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

Technical Specification

&

Preferred Make

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GENERAL

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 specifications 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 & propitious 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 thereof, 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. Wherever any reference to any Indian standard specification occurs in the documents relating to this contract, the same shall be inclusive of all amendment issued there to or revisions thereof, if any, up to the date of receipt of tenders. 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 MDL /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. MDL concerned Engineering Division, 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 take precedence. In case of any difference or discrepancy between specification & drawing, the specification shall take precedence. Any discrepancy shall be brought to the notice of Engineer In Charge, resolved mutually prior to implementation of that work. <u>All works shall be carried out as per the Latest working drawings, specifications, Indian standard codes, Central Public Work Department Specifications (VOL. 1 &2) & work done to the satisfaction of Engineer In Charge.</u>

II – LIST OF INDIAN STANDARDS:

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.	SUBJECT
A. CIVIL WORKS	
1. CARRIAGE OF MATERIALS	
4082-1996	Recommendations on stacking & storage of construction materials and components at site.
2. 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)
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.

I. S. CODE NO.	SUBJECT
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)
3. 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)
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)

I. S. CODE NO.	SUBJECT
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)-1 980	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)
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)
4. 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)

I. S. CODE NO.	SUBJECT
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)
5. STEEL WORK	
63-1978	Whiting for paints. (Reaffirmed - 1994)
198-1978	Varnish, gold size. (Reaffirmed - 1991)
12406 - 1988	Medium density fibre board for general purpose - (1992)
277-2003	Specification for galvanised steel sheets (plain and corrugated)
278-1978	Galvanised steel barbed wire for fencing. (Reaffirmed - 1991)
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
813-1986	Scheme of symbols for welding. (Reaffirmed – 2008).
814-2004	Covered electrodes for metal arc welding of structural steel (Reaffirmed 2010)
814 (Pt-I)	For welding products other than sheets. *
814 (Pt-II)	For welding sheets. *
817-1966	Code of practice for training and testing of metal arc welders. (Reaffirmed – 2003)
818-1968 (Reaf-03)	COP for safety & healthy requirements in electric & gas welding & cutting operation.
1038-1983	Steel doors, windows and ventilators
1081-1960(Reaf-2011)	COP for fixing & glazing of metal (steel & aluminium) doors, windows & ventilators
1148-1982(Reaf-92)	Hot rolled steel rivet bars (upto 40 mm diameters)for structural purposes (Reaffirmed 2001)
1161-1998	Steel tubes for structural purposes
1182-1 983(Reaf-00)	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
1363-1992 (Pt. 1-3)	Hexagon bolts, nuts & lock nuts (dia. 6 to 39 mm) & black hexagon screws (dia. 6 to 24 mm).(Reaf-98)
1599-1 985(Reaf-91)	Method for bend test for steel products other than sheet, strip, wire & tube (reaffirmed 1996).

1608-1995	Method for tensile testing of steel products (Reaffirmed 2001)
1821-1987	Dimensions for clearance holes for metric bolts. (Reaffirmed - 2003)
1852-1985	Rolling and cutting tolerance for hot rolled steel products. (Reaffirmed - 1991)
2062-2011	Structural steel (fusion welding quality). (Reaffirmed – 2016)
4351-2003	Steel door frames. (Reaffirmed – 1991)
4736-1986	Hot-dip zinc coatings on steel tubes. (Reaffirmed – 2001)
6248-1979	Metal rolling shutters and rolling grills (Reaffirmed – 2011)
6278-1971	Code of practice for white washing & colour washing. (Reaffirmed - 1991)
14276-195	Cement particle board
6. DEMOLITION AND DISMANTLING:	
1200(Pt.XVIII)-1974	Method of measurements of demolition and dismantling
7. SAFETY CODES	
818-1968 (Reaf-03)	Safety and healthy requirements in Electric and gas welding and cutting operations.
3696 (Pt.I)-1 987	Safety code for scaffolds
3696 (Pt.II)-1991	Safety code for ladders
3764-1992	Safety code for Excavation works
4081-1986	Safety code for blasting and related drilling operation
4130-1991	Safety code for Demolition of Building
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
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
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

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 born 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 IS specification 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 for carrying out the test	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 & thereafter : Mandatory – Once in one year from each source;Optional: once in 3 months from eachsource; Municipal supply - optional.

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test	Frequency of testing
Reinforced cement concrete	b) slump test	Field	IS: 1199	a) 20 cu.m. for slabs, beams and connected columns . b) 5 Cu.m in	a) 20 cu.m. Part there of or more frequently as required by the Engr.-in-Charge. b) Every 5 Cu.m.
	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.
Ready mixed cement (IS-4926)	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,
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:					
Lime	Chemical & physical properties of lime	Laboratory	IS; 6932 (part 1 to x)	5 M.T.	10 M.T. or part there of as decided by the Engineer-in-Charge

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test	Frequency of testing
Sand	Bulking of Sand	Field		20 CU.M.	Every 20 cu.m or part thereof or more frequently as decided by Engineer-In-Charge
	Silt content	Field	IS:383	20 CU.M.	Every 20 cu.m or part thereof or more frequently as decided by
	Particle size and distribution	Field Laboratory decided by Engr -in-Charge	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 Engineer-in-Charge
	Chloride & sulphate		Optional		Once in three months.

