

**MAZAGON DOCK SHIPBUILDERS LIMITED**

(Formerly known as Mazagon Dock Ltd.)

CIN : U35100MH1934GOI002079

(A Government of India Undertaking)

Shipbuilders to the Nation

Dockyard Road, Mazagon,

Mumbai 400 010.

INDIA

**Repair/Renovation of Shed no.06 for Fuel Cell Storage Plant,  
Anik Chembur Yard, MDL.**

**Technical Specification  
&  
Preferred Make**

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- Note** (i) Wherever make is specified in BOQ, the same shall prevail over list of preferred make.  
(ii) Wherever specification of BOQ item is not mentioned; then CPWD specification shall be applicable.  
(iii) Wherever make is specified in BOQ then manufacture's specifications & procedure shall be applicable.  
(iv) Wherever no specifications or make is specified than work is to be carried out as per the written instruction of the Engineer-In-Charge  
v) **The scaffolding cost up to 10m height is already considered in the Estimate for all the works. No additional cost towards scaffolding will be paid.**  
vi) Arrangement like Jack Mundas, cradles, ISMB, scaffolding requires for Placement of New structural trusses are to be done by contractor at their cost as per direction by Structural Engineer. No additional cost shall be paid for the same.

जयवंत राव  
JAYWANT RAO  
मुख्य अधिकारी (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

vi) **APPOINTMENT OF STRUCTURAL ENGINEER: -**

The Contractor has to appoint the Licensed Structural Engineer for design of structural members based on interpretation & reports of Non Destructive testing (NDT) carried out and field investigation on the existing Structural Columns, submit the method statement for execution, issue of GFC drawings, supervision, issue of Stability certificate etc. complete including submission along with Design calculations.

Structural Engineer shall be responsible for technical matters, supervision, quality control, monitoring of progress, inspection, joint measurement, certification of work and preparation of As-built drawings, issue of Stability Certificate for entire work.

**01) GENERAL:**

**1.1 Materials:**

All materials required to complete the works shall be procured by the contractor including steel and cement unless specified. All materials shall be of Indian origin of the best quality of their respective kinds as specified and shall conform strictly to the stipulations laid down by the latest Indian Standards. Standards issued elsewhere may be used only if approved by the Engineer-In-Charge and for those materials only for which appropriate Indian Standard does not exist.

**1.2 Sampling and Testing:**

The Contractor shall submit adequate number of samples of materials to the Engineer-In-Charge for approval giving all relevant information like source of supply, availability, etc. The approved samples shall be deposited with the Engineer-In-Charge, whenever so instructed.

The Engineer-In-Charge may order such tests and analysis as per requirement and as considers necessary and the Contractor shall bear the cost of all sampling and testing which is in consonance with the Indian Standards.

If tests on materials lead to rejection of the particular consignment, notwithstanding the results of the tests at the manufacturer's works or elsewhere or of test certificates or of any approval given earlier, such materials shall be removed forthwith from the site by him at his own cost and replaced by other proper consignment. All charges in connection with of the new materials shall be borne by the Contractor.

Samples required for approval and testing must be supplied well in time to allow for testing and approval, due allowance being made for the fact that if the first samples are rejected, further samples may be required. Delay to the Works arising from the late submission of samples will not be acceptable as a reason for delay in the completion of the Works.

**1.3 Storage of Materials**

Generally stacking and storage of construction materials at site shall be as per recommendations in IS: 4082. All materials required to be incorporated in the Works shall be stored in racks in bins, under cover etc. as appropriate and as amplified in the succeeding clauses to prevent deterioration or damage from any cause whatsoever to the satisfaction of the Engineer-In-Charge.

**1.4 Records & Usage of Materials**

The Contractor shall maintain detailed records of all materials received at Site or in his workshop and also about the consumption, balance in stock etc. and shall make such records available to the Engineer-In-Charge, if asked for. Depending on the types of materials the same should be used in the order in which they arrive at site and as directed by the Engineer-In-Charge.

**1.5 Contractor's Responsibility**

The Contractor shall be responsible for keeping the material in sound and acceptable condition from the time of consignment of any material is received at site and till its consumptions. Any

material not approved for use shall be removed from the site at Contractor's cost.

### 1.6 Workmanship

In all cases the work shall be carried out in accordance with the latest Indian Standard Specifications and the best Engineering practice. In the absence of such specifications, work shall be executed in accordance with any other relevant standards issued elsewhere as approved by the Engineer-In-Charge or as per the instructions and directions of the Engineer-In-Charge.

### 1.7 Constructional Plant (s)

The Contractor shall be responsible for the supply, use and maintenance of all Constructional Plant and Equipment so as to ensure smooth and efficient working of the job at his own cost. The Engineer-In-Charge shall have access to the Plant at all times.

### 1.8 Workmen and Staff

The Contractor shall ensure that they employ only capable and experienced labour force, foremen, other tradesmen and supervisory staff on the job capable of handling the types of work assigned to them in a workmanlike and efficient manner to the satisfaction of the Engineer-In-Charge. They shall also ensure that his Sub-contractors or nominated Sub-contractors also employ all workmen and supervisory staff capable of delivering work of a high standard. For all concrete work trained and experienced personnel at site shall be deployed.

### 1.9 Method of Measurement

Mode of measurement shall be in accordance with the relevant parts of IS: 1200 "Method of Measurement of Building and Civil Works" only, unless otherwise specified in various item wise specifications describes herein below.

### 1.10 Rates and Prices

Unless otherwise mentioned, the rates and prices set against items in the bill of quantities or which can be reasonably inferred there from complete as a functioning entity shall include all costs and expenses which may be required in and for the construction of the work such as- material to be incorporated in the works (permanent/ temporary), labour required for all operations, temporary works, tools and equipment's as required, all operations required for the completion and or maintenance of the relevant items as per specifications, all leads and lifts unless otherwise specifically mentioned in the items, including all general risks, liabilities and obligations set forth or implied in the documents on which the tender is based.

### 1.11 List of Bureau of Indian Standard Codes (BIS)

Following is the consolidated list of various Indian Standards relevant to the civil works appearing in this specification.

| Sr. No | IS Code No              | Particulars                                                                                                                              |
|--------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | IS : 4082-1977          | Carriage of materials.<br>Recommendation of stacking and storage of construction materials at sites.<br>(1st revision) (Reaffirmed-1990) |
| 2      | IS:1200 (Part 22)-1988  | Method of Measurement of Building & Civil Engineering Works-Part 22-Materials                                                            |
| 3      | IS : 17293-1974         | Safety code for working with construction machinery                                                                                      |
| 4      | IS : 7969-1975          | Safety code for handling & storage of building materials                                                                                 |
| 5      | IS : 8989-1978          | Safety code for erection of concrete framed structures                                                                                   |
| 6      | IS : 4014 (part 2) 1967 | Code of practice for steel tubular scaffolding - Part 2 - Safety regulations for scaffolding                                             |
| 7      | IS:13416 (Part 1) 1992  | Preventive measures against hazards at work places - Part 1 - Falling material hazard prevention.                                        |

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
महागड डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LI: \* = D

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|----|--------------------------|------------------------------------------------------------------------------------------------------------|
| 8  | IS : 13416 (Part 2)1982  | Preventive measures against hazards at work places recommendations - Fall prevention.                      |
| 9  | IS: 13416 (part 3) 1994  | Preventive measures against hazards at work places - Recommendations - Part 3 - Disposal of debris (MULBA) |
| 10 | IS : 13416 (Part 5) 1994 | Preventive measures against hazards at work places - Recommendations - Part 5 - Fire protection            |

#### EARTHWORK

| S. No | IS Code No          | Particulars                                                                                                                                                      |
|-------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | 3764                | Safety code for excavation work                                                                                                                                  |
| 2     | 6313 (Part-II)-1981 | Code of Practice for Anti-termite measures in Buildings (Part-II) Pre-constructional Chemical Treatment measures (1st Revision) (Amendments 3) (Reaffirmed-1991) |

#### MORTARS

| S. No | IS Code No | Particulars                                           |
|-------|------------|-------------------------------------------------------|
| 1     | 650        | Specification for standard sand for testing of cement |
| 2     | 3025       | Method of sampling and test for water                 |
| 3     | 8112       | Specification for 43 grade ordinary Portland cement   |
| 4     | 12269      | Specification for 53 grade ordinary Portland cement.  |

#### ROAD WORK

| S. No | IS Code      | Particulars                           |
|-------|--------------|---------------------------------------|
| 1     | <b>MORTH</b> | Ministry of Road Transport & Highways |

#### CONCRETE WORK

| S. No | IS Code No         | Particulars                                                                  |
|-------|--------------------|------------------------------------------------------------------------------|
| 1     | 383                | Specification for coarse & fine aggregate from Natural Source for Concrete.  |
| 2     | 456                | Code of Practice for plain and reinforced concrete.                          |
| 3     | 516                | Method of test for strength of concrete                                      |
| 4     | 1199               | Method of sampling and analysis of concrete                                  |
| 5     | 1200 (Part II)     | Method of measurement of building and civil engineering work (concrete work) |
| 6     | 1322               | Specification for bitumen felt for waterproofing and damp proofing           |
| 7     | 1791               | Specification for batch type concrete mixers                                 |
| 8     | 2386(Part I to IV) | Method of test for aggregate for concrete work                               |
| 9     | 2505               | General requirement for concrete vibrators immersion type                    |
| 10    | 2506               | General requirement for screed board concrete vibrators                      |
| 11    | 3812               | Specification for fly ash for use as Pozzolana and admix                     |
| 12    | 4656               | Specification for form vibrators for concrete                                |

#### REINFORCED CEMENT CONCRETE WORK

| S. No | IS Code No        | Particulars                                                                                                                                                     |
|-------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | 432 (Part I & II) | Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement Part-I mild steel and medium tensile steel bars |
| 2     | 1200 (Part V)     | Method of measurement of building and civil engineering work - concrete work (Part 5 - Form work)                                                               |
| 3     | 2505              | Code of Practice for bending and fixing of bars for concrete reinforcement                                                                                      |
| 4     | 2751              | Recommended practice for welding of mild steel plain and deformed bars for reinforced construction                                                              |

जयवंत शिपवर्क  
**JAYWANT**  
 प्रबंधक (त. से. सिविल)  
 CHIEF MANAGER (TS-CIVIL)  
 माझगांव डॉक शिपवर्कर्स लिमिटेड  
 MAZAGON DOCK SHIPBUILDERS LIMITED

|   |      |                                                                   |
|---|------|-------------------------------------------------------------------|
| 5 | 4925 | Batch plants specification for concrete batching and mixing plant |
| 6 | 9103 | For admixtures for concrete                                       |

#### BRICK WORK

| S. No | IS Code No         | Particulars                                                                                                      |
|-------|--------------------|------------------------------------------------------------------------------------------------------------------|
| 1     | 1200 (Part 3) 1976 | Method of measurements of building and civil engineering works: Part 3 brick work (3rd revision) Reaffirmed 1992 |
| 2     | 2212-1991          | Code of practice for brick work (1st revision)                                                                   |
| 3     | 1905-1980          | Code of Practice for structural safety of buildings - Masonry wall                                               |
| 4     | 2116-1980          | Specification for sand for masonry mortars (1st revision)                                                        |

#### MARBLE/GRANITE / STONE WORK

| S. No | IS Code No  | Particulars   |
|-------|-------------|---------------|
| 1     | 3316 - 1974 | Granite slabs |

#### STEEL WORK

| S. No | IS Code No            | Particulars                                                                                                                              |
|-------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | 800-1984              | Code of practice for use of structural steel in general in steel construction (2nd revision) (Amendments 2) (Reaffirmed 1991)            |
| 2     | 806-1968              | Code of practice for use of steel tubes in general building construction (1st Revision) (Amendment 1) (Reaffirmed 1991)                  |
| 3     | 812-1978              | Glossary of terms relating to welding and cutting of metals (Reaffirmed 1991)                                                            |
| 4     | 813-1986              | Scheme of symbols for welding (revised) (Reaffirmed 1991)                                                                                |
| 5     | 816-1969              | Code of practice for use of metal arc welding general construction in mild steel (1st revision) (Amendments 2) (Reaffirmed 1992)         |
| 6     | 818-1968              | Code of practice for safety and healthy requirements in electric and gas welding and cutting operations (1st revision) (Reaffirmed 1991) |
| 7     | 822-1970              | Code of procedure for inspection of welds (Reaffirmed 1991)                                                                              |
| 8     | 1200-1993 (Part VIII) | Method of measurements of building and civil engineering works steel work and iron works (4th revision)                                  |

|   |             |                                                                                               |
|---|-------------|-----------------------------------------------------------------------------------------------|
| 4 | 2571-1970   | Code of practice for laying in situ cement concrete flooring (1st revision) (Reaffirmed 1991) |
| 5 | 8042-1989   | Specification for white Portland cement (2nd revision) (Amendments 4)                         |
| 6 | 13755       | Ceramic tiles                                                                                 |
| 7 | 4457 - 1982 | Ceramic unglazed vitreous acid resting tiles                                                  |
| 8 | 3462        | PVC flooring (Vinyl Tiles)                                                                    |

#### FINISHING

| S. No | IS Code No           | Particulars                                                                                                                            |
|-------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 1     | 104-1979             | Specification for ready mixed paint, brushing, zinc chrome, priming (Reaffirmed 1993) (2nd Revision)                                   |
| 2     | 109-1968             | Ready mixed paint, brushing, priming plaster to Indian Standard colour No.361.631 white and off white (Reaffirmed 1993) (1st Revision) |
| 3     | 290-1961             | Coal tar black paint (Reaffirmed 1991) Revised                                                                                         |
| 4     | 419-1967             | Putty for use on window frames (Reaffirmed 1992) (Revised)                                                                             |
| 5     | 428-1969             | Distemper, oil emulsion, colour as required (Reaffirmed 1993) (1st Revision)                                                           |
| 6     | 1200-1976 (Part XII) | Method of measurements of building and civil engineering works: Part XII - Plastering and pointing (Reaffirmed 1992) (3rd Revision)    |

जयवंत राव  
  
 JAYWANT RAO  
 प्रमुख अभियंता (त. से. सिविल)  
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 माझगांव डॉक शिपबिल्डर्स लिमिटेड

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|----|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7  | 1200-1994(Part XIII) | Method of measurements of building and civil engineering works: Part XIII – white washing, colour washing, distempering and painting of building surfaces (5th Revision) |
| 8  | 1200-1987 (Part XV)  | Methods of measurements of building and civil engineering works: Part XV – Painting, polishing, varnishing etc. (Reaffirmed 1992) (4th Revision)                         |
| 9  | 2932-1994            | Enamel, synthetic, exterior (a) undercoating (b) Finishing (2nd Revision)                                                                                                |
| 10 | 5410-1992            | Cement paint (1st Revision)                                                                                                                                              |
| 11 | 1661                 | Application of plaster                                                                                                                                                   |
| 12 | 1542                 | Plaster for sand                                                                                                                                                         |
| 13 | 2645                 | Integral waterproofing compound                                                                                                                                          |
| 14 | 2395 (Part I & II)   | Painting workmanship                                                                                                                                                     |

#### DISMANTLING AND DEMOLITION

| S. No | IS Code No | Particulars                                                                                                                            |
|-------|------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 1     | 1200-1974  | Method of measurements of building and civil engineering works: Part XVII: Demolition and dismantling (Reaffirmed 1992) (3rd Revision) |

#### MISCELLANEOUS

| S. No | IS Code No | Particulars             |
|-------|------------|-------------------------|
| 1     | 2721       | G.I. chain link fencing |

#### ALUMINIUM WORK

| S. No | IS Code No | Particulars                                                                                                                         |
|-------|------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1     | 1285-1975  | Specification for wrought aluminium and aluminium alloy, extruded round tube and hollow sections (for general engineering purposes) |
| 2     | 1868-1996  | Anodic coatings on aluminium and its alloys – Specification                                                                         |
| 3     | 1948-1961  | Specification for aluminium doors, windows and ventilators (Reaffirmed 2001)                                                        |

#### WATER PROOFING

| S. No | IS Code No | Particulars                                                 |
|-------|------------|-------------------------------------------------------------|
| 1     | 2645-1975  | Specification for integral cement water proofing compounds. |
| 2     | 1077       | Brick bats                                                  |



जयवंत राव  
JAYWANT RAO

मुख्य प्रबंधक (त. से. सिविल)  
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माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

## **02) EARTH WORKS:**

### **Earthwork in Excavation & Backfilling**

#### **2.1 General**

Any excavation shall be started only after recording the existing ground levels jointly with the Engineer-In-Charge.

##### **2.1.1 Classifications**

All materials to be excavated shall be classified by Engineer-In-Charge, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of Engineer-In-Charge regarding the classification of the materials shall be final and binding on Contractor.

Earthwork will be classified under any of the following categories –

##### **2.1.1.1 Ordinary / soft Soils**

These shall include all kinds of soils containing kankar, sand, silt, moorum and / or shingle, gravel, clay, loam, peat, ash, shale etc. which can generally be excavated by spade, pick axes and shovel. This shall also include embedded rock boulders not longer than 0.5 metre in any direction and not more than 200mm. in any one of the other two directions.

