause of Triping–	1. Cause of Triping	1. Cause of Triping
	2. Mech. Cycle	2. Mech. Cycle–	2. Mech. Cycle	2. Mech. Cycle
	3. Electrical Cycle	3. Electrical Cycle–	3. Electrical Cycle	3. Electrical Cycle
	4. Contact Wear (%)	4. Contact Wear (%)–	4. Contact Wear (%)	4. Contact Wear (%)
	5. Trip History	5. Trip History–	5. Trip History	5. Trip History
Other	PFC for ON/OFF/TRIP	PFC for ON/OFF/TRIP as specified SLD	PFC for ON/OFF/TRIP as specified SLD	PFC for ON/OFF/TRIP as specified SLD
Mounting	Universal	Universal	Universal	Universal
Circuit Breakers shall confirm to Electrical Standards	IEC60947-I & II, IS 13947	IEC60947-I & II, IS 13947	IEC60947-I & II, IS 13947	IEC60947-I & II, IS 13947

Rated Operational Voltage: Ue	433V, +10%	433V, +10%	433V, +10%	433V, +10%
Current Rating(In) of Circuit Breaker shall be declared at	50OC	50OC	50OC	50OC
Utilisation Category	Class A	Class A	Class A	Class A
Suitable for Isolation	Yes	Yes	Yes	Yes
Operating Principle	Current Limiting	Current Limiting	Current Limiting	Current Limiting
Method of Installation	Fixed	Fixed	Fixed	Fixed
No. of Poles	As mentioned in SLD	As mentioned in SLD	As mentioned in SLD	As mentioned in SLD
Rated Insulation Voltage: Ui at 50 Hz	690V	690V	690V	690V
Rated Impulse withstand Voltage at Main Circuits	8kV	8kV	8kV	8kV
Rated Impulse withstand Voltage at Aux. Circuits	4kV	4kV	4kV	4kV
Short Circuit Making Capacity-Max. Prospective Peak Current	Shall be equal to (Icu X 2.1)	Shall be equal to (Icu X 2.1)	Shall be equal to (Icu X 2.1)	Shall be equal to (Icu X 2.1)
Mechanical Features:				
Three Distinct Positions ON/OFF/TRIP on MCCB	Yes	Yes	Yes	Yes
Flexibility of Connecting load either on TOP or BOTTOM	Yes	Yes	Yes	Yes
Possibility of Interchanging the protection release of MCCB on site	Yes	Yes	Yes	Yes

Extended Rotary Handle with Padlocking Facility	Yes	Yes	Yes	Yes
Door Interlock	Yes	Yes	Yes	Yes
Release Functions				
True RMS Sensing	Required	Required	Required	Required
Overload (L) Protection With Setting	Adjustable	Adjustable	Adjustable	Adjustable
Instantaneous Protection (I)	Adjustable	Adjustable	Adjustable	Adjustable
Integral Test facility for testing healthiness of Release	Required	Required	Required	Required
LED Indication to show % Loading of the release	Required	Required	Required	Required
Thermal Memory	Required	Required	Required	Required
Interlock	As specified in SLD	As specified in SLD	As specified in SLD	As specified in SLD
a) Bowden Wire	-	-	-	-
b) Castel lock provision	Yes	Yes	Yes	Yes
Under Voltage Coil with Continuous Rating and front Accessible	Yes	-	Yes	-
Shunt trip Coil with Continuous Rating and front Accessible	Yes	Yes	Yes	No

Miniature Circuit Breakers (MCB)

MCB's shall be of current limiting type, ISI marked confirms to IS 8828 – 1996.

The power loss per pole shall be low and shall be in accordance with IS 8828 – 1996.

All cable entries shall be either from bottom or top.

MCB's shall be of C - curve characteristic & shall have quick make & break non-welding self wiping silver alloy contacts for 10 kA short circuit both on the manual & automatic operation & Should have indication on front face

All the active, live parts of MCB's should be out of human reach, ensuring safety & confirms to IP: 55 degree of protection.

The MCB's must house transparent label holder to ensure circuit identification.

The MCB's must have fully insulated safety shutters.

The MCB's shall have lockable switching lever.

The Minimum electrical endurance shall be 20,000 operations.

The housing of the MCB shall be mounted self-extinguishing DMC (Dough Moulding Compound).

The short circuit Current shall be brought to zero within 4 to 5 milliseconds from the time they are established.

All MCB's shall have a minimum short circuit Capacity of 10kA RMS.

Single Pole / Single pole with Neutral / Double Pole / Triple pole / Four pole: MCB, ISI marked as per IS 8828 : 1996 (IEC 60898) with hammer trip and watch mechanism15 arc plates,10 KA capacity with nominal rating of 240/415V.

Distribution Board suitable for MCB's (MCBDB)

Horizontal / Vertical type DB's

MCBDB suitable for 230 V / 415 V, horizontal/vertical, with door of specified ways (poles), shall be phase segregated type having residual current protection in each phase, surface / flush mounting to house incoming and outgoing MCB's, and erected on iron frame.

DB's shall be prewired and shall be fabricated as per IS: 8623.

Suitable for flush mounting & surface mounting, with 100 A copper bus bar (or as specified) (For Horizontal type DB), neutral bar, earth bar & cable ties for cable management.

In case of Vertical DB the bus bar shall be of 250 A rating (or as specified)

DB's shall be of IP – 43 degree of protection with double door arrangement.

All the MCB distribution boards shall be fabricated out of 18 SWG thick sheet steel duly rust inhibited through a process of degreasing, pickling, phosphating & powder coating to an approved colour over primer & shall be of the totally enclosed dust proof type suitable for wall mounting.

All components shall be mounted on DIN rails & covered totally with a sheet steel cover rendering it finger-safe. Access to the internal connections shall be only through removing the cover sheet.

All DB's shall be internally prewired using copper insulated high temperature PVC wires.

Bus bars & neutral bar shall be fully insulated with standard colour code.

Bus bar withstanding capacity shall be 10kA.

DB's must have facility of reversing door without modification, pan assembly for ease of installation & convertible locking.

Residual Current Circuit Breaker(RCCB)

RCCBs shall be ISI marked as per IS 12640 (part 1) – 2000 and Confirming to IEC 61008-1.

It shall work on residual current energy, having 30 milliamp sensitivity (or as specified) and shall protect against earth leakage.Tripping time shall be maximum 30 millisecond (or as specified).

Breaking capacity shall be 20 kA with hammer trip and watch mechanism 15 arc plates.

RCCB shall operate for rated leakage at nominal Ten volts AC, and also in both, Neutral Open & Snapping condition.

RCCBs shall have trip free mechanism with quick make & break non-welding self wiping silver alloy contacts for 20 KA short circuit current both on the manual & automatic operation. Test knob facility shall be provided.

All the active, live parts of RCCBs should be out of human reach, ensuring safety & confirms to IP20 degree of protection.

The RCCBs must house transparent label holder to ensure circuit identification.

The RCCBs must have fully insulated safety shutters.

The Minimum electrical endurance shall be 20,000 operations.

Residual Current Circuit Breaker with over voltage cut Off (RCBO)

RCBO's with integral combination of RCCB+MCB, shall be ISI marked as per IS 12640 (part 1) – 2000 and Confirming to IEC 61008-1.It shall work on residual current energy, having 30 milliamp sensitivity (or as specified) with protection against earth leakage and over voltage upto 290 Volts.

Tripping time shall be maximum 30 milliseconds (or as specified).

Breaking capacity shall be 20 kA with hammer trip and watch mechanism 15 arc plates.

RCCB shall operate for rated leakage at nominal Ten volts AC, and also in both, Neutral Open & Snapping condition.

RCBO's shall have trip free mechanism with quick make & break non-welding self wiping silver alloy contacts for 10 kA short circuit both on the manual & automatic operation. Test knob facility shall be provided.

All the active, live parts of RCBO's should be out of human reach, ensuring safety & confirms to IP20 degree of protection.

The RCBO's must house transparent label holder to ensure circuit identification.

The RCBO's must have fully insulated safety shutters.

The Minimum electrical endurance shall be 20,000 operations.

Surge Protection Devices

Surge Protection Devices shall compliance according to IEC 61643-11:2012 and EN 61 643-11:2012 electrical installations must be protected against direct lightning and surge impulses with din rail Class I+II/Type 1+2 (10/350µs) surge arresters.

SPDs use MOV technology to allow for high lightning discharge currents, pluggable types avoid ejection of the cartridge during the discharge of the current and non-blow out technology avoids fire risks.

The SPD mustprovide either common protection in TNC network or common and differential mode protection in TT and TNS networks according to IEC 61643-11:2012 recommendations.

Supply, install and connect Surge Protective Devices with the following technical characteristics:

Technology : Metal oxide varistors

Impulse current wave form 10/350 µs :Iimp = 25 kA

Maximal discharge current wave form 8/20µs : Imax = 60 kA

Nominal discharge current wave form 8/20 µs : In = 25 kA

Voltage protection level : Up ≤ 1.5kV

Nominal voltage : UN = 230 V

Maximum countinuous operating voltage :Uc = 255 V

Short circuit withstand = 50 kA

Integrated thermal disconnector

Pluggable cartridge for an easy and quick intervention

Visual state indicator

Safety system

Auxiliary contact

No electrical consumption on visual state indicator

Back up protection with Fuse or Circuit breaker : ≤ 125 A ;

Certified standard IEC 61643-11 and EN 61643-11.

APFC PANEL with Harmonic suppressor

APFC panels shall be indoor type, sheet steel enclosed, compartmentalized for switchgear, single front IP-42 as specified in SLD / as per type tested design compliance with IEC 61921 by OEM.

415V capacitors have to be designed to provide the desired kVAR output as per SLD.

All switchgears for Capacitors shall be suitable for contactor switching type.

Capacitors - App or MPP Type IS: 13585 part-I 1994 at 525 Volts.

Contactor - Power contactors suitable for the kVAr ratings as per IEC 61921

Series reactor – 7% Copper wound dry type with class-F insulation, isolation levels exceeding 3kV-ac/1 minute. Reactors, contactor switching, iron core suitable as per requirement.

Harmonic filter circuit - Circuit suitable to filter Harmonics up to 17th Harmonics.

CRCA sheet - CRCA sheet 14/16 SWG with 9 tank process & powder coating suitable to site condition of required colour shade.

MS angles &channels - Size as per site condition.

Bus bar - Electrolytic aluminium bus bar of capacity as mentioned in SLD.

Exhaust fan: Tube axial exhaust fan of adequate capacity.

Fabrication materials: MS Jali, Hinges, nut bolts washers, screws etc. of suitable size.

Switchgear - MCB, MCCB, ACB as mentioned in SLD..

Power factor Controller Relay - 16 steps APFCR relay (with steps as specified in the Single Line Diagram), microprocessor type within / seperate built power factor meter & kVAR meter, programmable intelligent relay / dynamic correction Intelligent relay with switches time from selected 1sec.to 1200 sec. having display of system v/s, current, frequency, target PF, THD, short fall KVAR, active power KW, KVAR, Harmonic display up to 17th order, Loss of capacitance, RS485 communication port in-built.

Testing & Inspection

During fabrication, switchgear maybe subject to inspection. Manufacturer shall furnish all necessary information.

All routine verification and acceptance tests shall be carried out as per IEC 61921, IS 16636:2017, IEC 61439 at manufacturer's work under his care and expense.

If specifically agreed heat run test may be performed at manufacturer's works. Heatrun test shall be performed at least on one incomer and two outgoing verticalpanels of the ordered switchboard., shall include the following sections of the bus duct as a minimum:

Acceptance tests shall be as a general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, terminal boxes, location and connection of terminals etc.,

Manual and electrical operation of Circuit Breakers. / relays shall be checked under the worst conditions of auxiliary supply voltage.

Dry insulation test with power frequency voltage shall be conducted for the main and auxiliary circuits Insulation resistance of the main and auxiliary circuits and bus duct shall be checked before and after High voltage withstand test.

Operation check shall be carried out on selected typical feeder/sfor control function /interlock as per the schematic diagrams by manually simulating fault conditions and operation of control switches/relays etc.

Relays shall be tested with secondary injection test equipment. Breaker trip unit shall be tested using specific breaker test kit.

For equipment bought from other sub-suppliers, certified test reports of tests carried out at the manufacturers works shall be submitted. Normally all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works.

Certification

All offered equipments shall be of same design as per the type test report and shall have same constructional features and materials as per the type test reports as per IEC 61921, IS 16636:2017.

Shall have been type tested and witnessed by an authority of international repute, approved by the purchaser. Type test reports shall submitte during technical bid evaluation or during inspection at FAT.

Shall have been in continuous satisfactory service for similar application.

Manufacturing Facilities

To ensure timely delivery and adherance to project schedule supplier must have following

Adequate assembly area to assemble 500 switchboard cubicle in one month.

CNC press and bending machines in the same facility.

Paint shop along withpermanent 9 – 11 tank pretreatment Plant.

Adequate Loading & Unloading area.

Suppliers have routine test equipment

Inhouse temperature rise test facilities.

Quality control documentation and system and processes shall be available for inspection for all the previous and running work orders.

Specific requirements

Vendor is required to make his proposal based on these documents. If there is any deviation or any alternatives must be specifically mentioned in the proposal.

TECHNICAL DATA SHEET

SR No	Parameter	Specification	To be Filled By Contractor
1	Type of Panel	Compartmentalized	
2	Type of Mounting	Free standing Floor Mounted	
3			
4	Fault kA	36kA–1sec	
5	Thickness of CRCA sheets	Structural members - 3mm Covers and doors - 2mm Base channel - ISMC75 Glandplate - 3mm	
6	Painting / Process	Epoxypaint / As per 9 tank process	
7	Paint shade	interior & Exterior: RAL 7032	
8	Details of busbar	Electrolytic grade Aluminium of specified rating	
9	Cable Entry	Bottom / Top as specified inr espective drawings	
10	Enclosure Protection / Ventilation	IP –42 with louvers for Ventilation	
11	ControlWiring/ PowerWiring	Insulated 660 Volts Cu wire. Voltage Circuit : 1.5sqmm Current Circuit :2.5sqmm	
12	Cable Lugs / Cable glands	Asr equired	
13	Operating Height	1800mm max	
14	Mounting height of Relays / Meters ControlSwitches	Range 350mm to 1900mm	
15	TypeofC.T.	Cast resin	
16	Reference Ambient Temperature	40 Deg.C	

17			
18	Makes of the components to be used	As per approved makelist	
19	Components to be used	As per SLD & specifications	

TECHNICAL SPECIFICATIONS FOR ON GRID SOLAR SYSTEM

DEFINITION :-

A Grid Tied Solar Rooftop Photovoltaic (SPV) power plant consists of SPV array, Module Mounting Structure, Power Conditioning Unit (PCU) consisting of Maximum Power Point Tracker (MPPT), Inverter, and Controls & Protections, interconnect cables, Junction boxes, Distribution boxes and switches. PV Array is mounted on a suitable structure. Grid tied SPV system should be designed with necessary features to supplement the grid power during day time. Components and parts used in the SPV power plants including the PV modules, metallic structures, cables, junction box, switches, PCUs etc., should conform to the BIS or IEC or international specifications, wherever such specifications are available and applicable. Solar PV system shall consist of following equipments/components.

Solar PV modules consisting of required number of Crystalline PV cells. Grid interactive Power Conditioning Unit with Remote Monitoring System Mounting structures Junction Boxes.

Earthing and lightening protections.

IR/UV protected PVC Cables, pipes and accessories

SOLAR PHOTOVOLTAIC MODULES :-

The PV modules used should be made in IndiaThe PV modules used must qualify to the latest edition of IEC PV module qualification test or equivalent BIS standards Crystalline Silicon Solar Cell Modules IEC 61215/IS14286. In addition, the modules must conform to IEC 61730 Part-1 requirements for construction & Part 2 – requirements for testing, for safety qualification or equivalent IS.

For the PV modules to be used in a highly corrosive atmosphere throughout their lifetime, they must qualify to IEC 61701.

The total solar PV array capacity should not be less than allocated capacity (kWp) and should comprise of solar crystalline modules of minimum 250 Wp and above wattage. Module capacity less than minimum 250 watts shall not be accepted.

Adequate protective devices against surges at the PV module shall be provided. Low voltage drop bypass diodes shall be provided.

PV modules must be tested and approved by one of the IEC authorized test centres.

The module frame shall be made of corrosion resistant materials, preferably having anodized aluminium.

The EoI holder shall carefully design & accommodate requisite numbers of the modules to achieve the rated power in his EoI. MEDA/owners shall allow only minor changes at the time of execution.

Other general requirement for the PV modules and subsystems shall be the Following:

The rated output power of any supplied module shall have tolerance within +/-3%.

The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary by more than 2 (two) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.

The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP-65 rated.

I-V curves at STC should be provided by EoI holder.

SOLAR PV MODULES :-

Modules deployed must use a RF identification tag. The following information must be mentioned in the RFID used on each modules. This should be inside the laminate only.

Name of the manufacture of the PV module

Name of the manufacture of Solar Cells.

Month & year of the manufacture (separate for solar cells and modules)

Country of origin (separately for solar cells and module)

I-V curve for the module Wattage, Im, Vm and FF for the module

Unique Serial No and Model No of the module

Date and year of obtaining IEC PV module qualification certificate.

Name of the test lab issuing IEC certificate.

Other relevant information on traceability of solar cells and module as per ISO 9001 and ISO 14001

WARRANTIES :-

Material Warranty:

Material Warranty is defined as: The project developer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than five (05) years from the date of sale to the original customer ("Customer")

Defects and/or failures due to manufacturing

Defects and/or failures due to quality of materials

Non conformity to specifications due to faulty manufacturing and/or inspection processes. If the solar Module(s) fails to conform to this warranty, the project developer will repair or replace the solar module(s), at the Owners sole option.

Performance Warranty:

a. The predicted electrical degradation of power generated not exceeding 20% of the minimum rated power over the 25 year period and not more than 10% after ten years period of the full rated original output.

ARRAY STRUCTURE :-

Hot dip galvanized MS mounting structures may be used for mounting the modules / panels / arrays. Minimum thickness of galvanization should be at least 120 microns.

Each structure should have angle of inclination as per the site conditions to take maximum insolation. However to accommodate more capacity the angle inclination may be reduced until the plant meets the specified performance ratio requirements.

The Mounting structure shall be so designed to withstand the speed for the wind zone of the location where a PV system is proposed to be installed (wind speed of 150 kM/ hour). It may be ensured that the design has been certified by a recognized Lab/ Institution in this regard and submit wind loading calculation sheet to MEDA. Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed.

The mounting structure steel shall be as per latest IS 2062: 1992 and galvanization of the mounting structure shall be in compliance of latest IS 4759.

Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts.

Aluminium structures also can be used which can withstand the wind speed of respective wind zone. Necessary protection towards rusting need to be provided either by coating or anodization.

Aluminium frames should be avoided for installations in coastal areas.

The fasteners used should be made up of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels.

Regarding civil structures the EoI holder need to take care of the load bearing capacity of the roof and need arrange suitable structures based on the quality of roof.

The total load of the structure (when installed with PV modules) on the terrace should be less than 60 kg/m2.

The minimum clearance of the structure from the roof level should be 300 mm.

JUNCTION BOXES (JBs) :-

The junction boxes are to be provided in the PV array for termination of connecting cables. The J. Boxes (JBs) shall be made of GRP / FRP / Powder Coated Aluminium /cast aluminium alloy with full dust, water & vermin proof arrangement. All wires / cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands.

Copper bus bars / terminal blocks housed in the junction box with suitable termination threads Conforming to IP65 standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry. Single / double compression cable glands. Provision of earthings. It should be placed at 5 feet height or above for ease of accessibility.

Each Junction Box shall have High quality Suitable capacity Metal Oxide Varistors (MOVs) / SPDs, suitable Reverse Blocking Diodes. The Junction Boxes shall have suitable arrangement monitoring and disconnection for each of the groups.

Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.

All fuses shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

DC DISTRIBUTION BOARD :-

DC Distribution panel to receive the DC output from the array field.

DC DPBs shall have sheet from enclosure of dust & vermin proof conform to IP 65 protection. The bus bars are made of copper of desired size. Suitable capacity MCBs/MCCB shall be provided for controlling the DC power output to the PCU along with necessary surge arrestors.

AC DISTRIBUTION PANEL BOARD :-

AC Distribution Panel Board (DPB) shall control the AC power from PCU/ inverter, and should have necessary surge arrestors. Interconnection from ACDB to mains at LT Bus bar while in grid tied mode.

All switches and the circuit breakers, connectors should conform to IEC 60947, part I, II and III/ IS 60947 part I, II and III.

The changeover switches, cabling work should be undertaken by the EoI holder as part of the project.

All the Panel's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 or 230 volts, 50 Hz

The panels shall be designed for minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.

All indoor panels will have protection of IP54 or better. All outdoor panels will have protection of IP65 or better.

Should conform to Indian Electricity Act and rules (till last amendment).

All the 415 AC or 230 volts devices / equipment like bus support insulators, circuit breakers, SPDs, VTs etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions

Variation in supply voltage	+/- 10 %
Variation in supply frequency	+/- 3 Hz

PCU / ARRAY SIZE RATIO :-

The combined wattage of all inverters should not be less than rated capacity of power plant under STC.

Maximum power point tracker shall be integrated in the PCU/inverter to maximize energy drawn from the array.

PCU / INVERTER :-

As SPV array produce direct current electricity, it is necessary to convert this direct current into alternating current and adjust the voltage levels to match the grid voltage. Conversion shall be achieved using an electronic Inverter and the associated control and protection devices. All these components of the system are termed the “Power Conditioning Unit (PCU)”. In addition, the PCU shall also house MPPT (Maximum Power Point Tracker), an interface between Solar PV array & the Inverter, to the power conditioning unit/inverter should also be DG set interactive. If necessary. Inverter output should be compatible with the grid frequency. Typical technical features of the inverter shall be as follows:

Switching devices	IGBT/MOSFET
Control	Microprocessor /DSP
Nominal AC output voltage and frequency	415V, 3 Phase, 50 Hz (In case single phase inverters are offered, suitable arrangement for balancing the phases must be made.)
Output frequency	50 Hz
Grid Frequency Synchronization range	+ 3 Hz or more

Ambient temperature considered	-20o C to 50o C
Humidity	95 % Non-condensing
Protection of Enclosure	IP-20(Minimum) for indoor.
	IP-65(Minimum) for outdoor.
Grid Frequency Tolerance range	+ 3 or more

Grid Voltage tolerance	-0.20.15
No-load losses	Less than 1% of rated power
Inverter efficiency(minimum)	>93% (In case of 10 kW or above with in-built galvanic isolation) >97% (In case of 10 KW or above without in-built galvanic isolation)
Inverter efficiency (minimum)	> 90% (In case of less than 10 kW)
THD	< 3%
PF	> 0.9

Three phase PCU/ inverter shall be used with each power plant system (10kW and/or above) but in case of less than 10kW single phase inverter can be used.

PCU / inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.

Built-in meter and data logger to monitor plant performance through external computer shall be provided.

Anti-islanding (Protection against Islanding of grid): The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.

Channel Partner shall be responsible for galvanic isolation of solar roof top power plant (>100kW) with electrical grid or LT panel.

In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer. If Isolation Transformer is not incorporated with PCU/Inverter, there shall be a separate Isolation Transformer of suitable rating provided at the output side of PCU/PCU units for capacity more than 100 kW.

The PCU/ inverter generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to the utility services should follow the latest CEA (Technical Standards for Connectivity Distribution Generation Resources) Guidelines.

The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068-2 (1,2,14,30)/ Equivalent BIS Std.

The MPPT units environmental testing should qualify IEC 60068-2 (1, 2, 14, 30)/ Equivalent BIS std. The junction boxes/ enclosures should be IP 65 (for outdoor)/ IP 54 (indoor) and as per IEC 529 specifications.

The PCU / inverters should be tested from the MNRE approved test centres / NABL / BIS / IEC accredited testing- calibration laboratories. In

case of imported power conditioning units, these should be approved by international test houses.

INTEGRATION OF PV POWER WITH GRID :-

The output power from SPV would be fed to the inverters which converts DC produced by SPV array to AC and feeds it into the main electricity grid after synchronization. In case of grid failure, or low or high voltage, solar PV system shall be out of synchronization and shall be disconnected from the grid. Once the DG set comes into service, PV system shall again be synchronized with DG supply and load requirement would be met to the extent of availability of power. 4 pole isolation of inverter output with respect to the grid/ DG power connection need to be provided.

DATA ACQUISITION SYSTEM / PLANT MONITORING :-

Data Acquisition System shall be provided for each of the solar PV plant above 10 kWp capacity.

Data Logging Provision for plant control and monitoring, time and date stamped system data logs for analysis with the high quality, suitable PC. Metering and Instrumentation for display of systems parameters and status indication to be provided.

Temperature: Temperature probes for recording the Solar panel temperature and/or ambient temperature to be provided complete with readouts integrated with the data logging system.

The following parameters are accessible via the operating interface display in real time separately for solar power plant:

AC Voltage.

AC Output current.

Output Power

Power factor.

DC Input Voltage.

DC Input Current.

Time Active.

Time disabled.

Time Idle.

Power produced

Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage.

All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and read on the digital front panel at any time) and logging facility (the current values, previous values for up to a month and the average

values) should be made available for energy auditing through the internal microprocessor and should be read on the digital front panel.

PV array energy production: Digital Energy Meters to log the actual value of AC/ DC voltage, Current & Energy generated by the PV system provided. Energy meter along with CT/PT should be of 0.5 accuracy class.

Computerized DC String/Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box or separately.

String and array DC Voltage, Current and Power, Inverter AC output voltage and current (All 3 phases and lines), AC power (Active, Reactive and

Apparent), Power Factor and AC energy (All 3 phases and cumulative) and frequency shall be monitored.

Computerized AC energy monitoring shall be in addition to the digital AC energy meter.

The data shall be recorded in a common work sheet chronologically date wise. The data file shall be MS Excel compatible. The data shall be represented in both tabular and graphical form.

All instantaneous data shall be shown on the computer screen.

Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.

Provision for instantaneous Internet monitoring and download of historical data shall be also incorporated.

Remote Server and Software for centralized Internet monitoring system shall be also provided for download and analysis of cumulative data of all the plants and the data of the solar radiation and temperature monitoring system.

Ambient / Solar PV module back surface temperature shall be also monitored on continuous basis.

Simultaneous monitoring of DC and AC electrical voltage, current, power, energy and other data of the plant for correlation with solar and environment data shall be provided.

Remote Monitoring and data acquisition through Remote Monitoring System software at the owner / MEDA location with latest software/hardware configuration and service connectivity for online / real time data monitoring / control complete to be supplied and operation and maintenance / control to be ensured by the EoI holder.

The EoI holders shall be obligated to push real-time plant monitoring data on a specified intervals (say 15 minute) through open protocol at reciver location (cloud server) in XML/JSON format, preferably. Suitable provision in this regard will be intimated to the EoI holders.