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test	Frequency of testing
Cement	Test requirement	Fineness (m^2/kg)	IS 4031 (Part-II)	Each fresh lot	Every 50 MT or part
		Normal consistenc	IS 4031 (Part-IV)		
		Setting time (minutes) a) Initial b) Final	IS 4031 (Part-V)		
		Soundnes s a)Le-Chat expansion (mm) b) Autoclave (%)	IS 4031 (Part-III)		
		Compressi ve Strength (Mpa)	IS 4031 (Part-VI)		
Stone Aggregate	a) Percentage of soft or deleterious materials	General visual inspection / Lab test where required by the Engr-	IS 2386 Part II	One test for each source	One test for each source
	Particle size distribution	Field / Lab	-	10 cu.m	Every 40 cum. Or part thereof and
	) Estimationof Organic impurities	Field / Lab	IS 2386 Part II	10 Cum	-do-

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test	Frequency of testing
	b) Specific Gravity	Field / Lab	IS 2386	10 Cum	-do-
	Bulk Density	Field / Lab	IS 2386	10 Cum	-do-
	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.				
	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 for carrying out the test	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
Concrete Blocks	Dimensions of block Block Density Compressive strength Water absorption Drying shrinkage Moisture movement Retest – Drying shrinkage & Moisture movement if required	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.

Material	Test	Field / laboratory test	Test procedure	Minimum quantity of material / Work for carrying out the test		Frequency of testing
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.
	Chemical Composition		IS 1786 as per 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
Mosaic tiles			As per IS 13801 Para 14.6		5000 tiles and more for each manufacturer & thereafter for every	
Ceramic tiles			As per IS 13630		3000 tiles and more for each manufacturer and thereafter for every 3000 tiles or part thereof.	

OTHER MANDATORY TESTS: Soil core tests; Testing aggregate - particle size distribution; Ceramic tiles, Mosaic tiles

CI pipes: Dimensional, mass, Hydrostatic; GI pipes; Lead; RCC hume pipes; Stoneware pipes

ROAD WORK: Soil core tests; Grading of metal for WBM; Bitumen grade; Bitumen content; Load test on concrete gratings.

OPTIONAL TESTS: Testing aggregate-surface moisture, impact value pectrographic; alkali reaction; Dimensional tests of bricks; Testing the mass of zinc coating on GI door frame, steel windows, test for chemical and physical properties; Anodic coating on aluminium fittings and aluminium sections, Unit weight of aluminium sections;

Testing structural steel; Chequered plate, Unit weight, Thickness, Chemical and physical properties

Presence of preservative on factory made panelled door, kiln seasoned chemically treated wood products, Moisture content in wood products.

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.

Technical Specification for Civil Work

1. PLAIN / REINFORCED CONCRETE AND ALLIED WORKS:

1.1. SCOPE:

Scope of the specification deals with the structural 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.

1.2. 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.

1.3. CEMENT CONCRETE (PLAIN AND REINFORCED):

1.3.1. 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.

1.3.2. 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".

1.3.3. Materials for Standard Concrete: The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland/Portland puzzolana cement, clean sand, natural coarse aggregate, clean water, ice and admixtures if specially called for on drawings or schedule of quantities.

1.3.3.1. 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 taken 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.

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.

a) 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.

b) 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.

c) 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.

d) **Metakaoline: Metakaoline** having fineness between 700 to 900m^2/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 m^2/kg. The resulting material has high pozzolanicity.

e) **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.

B. <u>Specification for Storage:</u>

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 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 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 MDL), and until the results of such tests **are** found satisfactory, it shall not be used in any work.

1.3.3.2. 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.

1.3.3.2.1. Fine Aggregate: Fine aggregate except as noted above, and for other than light weight concrete shall consist of River natural or crushed sand 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.

1.3.3.2.2. 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.

1.3.3.2.3. 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 I.S. Sieve	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 uncrushed sand and items (iii) and (iv) for crushed sand.	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.

1.3.3.2.4. 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 born 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	85-100	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 sedim entation 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

1.3.3.3. 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 per	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 embedded steel and 500 mg/l for reinforced cement concrete work.
v)	Suspended matter	IS 3025 (Part 17)	2000mg / l

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

1.4. DESIGN MIX CONCRETE:

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

1.4.1. 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.