##### **2.1.1.2 Hard soil / Rock**

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite and all other materials which in the opinion of Engineer-In-Charge is rock, and could be removed with picks, hammer, crow bars, wedges and pneumatic breaking equipment. This shall also include excavation in macadam and tarred roads and pavements and masonry to be dismantled as also rock boulders not longer than 0.5 metre in any direction and not more than 200 mm. in any one of the other two directions.

##### **2.1.1.3 Method of Excavation**

Depending on the type of material, quantum of excavation and time for construction, the Contractor may carry out the work manually or by use of appropriate mechanical equipment.

#### **2.2 Details of Works**

##### **2.2.1 Dimensions / Levels**

Excavation for permanent work shall be carried out to the correct dimensions, lines and levels and profiles shown on the drawings or as directed by the Engineer-In-Charge. Rough excavation shall be carried out to a depth 150 mm. above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final level and extra excavation filled up as directed by the Engineer-In-Charge.

##### **2.2.2 Shoring and strutting**

The Contractor shall provide and maintain all planking and strutting as may be necessary to prevent any ground movement.

##### **2.2.3 Excavation to be kept dry**

The Contractor shall keep all excavation free from water, whether from sub-soil or from rains or from any other source, by pumping or other approved means.

##### **2.2.4 Sides and bottom of excavation**

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LTD.

Excavation shall be left open for as short period as practicable and necessary. Immediately before foundations or other work be constructed therein, the sides of excavation shall be trimmed, if necessary and the bottom shall be cleaned, free of loose or disturbed ground, dry well rammed and approved by the Engineer-In-Charge.

### **2.2.5 Stacking / Removal of excavated material**

Stacking, dumping, spreading at site or removal from site of excavated material shall be strictly as approved by the Engineer-In-Charge.

Excavated material suitable for filling shall be dumped in an orderly manner to required levels / grades as directed. All surplus material or material not suitable for filling shall be carried away from site to approved dumping ground.

### **2.2.6 Backfilling**

All return fill in excavated trenches, pits etc. shall consist of materials selected from excavation or elsewhere and shall be dry, friable and free from clay and plastic material, mud, vegetable, salts, sulphates and organic matter likely to decay and shall be subject to the Engineer-In-Charge's approval before use. All clods of earth shall be removed or broken. Where excavated material is mostly rock, it shall be broken to pieces not larger than 150mm size and mixed with properly graded murum or equivalent approved material. Filling shall be placed in layers not exceeding 150mm well-watered & consolidated by mechanical compaction machines or manually to achieve 95% proctor density if permitted by the Engineer-In-Charge and to the satisfaction of the Engineer-In-Charge.

## **2.3 Earthwork in Filling**

### **2.3.1 Material**

All fill material, whether out of surplus material from excavations or brought from any other source outside shall be subject to prior approval of the Engineer-In-Charge. The source of outside material shall also be approved by the Engineer-In-Charge.

All fill material shall be free from vegetable refuse and other organic matter, marine clay, black cotton soil, injurious salt and other material considered unsuitable by the Engineer-In-Charge.

All large clods shall be broken. Where the material is mostly rock, boulders shall be broken into pieces not larger than 15 cm. size, mixed with properly graded fine material like murum etc.

### **2.3.2 Filling over areas (site gradation) / roads /pathways**

Any filling work shall be started by the Contractor only after recording existing ground levels jointly with the Engineer-In-Charge.

Formation width and side slopes shall be as per drawings or as directed by the Engineer-In-Charge.

All banks shall be thrown up in layers of not more than 200 mm. in depth over the whole width between the surfaces of side slopes slightly concave in section, so as to retain water for subsidence. When on side long ground, the whole area of the bank of the slope shall be benched out or stepped so as to prevent material from slipping.

Each layer of filling shall be watered, rammed and thoroughly consolidated to the satisfaction of the Engineer-In-Charge and to obtain the density stipulated in the item. Compaction shall be done by mechanical compaction machines unless otherwise allowed by the Engineer-In-Charge. The normal allowance for subsidence or settlement shall be 5 cm. per 30 cm. depth of bank. This may be increased or decreased by the Engineer-In-Charge depending on the nature of the filling material used. Necessary field and laboratory tests shall be carried out by the Contractor to demonstrate that the specified density at moisture content is obtained in the fill at different stages of filling and after the fill to the entire height is completed, if so specifically called for.

The Contractor shall protect the fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the same at his own cost. If rock obtained from excavation (which may be used for filling and levelling to indicated grades without further breaking) is permitted for filling by the Engineer-In-Charge, filling shall be done in layers not exceeding 50cm approximately. After rock filling to the approximate

level, the voids in the rocks shall be filled with finer materials such as earth, broken stone etc. and the area shall be flooded with water so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm. thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 10 - 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken-up.

After the filling layers are consolidated, the surface and slopes shall be trimmed to the levels, formation width and to even and uniform gradient as per requirement.

### 2.3.3 Plinth filling

Plinth filling shall be carried out with approved material in layers not exceeding 15cm. watered and compacted with mechanical compaction machines such as pneumatic tampers, rammers etc. The Engineer-In-Charge may, however, permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches, the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finalised level of the filling shall be trimmed to the level/slope as directed / specified.

Where specifically specified, compaction of the plinth fill shall be carried out by means of 8 - 10 tonne approved type of roller. In this case fill layers can be upto a maximum of 300 mm. As rolling proceeds water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill. Rolling shall commence from the outer edge and progress towards the centre and continue until compaction to the satisfaction of the Engineer-In-Charge or provides density not less than that specified in the item but in no case less than 10 passes of the roller shall be accepted for each layer. The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

At places back filling shall be carried out with local sand if directed by the Engineer-In-Charge. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer-In-Charge has inspected and approved the fill.

### 2.4 Excavation:

The work to be done under this section comprise performance of all work necessary for excavation with shoring, strutting, dewatering, pumping including disposing of all surplus excavated material from the site as directed by the Engineer. Excavation shall be carried out in any type of soil, gravel, conglomerate, soft rock, boulders, old foundation, hard rock, concrete, asphalt or stone paved surfaces old masonry or concrete (plain or reinforced) encountered within width, length and depths indicated in the drawings. Where any temporary or permanent structure like sheet piling, diaphragm wall or piles have already been taken up, all excavation work shall be from the point carried out earlier and all precaution during further excavation and or any construction operation shall be exercised not to damage such existing temporary or permanent work. Where directed by the Engineer trees encountered within the work site shall be uprooted as per approved manner and serviceable wooden logs shall be stacked at site / disposed of as directed by the Engineer. Branches of trees etc. shall be disposed of or stacked at site as directed by the Engineer. No permanent work shall be commenced in the excavated area until the foundations pits have been inspected and approved by the Engineer. The Contractor may use any suitable excavated materials for incorporation in the permanent or temporary works as may be convenient subject to compliance with the specifications. Any obstacles encountered during excavation shall be reported immediately to the Engineer and shall be dealt with as directed by the Engineer.

### 2.5 Compaction:

Compaction of earth and sand filling in areas where foundations and floors are located, the degree of compaction achieved shall be minimum 95% of maximum dry density as obtained by Proctor compaction as per IS: 2720 (Part VII). Unless otherwise specified, in roads & other areas the degree of compaction shall be 95%.

### 2.6 Anti-termite Treatment:

#### Constructional Measures-

The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding

JAYWANT RAO

मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)

माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZGAON DOCK SHIPBUILDERS LIMITED

the building. (i) Earth free from roots, dead leaves, or other organic matter shall be placed and compacted in successive horizontal layers of loose material not more than 200 mm thick. Dry brick shall be inserted at last 50 mm in brick masonry for providing apron floor around the periphery. (ii) Brick on edge masonry in cement mortar shall be laid on the plinth wall. Dry brick shall be placed on the inner side of plinth wall for getting anticipated offset space for coarse sand and on the other side for installing anti-termite masonry groove. In the case of intermediate walls, dry bricks are placed on either side of the brick on edge masonry for getting offset space for coarse sand layer (iii) The dry brick for the anti-termite groove shall be taken out and dense cement concrete 1:3:6 (1 cement: 3 sand: 6 coarse aggregate by volume) sub-floor carpet shall be laid casting the anti-termite groove in position. In case of internal partition walls, the cement concrete sub-floor shall be laid on either side over the dry bricks to sufficient extent for getting staggered vertical joints over the joint of plinth wall and earth filling. (iv) Superstructure masonry shall be raised over the dense cement concrete sub floor carpet and over-head jobs completed. (v) The dry brick for coarse sand layer shall be removed and graded sand (of size 3 to 5 mm) layer at least 100 mm thick shall be compacted over the earth filling and underneath the partially laid dense cement concrete sub-floor carpet (vi) Dense cement concrete (1:3:6 mix.) sub-floor at least 75 mm thick shall be laid over the sand filling. Necessary finish may be provided to the cement concrete sub-floor carpet. (vii) Dry brick provided for apron floor shall be taken out and 600 mm wide formation of earth in 1:30 slope shall be made. Over the formation, 75 mm thick lime concrete 1:3:6 (1 lime:3 sand: 6 coarse aggregate, by volume) shall be laid. (viii) Over the 75 mm thick like concrete bed at least 25 mm thick cement concrete topping 1:2:4 (1 cement: 2 sand: 4 fine aggregate, by volume) shall be laid and 12 mm thick cement plaster shall be applied on foundation and plinth.

#### **2.6.1 Material:**

Chemical to be used for treatment shall be from the approved specialized agencies, proportion in accordance with IS 6313 (Part-II) subject to confirmation of the Engineer-In Charge. Graduated containers shall be used for dilution of chemicals with water in the required proportion to achieve the desired percentages of concentration.

#### **2.6.2 Safety Precaution:**

All chemical used for treatment shall be clearly labelled in properly sealed form, and kept securely closed in stores. Mixing is to be done with utmost care as per manufacturer's instructions. Chemicals are not allowed to contaminate with drinking water.

#### **2.6.3 Application:**

Chemical treatment of soils for the protection of buildings from attack of subterranean termites shall be done as per IS:6313 (Part-II). Proper check should be kept to ensure that the specified quantity of chemical is used for the required area during the operations. Time of application of Soil treatment should start when foundation trenches and pits are ready to take bed concrete/ levelling course in foundations. Laying of bed concrete / levelling course should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub- soil water. Treatment to the surface of earth filling within plinth shall also be done in the same manner before laying sub-grade for flooring. Treatment along the external perimeter of building shall be carried out after completion of the building by providing 30 mm deep holes in the soil with iron rods at intervals of about 15 cm unless otherwise specified by the manufacturer.

#### **2.6.4 Disturbance:**

The treated soil barrier shall not be disturbed. If for some reasons the treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system. The contractor shall provide 10 years guarantee bond to cover defects liability period.

### **03) MORTARS:**

#### **3.1 Cement**

##### **3.1.1 Standard**

Cement to be used in the Works shall be conforming to the following IS standards codes-

- 43 Grade Ordinary Portland Cement : IS 8112
- Portland Pozzolana Cement (fly ash based) : IS 1489 (Part-I)

##### **3.1.2 Supply & Storage**

JAYWANT RAO  
मुख्य अधिकारी (च. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
महाराष्ट्र डॉक शिपबिल्डर्स लिमिटेड  
MAHARASHTRA DOCK SHIPBUILDERS LIMITED

The cement to be used on works shall be OPC or PPC (fly ash based) as specified. Unless otherwise specified, Ordinary Portland Cement or PPC shall be supplied in bags containing 50 Kg. each. Stacking of cement rejected due to aging or not fulfilling IS requirements shall be at the cost of the Contractor. Cement held in storage for a long period shall be re-tested before its use, if directed by Engineer in charge.

### 3.1.3 Tests

A certified report, attesting the conformance of the cement to IS Specifications by the cement manufacturer shall be furnished to the Engineer-In-Charge, by the contractor.

Samples of cement shall be taken immediately on receipt of cement at site. The methods and procedure of sampling shall be as per **IS 3535**. Tests shall be carried out for fineness, initial and final setting time and compressive strength as per **IS 4031**.

Supplier of cement shall furnish the following documents before the cement is delivered to site -

Certificate conforming that chemical composition and physical characteristics are within the stipulated values for types of cement supplied as per relevant codes.

Certificate conforming that the chloride content in the cement is not in excess of 0.05 per cent of mass of cement.

If during subsequent testing of cement supplied in lots any of the properties are found to be outside the acceptable limits, the lot of cement shall be rejected.

Each 1000 bags or part thereof of cement or each wagon load of cement shall constitute one lot of cement for the purpose of conducting tests at site.

Samples for testing at site shall be taken at random from 2% of the total quantity supplied in one lot. For cement supplied in bags, samples shall be drawn from minimum of 5 bags and the 2% value shall be rounded to the next higher integer. For bulk cement, sampling shall be done with the help of slotted sampler to be as per IS 3535.

Results of test conducted on samples drawn shall be submitted to the Engineer-In-Charge for his approval. If in the opinion of the Engineer-In-Charge, the test results are not within permissible limits, the lot of cement from which samples have been obtained for testing shall stand rejected and the material shall be removed from site.

Following tests shall be conducted at site on each lot of cement delivered if required as per the instructions of Engineer - In - Charge.

**TABLE 1**

| Mandatory tests                        | Number of test/lot |
|----------------------------------------|--------------------|
| 1 Consistency of standard cement paste | 5                  |
| 2. Initial and final setting time      | 5 each             |
| 3. Compressive strength test           | 10                 |

Mean values of the results from the above results shall be taken as the representative value and the acceptance criteria shall be based on these test. All test procedures and computation of test results shall be as per IS 4031.

Apart from mandatory tests specified as above, the Engineer-In-Charge may at his discretion, call for any additional tests that he may consider necessary. All such tests shall be done on representative samples taken from each lot described above para and testing and computation of test results shall be done as per IS 4031. Charges for such testing shall be borne by the contractor.

### 3.2 Fine Aggregate

#### 3.2.1 Standard

Fine aggregate for different end uses (other than lightweight concrete) shall conform to the following standards:

For Structural Concrete - IS: 383 (between Grading Zones I & II)

For Mortar & Grout - IS: 2116

जयवंत राव

JAYWANT RAO

मुख्य (न. स. सिविल)

CHIEF MANAGER (TS-CIVIL)

माझगाव डॉक शिपबिल्डर्स लिमिटेड

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For Plastering

- IS: 1542 (Class A grading)

Fine aggregate shall consist of natural sands or machine crushed rock/gravel. It shall be clean, sharp, hard, strong and durable and free from dust, vegetable substances, adherent coating, clay, loam, alkali, organic matter, mica, soluble sulphate, gypsum or any other deleterious substances which can be injurious to the setting qualities / strength / durability of concrete. **Use of sea sand is prohibited.**

### 3.2.2 Source

Once a specific source of supply of fine aggregate is accepted, the source shall not be changed without prior approval of the Engineer-In-Charge.

### 3.2.3 Storage

Fine aggregates shall be stored at site in adequate quantity on clean and well maintained hard floor and areas not liable to flooding. Contamination with foreign matter and earth shall be avoided during storage and while heaping the materials.

### 3.2.4 Usage

Fine aggregate shall be thoroughly washed at site with clean fresh water such that the percentage of all deleterious matter is within the permissible limits as laid down in IS 2386 (Part-II).

Screening of sand shall be done if necessary, and as and when directed by the Engineer-In-Charge to remove all objectionable foreign matter and effecting any grading.

## 3.3 Water

### 3.3.1 Standard

Water supplied shall conform to the various provisions detailed under Clause 5.4 of IS 456:2000. Broadly stated water used for mixing and curing as also for cooling / washing of aggregates shall be clean and fresh, free from oils, acids, alkalizes, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Sea water or water from excavation shall not be used.

Potable water is generally considered satisfactory for mixing concrete. As a guide the following concentration represent the maximum permissible values:

To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The test shall be conducted as detailed in 8.1 of IS 3025 (Part 22).

To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal  $H_2SO_4$ . The test shall be conducted as detailed in 8 of IS 3025 (Part 23).

Permissible limits for solid content shall be as given in the table below:

TABLE 2

| Sl. No. | Particulars            | Tested as per     | Permissible limits Max                                                                                |
|---------|------------------------|-------------------|-------------------------------------------------------------------------------------------------------|
| i)      | Organic                | IS 3025 (Part 18) | 200 mg/l                                                                                              |
| ii)     | Inorganic              | IS 3025 (Part 18) | 3000 mg/l                                                                                             |
| iii)    | Sulphates (as $SO_3$ ) | IS 3025 (Part 24) | 400 mg/l                                                                                              |
| iv)     | Chlorides(as Cl)       | IS 3025 (Part 32) | 2000 mg/l<br>for concrete not consisting<br>embedded steel & 500 mg/l<br>for reinforced concrete work |
| v)      | Suspended matters      | IS 3025 (Part 17) | 2000 mg/l                                                                                             |

### 3.3.2 Storage

Water shall be so stored that it remains free from all deleterious materials as mentioned above.