TRANSFORMER “IF REQUIRED” & METERING :-

Dry/oil type relevant kVA, 11kV/415V, 50 Hz Step up along with all protections, switchgears, Vacuum circuit breakers, cables etc. along with required civil work.

The EoIirectional electronic energy meter (0.5 S class) shall be installed for the measurement of import/Export of energy.

The EoI holder must take approval/NOC from the Concerned DISCOM for the connectivity, technical feasibility, and synchronization of SPV plant with distribution network before commissioning of SPV plant.

Reverse power relay shall be provided by EoI holder (if necessary), as per the local DISCOM requirement.

POWER CONSUMPTION:

Regarding the generated power consumption, priority need to give for internal consumption first and thereafter any excess power can be exported to grid. Finalization of tariff is not under the purview of MEDA or MNRE. Decisions of appropriate authority like DISCOM, state regulator may be followed.

PROTECTIONS :-

The system should be provided with all necessary protections like earthing, Lightning, and grid islanding as follows:

LIGHTNING PROTECTION :-

The SPV power plants shall be provided with lightning &overvoltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc The entire space occupying the SPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors. Lightning protection should be provided as per IEC 62305 standard. The protection against induced high-voltages shall be provided by the use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth.

SURGE PROTECTION :-

Internal surge protection shall consist of three MOV type surge-arrestors connected from +ve and –ve terminals to earth (via Y arrangement).

EARTHING PROTECTION :-

Each array structure of the PV yard should be grounded/ earthed properly as per IS:3043-1987. In addition the lighting arrester/masts should also be earthed inside the array field. Earth Resistance shall be tested in presence of the representative of Department/MEDA as and when required after earthing by calibrated earth tester. PCU, ACDB and DCDB should also be earthed properly.

Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential.

GRID ISLANDING :-

In the event of a power failure on the electric grid, it is required that any independent power-producing inverters attached to the grid turn off in a short

period of time. This prevents the DC-to-AC inverters from continuing to feed power into small sections of the grid, known as “Islands.” Powered Islands present a risk to workers who may expect the area to be unpowered, and they may also damage grid-tied equipment. The Rooftop PV system shall be equipped with islanding protection. In addition to disconnection from the grid (due to islanding protection) disconnection due to under and over voltage conditions shall also be provided.

A manual disconnect 4-pole isolation switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall be locked by the utility personnel.

CABLES :-

Cables of appropriate size to be used in the system shall have the following characteristics:

Shall meet IEC 60227/IS 694, IEC 60502/IS1554 standards

Temp. Range: –10oC to +80oC.

Voltage rating 660/1000V

Excellent resistance to heat, cold, water, oil, abrasion, UV radiation

Flexible

Sizes of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire solar system to the minimum (2%)

For the DC cabling, XLPE or, XLPO insulated and sheathed, UV- stabilized single core multi-stranded flexible copper cables shall be used; Multi-core cables shall not be used.

For the AC cabling, PVC or, XLPE insulated and PVC sheathed single or, multi-core multi-stranded flexible copper cables shall be used; Outdoor AC cables shall have a UV-stabilized outer sheath.

The cables (as per IS) should be insulated with a special grade PVC compound formulated for outdoor use. Outer sheath of cables shall be electron beam cross-linked XLPO type and black in colour.

The DC cables from the SPV module array shall run through a UV- stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm.

Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers.

All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm; the minimum DC cable size shall be 4.0 mm2 copper; the minimum AC cable size shall be 4.0 mm2 copper. In three phase systems, the size of the neutral wire size shall be equal to the size of the phase wires.

Cable Routing / Marking: All cable/wires are to be routed in a GI cable tray and suitably tagged and marked with proper manner by good quality ferule or by other means so that the cable easily identified. In addition, cable drum no. / Batch no. to be embossed/ printed at every one meter.

Cable Jacket should also be electron beam cross-linked XLPO, flame retardant, UV resistant and black in colour.

All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions including High temperatures, UV radiation, rain, humidity, dirt, salt, burial and

attack by moss and microbes for 25 years and voltages as per latest IEC standards. DC cables used from solar modules to array junction box shall be solar grade copper (Cu) with XLPO insulation and rated for 1.1kV as per relevant standards only.

The ratings given are approximate. EoI holder to indicate size and length as per system design requirement. All the cables required for the plant shall be provided by the EoI holder. Any change in cabling sizes if desired by the EoI holder shall be approved after citing appropriate reasons. All cable schedules/ layout drawings shall be approved prior to installation.

Multi Strand, Annealed high conductivity copper conductor PVC type 'A' pressure extruded insulation or XLPE insulation. Overall PVC/XLPE insulation for UV protection Armoured cable for underground laying. All cable trays including covers to be provided. All cables conform to latest edition of IEC/ equivalent BIS Standards as specified below: BoS item / component Standard Description Standard Number Cables General Test and Measuring Methods, PVC/XLPE insulated cables for working Voltage up to and including 1100 V, UV resistant for outdoor installation IS /IEC 69947.

The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%.

The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%.

CONNECTIVITY :-

The maximum capacity for interconnection with the grid at a specific voltage level shall be as specified in the Distribution Code/Supply Code of the State and amended from time to time. Following criteria have been suggested for selection of voltage level in the distribution system for ready reference of the solar suppliers.

Plant Capacity	Connecting voltage
Up to 10 kW	240V-single phase or 415V-three phase at the option of the consumer
Above 10kW and up to 100 kW	415V – three phase
Above 100kW	At HT/EHT level (11kV/33kV/66kV) as per DISCOM rules

The maximum permissible capacity for rooftop shall be 1 MW for a single net metering point.

Utilities may have voltage levels other than above, DISCOMS may be consulted before finalization of the voltage level and specification be made accordingly.

TOOLS & TACKLES AND SPARES :-

After completion of installation & commissioning of the power plant, necessary tools & tackles are to be provided free of cost by the EoI holder for maintenance purpose. List of tools and tackles to be supplied by the EoI holder for approval of specifications and make from MEDA/ owner.

A list of requisite spares in case of PCU/inverter comprising of a set of control logic cards, IGBT driver cards etc. Junction Boxes. Fuses, MOVs / arrestors, MCCBs etc along with spare set of PV modules be indicated, which shall be supplied along with the equipment. A minimum set of spares shall be

maintained in the plant itself for the entire period of warranty and Operation & Maintenance which upon its use shall be replenished.

DANGER BOARDS AND SIGNAGES :-

Danger boards should be provided as and where necessary as per IE Act. /IE rules as amended up to date. Three signage shall be provided one each at battery –cum- control room, solar array area and main entry from administrative block. Text of the signage may be finalized in consultation with MEDA/ owner.

FIRE EXTINGUISHERS :-

The firefighting system for the proposed power plant for fire protection shall be consisting of:

Portable fire extinguishers in the control room for fire caused by electrical short circuits.

Sand buckets in the control room.

The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing PCUs as well as on the Roof or site where the PV arrays have been installed.

DRAWINGS & MANUALS :-

Two sets of Engineering, electrical drawings and Installation and O&M manuals are to be supplied. EoI holders shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their EoI along with basic design of the power plant and power evacuation, synchronization along with protection equipment.

Approved ISI and reputed makes for equipment be used.

For complete electro-mechanical works, EoI holders shall supply complete design, details and drawings for approval to owners before progressing with the installation work.

PLANNING AND DESIGNING:

The EoI holder should carry out Shadow Analysis at the site and accordingly design strings & arrays layout considering optimal usage of space, material and labour. The EoI holder should submit the array layout drawings along with Shadow Analysis Report to owner for approval.

DRAWINGS TO BE FURNISHED BY CHANNEL PARTNER AFTER

AWARD OF CONTRACT FROM BENEFICIARY:-

The Contractor shall furnish the following drawings Award/Intent and obtain approval

General arrangement and dimensioned layout.

Schematic drawing showing the requirement of SV panel, Power conditioning Unit(s)/ inverter, Junction Boxes, AC and DC Distribution Boards, meters etc.

Structural drawing along with foundation details for the structure.

Itemized bill of material for complete SV plant covering all the components and associated accessories.

Layout of solar Power Array

Shadow analysis of the roof

SOLAR PV SYSTEM ON THE ROOFTOP FOR MEETING THE ANNUAL ENERGY REQUIREMENT :-

The Solar PV system on the rooftop of the selected buildings will be installed for meeting upto 90% of the annual energy requirements depending upon the area of rooftop available and the remaining energy requirement of the

buildings will be met by drawing power from grid at commercial tariff of DISCOMs.

SAFETY MEASURES :-

The EoI holder shall take entire responsibility for electrical safety of the installation(s) including connectivity with the grid and follow all the safety rules & regulations applicable as per Electricity Act, 2003 and CEA guidelines etc.

DISPLAY BOARD :-

The EoI holder has to display a board at the project site (above 10 kWp) mentioning the following:

Plant Name, Capacity, Location, Type of Renewable Energy plant (Like solar wind etc.), Date of commissioning, details of tie-up with transmission and distribution companies, Power generation and Export FY wise.

Financial Assistance details from MEDA/MNRE/Any other financial institution apart from loan. This information shall not be limited to project site but also be displayed at site offices/head quarter offices of the successful EoI holder.

The size and type of board and display shall be appropriate.

TECHNICAL SPECIFICATIONS FOR cctv

2MP Fixed Dome Camera :-

S. No.	Features	Description
1.	Camera Type	Fixed Dome Camera
2.	Standard	ONVIF Profile S & G Compliant
3.	Certification	UL,CE, FCC, BIS
4.	Edge Storage	MicroSD/microSDHC/microSDXC slot supporting memory card for min. 128 GB (Min. Class 6 or higher, Card to be included). In the event of failure of connectivity to the network storage the camera shall record video locally on the SD card automatically. After the connectivity is restored these recordings shall be automatically merged with the network storage recording such that no manual intervention is required to transfer the SD card based recordings to network storage.
5.	Image Sensor	1/2.8" CMOS or better
6.	Resolution	Min.1920 × 1080 at 25 FPS or better
7.	Compression	H.264,H.265
8.	Streaming	Min. three compressed stream (Individually Configurable)
9.	Alarm & Audio	1 input, 1 output
10.	Pre/Post Alarm buffer	Yes
11.	ID/Password	Multi-level user ID/Password
12.	Encryption	HTTP(SSL/TLS)/HTTPS
13.	Video Authentication	For video authentication, classic watermarks/digital signature must be embedded in Video Stream along with name, time, date stamped which cannot be tampered
14.	Physical Layer	10/100 base Tx Ethernet
15.	Protocol	Minimum TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP™, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, Bonjour
16.	Lens Type	2.8 mm, Fixed lens with Manual focus
17.	Dynamic Noise Reduction	3D
18.	Slow Shutter	Support

19.	Antiflicker	Support
20.	Illumination	Color: 0.01 Lux or better at (F1.2, AGC ON), 0 Lux with IR Inbuilt IR (40 mtrs. or better)
21.	Signal Process	Digital Signal Process
22.	Privacy zones	3 or higher
23.	Auto Gain Control	Yes
24.	Back Light Compensation & High Light Compensation	Yes
25.	Electronic Shutter	1/3 s to 1/100,000 s
26.	White Balance	Yes
27.	Wide Dynamic Range	120dB
28.	Day and Night	Yes (as per minimum illumination)
29.	Operating Temperature	-30 °C to +60 °C Humidity 95% or less (non-condensing)
30.	Internet protocol Support	IPv4 and IPv6
31.	Housing	IP67
32.	Anti-Vandalism rating	IK10
33.	Edge based video content Analytics	Line crossing detection, Intrusion detection, Motion Detection, Video tampering, Scene change detection, Audio exception detection, Face Detection
34.	Power Source	Suitable adaptor shall be supplied to make the equipment work on 230V +10%, 50Hz and Power over Ethernet

2MP Fixed Bullet Camera :-

S. No.	Features	Description
1.	Camera Type	Fixed Bullet Camera
2.	Standard	ONVIF Profile S & G Compliant

3.	Certification	UL,CE, FCC, BIS
4.	Edge Storage	MicroSD/microSDHC/microSDXC slot supporting memory card for min. 128 GB (Min. Class 6 or higher, Card to be included). In the event of failure of connectivity to the network storage the camera shall record video locally on the SD card automatically. After the connectivity is restored these recordings shall be automatically merged with the network storage recording such that no manual intervention is required to transfer the SD card based recordings to network storage.
5.	Image Sensor	1/2.8" CMOS or better
6.	Resolution	Min.1920 × 1080 at 25 FPS or better
7.	Compression	H.264,H.265
8.	Streaming	Min. three compressed stream (Individually Configurable)
10.	ID/Password	Multi-level user ID/Password
11.	Encryption	HTTP(SSL/TLS)/HTTPS
12.	Video Authentication	For video authentication, classic watermarks/digital signature must be embedded in Video Stream along with name, time, date stamped which cannot be tampered
13.	Physical Layer	10/100 base Tx Ethernet
14.	Protocol	Minimum TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP™, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, Bonjour
15.	Lens Type	2.8 mm, Fixed lens
16.	Dynamic Noise Reduction	3D
17.	Slow Shutter	Support
18.	Antiflicker	Support
19.	Illumination	Color: 0.01 Lux or better at (F1.2, AGC ON), 0 Lux with IR Inbuilt IR (40 mtrs. or better)
20.	Signal Process	Digital Signal Process
21.	Privacy zones	3 or higher
22.	Auto Gain Control	Yes
23.	Back Light Compensation & High Light Compensation	Yes

24.	Electronic Shutter	1/3 s to 1/100,000 s
25.	White Balance	Yes
26.	Wide Dynamic Range	120dB
27.	Day and Night	Yes (as per minimum illumination)
28.	Operating Temperature	-30 °C to +60 °C Humidity 95% or less (non-condensing)
29.	Internet protocol Support	IPv4 and IPv6
30.	Housing	IP67
31.	Edge based video content Analytics	Line crossing detection, Intrusion detection, Motion Detection, Video tampering, Face Detection, Scene change detection
32.	Power Source	Suitable adaptor shall be supplied to make the equipment work on 230V +10%, 50Hz and Power over Ethernet

2MP IR Outdoor PTZ Camera:-

S. No.	Features	Description
1.	Camera Type	PTZ (Pan, Tilt, Zoom)
2.	Standard	ONVIF Profile S & G Compliant
3.	Certification	UL,CE, FCC, BIS
4.	Edge Storage	MicroSD/microSDHC/microSDXC slot supporting memory card for min. 128 GB (Min. Class 6 or higher, Card to be included). In the event of failure of connectivity to the network storage the camera shall record video locally on the SD card automatically. After the connectivity is restored these recordings shall be automatically pulled by the network storage recorder such that no manual intervention is required to transfer the SD card based recordings to network storage.
5.	Image Sensor	1/2.8" Progressive Scan CMOS or better
6.	Resolution	2 MP (1920 x 1080) at 25 FPS or better
7.	Compression	H.265, H.264
8.	Streaming	Min. Triple compressed stream (Individually Configurable)

9.	Audio	Audio Input/ Output 1 Ch
10.	Alarm	02//01
11.	Pre/Post Alarm buffer	Yes
12.	Security	User Authentication,IP Address filtering
13.	Physical Layer	10/100 base Tx Ethernet
14.	Protocol	Minimum IPv4/IPv6, HTTP, HTTPS, 802.1x, Qos, FTP, SMTP, UPnP, SNMP, DNS, DDNS, NTP, RTSP, RTCP, RTP, TCP/IP, UDP, IGMP, ICMP, DHCP, PPPoE, Bonjour
15.	Remote Administration	Remote configuration and status using web based tool
16.	System Update	Remote system update over Network using web client
17.	Lens Type	Optical zoom ; 32x or better IR corrected lens suitable for full HD camera. Focal length of lens ; upper range shall be 150mm or higher, Autofocus
18.	Dynamic Noise Reduction	3D
19.	Defog	Yes
20.	Illumination	Color: 0.005 lux, F1.6 or better B/W: 0.001 lux, F1.6
21.	IR Distance	Upto 150m
22.	Signal Process	Digital Signal Process
23.	Privacy zones	24 or higher
24.	Auto Gain Control	Yes
25.	Back Light Compensation	Yes
26.	High Light Compensation	Yes
27.	Electronic Shutter	1/30000s to 1s or better
28.	White Balance	Yes
29.	Wide Dynamic Range	120dB WDR
30.	S/N Ratio	≥55dB
31.	Day and Night	Support ICR
32.	Preset	min 250

33.	Pan, Tilt	Pan : 360° endless, Tilt From -15° to 90° with auto-flip
34.	Speed	Pan Manual Speed: 0.1°~160°/s, Pan Preset Speed: 240°/s Tilt Manual Speed: 0.1°~120°/s, Tilt Preset Speed: 200°/s
35.	Auto Tracking	Support
36.	Edge Analytics	Face Detection, Intrusion Detection, Line Crossing Detection, Region Entrance Detection, Region Exiting Detection, Unattended Baggage Detection, Audio Exception Detection
37.	Housing	IP66, IK10
38.	Region of Interest	Support
39.	Operating Temperature	-30°C to 65°C (-22°F to 149°F) Working Humidity ≤ 90%
40.	Power Source	Suitable adaptor shall be supplied to make the equipment work on 230V +10%, 50Hz or Power over Ethernet - Hi POE

64 Channel NVR-8 SATA:-

S. No.	Features	Description
1.	System	Dual OS system to ensure high reliability
2.	IP video input	64 ch upto 12MP resolution supported
3.	Incoming bandwidth	Min. 300 Mbps
4.	Outgoing bandwidth	Min. 200 Mbps
5.	Recording resolution	Upto 12MP
6.	Video o/p interfaces	2 HDMI port; atleast 1 supporting 4K resolution, 2 VGA port; atleast 1 supporting 2K resolution
7.	Audio o/p	1 ch
8.	Compression technique	H.265,H.264
9.	Live view/Playback resolution	Upto 12MP resolution
10.	Synchronous playback	Up to 16 channel
11.	Smart Playback function	Should support Smart search for the selected area in the video and smart playback to improve the playback efficiency

12.	VCA storage	Should support saving the captured VCA Pictures for smart IPC's VCA detection
13.	SATA interfaces	Hot swappable 8 sata interfaces with each supporting 8TB, should support ANR technology
14.	Power supply	Should Supports redundant power supply to improve the system stability
15.	RAID arrays	RAID0, RAID1, RAID5, RAID 6, RAID10
16.	Hot spare function	Should support N+1 hotspare function
17.	Network interfaces	2, RJ-45 10/100/1000 Mbps self-adaptive Ethernet interface
18.	Serial inetrfaces	RS-232, RS-485; Keyboard
19.	USB interface	3 × USB connectors, with atleast 1 USB 3.0
20.	Alarm i/o	16 i/p and 4 o/p
21.	Power supply	100 to 240 VAC, 50 to 60 Hz, Dual Power, Redundant
22.	Consumption (without hard disk)	≤ 30 W
23.	Working temperature	-10 to +55° C (+14 to +131° F)
24.	Working humidity	10 to 90 %
25.	Certfication	UL,CE,FCC,BIS

32 Channel NVR-8 SATA:-

S. No.	Features	Description
1.	System	Dual OS system to ensure high reliability
2.	IP video input	32 ch upto 12MP resolution supported
3.	Incoming bandwidth	Min. 300 Mbps
4.	Outgoing bandwidth	Min. 200 Mbps
5.	Recording resolution	Upto 12MP
6.	Video o/p interfaces	2 HDMI port; atleast 1 supporting 4K resolution, 2 VGA port; atleast 1 supporting 2K resolution
7.	Audio o/p	1 ch
8.	Compression technique	H.265,H.264

9.	Live view/Playback resolution	Upto 12MP resolution
10.	Synchronous playback	Up to 16 channel
11.	Smart Playback function	Should support Smart search for the selected area in the video and smart playback to improve the playback efficiency
12.	VCA storage	Should support saving the captured VCA Pictures for smart IPC's VCA detection
13.	SATA interfaces	Hot swappable 8 sata interfaces with each supporting 8TB, should support ANR technology
14.	Power supply	Should Supports redundant power supply to improve the system stability
15.	RAID arrays	RAID0, RAID1, RAID5, RAID 6, RAID10
16.	Hot spare function	Should support N+1 hotspare function
17.	Network interfaces	2, RJ-45 10/100/1000 Mbps self-adaptive Ethernet interface
18.	Serial inetrfaces	RS-232, RS-485; Keyboard
19.	USB interface	3 × USB connectors, with atleast 1 USB 3.0
20.	Alarm i/o	16 i/p and 4 o/p
21.	Power supply	100 to 240 VAC, 50 to 60 Hz, Dual Power, Redundant
22.	Consumption (without hard disk)	≤ 30 W
23.	Working temperature	-10 to +55° C (+14 to +131° F)
24.	Working humidity	10 to 90 %
25.	Certfication	UL,CE,FCC,BIS

16 Channel NVR :-

S. No.	Features	Description
1.	System	Dual OS system to ensure high reliability
2.	IP video input	16 ch upto 8MP resolution supported
3.	Incoming bandwidth	Min. 160 Mbps
4.	Outgoing bandwidth	Min. 160 Mbps

5.	Recording resolution	Upto 8MP
6.	Video o/p interfaces	HDMI port; Supporting 4K resolution, VGA port; Supporting 2MP resolution
7.	Audio o/p	1 ch
8.	Compression technique	H.265,H.264
9.	Live view/Playback resolution	Upto 8MP resolution
10.	Synchronous playback	Up to 16 channel
11.	Smart Playback function	Should support Smart search for the selected area in the video and smart playback to improve the playback efficiency
12.	VCA storage	Should support saving the captured VCA Pictures for smart IPC's VCA detection
13.	SATA interfaces	2 Sata interfaces with each supporting 6TB, should support ANR technology
14.	Network interfaces	1, RJ-45 10/100/1000 Mbps self-adaptive Ethernet interface
15.	USB interface	2 × USB connectors, with atleast 1 USB 3.0
16.	Alarm i/o	4 i/p and 1 o/p
17.	Consumption (without hard disk)	≤ 15 W
18.	Working temperature	-10 to +55° C (+14 to +131° F)
19.	Working humidity	10 to 90 %
20.	Certfication	UL,CE,FCC,BIS

8 Channel NVR :-

S. No.	Features	Description
1.	System	Dual OS system to ensure high reliability
2.	IP video input	8 ch upto 8MP resolution supported
3.	Incoming bandwidth	Min. 80 Mbps
4.	Outgoing bandwidth	Min. 160 Mbps
5.	Recording resolution	Upto 8MP

6.	Video o/p interfaces	HDMI port; Supporting 4K resolution, VGA port; Supporting 2MP resolution
7.	Audio o/p	1 ch
8.	Compression technique	H.265,H.264
9.	Live view/Playback resolution	Upto 8MP resolution
10.	Synchronous playback	Up to 8 channel
11.	Smart Playback function	Should support Smart search for the selected area in the video and smart playback to improve the playback efficiency
12.	VCA storage	Should support saving the captured VCA Pictures for smart IPC's VCA detection
13.	SATA interfaces	2 Sata interfaces with each supporting 6TB, should support ANR technology
14.	Network interfaces	1, RJ-45 10/100/1000 Mbps self-adaptive Ethernet interface
15.	USB interface	2 × USB connectors, with atleast 1 USB 3.0
16.	Alarm i/o	4 i/p and 1 o/p
17.	Consumption (without hard disk)	≤ 15 W
18.	Working temperature	-10 to +55° C (+14 to +131° F)
19.	Working humidity	10 to 90 %
20.	Certfication	UL,CE,FCC,BIS

24 Port Managed PoE Switch:-

S. No.	Features	Description
1.	Switch Type	Managed Switch
2.	Network Ports	24 port 10/100M RJ45, 2 port 10/100/1000M RJ45
3.	PoE Port	Port 1 to 24
4.	SFP Port	2, 1000M ComboPort
5.	Network & PoE Standard	IEEE802.3, IEEE802.3u and IEEE802.3x, IEEE 802.3af, IEEE802.3at

6.	Backplane bandwidth	8.8 Gbps
7.	Switch max. power	370W
8.	MAC Address Table	4k, Automatic learning/Aging
9.	Port max. power	30W
10.	Power Consumption	≤440W
11.	Working Temperature	Temperature:0°C-40°C, Humidity: 10% to 90% (Relative humidity, without condensation)
12.	Storage Temperature	-40°C-70°C, Humidity: 5% to 90% (Relative humidity, without condensation)
13.	Data Transfer Rate	Ethernet: 20 Mbps (full-duplex) Fast Ethernet: 200 Mbps (full-duplex) Gigabit Ethernet: 2000 Mbps (full-duplex)
14.	Security	MAC address binding, N: 1 port mirroring

32" MONITOR:-

S. No.	Features	Description
1.	Product Type	Workstation LED monitor
2.	Certification	UL, CE, FCC, BIS
3.	Backlight	LED Backlight
4.	Diagonal size	32''
5.	Resolution	1920 * 1080
6.	Visual angle	Horizontal - 178^0 ; Vertical - 178^0
7.	Response time	6.5ms
8.	Contrast	3000:1or better
9.	Brightness	300cd/m2 or better
10.	Input interface	VGA x 1, BNC x 1, HDMI x 1
11.	Operating Temperature	5°C ~ 40°C
12.	Working life	≥60,000 Hours
13.	Remote control	IR remote control shall be supported. Shall be supplied as accessory along with display

Electrical & ELV system Make list		
Sr.No.	Description	Makes / Brand
1	PVC Conduit-(HMS)	Polycab/Legrand/ Precision/ Diamond
2	PVC Casing Capping	MODI / DIMOND / Austo Plast/Polycab
3	Under Floor junction / PVC ROH	M.K./Honeywell
4	PVC wires	RR Kable/Polycab /KEI
5	Modular Switches/Sockets/Modular Plates	Legrand / Schneider /L&T/ MK / Anchor/Panasonic / Hager / ABB
6	Electronic Step Regulator	Legrand / Schneider / MK / Hager /L&T/ ABB/Panasonic/Anchor
7	Telephone Jack	Legrand / Schneider / MK / AMP/D-Link/Anchor/Panasonic / Hager / ABB/L&T
8	TV Sockets	Legrand / Schneider / MK /AMP/D-Link /Anchor/Panasonic/ Hager / ABB/L&T
9	Computer Jack	AMP /Legrand / Schneider / Systimax /D-Link/L&T
10	Bell indicator	Legrand/M.K./ L&T/Schneider/Hanger/Anchor/Panasonic
11	Telephone Cable	RR Kable/ Polycab /KEI /Anchor
12	Co-Axial Cable	RR Kable/Polycab /KEI /Anchor
13	Telephone Instrument	Panasonic/ Beetal/ G.E
14	CAT-6 Cable	Amp/ Systimax/ Legrand / Schneider /D-link
15	Wi-Fi Instrument	Cisco/ MOJO / Aruba /HP
16	LED Lamps	Philips / Crompton / Panasonic
17	LED Indoor Luminaries	Bajaj / Wipro / Philips / Crompton / Panasonic
18	Street Light LED Fitting/ Bollards	Bajaj / Wipro / Philips / Crompton / Panasonic