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/m³**	**Maximum Free Water Cement Ratio**	**Minimum grade of concrete**	**Minimum Cement Content Kg/m³**	**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.

4. **Nominal cover to meet specified period of fire resistance**

Fire resistance	Nominal cover						
	BEAMS		SLABS		RIBS		COLUMNS
	Simply Supported	Continuous	Simply Supported	Continuous	Simply Supported	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 contractor's 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.

1.4.2. 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 M45 M50	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}

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

1.4.3.1. 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 Engineerin-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.

1.4.3.2. 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 workability	Slump (mm)
(1)	(2)	(3)
Blinding Concrete; Shallow Sections; Pavement using pavers	Very low	See note 1.
Mass concrete; Lightly reinforced Sections in slabs, Beams, walls, columns; Floors; Hand placed pavements; Canal lining; Strip footings	Low	25-75
Heavily Reinforced sections In slabs, beams, walls, columns, slip form work; pumped concrete	Medium	50-1 00 75-100

Trench fill, In-situ piling	High	100-1 50
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 the project. Suppliers and contractor's 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.

1.4.3.3. 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 IS4925)

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	**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 with IS 1791 and IS 12119. The mixers shall be fitted with water measuring (metering) devices. 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 retards, plasticisers and superplsticisors shall be restricted to 0.50,1.0 and 2.0 % respectively by weight of cementecious 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.

1.5. 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.	Cast iron cube moulds 15 cm. Size	12 Nos.(min.)
2.	Slump cone complete with tamping rod	1 Set
3.	Lab. balance to weigh upto 5 kg. with sensitivity of 10	1 No.
4.	Laboratory balance of 2 kg. capacity and of sensitivity	1 No.
5.	I.S. sieves for coarse and fine aggregates.	1 Set
6.	A set of measures from 5 ltrs. to 0.1 ltr.	1 Set
7.	Electric oven with thermostat upto 120 0C.	1 No.
8.	Pycnometer	1 No.
9.	Calibrated glass jar 1 ltr. Capacity	2 Nos.
10	Glass flasks and metal containers	As required
11	Concrete cube testing machine (optional)	1 No.

1.6. 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 MDL.** 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.

1.7. SAMPLING AND STRENGTH TEST OF CONCRETE:

1.7.1. *Samples from fresh concrete shal be taken as per I.S. 1199 and cubes shal 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 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 (+/-) 2	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

1.7.2. 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.

1.7.3. 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.

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

1.7.5. 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.

1.7.6. Standard Deviation: Vide clause 4.4.2 of this specification.

1.8. 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 test results in N / mm²**	**Individual test results in N/mm²**
(1)	**(2)**	**(3)**
M 15	= / > f_{ck}+ 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm² or = / > f_{ck} + 3 N / mm² whichever is greater	= / >fck –3 N/ mm²
M 20 Or Above	= / > > f_{ck} + 0.825 x established standard deviation (rounded off to nearest 0.5 N/ mm² or = / > f_{ck} + 4 N / mm² , whichever is greater	= / > 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.

1.9. 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 6.260, 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.

1.10. 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 and/or load 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.

1.11. TESTING OF STRUCTURES:

1.11.1. 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 test, 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.

1.11.2. 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

1.11.3. 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 4:11:3) may be resorted to.

1.11.4. 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.

1.11.5. 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.

1.11.6. 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.

1.11.7. 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.

1.12. 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 381 2or 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 kg/m³ of Concrete.
(1)	(2)	(3)
i)	Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete	0.4
ii)	Reinforced concrete or plain concrete containing	0.6
iii)	Concrete not containing embedded metal or any material requiring protection form chloride	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 cment complying with IS 6909 or as approved by the Engineer-in-Charge.

1.13. 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.

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.

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.

1.13.1. 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.

1.13.2. BONDING MORTAR:

Immediately before concrete placement begins, prepared 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.

1.13.3. 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.

1.13.4. 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.

1.13.5. 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.

1.13.6. 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.

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 sue 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 horizontals and not steeper than 1 vertical to 2 horizontals, 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. 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.

1.13.7. COMPACTION:

1.13.7.1. 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 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.

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.

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.

1.13.8. 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 for thorough bounding as directed by Engineer-in-Charge.

1.13.9. 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 congregation of steel make placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position.

1.13.10. 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.

1.14. 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.

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 agent s should be thoroughly removed from joint surfaces.

If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made where the work is stopped. Joints shall be either vertical or horizontal, unless shown otherwise 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 either on the concrete itself or upon the shuttering. 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.

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.

1.15. 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, 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 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 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 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 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, hassian 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 poly ethylene 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.

1.16. 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.

1.17. REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE :

Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over 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 exposes 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.

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.

1.18. 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.

1.19. PROTECTION:

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

1.20. 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.

1.21. 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.

1.22. 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 eceiving concrete. The surface of absorptive soil against which

concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn form the freshly placed concrete and later shall help to cure the concrete.