जयवंत राव  
JAYVANT RAO  
(त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZGAON DOCK SHIPBUILDERS LIMITED

#### **3.3.4 Tests**

No water shall be used until tested for its chemical and other impurities in accordance with IS 3025 to ascertain its suitability. Tests shall be conducted whenever the source is changed or during seasonal variation.

#### **3.4 Fly Ash**

##### **3.4.1 Material**

Fly ash is a finely crushed residue resulting from the combustion of pulverised coal in boilers. Fly ash used shall be as per IS: 3812-1981. It shall be clean and free from any contamination of bottom ash, grit or small pieces of pebbles. Fly ash adding is meant for use to improve grading of its pozzolanic properties. Grades and proportion of fly ash shall be as specified in the item description in accordance with relevant IS provision. It is obligatory on the part of supplier/ manufacturer that the fly ash conforms to the requirement if mutually agreed & shall furnish a certificate to this effect to the purchaser or his representative.

Fly ash shall be protected from dirt collecting on it.

##### **3.4.2 Mortar Mixing**

Cement and sand in the specified proportion shall be mixed in dry thoroughly by using mechanical mixer or by hand mixing, if permitted. Composition (cement and sand mortar, or lime and sand mortar or cement, lime and sand mortar) and proportions of mortars shall be as specified in the respective items of work. The ingredients of the mortar shall be accurately gauged by measure.

##### **3.4.3 Precaution**

Mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.



जयवंत राव

JAYWANT RAO

मुख्य प्रबंधक (त. से. सिविल)

CHIEF MANAGER (TS-CIVIL)

माझगांव डॉक शिपबिल्डर्स लिमिटेड

MAZAGON DOCK SHIPBUILDERS LIMITED

#### **04) PLAIN CEMENT CONCRETE (PCC) WORKS:**

##### **4.1 Cement**

Cement shall be as specified under –Mortars specifications.

##### **4.2 Aggregate**

###### **4.2.1 Coarse Aggregates**

Standard: Coarse aggregate for use in concrete (other than light weight concrete) shall conform to IS 383.

Coarse aggregate shall have a minimum specific gravity of 2.6 (saturated surface dry basis). Aggregate below this specific gravity shall not be used without specific permission of the Engineer-In-Charge.

Coarse aggregate shall consist of natural or crushed stone, angular in shape with granular or crystalline surfaces or approved river shingle or gravel, rounded in shape. All aggregate shall be clean and free from elongated, friable, flaky or laminated pieces, adherent coatings, clay lumps, mica, organic matter and any other deleterious matter that may cause corrosion of reinforcement or impair the strength and / or durability of concrete. It shall be chemically inert, hard, strong, dense, and durable against weathering.

The maximum quantities of deleterious materials in the coarse aggregate shall not exceed the limits indicated in the IS 383 when tested as per IS 2386 Part-I & Part-II "Method of Tests for Aggregate for Concrete".

###### **4.2.1.1 Source**

Once a specific source of supply of coarse aggregate is accepted, the source shall not be changed without prior approval of the Engineer-In-Charge.

Supplier of aggregates shall furnish the following information before the material is delivered to site:

Precise location of source from where the material is to be supplied

Trade group of principal rock type as per table given below

Presence or reactive minerals.

**TABLE 3**

|                                 |                                      |
|---------------------------------|--------------------------------------|
| Trade group names of aggregates | Granite, Gabbro, Dolerite, Rhyolite, |
| To be used for concrete         | Basalt, Quartzite, Gneiss            |

The supplier shall also furnish reports of test results giving the following information for approval to Engineer-In-Charge before delivery of material at site:

- Specific gravity
- Bulk density
- Moisture content
- Absorption value
- Aggregate crushing strength
- Aggregate impact value
- Abrasion value
- Flakiness index
- Elongation index
- Limits of deleterious substances in the aggregate
- Soundness of aggregate
- Potential reactivity of aggregates.

###### **4.2.1.2 Storage**

Coarse aggregate of available sizes shall be stored at site as separate stacks over clean and well maintained hard floor and areas not liable to flooding. Alternatively, they will be stored in bins.

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. It shall be kept in layers not exceeding 1.2 m in height to prevent coning or segregation.

#### **4.2.1.3 Usage**

Coarse aggregate, which is not clean, shall be washed with clear fresh water before use in the job. Screening would be done if considered necessary by the Engineer-In-Charge without extra cost.

#### **4.2.1.4 Tests**

All test shall be conducted in accordance with IS 2386 (Part I to VIII).

In addition to above, the following tests shall be carried out on representative samples from every lot of aggregates after delivery at site. These test results are to be submitted to the Engineer-In-Charge for his approval. Acceptance criteria for aggregates shall be based on the results of this set of tests only. If in the opinion of the Engineer-In-Charge, the test results are not within permissible limits, the lot of aggregates from which the samples have been obtained for testing shall stand rejected and the material shall be removed from the site.

Mandatory Tests on Aggregates at site shall be min. 3 on each 10 cub.m or part there of as per IS: 2386. Mean value of the results from site test shall be taken as the representative value and the acceptance criteria shall be based on these. All test procedures & computations for test results shall be as per IS 2386.

Apart from above, the Engineer-In-Charge may at his discretion, call for any additional tests that he may consider necessary. Sampling, procedure and computations for such test shall be done in accordance with IS 2430 and IS 2386 as applicable.

### **4.2.2 Fine Aggregates**

Fine aggregates shall be as specified under -Mortars specifications.

#### **4.2.1 Water**

Water shall be as specified under -Mortars specifications.

#### **4.2.2 Fly Ash:**

Fly ash shall be as specified under -Mortars specifications.

#### **4.2.3 Admixtures:**

Admixtures if required, shall be as specified under RC Concrete specifications.

#### **4.2.4 Placing of Cement Concrete**

Placing of cement concrete shall be as specified under- Reinforce Cement Concrete specifications (relevant as applicable). All concrete shall be protected against damage until final acceptance by the Engineer-In-Charge.

#### **4.2.5 Formwork**

Formwork may be of timber, plywood, steel or other metal, plastic or concrete or any suitable material as per the direction of Engineer-In-Charge.

Formwork (or shuttering) comprises all forms and moulds made up of planks and sheeting etc., shores, bracings and struts, ties, anchors and hangers, steel rods, bolts and allied inserts, uprights, walling, wedges and all other temporary supports for concrete work during the process of concreting and setting.

Form work design parameters and specifications shall be as specified under- Reinforce Cement Concrete (relevant as applicable).

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (सि. ए. सिविल)  
CHIEF MANAGER (S. CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

#### 4.2.6 Measurement

All measurements shall be as per relevant part of IS 1200. Any work done in excess over the specified dimensions or sections shown in the drawing shall be ignored.

Concrete work executed under water, in liquid mud or under foul positions shall be measured separately as instructed by the Engineer-In-Charge.

No deductions shall be made for- Opening upto 0.1 sq.m, volume occupied by pipes, conduits, sheathing, small voids etc.

#### **05) REINFORCED CEMENT CONCRETE:**

##### **5.1 Cement**

Cement shall be as specified under - Mortars specifications.

##### **5.2 Coarse Aggregate**

Coarse Aggregates shall be as specified under- Mortars specifications.

##### **5.3 Fine Aggregate**

Fine aggregates shall be as specified under- Mortars specifications.

##### **5.4 Water**

Water shall be as specified under -Mortars specifications.

##### **5.5 Fly Ash:**

Fly ash shall be as specified under -Mortars specifications.

##### **5.6 Admixtures**

###### **5.6.1 General:**

Admixtures if permitted shall comply with IS 9108 Concrete admixtures are proprietary items of manufacturer and shall be obtained from established /approved manufacturers.

Admixtures should not impair durability of concrete nor combine with the constituent to form harmful compounds nor increase the risk of corrosion of reinforcement.

The workability, compressive strength and slump with and without use of admixtures shall be established during the trial mixes prior to use of admixtures.

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

The chloride content of admixtures shall be independently tested for each batch before acceptance.

If two or more admixtures are used simultaneously in the same concrete mix, data shall be obtained to assess their interaction and to ensure their compatibility.

The Contractor shall provide the following information concerning each admixture after using the same from the manufacturer:

Normal dosage and detrimental effects, if any, of under dosage and over dosage.

The chemical names of the main ingredients in the admixtures.

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
महाराष्ट्र डॉक शिपबिल्डर्स लिमिटेड  
MAHARASHTRA DOCK SHIPBUILDERS LIMITED

The chloride content, if any, expressed as a percentage by the weight of the admixture. Values of dry material content, ash content and relative density of the admixture which can be used for uniformity tests.

Whether or not the admixture leads to the entrainment of air when used as per the manufacturer's recommended dosage and of so to required extent.

Where two or more admixtures are proposed to be used on any one mix, confirmation as to their compatibility.

Assurance with documentary evidence to show that there would be no increase in risks of corrosion of the reinforcement or other embedment as a result of using the admixture.

In addition, the following conditions also shall be satisfied:

"Plasticizers" and "super-plasticizers" shall meet the requirements indicated for "water reducing admixtures".

Except where resistance to freezing and thawing and to disruptive action of de-icing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS 1199 shall be not more than 2% higher than that of the corresponding control mix and in any case not more than 3% of the test mix.

The chloride content of the admixture shall not exceed 0.2% when tested in accordance with IS 6925. In addition, the maximum permissible limit of chloride content of all the constituents of concrete as indicated in IS 456:2000 shall also be observed.

Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch of different items.

The tests that shall be performed with permissible variations in the same are indicated below:

Dry material content: to be within 3% and 5% of liquid and solid admixtures respectively of the value stated by the manufacturer.

Ash content: to be within 1% of the value stated by the manufacturer.

Relative density (liquid admixtures) : to be within 2% of the value stated by the manufacturer.

All tests relating to the admixtures shall be conducted periodically as decided by the Engineer-In-Charge at an independent laboratory and compared with the data given by the manufacturer.

## **5.7 Material Admixtures**

### **5.7.1 Pozzolana**

Pozzolonic materials conforming to IS 3812 may be used with the permission of the Engineer-In-Charge provided uniform blending with cement is ensured.

Fly ash (Pulverized fuel ash)

Fly ash conforming to Grade 1 of IS 3812 may be used as part of replacement of Ordinary Portland cement provided uniform blending with cement is ensured.

### **5.7.2 Silica fume**

Silica fume conforming to standard acceptable to the Engineer-In-Charge may be used as part replacement of cement provided uniform blending with cement is ensured.

### **5.7.2 Rice husk ash**

Rice husk ash giving required performance and uniformity characteristics may be used with the approval of the Engineer-In-Charge.

### **5.7.2 Metakoline**

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. सं. सिविल)  
CHIEF MANAGER (T.S. CIVIL)  
भाइगांव डॉक शिपविल्डर्स लिमिटेड

Metakoline having fineness between 700 to 900sq.m per kg may be used as Pozzolonic material in concrete.

### **5.7.2 Ground granulated blast furnace slag (GBSS)**

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 ensured.

## **5.8 CONCRETE WORK**

### **5.8.1 General**

This section covers the requirements for furnishing of cement concrete including materials proportioning, batching, mixing, testing, placing, compacting, finishing, jointing, curing & all other work as required for cast-in-situ or ready mixed plain and reinforced concrete.

### **5.8.2 Submittals**

#### **5.8.2.1 Materials Reports**

Prior to start of delivery of materials required for cement concrete the following shall be submitted by the Contractor to the Engineer for approval.

Recommended suppliers and / or sources of all ingredients for making concrete including cement, fine & coarse aggregates, water and additives including samples thereof.

Quality Inspection Plan to ensure continuing quality control of ingredients by periodic sampling, testing and reporting to the Engineer on the quality of materials being supplied.

#### **5.8.2.2 Plant and Equipment**

The contractor shall submit the proposed programme, methods and details of plant and equipment to be used for batching, mixing and placing of concrete to the Engineer, well in advance prior to start of work.

#### **5.8.2.3 Certificates**

With each mix design, the Contractor shall submit test reports on concrete cubes and as well as on ingredients to be used at the actual construction work for approval of the Engineer.

In case the source, brand or characteristic properties of the ingredients are required to be varied during the term of the contract, a revised mix design report shall be submitted to the Engineer.

#### **5.8.2.4 Schedules**

The Contractor shall prepare working schedules for dates and quantity, location of pouring of concrete for each item of work and submit same to the Engineer at least 48 hours before commencement of such work.

### **5.8.3 Materials**

Before bringing to the site, all materials for cement concrete shall be got approved by the Engineer. All approved samples shall be retained in the office of the Engineer before placing orders for the materials with suppliers. The materials brought on to the works shall conform in every respect to their approved samples.

Fresh samples shall be delivered to the Engineer whenever type or source of any material changes. The contractor shall check each fresh consignment of materials as it is brought on to the works to ensure that they conform to the specifications and / or approved samples.

The Engineer shall have the option to have any of the materials tested to find whether they are in accordance with specifications. All bills, vouchers and test certificates which in the opinion of the Engineer are necessary shall be produced for his inspection when required.

Any materials which have not been found to conform to the specifications and not approved by the Engineer shall be removed from the site by the contractor within the time stipulated by the Engineer.

#### **5.8.3.1 Cement**

The cement used shall be Ordinary Portland Cement conforming to IS: 8112.

Whenever possible all cement of each type shall be obtained each from one constant source throughout the contract. Cement of different types shall not be mixed with one another. Different brands of cement, or the same brand of cement from different sources, shall not be used without prior notification and approval of Engineer.

The cement shall be supplied either packed in bags or in silos installed for the purpose of supply. Packed cement shall be delivered to the site in original sealed bags which shall be labeled with the

मुख्य प्रबंधक (त. से. सिविल)  
MANAGER (TS-CIVIL)  
श्रीमंत डोक शिपबिल्डर्स लिमिटेड  
SHRIMANT DOK SHIPBUILDERS LIMITED

weight, date of manufacture, name of manufacturer, brand and type. Cement received in torn bags shall not be used. Moreover, bags of cement which vary in weight by more than 3% shall not be accepted.

All cement shall be fresh when delivered and at ambient atmospheric temperature.

In fair-faced elements, the cement used in the concrete for any complete element shall be from a single consignment. All cement for exposed concrete shall be from the same approved source and uniform in colour.

With each and every delivery of cement the contractor shall provide the manufacturer's certificate that the cement conforms to the relevant Indian Standard.

The Contractor shall provide facilities for making 7 days' tests and 28 days from time to time in accordance with IS:3535, IS:4031 and IS:4032 (Latest Edition) and shall allow for carrying out such tests as may be required by the Engineer and for reporting the results.

#### **5.8.3.2 Aggregates**

Aggregates from natural sources shall be in accordance with IS: 383. The Contractor shall submit to the Engineer certificates of grading and compliance from the suppliers for all consignment of aggregate. In addition, from time to time, the Contractor shall test that aggregate at site in accordance with IS: 2386 Part I, II & III. The contractor shall allow for and provide all necessary apparatus for carrying out such tests and for supplying test records to the Engineer. The aggregates shall be free from salts or other harmful chemical impurities.

For fair-faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities, which may cause discoloration.

#### **5.8.3.3 Fine Aggregates**

The fine aggregate shall be pit sand, river sand or other approved sand conforming to IS: 383. It shall be free from clay, loam, and earth or vegetable matter & from salt or other harmful chemical impurities. In case impurities cannot be removed by screening process, sand shall be washed and cleaned to the satisfaction of the Engineer. It shall be clean, sharp, strong, angular and composed of hard siliceous material.

#### **5.8.3.4 Silt Content**

The maximum quantity of silt in fine aggregates as determined by the Field method shall not exceed 8 percent by volume.

#### **5.8.3.5 Coarse Aggregate**

The coarse aggregate shall be crushed stone conforming to IS: 383, having nominal size of 20 mm & 40 mm as per requirements and as approved by Engineer.

Coarse aggregate obtained from crushed or broken stone shall be angular, hard, strong, dense, durable, clean and free from soft, friable, thin flat, elongated or flaky pieces.

Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the works, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes & blending them in correct proportions as and when required.

#### **5.8.3.6 Water**

Water used in the works shall be potable water & free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and / or washing aggregate shall be fresh and clean, free from injurious amounts of oil, salts, acids, alkali, other chemicals and organic matter. Water shall be from the source approved by the Engineer and shall be in accordance with IS: 456 (latest edition)

Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use. No water shall be used until tested, found satisfactory and approved by Engineer. Water testing kit shall be made available at site for random checking of water.

#### **5.9 READY-MIXED CONCRETE**

Concrete mixed in a stationary mixer in a central batching and mixing plant or in a truck-mixer and supplied in the fresh condition to the purchaser either at the site or into the purchaser's vehicles.

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

**5.9.1 Approved Plant:** Ready mixed concrete conforming to IS 4926: 2003 shall be supplied from **Ultratech, ACC, Godrej, Lafarge, RMC India, Hella Infra Market, RDC, Ecomix, Dev RMC LLP, Manoj Infra Market RMC plant** or other any plant as approved by MDL Engineer in Charge.