19	Outdoor Landscape Light fitting	Philips / Crompton / HYBEC
20	Exhaust Fans	Almonard/ Bajaj/Crompton/Orient/Atomberg
21	Sweep Ceiling fan	Almonard/ Bajaj/Crompton/Orient/Atomberg
22	Industrial type exhaust fans	GE / Almonard/ Bajaj/Crompton/Orient
23	Water Heaters	Bajaj / Recold / AO-Smith / Crompton
24	Split AC	Mitshubishi/Toshiba / Daikin
25	Water Cooler	Voltas / Usha/Bluestar/whirlpool/Kent
26	Water Purifier	Aqua guard / Kent / Ao-Smith/ PUREIT
27	Inverter	APC / Sukam / Neowatt - Consul / Emerson - / Numeric- Legrand /Schneider/Eton
28	UPS	APC / Neowatt - Consul / Emerson - / Numeric- Legrand /Schneider/Eton
29	Batteries	Exide / Amaron/ Standard /Amara Raja
30	Modular DB, MCB/MCCB / RCCB / RCBO	Legrand / Schneider /L&T/ ABB / Siemens
31	Industrial Sockets	Legrand / Schneider /L&T/ ABB
32	HT Metering	Huphen/As per MSEB approved make
33	11 kV Kiosk	As per MSEB approved make
34	APFC Panel	L & T / Siemens / Schneider / ABB / Legrand/Malde
35	PVC /XLPE Armoured Cables	RR Kable/ Polycab /KEI / Gloyster
36	HDPE Pipe	Finolex / Abhay Polyster/Gyamsin India
37	Cable Tray	Indiana/ Dumas / Profab / Indiana
38	GI Pipe Pole	TATA / Jindal / Mittal steel
39	High Mast	Bajaj / Wipro / Philips / Crompton / Panasonic
40	Octagonal Pole	Bajaj / Wipro / Philips
41	Maintenance free earthing	Ashlok / Equivalent
42	Transformers	Kirloskar/ABB/Crompton/Volt Amp/ Siemens

43	DG Set	Engine -Cummins /Caterpillar / Kirloskar / Perkins/Greaves Alternator- Stamford/Kirloskar/Greaves/Caterpillar/Perkins
44	Pump / Motor Starter	L&T / Siemens / ABB / Schneider
45	Decorative Luminaires	Bajaj / Wipro / Philips / Crompton / Panasonic / K-Lite/ HYBEC/Lighting Technology
46	Exit Signage - self powered	Clipsal / Pro-lite / Bajaj
47	MV Panel	L & T / Siemens / Schneider / ABB / Legrand
48	MV /LV Switchgears	**ACB** -L & T (Omega) / Siemens (3WL) / Schneider (NW) / ABB (E-max 2) **MCCB** - L & T (D-sine) / Siemens (3VA) / Schneider (NSX) / ABB (T-max)
49	HT Panel	L & T / Siemens / Schneider / ABB / CGL
50	PIR Motion Sensor	Bajaj / Wipro / Legrand
51	11 KV VCB	L & T / Siemens / Schneider / ABB / CGL
52	11 KV RMU	L & T / Siemens / Schneider / ABB / CGL
53	Decorative Pole	Bajaj / Wipro / Philips / Crompton / Panasonic / K-Lite/ HYBEC/Dwarka
54	PTL / Bollards	Bajaj / Wipro / Philips / Crompton / Panasonic
55	MDF Box	Krone / ITI / Equivalent
56	Krone Module	Krone / ITI / Equivalent
57	POE / Non POE Network Switch	Cisco / HP / Juniper/Aruba
58	Fiber LIU & accessories	Amp / Legrand / D- Link / Schneider/ Systimax
59	Network Rack	CISCO/ Aruba/ Juniper
60	Fibre Optic cable and Accessories	Amp / Legrand / D- Link / Schneider / Systimax
61	Beam Detector	System Sensor / Fire Ray / Siemens / Notifier /Simplex/Honeywell
62	Response Indicator	Ravel / Agni /Siemens / Notifier /Simplex/Honeywell

63	FRLS Armoured Cable (Red Colour)	Polycab /Lapp / Caliplast / Neolex
64	Cat 6 Armoured cable	Amp / Legrand / D- Link / Schneider / Systimax
65	Outdoor Twin wall Junction BOX	Valrack / Rittal / Sell Rack
66	Wireless LAN controller	Cisco /HP/Mojo
67	EPABX	NEC / LG / Matrix / Panasonic /Sony
68	Fire Alarm Control Panel	Notifier / Siemens / GE Edward / Simplex /Honeywell
69	Repeater Panel	Notifier / Siemens / GE Edward / Simplex /Honeywell
70	BMS & GUI software	Notifier / Siemens / GE Edward / Simplex /Honeywell
71	Detectors (Smoke, Heat, Muti sensor)	Notifier / Siemens / GE Edward / Simplex
72	Beam Detectors	System Sensor / Fire ray /Siemens /Notifier
73	Manual Call point	Notifier / Siemens / GE Edward / Simplex
74	Control/ Monitor Module	Notifier / Siemens / GE Edward / Simplex /Honeywell
75	Strobe cum sounder / Hooter	Notifier / Siemens / System Sensor
76	Response Indication	Ravel / Agni / Siemens /Honeywell
77	SMPS DC Power Supply	Micro Power / Syntel
78	Speaker (Cone / Box Type / outdoor)	Honeywell / Bosch / Ateis / JBL / Sony / Cisco
79	IP Based Zone Controller	Honeywell / Bosch / Ateis / JBL / Sony / Cisco
80	Digital Amplifier / Power Amplifier	Honeywell / Bosch / Ateis / JBL / Sony / Cisco
81	Mixer Amplifier	Honeywell / Bosch / Ateis / JBL / Sony / Cisco
82	Microphone (MIC) / Call station	Honeywell / Bosch / Ateis / JBL / Sony / Cisco
83	Wireless Microphone	Honeywell / Bosch / Ateis / JBL / Sony / Cisco

84	Music Player	Philips / LG / sony / Samsung or Equivalent
85	Speaker Armoured / Flexible cable	Polycab / Lapp / RR / Neolex / Caliplast
86	IP Dome Type Camera	Sony / Bosch / Honeywell
87	IP Bullet Type Camera	Sony / Bosch / Honeywell
88	IP PTZ Camera	Sony / Bosch / Honeywell
89	Network Video Recorder (NVR)	Sony / Bosch / Honeywell
90	Video management Software	Bosch / Honeywell / Milestone / Genetec / cisco / polycom
91	Surveillance Hard disk	Seagate / WD / sony
92	Server / CCTV Workstation	Dell / HP / Lenovo
93	CCTV Monitors	Sony / Samsung / LG / Philips / Panasonic
94	Biometric Reader & controller	Verdi / Smart I / Spectra / HID
95	Access Control Software	Verdi / Smart I / Spectra / HID
96	Smart Card	HID
97	Electro Magnetic Door Lock & door Sensor	Trimac / BEL / Draficas / Algatel / Dorma
98	Exit Switch Button (bell push type)	Anchor / Legrand / Honeywell
99	Hotel Door Lock System with software	Onity / Ingersoll Rand / Assa Abloy
100	Projector	Sony / Epson / Panasonic or Equivalent
101	Motorized Screen	Dalite / Liberty / Elite / Panasonic
102	HDMI cable	Kramer / MX /BELDEN
103	Lighting Automation	Lutron / Creston / Schneider Elelctric / Siemens
104	Smart TV	Sony / Samsung / LG / Philips / Panasonic
105	FRLS Flexible Cable	Polycab/ RR Kabel / Neolex / KEI / Finolex
106	Lifts	Otis / Kone / ThyssenKrupp/ Mitsubishi

107	Solar PV Panel	Havells Enviro, Tejonidhi infrastructure Pvt. LTD Technologies Pvt. Ltd.,Tata Power Solar Systems Ltd. Green Brilliance energy PVT.LTD, Jain Irrigation System Ltd / Warry/ Sun Technich
108	Solar Inverter	Schneider / Solar Edge / Sungroew/ Delta/Solax /SMA / Fronius / Polycab/ Microtech / Excide / DB
109	VOLTMETER (AC / DC)	L & T / SCHNEIDER / SIEMENS / RISHABH / MECO / AE/ SELECT/TRINITY
110	AMMETER (AC / DC)	L & T / SCHNEIDER / SIEMENS / RISHABH / MECO / AE/ SELECT/ TRINITY
111	POWER CONTACTORS	ABB / SIEMENS /L&T/ SCHNEIDER
112	INDICATING LAPS (LED type) :	L & T / SCHNEIDER / SIEMENS / TEKNIC/ TRINITY
113	PUSH BUTTONS	L & T / SCHNEIDER / SIEMENS / TEKNIC/ TRINITY
114	AUTO / MANUAL SELECTOR	L & T / SCHNEIDER / SIEMENS / TEKNIC/ SELECT/ TRINITY
115	TIMERS	L & T / SCHNEIDER / SIEMENS / TEKNIC / EAPL / SELECT/ TRINITY
116	TERMINAL BLOCKS	ELMEX / WAGO / CONNECTWELL / PHEONIX CONTACT/ TRINITY
117	CURRENT TRANSFORMERS	AE / INDCOIL / KAPPA / VOLTAMPS / RICCO
118	OVER LOAD RELAY	ABB / SIEMENS /L&T/ SCHNEIDER
119	SINGLE PHASE PREVENTORS	ABB / SIEMENS /L&T/ SCHNEIDER
120	ENGINE CONTROL SELECTOR	SALZER / L & T / KAYCEE / SIEMENS / SCHNEIDER/ SELECT
121	MAIN SUPPLY SELECTOR – DPMCB	ABB / SIEMENS /L&T/ SCHNEIDER
122	BATTERY CHARGING SEL	SALZER / L & T/ KAYCEE
123	BATTERY CHARGER	KAYBEE POWEREC / CHABBI
124	SIREN / HOOTER	KHERAJ/EQUI.

125	TOGGLE SWITCH	JAY / EQUI
126	RODENT SYSTEM	VARNA ENTERPRISES / MESSAR/ DAKSHATA INDIA

Special Additional Conditions

Electrical Works

General conditions of supply of electrical equipments:

I. The tenderer / bidder shall submit all technical data and catalogues of all relevant manufacturers he wishes to supply in his offer. However, the supply and selection of materials and makes shall comply with the standards and approvals set herein only. If any deviations are noted, they shall be listed separately, the bidder at his own discretion may list out any such reasons on quality / specifications / technical data for deviating from approved makes. These shall then be appropriately considered. However all such deviations shall ONLY be made by the bidder as alternate to the makes and materials specified. If these are not indicated then the bidder's offer is likely to be rejected.

II. All tests to be performed prior to supply shall be indicated clearly by the bidder. It is generally expected that all type and routine tests for all, equipments required to be supplied under this tender shall complied to, however if the bidder wishes to deviate for certain reasons all such reasons should be clearly brought out in the offer. Specifically, all tests shall be called for noted in this section.

III. The successful tenderer / bidder shall be entirely responsible for Guarantee of every equipment supplied performing in a continuous manner and mode acceptable to the Owner.

IV. The successful tenderer / bidder shall submit minimum eight sets of all equipments drawings, maintenance manuals, test certificates, guarantees of equipments etc. to the Owner, at the time of supply.

General conditions for tests to be called for approval purpose:

I. The successful tenderer / bidder shall carryout in the presence of Owner's Representative all such tests that are underlined in Annexure. Such tests shall be carried out at the manufacturers or at works of bidder or at sub-works if the Bidder in a manner as underlined in the said Annexure.

II. The successful tenderer shall then forward all the relevant copies of Test so performed in sets for the record of the Owner / Client / Consultants.

III. The successful tenderer shall consider all these costs in the net unit rate under specific items in the tender in stated items in Schedule of Quantities.

IV. The successful tenderer shall give clear 15 days notice in writing for all such tests to be carried out at relevant place of Manufacture, Works, and Sub-works etc. The cost incidental to such tests being carried out shall be

borne by the successful tenderer and shall be deemed to have been included in the specific unit rate of that item. However, the cost incidental to the Owner's Representative making such visits for inspection only shall be borne by the Owner in a manner determined fit by the Owner.

Mode of measurements:

The mode of measurements for this contract shall be on item rate basis and shall include all quantities specified in the Bill of Quantities of this tender. It shall be further deemed that all variations and deviations if specifically agreed to in writing shall also form as an extended part of this tender and shall be subject to first verifications of quantities on the basis of mode of measurements herein stated. For the sake of clarifications the different terms stated hereinafter shall form the basis of Mode of Measurements taken with a specific purpose of determining the extent of work executed. This shall primarily form the basis of the billing of quantities for payments.

Job:-

It shall be defined as all works specified in detail specifications and in the bill of quantities. These shall mean all works associated with it for the specific purpose of commissioning that item. Nothing shall be deemed to be excluded even though specifically not brought out in the tender. It shall be basically the responsibility of the successful bidder/tenderer to understand the meaning herein contained.

Lump sum:-

It shall mean all works included in this tender and shall not be subject to any individual items as a piece of running meter item. Everything under this unit shall be construed to mean that every item required for completing and commissioning that specific item.

Meter:-

It shall mean the standard measurement unit as defined in the International Measurement Codes. These shall be the basis of unit, wherever, specified and shall not contain any tail wires, overlapped joints, wastage of cut lengths etc.

Number (No.):-

These shall be deemed to contain all physically measurable numbers of quantities executed in the course of the Contract.

Points:-

Under the heading of Light Point wiring, Power Point wiring, socket/receptacle outlets, this unit shall be applicable. The unit defined for various points applicable and defined is as stated herein under:-

Light Points control:

All point wiring done should be done according to the specification mentioned in the PWD/Tender.

Notes:-

The Contractor shall give due notice to the Owner / Employer and/or Client / Consultants in writing whenever any work is to be buried in the earth or made inaccessible later on, in order that the work may be inspected and correct dimensions taken before such burial in default where of the same shall be the option of the Owner/Employer and/or Client / Consultants by either opened up for measurement at the Contractors expense and no allowance shall be made for such work.

Safety codes:

Scaffolds:-

i. Suitable scaffold shall be provided for workmen for all works that cannot safely be done from the grounds or from solid construction except in the case of short duration work which can be done safely from ladders. When a ladder is used, it shall be of rigid construction made either of good quality wood or steel. The steps shall have a minimum width of 450 mm and a maximum rise of 300 mm. Suitable hand holds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper than 1/4 to 1 (1/4 horizontal and 1 vertical).

ii. Scaffolding or staging more than 4.0 m above the ground floor swung or suspended from an overhead support or erected with stationary support shall have a guard rail properly bolted, braced or otherwise secured at least 1.0 m above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

iii. Working platform, gangways and stairway shall be constructed that, they do not sag unduly or unequally and if the height of the platform, gangway or stairway is more than 4.0 m above ground level or floor level, they shall be closely boarded and shall have adequate width and be suitably fenced as described in 29(ii)

iv. Every opening in the floor of a building or in a working platform shall be provided with suitable means prevent the fall of persons or materials by providing suitable fencing or railing.

v. Wherever there are open excavations in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into excavations.

vi. Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in length while the width between side rails in rung ladder shall in no case be less than 290 mm. for ladder up to and including 3 m in length. For longer ladders this width shall be increased at least 20 mm for each additional meter of length.

vii. A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to construction.

Other Safety Measure:

i. All personnel of the Contractor working within the plant site shall be provided with safety helmets. All welders shall wear welding goggles while doing welding work and all metal workers shall be provided with safety gloves. Persons employed on metal cutting and grinding shall wear safety glasses.

ii. Adequate precautions shall be taken to prevent from electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public.

Excavation and Trenching:

All trenches, 1.25 meter or more in depth, shall at all times be supplied with at least one ladder for each 30m. in length or fraction thereof. The ladder shall be extended from bottoms of the trench to at least 1 m. above the surface of the ground. Sides of trenches which are 1.5 m. or more in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger of sides collapsing. The excavated material shall not be placed with 1.5 m of the edges of the trench or half of the depth of the trench whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

The Contractor shall take all measures on the site of the work to protect the public from accidents and shall be bound to bear the expenses of defence of every suit, action or other proceedings at law that may be brought by any persons for injury sustained owing to neglect of the above precautions and to pay any such persons or which may with the consent of the contractor be paid to compromise any claim by such person.

Demolition:-

Before any demolition work is commenced and also during the process of the work:

a) All roads and open areas adjacent to the work site shall either be closed or suitably protected.

b) No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by the operator shall remain electrically charged.

c) All practical steps shall be taken to prevent danger to persons employed from the risk of fire or explosion or flooding. No floor, roof or other part of the building shall be as over-loaded with debris or materials as to render if unsafe.

Personal Safety Equipments:-

All necessary personal safety equipment as considered adequate by the Engineer should be kept available for the use of the person employed on the site and maintained in a condition suitable for immediate use and the

contractor should take adequate steps to ensure proper use of equipment by those concerned.

1) Workers employed on mixing asphalted materials, cement and lime mortars shall be provided with protective footwear and protective goggles.
2) Those engaged in white washing and mixing or stacking of cement bags or any material which is injurious to the eyes shall be provided with protective goggles.
3) Those engaged in welding works shall be provided with welder's protective eyesight lids.
4) Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
5) When workers are employed in sewers and manholes, which are in use, the contractor shall ensure that the manhole covers are opened and are ventilated at least for an hour before the workers are allowed to get into manholes and manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.
6) The contractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting the following precautions should be taken :

   i. No paint containing lead products shall be used except in the form of paste or ready made paint.
   ii. Suitable face masks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.

   iii. Overalls shall be supplied by the contractor to the workmen and adequate facilities shall be provided to enable the working painter in wash during the cessation of work.
   iv. When the work is done near any public place where there is risk of drowning all necessary equipments should be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision should be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

Inspection at Various Manufacturers' Works:

The Contractor has to borne all the Expenditure for One Representative of Client, One Representative of Consultants and One Representative of Client and MSEB / PWD for all the visits required for Inspection purpose out of Mumbai. This expenditure shall include Air Fare / First Class lodging, boarding and local conveyance.

SAFETY REGULATIONS

General:

Contractor shall adhere to safe construction practice and guard against hazardous and unsafe working conditions and shall comply with Employer's safety rules as set forth herein.

Safety regulations:

In respect of all labour, directly or indirectly employed in the work for the performance of Contractor's part of this agreement, the Contractor shall at his own expense arrange for all the safety provisions as per safety codes of Indian Standards Institution, statutory requirements of Factory Building Act and all other statutory requirements, Regulations, Rules, and orders made there under and such other acts as applicable. Special attention shall be given to the various provisions of safety codes of Factories Act, 1948 & statutory amendments or modifications enforced time to time.

The Contractor shall observe and abide by all safety, fire safety regulations adopted by the Employers. Before starting construction work, Contractor shall consult Employers safety Security officer and must make good to the satisfaction of the Employer any loss or damage due to fire to any portion of the work done or to be done under this contract or to any of the Employer's existing property.

First aid and industrial injuries:

Contractor shall maintain first aid facilities for his employees and those of his sub-Contractors.

Contractor shall make outside arrangements for ambulance service and for the treatment of industrial injuries. Names of those providing these services shall be furnished to Employers prior to start of construction and their telephone numbers shall be prominently posted in Contractor's field office.

All critical, industrial, reportable and fatal injuries shall be reported promptly to Employers first and then to Factory Building inspector's office and police department and a copy of Contractor's report covering each personal injury requiring the attention of a physician shall be furnished to the Employers. A Contractor shall take all necessary action vis a vis the compliance of statutory requirements of said authorities. Contractors shall settle all such incidences and keep the Employer indemnified against complications arising out of the same.

General rules:

Smoking within the Work Area, is strictly prohibited Violators of the "No Smoking" rules shall be discharged immediately.

General safety:

Before any demolition work is commenced and also during the process of the demolition work, No electric cable or apparatus, which is liable to be a source of danger, shall remain electrically charged.

All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

All persons connected with the execution of works shall were safety helmets, safety shoe, gloves, safety belts, shields, goggles and protective appliances, safety ladders, platforms etc. to the specific requirements of the work.

Suitable screens, curtains (plastic mesh hassion) shall be provided. The same shall be maintained in good condition at all the times.

Precautions against fire:

The Contractor will have to provide adequate Fire Extinguishers / Fire Buckets and drums at work site as recommended by Consultants representative. They will have to ensure all precautionary measures and exercise utmost care in handling the

inflammable gas cylinders/inflammable liquid/paints etc. as advised by CONSULTANTS. Temporary combustible structures will not be built near or around the work site.

Explosives:

Explosives shall not be stored or used on the works or on the site by the Contractor without the permission of the Consultants representative in writing and then only in the manner and to the extent to which such permission is give. When explosives are required for the works they shall be stored in a special magazine to the provided at the cost of the Contractor in accordance with the Explosive Rules. The Contractor shall obtain the necessary license for the storage and the use of explosives and all operations in which or for which responsibility of the Contractor shall indemnify the Employer against any loss or damage resulting directly or indirectly.

Preservation of place:

The Contractor shall take requisite precautions and use his best endeavours to prevent any riotous or unlawful behaviour by or amongst his workmen and others employed on the works and for the preservation of peace and protection of the inhabitants and security of property in the neighbourhood of the work. In the event of the Employer requiring the maintenance of special police force at or in the vicinity of the site during the tenure of works, the expense thereof borne by the Employer shall be recoverable from the Contractor.

Outbreaks of infectious diseases:

The Contractor shall remove from his camp such labour and their families as refuse protective inoculation and vaccination when called upon to do so by the Consultants representative. Should cholera, plague or other infections diseases break out the Contractors shall burn the huts, beddings, clothes and other belongings of or used by the infected parties and promptly erect new huts on the sites as required by Consultants representative failing which within the time specified in the Client's requisition, the work may be done by the Employer and the cost thereof recovered from the Contractor.

Use of intoxicants:

The sale of advent spirits or other intoxicating beverages upon the work in any of the buildings encampments or tenements owned, occupied by or within the control of the Contractor or any of his employees is forbidden and the Contractor shall exercise his influence and authority to the utmost extent to secure strict compliance with this condition.

In addition to the above, the Contractor shall abide by the safety code provision as per CPWD safety code and Indian Standard Safety Code framed from time to time.

Breach of safety regulations:

Breach of safety regulations will be viewed very seriously and the Contractors shall be liable for punitive action as will be recommended by the safety officer of the Employers.

TECHNICAL SPECIFICATIONS

IV- FIRE FIGHTING WORKS

1. FIRE PROTECTION REQUIREMENTS

General:

Fire safety in building has become very important consideration in construction and maintenance. A normal office building has fire load in the form of large quantity of papers and furnishing. Buildings like Hospitals, Laboratories, Auditorium, Libraries, and Museum etc. require fire safety provisions by virtue of their type of occupancy and importance irrespective of their height. The design and installation of a fire fighting system is of utmost importance. The fire fighting installation on completion will have to be got cleared from the local fire fighting authorities (Fire Service) for its efficacy, suitability and usability by the Fire Service in the event of a fire.

The contractor should have valid license from Directorate of Maharashtra Fire Services in relation to:

a) Fire fighting system installation such as Hydrant, Sprinkler, Pumping etc.

b) Detection and fire suppression system.

Following types of water based fixed fire fighting installations are normally provided in buildings:

Hydrant system

Wet Riser

Down Corner

Automatic Sprinkler

The design of fire fighting system for a building shall base as per the provisions in National Building Code of India (Part IV) (Amended upto date) and also considering the provisions in the Development Control Rules of local body/authority.

The operating pressure of individual hydrant shall be between 5.5 kg/cm^2 to 3.5.kg/cm^2 and the operating pressure of the furthest level hydrant from main pump shall be minimum 3.5 kg/cm^2

The pipeline will be designed in such a way that it should be possible to get discharge at any location.

Specifications:

This part deals with the specifications of following pumps.

Specification No(s)

1.1 1. Main Fire Pump (Single Stage) (FF-MFP/SSC)

2. Jockey Pumps (FF-MFP/JP)

3. Booster Pumps (FF-MFP/BP)

Scope:

Supplying, installing, testing, perfect aligning, proper leveling and commissioning of Fire service main/jockey/booster pump single/multi stage having specified discharge and head with required HP or similar to with minimum parameters, confirming to IS:1520 with specified size of suction and delivery pipes, coupled with squirrel cage. A.C. induction motor. The pump set shall be erected in alignment on cement concrete foundation. The Main Fire pumps should be able to deliver minimum operating pressure of 3.5kg/cm^2 at highest and farthest hydrant.

Material:

Pump Body:

The centrifugal pumps shall conform to IS 1520. The pump casing shall be of heavy section close grained cast iron and designed to withstand 1.5 times the working pressure. The casing shall be provided with shaft seal arrangement as well as flanges for suction and delivery pipe connections as required.

Impeller:

The impeller shall be bronze. This shall be shrouded type with machined collars. Wear rings, where fitted to the impeller, shall be of the same material as the impeller. The impeller surface shall be smooth finished for minimum frictional loss. The impeller shall be secured to the shaft by a key.

Shaft:

The shaft shall be of stainless steel EN-8/C-40 and shall be accurately machined. The shaft shall be balanced to avoid vibration at any speed within the operating range of the pump.

Shaft Sleeve:

The shaft sleeve shall be of bronze

Bearing:

The bearing shall be of stainless steel and of ball or roller type suitable for duty involved. These shall be grease lubricated and shall be provided with grease nipples

/cups. The bearings shall be effectively sealed against leakage of lubricant of lubricant or entry of dust or water.

Shaft seal:

The shaft seal shall be mechanical type so as to allow minimum leakage. A drip well shall be provided beneath the seal.

Motor:

Suitable HP squirrel cage induction motor, TEFC (totally enclosed fan cooled) synchronous speed 2900 RPM, suitable for operation on 415 volts, 3 phase 50 Hz AC with IP 55 protection for enclosure, horizontal foot mounted type with Class-"F" insulation, conforming to IS-325.

Body: Cast iron

Rotor Shaft: Stainless steel

Bearing: Refer specification for bearing under Pump above.

Winding: Class "F" insulated copper winding.

Base plate: Fabricated from Mild steel, foundation bolts etc.

Cement Concrete Foundation: Cement, Sand and Water, in 1:2:4 ratio.

Anti Vibrating Pads: Made from high quality rubber of specified grade and strength.