1.23. 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.

1.24. 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.

1.25. 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.

1.26. 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.

1.27. 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 300C.

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.

1.28. 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.

1.29. 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.

1.30. PRECAST CONCRETE & 4.31 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 columns, fencing posts, door and window frames, lintels, chajjas, copings, sills, shelves, slabs, louvers 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 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.

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.

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.

1.31. 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 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.

1.32. 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.

1.33. GROUTING :

1.33.1. 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
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. The use of hot, strong, caustic solution for this purpose will be permitted.

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.

1.33.2. Special Grout : Special grout where specified on the drawing shall be provided in strict accordance with the manufacturers instructions/ specifications on the drawings.

1.34. 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.

1.35. 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.

1.36. 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	Cement	Quantity of materials used per bag of			
		Fine aggregate	Coarse aggregate	Total of fine sand	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	0.688	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
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 authorised, it should be done on a water tight platform.

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.

1.37. SPECIFIC REQUIREMENTS FOR CONCRETE AND ALLIED WORKS :

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.

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 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.

* * *

2. FORM WORK:

2.1. 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 forwork shall be clean, smooth & straight.

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-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.

2.3. 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:

2.3.1. 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.

2.3.2. 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)

2.4. 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.

2.5. 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 form sap, shakes, 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.

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.

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 and built upon sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m. or as directed by Engineer-in-Charge.

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 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.

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 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.

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 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.

2.9. 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.

2.10. 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.

2.11. 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.

2.12. 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.

In normal circumstances (generally where temperatures are above 15 0C.) 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 and lower temperature, the stripping time recommended above may be suitably modified.

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 reentrant 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.

2.13. 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.

3. STEEL FOR CONCRETE REINFORCEMENT:

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

4.1. 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.

4.2. 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/cumm 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.

4.3. 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 MDL Engineers 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 the purpose of carrying out tests for tensile strength, proof stress, percentage elongation and percentage elongation at maximum force for bars 28 mm in diameter and above, deformations of the bars only may be machined. For such bars, the physical properties shall be calculated using the actual area obtained after machining. The following IS codes shall be referred for test methods:

SN	Title	IS No	ISO No.
i	Mechanical testing of metals -Tensile testing	1608	6892
ii	Methods for bend test	1599 7438 &	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.
	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%
Phosphoru	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	8% more than the actual 0.2% proof stress/yield stress but not less than 545.0	10% more than the actual 0.2% proof stress/ yield stress but not	6% more than the actual 0.2% proof stress/yield stress but not less than 585.0 N/mm²	8% more than the actual 0.2% proof stress /yield stress but not	6% more than the actual 0.2% proof stress/yield stress but not less than 660.0 N/mm²
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.

4.4. 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 approved, 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.

4.5. 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.

4.6. NOMINAL SIZES

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

4.7. 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		
		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

4.8. 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.

4.9. 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 injure the materials. 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 645^0C) 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, injure 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.

4.10. 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.

4.11. 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

4.12. 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 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 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.

4.13. 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.

4.14. INSPECTION:

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

4.15. 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	**6**	**7**	**8**	**10**	**12**	**16**	**18**	**20**
Cross Sectional area	28.30	38.50	50.30	78.60	113.1	201.2	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	**22**	**25**	**28**	**32**	**36**	**40**	**45**	**50**
Cross Sectional area	380.3	491.1	614.0	804.6	1018.	1257.	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.

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4. READY MIX CONCRETE:

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

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

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

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

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

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.

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.

4.2. MATERIALS:

A. **The cement** used shall be of specified grade ordinary Portland cement or low heat Portland cement 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.

B. **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.

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

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

E. **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) – 1981. 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.

4.3. 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.

A. 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.

B. 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.

4.4. GENERAL REQUIREMENTS:

A. 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.

B. 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^{0}C) 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.

C. The temperature of the concrete at the place and time of delivery shall be not less than 5^{0}C. Unless otherwise required by the purchaser, the concrete shall be delivered when the site temperature is less than 2.5^0 C.

D. Adequate facilities shall be provided by the manufacturer/supplier to inspect the materials used the process of manufacture and methods of delivery of concrete. He shall also provide adequate facilities to take samples of the materials used.

E. 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.

F. The sampling and testing of concrete shall be done in accordance with the relevant requirements of IS 456, IS 1199 and IS 516.

G. 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 -2000.

H. The testing shall be carried out in accordance with the requirements and the cost shall be borne by the Contractor.

I. 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.

J. 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.

*** * * ***

5. 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, for 7 days and 28 days.

i) All ingredients of concrete should satisfy the requirements of relevant IS codes and specifications.

5.1. Curing, Protecting, Repairing and Finishing

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.

Curing of concrete with low water binder ratios having partial replacement of cement by pozzolanic materials.

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.

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 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.