## **5.9.2 MATERIALS:**

### **Selection and Approval of Materials,**

Materials used should satisfy the requirements for the safety, structural performance, durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

#### **5.9.2.1 Cement**

Cement used for concrete shall be in accordance with the requirements of IS 456.

**5.9.2.2 Mineral Admixtures** — Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

#### **5.9.2.3 Aggregates**

Aggregates used for concrete shall be in accordance with the requirements of IS 456. Unless otherwise agreed testing frequencies for aggregates shall be as given in Annex B.

#### **5.9.2.4 Chemical Admixtures**

Use of chemical admixtures shall be permitted in accordance with the provisions of IS 456.

It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and to determine the dosage required to give the desired effect.

Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.

When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

The amount of admixture added to a mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

#### **5.9.2.5 Water:**

Water used shall be in accordance with the requirements of IS 456-2000 Cl.5.4

The use of re-cycled water is encouraged as long as concrete of satisfactory performance can be produced and steps are taken to monitor the buildup of chlorides in any recirculated water and that any subsequent adjustments to the mix design are made to ensure that any overall limit on chloride contents is satisfied. The addition of any recycled water shall be monitored and controlled to meet these requirements.

The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer's production staff and truck-mixer drivers shall be made aware of the appropriate responses to variations in concrete consistence of a particular mix caused by normal variations in aggregate moisture content or grading.

## **5.9.3 Ready Mix Concrete**

General specifications shall be as described under- **Reinforced cement concrete** specifications & shall generally comply with the requirements of IS: 456 - 2000.

Ready mixed concrete is the concrete delivered at site from a Central Plant. The delivery is made by either agitator truck or truck mixer in a plastic condition requiring no further treatment before being placed in position in which it is to set and harden. The ready mix concrete shall conform to IS 4926, Specification for Ready Mixed Concrete is subject to the following:

- The ready mixed concrete shall be Centrally Mixed Concrete unless otherwise specifically mentioned.

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
डॉक शिपबिल्डर्स लिमिटेड  
DOCK SHIPBUILDERS LIMITED

- Batching plant: The batching plant shall be of fully automatic central batching and mixing type conforming to the provisions of IS: 4925. The capacity of the plant shall not be less than 30 cu.m./ hour.
- The ready mixed concrete shall be manufactured strictly as per the approved mix design by Engineer-In-Charge and supplied on the basis of specified strength based on 28-day compressive strength of 15 cm cube tested in accordance with IS: 456 - 2000. For any change in quality / quantity in the ingredients of a particular concrete for which mix has been designed earlier and approved by the Engineer-In-Charge, the mix has to be redesigned and accordingly approval shall be obtained prior to use.
- Since the ready mixed concrete is a tailor made concrete, certain precautions are necessary for the concrete mix. Some of these are as listed below:
- Minimum quantity of cement and the details regarding proportioning and works control shall be in accordance with IS: 456-2000.
- The air content of the concrete shall not be more than 2% in any case. This shall be established by necessary testing at worksite.
- The dosage of the admixture shall be given at the batching plant only. Subsequent dosage of admixture shall not be permitted thereafter unless otherwise permitted by the Engineer-In-Charge.

Water shall not be added to ready-mixed concrete to restore the workability of concrete. However, the workability can be restored to the design slump by use of proper admixture (without retarding effect) with prior approval of the Engineer-In-Charge provided the slump has not dropped below 50 mm. For the concrete with slump less than 50 mm and more than zero mm, the slump shall not be revised after the initial setting of the concrete. The initial setting of the concrete shall be established at worksite by the procedure in accordance with IS: 8412 -Method of test for determining setting time of concrete by penetration resistance.

When a truck mixer or agitator truck is used for transporting concrete, the concrete shall be delivered to the site for work the exact location as approved by the Engineer-In-Charge. Discharge of the concrete to be done by chute only to avoid segregation. The slump shall be checked at this delivery point. Further transport and placing of concrete along with compaction shall be completed prior to initial setting of concrete. In any case total transport time not to exceed 1½ hours.

#### 5.9.4 Placing of Concrete:

When placing of concrete by manually the following shall apply -

Method of placing of concrete shall be such that no segregation occurs during placing. In manual placing, contractor has to arrange proper paths for the free movement of wheel barrows. Contractor has to prepare method statement for placing operation and get the same approved from Engineer-in-charge prior to actual execution. Generally concrete shall not be dropped freely from a height of more than 1.5 meters in the works of watertight structures and 2 m. in all other works. When required to be deposited from a greater height, it shall be done through a metal-lined chute with slope no flatter than 1:2 (Vertical : Horizontal) and not steeper than 1:3. The discharge end of the chute will be provided with a baffle plate to prevent segregation. The discharge end of the chute shall be maintained above the surface of the concrete in forms and concrete shall not be permitted to fall from the end of chute by more than 1 m. During cleaning a chute, the waste water shall be kept clear of the forms.

#### 5.9.5 Admixtures

Contractor shall submit the following before any admixtures is approved by the Engineer-In-Charge for their use -

- Certificate conforming that the use of a particular brand of admixture shall not be harmful to concrete in any way.
- Certificate conforming the exact dosage of admixture of a particular brand
- Certificate stating the specific purpose for which the admixture is to be used.

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (न. रा. विभाग)  
CHIEF MANAGER (N.S. DIV.)  
महाराष्ट्र डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LTD.

- Special precautionary measures to be taken in the manufacturer of concrete when using the particular brand of admixture.
- Certificate conforming that the admixture conforms to specifications of IS 9103 or to ASTM – C 260, ASTM – C 10, ASTM – C 595 or to ASTM-C 618.

Engineer-In-Charge at his discretion may require tests to be performed to reconfirm the characteristic properties of any admixture. All such tests shall be done in accordance with IS 9103.

All tests described above shall be done at the site laboratory or at a laboratory to be identified by the Engineer-In-Charge depending on the test to be conducted.

All test shall be done in the presence of a representative nominated by the Engineer-In-Charge and a representative of the concrete manufacturer / Contractor when tests are performed at the site laboratory. All observations and reports of test shall be jointly signed by the two representatives before the test results are submitted to the Engineer-In-Charge for approval.

Expenses for all materials used for testing, sampling procedures and testing including preparing reports shall be borne by the Contractor.

### **5.9.6 Sampling & testing for quality control of concrete**

#### **Fresh concrete**

Fresh concrete shall be tested for

- Slump
- Compacting factor/workability
- Consistency
- Weight per cubic metre, cement factory and air content.

#### **Slump**

For concrete totally mixed in a central plant, slump shall be checked at

- immediately during loading of trucks
- Point of discharge from the delivery truck
- Final placement location

At placement location the slump measured shall conform to the design slump. Manufacturer of concrete shall adjust for loss of slump in transit and establish the requirements of design mix. All slump measurements shall be done within a period of 20 minutes from the time cement is added to the mixer. Placement contractor shall transport concrete from truck discharge point to actual placement location within 10 minutes of delivery before the final slump reading is taken at placement location.

For concrete entirely mixed in transit or for shrink mix concrete, slump readings shall be taken at

- point of discharge from delivery trucks
- final placement location

For measuring concrete slump at point of discharge from delivery trucks, samples shall be taken from concrete omitting the first and the last 15 % of the load. For concrete delivery or placed by pumping, sampling shall be similar to those specified for delivery trucks.

Slump measurement of ready mix concrete transported by buckets shall be at locations specified in above para with some limits of time. Sampling from buckets shall be such that the buckets containing discharge from mixer for the and last 15% are omitted.

At placement locations, samples for checking slump shall be collected from every 20 cum of concrete or part thereof placed at location for each type of concrete.

For all slump checks ~~at least~~ <sup>at least two</sup> recordings shall be made and the average value taken as the recorded slump.

WANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
MANAGER (TS-CIVIL)  
साइगांव डॉक शिपबिल्डर्स लिमिटेड  
SAIGAN DOCK SHIPBUILDERS LIMITED

Slump checks for concrete in the laboratory shall be carried out as and when required by the manufacturer of concrete during the mix design stage and during the progress of work for control on field results.

Slump readings shall only be a guideline for concrete consistency and shall not be taken as the acceptability criteria for concrete placed at location. All slump tests shall be carried out in accordance with IS : 1199.

For quality control of strict check on the strength of concrete shall be maintained along with other field requirements such as workability, consistency, slump etc. mentioned in para above.

Acceptability criterion for concrete as specified in para above shall only be applicable.

Test on cube crushing strength of concrete in accordance and compliance with IS 456-2000 and IS 516 shall be done as under –

- Samples of fresh concrete shall be taken from concrete at central batch plant mixer while loading delivery trucks or other transport and also from concrete transported to placement location.
- Test on specimens made from samples collected at placement location shall be considered as field test specimens and results therefrom shall be the criterion of concrete strength. Test in specimens made from samples at the batch plant shall only be taken as guide lines test. Only in the case of doubtful result, the Engineer-In-Charge may refer to such guide line results for deciding on the quality of concrete
- For truck mix concrete and shrunk mix concrete guide line test specimens shall be made from samples collected at discharge location from mixing trucks. For this purpose, first and last 15% of the load shall be omitted while collecting samples.

The contractor shall set up a laboratory at this own expense which shall have facilities for conducting all necessary field test on materials and field and laboratory test on concrete. The laboratory shall be staffed with qualified and experienced scientists and technicians.

#### Industrial Vacuum Dewatered Flooring

General specifications for RCC grade slab/ structural slab shall be as described under- Reinforced cement concrete specifications & shall generally comply with the requirements of IS: 456 - 2000.

#### 5.9.7 Laying of Concrete

Laying of concrete for Grade slab/ structural slab shall be generally as described under-Reinforce cement concrete specifications and laid to the required slope and level as shown on the drawing subject to prior approval of Engineer-In-Charge. Vibrating of the laid concrete with double beam screed vibrator till its setting unless otherwise recommended by the process agency. Dewatering of the laid concrete shall be done by using suction pipe and pump after laying lower matt shall be laid on green concrete and excess water can be removed and optimum water cement ratio can be maintained by use of "TREMIX" or other approved process subject to approval of Engineer-In-Charge. The contractor shall execute the work strictly as per the process agency's specifications, methodology and instructions in regard to use of screed vibrators, channels, shuttering, dewatering unit, power floater, power trowel, etc. to get desired smooth finish over a levelling course etc. complete.

- Cutting and filling sealant of grooves / sawed joints / strips for placing land ties etc. shall be as shown on approved drawings, as instructed by the process agencies subject to prior approval of Engineer-In-Charge.
- Application of non-metallic floor hardener of approved makes / unless otherwise specified at 7 Kg/Sq.m. shall be sprinkled over green concrete in alternate bags and trowel simultaneously. Floor laid is to be trowel to acquire desired smooth finish with power trowel.
- When initial setting of concrete is reached, from next day onwards curing with water shall be carried out for minimum seven days.

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. शिपबिल्डिंग)  
CHIEF MANAGER (T. S. SHIPBUILDING)  
माझगांव डॉक शिपबिल्डिंग लिमिटेड  
MAZGAON DOCK SHIPBUILDERS LIMITED

## 5.9.8 Placing of Concrete – (Plain & Reinforced)

### 5.9.8.1 Grades of Concrete

Various grades of concrete shall be as per **IS 456 - 2000 (latest)** with specified characteristic compressive strength against these grades in accordance with Table 2 in the said IS. In the grade designation, letter 'M' refers to the mix and the number to the specified characteristic compressive strength of 15 cm. cube at 28 days expressed in N/mm<sup>2</sup>. The characteristic strength is defined as the strength of material below which not more than 5 percent of the test results are expected to fall.

The mix shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than appropriate values given in Table 2 of IS 456:2000. The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times the standard deviation.

### 5.9.8.2 Design Mix Concrete

All RC work shall be in "Design Mix Concrete" only. The Contractor shall make all the necessary tests from approved authorized laboratories like VJTI, IIT, Sardar Patel College, etc. to determine for each grade of concrete, the proportions of various ingredients by weight to arrive at the desired design mix to the satisfaction of the Engineer-In-Charge. Such mix will be known as the "declared mix". No deviation from the "declared mix" will be permitted without the approval of the Engineer-In-Charge. Approval by the Engineer-In-Charge to such "declared mix" shall not relieve the Contractor of his responsibility to use in the Works at all times only concrete as specified in the relevant drawings.

The Contractor shall be entirely responsible for design of concrete mixes of the specified performance to suit the degree of workability and characteristic strengths required for the various parts of the Works.

Concrete shall meet with the strength requirements and minimum cementations material, maximum w/c ratio as indicated in TABLE 5 of IS 456:2000 hereinafter unless specifically stated otherwise.

Alternative mixes may be designed by the Contractor for use in both thin and narrow sections and thick sections. Special mixes using finer aggregates may be designed by him for in filling pockets and narrow spaces and for regions of congested reinforcement.

### 5.9.8.3 Nominal Mix Concrete

Nominal mix concrete may be allowed by the Engineer-In-Charge at his discretion. The proportions of materials shall be in accordance with Table 9 of IS 456-2000. The relevant details at a glance are indicated in given below in Table 4.

**TABLE - 4**

| Grade of Concrete | Total quantity of dry aggregates by Mass per 50kg of Cement, to be taken as the sum of the individual Masses of Fine & Coarse Aggregate, Kg, Max. | Quality of water per 50Kg. of cement, Max. |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| M 10              | 480 Kg.                                                                                                                                           | 34 Litres                                  |
| M 15              | 350 Kg.                                                                                                                                           | 32 Litres                                  |
| M 20              | 250 Kg.                                                                                                                                           | 30 Liters                                  |

The proportion of fine aggregate to coarse aggregate by mass shall generally be 1:2 subject to an upper limit of 1:1 ½ and lower limit of 1:2 ½.

**TABLE - 5**

| I.S. Sieve | Percentage passing for single sized aggregate of nominal size | Percentage passing for graded aggregate of nominal size |
|------------|---------------------------------------------------------------|---------------------------------------------------------|
|------------|---------------------------------------------------------------|---------------------------------------------------------|

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF ENGINEER (TS-CIVIL)  
महंगांव डॉक शिपबिल्डर्स लिमिटेड  
DOCK SHIPBUILDERS LIMITED

| Design<br>ation | 40<br>mm.  | 20<br>mm.  | 16<br>mm. | 12.5<br>mm. | 10<br>mm.  | 40<br>mm.  | 20<br>mm.  | 16<br>mm.  | 12.5<br>mm. |
|-----------------|------------|------------|-----------|-------------|------------|------------|------------|------------|-------------|
| 63 mm.          | 100        | -          | -         | -           | -          | -          | -          | -          | -           |
| 40 mm.          | 85-<br>100 | 100        | -         | -           | -          | 95-<br>100 | 100        | -          | -           |
| 20 mm.          | 0-20       | 85-<br>100 | 100       | -           | -          | 30-70      | 95-<br>100 | 100        | 100         |
| 16 mm.          | -          | -          | 85-100    | 100         | -          | -          | -          | 90-<br>100 | -           |
| 12.5<br>mm.     | -          | -          | -         | 85-<br>100  | 100        | -          | -          | -          | 90-<br>100  |
| 10 mm.          | 0-5        | 0-20       | 0-30      | 0-45        | 85-<br>100 | 10-35      | 25-55      | 30-70      | 40-85       |
| 4.75<br>mm.     | -          | 0-5        | 0-5       | 0-10        | 0-20       | 0-5        | 0-10       | 0-10       | 0-10        |
| 2.36<br>mm.     | -          | -          | -         | -           | 0-5        | -          | -          | -          | -           |

#### 5.9.8.4 Mix Design & Proportioning

Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcements and completely fills the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impartibility.

Determination of the proportions by weight of cement, aggregates and water shall be based on design of the mix.

As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23-1982.

All concrete proportions for various grades of concrete shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing & compacting.

#### Standard Deviation

Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with clause 9.2.4 of IS 456.

#### Acceptance Criteria

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

- The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of Table 6 of IS 456 - 2000.
- Any individual test result complies with the appropriate limits in column 3 of Table 6.

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

- The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least  $0.3 \text{ N/mm}^2$
- The strength determined from any test results is not less than the specified characteristic strength less  $0.3 \text{ N/mm}^2$

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. सं. सिविल)  
CHIEF MANAGER : S-CIVIL  
महागांव डॉक शिपबिल्डर्स लिमिटेड  
MAHAGON DOCK SHIPBUILDERS

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 col. 3 of Table 6 or in item (b) of above 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 60 cubs. m

If the concrete is deemed not to comply pursuant to quality of concrete represented by strength Test result as above, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

#### **Cement content of concrete**

For all grades of concrete manufactured / produced, minimum cement content in the concrete shall be 370 Kg per Cubic meter of concrete. Also, irrespective of the grade of concrete, the maximum cement content shall not be more than 500 kg per cub. m of concrete. These limitations shall apply for all types of cements of all strengths.

Actual cement content in each grade of concrete for various conditions of variables shall be established by design mixes and approved by the Engineer-In-Charge.