Hardware: Mild Steel

Method of Construction:

The surface of the pump foundation should be chipped with pneumatic hammer or sharp pointed chisel. The teak wood box of appropriate size shall be placed and filled with cement concrete in 1:2:4 ratio with 20 x 25 mm stone metal and required size and strength of foundation nut & bolts. The necessary curing and finishing shall be done in approved manner. The M.S. fabricated base plate of suitable size and strength should be fixed with anti-vibration rubber pads. Proper leveling and alignment shall be observed before tightening of foundation bolts. Both the pump and motor shall be placed on common base plate frame with perfect alignment, proper leveling. The pump should be connected to pipe line with M.S. flanges, caskets, nut bolt etc. and shall be checked for the leakages. The coupling guard shall be provided with nut bolts of required size. The pump shall be tested for 3.5 kg/cm^2 pressure at highest and farthest point of the building for minimum 2 hours. The necessary test certificate from manufacturer of pump and motor shall be

produced. The motor should have efficiency more than 90% and power factor above 0.80.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.2 Pipes

Specification No. (FF-PP)

Scope:

Supplying erecting C class (Heavy Duty) galvanized iron pipe, ISI mark of specified diameter with screwed sockets, Joints & necessary G.I. fittings such as sockets, check nuts, elbows, bends, tees, reducers, enlarger, plugs, etc. including electric resistance welding (ERW), fixing with clamps and all connected works such as two coats of synthetic enamel **painting including etch primer** (PAINTING THICKNESS: MIN 60 MICRON PER COAT) for aboveground pipes, excavation, drilling holes in wall, slabs, backfilling & making good the damages.

Jointing process for piping works:
Root welding + Fill up E-6013 (SMAW)

WELDING ROD: ESAB / ADVANI OERLIKON (E 6013)

Material:

The galvanized iron pipes shall be of type and diameter as specified and shall comply with I.S.1239-1973 and 1969 for the specified type. The specified diameter of the pipes shall refer to the inside diameter of the bore pipes. The fittings of which the galvanizing has been damaged shall not be used. For the firefighting works, the C Class pipes and accessories shall be used.

Anti-Corrosive Protection on Under Ground Pipe:

Corrosion protection tape shall be wrapped on M.S. Pipes to be buried in ground. This corrosion protection tape shall comprise of coat tar/asphalt component supported on fabric of organic of organic or inorganic fiber and minimum 4mm. thick and conform to requirement of IS: 10221-Code of practice for coating and wrapping of underground mild steel pipe line. Before application of corrosion protection tape all foreign matter on pipe shall be removed with the help of wire brush and suitable primer shall be applied over the pipe thereafter. The primer shall be allowed to dry until the solvent evaporates and the surface becomes tacky. Both primer and tape shall be furnished by the same manufacturer. Corrosion protection tape shall then

be wound around the pipe in spiral fashion and bounded completely to the pipe. There shall be no air pocket or bubble beneath the tape. The overlaps shall be 15mm and 250mm shall be left uncoated on either end of pipe to permit installation and welding. This area shall be coated and wrapped after the pipe line is installed.

The tapes shall be wrapped in accordance with the manufacturer's recommendations. If application is done in cold weather, the surface of the pipe shall be pre-heated until it is warm to touch and traces of moisture are removed and then primer shall be applied and allowed to dry. No joint shall be located in the thickness of the walls. If the pipe is required to be cut and the end threaded, the burns of the cut end shall be filled smooth and any obstruction in the bore shall be entirely eliminated. The rate includes wastage in cutting etc. When the pipe is to be fixed to walls it shall be fixed with standard bracket, clips or holder bates keeping the pipe about 12mm clear of the wall. The pipe shall be fixed to the wall horizontally and vertically and parallel to one another when more than one pipe is laid unless unavoidable. The supporting clips etc. for the pipe shall be spaced at about two meters or so as necessary. When holes are not left during construction they shall be cut into the walls or slabs, etc. to pass the pipe through or to fix clamps, etc. after fixing of the pipes, clamps etc. these shall be neatly made good.

Pressure Testing:

All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 10 kg/cm^2 for a period not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-charge. Piping repaired subsequent to the above pressure test shall be re-tested in the same manner. System may be tested in sections and such sections shall be securely capped. Pressure gauges may be capped off during pressure testing of the installation.

Method of Construction:

Galvanized iron pipes of specified diameter and type and galvanized iron fittings with ERW shall be erected on MS angle support with one coat of etch primer and two coats of Post Office fire red enamel paint duly tested to 1.5 times of working pressure. Excavating and back filling trenches including dewatering, cutting through walls, floor etc. and making site good. Laying, jointing, and fixing the pipe with the fittings including cutting pipes, wastage and threading the ends. At all the road crossings the pipes shall be laid lower than the crust of the road. During excavation if, any other service pipes (Water, electric, telephone, etc) come across, these shall be carefully protected and supported. Any damages done shall be made good. The pipe shall be laid on a well compacted bed in the trench. The trench after laying the pipe

shall be refilled except at the joints in layers and manually rammed. Care shall be taken to see that no earth, etc. gets inside the pipes. The filling shall be kept raised by about 5cm. for subsequent settlement. Bedding and cushioning of murum, good earth, or sand shall be provided for the pipe in case of trench through rock. The trench at the joints shall be filled similarly after satisfactory testing of the pipe. Any surplus excavated stuff shall be disposed of satisfactorily without causing nuisance.

Mode of Measurement:

Measurement shall be for one metre of each type and diameter of pipe laid complete with fittings, clamps etc. as specified. The lengths shall be measured net on the straight and bends along the center line of the pipes and fittings correct up to a cm.

1.3 Strainer (+ve suction)

Scope:

Specification No. (FF-VL/ELS)

Supplying and installing end line strainer of specified diameter conforming to IS: 907, fabricated out of brass perforated sheet of 14 SWG (2.0 MM Thk) duly with brazing with flange or pipe with nut bolts, gaskets, washers etc, in position for only suction in approved manner.

Material:

Body: cast iron

Strainer screen: stainless steel/Brass screen of 1 mm thick perforated sheet with 3 mm dia holes

Flange: Cast iron/ M S sheet

Method of Construction:

End line strainer shall be fitted with provided flange, gaskets, nut bolts etc. and to be erected at the end of suction pipe, including labour and required tools and plants.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.4 Sluice valve

Specification No. (FF-VL/SV)

Scope:

Supplying and installing cast iron double flange sluice valve of specified diameter conforming to IS:780, ISI mark, having cast iron body and gun metal working parts

with nut bolts, gaskets etc. and tested to 1.5 times of working pressure, in an approved manner.

Material:

Body: a) Brass b) Leaded tin bronze

Bonnet or cover: a) Leaded tin bronze b) Forged brass, c) Brass

Stuffing box, disc hinge, check nut, stem nut, disc retaining nut, gland, gland nut, gland flange, body seat rings and disc or wedge facing rings (where renewable): a) Leaded tin bronze, b) Extruded brass rod, c) Forged brass d) Brass

Stem, hinge pin and plug: a) Extruded brass b) High tensile brass, c) Forged Brass

Ball (for ball type check valves): Chromium steel.

Nut bolts: Mild steel

Hand Wheel: Cast iron

Gasket: Compressed asbestos fibre

Gland packing: a) Hemp and jute b) Asbestos

Spring: Phosphor bronze wire

Seating ring: Synthetic rubber

Method of Construction:

The double flange sluice valve shall be fitted with provided flange, gaskets, Nut bolts, etc. to be fitted to pipe, accessories with washers, spring washers, check nuts as required with proper alignment so as to be leak proof including necessary labour and required tools and plants.

Mode of Measurement;

Executed quantity shall be measured on number basis.

1.5 Butterfly valves

Specification No. (FF-VL/BFV)

Scope:

Supplying & installing cast iron double flange butterfly valve of size 75/80mm. dia confirming to IS: 13095 having cast iron body. FG 220 Nitrite rubber replaceable seat with Moulded "O" ring, C.I. powder coated disc flow control complete & instead to 1.5 times of working pressure in an approved manner.

Material:

Body: Cast iron Spheroid graphite iron Carbon steel.

Disc: a) Cast iron Spheroid graphite iron carbon steel, b) Stainless steel Gun metal c) Aluminium bronze

Shaft: a) Stainless steel b) Carbon steel Aluminium bronze Nickel copper alloy

Seating ring Seal retaining ring: a) Stainless steel, b) Gun metal aluminium bronze deposited metal suitable for duty or resilient material.

Seat: Elastomers

Shaft bearing seals: Manufacturer's standards suitable for duty.

Internal fastenings: Stainless steel

External bolting: Carbon steel

Method of Construction:

The double flange butterfly valve shall be fitted with provided flange, gaskets. Nut, bolts etc. to be fitted to pipe, accessories with washers, spring washers, check nuts as required with proper alignment so as to be leak proof including necessary labour and required tools and plants.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.6 Non Return Valves

Specification No. (FF-VL/NRV)

Scope:

Supplying & installing double flange NRV of specified diameter conforming to IS: 5312 (Part-1), ISI mark, having cast iron body and gun metal working parts with nut bolts, gaskets etc.and tested to 1.5 times of working pressure in an approved manner.

Material:

Body, cover, door, bearing holder: Grey cast iron

Hinge pin, door pin and door suspension pin: Stainless steel

Body seat rings: Leaded tin bronze

Door face ring: Leaded tin bronze

Bearing bushes/Bearing block: Leaded tin bronze

Plugs for hinged pin/Air release plug: Leaded tin bronze

Bolts: Carbon steel

Nuts: Carbon steel

Gaskets: Rubber

Hinges: Grey cast iron

P N Rating and Test Pressure:

S.No.	PN Rating	Test for	Test Pressure (Gauge)MPs	Test Duration in minutes
1	PN 1.0	Body Seat	1.5 1.0	5 2
2.	PN 1.6	Body Seat	1.5 1.0	

Method of Construction:

The double flange NRV shall be fitted to pie with provided flange, gaskets, and nut bolts etc. accessories with washers, spring washers, and check nuts as required with roper alignment so as to be leak proof including necessary labour and required tools and plants.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.7 Hydrant Valves (Landing Valves)

Specification No. (FF-VL/HV)

Scope:

Supplying and installing gun metal single outlet, hydrant valve Morris pattern, oblique type, conforming to IS:5290, ISI mark, with G.M. blanks cap and M.S. or G.I. chain in an approved manner.

Material:

Valve Body, bonnet, stop valve, Check nut, female outlet: Bronze/Aluminium alloy or Stainless Steel as per BOQ

Hand Wheel: M.S. or C.I. (Black painted)

Spring: Made of phosphor wire

Washer, Gasket: Rubber

Blank Cap: ABS plastic

Method of Construction:

The hydrant valve shall be connected with provided flange, gaskets, Nut bolts etc. with use of required tools and plants.

The water discharge shall be not less than 900 lpm for single head and 1800 lpm for double head valves at 7kg/cm^2

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.8 Hose Reel

Specification No. (FF-FFA/HRD)

Scope:

Supplying and installing wall mounting swinging Hose reel drum as per IS:884 and fitted with 19mm dia. 30 meter long high pressure polypropylene (Polyhose) pipe as per IS: 444 (type III) G.M. chrome plated nozzle and 19 mm dia. And G.M. gate valve on the inlet pipe with necessary M.S. Bracket for holding Hose reel drum fitted in position with wall fasteners, in an approved manner.

Material:

Hub and sides: Aluminium Alloy/Mild steel/Aluminium sheet.

Wall Bracket: Cast iron/Mild steel

Hose tube (20mm): Thermoplastic (Textile Reinforced) Type-2, (Nominal internal dia) as per IS-12585

Nozzle with branch Pipe: Brass as per IS 8090

Stop Valve (Ball Valve): Gun metal

Method of Construction:

The wall mounting swinging Hose reel drum with Gun Metal Nozzle, gate valve, shall be connected on M.S. bracket with provided flange, gaskets, Nut bolts etc. with use of required tools and paints. The water flow rate shall be not less than 24 LPM and the range of jet shall be not less than 6 metre.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.9 R.R.L. Hose Pipe

Specification No. (FF-FFA/RRL)

Scope:

Supplying fire fighting R.R.L. Hose pipe, conforming to IS: 636 (Type-A) 15 meter length, fitted with male and female G.M. coupling conforming to IS: 993, with ISI mark.

Material:

Hose pipe material: Rubber lined woven jacketed & 63mm in dia., the lining and the cover shall be of uniform thickness, reasonably concentric and free from air blisters, porosity and splits. The tensile shall be minimum 5.00 MPa and shall withstand pressure of 10.2kg/cm^2

Coupling: Gun metal

Method of Construction:

Hose pipe of 15 metre length with male and female Gun metal coupling shall be connected as per direction.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.10 Nozzles

Specification No. (FF-FFA/NZ)

Scope:

Supplying G.M. branch pipe of 63 mm diameter with specified length fitted with 20 mm diameter detachable hexagonal nozzle confirming to IS: 903, ISI mark.

Material:

Nozzle: Chrome plated Gun metal

Method of Construction:

Gun metal hexagonal nozzle fitted with required tools and plants including necessary labour, material etc.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.11 Fire Brigade connection

Specification No. (FF-FFA/FBC)

Scope:

Supplying and installing fire brigade Header pf 150mm Φ G.I. "C" class pipe having 2 Nos. of 100mm 'T' outlet with 100mm Φ flange, fitted with 2 Nos. of G.M. fire branching inlet connection, each consisting of 2 Nos. 63mm dia. G.M. male inlet for supplying water in fire tank.

Material:

Pipe material: G.I. 'C' class (Heavy duty)

Branching inlet: Gun metal

Male inlet: Gun metal

Method of Construction:

In case under ground storage tank is not approachable by fire tenders, a 4 way 63mm diameter instantaneous male inlet connection is provided at street level and connected to UG tank with 1 meter length of 150mm. diameter underground pipe. The whole unit shall be placed in provided MS box made of 2mm thick MS sheet with openable glass cover.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.12 Siamese connection (Fire service inlet)

Specification No. (FF-FFA/SMC)

Scope:

Supplying and installing fire brigade Header (Siamese Connection) of 150mm Φ G.I. 'C' class pipe having 2 Nos. of 100mm 'T' outlet with 100mm Φ flange, fitted with 2 Nos. of G.M. Male inlets with spring type NRV for supplying water to Wet riser.

Material:

Pipe material: G.I. 'C' class

Branching inlet: Gun metal

Male inlet: Gun metal

Non Return Valve: As per **(FF-VL/NRV)** above

Method of Construction:

In order to facilitate feeding of water in the system by fire service, a 4 way 63mm diameter collecting head shall be provided and connected with each riser/down corner and the ring main with non return valve and with provided butterfly/sluice valve. This should be located at a place where fire brigade tender can reach.

The whole unit is placed in provided MS box made of 2 mm thick MS sheet with open-able glass cover.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.13 Air Cushion Tank (Air Vessel)

Specification No. (FF-FFA/ACT)

Scope:

Supplying and installing Air Vessel of 300mm Φ 1.5 mtr. In height M.S. Tank fabricated from M.S. black ERW pipe, conforming to I.S.3589, having 6mm thickness, dish end at both ends, duly welded with 300mm Φ pipe, having inlet of 50mm Φ , duly fitted with 50mm Φ sluice valve and 20/25mm Φ drain with G.M. gate valve, to be installed inside pump house along with provided M.S. angle tripod.

Material:

Air Vessel: MS ERW pipe confirming to IS: 3589

Tripod: MS angle of size 75 x 75 x 5mm

Method of Construction:

300mm dia. 1.5 metre height air vessel, Gate Valve, flanges, MS angle Tripod including necessary labour, material and use of required tools and plants.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.14 Air Release Valve

Specification No. (FF-FFA/ARV)

Scope:

Supplying and erecting Air release cock of 20/25mm Φ made from G.M. with necessary G.I. coupling for fixing on top of Air vessel or on wet riser.

Material:

Air release Valve: Gun metal

Coupling: G.I.

Method of Construction:

Air release Valve with necessary GI coupling shall be fixed on top of wet riser with required labour, tools etc.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.15 Pressure Gauge

Specification No. (FF-FFA/PG)

Scope:

Supplying and installing pressure guage of 100 mm dia or 0-14 kg/cm2 fitted with 12/15mm Φ pad cock valve, G.I. nipple, elbow etc. as per requirement in an approved manner.

Material:

Pressure gauge: 100 mm diameter made from brass metal

Cock valve, elbow, pipe: G.I.

Method of Construction:

The 100 mm dia Pressure Guage with G.I. cock valve, erected with G I pipe including accessories with required labour, tools. Etc. as directed by engineer - in -charge.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.16 Pressure Switch

Specification No. (FF-FFA/PS)

Scope:

Supplying and installing pressure switch with 12/15mm Φ isolation valve, G.I. nipple, elbow etc. in an approved manner.

Material:

Pressure switch: Brass metal

Isolation valve, elbow, Nipple: G.I.

Method of Construction:

The Pressure switch with G.I. isolation valve, and necessary G.I. fittings (elbow, Nipple) fitted with required labour, tools. Etc.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.17 Gate Valves

Specification No. (FF-VL/GV)

Scope:

Supplying and installing Gun metal Gate valve of specified diameter having threaded ends conforming to IS: 778, ISI mark, along with G I threaded nipple.

Material:

Body: a) Brass b) Leaded tin bronze

Bonnet or cover: a) Leaded tin bronze b) Forged brass, c) Brass

Stuffing box, disc hinge, check nut, stem nut, disc retaining nut, gland, gland nut, gland flange, body seat rings and disc or wedge facing rings (where renewable): a) Leaded tin bronze, b) Extruded brass rod, c) Forged brass d) Brass

Stem, hinge pin and plug: a) Extruded brass b) High tensile brass, c) Forged Brass

Ball (for ball type check valves): Chromium steel.

Nut bolts: Mild steel

Hand Wheel: Cast iron

Gasket: Compressed asbestos fibre

Gland packing: a) Hemp and jute b) Asbestos

Spring: Phosphor bronze wire

Seating ring: Synthetic rubber

Method of Construction:

The Gate valve shall be fitted to pipe with provided flange, gaskets, Nut bolts, etc. to accessories with washers, spring washers, check nuts as required with proper alignment so as to be leak proof including necessary labour and required tools and plants.

Mode of Measurement;

Executed quantity shall be measured on number basis.

1.18 Orifice Plate

Specification No. (FF-FFA/OP)

Scope:

Supplying and erecting one no. Brass orifice plate having 6 mm thick with specified outer diameter and suitable inner diameter to reduce the pressure between 3.2 kg/cm2 to 5.5 kg/cm2.

Material:

Body: Stainless steel 6 mm thick

Method of Construction:

The orifice plate shall be placed before the hydrant valve

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.19 Foot Valve with Strainer (-ve suction)

Scope:

Specification No. (FF-VL/FV)

Supplying and installing cast iron foot valve of specified diameter with strainer conforming to IS: 4038 with Gun metal seat (flapper), nut bolts, gasket, washers etc. for negative suction.

Material:

Housing, seat discs and disc plates: Grey cast iron

Hinge pins and disc guide: High tensile Stainless Steel bars

Strainers: a) Grey cast iron b) Galvanized steel.

Disc faces: a) Vegetable tanned leather (Min.3 mm thick), b) Leaded tin bronze, c) Natural rubber (with reinforcement of cotton canvas)

Flange jointing nature: a) Compressed fiber board or rubber minimum 1.5mm thick. The fiber board shall be impregnated with chemically neutral oil and shall have a smooth and hard surface. b) Compressed asbestos fiber.

Method of Construction:

The footwall with strainer shall be fitted with provided flange, gaskets, nut bolts to be erected at required position and fitted firmly to pipe with proper alignment so as the joints should be leak proof with shellac and other material required including necessary labour and required tools and plants.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.20 Priming Tank

Specification No. (FF-VL/FFA/PT)

Scope:

Supplying and Installing One piece Moulded hdp /Fibre water tank of required capacity with necessary plumbing material on provided M.S. structural supports in an approved manner.

Material:

Priming Tank: HDPE/Fiber of good quality material

Gate Valves: As per (FF-VL/GV) above

Method of Construction:

The priming tank shall be installed on provided M.S. structural supports with 20/25 mm dia. Inlet valve and 50mm dia. Outlet valve with provided necessary G.I. piping upto delivery of main fire pump before non-return valve.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.21 Scope: (Armoured cables)

Specification No. (CB-LT/AL, CB-LT/CU)

Providing armoured cable of specified voltage level, size & specified conducting material Aluminium / Copper), including required material, hardware's for erection and erecting on wall, ceiling, RCC slab or drawing the same through pole, pipe, laying in provided conduit, trench, ducts, trays as per approved method of construction including glands, lugs, etc.

Material:

Cables:

Cables shall be PVC for LT/MP and XLPE for HT and of required construction, colour, shall carry ISI mark, IS No. manufacturer's name, size, duly embossed/screen printed at every meter and having the total count of progressive length in meter at each mark.

Earth wire: Galvanized iron (GI) wire of appropriate gauge

Glands: As per specification

Lugs: As per specification (CB-CL/AL, CB-CL/CU)

Saddles: Saddles fabricated from GI sheet of required gauge and size depending on dia of cable either galvanized or painted with superior quality enamel black paint with necessary shearing mechanical strength, semi circular shaped with extended piece having suitable holes for fixing.

G.I. Strip: 22.g x 25mm width G.I. Strip.

Clamps : MS Clamps fabricated of required length and shape, having the size of 3/6mm thick mild steel having 25/50mm width (as per size of cable), rounded ends with wooden/resin cast grip for holding the cable.

Identification tags: For identifying root, connection position GI strip with identification mark/name embossed/painted with arrangement to tie should be fix on cable or arrangement of ferrules to be done.

Hardware: Sheet Metal (GM) screws of required sizes, plugs/wooden gutties, etc.

Method of Construction:

General:

a) Irrespective of method of construction the cable ends shall be terminated with appropriate size & type of glands with lugs duly crimped, as directed by Site engineer.

b) Wherever the cable has to be bent, the turning radius shall be as mentioned in Table No.7/2. Grouping of cables shall be done with adequate distance between cables as mentioned. In IS so as to minimize de-rating. Cables shall be tagged / ferruled with identification name/mark at the point from where distribution starts and at ends. Bare earth wire of appropriate size shall run along with the cable. Earth wire running with the cable shall be terminated at the earth terminal nearest to cable termination.

1.21.1 Erection of Cable on Surface:

Erection shall be done as per the routes and layout finalized, in perfect level and a plumb. Before fixing the cable shall be straightened as far as possible for good aesthetics look, continuous bare GI earth wire of required gauge shall be run. Cable with G.I. wire shall be fixed by saddles firmly clipped on cable and shall be fixed to wall with minimum 50 x 8mm SM screws with plugs/wooden gutties, etc. (Distance between two supports / saddles shall be minimum 450mm). Wooden gutties shall be used wherever required (Especially for stone wall). The entries made in wall, floor slab, etc. for laying the cable shall be made good by filling and finishing with plastering the same.

1.21.2 Erection of cable/s on trays:

Cable/s shall be laid with PVC tags on GI trays. At bending point care shall be taken so that sharp edges of sheet will not damage insulation of cable.

Mode of Measurement:

Executed quantity shall be measured on the basis of running meter per run of cable.

1.22 Sprinklers

Specification No. (FF-SPR)

Scope:

Supplying and erecting 15 mm dia. NBCM Body chrome finished, pendent type quartzoid bulb sprinklers.

Material:

Chrome plated sprinkler bulb having 68 degree/78degree C fixed temperature rating UL listed.

Method of Construction:

The sprinkler bulb shall be fitted to sprinkler pipe line and tested for required pressure.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.23 Concealed Sprinklers

Scope:

Supplying and erecting 15 mm dia. NBCM Body chrome finished, pendent type quartzoid bulb concealed type sprinklers.

Material:

Deflector: Bronze

Cover Plate: Fusible solder

Frame: Die cast brass

Cup: Cold rolled steel, zinc chrome plated

Cover/Escutcheon: Brass per UNS C26000

Lodgement Spring: Stainless steel

Protective Cap: Polyethylene

Cover Finishes: • Chrome plated/ • White painted / • Flat black / • Custom painted

Chrome plated sprinkler bulb having 68 degree/78degree C fixed temperature rating UL listed.

Method of Construction:

The sprinkler bulb shall be fitted to sprinkler pipe line and tested for required pressure.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.24 Fire Alarm Control Panel (Addressable)

Local Control Panel

Specification Nos

Fire Alarm Control Panel(FF-FAAS/FACP)

Local control Panel (FF-FAS-LCP)

Scope:

Supplying, erecting, testing & commissioning of Fire Alarm Control Panel with all accessories.

Material:

Panel: Microprocessor based addressable Main Fire Alarm Control Panel (FACP) with necessary Test Certificate from ERTL as per IS 2189-1999 provided with SMPS (Switch Mode Power Supply) of suitable battery (2x12V) 24V, 24 AH capacity maintenance free battery as standby supply to switch over automatically for a period of 8 hours in case of A.C. supply failure to panel with 7 AH capacity battery charger, panel shall have following features.

a) Visual zone indication in which fire has emerged
b) Audio alarm devices
c) Acknowledge reset and test devices
d) Visual indication (2x20 character LCD display) incorporating following indications

   i) Fire condition
   ii) Fault condition
   iii) A.C. Pilot indication
   iv) Low battery indication
   v) Blown fuse indication A.C. as well as D.C.
   vi) Built in electronic hooters of 2 tone round for fire condition and single tone for fault condition.

   vii) Open and short circuit fault
   viii) Push button switch for checking each zone.
   ix) Push button to disable audio alarm
   x) Reset push button.

e) Fire protection and alarm circuit shall have modular design using electronic plug in type printed circuit boards (PCB) with spare cards.

Method of Installation:

The microprocessor based main fire Alarm control panel designed as per IS 2189-1999 with ERTL Test certificate shall be fixed at accessible place so that security or fire personal can attend to the fault immediately.

Testing:

The control shall be tested for following features:

1) Alarm cancel Test
2) Reset 1 lamp
3) Fire Test
4) Open Test(for detector & hooter)]
5) Short circuit Test (for detector & hooter)
6) Walk Test(one man test)
7) Sounder Test

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.25 Pill Box (Manual Call Point [MCP] (CONVENTIONAL)

Specification No. (FF-FAAS/MCP)

Scope:

Supplying, erecting, testing, and commissioning pill box with break glass, push button. MCP is manually operated device used to initiate an alarm signal.

Material:

Push Button: Plastic

Enclosure: CREAMS with 100/150mm round/square with Glass cover.

Hammer with chain: Brass

Enamel paint: Superior quality Post Office red colour.

Hardware: S.M. Screw

Plugs: Plastic

Method of Construction:

The pill box with break glass cover, push button in circular/square enclosure with push button kept inside per set with a glass outside marked "IN CASE OF FIRE BREAK GLASS" provided with a small hammer and chain fixed to the pill box shall be mounted on wall or any other place as directed and provided with cable entry with suitable terminal inside and painted with two coats of red oxide and two coats of post office red enamel paint.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.26 Hooter: (CONVENTIONAL)

Specification No. (FF-FAAS/HTR)

Scope:

Supply and erecting hooters with CRCA enclosure duly connected to main amplifier to radiate two tone sounds for public.

Material:

Hooter: Electronic type with 6W output, Line matching transformer

Enclosure: CRCA sheet of 14 SWG with perforation

Enamel paint: Superior quality Post Office red colour

Hardware: S.M. Screw

Plugs: Plastic

Kitties: Wooden

Method of Construction:

The electronics hooter with Line matching transformer shall be enclosed in suitable size perforated CRCA enclosure and installed as per instructions and shall be connected and fixed at suitable site to ensure that the alarm is heard anywhere in the protected area. The minimum sound level shall be 80 dB.