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.

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.

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.

Curing Equipment:

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

5.2. Form Work

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.

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.

Type of Form Work:
Form work may be of 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.

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.
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 lightness, 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. 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.

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 offits 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 and built upon sections as placing of concrete proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 m or as directed by Engineer-in-charge.

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

i) 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.

j) No member shall be eccentric upon vertical member

k) The number of nut sand bolts shall be adequate.

l) Provisions of the design and/or drawings shall be complied

m) Cantilever supports shall be adequate

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

o) Guy ropes or stays shall be tensioned properly

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

q) Required camber shall be provided over long spans

r) Supports shall be adequate, and in plumb within the specified tolerances.

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 pozzoonas. In case of wooden shutter approved quality of form oil or plastic sheet can be use for this purpose.

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.

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.

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.

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.

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 form work.

In normal circumstances (generally where temperatures are above 200 C.) forms may be struck after expiry of the following periods.

S. N	Part of Structure	Earliest concrete age at stripping		
		Cement with low and having pozzolonas	Ordinary Portland cement concrete	Portland Pozzolana C.C Fly Ash Based
a)	Walls, columns and vertical sides of beams	3 days	24 to 48 hours as directed by the E-I-C.	3 days
b)	Slabs(Props left Under)	14 days	3 days	7 days
c)	Beam, soffits (Props left under)	14 days	7 days	10 days
d)	**Removal of props** i)Spanning upto 4.5m ii) Spanning over 4.5m	 14 days 14 days	 7 days 14 days	 10 days 14 days
e)	**Removal of props in beams & arches** i) Spanning upto 6m ii) Spanning over 6m	14 days 14 days	14 days 21 days	14 days 21 days
f)	For perforated 120mm thick	14 days	14 days	14 days

Skirting 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.

* * *

6. IRONITE (OR HARDONATE) FLOORING.

GENERAL:

To withstand heavy wear and tear, concrete flooring with metallic concrete hardening compound such as Ironite/ hardonate shall be laid as wearing layer as detailed below:

METALLIC / NON METALLIC CONCRETE HARDENING COMPOUND:

The metallic compound shall be Non Metallic / Ironite/ Hardonate of approved quality consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, grease and soluble alkaline compound.

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 metallic hardening compound topping.

METALLIC / NON METALLIC CONCRETE HARDENER TOPPING:

This shall consist of 12mm. thick layer of mix 1:2 (1 part of cement mixed with hardener: 2 parts of stone aggregate of 6 mm. nominal size by volume). The metallic / Non Mettalic concrete hardener compound being mixed with cement in the ratio of 1:4 (1 metallic concrete hardener: 4 cement used by weight) or as specified by the manufacturer. Concrete hardener shall be dry mixed thoroughly with cement on a clean dry pucca platform. This dry mixture shall then mixed with stone aggregate 6mm. nominal size or as otherwise specified in the ratio of 1:2 (1 cement mixed with hardener: 2 stone aggregate) by volume, and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete, water cement ratio not exceeding 0.4.

The mixture so obtained shall be laid in 12mm. thickness, on cement concrete floor within 1 to 4 hours of its laying. The topping shall be laid true to provide a uniform and even surface. It shall be firmly pressed into the bottom concrete so as to have good bond with it. The concrete shall be compacted well mechanically. Manual compaction will not be permitted unless approved by the Engineer-in-charge. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.

CURING, PRECAUTIONS, MEASUREMENTS ETC.:

Specifications for curing, precautions, quantity measurements etc. shall be same as specified for cement concrete flooring.

* * * *

7. CEMENT PLASTERING FOR WALLS & CEILINGS AND SAND FACE / ROUGH CAST PLASTERS:

a. 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.

b. 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 (Pt. III) (Code of practice for cement and cement plaster finish on walls and ceilings). All general precautions as specified in I.S. 1661 (Pt. III) 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 of approved make shall be mixed and laid as per manufacturers specification.

c. 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 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 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 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 plaster of paris/epoxy putty/silicon sealants, Rubber based sealants (brand name TECHMAT/TECHCOAT) by caulking guns or by approved methods as instructed/approved by Engineer-in-Charge.

d. 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 and shall be paid extra in the rates given in schedule of quantities.

e. MIX PROPORTIONS:

The mortar for plastering shall be of proportion as specified in the item schedule. The mixes specified in the schedule are volumetric.

f. 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 platform. 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.

6 / 12 / 15 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, ironite 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.

g.

(A) NEERU FINISH:

Wherever specified, the surface rendered shall be finished smooth with good quality lime neeru class 'C' conforming to I.S. 712-1956. 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 contractor's 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.

(B) TEROL FINISH OF TERRACO:

Wherever specified, the surface rendered shall be finished smooth with 0.5 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.

(C) PLASTER OF PARIS (POP – $CaSO_4$, 1 / 2H_2O) 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.