#### **Approval of Design Mix**

The contractor shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer-In-Charge for approval. Concrete of any particular design mix and grade shall be produced / manufactured for works only on obtaining approval of the Engineer-In-Charge.

For any change in quality/quantity in the ingredients of a particular concrete for which mix has been designed earlier and approved by the Engineer-In-Charge, the mix has to be redesigned and approval shall be obtained again.

#### **Quality Assurances Measures**

In order that properties of the completed structure be consistent with the requirements and the assumptions made during planning and design adequate quality assurance measures shall be taken. Quality Assurance procedures be developed and submitted to the approval of Engineer-In-Charge. The said Quality Assurance plan shall fulfil the requirements detailed under clause no. 10.1 of IS: 456 - 2000.

#### **Proportioning & Batching**

Preliminary tests shall be carried out to determine the proportions by weight of cement, coarse and fine aggregate to produce the desired grade of concrete. These proportions shall be maintained during subsequent concrete batching by means of weight batchers conforming to IS 2722.

The accuracy of the measuring equipment shall be within  $\pm 2$  percent of the quantity of cement being measured and within  $\pm 3$  percent of the quantity of aggregate, admixtures and water being measured.

The batcher shall be tested for accuracy of calibration before commencement of the work and at least once a week thereafter or more frequently, if so required by the Engineer-In-Charge.

All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked.

#### **Grading of Aggregate & Foreign Material Limitations**

Coarse Aggregate

- Coarse aggregates shall be either in single size or graded; in both cases, the grading shall be within acceptable limits.

मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माइगांव डॉक शिपबिल्डर्स लिमिटेड  
TAGON DOCK SHIPBUILDERS LIMITED

- The percentages of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the volumes given in table here below.

**TABLE - 6**

| Deleterious Substance                                                                               | PERCENT BY WEIGHT |         |
|-----------------------------------------------------------------------------------------------------|-------------------|---------|
|                                                                                                     | Uncrushed         | Crushed |
| i) Coal & Lignite                                                                                   | 1.00              | 1.00    |
| ii) Clay lumps                                                                                      | 1.00              | 1.00    |
| iii) Material finer than 75 micron                                                                  | 3.00              | 3.00    |
| iv) Soft fragments                                                                                  | 3.00              | --      |
| v) Shale                                                                                            | --                | --      |
| vi) Total of percentages of all the deleterious materials (except mica) including SI no. (i) to (v) | 5.00              | 5.00    |

**Fine Aggregate**

- Unless otherwise directed or approved, the grading of sand shall be within the limits indicated in table here below.

**TABLE - 7**

| I.S. Sieve Designation | Grading Zone-I<br>% passing | Grading Zone - II<br>% passing | Grading Zone - III<br>% passing | Grading Zone - IV<br>% passing |
|------------------------|-----------------------------|--------------------------------|---------------------------------|--------------------------------|
| 10 mm.                 | 100                         | 100                            | 100                             | 100                            |
| 4.75 mm.               | 90-100                      | 90-100                         | 90-100                          | 95-100                         |
| 2.36 mm.               | 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                           | 80-100                         |
| 300 micron             | 5-20                        | 8-30                           | 12-40                           | 15-50                          |
| 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 microns I.S. sieve, by total amount not exceeding 5 percent, 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.

Fine aggregate 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 I.S. sieve sizes 4.75 mm., 2.36 mm., 1.18 mm., 600 microns 300 micron and 150 microns and dividing the sum by 100.

- The percentage of deleterious substances in sand delivered to the mixer shall not exceed the values given in table here below:

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

TABLE - 8

| Deleterious Substance                                                                                                                                                | PERCENT BY WEIGHT |         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------|
|                                                                                                                                                                      | Uncrushed         | Crushed |
| i) Coal & Lignite                                                                                                                                                    | 1.00              | 1.00    |
| ii) Clay lumps                                                                                                                                                       | 1.00              | 1.00    |
| iii) Material finer than 75 micron                                                                                                                                   | 3.00              | 15.00   |
| iv) Soft fragments                                                                                                                                                   | --                | --      |
| v) Shale                                                                                                                                                             | 1.00              | --      |
| vi) Total of percentages of all the deleterious materials (except mica) including SI no. (i) to (v) for uncrushed and SI. No. (i) & (ii) for crushed fine aggregate. | 5.00              | 2.00    |

#### Water Cement Ratio (W/C Ratio)

- The water-cement ratio is defined as the weight of water in the mix (including the surface moisture of the aggregates) divided by the weight of cement in the mix. Free water-cement ratio should not exceed 0.40 for substructure and 0.45 for superstructure unless otherwise specified.
- Only such quantity of water shall be added to the cement / cementations material and aggregates in the concrete mix as to ensure dense concrete, specified surface finish, satisfactory workability, consistent with the strength stipulated for each class of concrete. 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.
- The actual water-cement ratio to be adopted shall be determined in each instance by the Contractor & approved by the Engineer-In-Charge.

The W/C ratio determined and approved for use by the Engineer-In-Charge shall be maintained throughout the corresponding part of the Works. Approved tests conforming to relevant IS Codes subject to approval of Engineer-In-Charge shall be undertaken periodically by the Contractor for maintaining the consistency. Such ones comprise frequent determination of the water content of the aggregate during the progress of work as specified in IS 2386 (Part-III). To allow for the variation in weight of aggregates due to variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

- The Contractor shall exercise special precautions on the water content for concrete work since the colour of such concrete is sensitive to small variations of water in the mix.

Volumetric mixing may be allowed by the Engineer-In-Charge at his discretion by converting the "declared mix" to corresponding mix by volume. Allowance for bulkage shall be made in accordance with IS 2386(Part 3). Periodic checks shall be made on mass / column relationship of the materials. Similarly, where cement is measured by bags directly reasonable number of cement bags should be weighed periodically to check the net mass as directed by the Engineer-In-Charge.

#### Workability

- Workability of concrete should be checked at frequent intervals. It shall be checked at frequent intervals by approved tests such as slump tests, compacting factor tests etc. in accordance with IS 1199. If required, the same shall be controlled by adjusting the dosage of the admixtures if permitted by the Engineer-In-Charge.
- The range of slumps for various types of work shall generally be as follows subject to approval by the Engineer-In-Charge unless stated otherwise. Slump required for workability shall be achieved, if necessary by using approved super plasticizer without any extra cost.

JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
एच. डी. शिपबिल्डर्स लिमिटेड  
H. D. SHIPBUILDERS LIMITED

TABLE - 9

| Placing condition                                                                                                                                                                                                                                                                                                                                                              | SLUMP (in mm.) |         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---------|
|                                                                                                                                                                                                                                                                                                                                                                                | Maximum        | Minimum |
| Blinking concrete; shallow sections; Pavement using Pavers                                                                                                                                                                                                                                                                                                                     | 75             | 25      |
| Mass concrete; Lightly reinforced sections in slabs, beams, walls, columns, Floors, hand placed pavements, Strip footings                                                                                                                                                                                                                                                      | 75             | 25      |
| Heavily reinforced sections in slabs, beams, walls, columns;                                                                                                                                                                                                                                                                                                                   | 100            | 50      |
| Slip formwork, Pumped concrete                                                                                                                                                                                                                                                                                                                                                 | 100            | 75      |
| Trench fill; In-situ piling                                                                                                                                                                                                                                                                                                                                                    | 150            | 100     |
| <b>Note:</b><br>For most of the placing conditions, internal vibrators (needle vibrator) are suitable. The diameter of the needle shall be determined based on the density and the spacing of reinforcement bars and thickness of the sections. For trieme concrete, vibrators are not required to be used and clause 7.1.2 of IS : 456 - 2000 shall be followed in such case. |                |         |

#### 5.9.8.5 Mixing of Concrete

All concrete whether design mix or nominal mix shall be mixed in an approved mechanical mixer. The mixer shall comply with IS: 1791 & IS: 12119. The mixer shall be fitted with water measuring (metering) devices. Material for concrete shall be deposited into the mixer drum while it is in rotation in the following order.

#### Coarse aggregate, cement, fine aggregate and water

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 not be remixed.

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

The volume of mixed material shall not exceed the manufacturer's rated mixer capacity.

Temperature of aggregate, water and cement when added to the mixer shall be such that the temperature (minimum & maximum) of the concrete at the time of placement shall be as specified in IS 456: 2000

The mixer shall be thoroughly cleaned of all hardened sticking concrete and foreign materials before beginning the concreting operations and also at frequent intervals between batches and at the end of concreting work by spraying the drum with cool water.

Concrete shall be discharged from the mixer on to a level, clean and water-tight surface. The area surrounding the mixer and the aggregate stacks shall be kept clean.

Subject to the approval of the Engineer-In-Charge, the Contractor may use waterproofing admixtures and / or other chemical admixtures and additives in concrete. The proportions and the mode of use shall be as per the manufacturers' instructions. The Contractor shall furnish complete literature in regard to such admixtures / additives to the Engineer-In-Charge.

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF ENGINEER (T.S. CIVIL)  
माझगाव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

Dosage of retarders, plasticizers and super-plasticizers shall be as per manufacturer's requirement and subject to approval of the Engineer-In-Charge. Unless otherwise specified. It shall be restricted to 0.5, 1.0 and 2.0 percent respectively by weight of cementations materials unless a higher value is permitted by the Engineer-In-Charge. Approval of mix design shall be by the Engineer-In-Charge prior to actual executions.

Mixing of cement mortar or concrete which has partially set shall not be permitted under any circumstances.

#### **5.9.8.6 Transporting and Placing of Concrete**

Concrete shall be handled from the place of mixing to the place of final placing as rapidly as practicable by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability. Entire operation shall not take time more than the initial setting time of concrete under the prevailing site conditions.

During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

The concrete shall be deposited as nearly as practicable in its final position to avoid re-handling. No concrete shall be permitted to be used in the Works after initial set has taken place. Concreting of beams, slabs and similar members shall be carried out in one continuous operation to the full depth of the member and the sequence of placing shall be so arranged as to avoid disturbance of partially set concrete.

Method of placing of concrete should be such that no segregation occurs during placing. Generally concrete shall not be dropped freely from a height of more than 1.2 meters in the works of watertight structures and 1.6 m. in all other works. When required to be deposited from a greater height, it shall be done through a metal-lined chute with slope no flatter than 1:3 (vertical: horizontal) and not steeper than 1:2. The discharge end of the chute will be provided with a baffle plate to prevent segregation. The discharge end of the chute shall be maintained above the surface of the concrete in forms and concrete shall not be permitted to fall from the end of chute by more than 1 m. During cleaning a chute, the waste water shall be kept clear of the forms.

#### **5.9.8.7 Compaction of Concrete**

Except for thin layer of plain concrete (for which tamping may be allowed), each layer of all grades / mixes of concrete shall be thoroughly compacted with approved mechanical vibrators of adequate power or as per IS 2505, IS 2506, IS 2514 supplemented by hand spreading, rodding and tamping as directed so that concrete works around the reinforcement, around entrapped fixtures and into corners of the formwork, embedded air is expelled, dense concrete is obtained and the exposed surfaces are free from air pockets, honey-combing and other defects.

Type of vibrators (immersion vibrators, shutter vibrators, surface vibrators etc.) to be used shall depend on the type of structure for which concreting is done and shall have the approval of the Engineer-In-Charge. The size and number to be provided shall be such as to ensure proper consolidation.

General precautions to be taken in vibration work shall be as follows-

- Concrete once vibrated shall not be vibrated again.
- Partially hardened concrete or mortar shall not be re-tamped.
- Over-vibration, under-vibration or vibration of very wet mixes should be avoided.
- Tapping or external vibration of forms by hand tools or immersion vibrators shall not be permitted.
- Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. These vibrators shall not be allowed to come in contact with the reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.
- Whenever external vibrators are used, the design of formwork & the disposition of vibrators should be given special consideration to ensure sufficient compaction and surface blemishes.

JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF ENGINEER (TS-CIVIL)  
साह्याव डॉक शिपबिल्डर्स लिमिटेड  
SAHYA DOCK SHIPBUILDERS LIMITED

**a) Concreting in Inclement Weather**

During heavy rains, concreting shall be stopped keeping appropriate temporary stop ends and newly cast concrete shall be instantly covered by suitable protective means. Any concrete damaged due to rainstorms etc. shall be replaced appropriately as directed by the Engineer-In-Charge at the expense of the Contractor.

**b) Concreting under water**

When it is necessary to deposit concrete under water, the Contractor shall submit to the Engineer-In-Charge for his approval the method of carrying out the work together with the materials and proportions thereof he propose to use. In no case such concrete be considered as "Design Mix Concrete"

**c) Curing**

All concrete shall be protected during hardening from the harmful effects of sunshine and drying winds. All exposed surfaces of newly placed concrete shall be kept continuously in a damp or wet condition by water ponding or by covering with a canvas, hessian or similar other water absorbent materials and kept continuously wet for at least seven days from the date of placing of concrete. Likewise, all formwork directly in contact with concrete shall be kept dry. Curing compounds to provide surface coating with specking equipment may also be used if permitted by the Engineer-In-Charge. The necessary literature shall be furnished by the Contractor for the purpose.

For in-situ slabs (whether for flat roofs or other level surfaces, floors, pavements, sidewalks etc.), curing shall be by pounding only.

The curing period for water-tight structure shall be 10 days. In the case of concrete where mineral admixtures or blended cements are used the curing period shall be extended to 14 days.

The Contractor shall take good care in the arrangement (whether by continuous fine mist spraying or sprinkling or by covering with clean sand or wet gunny bags or by any curing compounds) and execution of curing so that curing will be carried out without interruption during the nights, Sundays and holidays.

Water for curing shall be of the same quality as used for concrete.

**d) Expansion Joints**

Expansion joints in the watertight structures shall always be provided with water-stop for the entire length of joints unless otherwise specified or as specified in the item description. The work shall be carried out in strict accordance with the manufacturer's instructions.

**e) Construction Joints & Keys**

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

If stopping of concreting becomes unavoidable anywhere, properly formed construction joints shall be made along where the work is stopped. These joints shall be either vertical or horizontal, unless shown otherwise on drawings. In case of an inclined or curved member, the joint shall be at right angles to the longitudinal 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 formwork to ensure a horizontal line and if directed shall also be used to form a grooved joint. For tank walls and similar work joints shall be formed as per IS 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 joint shall be in accordance with the following.

• **Column Joint**

जयवंत राव  
JAYWANT RAO

मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)

महागाव डॉक शिपबिल्डर्स लिमिटेड  
MAHAGON DOCK SHIPBUILDERS LIMITED

In a column, the joints 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 columns, piers or walls, before depositing in beams, girders or slabs supported thereon.

• **Beam & Slab Joint**

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 on drawings. 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 unavoidably at right angles to the principal reinforcement, the joint shall be vertical and at the middle of the span.

• **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 water tightness.

Where the work has to be resumed on a surface which has hardened, any skin or laitance shall be removed and the surface roughened by hammering with an approved power-operated "bush" hammer followed by wire brushing to remove all loose practices. When using this procedure, great care shall be taken to avoid disturbing concrete matrix. The surface is then thoroughly wetted. Fresh concrete should thoroughly be vibrated near the construction joint 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 key may be provided. Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces.

Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire on bristle brushes or by using water jets, care being taken to avoid dislodgment of particles of aggregate. The prepared surface should be in a clean saturated surface dry condition when fresh concrete is placed, against it. Fresh concrete shall be thoroughly vibrated near construction joint so that mortar from new concrete flows between large aggregates and develop proper bond with old concrete.

**f) Sampling & Testing of Concrete**

For preliminary tests (initial trial mix), test specimen shall be prepared with at least two different water / cement ratio for each class of concrete consistent with the workability required for the nature of the work. The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually employed in the works. All the cubes shall be made, cured and tested in accordance with IS : 516

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 Engineer-In-Charge's request (all must be in serviceable conditions) -

|                                                                                                                |       |
|----------------------------------------------------------------------------------------------------------------|-------|
| Concrete cube-testing machine suitable for 15 cm. cubes of 100 Tonnes capacity with providing calibration ring | 1 No  |
| Cast Iron cube moulds 15 cm. size 18 Nos. (minimum)                                                            | 18 No |
| Slump cone complete with temping rod                                                                           | 1 Set |
| Laboratory balance to weight upto 5 Kg. with sensitivity of 10 gm                                              | 1 No  |
| IS sieves for coarse & fine aggregates                                                                         | 1 Set |
| A set of measuring cylinder from 5 ltr. to 0.1 ltr.                                                            | 1 Set |
| Laboratory balance of 2 Kg. capacity with sensitivity of 1 gm                                                  | 1 No  |

**Note:** Arrangement shall be made by Contractor to have the cubes tested in an approved laboratory in lieu of a testing machine at site at his expense, with the prior consent of the Engineer-In-Charge.

JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZGAON DOCK SHIPBUILDERS LIMITED

Three test specimens unless otherwise specified shall be made from each sample for testing at 28 days. Additional samples shall be taken for determining the strength of concrete at 7 days or at the time of striking the formwork, or to determine the duration of curing or to check the testing error. Additional samples shall also be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS 516.