Mode of Measurement:

Executed quantity shall be measured on number basis.

1.27 Contractor shall prepare detail drawings for FF systems and obtain prior approval of the same from the local fire authority. Contractor shall keep a constant liaison with the local fire authority to keep them aware of the progress and standards of work followed, and for the inspections to be carried out during execution work. Contractor shall obtain all NOC/Approvals/Completion certificates with respect to fire fighting system installation from the Local Fire Authority required for occupancy of the building.

1.28 Latest revisions including amendments of codes and standards to be followed.

1.29 Contractor to note that, if the items mentioned in the specifications, drawings are not included in the BOQ, then the Contractor is required to provide the same without any additional cost and the same need to be included in the overall offered price for the project.

1.30 Appointment of sub-contractor/agency for Fire Fighting work.

The Principal Contractor shall propose the sub-contractor/agency which it intends to appoint for execution of Fire Fighting (FF) works, with the submission of documentary proofs to prove the credentials of the agency and experience of earlier completed FF work for review and approval by the Consultant/MDL. The Principal Contractor shall appoint the sub-contractor/agency only after approval of the Consultant/MDL.

1.31_Contractor shall perform all such test may be necessary and required by the local authorities to meet statutory requirements and bye-laws in force at his own cost.

1.32 The welding procedure, types of electrodes etc. shall be in accordance with the following IS codes/specifications.

Welding procedure – IS: 823

Welding electrodes – IS: 814, but of approved makes only (ESAB, Advani Oerlikon)

Testing of welders – IS: 817

Qualified welders having qualification certificates shall be deployed at site for welding work.

1.33 Painting shall be done only after completion of fabrication work and testing. The instructions of paint manufacturer shall be followed. **Paint and primer brands to be approved by the Consultant and Client before procurement and before starting the painting work**. All rust, dust, scales, welding slag or any other foreign materials shall be removed fully, so that a clean and dry surface is obtained prior to painting. Any other oily traces shall be removed by use of solvent prior to surface cleaning. Coat of primer must be applied immediately within 3 hours of cleaning. Two coats of approved shade (Post office red) of enamel paint over a coat of approved primer to be applied.

1.34 **Drawings**

The Fire Fighting (FF) Drawings issued with tender, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract.

These Drawings under no circumstances shall be scaled. Execution & Erection drawings to be prepared by the Contractor based on the Tender drawing.

The contractor shall follow the tender drawings in preparation of his shop drawings, and for subsequent installation work. He shall check the drawings of other trades to verify spaces in which his work will be installed.

The contractor shall examine all interior, structural, plumbing, HVAC, electrical and other services drawings and check the existing works. Before starting the work, Contractor shall report to the Client / Architect / Consultant about any discrepancies and obtain clarification. Any changes found essential to coordinate installation of his work with other services and trades, shall be made with prior approval of the Client – MDL / Architect / consultant without additional cost to the Client – MDL.

Technical Data Sheet

Contractor shall submit the technical data sheet for all the items, equipments after award of Contract and get it approved before procurement of the items

Execution Drawings

All the Execution, installation, shop drawings shall be prepared by the Contractor on computer through AutoCAD System based on Tender Drawings.

Within two week of the award of the contract, contractor shall furnish, for the approval of the Client – MDL / Architect / Consultant, **three sets** of detailed Execution drawings in A1 color printout of all equipment and materials including detailed showing exact location of all the FF items.

These Execution drawings shall contain all information required to complete the Project as per specifications and as required by the Client – MDL/ Architect / consultant.

Each Execution drawing shall contain tabulation of all measurable items of equipment / materials / works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all execution drawings**. Minimum 4 sets of drawings 'A1' size color printout** shall be submitted after final approval along with softcopy.

Each item of equipment / material proposed shall be from the manufacturers given in list of makes and as per relevant standards and codes.

When the Client – MDL / Architect / Consultant makes any amendments in the above drawings, the contractor shall supply three fresh sets of drawings with the amendments duly incorporated along with check prints, for approval.

No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved execution drawing for the material / equipment / installation.

No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved program.

Manufacturers drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labelled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

Also, wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installation.

Approval of execution drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

Where the contractor proposes to use an item of equipment, other than that specified or

detailed on the drawings, which requires any redesign, all such re-design, and all new drawings and detailing required therefore, shall be prepared by the contractor at his own expense and get it approved from the Client – MDL / Architect / Consultant. Any delay on such account shall be at the cost of and consequence of the Contractor.

Where the work of the contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the Client – MDL/Architect/Consultant, the contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:100, clearly showing how his work is to be installed in relation to the work of other trades.

Within two weeks of approval of all the relevant shop drawings, the contractor shall submit four copies of a comprehensive anticipated variation in quantity statement to Consultant/MDL

1.35 SANCTIONS/APPROVALS FROM STATUTORY AUTHORITIES.LOCAL FIRE DEPARTMENT

The Contractor shall be fully responsible and shall carry out the following activities and will be the scope of work under FF system.

- Submission of drawings
- Obtaining the approval of the drawings
- Arranging inspection of site by officials of the Authority
- Obtaining the final no objection/completion certificate after submission of required documents
- Any other statutory approvals required

As Built Drawings

Contractor shall submit as built drawings as and when work in all respects is completed. These drawings shall be submitted in the form **of two sets of CD's and four set of Hard copy – 'A1' Size color printout.**

These drawings shall clearly indicate complete Fire Fighting system Equipment layouts and piping layouts, location of wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, wiring and other services.

Operating Instruction & Maintenance Manual

Upon completion and commissioning of system the contractor shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract.

This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the contractor shall submit **four (4) complete bound sets** of operating instructions and maintenance manuals; one each for retention by Consultant and Client – MDL / Architect / Consultant and two for Client – MDL's Operating Personnel.

These manuals shall also include detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for period of maintenance of each equipment.

Quiet Operation and Vibration Isolation

All equipment shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Client – MDL / Architect / Consultant. In case of rotating machinery, sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Contractor at his own expense. The contractor shall guarantee that the equipment installed shall maintain the specified NC levels. Further, any noise & vibration above specified industrial Standards / values shall not be accepted

1.36 PIPING

Pipes of the following types are to be used:

G.I. pipes as per IS : 1239, heavy duty (for pipes of sizes 150 mm N.B. and below) suitably lagged on the outside to prevent soil corrosion.

GI pipe lines up to 150 mm dia. shall have all fittings as per IS:1239, Part-II (heavy grade) while pipelines above 150 mm dia shall be fabricated from IS:3589 Gr.320 pipes as applicable or from steel plates

All pipes shall be adequately supported from ceiling or walls by means of G.I anchor fasteners by drilling holes with electrical drill machine in an approved manner as recommended by manufacturer of the fasteners. All supports/clamps shall be fabricated from M.S structural like angles, channels, rods, flats etc. and shall be painted with 2 coats of enamel paint on one coat of primer. Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor, braces, dampener, expansion joint and structural steel to be attached to the building structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultant / Client / Architect. **The total assembly of G.I Hangers & supports should be from a single preferred make amongst the preferred makes list**

The piping system shall be capable of withstanding 150% of the working pressure including water hammer effects. Piping system to be hydro tested at 1.5 times of working pressure.

Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipeline of strategic points (@ at every 15-20 mtr.) to facilitate erection and subsequent maintenance work.

Excavation for pipe line shall be in open trenches. Pipes shall be buried at least one meter below ground level and shall have 230 mm x 230 mm masonry supports at least 300mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement: 4 coarse sand: 8 stone aggregate) of size 380 x 380 x 75 thick resting on firm soil.

Wherever required Contractor shall support all trenches or adjoining structures with adequate supports to prevent landslides during construction.

On completion of testing and painting trenches shall be refilled with excavated earth in 15 cm layers and compacted.

Contractor shall dispose off all surplus earth outside MDL at an authorized dumping area.

Contractor shall provide suitable cement concrete anchor blocks for overcoming pressure thrusts in underground / external pipes. Anchor blocks shall be of cement concrete 1:2:4 mix.

MEASUREMENT

Piping work shall be measured per linear meter of finished length as installed at site, along the centre line and shall include all fittings (including flanges). Separate measurement of pipe, fittings, flanges etc. shall not be done for measurement and for calculating the length. Finished length of piping work as installed at site will only be measured.

Welding/joining/fixing/Painting/wrapping/coating/pipe-supports/testing of pipes shall be included in the rate for piping work

2.0 INTELLIGENT ADDRESSABLE FIRE ALARM SYSTEM

2.1. BASIS OF DESIGN

An Intelligent Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the building. The IFAS shall be of the digital, distributed processing, real time, multi-tasking, multi-user and multi-location type.

The IFAS provided shall be able to tie-up the following Mechanical, Electrical & Low Voltage Services into an integrated system.

a. Air Handling Units

b. Lifts

The system shall be provided with Addressable and Analog fire alarm initiating, annunciating and control devices.

The addressable and intelligent system shall be such that smoke sensors, thermal/heat sensors, manual call points etc., can be identified with point address. The system shall be capable of:

a. Setting smoke sensor sensitivity remotely to either high sensitivity manually or on a pre-programmed sequence e.g. occupied/unoccupied period. The FAS shall be able to recognize normal and alarm conditions, below normal sensor values that reveal trouble condition, and above normal values that indicate either a pre alarm condition or the need of maintenance.

b. The operator shall also be able to adjust alarm and pre alarm thresholds and other parameters for the smoke sensors.

c. Provide a maintenance/pre-alert alarm capability at smoke sensors to prevent the detectors from indicating a false alarm due to dust, dirt etc.

d. Provide alarm verification of individual smoke sensors. Systems that perform alarm verification on a zone basis shall not be acceptable. Alarm verification shall be printed on the printer at the Control Station's printer to enhance system maintenance and identify possible problem areas.

e. Provide local numeric point address and Indicating display of device and current condition of the point. Local annunciation shall not interfere with annunciation from the Fire Control System.

f. Provide outputs that are addressable, i.e. outputs shall have point address. The operator shall be able to command such points manually or assign the points to Logical Point Groups (Software Zones) for pre-programmed operation.

In the event of a fire alarm, but not in a fault condition, the following action shall be performed automatically.

a. The System Alarm Indication on the main fire alarm control panel shall flash.

b. A local piezo-electric sounder in the control panel shall be sounded.

c. The LCD display on the main fire alarm control panel shall indicate all information associated with Fire Alarm condition including the type of alarm point and its location within the premises.

d. History storage equipment shall log the information associated with the Fire Alarm Control Panel condition, along with the time and date of occurrence.

e. All system output programs assigned via control-by-event programs that are to be activated by a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

f. All lifts initiated through the systems will automatically be returned to Ground Floor.

g. Air handling units on affected floors shall automatically be switched OFF and simultaneously respective fire dampers shall also be closed.

h. Shall give output for staircase pressurization fans to put on.

i. Shall give signal for start smoke evacuation system.

2.2. FIRE ALARM CONTROL PANEL (F A C P)

2.2.1 The distributed Intelligent Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel as well as providing a communication interface to the central station. FACP shall have its own microprocessor, software and memory and should be listed under UL864 or EN54. In the event of failure of the central or communication breakdown between the central station and the FACP, the FACP shall automatically operate on stand-alone mode without sacrificing any functions.

2.2.2 The memory data for panel configuration and operation shall reside in non-volatile memory (EPROM). The card containing the memory shall have battery back-up for up to 100 hours on the board itself, if required.

2.2.3 FACPs shall supervise detection circuits and shall generate an alarm in case of abnormal condition.

2.2.4 FACPs shall provide general purpose inputs for monitoring such functions as low battery or AC power failure. FACPs shall provide tamper protection and commandable outputs, which can operate relays or logic level devices. Output commands shall take any of, but not limited to, maintained command, Momentary Command, Alarm Follow, or Alarm latch as required. Any relay in the FACP which is intended to be removable shall be supervised against removal.

2.2.5 Smoke detectors shall be powered using the FACP-based smoke detection circuits. FACPs shall provide for resetting smoke detectors, fault-isolation and sensor loop operation. It shall be possible to mix different fire devices within the same FACP to optimize field wiring.

2.2.6 FACPs shall provide indication for communication with the central console and alarm/trouble conditions in each sensor loops.

2.2.7 FACPs shall provide monitoring and control of one floor or area or for multiple floors or areas. FACPs shall meet the following requirements to assure the integrity and reliability of the system.

a. The FACP shall be UL (9th Edition) listed independently as a fire alarm control panel.

b. FACP electronics shall be contained in an enclosure made of minimum 16 gauge steel. Access to FACP switches and electronics shall be by key-lock. Usage of no other tools should be required. Visual indicators of FSP status for each zone shall be visible without opening the key-locked cover.

2.2.8 All hardware and software to allow the FACP configuration and operation to be changed shall be provided. Memory data shall be contained in non-volatile memory (EPROM).

Alarm verification with field-adjustable time from 0 to 60 seconds for individual smoke detector shall be provided. During the alarm verification, the panel shall retard the alarm until the end of the period. If the alarm is only a transient smoke alarm, the panel shall automatically reset the alarm. Only a verified alarm shall initiate the alarm sequence for the software zone (Logical Point Group) or point. Final time setting shall be as per approval of the fire authorities. When alarm verification is being performed on a smoke detector, the action shall be printed on the listed printer(s).

2.2.10 Display at the FACP shall be provided to indicate point in alarm or trouble. In such systems, means for manually scanning the points in trouble shall be provided and a trouble and alarm LED shall be used to indicate that there are points in

alarm/trouble. The alarm/trouble LED shall only extinguish when all alarm/troubles are cleared from the loop.

2.2.11 It shall be possible to command test, reset and alarm silence from both the FACP and the central console.

2.2.12 FACP switches shall allow authorized personnel to accomplish the following, independent of the central console:

a. Initiate a general alarm condition.

b. Silence the local audible alarm.

c. It shall be possible to acknowledge (Silence the local FACP audible without silencing the alarm indicating devices (hooters).

d. Reset all zones (Logical Point Group) / points, after all initiating devices have returned to normal.

e. Perform a complete operational test of the microprocessor and memory with a visual indication with each board.

f. Test all panel LEDs for proper operation without causing a change in the condition of any zone (Logical Point Group)

g. Walk Test

2.2.13 Software zones/loops shall be circuited and protected by Fault Isolation Modules such that in the event of a zone/loop short-circuit, not more than twenty (20) devices shall be left non-functional.

2.2.14 Intelligent Smoke and thermal sensors shall be located as shown and shall report sensed levels in analog form.

2.2.15 Monitor modules shall be provided to monitor and address contact-type input devices. The monitor module shall be supervised by FACP.

2.2.16 The FACP shall process the true continuous analog signal from the sensors. In addition, the FACP shall further process all analog values for pre-alarm limits to prompt the operator for early maintenance. If a sensor value increases to an above normal level or a pre-alarm limit for an extended duration, the FACP shall communicate maintenance pre-alarm.

a. Any time sensor value transitions beyond the secondary and higher limit value, an alarm initiation and report shall be issued.

b. Limits and sensor values shall be displayed, modifiable, and reported in

decimal values.

c. The FACP shall have Drift Compensation facility to compensate for environment. The FACP shall have the ability to recalibrate Pre-alarm and Alarm limits if required, after comparing each sensor's operating characteristics with the set sensitivity. This should be carried out at least once in every 24 hours. FACP should annunciate trouble conditions when sensor(s) is beyond compensation range (excessively dirty sensor).

d. The FACP should be UL listed / FM approved or EN 54 approved to provide the sensitivity measurement and documentation required by NFPA72E.

2.2.17 FACP shall have real-time clock to prevent loss of time and date in case of failure of power supplies.

2.2.18 The display on FACP shall provide indication for AC Power, System Alarm, System Trouble/Security Alarm, Display Trouble and Signal Silence.

2.2.19 Minimum two different password levels will be provided to prevent unauthorized System control or programming.

2.2.20 Operator control switches for Signal Silence, lamp Test, Reset, System Test and Acknowledge shall be provided.

2.2.21 The FACP should truly field programmable. This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate the FACP panel to reconfigure the above parameters.

2.2.22 The FACP should have a degraded mode of operation. In the event of the CPU failure the field devices (detectors & modules) should be able to take a decision degrade mode to ensure reliability even during failure.

2.2.23 Power supply unit of FACP shall have following characters:

a. The main power supply shall be 230 VAC±10%, 50 Hz±1% and shall in turn provide all necessary power of the FACP.

b. It shall provide a battery charger for 24 hours for standby power using dual-rate charging technique for fast battery recharge.

c. It shall provide a very low frequency sweep earth fault detect circuit, capable of detecting earth faults on sensitive addressable modules.

d. It shall provide indication for battery voltage and charging current.

2.2.24 For ease of service, all wiring terminal blocks shall be plug-in type and shall have sufficient capacity for 18 to 12 AWG wire termination. Fixed terminal blocks shall not be acceptable.

3. DETECTORS & ADDRESSABLE DEVICES

3.1 GENERAL FEATURES COMMON TO ALL DETECTORS

a. Compatibility: All automatic fire detectors shall be interchangeable without requiring different mounting bases or alterations in the signal panel.

b. Sensitivity: On average 30 mgs of burned material per cu.m. (as measured in a 1 cu.m. chamber or .5% obs/ft) shall release an alarm sensitivity which shall be adjustable according to the use of the space.

c. Power Consumption: Each detector shall use the minimum of power, for economic circuits, so that it shall have capacity to connect at least 240 devices & detectors (120 detectors+120 devices) in one loop.

d. Built-in-response indicator: Each detector shall incorporate indicator "LED" at the detector which shall blink during normal condition and light up on actuation of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp.

e. Maintenance: All detectors shall be fitted either with plug-in system or bayonet type connections only, from the maintenance and compatibility point of view.

f. Construction: The detector shall be vibration and shock proof. When disassembling for cleaning purposes, its components must not be damaged by static over voltage.

g. Atmospheric and Thermal Disturbance: The detector shall so designed as to be practically immune to environmental criteria such as air currents, humidity, temperature fluctuations, pressure and shall not trigger false alarm, due to the above conditions.

h. Continuous Operation: An alarm release shall not effect a detector's functioning. After resetting the alarm, the detector shall resume operation without any readjustment.

i. Adaptability to ambient conditions: Detectors shall be designed for adaptability to humid locations. No performance deterioration shall be acceptable.

3.2 ADDRESSABLE HEAT DETECTORS

Heat detectors shall be intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum to 240 intelligent detectors and devices in any combination should connect to one loop.

Heat Sensors shall be intelligent and addressable devices and shall connect to one of the C.I.E. loops.

The Sensors shall use an electronic sensor to measure thermal conditions caused by a fire and shall, on command from the C.I.E., send data to the C.I.E. representing the analogue level the temperature at the sensor.

3.3 ADDRESSABLE SMOKE DETECTOR

The intelligent smoke detector shall be an addressable device that is designed to monitor a minimum of photoelectric technologies in a device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires.

The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

An output connection shall be provided in the base to connect an external remote alarm LED.

3.5 ADDRESSABLE MANUAL STATIONS

Addressable manual stations shall be provided to connect to the Fire Alarm Control Panel loops. The manual stations shall on command from the Control Panel send data to the panel representing the state of the manual station.

Stations shall be suitable for surface mounting as shown on the plans, or semi-flush mounting, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor unless otherwise specified by applicable building codes.

3.6 ADDRESSABLE MONITOR MODULE

The monitor module shall provide address-setting and shall also store an internal identifying code which the Fire Alarm Control Panel shall use to identify the type of device. Modules using binary jumpers are not acceptable. An indication shall be provided which shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

3.7 RESPONSE INDICATOR

In addition to built-in response indicator in each detector, secondary response indicator of LED type shall be provided outside the rooms wherever asked for by the

Architect/Interior Designer, for indication of fire through detector in the room. The design & colour shall be as per Interior Designer approval.

3.8 CONTROL MODULE

The control module shall provide address-setting and shall also store an internal identifying code which the control panel shall use to identify the type of device. Modules which use binary jumpers are not acceptable. An indication shall be provided which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.

3.9 ADDRESSABLE HOOTERS

All field hooters should preferably be addressable and software configurable. All hooters should be able to provide at least a minimum of 3 different tones, which should be user configurable. The minimum decibel level of each hooter should be 90db. All hooters should be UL/FM listed.

3.10 OTHER DEVICES

Fault-isolation of fire zones (Logical Point Group) / circuit modules shall be provided to enable part of a fault-tolerant loop to continue operating when a short occurs in the loop.

4. FUNCTIONAL REQUIREMENTS

4.1 INTELLIGENT SYSTEM DEVICES

a. Each device shall be assigned a unique address via electronic addressing. Address selection via rotary switch are also acceptable.

b. Devices shall receive power and communication from the same pair of conductors.

4.2 SENSORS

a. All fire sensors shall mount on a common base to facilitate the changing of sensor type if building conditions change. The base shall be incompatible with conventional detectors to preclude the mounting of a non-intelligent device.

b. Each sensor shall contain an LED which shall blink each time the sensor is scanned by the FACP. If the FACP determines that the sensor is in alarm, the FACP shall command the sensor LED to get latched on.

c. Each sensor shall be capable of being tested for alarm via command from the FACP.

d. Each sensor shall respond to FACP scan for information with its type identification to preclude inadvertent substitution of another sensor type. The FACP shall continue operation with the detector installed but shall initiate a

mismatch (trouble) condition until the proper detector is installed.

e. Each sensor shall respond to FACP scan for information with an analog representation of measured fire-related phenomenon (smoke density, particles of combustion, temperature). Systems which only monitor the presence of conventional detector in an addressable base shall not be acceptable.

4.3 **INPUT DEVICES**

a. The input device shall provide an addressable input for N.O. or N.C. contact devices such as manual stations etc.

b. The input device shall provide a supervised initiating circuit. An open-circuit fault shall annunciate at the FACP (subsequent alarms shall be reported).

c. The device shall contain an LED which will blink upon being scanned by the FACP. Upon determination of an alarm condition, the LED shall be latched on.

4.4 **AUTOMATIC FUNCTIONS AT FACP**

The alarms shall be displayed at the FACP on an LCD display. The display shall indicate the device in alarm by ID number, the appropriate alarm state, and the current time and date. It shall also display a point description of minimum 32 characters and, the respective analog value. The display shall also contain a minimum 40 characters alarm message. It shall be possible to see the number of acknowledged alarms, number of current fire alarms, number of trouble conditions and number of other miscellaneous alarms in the system. The FACP printer shall print out same information displayed on the LCD display. The LCD display and printer shall be powered directly from the panel.

4.5 **MANUAL FUNCTIONS AT FACP**

i. At any given time, operator shall have the following manual capabilities at FACP by means of switches located behind a key-locked cover:

   a. Initiate an alarm summary display on the FACP LCD display. This display shall step through all currently active alarms in the system.

   b. Initiate a summary printout of all currently active alarms on the FACP printer.

   c. Initiate an “all-point summary” printout on the FACP printer recording the status of each system point (initiating circuits, indicating circuits etc.)

   d. If the alarm is ignored by an operator than the history of same to be available

ii. At any time, the operator shall have following manual capabilities at the FACP under password control; Operator privileges and ID numbers of up to four

digits shall assignable by the main operator or designated alternate. Actions taken by operators shall automatically be printed on the FACP printer with operator initials, time and date.

a. Commands output points to different mode. Such commands shall be printed with selected descriptors ON/OFF/AUTO, OPEN/CLOSE, DAY/NIGHT etc. In addition, command shall be used to ISOLATE or DISCONNECT points. When isolated, alarms and troubles shall be received but not acted upon.

b. Modify system parameters. Alphanumeric key pad shall be provided for operators to modify the following parameters :

- Change sensor alarm and pre-alarm threshold
- Update date and time
- Change point descriptors
- Change action message
- Disable a point
- Change sensor verification time
- Change password
- Activate/deactivate indicating output control point
- Control-by-event programs on line

c. Select a system status report for printing on the printer from the control station. The following real time reports shall be provided:

- All point log.
- Alarm summary
- Trouble summary
- Status summary
- Sensitivity log
- Disabled points log.
- Isolated points log
- Disconnected points log
- Logical group points log

The sensitivity log shall print the analog value of each addressable analog sensor.

d. Select printing of a trend sensitivity log which when enabled, shall print minimum last 24 analog values for every addressable analog sensor taken at predetermined intervals. Systems which limit the number of addressable analog sensors which can be trended are not acceptable.

e. Select a sequence of programmed commands which can be automatically executed, in sequence, via a single command.

f. Perform a walk-test function such that a operation can be periodically checked out for all initiating devices on a zone. In walk test mode, all initiators on the selected zone shall automatically be isolated. As each device is placed into an alarm or trouble condition, the FACP shall print

the condition and automatically reset the device. No audible signals shall be initiated from the zone to prevent disruption of building occupants. If a zone is inadvertently left in the walk-test mode, it shall automatically reset to normal after a five-minute idle time is exceeded.

4.6 **SYSTEM SUPERVISION**

a. In the normal supervisory condition, only the "POWER" ON, and "RUN" conditions, shall be illuminated. The LCD display shall display "System Normal" and the current time and date.

b. The LCD display shall indicate the loss of power condition and the printer shall record the same. Following restoration of normal AC power, the trouble indicators shall be automatically reset and the printer shall record the 'return to normal condition'.

c. The LCD display shall indicate the loop in trouble and the printer shall record same.

d. The LCD display shall indicate trouble and the printer shall record same. Operation of a momentary "Silence" switch shall silence the audible trouble signal but the visual "Trouble" LEDs shall remain ON until the malfunction has been corrected and the system has reset. The FACP printer shall record this action.

4.7 **PROGRAMMING OF FACP**

The LCD display and printer programming shall be accomplished on site by means of QWERTY keypad inbuilt in panel which shall plug into the FACP. Modules requiring off-site programming are not acceptable. LCD shall initiate test of all addressable sensors in the system.

Programming functions shall include alarm/trouble type assignment, point descriptor assignment, alarm message assignment etc. Data file for the LCD display and a printer shall be stored in EEPROM.

5.0 **FIRE CONTROL SEQUENCES**

Upon activation of fire alarm devices:

FACP will display the exact address & alarm in the panel.

The Central Control Station shall switch OFF the AHUs of the affected floor fire damper and toilet exhaust fans while the AHUs on the other floors shall remain operational so as to keep the area under positive pressure. Staircase pressurization fans shall be operated through the fire alarm system.

The lifts alarms (provided by lift) shall be tied to the Fire Alarm System. The Fire Alarm

System shall function as follows:

In the event of a fire, a signal will be provided by the Fire Alarm System to return all lifts to ground floor.

Should an emergency alarm originate from an individual lift, an audible alarm shall sound at Fire Control Station.

When an alarm is detected

- All include annunciating devices on the floor one above and one below shall sound.
- The air handling unit for the floor shall be stopped.
- The air handling unit on the floor above and the floor below shall be started unless those floors are also in alarm.