(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 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 contactor.

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.

8. SAND FACED CEMENT PLASTER:

8.1. 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 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, mulliions, 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/sstrucutrald 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.

9. 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.

* * *

10. 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.

* * * *

11. 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.

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.

1. BRICK BAT COBA WATERPROOFING ON TERRACE:

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.

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.

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. 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.

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.

2. CHINA MOSAIC WATER PROOFING:

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.

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.

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.

3. TAR FELT WATER PROOFING:

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.

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.

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 occurs 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.

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.

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.

4. CEMENT BASED WATER PROOFING OF W.C. AND BATHS AREAS:

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.

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.

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.

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 week's 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.

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.

5. CEMENT BASED WATERPROOFING OF ROOF TERRACES:

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.

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.

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.

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.

6. INTERNAL WATERPROOFING FOR OVERHEAD WATER TANK / LIFT PIT / UNDERGROUND SUMP OR TANKS:

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.

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 contractor's 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.

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.

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.

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.

7. WATER PROOFING TREATMENT OF EXPANSION JOINT AT ROOF LEVEL:

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.

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.

MODE OF MEASUREMENT:

The measurement for the joints thus waterproofed, shall be made in Running Metres upto two places of decimal of a metre.

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12. INTEGRAL CEMENT BASED WATER PROOFING TREATMENT OF UNDER GROUND WATER TANKS, SWIMMING POOLS, BASEMENTS ETC. FROM OUTSIDE:

A- ON HORIZONTAL SURFACES

A-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.

A-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.

A-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.

A-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.

A-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

A-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.

A-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.

A-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.

A-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.

A-10. Rate: The rate shall include the cost of labour & materials involved in all the operations described above.

B- ON VERTICAL SURFACES

The vertical water proofing treatment either from inside or outside shall be undertaken only when the entire work is structurally complete.

B-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.

B-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.

B-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.

I. Step: 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.

II. Step: 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.

III. Step: 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.

IV. Step: 4th Layer: Finishing with Neat Cement Punning:

(a) 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.

B-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.

B-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.

B-6. Rate: The rate shall include the cost of all labour and materials involved in all the operations described above and for all heights.

B. 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 (+/-)**

APPENDIX "A"

LIST OF APPROVED MAKE / MODEL

PREAMBLE:

1) All materials shall conform to relevant technical specifications of Volume – 4 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 **Fe415/Fe415D/Fe500/Fe550/Fe550D** grade (the grade to be procured is to be 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.

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
		Portland Pozzolana Fly Ash based cement (for all works Other than Concrete) of Ultratech, A.C.C., Rajashree,Ambuja.
2.	Cement (White)	Birla White / J.K.White
3.	T.M.T. Steel	SAIL, Tata Steel Ltd., RINL, Jindal Steel & Power Ltd.; Essar and JSW
4.	Structural steel	SAIL/TATA/RINL/IISCO/ ESSAR
5.	Ready Mixed Concrete	ACC/L&T /Ultratech/ Lafarge /RMC / Godrej
6.	Precast Concrete Products – Kerb stone Etc.	Vyara Tiles ,SUPER TILES, VITCO , HINDUSTAN BLOCK
7.	Antitermite Treatment	PCI, Pecopp, Godrej Hi-Care
8.	Stainless Steel	Jindal/SAIL/ Mukand/ Outokumpu
9.	Ceramic Tiles	Kajaria –Flooring /H. R. Johnson (I)/NITCO/Somany
10.	Factory made Concrete cover blocks	Raj cover blocks / Astra concrete products
11.	Anti-Root ; Filtering , Drainage Layer Waterproofing	TIKI TAR DANOSA ; BASF ; STP; DR FIXIT-Pidilite ; Sika
12.	External Paver Tiles Series	H. R. Johnson (I)-Endura/Vyara Tiles/ SUPER TILES
13.	Agglomerate Composite Marble	CMC/Asian/Johnson

14.	Heavy duty Industrial Tiles	Kajaria –Flooring /H. R. Johnson (I)/ Somany
15.	Kotah Stone	As approved by Architect
16.	Steel Grey Granite	As approved by Architect
17.	Vinyl Flooring	Responsive/Nora/Armstrong
18.	Paint	Asian Paints / Nerolac /Akzo Nobel (Dulux)/ Berger/ Jenson Nicholson/ Noble Paints
19.	Texture Paint - External	RENOVA -DAMANI DYE STUFF , RUFF COTE -INDIAN PAINTS
20.	Enamel Paint	Asian Paints / Nerolac / Berger/ Jenson Nicholson /Akzo Nobel
21.	Clear, frosted, Fire Rated Glass for Door & Window & Partition Mirror	SAINT GOBAIN, ASAHI INDIA GLASS LTD, GUJARAT GUARDIAN - MODIGUARD, Fire Rated Glass- Shakti Hormann
22.	Aluminium Sections For Doors, Windows & Wall Spans	Jindal/ Hindalco
23.	Steel Doors, Windows & Pressed Steel Door Frames	Godrej/ Shakti Hormann / NCL Alltek & Seccolor Ltd Steel Fire Proof Door- Promat, Shakti Hormann/Godrej
24.	Anodized aluminum fittings for doors/windows	Crown/ALANS/Classic/Bharat/ Argent / Shalimar
25.	Flush Doors	Anchor/Duraboard /Kit ply / Merino Ply / Shreeji Doors/ Anand Marine Ply- Anchor, Kit ply, Century
26.	Laminate (All doors)	Greenlam /Merino / Royale touche Century
b)	Laminate (Toilet doors)	Greenlam /Merino / Royale touche Century