For works test, samples from fresh concrete shall be taken as per IS 1199 and cubes shall be made, cured and tested in accordance with IS 516 unless specified or instructed otherwise by the Engineer-In-Charge. Minimum frequency for sampling of concrete of each grade shall be in accordance with the following:

**TABLE 10**

| Quality of concrete in the work m <sup>3</sup> | Number of samples                                                                  |
|------------------------------------------------|------------------------------------------------------------------------------------|
| 1 - 5                                          | 1                                                                                  |
| 6 - 15                                         | 2                                                                                  |
| 16 - 30                                        | 3                                                                                  |
| 31 - 50                                        | 4                                                                                  |
| 51 and above                                   | 4 plus one additional sample for each additional 50 m <sup>3</sup> as part thereof |

**Note:** At-least one sample shall be taken from each shift when concrete is produced at continuous production unit, such as ready-mixed concrete plant, frequency of sampling shall be subject to the approval of Engineer-In-Charge.

The acceptance criteria of concrete tests shall be as per Clause 16.1, 16.2, 16.3, 16.4, 16.5 & 16.6 of IS 456-2000.

**g) Concrete Below Specified Strength** Should the concrete tests fail to meet the minimum specified strength requirements for the respective grades of concrete, the Engineer-In-Charge may take one of the following decisions –

Instruct the Contractor to carry out such additional tests (e.g. NDT test, core test, load-test etc.) and/or remedial measures to ensure the soundness of the structure at the Contractor's expense.

The Engineer-In-Charge may accept the work provided it meets the relevant acceptance criteria as stipulated in IS 456-2000. Any decision to accept the work shall be entirely at the discretion of the Engineer-In-Charge who may make a reduction in the rate of the appropriate item.

The work will be rejected and any consequential action as needed shall be taken at the Contractor's expenses including cutting out and replacing a part or whole of the work.

**h) Repair & Replacement of unsatisfactory Concrete**

Immediately after the shuttering is removed, the surface of concrete shall be carefully inspected and all defective areas called to the attention of Engineer-In-Charge who may permit patching of the defective areas or also reject the concrete unit either partially or fully shall be attended. Rejected concrete shall be removed and replaced by Contractor at No additional expense. Holes left by 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 2.36 mm. IS sieve after removing loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of the concrete. Concrete surfaces shall be finished as described under the particular items 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 pores shall be filled in. The mortar shall be well worked into the surface with a 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 surface. Surface irregularities shall be removed by grinding.

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (T. S. CIVIL)  
माझगाव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

- **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 instructions of the manufacturer. Only flexible epoxy shall be permitted with certain minimum solid contents as recommended by the Engineer-In-Charge. The use of epoxy if any shall be at no extra cost to the Employer.

- **Method of Repair**

Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows. The holes to be patched shall be roughened and thoroughly soaked with clean water until absorption stops.

Before surface treatment, grouting may have to be done by equal strength shrinkable grout. Unless otherwise specified, 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 prod 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 flat and a smooth finish obtained by wiping with hessian, a steel trowel shall 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 too 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 Engineer-In-Charge, to match the shade of the patch with the original concrete.

- **Curing of patched work**

The patched area shall be covered immediately with an approved water retaining, 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 or sprinkling for not less than 10 days.

- **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 be tightly bonded to the concrete and shall be sound, free from cracks after the fillings have been cured and dried.

**i) Finishing**

This specification is intended to cover the treatment of concrete surfaces of all structures. Areas requiring special finish not covered by this specification shall be clearly indicated on the drawings and special specifications, if any shall be furnished by the contractor for approval.

**Finish for Formed Surfaces**

The type of finish for formed concrete surfaces shall be as follows, unless otherwise specified.

For surface 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 waterproofing material, 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 cleanup of loose or adhering debris.

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (सिविल)  
CHIEF MANAGER (TS-CIVIL)  
महाराष्ट्र डॉक शिपबिल्डर्स लिमिटेड  
MAHARASHTRA DOCK SHIPBUILDERS LIMITED

Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless the drawing specifies a horizontal surface or shows the slope required, the tops of narrow surface such as stair treads, walls, curbs and parapets shall be sloped across the width approximately 1 in 30. Broader surface 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 smoothing screened and levelled to produce even surfaces. Surface irregularities shall not exceed 6 mm. Surfaces which will not be covered by backfill, concrete or tiles toppings such as outside decks, floors of galleries and sumps, parapets, gutters, sidewalks, floors and slabs, shall be consolidated, screened 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 screened surface has attained the 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 the Engineer-In-Charge.

- **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 a smooth finish.

A smooth finish shall be obtained with the 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 by grinding etc. and all blemishes, projections etc. removed leaving the surfaces reasonably smooth and unmarred.

- **Integral cement concrete finish**

When specified on the drawings an integral cement concrete finish or specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified on the drawings, as per IS 2571. The surface shall be compacted and then floated with a wood 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.

- **Protection**

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

- **Measurement**

Dimensions shall be measured to a cm except for the thickness of slab which shall be measured correct to 0.50cm. The areas shall be worked out nearest to 0.01 Sq.m.

The cubical contents shall be worked out to nearest 0.01 cubic meter. Reinforced cement concrete shall be classified under different category and measured as categorized in the item description.

No deductions shall be made for-

- Ends of dissimilar material (e.g. joist, beams, post girders, rafters, purlins, corbels, steps etc.),
- volume occupied by water pipes, conduits etc. Nothing extra shall be paid for leaving and finishing such cavities and holes.
- The concrete displaced by the reinforcement, inserts shall not be deducted.
- No deduction shall be made for openings less than 0.10 Sq.m. in area where concrete is measured in Sq.m. and 0.02 Cu.m. where concrete is measured in Cu.m.

The measurement of RCC work between various units shall be regulated as below-

a) Footings (sloped) -

$$\text{Volume} = h / 3 (A_1 + A_2 + \sqrt{A_1 \times A_2})$$

where A1 & A2 are areas at top and bottom respectively and h = perpendicular height of the trapezoidal portion.

b) Slabs -

They shall be measured full on superficial areas in the plane of the slab.

c) Columns -

When in junction with slab, the thickness of slab shall be deducted in computing the column height.

d) Beams -

They shall be measured as clear length between supporting beams and columns. Depth shall be measured clear below slab.

e) Lintels

The length shall be measured including the bearing lengths.

f) Chajja's

Measurement of chajjas shall be inclusive of bearings.

• **Rate**

The rate includes the cost of material and labour involved in all the operations described above except for the cost of centering and shuttering unless specified. Reinforcement shall be measured separately.

Unless otherwise specified the rates of concrete work shall allow for-

- i) Use of metal 12mm and below in size well-graded in thin members or where reinforcement is crowded,
- ii) any shapes and sizes of various members,
- iii) all architectural effects like chases, ledges, moulds, grooves, chamfers etc.
- iv) provision of any openings, pockets, channels, holes, wooden blocks etc
- v) provision of cover blocks (made out of precast cubes in CM of the same strength as that of concrete of the member or equivalent approved material) to maintain the specified cover to reinforcement
- vi) work at all depths and heights and levels and locations
- vii) taking out and testing of cubes as per IS specifications
- viii) For machine mixing and through vibrating.
- ix) The rates for all concrete work shall be for unfinished work only. (It may be noted that all concrete surfaces need not be plastered and all unplastered surfaces are not necessarily form-finished)
- x) Cost towards Design Mix and approval. Brickwork

**06) BRICKWORK:**

Scope of Work: The work covered under this specification pertains to procurement of well burnt clay bricks of class 35 unless otherwise specified and workmanship in building walls of various

JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
श्री लॉक शिपबिल्डर्स लिमिटेड  
SHIPBUILDERS LIMITED

thickness, in strict compliance with the specifications and applicable drawings.

### 6.1 Materials:

Brick shall be well burnt clay bricks of designated class and shall satisfy the strength criteria and shall be got approved by the Engineer-in-Charge before incorporation in the work. The bricks shall be hand moulded or machine moulded and shall be free from nodules of free lime, visible cracks, flaws, warpage and organic matter.

In general, the nominal size of bricks (F.P.S.) shall be 22.9 x 11.4 x 7 cm. (9"x4.5"x2.75"). Permissible tolerance on dimensions shall not be more than (+/-) 8%. The contractor shall get approved the sample and source of bricks from Engineer-in-Charge before procurement on large scale and shall maintain the same for the entire work. The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour.

Bricks for Mumbai / Pune and surrounding areas, unless otherwise specified, shall be as per relevant IS of class designation 35 of size 22.5 x 11.1 x 7 cm. Permissible tolerance on dimensions shall not be more than (+/-) 8%.

Unless otherwise specified, bricks for Eastern Zone works (Kolkata / Bhubneshwar / Shillong etc.) shall be of class designation 75 of size 25 x 12.5 x 7.5 cm. Permissible tolerance on dimensions shall be as per relevant IS.

In case the size of bricks used in the work is found lesser than the specified one but within the permissible tolerance i.e. (-) 8%, the following shall apply:

- i. Extra cement consumed due to more number of joints and due to additional thickness of plaster than the specified in the tender to match with adjoining columns and beams, shall be borne by the contractor without any extra cost to the department.
- ii. If the plastering to be done is more than the specified thickness to maintain the plaster surface to perfect line, level and plumb with adjoining columns, beams, walls etc., the contractor shall be responsible to provide more thickness of plaster at his own cost and nothing extra will be paid on this account.

In case the size of bricks used in the work is found more than the permissible, the contractor shall chip out the exposed edges of bricks upto the required level of wall to receive specified thickness of plaster.

Bricks shall generally conform to I.S. 1077-1992. In any case minimum crushing strength shall not be less than 35 kg/cm<sup>2</sup> and water absorption shall not be more than 25% by weight. The Engineer-in-Charge shall have the right to reject bricks obtained from any field where the soil has an appreciable quantity of sulphates and chlorides. The specifications for cement, sand and water shall be same as described herein before under cement concrete. Bricks shall be thoroughly soaked in water before using till the bubbles ceases to come up. No half or quarter brick shall be used except as closer. The closer shall be cut to required size and used near the end of the walls. The walls shall be raised truly to plumb. The type of bond to be adopted shall be decided by the Engineer-in-Charge, but vertical joints shall be laid staggered.

### 6.2 Workmanship:

Four courses of brick work with four joints should not exceed by more than 40 mm., the same bricks piled one over the other without mortar.

Brick work shall not be raised more than 10 courses a day unless otherwise approved by the Engineer-in-Charge. The brick work shall be kept wet for at least 7 days. Brick work shall be uniformly raised allround and no part shall be raised more than 1.0 meter above another at any time. All joints shall be thoroughly flushed with mortar of mix as specified in the schedule of

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधी (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगड डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

quantities, at every courses. Care shall be taken to see that the bricks are bedded effectively and all joints completely filled to the full depth.

The joints of brick work to be plastered shall be raked out to a depth not less than 10 mm. as the work proceeds. The surface of brick work shall be cleaned down and watered properly before the mortar sets.

The adhesion between the brick masonry surface and the concrete surface of columns, beams, chajjas, lintels etc. should be proper by ensuring that the concrete surface coming in contact with brick masonry is hacked/ chipped/ keyed, cleaned and cement slurry is applied so that a proper bond is achieved between the two dissimilar materials. It is the responsibility of the contractors to ensure that there will not be any cracks/ fissures anywhere in the brick masonry.

In case the cracks appear subsequently in those areas, they should be made good by cement grouting or epoxy putty grouting/ poly sulphide compound grouting or as per standard modern specifications/ methods with the prior approval of the Engineer-in-Charge, at the cost of the contractor.

All the courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Specified mortar of good and approved quality shall be used. Lime shall not be used where reinforcement is provided in brick work. The mortar should completely cover the bed and sides of the bricks. Proper care should be taken to obtain uniform mortar joint throughout the construction. the walls should be raised uniformly in proper, approved bond. In construction of the wall, first of all two end corners are carefully laid to line and level and then in between portion is built, with a cord stretching along the headers or stretchers held in position at the ends. This helps in keeping the alignment of the courses and maintaining them in level. Similarly, all other courses are built. Care shall be taken to keep the perpend properly aligned within following maximum permissible tolerances:

- a. Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.
- b. Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5mm.
- c. Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.
- d. Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.
- e. A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1-meter rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

No brick work shall be carried on during frosty weather except with the written permission of the Engineer-in-Charge, who will give special directions as to the manner in which the work is to be performed. All brick work laid during the day, shall, in seasons liable to frost, be properly covered up at night as directed by the Engineer-in-charge. Should any brick work be damaged by frost, the brick work shall, at the discretion of the Engineer-in-Charge, be pulled down and made good, at the cost of the contractor. Concrete surfaces of columns, beams, lintels, chajjas etc. coming in contact with masonry work shall be include wire brushed and shall include cleaning brickwork covered with fungus or deleterious materials.

Brick work shall be well watered/ cured throughout the day for at least a week from the date of building and the work shall be protected from sun and rain.

### 6.3 Half Brick Work:

Materials and workmanship for a half brick or brick on edge partition wall shall be as specified above. The wall shall be stiffened by R.C.C. stiffeners of size 115 mm. wide x 80 mm. thickness to the full length of wall and shall be provided with 2 Nos. 6 mm. diameter M.S. bars or as specified in the schedule as bottom reinforcement (only the M.S. reinforcement will be paid separately under

relevant item). These bars shall be securely anchored at their end where the partition end. The free ends of the reinforcement shall be keyed into the mortar/P.C.C bed block of the main brick work to which the half brick work is joined. Overlaps in reinforcement, if any, shall not be less than 30 cm.

The rates for brick work shall include the cost of the following:

- i. Providing and fixing necessary single or double scaffolding and removing the same after the work is completed.
- ii. Form work for stiffeners concrete as required.
- iii. Watering, curing, lifting of materials to any height.
- iv. Raking out of joints to receive plaster.
- v. Forming slab sittings, cutting or leaving holes for lugs of windows, doors, sills, switch boxes etc.
- vi. Making good all holes, chases, etc. to any depth due to conduit pipes, holdfasts, bolts, switch & plug boxes etc.
- vii. Bedding and pointing precast lintels, sills etc. in or on walls. For the purpose of measurements, the thickness of one brick wall and over shall be taken in terms of multiples of half brick.

#### 6.3.1 Sampling and tests:

Samples of bricks shall be subjected to the following **mandatory tests**:

- a) Dimensional tolerance      b) Water absorption      c) Efflorescence      d) Compressive strength

Note: 1. Cost of above tests shall be borne by the contractor.

2. Frequency of test shall be as per relevant IS specifications.

#### 6.3.2 Mode of measurement:

- a) For Brick Work Measured in Cubic Meters:

The contract rate shall be for a unit of one Cubic meter of brick masonry as actually done. 230 mm. thick (or as specified in schedule) brick walls shall be taken as one brick thick.

All openings in brick work for doors, windows and ventilators shall be deducted to get the net quantity of actual brick work done.

Openings or chases required for P.H. or electrical inserts less than 0.1 sqm. and bearing of precast concrete members shall not be deducted.

No extra payment shall be made for any extra work involved in making the above openings or placements.

#### • For brick work measured in Square metre:

Half brick thick masonry walls shall be measured in Sqm. All openings in brick work for doors and windows and ventilators shall be deducted to get the net quantity of actual work done. Openings or chases required for P.H. or Electric inserts less than 0.1 Sqm. and bearing of precast concrete members shall not be deducted. No extra payment shall be made for extra work involved in making the above openings or placements.

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Stones shall be the best available local stone from approved quarry. They shall be tough, hard, dense, sound and durable, free from cracks, veins, crystals, cavities and other flaws and defects and shall conform to IS 1567 (Part-I). They shall not absorb water more than 5% of their dry weight when immersed in water and tested as per IS 1124 and shall have uniform colour and texture.

When used for soling, stones shall be flat bedded and the smallest size shall be equal to the specified thickness of soling with length and breadth generally not exceeding twice the thickness.

Rubble shall be broken or crushed to pieces to pass through the square mesh of about 65 mm. and all pieces shall be retained on a square mesh of about 10 mm. Not more than 20% of any sample shall exceed 75 mm. in its greatest dimensions. The metal shall roughly be cubical in shape and more or less of uniform size with sharp edges for proper interlocking. Rounded, flaky thin and elongated material shall not be acceptable.

The item to includes all labour , materials, tools, scaffolding unless specified etc. necessary to complete the works as per drawing or as directed by the Engineer-In-Charge. Rubble is placed vertical with broad based at bottom. The gaps shall be filled with smaller stones and compacted properly.

### 7.2 Hard core soling (trap rubble stone soling :

The hard core shall consist of layers of uniform thickness of trap stone rubble (of size 150 mm to 230 mm) or any other approved stone carefully set as close as possible on ground properly formed for the purpose. The packing shall consist of large stones. The interstices between the rubble stones shall be filled up with stone chips, spalls, and oversized metal removing the projection of the upper part of the packing so as not to loosen the hard core soling. Also spreading approved hard murrum or good soil collected/stacked during excavation etc., complete, the hard-core soling should be thoroughly rammed, watered, settled to place and made compact. Proper Compaction to be done by vibratory roller of 8 to 10Tonn capacity so that no settlement occurs in future.