If the alarm has not been acknowledge at the central panel within one minute, all audible annunciating devices on the floor above and the floor below shall sound.

It the alarm has not been acknowledged at the central panel within three minutes, all audible annunciating devices on the building shall sound.

LIST OF APPROVED MAKES FOR FIRE FIGHTING & FIRE ALARM SYSTEMS

A) Water Based Systems:

SR NO.	DESCRIPTION	MANUFACTURER/VENDOR
1.	M.S. ERW Pipes	Jindal/Tata
2.	BUTTERFLY VALVE / SLUICE VALVE / BALL VALVE / ARV /NRV / GATE VALVE	Kirloskar /Audco /Leader/Intervalve / Advance / L&T
3.	PRESSURE REGULATING VALVE	Tyco/L&T/Danfoss / Darling Meusco
4.	Foot valve with strainer /Strainer	Kirloskar /Audco /Leader/Intervalve / Advance / L&T / Normex
5.	G.M Gate Valve	Kirloskar /Audco /Leader/Intervalve / Advance / L&T / Zoloto

6.	MS/GI FLANGE & FITITNGS	Newzel Industries / Superforge / Gayatri Forge / Pipefit / Fittech
7.	G.M. 63 mm dia single hydrant oblique pattern valve	Newage/Minimax/Essel/ Safex
8.	G.M. 63mm dia branch pipe with nozzle/G.M. male-female couplings	Newage/Minimax/Essel/ Safex
9.	Fire hose RRL	Newage /Safex/ Minimax/Essel
10.	Ms hose box of 18 SWG sheet	Jay / Equivalent
11.	4 way Siamese connection	Newage / Minimax / Safex
12.	Anti-corrosive tape 4mm & primer	IWL/IPL
13.	Pressure switch	Indfoss / Switzer
14.	Priming tank with 100 mm dia flanged outlet	Sintex
15.	Hume pipe	Any IS Marked.
16.	Fire Pumps	Kirloskar/ Mather Platt /C&G
17.	Electric Motor	Kirloskar/Crompton/Siemens /ABB
18.	Fire panel	Main components :Merlin Gerin / L & T
19.	Alarm Valve	HD / Viking / Spraysafe / Tyco
20.	Sprinklers	HD / Viking / Spraysafe / Tyco
21.	Cables	Polycab/KEI,/Havells
22	Pressure Gauge	H Guru / Febig
23	CP brass ware fittings (Cocks, mixers etc)	Parryware/Kohler/Jaquar
24	CP Flush valve	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
25	CPVC pipes & fittings	Astral/Supreme/Prince (SMARTFIT, EASYFIR)/Finolex

26	UPVC -SWR pipes & fittings	Astral/Supreme/Prince (SMARTFIT, EASYFIR)/Finolex
27	CI surface box	IS Mark
28	GM gate, check, globe valves	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
29	CI foot valve & Strainer	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
30	CI NR valves	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
31	Ball / Butterfly Valve	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
32	Pressure Regulating Valves	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
33	ARV	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
34	CP brass ware fittings (Cocks, mixers etc)	Parryware/Kohler/Jaquar
35	CP Flush valve	Leader/ Zoloto/Kirloskar/L &T/Audco, Intervalve and Advance value
36	CPVC pipes & fittings	Astral/Supreme/Prince (SMARTFIT, EASYFIR)/Finolex
37	UPVC -SWR pipes & fittings	Astral/Supreme/Prince (SMARTFIT, EASYFIR)/Finolex
38	GSW pipes	Perfect any ISI Mark
39	Water pump	DAF/Kirloskar/Crompton
40	Electric Motors	Siemens/Kirloskar/Crompton
41	Electric panel components	Siemens/L&T/Arrow
42	CI surface box	IS Mark
43	Cables	Polycab/KEI,/Havells

B) Fire Alarm System & Extinguishers:

SR NO.	DESCRIPTION	MANUFACTURER/VENDOR/ SUPPLIERS
1.	Main Fire Alarm Panel (UL / FM / LPCB Approved)	Notifier/Edwards/Simplex/ Apollo
2.	Smoke / Heat Detectors with Base (UL / FM / LPCB Approved)	Notifier/Edwards/Simplex/ Apollo
3.	Devices & Modules (UL / FM / LPCB Approved)	Notifier/Edwards/Simplex/ Apollo
4.	Cables	Polycab/KEI,/Havells
5	Fire survival cable	AFW / FRTEK / RAVIN / BONTON / TYCO
6.	Extinguishers	Ceasefire / Minimax

TECHNICAL SPECIFICATIONS

V- LIFT

MRL Lifts

Scope:

Specification No (LFT)

Supplying erecting and commissioning passenger lift, hospital lifts and goods lift with technical requirements of lift installation, its components, safety devices various type of controls and methods of operation. The selection of a particular type of control and method of operation will be guided by the requirements in individual case such as nature of building, usage, occupancy, traffic pattern, etc. and has to be decided in individual case considering quality and quantity analysis of service.

Recommended Standards:

The following list is for Indian Standards which are acceptable as good practice and accepted standards;

IS 14665 part I	:	Guidelines for outline dimensions of passenger, goods, service and hospital lifts.
IS 14665 part II	:	Code of practice for installation, operation and maintenance of lifts.
IS 14665 part III	:	Safety rules
IS 14665 part IV	:	Components
Development Control		
Rules	:	Of concerned Corporation or Local Authority
National Building Code 2005		
Bombay Lift Act 1939		
Bombay Lift Rules 1958		
I. E. Rules 1956	:	Reprint as per 2005

Material:

- **Electric Supply:**

Three phase, 50 c/s, 415 V electric supply shall be made available by owner. The entire lift equipments should be suitable for operation at +10% to - 20% of the rated supply voltage.

- **Gearless machine:**

The gearless machine shall consist of a motor, traction sheave and break-drum or brake disc completely aligned on a single shaft. Gearless machine shall be AC. gearless with VVVF drive.

- **Geared machine;**

The lift machine shall be of worm gear reduction type with motor, brake, worm gearing and driving sheave and suitable for type of control specified.

- **Electric motor:**

Energy efficient Electric motor of suitable HP with class F insulation and S-4 duty cycle

- **Car:**

As per IS 14665 part IV with MS Girders, bracings of adequate size and strength at the bottom and top with angle iron frame and side panels of CRCA/MS of 16 gauge duly powder coated paint or SS sheet of 18 gauge with mirror or hairline finish with safety factor more than 5.

- **Signals:**

FPI in car and CPI at all landings are to be provided with up / down direction indicators with call registration facility.

- **Variable Voltage Variable Frequency:**

Incoming mains AC power is first rectified to DC and then inverted to provide controlled AC current to the elevator drive. Precision monitoring is required for motor speed, car direction, position and load to enable the pulse width of the AC power supplied to the motor and to be adjusted to ensure that elevator speed is maintained very accurately to an ideal profile. Energy saving through reduced power consumption should be achieved.

- **Controls:**

Microprocessor based Control panel duly wired with proper size and strength of copper wire.

- **Control panel box**:

Control panel box of MS sheet of 16 gauge with duly power coated of MS sheet of 16 gauge.

- **Driving / traction pulley:**

Sheaves and pulleys shall be of hard alloy, cast iron, SG iron or steel and free from cracks, sand holes and others defects. They shall have machined rope grooves. The traction sheave shall be grooved to produce proper traction and shall be of sufficient dimension to provide for wear in the groove. The deflector sheave shall be grooved so as to provide a smooth bed for the rope.

- **Over speed governor:**

The car safety shall be operated by speed governor located overhead and driven by governor rope suitably connected to the car and mounted on its own pulleys. Governor shall be provided for lifts with a travel of more than 5.5 meters. The governor rope shall be not less than 6mm in dia and shall be made of steel or phosphor bronze. These shall be in accordance with IS 14665 (part 4lsec-4): 2001.

- **Electromagnetic breaks:**

The lift drive machinery shall be provided with an electro-magnetic brake or motor operated brake normally applied by means of springs in compression when the operating device is in off position. The brake shall be suitably curved over the brake drum or brake disc and provided with fire proof friction lining. The operation of brake shall be smooth, gradual and noiseless. The brake shall be designed to be of sufficient size and strength to stop and hold the car at rest with rated load. The brake should be capable of operation automatically by the various safety devices.

- **Automatic Rescue Devices (ARD)**

ARD should monitor the normal power supply in the main controller and shall activate rescue operation within 10 seconds of normal power supply failure. It should bring the elevator to the nearest floor at a slower speed than the normal run. While proceeding to the nearest floor the elevator will detect the zone and stop. After the elevator has stopped, it automatically opens the doors and parks with door open. After the operation is completed

by the ARD the elevator is automatically switched over to normal operation as soon as normal power supply resumes.

In case the normal supply resumes during ARD in operation the elevator will continue to run in ARD mode until it reaches the nearest landing and the doors are fully opened. If normal power supply resumes when the elevator is at the landing, it will automatically be switched to normal power operation.

All the lift safeties shall remain active during the ARD mode of operation.

The battery capacity should be adequate so as to operate the ARD for duration of at least 30 minutes.

- **Suspension wire rope:**

Round strand steel wires ropes made from steel wire ropes having a tensile strength not less than 12.5 tones / cm2 and of good flexibility shall be used for lift. Lubrications between the strands shall be achieved by providing impregnated hemp core.

- **Guide rails:**

The guide rails shall be continuous throughout the entire travel and shall withstand without any deformation by the action of safety gear with a fully loaded car. Generally the guide rails shall be supported by brackets secured to the hoist way frame at each floor. The rails shall be securely fastened to the brackets or other supports by approved heavy rail clamps. Guide rails shall extend from pit floor to the underside of concrete slabs or grafting at top of the lift well. They shall be erected in plumb and parallel with a maximum deviation of 3mm.

- **Buffers:**

Buffers shall be suitable for installation in the space available. Buffer anchorage at pit floors shall be installed avoiding puncturing of water proofing. Oil buffers of the car and counter weight shall be of the spring return type or of gravity type. The contractor must indicate the name of buffer manufacturers, buffer stroke & certified maximum loads.

Method of Construction:

- Bar chart shall be prepared as per tender condition and requirement.
  Lift hoist way measurement shall be done before finalizing the material quantity.

- Drawing should be prepared according to tender specification considering hoist way size and permission from Lift Inspector for erection of lift should be taken prior to commencement of erection.
- White wash in lift well shall be carried out by the client.
- Site in full readiness shall be handed over to the agency.
- Minor civil work pertaining to front wall architraves internal / external plastering etc. shall be done by the lift agency.
- Prepare and install scaffolding and template by adjustment required.
- List of components / finished items those are not manufactured by lift manufacturer shall be informed by the agency.
- Brackets are to be erected and fixed in to plum line.
- Put the fasteners (16 mm dia x 100 mm) if the brackets are to be fixed on RCC wall / beam / lintel or fix rig bolts if brick work found in RCC.
- After fixing brackets and guides with adjustment fix the car and counterweight
- Fix the landing door frame / door bottom with sill and suitable brackets to with stand the load of passenger / freight as per specification
- Fix metal trunking / PVC pipe as per IS requirement

- Complete civil work such as fixing up hoist way, push button, buffers, machine room I beams for resting machine, foundation for control panel, minor civil work, making holes in bottom slab of machine room to pass traction rope, speed governor rope / wiring and complete finishing according to sizes and specification.
- Electrical wiring in lift shaft and supply cable shall be carried out from electrical agency as per requirement of lift rules.
- Fix machine with complete gear box unit, suitable rubber pad / anti vibrating pad, diverter if required with alignment as per norms.
- Fix the control panel at accessible height from floor level to inspect, connect, and operate easily.
- Put wires in accordance with the control panel connection diagram according to colour code in metal trunking with insulating paper on all bends, corners. Metal trunking shall be duly earthed from top to bottom according to IS specifications.
- Mid way junction boxes are to be fixed according to size but it should be marked by every wire with nos. (Ferrules) Traveling cables should be fixed with suitable hanger to take load of travelling cable and put extra wire of 20 % approximately
- Fix the car and counterweight frame according to sizes, adjustment of safety block wedges shoes as per requirement.
- **Toe Guard Aprons:**
- The toe guard apron of gauge not less than 1.6mm sheet steel may be provided extending at least 15mm beyond entrance jams at each side. The guards shall have a straight vertical face extending below the level of the finished car floor and not less than the depth of the levelling zone plus 7.5mm. It shall be seamed to car platform construction and be reinforced and braced.
- **Car Apron, Landing Thresholds and Sills:**
  An apron shall be fitted to the car platform such that no dangerous gap exist at any time when the landing door is opened, Thresholds and sill plates shall be provided at the landings also. The distance between landing sill and the sill on car platform shall not be more than 30mm.

- **ARD should be provided**
- **Emergency Power Supply for lift car, fan and intercom system:**
  This shall include suitable secondary battery with trickle/Boost charge arrangement and inverter power pack with necessary contactors for supply to light fixtures in the lift car, fresh air fan in lift car. The same battery shall also feed the alarm bell and communication equipment.

- **Inter-communication system:**
  Intercom system shall be provided in car to have communication in case of an emergency and shall be connected to re-chargeable battery supply.

- **Ratings and Instructions:**
  Inside the lift car, the lift supplier shall also provide a stainless steel metallic plate indicating the rated load and detailed instructions for the passengers. This shall be mounted at a suitable place.

- **General:**
  - **a)** Put main traction ropes from car to counterweight with rope tension adjustment.
  - **b)** Put counterweight i.e. of CI blocks in counter weight frame for suitable equilibrium.
  - **c)** Put car platform and car with adjustment.
  - **d)** Fix car door and panels / car push button/ fall ceiling light, fan.
  - **e)** Fix landing panels and put in lock in circuit.
  - **f)** Fix hoist way accessories like drum reels terminators, final limits, levelling
  - **g)** Removing the scaffolding.

h) Connect three phase supply from main switch along with earthing to controllers as per instruction given.
i) Wiring from controller to motor along with earth wire is to be completed.
j) Check motor / gear oil.
k) Start lift in maintenance mode.
l) Check adjustment of hoist way switch/ safety doors and check all parameters of shaft.
m) Put controller on normal mode.
n) Test run to be taken and & service inspection of lift with all safeties shall be done in presence of site in charge.

o) Pre commissioning work such as cleaning of shaft, pit etc shall be done.
p) After completion of work, NOC shall be obtained from lift inspector
q) by the agency before putting LIFT in to operational use.

Testing of Lift Installation:

Tests at site:

(a) Levelling Test:

Accuracy of the floor levelling shall be tested with the lift empty, fully loaded. The lift shall be run to each floor while travelling both in upward and downward directions and the actual distance of car floor above, below landing floor shall be measured. In each case there shall not be any appreciable difference in these measurements for levelling at the floors when the car is empty and when it is fully loaded. The tolerances for levelling shall be as specified in para 8 of chapter IV, section I.

(b) Safety Gear Tests:

Instantaneous safety gear controlled by a governor should be tested with contract load and a contract speed, the governor being operated by hand. Two tests should be made, however, with wedge clamp or flexible clamp safeties, one with contract load in the car and the other with 68 kg (equivalent to one person) in the car. The stopping distance obtained should be compared with the specified figures and the guides, car platform, and safety gear should be carefully examined afterwards for signs of permanent distortion.

Counterweight safety gear should be tripped by the counter weight governor and the stopping distance noted. In this case, however the governor tripping speed may exceed that of the car safety governor but by not more than 10 percent.

During the safety gear tests, car speed (from the governor or the main sheave) should be determined at the instant or tripping speed with that stated in IS. The governor jaws and rope should be examined for any undue wear.

(c) Contract speed:

This should be measured with contract load in the car, with half load, with no load, and should not vary from the contract speed by more than 10 percent. The convenient method is by counting the number of revolutions, made by the sheave or drum in a known time, Chalk mark on the sheave or drum and a stop switch will facilitate timing but care must be exercised to ensure that no acceleration or retardation periods are included. If the roping is 2 to 1 the sheave speed is twice the car speed. Alternatively, the speed can be measured by a tachometer applied directly to shaft immediately below the sheave.

(d) Lift balance:

After the above test, some of the weight shall be removed until the remaining weights represent the figures specified. With this condition at half way travel the effort required to move the lift car in either direction with the help of winding wheel shall be as nearly as can be judged by the same.

(e) Car and landing doors interlock:

The lift shall not move with any door open. The car door relay contact and the retiring release cam must be tested. The workings of the door operation and the safety edges and light equipment if any provided shall also be examined.

(f) Controllers:

The operation of the contactors and interlocks shall be examined and it shall be ascertained whether all the requirements laid down in the specifications have been met.

(g) Normal terminal stopping switches:

These shall be tested by letting the car run to each terminal landing in turn, first with no load and then with contract load and by taking measurements, top and bottom over travels can be ascertained.

(h) Final terminal stopping switches:

The normal terminal stopping switches shall be disconnected for this test. It shall be ensured that these switches operate before the buffers are engaged.

(i) Insulation Resistance:

This shall be measured (after removing the electronic PCB's and their connection) between power and control lines and earth and shall not be less than 5 mega-ohms when measured with D.C. voltage of 500 volts. The test shall be carried out with contactors so connected together as to ensure that all parts of every circuit are simultaneously tested.

(j) Earthing:

Earthing continuity of all conduits, switches, casing and similar metal work shall be tested.

(k) Ropes:

The size, number construction and fastenings of the ropes should be carefully examined and recorded.

(I) Buffers:

The car should be run on to its buffers at contract speed and with contract load in the car to test whether there is any permanent distortion of the car or buffers. The counter weight buffers should be tested similarly. Test report shall be intimated after testing at works.

Service Temperature Test:

A continuous run of one hour should be made with number of starts and stops to reproduce as nearly as practical the anticipate duty in service. (The standard duty cycle is for 180 starts per hour). It is very difficult in practice to carry out this test with alternate starts at

full load and no load and it is necessary therefore to simulate these cycles. A suitable test for all motors except squirrel cage motors is to run the car up from the bottom landing with contract load and stop at each floor. From the top floor a non stop run is made to the lowest floor and the upward journey with stop is then repeated. The time intervals between stops and starts at the floors should be uniform and such as to give about 150 starts in one hour. At the end of this run the temperatures of the armatures and fields of the motor and generator are recorded. The temperature rise should, not exceed 55 deg C or 75 deg C for class A or B insulation respectively.

Method of Construction: Executed quantity will be counted on number basis. (i.e. each)

List Of Approved Makes		
SR No.	**Items**	**Makes (ISI marked)**
1	Passenger/ Service Lift	Otis / ThyssenKrupp/ Mitsubishi / Kone/Schindler
2	Dumbwaiter Lift	Mitsubishi/ Shree Elevators/Franco elevators/Schindler/Marnoic/ Schindler/Monarch

TECHNICAL SPECIFIACTION FOR

VI - HVAC WORKS

1. VRV/VRF SYSTEM

The Variable Refrigerant Flow (VRF / VRV) System should be air cooled, split type air conditioning system consisting of singular condensing units connected to multiple indoor units, each having the capability of individual set point control. The system should have the ability to connect each condensing unit to required indoor units of different types and capacities on one refrigerant circuit. The system is to be of the cooling type. Each Condensing unit should incorporate at least one inverter based scroll/ rotary compressor & two fixed scroll/ rotary compressors, to obtain 10% to 100% step less capacity control for enhanced Power saving. The Indoor units should be provided with Corded Remote Control as a standard accessory.

a) Refrigerant

The Entire Condensing unit and Evaporating unit should be Factory assembled and tested .The units should come with an initial charge of refrigerant R410A / other equivalent refrigerant. Any additional refrigerant is to be added at site.

b) Ambient conditions

To be capable of operating within a wide range of ambient temperatures, the Condensing units should be capable of provide cooling within an ambient range of 5 Deg. C to 43 Deg. C. D.B. The regulation in Refrigerant flow is to be achieved by inverter based scroll/rotary compressor, head pressure control (by varying fan speeds) and hot gas bypass connection.

c) Refrigerant Piping Distance Limits

To be capable of refrigerant piping runs up to 150m between the condensing unit and indoor units with 50m level difference without any oil traps or double risers. The Oil Equalizing line should be inside the Condensing unit, to avoid 'inverted' oil traps at site.

d) Condensing Units

They shall be fully weatherproofed, factory assembled and pre-wired with all necessary electronic and refrigerant controls. The casing shall be from mild steel panels coated with a baked enamel finish. Provide the condenser coil fins with a corrosion resistant finish.

Larger Condensing Units shall incorporate 3 compressors in condensing units with at least one inverter scroll/rotary compressor and other two fixed speed scroll/rotary compressors.

The design shall be modular type allowing for side by side installation of the condensing Units.

Fan Motor Speed Control:

The condensing unit fan motors to have at least two speed operations to maintain constant head pressure control in all ambient temperatures and modes of operation.

Outdoors units of the VRV / VRF system shall be compact air cooled type.

The compressor shall be of the high efficiency complaint scroll design with an EER of not less than 11.1 BTUH/watt (COP of not less than 3.25) at ARI rating conditions. Each compressor shall have in-built overloads, HP and LP controllers and mounted on vibration isolators.

"Coated PE Fins (with special acryl pre-treatment)" for Al fins of Condenser Coils is mandatory for increased durability to salt corrosion.

i) Compressors

The compressor shall be highly efficient at least one inverter based scroll/rotary compressor & two fixed scroll/rotary compressors. The compressors shall have electronic controls, capable of loading and unloading to follow the variations on cooling using the latest axial compliant sealing technology. The microprocessor panel should incorporate control for precise monitoring of status of the system.

ii) Heat Exchanger

The heat exchanger shall be constructed from seamless copper tubes mechanically bonded to aluminum fins to form a cross fin coil. The aluminum fins shall be treated with an anti-corrosion film.

iii) Refrigerant Circuit

The refrigerant circuit shall be complete with condensing unit with refrigeration compressors, motors, fans, condenser coils, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut down valves, service ports, receivers and accumulators and all other components which are essential for safe and satisfactory operation.

iv) Safety Devices

Provide the following safety devices as a part of the outdoor unit: High pressure switch, fuses, crank case heater, fusible plug, over current protector.

v) Oil Recovery

Equip the unit with an oil recovery system to ensure stable operation for systems with long refrigerant piping. Operate the oil recovery system after the first hour of operation and then every consecutive 4 hours of operation. Also fit high efficiency oil separators to the discharge side of the compressor together with factory fitted oil equalization system.

vi) Selection Switches

Fit the condensing unit printed circuit board (PCB) with selection switches for the length of pipe work, emergency operation switches and service mode switches, together with LED indications for operation / fault indication.

e) Refrigerant Pipe work

The scope of Refrigerant Piping work shall include Supply, installation, testing and commissioning all interconnecting pipe work between the condensing unit and the Indoor units. The piping shall be refrigerant quality seamless copper tube with brazed connections and with the appropriate Distribution joints and headers. The piping should be routed at site in such a manner, that brazed joints in the Ref. Piping are kept to a minimum. During brazing, pass dry nitrogen through the pipe work. For outdoor piping, the pipes, after insulation, should be covered with Woven Glass Cloth 125 gsm finished in U/V Treated, pigmented Epoxy for Outdoor Piping, as per relevant code. All refrigerant pipes shall be insulated with elastomeric nitrile rubber of adequate thickness as per manufactures standards or ASHARE Guidelines whichever is stringent and the same shall be submitted to consultant or client for approval.

i) Joint Orientation

The Distribution refrigeration pipe joints and headers shall be located in an appropriate orientation to enable correct distribution of refrigerant. The Distribution Joints should be factory insulated with pre-formed sections of EPDM / Equivalent.

ii) Cleanliness of piping

All pipe work must be kept clean and free from contamination to prevent breakdown of the system. Seal all pipe ends and keep sealed until immediately prior to making a joint.

iii) Pressure Testing

The piping shall be vacuum dehydrated immediately after installation of pipe work and prior to sealing of insulation joints and start up of equipment & pressure tested to 3,800kPa; held for a minimum of 24 hours & checked for leaks and repaired if necessary. Following this, the pipe work to be vacuum dehydrated to (-755mmHg) and held for one to four hours depending on the pipe length.

iv) Fixing Pipe work

Pipes shall be layed on GI cable tray of adequate size and supports shall be fixed at minimum of 2 meter centers with suitable saddling arrangement. Exposed Refrigerant pipes on the terrace shall be covered with open able GI Cable trays.

1.1.1 General

The system selected is a modular system, with number of indoors connected to centrally located outdoor units, as per detail designing given in the tender. The outdoor units for all the system shall be air cooled type and mounted on terrace of the building. Indoor units in various areas shall be as per enclosed drawings/ Bill of Quantities.

Wherever feasible in open spaces or large rooms the indoor units shall be logically split and connected to separate outdoor units.

All the VRV air conditioners shall be fully factory assembled, wired, internally piped & tested. The outdoor unit shall be pre-charged with first charge of R410a refrigerant. Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 415 V ± 10%, 50 Hz ± 3%, 3 Phase supply for outdoor units & 230 V ± 10%, 50 Hz ± 3%, 1 Phase supply for indoor units.

The VRV system shall provide stable, trouble free & safe operation, with flexibility of operating desired indoor units. The outdoor units must be capable of delivering exact capacity proportional to the number of indoor units switched on & the heat load in the air conditioned area. The proportional operation shall be achieved by varying speed of the compressor in the outdoor units.

The operation of the VRV system shall be through independent wired remote controllers/ wireless controller as specified. The entire system shall be controlled by a system controller and shall be integrated through BACNET protocol with an intelligent building management system. The system controller shall be able to control start / stop on time schedule and also provide common fault from the system. The BMS will be provided by others.

1.1.2 Outdoor Units

Outdoor units of the VRV system shall be compact air cooled type.

All the compressors of the outdoor units must be hermetically sealed scroll/Rotary type. Each module of outdoor unit must have at least 1 inverter compressor, suitable to operate at varying heat load proportional to indoor requirement.

The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 43 Deg C, in cooling mode & 20 Deg C to 15 Deg C in heating mode

The outdoor units must be suitable for up to 150 m refrigerant piping between outdoor unit & the farthest indoor units, total piping of 300 m for all the indoor units. Allowable level difference between outdoor unit & indoor units shall be 50 m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom. Allowable level difference between various indoor units connected to one out door unit shall be up to 15 m.

Back up operation, in case of failure of one of the compressors of outdoor unit, for single module outdoor units or failure of one of the modules in case of multiple module outdoor units shall be possible. The VRV outdoor unit shall always be supplying at least 33% of back up operation, of the full load capacity.

The outdoor unit shall employ system of equal run time for all the compressors, inverter or on / off type, within each outdoor unit – Single Module or Multi Module.

The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 43 Deg C, in cooling mode.

Air cooled condenser shall have Axial Flow, upward throw fan, directly coupled to fan motors with minimum IP 55 protection. The outdoor unit condenser fan shall be able to develop external static pressure up to 7.5 mm of H2O. The outdoor unit should be with canopy at top to protect from heavy rain.

The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.

Starter for the Outdoor Unit compressor shall be “Direct on Line” type. Inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting. Specification for starter panels furnished in below electrical section.