27.	Expansion Joint & Bitumastic membrane Waterproofing	Bitumen expansion board-Shalitex of STP /Tiki Tar. Polyester reinforced APP membrane waterproofing & Anti –root APP membrane - of STP /Tiki Tar / BASF
28.	Integral Water Proofing Compound	MC Bauchemie; BASF, Fosroc, STP, Sika, Penetron.
29.	White cement based putty for concrete / plastered surfaces	Wall care putty of M/s. Birla White; Plasto Shine wall putty of M/s. Walplast Products Pvt. Ltd.
30.	Polycarbonate Sheet	Danpalon / Palram/ Lexan
31.	Floor spring & floor lock	Dorma/Godrej/ Enox/ Sevax **/ /**Hardwyn
32.	Door / Carpentry hardware	Dorma/Godrej/ Ebco/Hettich /Hafele
33.	Water Proof cement paint	Snowcem/Asian Paints/Berger
34.	Mineral Fiber Ceiling	Armstrong/UGG Boral
35.	Welding Rods	ADOR/ Esab/ D& H welding
36.	Fastner	HILTI INDIA , FISCHER(BOSCH) , POWERS INDIA
37.	Ready mix plaster	Ultratech / Sound Buildcare Pvt.Ltd./M/s Wall Plast products
38.	AAC block	Ultratech-Xtralite / Aerocon/ Siporex
39.	Cement particle board	NCL Industries Ltd.
40.	Vitrified Tiles	RAK / KAJARIA/ Restile/H.R.Jhonson (I) /Nitco /Somany
41.	Structural Glazing	
a)	Aluminium Section	Jindal / Hindalco / Nalco/Vedanta
b)	AIuminium Section finishes	anodised
c)	D.G.U. Glass , Fire Rated Glass	SAINT GOBAIN,GUJARAT GUARDIAN - MODIGUARD , ASAHI INDIA GLASS LTD
d)	S.G.U. Glass	SAINT GOBAIN,GUJARAT GUARDIAN - MODIGUARD , ASAHI INDIA GLASS LTD
e)	A.C.P.	ALUCOBOND, ALUDECORE,ALTOBOND

42.	Architextural Expansion Joint	**Sanfield –** Floor to Floor – SAPX Wall to Wall – SCTR Terrace – SRFL External wall to wall – Metazeal **Kantaflex** – Floor to Floor – DA6 Wall to Wall – CM6
43.	False Flooring	Unifloor /Flexi Access Floor/ Armstrong
44.	Wooden Laminated Flooring	Pergo/Tiles/ Xylos,/Armstrong/Vista.
45.	Commercial Plywood, Marine Plywood & Prelaminated Particle Board	Century/Green/Kit ply/ Anchor
46.	Veneer	Century / Durian,/ Timex/ANCHOR
47.	Drawer Sliding Fittings	Earl Bihari (EBCO)/ Godrej/ Hettich
48.	Acrylic Sheets	Sanmati Acrylics/Acrylic Sheet India/ Acry Plus
49.	Vertical/Roller blinds	Vista/MAC/DACK
50.	Bitumen	STP, TIKITAR, IWL
51.	Pest Control	PCI, PECOPP, GODREJ HI-CARE
52.	Plaster of Paris	KHATRI INDIA, GYPROC CHAMPION PUTTY -SAINT GOBAIN GYPROC
53.	Polyester triangular fibre - Polyproplylene Fibres / Glass Fibres	Polyproplylene Fibres -RELIANCE - RECRON 3S & Glass Fibres- OWENS CORNING INDIA- CEM-FIL
54.	Crystalline Waterproofing Liquid	XYPEX INDIA, EVERCRETE INDIA , KRYTON INDIA
55.	Compact Cubicle Partition	Merino, Greenlam
56.	Waterproofing System - Penetrative Primer	DR. FIXIT -PIDILITE ; MAPEI INDIA