Steel reinforcement shall be of Thermo Mechanically Treated (TMT) bar confirming to IS 1786 (latest edition).

The Contractor shall be responsible for preparing, checking all bar bending schedules against the drawing and obtain approval from the Engineer before cutting and bending and prior to fixing of steel. The Contractor shall remove from site, at his own risk and cost, any steel bar fixed in position, without obtaining prior approval of bar bending schedule from the Engineer.

Reinforcement shall be to the size and shape as shown in drawings and bent cold, correctly and accurately in accordance with IS: 2502 "Code of Practice for Bending and Fixing Bars for Concrete Reinforcement". Hooks, L-bends, ties, binding wires & any other subsidiary reinforcement, which are not shown in its correct position shall be provided by the contractor as per instructions of the Engineer. As far as possible laps in bars shall be avoided. Any laps and chairs provided by the contractor other than authorized as per approved bar bending schedule shall be considered to have been provided by the contractor for his own convenience and shall not be measured and paid.

Preferably, bars of full length shall be used. Lap of bars, where necessary, shall be done in accordance with the drawings or as directed by the Engineer and as specified in IS:456. Wherever facility is available, or there is any requirement, welding of bars may be adopted to in lieu of overlap.

JAYWANT RAO  
मुख्य अधिकारी (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
एच.ए.ए. डॉक शिपबिल्डर्स लिमिटेड  
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The location and type of welding shall be as approved by the Engineer and as shall be done in accordance with IS:2751.

The lapping of bars shall be staggered for different bars and located at points where neither shear nor bending moment is maximum. Hooks, etc. shall be provided as per Indian Standard Practice and as shown in the drawings.

#### **8.4 Chairs:**

The Contractor shall provide necessary steel chairs, etc. or other subsidiary reinforcement which are not shown on the drawings but may be necessary to keep the reinforcement firmly in its correct position as per the instructions of the Engineer. Hooks, L-bends and laps in bars as per technical requirements shall be provided by the Contractor as shown in the drawing and as instructed by the Engineer.

#### **8.5 Placing in Position:**

Reinforcement bars shall be placed in position as shown in the drawings. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.90 mm (20 SWG) thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during the deposition of concrete. The concrete cover shall not be less than that specified in the drawings. The bars shall be bend and fixed in accordance with the procedure specified in IS:2502.

Tack welding shall also be permitted in lieu of binding with steel wire if approved by the Engineer. The bars shall be kept in position by the following methods.

In case of beam and slab construction, precast cover blocks in cement mortar 1:2 (1 cement: 2 coarse sand), 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.

In case of beams with more than one layer of reinforcement at top or bottom or slabs the vertical distance between the horizontal bars shall be maintained by introducing spacers or support bars of steel at 1.0 meter or at shorter spacing to avoid sagging.

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 cement mortar (1:2) suitably tied to the reinforcement.

In case of other R.C.C. structure such as arches, domes, etc. cover blocks spacers & templates shall be used as directed by the Engineer.

#### **8.6 Storage of Steel Reinforcement:**

it shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Steel reinforcement, shall be stored clear of the ground, on rack or otherwise supported, covered in bundles indicating the type, number, size, length, diameter and date of delivery to the site of the bars and fabric reinforcement as per IS: 456 and as directed by the Engineer.

#### **8.7 Approval of Reinforcement:**

The Contractor must obtain the approval of the Engineer to the reinforcement fixed in position, before concrete is deposited on the shutters.

#### **8.9 Structural Work in built-up section (Welded/ bolted)**

Although Broad Specifications for Structural Steel Works are as indicated below, the entire work shall be executed strictly in keeping with the working methodology, sequence of operations, safety and security etc. as approved by the Engineer-In-Charge, in best workmanship in conformity with relevant IS codes and the specifications of this tender document.

The Tenderer shall submit his own fabrication / erection methodology comprising sequence of operations to suit the works requirement such as -

- Material movement / storage of material
- Fabrication scheme considering space constraints
- Scheme for erection to be done at about 30 mtr. height for trusses
- Retractable Roof work
- Sliding Motorized Doors work
- Structural steel work of Blasting Chamber.

जयवंत राव  
JAYWANT RAO

मुख्य अभियंता (त. से. सिविल)  
CHIEF ENGINEER (T. SE. CIVIL)

माझगॉन डॉक शिपयार्ड लिमिटेड  
MAZAGON DOCK SHIPYARD LIMITED

- Necessary Safety precautions as per prevailing rules.
- Security formalities to be maintained being a MDL area.

### 8.10 General

In addition to the requirements contained in this Specification, all materials shall conform to the latest edition of the relevant Indian Standard or its equivalent standard approved by the Engineer-In-Charge and shall, if required, be tested as prescribed therein.

In the event of conflict between this Specification and recognised standards, then the requirement of this Specification shall govern.

The work shall be carried out by competent personnel skilled in their various trades. All work shall be of the highest quality and the work shall be the subject of inspection and approval of the Engineer-In-Charge and the Employer.

All material shall be obtained from an approved supplier and manufacturer's appropriate test certificates shall be available upon request by the Engineer-In-Charge or the Employer.

All Steelwork shall be straightened or curved as necessary by pressure and not by hammering.

When bolt heads or nuts bear upon bevelled surfaces they shall be provided with square tapered washers to afford seating for the nut square with the axis of the bolt.

All nuts and bolts specified on the Drawings shall be to the required size with correct threaded length, and be supplied with matching nuts and washers also of the same material, except where electrolytic action is to be avoided.

Where small parts such as bolts and nuts etc. are to be sherardised, they shall be treated to receive a coating of finished thickness not less than 30 microns.

Where bolts, nuts and washers etc. are to be hot dip galvanised, they shall be treated to receive a finished thickness of zinc coating of not less than 80 microns' thickness.

The Contractor shall give due notice to the Engineer-In-Charge in advance of the materials or workmanship getting ready for inspection.

The Engineer-In-Charge shall have free access at all reasonable times to those parts of the contractor's work which are concerned with the fabrication of the steel work and those portions of the site where assembly or erection is being carried out. The contractor shall give all reasonable assistance required in connection with the inspection and testing of the work.

No part of the work shall be treated as approved unless so informed by the Engineer-In-Charge in writing. However, approval of any material fabricated at shop / field shall not invalidate final rejection at site by the Engineer-In-Charge if it fails to be in proper condition or has fabrication inaccuracies, which prevents proper assembly. Similarly, any approval of the fabrication and / or erection by the Engineer-In-Charge shall not relieve the Contractor of his responsibility for furnishing material and / or workmanship conforming to the requirements of the specifications.

All sections shall be free from surface defects such as pitting, cracks, laminations, twists, bends etc. The use of defective sections shall not be permitted and all such rejected material shall be immediately removed away from the store / site at contractor's cost.

All sections shall be marked for identifications and each lot shall be accompanied by manufacturers quality certificate, chemical analysis and mechanical characteristics as specified in relevant IS Codes.

Each lot of electrodes, bolts, nuts etc. shall be accompanied by manufacturer's quality test certificate conforming to relevant IS codes.

Materials at the shops shall be kept clean and protected from weather.

All members likely to collect rain water shall have drain holes.

जयवंत राय  
JAYWANT RAY  
मुख्य अभ्यंक (त. से. सिविल)  
CHIEF ENGINEER (TS-CIVIL)  
जयवंत राय लिमिटेड  
JAYWANT RAY LIMITED

Not more than one shop shall be provided to make the full length of a member.

All bolts, nuts, washers, rivets, electrodes, screws, etc. shall be supplied 10% in excess of the requirement in each category and size.

#### 8.11 Materials -

Unless specified otherwise various materials shall conform to the following IS Codes and Standards.

- Structural steel ( Standard quality) : IS:226
- Rolled steel sections : IS: 808
- Steel tubes for structural purpose : IS: 1161
- Structural steel (for walkways, ladder, hand rails) : IS: 1977
- Welded Electrodes : IS: 811
- Threaded fasteners : IS 1367

#### 8.12 Supply:

Supply of structural steel and all required material for the works shall be arranged by the Contractor.

#### 8.13 Receipts and storing of materials

All steel shall be carefully off-loaded and stacked on timber or concrete supports suitably spaced on a firm level surface, and of sufficient height to keep steel clear of the ground and water. The steel shall be stored separately, by section size or thickness.

All sections shall be checked, sorted out and arranged by grade and quality in the store as per instructions of the Engineer-In-Charge.

All bolts including nuts and washers shall be thoroughly checked, sorted out and arranged diameter wise by grade and quality in the store.

All materials shall be kept protected from corrosion. Storing shall be generally in accordance with IS: 4082.

Welding electrodes and welding wires if used shall be stored separately in their original bundles or cartons, in a dry place adequately protected from weather and other effects as per IS :9595 and as per instructions given by Engineer-In-Charge. Electrodes shall be kept dry.

#### 8.14 Shop Drawings

If instructed by Engineer – In – Charge, the Contractor shall prepare all the fabrication and erection drawings for the structural steel work. These shall be prepared on the basis of the Engineer's design drawings 'released for preparation of shop drawings or approved for construction (AFC) drawings and shall be used for further work on the written approval to these drawings by the Engineer-In-Charge to the Contractor. Such approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details. Furthermore, any approval shall not relieve the Contractor from the responsibility for correctness of engineering, design of connections, workmanship, fit of parts, details, materials, errors or omissions of any and all work shown thereon.

The Contractor should check for erection clearance and ensure that detailing of connections is carefully planned to obtain ease in erection of structures, including field welded connections and bolting. Particular care is required when detailing joints with the use of high strength friction grip bolts as this involves clearances for use of sockets with torque wrench.

The contractor shall submit design calculations for substitution, if any and for the connection details proposed by him.

The fabrication drawings shall be revised by Contractor to reflect all revisions in design drawings as and when such revisions are made by the Engineer-In-Charge. The revised fabrication drawings shall be submitted to the Engineer-In-Charge for approval. Only approved and marked for construction drawings with appropriate revisions marking drawings shall be used for carrying out the fabrication work. Unchecked, unsigned and drawings without any stamp of (AFC) shall not be used for the purpose of proceeding with the work. If it is found that the contractor has not adhered

जयवंत राव  
CHIEF MANAGER (S-CIVIL)  
महाराष्ट्र राज्य सरकार  
महाराष्ट्र राज्य सरकार  
महाराष्ट्र राज्य सरकार

to these stipulations, the fabrication work shall be liable for rejection.

The details regarding the reproducible, number of prints to be furnished etc. shall be as per the tender provisions.

### **8.15 Laying Out**

As shown on drawings or as directed by the Engineer-In-Charge.

### **8.16 Fabrication**

#### **Standard**

All fabrication shall be done strictly as per the (AFC) drawings with latest revision in accordance with IS: 800 (Code of Practice for use of Structural Steel in general Building Construction) and IS: 1915 (Code of Practice for Steel Bridges) and also in accordance with IS:9595 and other relevant IS Codes and ISI Hand book SP-6 (1), subject to approval of the Engineer-In-Charge.

No holes or notches shall be made in the steel work other than those shown on the drawings without approval of the Engineer-In-Charge. Similar approval must be obtained prior to the enlargement of any hole.

The butting end of members shall be faced in a milling or ending machine after the members have been completely fabricated so as to butt in close contact over the entire surface.

### **8.17 Templates**

Extensive use of templates shall be made. The templates shall be steel bushed where considered necessary by the Engineer-In-Charge. In case actual members are used as templates for drilling similar pieces it will be at the discretion of the Engineer-In-Charge to decide whether such pieces are fit to be incorporated in the finished structure. The Contractor shall arrange for corresponding parts of each unit manufactured from the same drawings, to be interchangeable, as far as economic manufacturing conditions permit and shall advise the Engineer-In-Charge of the precise arrangements made in this respect.

### **8.18 Connections**

Shop/field connections shall be effected either by welding or by high strength friction grip bolts as specified. High tensile bolts shall be used for field connections and standard MS bolts conforming to IS: 1363 may be used for field connections for light members such as purlins, girths, staircase stringers and landing beams or for other connections also, if permitted by the Engineer-In-Charge.

Where necessary, tapered washers or flat washers or spring washers shall be used with bolts. In case of high strength friction grip bolts, hardened washers shall be used under the nuts or the heads depending upon whether the nuts or the heads are turned to tighten the bolts. The length of the bolts shall be such that at least one thread of the bolt projections beyond the nut except in case of high strength friction grip bolts where this projection shall be at least three times the thread pitch.

All connections and splices shall be designed for full strength of members or loads indicated unless otherwise approved.

All connections shall be precisely shown on the drawings and shall be strong enough to develop the full strength of the member and shall be subject to the approval of the Engineer-In-Charge.

All field connections shall be made with black steel bolts. All surfaces of steel and bolts shall be entirely free of paint, lacquer or other protective substance. All shop connections shall be welded as approved by the Engineer-In-Charge. As far as possible, it should be ensured to have down hand welding for all shop joints.

In all cases where bearing is critical, the unthreaded bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if no longer grip bolt has to be used for this purpose. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice. Unless otherwise noted, beam end connections shall be designed for 60% of the shear capacity of the beam section plus additional axial forces, if shown on the Engineer's design drawings.

JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF ENGINEER (TS-CIVIL)  
सायगांव डॉक शिपबिल्डर्स लिमिटेड  
SAIGANG DOCK SHIPBUILDERS LIMITED

Materials at the shops shall be kept clean and protected from weather.

Not more than one shop splice shall be provided to make the full length of a member.

All bolts, nuts, washers, rivets, electrodes, screws etc. shall be supplied 10% in excess of the requirement in each category and size.

### 8.19 Straightening

All material shall be straight and if necessary shall be straightened and/or flattened by pressure, unless required to be of curvilinear form and shall be free from twists. Straightening will be done by methods that will not injure the materials. Long plates shall be straightened by passing through a mangle or levelling rolls and structural shapes by hydraulic or mechanical bar straightening machines. Heating of rolled sections and plates for purposes of straightening shall not be permitted. Limited applications of heat with a gas-torch shall be permitted on approval of Engineer-In-Charge in writing. Sharp kinks or bends shall be the cause for rejection.

### 8.20 Rolling and Forming

Plates for circular structural members shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

### 8.21 Cutting

Rolled sections shall be sawed or milled to length. Small plate pieces like gussets may be sheared or cropped to size. Sawing, shearing and cropping shall be clean, reasonably square and free from any distortion. All re-entrant corners shall be shaped notch-free to a radius of at least 12mm.

Gas-cutting shall preferably be done by a mechanically guided torch. Hand flame cutting may, however, be permitted where the part being cut shall not be subjected to substantial tensile stresses and only when approved by the Engineer-In-Charge. Gas-cut edges shall be free of gouges. Any gauges that remain after cutting shall be removed by grinding.

Gas-cutting shall normally only be permitted for mild steel though gas cutting of high tensile steel may also be permitted, provided special care is taken to leave sufficient metal to be removed by machining so that all metal that has been hardened by flame is removed except where the material is subsequently joined by welding, no loading shall be transmitted into metal through a gas cut surface.

Edge planing of sheared, cropped or gas cut edges is not intended unless the edges warrant such planing or is specifically called for by the Engineer-In-Charge.

Punching shall not be resorted to unless previously approved by the Engineer-In-Charge. Where permitted in secondary members such as purlins, side sheeting runners, packing plates and lacing bars, holes may be punched full size through material not over 12 mm thick except where required for close tolerance bolts or barrel bolts. Holes must be clean cut, without burr or ragged edges. Holes through more than one thickness of material (e.g. compound stanchions and girder flanges) shall be drilled after assembling and tightly clamping or bolting the members together. The various thickness shall then be separated, burrs formed by the drill removed and the members reassembled.

Sub-punching may be permitted before assembly provided the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not exceed 16 mm.

Holes for all other connections shall be drilled accurately and burrs removed effectively.

Punching shall not be adopted for dynamically loaded structure or its part.

Holes for bolts shall not be more than 1.5 mm larger in diameter than the nominal diameter of the bolt. Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and remade to a diameter equal to the nominal diameter of the shank or barrel. This shall be subject to tolerance specified in IS 919. Parts to be connected with close tolerance or barrel bolts shall be firmly held together by tacking bolts or clamps and the holes drilled through one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not possible the parts shall be drilled

जयवंत राव  
CHIEF MANAGER (TS-CIVIL)

मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)

माडगांव डॉक शिपयार्ड लिमिटेड

and reamed separately.

Where reamed members are taken apart for stripping or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted.

Gas-cutting of holes shall be strictly prohibited. Poor matching, over drilling and ovality in holes shall be a cause for rejection.

When batch-drilling is carried out in the operation through two or more separable parts, these parts shall be separated after drilling and the burrs removed.

### 8.22 Machining

Column splices and butt joints of struts and compression members depending on contact for load transmission shall be accurately machined and close butted over the whole section with a tolerance not exceeding 0.2mm locally at any place.