Refrigerant control in the outdoor unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.

Noise level of outdoor units shall not exceed 65 dB (A) at a distance of 1.5 m from the unit.

The outdoor units shall confirm to Technological Guideline for Harmonic Suppression – JAEG 9702-1995. High Harmonic Environmental Target Level for Power Distribution system shall be 5%.

Outdoor units shall be complete with following safety devices:

- High pressure switch
- Fan driver overload protector
- Over current relay
- Inverter Overload Protector
- Fusible Plug
- Short Circuit Protection

Unit shall be supplied with

- Installation manual
- Operation Manual
- Connection Pipes
- Clamps

1.1.3 Indoor Units

a) Ceiling Mounted duct type units

These units shall be ceiling suspended with suitable supports to take care of operating weight of the unit, without causing any excessive vibration & noise.

The cold air supplied by these units will be supplied to the area to be air conditioned, through duct system specified in the tender.

Each indoor unit must have electronic expansion valve operated by microprocessor thermostat based temperature control to deliver cooling/ heating as per the heat load of the room.

The unit casing shall be Galvanized Steel Plate.

Unit must be insulated with sound absorbing thermal insulation material,

The noise level of unit at the highest operating level shall be selected to meet the noise criteria specified for each area.

The unit must be able to develop external static pressure of 25mm (250Pa) at the specified air quantities – to match the specified supply air ducting, grills and extract grills plus 5Pa.

Unit must have Thermal Fuse for fan motor protection, in case of motor heating.

Each indoor unit shall have factory installed as standard equipment, maintenance free long-life filter and resin net with mold resistant.

The unit will be connected in series to a suitable outdoor unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the bill of quantities.

b) Air Handling Unit

These units shall be Ceiling suspended, double skin air handling units. AHU housing shall be constructed of 0.6mm thick galvanized pre-coated sheet on outside and 0.6 mm thick plain GI sheet inside.

The panels shall be insulated with a 25mm thick CFC free Puff insulation having a thermal conductivity of 0.59 W/m²K. AHU shall have DX cooling coil (VRV/VRF compatible), Pre filter section, insulated drain pan, Plug type / DIDW type fan (single or twin blower fan, bidder should select the fan as per CFM qty & fan section, high efficiency motor (EFF1), IP55 protection, Motor Suitable for 415+ 10% volts, 3 phase 50 Hz AC supply. AHU should have marine light, door limit switch.

The filters used in AHUs should have MERV value 8.

Fan Motors Should be minimum IE3 rated. ADP - 54 deg F AHU should provide with LEV kit. (Connection kit between VRF ODU and AHU cooling coil). Power supply should be in the scope of Electrical Contractor. Height of the AHU should not be exceeding above 750mm.

c) Cassette - Round Flow:

Designed for low-noise operation, these AC's ensure pleasant air conditioned environment. They are easy to install and give you high quality cooling and healthy breathing indoor air.
Available in 1.0, 1.5, 2, 3 and 4 TR
Sleek and stylish, goes with any modern décor
Quiet and efficient air flow in 360 deg. orientation with improved temp. Distribution
The air filter has an anti-mould & antibacterial teratment that prevents the growth of mould generated from dust or moisture.
Programmable Timer
Power-saver compressor
Fuzzy logic
Integrated drain pump
Non flocking surfaces, which repel dirt& also easy to clean.

1.2.1 Specification for Controls System for VRF air conditioning system:

a) Wired/Wireless Remote Controller:

Wired/Wireless remote controller shall be supplied as specified in the “Bill of Quantities”

The controller must have large crystal display screen, which displays complete operating status.

The digital display must allow setting of temperature with 1 Deg C interval.

Remote shall be able to individually program by timer the respective times for operation start and stop for a period of 1 week.

Remote shall have 24 hrs. Clock function.

Programming can be enabled or disabled. Provide scheduling of start / stop and temperature limit – 5 settings per day.

Remote must be equipped with thermostat sensor in the remote controller that will make possible more comfortable room temperature control

The remote shall be able to monitor room temperature & preset temperature by microcomputer & can select cool/ heat operation mode automatically.

The remote must constantly monitor malfunctions in the system & must be equipped with a "self diagnosis function" that let know by a message immediately when a malfunction occurs.

It shall be possible to wire the remote up to 500 RMT in case of wired remote controller.

Compact light receiving unit to be mounted into wall or ceiling shall be included in case of wireless remote controller if applicable.

2. FANS

2.1.1 Toilet Exhaust Fan:

All Toilet Exhaust Fans as per BOQ Specification. Fan shall installation with necessary accessories as per Manufactures guideline. Exhaust air shall carry through G.I Ducting / Pipe & Outlet of shall be 45 angles with decorative louvers & Bird screen. Fan shall be installed with necessary cabling work (interconnect with toilet lighting).

2.1.2 Performance Data

All fans shall be selected for the middle range & lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

2.1.3 Testing

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall confirm to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current

3. AIR DISTRIBUTION SYSTEM

3.1.1 Scope

The scope of this section comprises supply fabrication, installation and testing of all sheet metal ducts, supply, and installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the drawings.

3.1.2 Duct Materials

Galvanizing shall be Class VII – light coating of zinc, nominal 180gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

Application	Material

1) Ducting for HVAC work.	Cold rolled sheets continuous galvanized with zinc coating as per class VII - Light Coating of zinc, Nominal 180 gm/Sq. m surface area.
2) Supports & duct flanges	Mild steel structural steel sections
3) Gasket	Foamed/neoprene rubber 3.2 mm (1/8") min.
4) Bonding/sealant	Mastic sealant

3.1.3 Gauges, Bracing by Sizes of Duct

All ducts shall be fabricated from galvanized steel of the following thickness as per IS - 655, as indicated as below:

Longer Side (mm)	Minimum Sheet Thickness(mm)		Minimum Sheet Thickness(Gauge)	
	GI	Aluminum	GI	Aluminum
750 and below	0.63	0.80	24	22
751 to 1500	0.80	1.00	22	20
1501 to 2250	1.00	1.25	20	18
2251 & above	1.25	1.60	18	16

3.1.4 Fabrication Standards & Equipments

All duct construction and installation shall be in accordance with SMACNA/ IS - 655 standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

A coil (Sheet metal in Roll Form) line to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges to be machine treated using lock formers, flangers and rollers for turning up edges.

3.1.5 Duct Construction

Girth angles and companion flanges shall be mitered and welded at corners and riveted to duct sheets at 75 mm (3") centers. Flanged joints shall be made with 9.5 mm (3/8") GI bolts spaced at 100 mm (4") centers and provided with 3.2 mm (1/8") foamed/neoprene

rubber gasket. All joints and seams shall be rendered air tight with mastic sealant. Longitudinal scams shall be inside groove of Pittsburgh type.

Standard elbows with a R/D ratio of not less than 1.25 shall be used as far as possible. Where space restrictions do not permit use of standard radius elbow with less R/D ratio square elbow with equally space double thickness vanes may be used. Length of tape ducts shall be at least four times the maximum size difference between the ends.

All duct lining for acoustic insulation shall be carried out as specified under sec "NOISE & VIBRATION" before the duct is installed in position.

Samples of sheet from each lot selected at random by Engineer's site representative shall be subject to approval & gotten tested for thickness and zinc coating at Contractor's expenses.

All ducts shall be fabricated and installed in workmanlike manner, generally conforming to relevant BIS Codes.

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA/IS codes.

Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities.

The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA/IS practice, to ensure air tightness.

All exposed ducts up to 60 cm width within conditioned spaces shall have slip joints - or flanged joints. The internal ends of slip joints shall be in the direction of air flow. Ducts and accessories within ceiling spaces, visible from air conditioned areas shall be provided with two coats of mat black finish paint.

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.

Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

All ducts shall be installed generally as per tender Drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor.

The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Engineer's site representative in all its parts and details.

All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstruction in the building, whether or not the same are shown on the Drawings. Where necessary to avoid beams or other structural work plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

If a duct cannot be run as shown on the Drawings, the Contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Engineer's site representative.

All duct work shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel under ducts at no greater than 2 meter centre to centre distance. All vertical duct work shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles/ channels shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats.

Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building.

Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.

All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, ductable units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve atleast 10 cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

3.1.6 Duct Supports

Duct supports shall be as follows:

Duct perimeter (mm)	Supporting Angle/ rod	Location
Up to 1500	40 x 40 x 5 mm (1' F x 1' F) x (5¼") MS angle with 9 mm (3/8" tie rod)	At Transverse Joints
From 1500 to 2500	40 x 40 x 6 mm (1 ½ x 1 ½ x ¼") MS angle with 12.5 (½") mm tie rod	At Transverse Joints
Over 2500	50 x 50 x 6 mm (2 x 2 x ¼") MS angle with 15 mm (5/8") tie rod	At Transverse Joints

Additional supports should be taken wherever the engineer-in-charge instructs. The tendered has to include the price of supports in ducting rates even if he has to take the supports from purling. The supports from purling should be taken without making holes by drilling/gas cutting the purling/main frame. Additional purling if required by HVAC contractor will be in HVAC contractor's scope of works.

All duct supports, flanges, hangers shall be painted with red oxide and black enamel paint after installation.

Ducts connecting to air moving apparatus shall be through fire resistant double canvas cloth. The flexible connection shall not be less than 75 mm and not more than 200 mm

3.1.7 Dampers

Dampers shall be multi-blade type with opposed blades or parallel blades of Aluminium Aerofoil construction rotating in permanently lubricated ball/roller bearings. Blades shall be 250 mm (10") max. Width and 1200 mm (48") maximum length mounted in a 50 mm (2") channel frame. Blades shall be connected with suitable linkage for gang operation by an operating rod extending beyond the frame and insulation if any and terminating in a locking quadrant with damper position indicator. Damper larger than 1200 mm (48") in width shall be furnished in multiple sections. Dampers should be located in branch ducts to facilitate balancing of the system.

Dampers shall be manual or motorized as shown on drawings and BOQ. All actuators shall be rated for actual duty conditions. The selection of same shall be submitted by contractor for approval.

All the dampers shall be of Min.18 G GI Frame with 18 G extruded Aluminum blades.

3.1.8 Supply and Exhaust Air Terminals:

Finish of all the air diffusing equipment shade shall be approved by architect before installing. Supply and return air terminals shall be made of Min 20 G extruded aluminum section as mentioned in BOQ.

Supply air grilles shall be Single/double deflection type with horizontal face bars and vertical rear bars placed in a rigid marginal frame. Bars shall be shaped and paced at 18 mm (3/4") centers with swaged pivot pins positively holding the deflection setting under all conditions of velocity and pressure. All grilles shall be provided with integral opposed blade, grille face key operated dampers.

Return grilles shall have fixed face bars shaped and set at 18 mm (3/4) centers. Bars shall be set at suitable deflection for vision proof installation. The grilles shall be complete with rigid marginal frames and shall be matching with the supply grilles.

Ceiling diffusers shall be round/square/rectangular face flush type horizontal air diffusion pattern. Diffusers shall have ample margins to minimize ceiling smudge. All supply air diffusers shall be provided with face operated volume control dampers.

Linear diffusers/grilles shall be die formed, flush mounted type with single or double directional air flow. The diffuser/grille shall be in a mild steel frame with minimum 20 mm margin. All linear air diffusing equipment shall be fitted with a distribution sheet metal plenum. The ends of all linear grilles/ diffusers should be with end flanges.

Mild steel grilles and diffusers shall be fabricated out of 1.0 mm mild steel and painted with two coats of red oxide. All duct collars terminating on to a grille or diffuser shall be given two coats of black paint for a length of 300 mm from inside. Grilles and diffusers shall be selected for an aerodynamic noise power not in excess of NC 30.

3.1.9 Measurements for Ducting

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centre-line measurements described herewith:

a) Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the centre of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centre line distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centre line.

The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other

accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

b) Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:
i) Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

ii) Diffusers - cross section area for air flow at discharge area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

iii) Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

iv) Fire dampers - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.

v) Flexible connection - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

3.1.10 Testing & Balancing

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by smoke tes as per standards.

The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge, at various outlets and return air shall be identical to or less/excess than 5 percent in excess of those specified and quoted.

Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.

4. INSULATION

a) Scope

The scope of this section comprises the supply and application of insulation conforming to these specifications.

4.1) Material Thermal Insulation

Insulation material for Duct & Pipe insulation shall be closed cell Elastomeric Nitrile Rubber. Thermal conductivity of the insulation material shall not exceed 0.038 W/moK or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30oC. Density of the nitrile

rubber shall be 40-60 Kg/m3. The product shall have temperature range of –40 oC to 105oC. The insulation material shall be fire rated for Class 0 as per BS 476 Part 6: 1989 for fire propagation test and for Class 1 as per BS 476 Part 7:1987 for surface spread of flame test. Water vapor permeability shall be not less than 0.024 per inch (2.48 x 10-14 Kg/m.s.Pa i.e. μ=7000: Water vapor diffusion resistance). The material shall have approval from the Chief Fire Officer if required. Material shall also be FM global approved.

4.2) Acoustic Insulation

Internal Insulation material for Duct insulation shall be 25mm thick 48kg/m3 open cell nitrile rubber and covered with 26G perforated aluminum sheets. Density of the nitrile rubber shall be Min 120 Kg/m3, NRC 0.6. The product shall have temperature range of –20 ◦ C to 85◦C. The insulation material shall be fire rated for Class 0 as per BS 476 Part 6: 1989 for fire propagation test and for Class 1 as per BS 476 Part 7:1987 for surface spread of flame test. The material shall have approval from the Chief Fire Officer if required. Material shall also be FM global approved.

4.3) Under deck Insulation

The insulation material shall satisfy the following requirements: -

Material	Thickness (mm)	Density (Kg/cu.m)
For Under deck Insulation on exposed Roof		
Nitrile rubber	50	16

Insulation material for under deck insulation of exposed concrete slab shall be 25 mm thick Nitrile rubber of 16 Kg/m3 fixed to slab with 8 5/20 grade hot bitumen and mechanically fastened at suitable intervals using GI screw washer & GI diagonal wires. The insulation shall be covered with 36 G Aluminums Foil. Insulation work to be coordinated with other agencies and repair to be included by contractor as per site requirement.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapor permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be non-flammable, vapor proof adhesive strictly as per manufacturer's recommendations.

b) Application of Insulation

i) Application of Duct Thermal Insulation

External thermal insulation shall be provided as follows:

The thickness of nitrile rubber shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubber sheets to size with sufficient allowance in dimension. Cutting of nitrile rubber sheets shall be done with adjustable blade to make 900 cut in thickness of nitrile rubber sheet. Hacksaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer.

ii) Application of Duct Acoustic Insulation

Internal Acoustic insulation shall be provided as follows:

The thickness of fiber glass faced shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut fiber glass sheet with sheets to size with sufficient allowance in dimension. Cutting of fiber glass sheets shall be done with adjustable blade to make 90^0 cut in thickness of fiber glass sheets. Hacksaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted.

Provide external thermal insulation to entire length of duct in addition to acoustic lining in accordance with the specifications. The duct sizes shall be adjusted to compensate the thickness of internal insulation.

iii) Application of under deck Insulation on exposed Roof

Under deck insulation shall be 50mm thick TF Quality expanded polystyrene (32 Kg/m3). Under deck surface of ceiling shall be cleaned and made dirt free. Insulation panels shall be pasted on this surface with black CPRX compound. 28g wire net shall be tightened around insulation so as to avoid any kind of sagging. Ends of net shall be overlapping by at least 25mm. Overlaps shall be screwed with galvanized screws to avoid rusting.

c) Protective coating over Thermal Insulation

To provide mechanical strength and protection from damage all pipe / duct insulated with nitrile rubber as indicated in BOQ shall be covered with fiberglass fabric of 7 mil minimum thickness.

Insulated pipes & ducts exposed to UV rays shall be covered with fiberglass fabric. Over fabric one coat of fire proof epoxy or acrylic compound shall be applied. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

4.4) Measurement of Insulation

Duct insulation and acoustic lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermal insulated or acoustically lined duct shall be based on the perimeter at the centre of thickness of insulation, multiplied by the centre-line length of dueling including tapered pieces, bends, tees, branches etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.

5. Specification for Hot Dip Galvanizing Process

(For Mild Steel Used For Earthling, Cable Trays or Junction Boxes For Electrical

Installation.)

a) **General Requirements**

i) Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS:209-1992.

ii) Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm in

Accordance with IS: 6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square meter shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux,

Ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs,

Rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

6. Appointment of sub-contractor/agency for HVAC work:

6.1. The Principal Contractor shall propose the sub-contractor/agency which it intends to appoint for execution of HVAC works, with the submission of documentary proofs to prove the credentials of the agency and experience of earlier completed VRV/VRF systems for review and approval by the Consultant/MDL. **The Principal Contractor shall appoint the sub-contractor/agency for HVAC work only after approval of the Consultant/MDL.**

6.2. **Coordination with Other Agencies:**
The contractor shall co-ordinate with all other agencies involved in the work so that the work of other agencies is not hampered due to his work. Ducting, piping, cabling or any other work, which directly affect the progress of building work, shall be given priority.

6.3. **Testing & Commissioning**
The performance, testing & commissioning of the complete HVAC system is required to be carried out by the HVAC Contractor to comply with the various parameters specified in the tender documents. **Contractor shall submit Testing & Commissioning**

methodology for complete HVAC system for review & approval of Client / Consultant. Testing & commissioning of HVAC system shall be done strictly in accordance with approved methodology.

Contractor shall also provide four copies of record of all safety and automatic control settings for the entire installation. The installation shall be tested again after removal of defects and shall be commissioned only after approval by the Client – MDL/ Architect / Consultant.

All tests shall be carried out for satisfactory performance in the presence of the representatives of the Client – MDL / Architect / Consultant.

All instruments, services needed for the tests shall be furnished by the Contractor themselves. All testing instruments shall be calibrated and the Contractor shall produce calibration certificates in support.

Contractor shall raise call for inspection sufficiently in advance for witness by Consultant /MDL via officially acceptable means such as e-mail & letters

6.4. **Servicing of HVAC System during Defect Liability Period**

Contractor to arrange **free of cost quarterly servicing** of the entire HVAC system installed during Defect liability period to keep the system in good and trouble free operating conditions. The servicing agency appointed should be OEM or authorized agency of OEM.

6.5. **DOCUMENT**: **TECHNICAL DATA SHEETS**

Contractor shall submit the technical data sheet for all items after award of Contract and get it approved before procurement of the items. Technical data sheet of indoor & outdoor units to have parameters mentioned but not limited to those listed.

7. VRV/VRF SYSTEM_OUTDOOR UNIT		
(Technical information to be furnished in following format by Bidder after award of contract & before procurement.)		
SR. NO.	**SPECIFICATION**	**TO BE FILLED IN BY BIDDER**
	OUTDOOR UNIT :	
1.1	**COMPRESSOR**	
	Make	
	Type	
	Model no.	
	Max. Speed (rpm)	
	No. of Inverter / digital type compressor	
	% of full load capacity	
	% of Power consumption	
	Type of drive	
	List of safety device provided on compressor	
	Test pressure of compressor (kg./sq.cm.)	
	Refrigerant	
	Design conditions (at peak load)	
i)	Suction temperature(°C)	
ii)	Discharge temperature(°C)	
iii)	Suction Pressure (kg./sq.cm.)	
Iv)	Discharge Pressure (kg./sq.cm.)	

	Capacity of compressor at design conditions at full load (TR)	
	BKW at design conditions	
	Recommended motor HP	
	Overall dimensions of Outdoor Unit (mm) (Height, Width & Depth)	
	Weight of the Units	
1.2	**FAN SECTION :**	
	Fan dia. (mm)	
	No.of fans	
	Fan speed (rpm)	
	Type of drive	
	Design air quantity (cu.m./hr.)	
	KW at full load	
	Motor HP	
1.3	**CONDENSER COIL :**	
	Tube material	
	Fin material	
	No.of rows	
	Design heat rejection capacity (TR)	
1.4	**ELECTRIC MOTOR FOR CONDENSER FAN :**	
	Make	
	Type	
	Method of starting	
	Rated output (HP)	
	Range of working voltage (volts)	
	Rated frequency (Hz)	
	Rated speed (rpm)	
	Full load current (Amps.)	
	Starting current (Amps.)	
	Class of insulation	
	Efficiency and power factor at full load	
1.5	**COP**	
	COP of ODU capacity at 125% Diversity	
	COP of ODU capacity at 100% Diversity	
	COP of ODU capacity at 75% Diversity	
	COP of ODU capacity at 50% Diversity	
1.6	**DERATION CAPACITY in BTU / HR**	
	Actual Deration Capacity of ODU at 40 °C	
	Actual Deration Capacity of ODU at 43.0 °C	

VRV/VRF SYSTEM_INDOOR UNIT		
(Technical information to be furnished in following format by Bidder after award of contract & before procurement.)		
SR. NO.	**SPECIFICATION**	**TO BE FILLED IN BY BIDDER**
	INDOOR UNIT :	

1.1	**COOLING COIL :**	
	Tube material	
	Fin material	
	Overall dimensions of Indoor Unit (mm) (Height, Width & Depth)	
	Weight of the Units	
1.2	**EVAPORATOR FAN SECTION :**	
	Maximum air discharge capacity (cu.m./hr.)	
1.3	**ELECTRIC MOTOR FOR EVAPORATOR FAN :**	
	Make	
	Type	
	Method of starting	
	Rated output (HP)	
	Range of working voltage (volts)	
	Rated frequency (Hz)	
	Rated speed (rpm)	
	Full load current (Amps.)	
	Starting current (Amps.)	
	Class of insulation	
	Efficiency and power factor at full load	

DOUBLE SKIN AHU		
(Technical information to be furnished in following format by Bidder after award of contract & before procurement.)		
SR. NO.	**SPECIFICATION**	**TO BE FILLED IN BY BIDDER**
1.0	**GENERAL**	
1.1	Manufacturer	
1.2	Overall dimensions	
1.3	Operating weight	
1.4	Material thickness of outer casing (G.)	
1.5	Material thickness of inner casing (G.)	
1.6	Material / finish of outer casing	
1.7	Material / finish of inner casing	
1.8	Insulation material for casing	
1.9	Insulation thickness (MM)	
1.10	Material thickness of drain pan	
1.11	Insulation material of drain pan	
1.12	Thickness of drain pan insulation	
1.13	Fan section Cooling coil section Filter	

1.14	Material of structural member	
2.0	**FAN**	
2.1	Maximum air discharge capacity (cfm)	
2.2	Maximum static pressure (m.m.w.g.)	
2.3	Maximum fan speed (rpm)	
2.4	Fan diameter (m.m.)	
2.5	No. of fans	
2.6	Balance (static and/or dynamic)	
2.7	IKW at full load.	
2.8	Motor H.P.	
3.0	**FAN MOTOR**	
3.1	Make	
3.2	Type	
3.3	Method of starting	
3.4	Rated output (HP)	
3.5	Range of working voltage (volts)	
3.6	Rated frequency (Hz)	
3.7	Rated speed (rpm)	
3.8	Full load current (Amps.)	
3.9	Starting current (Amps.)	
3.10	Class of insulation	
3.11	Efficiency and power factor at full load	
3.12	Type of vibration isolation for fan & motor	
4.0	**COOLING COIL**	
4.1	Tube material	
4.2	Tube diameter (mm)	
4.3	Tube thickness (mm)	
4.4	Fin material	
4.5	No. of fins per cm.	
4.6	Coil face area (sq.m.)	
4.7	No. of rows	
4.8	Design ADP (deg.c.)	
4.9	Design air circulation through coil (CFM)	
4.10	Design air velocity through coil (m/s)	
4.11	Design air pressure drop (pascal)	
4.12	Design air inlet temperature - DB (deg.c.)	
4.13	Design air outlet temperature - DB (deg.c.)	
4.14	Design air inlet temperature - WB (deg.c.)	
4.15	Design air outlet temperature – WB (deg.c.)	
4.16	Air velocity across coil (m/s)	
4.17	Design heat absorbing capacity (TR)	

4.18	Air velocity across coil (m/s)	
4.19	Design heat absorbing capacity (TR)	
5.0	**FILTERS**	
5.1	Make and type	
5.2	Material of filter medium	
5.3	Size of filter including frame (mm×mm×mm)	
5.4	Effective filter area (sq.m.)	
5.5	Velocity through filter (m/s)	
5.6	Pressure drop through clean filter (m.m.w.g.)	
5.7	Efficiency	

Note:-

If the Contractor wishes to suggest improvements in the technical parameters without changing the major Contract technical specification & requirement, then the same need to be informed to the Consultant and Client for consideration with proper justification. However the Consultant's and Client's decision will be full and final and binding on the Contractor

8. APPROVED/PREFERED MAKE LIST

S.NO.	COMPONENT	APPROVED MAKE
1	VRF MAKE	MITSUBISHI/ O GENERAL / DAIKIN
2	AHU	EDGETECH/ NEUTECH/WAVE/ZECO/CITIZEN
3	BUTTERFLY/BALL VALVE	AUDCO / KEYSTONE / ADVANCE / CASTLE
4	PRE-INSULATED DUCT	PAL / AASAWA / ZECO
5	DX INVERTER UNITS	MITSUBISHI/ O GENERAL / DAIKIN
6	VRV PIPING WITH INSULATION	MANDEV/RAJCO/OEM APPROVED
7	PIPE - CPVC / UPVC	ASTRAL/PRINCE
8	INSULATION (NITRILE RUBBER)	ARMAFLEX/ARMACELL/LP
9	EPS/ THERMOCOLE	BEARDSELL/ COOLINE
10	PROPELLER FANS	NICOTRA/KRUGER/ CROMPTON/ALSTOM
11	PLENUM BOXES	COSMOS / RUSKIN TITUS/AIR MASTER

12	DIFFUSERS/GRILLS	COSMOS / RUSKIN TITUS / AIR MASTER
13	DUCTING SHEETS	SAIL / JINDAL / TATA / UTTAM
14	ANCHOR FASTNERS	HILTI/ FISCHER
15	MCB / MCCB	L&T / SIEMENS / SCHNEIDER/ABB
16	FIRE DAMPERS/DAMPERS	COSMOSS/RUSKIN TITUS/AIR MASTER
17	VCD (G.I.)	COSMOSS/RUSKIN TITUS/AIR MASTER
18	TEMP SENSOR & PR. SENSOR, FIELD DEVICES	H-GURU, DANFOSS, BELIMO, HONEYWELL, JOHNSON CONTROLS/SIMENS
19	ELECTRICAL CABLING	POLYCAB/RR KABALS/CCI
20	FLEXIBLE DUCTING	TWIGA/OWENS
21	PANEL	URMI TECHNOLOGIES
22	PIPE FITTINGS & GASKET	TYCO/VICTAULIC/MECH(JINAN MEIDE)
23	INSULATED FLEXIBLE DUCT	TWIGA/OWENS
24	DRAIN PUMP	INFINITY/LIBERTY/ASPEN/SAURMEN
25	BMS/DDC Control	SIEMENS/JOHNSON CONTROL/HONEYWELL
26	FAN	KRUGER/HUMIDINE/NICOTRA
27	VFD	DANFOSS/JOHNSON CONTROL/ABB/SIEMENS/L&T

VII - TECHNICAL SPECIFIACTION FOR STP WORK

INTRODUCTION:-

The Sewage recycle plant is designed to treat 80 m^3/day of sewage. The Treated water outlet quality will be as mentioned in Tenders requirements for recycle and reuse the water for flushing purpose.