57.	APP Waterproofing Membrane	STP, TIKI TAR , IWL; Carlisle
58.	Waterproofing coating	BASF, MAPEI INDIA, FOSROC, SUNANDA,ASIAN PAINT, MASTER BUILDERS, DR. FIXIT -PIDILITE
59.	Adhesive for Granite Stone Joinery	ARALDITE (STANDARD TYPE) - HUNTSMAN ADVANCED MATERIAL
60.	Glass Wool	UP TWIGA , LLOYD INSULATION ,ISOVER -SAINT GOBAIN
61.	PU Coating on Veneer	MRF CORP, ICA ,ASIAN PAINTS
62.	False ceiling -Gypsum Board & Moisture Resistant Gypsum Board ;Mineral Fibre Board, wood ; Grid Ceiling	SAINT GOBAIN GYPROC INDIA ; USG BORAL INDIA; AMSTRONG
63.	Mirror	SAINT GOBAIN,GUJARAT GUARDIAN - MODIGUARD , ASAHI INDIA GLASS LTD
64.	Adhesive for Wood, Laminate	MARINE FEVICOL-PIDILITE MAKE; EURO - JYOTI RESINS & ADHESIVE
65.	Adhesive for PVC Laminate	MARINE FEVICOL-PIDILITE MAKE; SUPER BOND
66.	Silicone Based Clear Water Repellant coating	MONOPOL 333 OF KRISHNA CONCHEM , TECHREPEL -CHOKSEY ,DULUX WEATHERSHIELD CLEAR - AKZO NOBEL
67.	Elastomeric Exterior Paint	DR FIXIT RAIN COAT OF PIDILITE MAKE , CLEAR SEAL -APURVA MAKE
68.	Epoxy Resin Old To New Bonding Agent	KRISHNA CONCHEM , SUNANDA , SIKA
69.	Reinforcement Rust Preventive Coating	KRISHNA CONCHEM, SUNANDA , CHOKSEY CHEMICALS
70.	Rubber Flooring	NORA MAKE -DEALER IN INDIA ZEN EQUIP INDIA; RESPONSIVE INDUSTRIES; EBACO INDIA
71.	Non Metallic Hardner	Sika, Fosroc, BASF

72.	Dry Cladding (Porcelain)	TECHLAM-CLASSIC MARBLE CO.; H.R. JOHNSON; KALE OR EQUIVALENT AS APPROVED BY ARCHITECT.
73.	Structural Silicon Sealant	DOWCORNING,GE-MOMENTIVE PERFORMANCE MATERIALS INDIA, WACKER INDIA
74.	Aluminium Facade Sun Louvers System	HUNTER DOUGLAS; CONSTRUCTION SPECIALTIES
75.	Concrete Interlocking Paver Blocks	SUPER TILES, VITCO , HINDUSTAN BLOCK; VYARA TILES
76.	Stainless Steel Kitchen Sink	NIRALI -JYOTI INDIA METAL, NEELKANTH- TROPICAL INDUSTRIES, JAYNA SINKS
77.	Stainless Steel Pipe For Handrailing	For Pipe-JINDAL, ZENITHBIRLA, MUKAND; Fabricated Pipe Handrailing-KICH INDIA, INDIANA
78.	Glass Fibre Reinforced Concrete Chajja/ Cornice	BIRLA WHITE CEMENT -GRC DIVISION, EVEREST COMPOSITES,
79.	Soft Closing Drawer Channel	HETTICH,BLUM, EBCO
80.	PVC Edge Banding	REHAU,PEGASUS,FIBRO
81.	Aluminium /PVC Bird Net	GEETA ALUMINIUM, BALAJI SAFETY sssNETS; NETS "N" SCREENS; REACH NETTINGS,
82.	High Pressure Laminate Exterior Panels	FUNDERMAX,TIMEX,AMULYA MICA
83.	Landscape	Garden solutions , Green smile
84.	SentryGlas	Saint Gobain, DuPont
85.	Stepping Stone for treads & Risers Full body vitrified	H.R. Johnson Endura Series;
86.	Expansion Joint Filler Board	STP-shalitex Board ; Tikitar , IWL
87.	False ceiling -Calcium Silicate Board	Ramco Hilux
88.	Styrofill geofoam (Filler)	BASF / Owens Corning / Carlisle
89.	UPVC Fins	Finesta , Citadel

APPENDIX "B"

THEORETICAL STANDARD REQUIREMENT OF CEMENT FOR VARIOUS ITEMS OF WORK

S.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 Engr-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

S.NO.	BRIEF DESCRIPTION OF ITEM	UNIT	CEMENT IN BAGS
(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
S.NO.	**BRIEF DESCRIPTION OF ITEM**	**UNIT**	**CEMENT**

			IN BAGS
(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	Cementplaster in C.M. 1:4, 20mm. thick rough finish (for external brick/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

S.NO.	BRIEF DESCRIPTION OF ITEM	UNIT	CEMENT IN BAGS
(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