It is proposed to have partially above underground ground and fully automatic package type containerized Sewage Treatment Plant based on Moving Bed Bio Reactor (MBBR) technology. The STP shall be designed as a package type plant in MSEP/ civil including necessary chemical dosing. All the piping pumps shall be inside to the modular plant. All the equipments, piping, pumps, blowers and electrical need to be mounted on a skid annexed. M.S. puddle flange (hot dip galvanized after fabrication), inlet, outlet overflow, vent, M.S. cover, drain channel with M.S. gratings sump to house pumps. The raw sewage collection sump with double bar SS screen shall be a part of the STP.

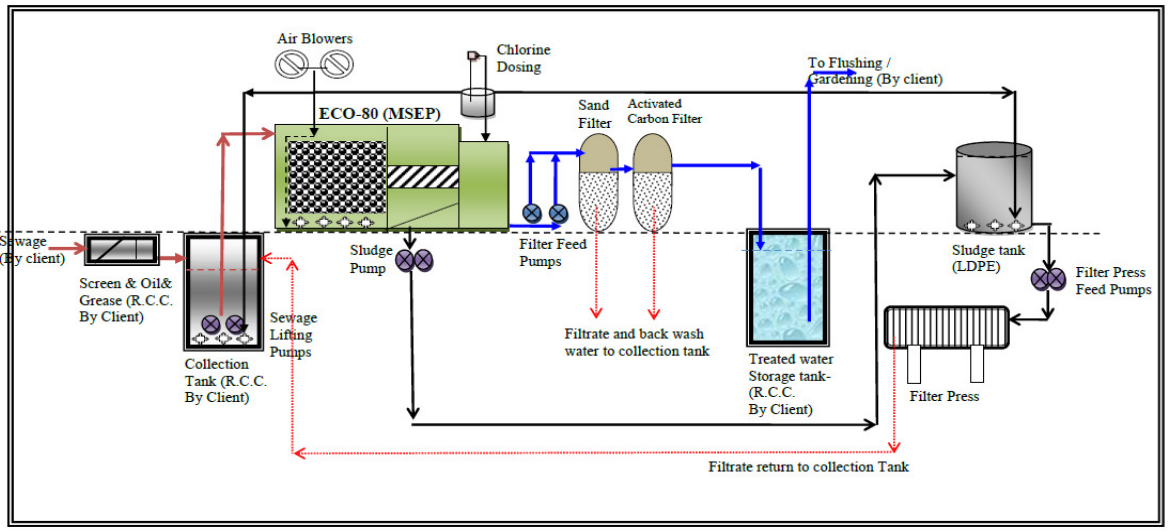
The space available for STP and tertiary treatment plant is as shown in the tender drawing.

DESIGN BASIS:-

The STP shall be designed based on the following parameters:

Sr.no	PARAMETER	UNIT	Inlet	OUTLET
1.	PH	..	7.5 – 8.5	6.5 – 8.5
2.	Total Suspended Solids	mg/l	< 200	<5
3.	BOD	mg/l	< 250-300	<5
4.	COD	mg/l	<400-500	<20
5.	Turbidity	NTU		<1
6.	Oil & Grease	mg/l	<20	BDL
7.	EColi			Nil

REQUIRED STP SNAP SHOT AS:-



TREATMENT PHILOSOPHY:-

- The primary objective of the sewage treatment plant is to provide the required quality of water on a consistent basis and for flushing use.

- Space being a severe constraint (space allotted for the Plan is shown in the layout drawing, which is part of the tender document), Compact, prefabricated systems are preferred.

- MBBR tank shall be fabricated with Mild Steel with Epoxy Coating (MSEP) and they are also in the supply scope of the contract.

- Due weight age will be given to energy efficient and low running cost systems.

- The system shall be provided with control panel, air blower.

COMPONENTS OF STP AND TERTIARY TREATMENT:-

LEAST REQUIREMENT OF STP SYSTEM.

The STP shall consist of following units but not limited to these unit as may be required by the manufacturer's design.

Perforated bar screen chamber including 1 no. S.S. bar screen having provision for lifting arrangement etc. complete as required.
Collection cum Equalization sump.
MBBR tank with air diffuser and piping, valves in all respect complete of adequate capacity.
Fine air bubble jet diffuser with EPDM seat having minimum number of diffusers to be provided in Aeration chamber.
All Submerged piping for air / water
Designing detail engineering, supervising the unit as mentioned above excluding civil work.
SS304 rungs in all tanks & Mild steel Platform for maintenance as required.
Supply of all required Civil & Mechanical/Electrical shop drawings by the contractor and approved by Project Manager.
For disinfection by Sodium Hypo Dosing system.
Weather proof Electrical Panel for the STP Plant.

DETAILS OF EQUIPMENT AND ACCESSORIES

Manual Bar Screen Chamber (Coarse & Fine)

- The Raw sewage will be passed through the Manual Bar screen (Coarse and Fine) for removal of floating matters from the sewage which will be scrapped out. This screened sewage will be collected in the collection tank.

- Bar screen shall be of Mild Steel Epoxy Coating (MSEP) construction. Drip trays shall be provided to hold and drainage of the screenings.

- A manual by-pass screen of 30mm opening with stainless steel drip tray shall be provided.

- An isolation valve shall be provided to divert the flow to the bypass screen when the screen requires service.

Collection cum Equalization Tank

- Collection will be equipped with air grid in the tank, which will help in keeping the sewage in suspension and avoid septic.

- Aeration grids will be provided for mixing purpose. The equalized sewage shall be pumped in MBBR tank for further treatment.

- RCC Equalization tank shall be provided by the client.

- Details of Equalization tank will be as per Suppliers details

Sludge Plumps (located inside the collection pump)

- Providing and fixing progressive cavity Sludge pump for delivering the sludge under pressure of 5-6 Kg/sqcm.

- The pumps shall have CI casing and Impeller & SS shaft & sleeve with mechanical rotary shaft seal connected by a flexible tier type coupling to TEFC induction motor mounted

on a common channel base-plate with coupling guard, Pressure gauge with GM isolation cock, suitable vibration eliminator pads of approved design.

- Motor shall be suitable for including all necessary piping, valves and other accessories skid foundation complete as required.
- Capacity / Flow Rate : As per the supplier's details
- No of Pumps : 1 W + 1 S

Sludge Collectors

- The sludge collectors serve to scrape the settled sludge to the sludge pump pit and Skimmer shall collect the scum.
- Each shall be of mechanical drivers for full automatic operation.
- All components such as chain, specter, etc. inside the tank shall be made of non-metallic material (such as cast nylon).
- The necessity shall be subject to change as per STP supplier.

Moving Bed Bio- film Reactor

- **The Reactor shall be of a package type fitting easily in the earmarked space and headroom constraints.**
- **Power consumption shall be minimal and so shall be the operation and maintenance requirements.**
- **A PLC (semiautomic) controlled plant with unmanned operation will be preferred.**
- **MBBR tank shall be made of Mild Steel with Epoxy painted.**

Mechanical Sludge Dewatering System

- The Bio sludge from Tube settler and shall be taken to sludge sump.
- Filter press feed pump will pump the sludge into the sludge holding bag for disposal.

Sludge Return Pump

- Providing and fixing progressive cavity Sludge pump for delivering the sludge under pressure of 5-6 Kg/sqcm.
- The pumps shall have CI casing and Impeller & SS shaft & sleeve with mechanical rotary shaft seal connected by a flexible tier type coupling to TEFC induction motor mounted on a common channel base-plate with coupling guard, 150 mm dia. pressure gauge with GM isolation cock, suitable vibration eliminator pads of approved design.

- Motor shall be suitable for including all necessary piping, valves and other accessories skid foundation complete as required.
- Capacity / Flow Rate : As per the supplier's details
- No of Pumps : 1 W + 1 S

Filter Feed Pumps

- Providing and fixing Horizontal centrifugal or submersible pumps for filtration.
- The pumps shall be made of CI casing, bronze Impeller, SS shaft & sleeve; Mechanical Seal are connected to a TEFC induction motor mounted on a common channel base frame with coupling guard, 150 mm dia pressure gauge with GM isolation cock, suitable vibration eliminator pads of approved design.
- Motor to be suitable for 400/440 V, 3 Phase, 50 cycles AC power supply, including all necessary piping, valves and other accessories and skid complete as required.
- Capacity / Flow Rate : As per the supplier's details
- No. of Pumps : 2 nos. (1W + 1 S)

Air Blowers

- Air blowers shall be provided in duplicate (i.e. one working and one standby).
- Blowers shall be Twin lobe rotary compressor complete with motor, base-plate, inlet filter, intake silencer and off-load starting system outlet silencer, anti-vibration damper, flexible coupling, filter restriction indicator, non-return valve, pressure relief valve, V-belt system or direct drive coupling.
- The casing rotor shall be of cast iron construction. Bearings and gears shall be grease lubricated. Motor speed shall be 1500 rpm.
- The size and performance of the air blower shall be so selected that it can provide a minimum air flow rate 0.5 l /sec / diffuser to 1l/sec/diffuser maximum, and to maintain a minimum of 2.0mg/l dissolved oxygen in the aeration tanks in operation.

Air Diffusers

- Air diffusers shall be made to provide a uniform distribution of fine bubble air release performance in the system.
- The air diffuser shall be either made of PVC or Polypropylene Material.
- Diffuser shall be of self-cleaning, non-clog disc or dome-shaped type.

- Oxygen transfer efficiency shall not be less than 20% at 3.5m submergence in clear water. Alternatives may be offered for consideration.

- Diffuser hold down assemblies shall consist of a retainer bolt, a matching washer and gasket.

- Sealing gasket shall be composed of solid neoprene rubber and shall be conform to ASTM D-2000 and shall be suitable for withstanding the effects of wastewater high temperature up to 120 Deg.C.The Contractor shall submit calculation to justify the diffuser selection and air requirement during the detailed design.

Filtration with MGF, ACF & SF

- MGF is Multi grade sand filter; Different grades of the sand will be filled in the MGF.
- It shall provide filtration for the suspended solids present in the sewage and further passed through the Activated Carbon Filter (ACF).
- The ACF will remove part of the organics in the sewage. Further the sewage will pass through the softener for removal of Hardness.

Multi Grade Sand Filter: MSEP Vessel

- Supply, installation, testing & commissioning of vertical self supporting multi grade sand filter fabricated from MSEP.Pressure gauges at inlet & outlet, sample cock, uPVC face piping, MPV and all accessories, with initial charge of filter media for multi grade sand filter, testing and commissioning complete.
- Type : Vertical pressure vessel with multi port valve
- Flow rate : As per the supplier's details
- Max. Operating pressure: 3.0 kg/Sq.cm
- Test pressure : 6 Kg/Sq.cm
- Filter Media : Silica quartz mechanical sand with pebbles & gravels as supporting media
- Suggested dia. meter : Not less than 350mm

- **Activated Carbon Filter**

- Supply, installation, testing & commissioning of vertical self supporting Activated Carbon Filter (ACF) fabricated from MSEP, Pressure gauges at inlet & outlet, sample cock, uPVC face piping, MPV and all accessories, with initial charge of filter media for activated carbon filter, testing and commissioning complete.

- **Type: Vertical Blow Down**
- **Flow rate: As per the supplier's details**
- **Max. Operating pressure: 2.5 kg/Sq.cm**
- **Test pressure: 6 Kg/Sq.cm**
- **Filter Media: Activated carbon with layers of pebbles & gravels**

Note: - Contractor has responsibility to check the water hardness from actual water analysis report before procuring the equipment.

SCOPE OF SUPPLY:-

To Be Provided By Supplier:

Sr.No	Description	Parameters	Provided by Supplier
1.	Manual Bar Screen		
	Quantity	1 No. (Working)	
	Type	Coarse	
	MOC Of Bar	SS 304 / M.S with Epoxy Coating	
2.	Air Grid in the Collection Tank		
	Quantity	1 Lot	
	MOC Of Grid	PVC	
	Alternatively, a submerged aerator shall be provided		
3.	Raw Sewage Transfer Pump		
	Type	Submersible	
	Capacity	As per manufacturers details	
	Head	To be specified by the vendor	
	Material of Construction	Casing - CI, Impeller - CI	
	Quantity	2 nos (1 working + 1 standby)	
4.	Moving Bed Bio Reactor (MBBR)		
	Diameter	To be specified by the vendor	
	Length of Shaft, m	To be specified by the vendor	

Sr.No	Description	Parameters	Provided by Supplier
	Specific surface of media, sqm/cum	To be specified by the vendor	
	MOC of Tank	Mild Steel with epoxy coating or Equivalent.	
5.	Air Blower		
	Type	Twin lobe rotary compressor Type	
	Capacity	As required by the process	
	Head	As required by the process	
	Material of Construction	CI	
	Quantity	2 nos. (1 working + 1 standby)	
6.	Tube Settler		
	Capacity	To be specified by the vendor	
	MOC of Media	PVC / PP	
	MOC Of Tank	Mild Steel with epoxy coating /RCC/ FRP / Equivalent	
7.	Hypo Dosing System		
	Capacity of Tank	To be specified by the vendor	
	MOC of Tank	HDPE/PP/ Equivalent	
	Complete with 1 Nos. of Dosing Pump and 1 No Agitator Mechanism		
8.	MGF Feed Pumps		
	Type	Centrifugal Horizontal	
	Capacity	As per manufacturers details	
	Head	To be specified by the vendor	
	Material of Construction	Casing – CI, Impeller - Bronze, Shaft - SS	
	Quantity	2 nos. (1 working + 1 standby)	
9.	MGF		
	Capacity	To be specified by the vendor	

Sr.No	Description	Parameters	Provided by Supplier
	Type	Vertical Down flow	
	Working Pressure	3.0 kg/cm2	
	Filter media	Graded Sand Filter media	
	Time required for Backwash	15 – 20 min	
	Material of Construction	MSEP	
	Valve Type	Multi Port Valve (MPV) - AUTO	
	Internal Painting of vessel	Internally Epoxy.	
	External Painting of vessel	2 Coats of Red Oxide primer.	
	Frontal Piping	1 Lot in PVC	
	Quantity	1 no.	
	Pressure Gauge	2 No(Inlet & Outlet)	
10.	ACF		
	Capacity	To be specified by the vendor	
	Type	Vertical Down flow	
	Working Pressure	2.5 kg/cm2	
	Filter media	Sand Media, Granular Activated carbon	
	Time required for Backwash	5 – 7 min	
	Material of Construction	MSEP	
	Valve Type	MPV - AUTO	
	Internal Painting of vessel	Internally Epoxy.	
	External Painting of vessel	2 Coats of Red Oxide primer.	
	Pressure Gauge	2 No(Inlet & Outlet)	
	Frontal Piping	1 Lot in PVC	

Sr.No	Description	Parameters	Provided by Supplier
	Quantity	1 no.	
11.	Filter Press Feed Pumps		
	Type	Horizontal Centrifugal pump	
	Capacity	To be specified by the vendor	
	Head	To be specified by the vendor	
	Quantity	2 nos. (1 working + 1 standby)	
12.	Sewage Collection bag		
	Type	Manual	
	Capacity	5 Kgs/Day Dry Solids	
	Quantity	2nos working	
	Capacity	As per manufacturers details	
13.	Valves		
	Quantity	1 Lot	
	MOC	PVC PN 10 Rating / CI-Teflon coated contact parts	
14.	Piping		
	Quantity	1 Lot	
	MOC	PVC PN 10 Rating/ PP of same rating/MS with external coating.	
15.	Weather proof Electrical Panel		
	Quantity	1 Lot	
	MOC	Ms- Powder Coated	
16.	Instrumentation with PLCs	1 Lot	
17.	**Raw wastewater Equalization Tank –** To be specified by the vendor in RCC is being provided by the client.		
18.	**Treated water Tank – (Client Scope)** The treated water from the STP shall be stored in a UG treated water tank adjacent to the STP from where it will be used for gardening.		

Sr.No	Description	Parameters	Provided by Supplier
	Type of Tank	RCC/ Equivalent	
	Capacity of Tank	**40 cum**	
19.	**2 Nos. of Single Trolley to be arranged by the contractor**		

SERVICES TO BE PROVIDED BY THE CLIENT:-

- Electrical supply to MCC panel
- Supply, laying & Termination of Incoming cable to the STP MCC.
- Plant illumination if required.
- Provision of Ventilation as whole plant system where all pumps of supply pump of bldg, air blower, and tertiary system is totally underground.
- Laboratory facilities including necessary instruments & chemicals.
- Acid / alkali / chemicals and any other consumables like Lubricants, oils and grease including the first charge.
- Relevant connections from termination points.
- All dilution water connections to the chemical solution tanks.
- Instrument air at one point near the plant at required pressure.
- All statutory charges for clearances and sanctions required for the implementation of the project.
- Sludge Disposal from the Plant.
- Construction Power & Water Supply

BATTERY LIMITS:-

Raw Sewage Inlet to Equalization Tank

Sludge at the outlet of sludge pump

Treated water at outlet of Treated Water Transfer Pump.

NOTE:-

The bidder shall indicate the following:

The overall schematic shall be provided.

The motor capacities (HP) of all pumps required by the process.

A comprehensive list of chemicals, filtration sand and resin required by the STP and an indication of the annual consumption of each for the said capacity.

Computation of Alum/ Polymer dosage.

The contractors to offer comprehensive A.M.C. at the time of submission of their offer.

The contractor to include their charges for training & Operation cost of 3 months.

Permission required from Municipal Authority/ MPCB, if any, is to be arranged by the contractor.

Warranty and Guarantee for the Plant and Machinery.

Instruction and Operation Manuals to be handed over to the client.

SCOPE OF WORK FOR OPERATION & MAINTENANCE (O & M) STP:-

- Compulsory O & M Period 3 months after the commissioning of plant:

On the completion of all work, the contractor shall run the STP to stabilize the same for three months (90 days) before handing over the same to the MDL officials.

- The minimum time period required will be of 3 months.

- During the O & M all the charges for electricity or diesel for DG sets will be borne by MDL.

ADDITIONAL PERIOD FOR THE OPERATION AND MAINTENANCE:-

- After the three months period of it is the discretion and power of the Engineer in charge to continue the O & M for further time period or MDL authority will provide its own staff for the running.

- The earnest money or security deposit will be returned or refund to the bidder if MDL take over the O & M at its own level.

- However the bidder has to quote the price for consecutive 1'st, 2'nd and 3'rd year separately along with the Price bid. The security amount of 2% of O&M cost will be retained by the department if the bidder will be allowed to continued the service of O&M.

- Following points will be kept in view by the agency during O&M period and the cost of 3 month should be included in the scope of O&M work.

a) The STP and the space around various units shall be kept clean.

b) All tank should have scrubber liner from inside.

c) Proper illumination will be ensured at night. The contractor may employ qualified and trained employees as per the requirement of the Engineer in charge on contract basis.These employees whether they are employed by the agency directly or through any agency shall be the employees of the contractor for all purpose whatsoever and shall not be deemed to be in the employment of MDL for any purpose whatsoever.

d) Any repair to the structures damaged due to natural disaster e.g. earthquake/floods, shall be done by the MDL.

e) The incoming/treated sewage water shall be tested in MPCB/CPCB certified labs for the different parameters from approved labs.

f) The sampling will be done with mutual consent and in - presence of authorized staff of both sides only.

g) The parameter covered will be BOD, COD, TSS, oil and grease and the cost of first three sampling will be paid by the contractor.

h) All sorts of Tool and plant, required for proper O&M of the Plant, shall be arranged by the contractor at his own cost.

i) The O&M cost shall be payable on monthly basis on completion of every month and on submission of monthly bills by the contractor.

j) The spares required shall not be payable to the contractor as the cost is included in the O&M charges quoted by the contractor.

k) The sampling of the treated water tests shall be performed for at least once a month from final outlet of STP only.

l) The comprehensive manual to be submitted before the operation and maintenance period i.e. before commissioning of the plant.

CIVIL WORK SPECIFICATIONS:-

- Earthwork, Plain cement concrete, Reinforced Cement Concrete, Brick Masonry, Plastering, Pipe laying, flooring, doors & windows. Finishes & other contingent building works will be done as per standard procedure and guideline.
- All surplus soil during excavation shall be transported and disposed of as directed by the Engineer-in charge. In case the excavated material falls short of requirement, the backfill earth shall be taken from borrow pits approved by the Engineer in charge.
- A permanent baseline & bench marks shall be established to serve as reference.
- All excavated materials obtained from excavation shall be MDL's property.

DETAILS OF ELECTRICAL WORKS:-

General Specification of Equipment

- LT Panel, cubicle type suitable for floor mounting and comprising incoming power control switch, Ammeters, Voltmeter, Phase Indicating Lamps, MCBs and Starters for the feeders all complete. Also to be provided are two nos. Automatic Level Controller for actuating the Raw Effluent /Treated effluent. Necessary Auto manual Selector Switches shall also be provided.
- Local push button starters shall also be provided near the Aerator equipments and mounted in weatherproof enclosures.
- Necessary power wiring by armored PVC Cables or by PVC insulated wire in conduit from LT Panel to equipment motors shall be provided with necessary tray/ support etc complete and internal lighting of entire STP Plant.
- Necessary earthing as per I.E. rules.
- Lighting shall be as per IS requirements and fixtures shall be of standard make and the make and size of cables used should be approved from consultant.
- Energy meter (approved make) should be provided in the panel.
- 1 no spare feeder with MCB of suitable capacity shall also be provided in the LT Panel.
- The switchboard shall be metal clad, totally enclosed, rigid, compartmentalized design, floor mounting, air insulated, extensible cubicle type for use on medium voltage power, 3 phases 4 wire 50 cycles system.
- The equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions. Means shall be provided to facilitate ease of inspection, cleaning, and repairs for use in installations where continuity of operation is of prime importance.

DOCUMENTS TO BE SUBMITTED WITH TENDER:-

The renderer shall submit the following details along with the tender

- Flow scheme with hydraulics
- Size of units
- Description of process
- List of mechanical and electrical equipment
- Total Power requirement unit wise
- Guarantees

DRAWINGS AND DOCUMENTS:-

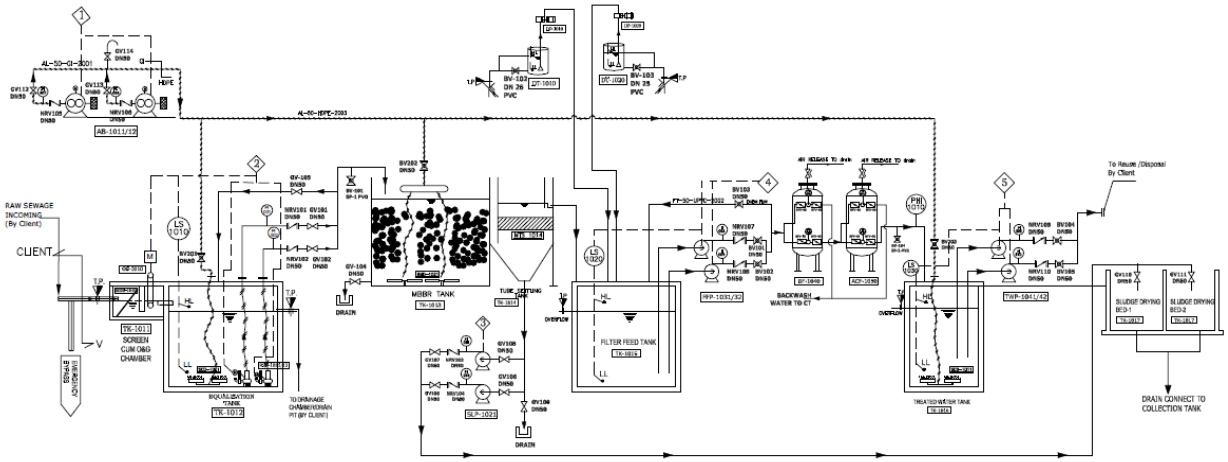
- The detailed drawings, specifications available with MDL engineers will form part of this tender specification.

- These documents will be made available to the contractor during execution of work at site. The contractor will also ensure availability of all drawings / documents at work place.
- Necessary drawings / documents by MDL to carry out the construction work will be furnished to the contractor by MDL (except those proposed to be prepared by contractor, as mentioned in this contract, if any) on loan which shall be returned to MDL Engineer at site after completion of work. Contractor shall ensure safe storage and quick retrieval of these documents.
- The contractor shall maintain a record of all drawings and documents available with him in a register as per format given by MDL Engineer. Contractor shall ensure use of pertinent drawings / data / documents and removal of obsolete ones from work place and return to MDL.
- The data furnished in various annexure enclosed with this tender specification are only approximate and for guidance. However, the change in the design and in the quantity may occur as is usual in any such large scale of work.
- Should any error or ambiguity be discovered in the specification or information the contractor shall forthwith bring the same to the notice of MDL before commencement of work. MDL's interpretation in such cases shall be final and binding on the contractor.
- Deviation from design dimensions should not exceed permissible limit. The contractor shall not correct or alter any dimension / details, without specific approval of MDL.

BILL OF QUANTITY:-

Sr. No.	Description	Unit	Quantity
A	Supply, Installation, Testing & Commissioning Package type underground STP along with tertiary treatment as specified in technical specifications. **Capacity:- 80 KLD**	**Nos.**	**1**

SCHEMATIC OF STP:-



P & I DIAGRAM

Typical MBBR schematic diagram

Note: - Above schematic may differ as per the manufacturer.

LIST OF APPROVED MAKES:-

S.NO.	**COMPONENT**	**APPROVED MAKE**
1	Bar Screen	As per manufacturer's design
2	Air Blower	Airvac/Everest / Vardhaman or equivalent
3	Diffusers	Scogen / Everest/Equivalent

4	MBBR Media, Tube settler	As per manufacturer's design
5	Hypo Dosing Tank	Sintex/Thermax or Equivalent
6	Hypo Dosing Pump	Asia LMI/Thermax/ equivalent
7	Ozonator	Ozonics/ Ozonetek/Aquazone/equivantent
8	Agitator for brine tank	as per manufacturer's design
9	Float switch	Innovative / equivalent
10	Equalized waste water transfer pump	Johnson / Kirloskar / wilo/equivantent
11	Soft Water lifting pumps	Johnson / Kirloskar / wilo/equivantent
12	Sludge pump, Filter pump	Johnson / Kirloskar / wilo/equivantent
13	Electrical Switchgear	Siemens/ L&T/ Schneider
14	PLCs	Siemens, Allen Bradley, Schneider/equivantent
15	Electrical cabling/wiring	Polycab / Universal /RR Kabal//equivantent