In column caps and bases, the ends of shafts together with attached gussets, angles, channels, etc. after welding together shall be accurately machined so that the parts connected, butt over the entire surfaces of contract. In no case the parts connected butt less than 90% of the surface of contract. Care shall be taken that these connecting angles or channels are fixed with such accuracy that they are not reduced unduly in thickness in machining.

Ends of all bearing stiffeners shall be machined or ground to fit tightly at both top and bottom.

Where sufficient gussets or welding are provided to transmit the entire loading, the column ends need not be machined.

### 8.23 Splicing

Splicing of built up/compound/latticed sections shall be done in such a fashion that each component of the section is joined in a staggered manner.

Where no butt weld is used for splicing, the meeting ends of two pieces of joist/channel/built up section shall be ground flush for bearing on each other and suitable flange and web splice plates shall be designed and provided for the full strength of the flange/web of the section and welds designed accordingly.

Where full strength butt weld is used for splicing (after proper edge preparation of the web and flange plates) of members fabricated out of joist/channel/built up section, additional flange and web plates shall be provided, over and above the full strength butt welds, to have 40 % strength of the flange and web.

Where a cover plate is used over a joist/channel section the splicing of the cover plate and channel/joist sections shall be staggered by minimum 500 mm. Extra splice plate shall be used for the cover plate and joist/channel section as per provision of relevant IS Codes.

## 2.7 Welding

Welding shall generally be done by electric arc process and shall conform to the respective IS Codes and Standards as listed above.

### 8.25 Welding Procedures

The Contractor shall make necessary arrangement for providing sufficient number of welding sets of required capacity, all consumables, cutting & grinding equipment with requisite accessories/auxiliaries, equipment etc.

The Contractor shall submit the welding procedure for each type of joint for the approval of the Engineer-In-Charge and shall ensure that copies of the same are at all times, readily available to the welders employed on the Works. The procedure shall include all details with reference to provisions of IS 823 and IS 4353. It should be specifically ensured that filter glass used in welding helmets shall be of internationally accepted quality and make.

JAYWANT RAO  
मुख्य प्रबंधक (स. से. सिविल)  
MANAGER (TS-CIVIL)  
एन. एस. लिमिटेड  
N. S. LIMITED

The welding procedure shall be such as to ensure that the weld metal can be fully and satisfactorily deposited throughout the length and thickness of all joints and that distortion and shrinkage stresses are reduced to a minimum and that the welds meet the requirements of quality specified.

Welding plant and accessories shall have capacity adequate for the welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality. The Contractor shall maintain all welding plants in good working order. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided.

Welding of various materials under this specification shall be carried out using one or more of the following processes –

- Manual metal arc welding process (MMAW)
- Submerged arc welding process (SAW)

Submerged arc, automatic or semi-automatic welding shall be generally be employed. Only where it is not practicable to use submerged arc welding, manual arc welding maybe resorted to.

Voltage and current (and polarity if direct current is used) shall be set according to the recommendations of the manufacturer of the electrode being used and suitability to thickness of material, joint form etc. Adequate means of measuring the current shall be available either as part of the welding plant or by the provision of a portable ammeter. In checking the welding current, a tolerance of 10% or 30 Amperes from the specified value whichever is less shall be permitted.

The welding procedure adopted and the consumables used shall be specifically approved by Engineer-In-Charge. Welding electrodes used shall conform to IS : 814 (latest) and shall be supplied by manufacturer approved by the Engineer-In-Charge. Any electrode which has part of its flux coating broken or is damaged shall be rejected.

No welding shall be done on base metal at a temperature below 5 Deg. C. Base metal shall be preheated as required to the temperature given in the table below prior to tack welding or welding. When base metal not otherwise required to be preheated is at a temperature below 0 deg. C, it shall be preheated to at least 20 Deg. C prior to tack welding or welding. Preheating shall be done of the surface of the base metal on which the weld metal is being deposited within 75 mm on each side of the point of welding to the specified preheated temperature and this temperature shall be maintained as minimum inter-pass temperature while welding is in progress. The temperature shall be measured on the face opposite to that heated. However, there is access to only one face, the heat source shall be removed to allow for temperature equalization (one minute for each 25 mm of plate thickness) before measuring the temperature.

**TABLE - 14**

| Thickness of thickest part at point of welding | Minimum preheat and inter-pass temperature |                                       |               |                             |
|------------------------------------------------|--------------------------------------------|---------------------------------------|---------------|-----------------------------|
|                                                | Other than low hydrogen welding electrodes | Low hydrogen welding electrodes       |               |                             |
|                                                |                                            | IS:226 steel or IS:2062 steel         | IS: 961 steel | IS:226 steel, IS 2062 steel |
| Upto 20 mm.                                    | None                                       | Welding with this process not allowed | None          | 10 Deg. C                   |
| Over 20 mm. to 40 mm. incl.                    | 65 Deg. C                                  |                                       | 10 Deg. C     | 65 Deg. C                   |
| Over 40 mm. to 63 mm. incl.                    | 110 Deg. C                                 |                                       | 95 Deg. C     | 110 Deg. C                  |
| Over 63 mm                                     | 150 Deg. C                                 |                                       | 110 Deg. C    | 65 Deg. C                   |

जयवंत राव  
JAYAWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
महाराष्ट्र लिमिटेड  
MAZAGON DOCK BUILDERS LIMITED

Welding shall be done with the structural in flat position in a down hand manner wherever possible. Adequate care shall be taken to maintain the current and polarity for the type of electrode used and nature of work.

No welding shall be done when the surface of the members is wet nor during periods of high wind unless the welding operation and the work are properly protected.

Before commencing fabrication of member or structure in which welding is likely to result in distortion and/or locked up stresses, a complete programme of fabrication, assembly and welding shall be made and submitted to the Engineer-In-Charge for approval. Such a programme shall include besides other appropriate details, full particulars in regard to the following:

- a) Proposed pre bending in components such as flanges and presetting of joints to offset expected distortion.
- b) Make up of sub-assemblies proposed to be welded before incorporation in the final assembly.
- c) Proposed joint forms, classification of wire and flux or covered electrodes, welding process including fitting and welding sequence with directions in which freedom of movement is to be allowed.
- d) Proposed number, spacing and type of strong backs and details of jigs and fixtures for maintaining proper fit up and alignment during welding.
- e) Any other special features like assembling similar members back to back or stress relief.

#### **8.26 Sequencing of welding**

- a) The contractor shall choose the welding sequence after carefully studying each case such as to minimize distortion and shrinkage and submit the same to the Engineer-In-Charge for comments and approval.
- b) As far as practicable, all welds shall be made in sequence that will balance the applied heat of welding while the welding progresses.
- c) The direction of the general progression in welding on a member shall be from points where the parts relatively fixed in position with respect to each other towards points where they have a greater relative freedom of movement.
- d) All splices in each component part of a cover-plated beam or built up member shall be made before the component part is welded to other component parts of the member.
- e) Joints expected to have significant shrinkage shall be welded before joints expected to have lesser shrinkage.
- f) Welding shall be carried continuously to completion with correct number of runs.

#### **Preparation of fusion faces**

Preparation of fusion faces shall be done in accordance with the approved fabrication drawings by shearing, chipping, machining or gas cutting (except that shearing shall not be used for thickness over 8 mm). The faces shall be smooth, uniform and free from irregularities such as fins, tears, laminations etc. as would interfere with the deposition of the specified size of weld to be the cause of defects.

Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint, moisture and any other foreign material, which might affect the quality of weld. Surfaces shall be wire-brushed vigorously or machined/ground, if found necessary by the Engineer-In-Charge.

Welding of joints shall be undertaken only on approval by the Engineer-In-Charge of the alignment, levels etc. of the members to be jointed.

जयवंत राव  
JAYWANT RAO  
(त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
श्री शिवाजी एंजिनिअर्स लिमिटेड  
SHRI SHIVAJI ENGINEERS LIMITED

### 8.27 Gaps for Joints

Parts to be fillet welded shall be brought in as close contact as possible and in no event shall they be separated by more than 1.5 mm. In case of a gap of more than 1.5 mm the size of the fillet weld shall be increased by the amount of the gap. A gap greater than 3 mm. wide shall be packed with MS shims and the weld increased by the amount of the gap.

Abutting parts to be butt welded shall be carefully aligned together within a gap of 3 mm and correct root gap shall be maintained throughout the welding operation.

Gaps shall be set by means of suitable jigs and the steel work held firmly in position by clamps or bolts until the welded joint is sufficiently rigid to be freed of clamps without causing strain or distortion.

Misalignment greater than 25 percent of the thickness of the thinner plate or 3 mm. whichever is smaller shall be corrected and in making the correction the parts shall not be drawn into a slope sharper than 2 Deg. (1 in 27.5)

### Fillet Welds

The minimum leg length of a fillet weld as deposited should not be less than the specified size and the throat thickness as deposited should not be less than that tabulated below –

#### Angle between fusion faces

#### Throat thickness

|            |            |          |
|------------|------------|----------|
| 60 Deg. C  | 90 Deg. C  | 48 mm    |
| 91 Deg. C  | 100 Deg. C | 16.5 mm  |
| 101 Deg. C | 106 Deg. C | 15 mm.   |
| 107 Deg. C | 113 Deg. C | 14 mm    |
| 114 Deg. C | 120 Deg. C | 12.5 mm. |

In no case should a concave weld be deposited without the specific approval of the Engineer-In-Charge unless the leg length is increased from the above specified so that the resultant throat thickness is as great as would have been obtained by the deposition of a flat. Welding sequence should be such as to have minimized shrinkage stresses. After each run of weld, all slag shall be removed and final run shall be protected by clean boiled linseed oil till approved.

### 8.28 Butt Welds

All main butt welds shall be full penetration butt welds, unless otherwise specified with complete fusion of the root edges. The ends of the welds shall have full throat thickness. This shall be obtained on all main welds by use of extension pieces adequately secured on either side of the main plates. Additional metal remaining after the removal of the extension pieces shall be removed by machining or by other approved means and the ends and surfaces of the weld shall be smoothly finished by machining or other approved means. Where the abutting parts are thinner than 20 mm, the extension pieces may be omitted but the ends of butt welds shall then be chipped or gouged out to sound metal and side welded to fill up the ends to the required reinforcement.

### 8.29 Quality of Weld

The weld metal as deposited shall be free from blow holes, cracks, slag inclusions, excessive porosity, cavities and other faults. It shall be properly fused with the parent material without overlapping or serious under-cutting at the toes of the weld. The weld surfaces shall be cleaned of slag or flux and show a uniform and consistent contour and regular appearance.

### 8.30 Faulty Works

In the event of excessive convexity, weld size is to be reduced by removing the excess weld metal. In the event of faulty work, the defective portions shall be cut out and re-welded. Where serious under-cutting occurs, additional weld metal shall be deposited to make good the reduction. In case of members getting distorted due to heat of welding, the members are to be straightened out by mechanical means or by careful applications of limited amount of heat when temperature of the areas affected more than 650 C.

जयवंत राव

CHIEF MANAGER (TS CIVIL)

CHIEF MANAGER (TS CIVIL)

महानगर लोक निर्माण विभाग

### 8.31 Protection

Immediately after dislodging, inspection and approval, all site welds and the surrounding surfaces shall be painted to protect the metal.

### 8.32 Tolerances

The dimensional and weight tolerances for rolled shapes shall be in accordance with IS: 1852 and/or ASTM A6.

No rolled or fabricated member shall deviate from straightness by more than 1/1000 of the axial length or 100 mm whichever is smaller.

The length of members with both ends finished for contact shall have a tolerance of  $\pm 1$  mm.

Members without ends finished for contact bearing shall have a tolerance of  $\pm 1.5$  mm for members upto 10 meters long and a tolerance of  $\pm 3$  mm for members over 10 meters in length.

Lateral deviation between centre line of web plate and centre line of flange plate at contact surface in the case of built up sections shall not exceed 3mm.

The combined warp age and tilt of flanges in welded built up sections shall not exceed 1/200<sup>th</sup> of the flange width or 3 mm whichever is smaller.

The deviation from flatness of welded plate girder web in the length between stiffeners or a length equal to the depth of the girder shall not exceed 1/150<sup>th</sup> of such length.

Deviations from the specified depth of welded girders measured at the centre line of the web shall not exceed  $\pm 3$  mm upto a depth of 1000 mm,  $\pm 5$  mm for depths above 1000mm, upto 2000mm and  $+ 8$ mm and  $- 5$ mm for depths over 2000mm.

### 8.33 Inspection and testing of weld:

The Contractor shall carry out procedure tests in accordance with IS: 7307 to demonstrate by means of a specimen weld of adequate length on steel sample of that to be used that he can make welds with the welding procedure to be used for the work for the complete satisfaction of the Engineer-In-Charge. The test weld shall include weld details from the actual construction and it shall be welded in a manner simulating the most unfavourable instances of fit-up, electrode condition etc. which are anticipated to occur on the particular fabrication. Where material analysis is available, the welding procedure shall be carried out on material with the highest carbon equivalent value.

After welding, but before the relevant tests given in IS: 7307 are carried out, the test weld shall be held as long as possible at room temperature, but in any case not less than 72 hours and shall then be examined for cracking. The examination procedure shall be sufficiently rigorous to be capable of revealing significant defects in both parent metal and weld metal.

After establishing the welding method, the Contractor shall finally submit to the Engineer-In-Charge for his approval the welding procedure specification in standard format given in IS: 9595 before starting the fabrication.

Approval to the welding procedure by the Engineer-In-Charge shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

The Contractor shall satisfy the Engineer-In-Charge that the welders are suitable for the work upon which they shall be employed. For this purpose, welders shall have satisfied the relevant requirements of IS 7318. If the welders shall be working to approved welding procedures, they shall have satisfied the relevant requirements of IS 7310.

Unless specified otherwise, inspection of steel work shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work. Stage inspection during the progress of the work shall be carried out during final assembly and erection at the Site.

JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
श्री. रॉक डिपॉजिटर्स लिमिटेड  
SHRI. ROCK BUILDERS LIMITED

The method of inspection shall be according to IS: 822 and extent of inspection and testing shall be in accordance with the relevant application standard or in the absence of such a standard as specified by the Engineer-In-Charge. Welds shall not be painted or otherwise obscured until they have been inspected, approved and accepted.

The Engineer-In-Charge or his representative shall have access to the Contractor's work at all reasonable times and the Contractor shall provide him with all facilities necessary for inspection during all stages of fabrication and erection with but not limited to the following:

- i) To check the conformity with the relevant standards and suitability to various welding equipments & their performance
- ii) To witness/approve the welding procedure qualification.
- iii) To witness/approve the welder's performance qualification.
- iv) To check whether shop/field welding being executed is in conformity with the relevant specifications and codes of practice.

All welding shall be subject to inspection and tests as specified by the Engineer-In-Charge.

The Engineer-In-Charge may require test plates to be prepared in accordance with IS: 1181 "Qualifying Test for Metal Arc Welding (Engaged in welding structures other than pipes)". At main butt welds, these may be taken from plates cut from extensions of the main plates and fixed as extensions at the butt joints, so that the direction of rolling is parallel to that of the main plates and the welds continuous with the main welds.

The Engineer-In-Charge may require radiographic tests and ultrasonic tests to be carried out to check full strength butt welds at contractor's cost. These shall be in accordance with the recommended U.W. 51 of ASME Code Section VIII. Other non-destructive tests could be as follows -

### 8.33.1 Magnetic Particle Test

This is carried out to examine the root and intermediate passes of weld in accordance with the following as decided by the Engineer-In-Charge -

- ASTM Specification. E-109
- ASTM Specification E-138

If heat treatment is performed, the completed weld shall be examined after the heat treatment. Magnetic particle test shall be carried out using alternating current. Direct current may be used with the permission of the Engineer-In-Charge.

### 8.33.2 Liquid Penetrate Inspection

In the case of welds examined by Liquid Penetrate Inspection, such tests shall be carried out in accordance with ASTM-E-165 or IS: 3658.

The above tests are generally not required to be carried out but if and when required, they shall be paid done as specified at contractor's cost.

### 8.33.3 Radiography Test

#### Ultrasonic Testing

- (a) Testing of welds shall be undertaken by an independent accredited testing authority selected by the Contractor and approved by Engineer-In-Charge. The Contractor shall be responsible for all costs of such testing. All welds shall be tested as specified.
- (b) The Contractor shall inspect each welded joint & they shall be inspected for edge fusion and the possibility of cracking. Testing of welds shall be by ultrasonic examination and they shall be carried out by the Contractor in accordance with standards to the approval of the Engineer-In-Charge. The Engineer-In-Charge shall have the opportunity to witness any or

जयवंत राव

JAYAWANT RAO

मुख्य निर्देशक (न. मे. सिविल)

मुख्य निर्देशक (न. मे. सिविल)

माझगांव डॉक शिपाईलंदर्स मजदूर

all of the tests. The Contractor shall give adequate prior notice before the commencement of any tests. All ultrasonic operators shall be fully qualified, and each weld shall be examined with sufficient probe angles to guarantee full coverage of the joint.

- (c) The Contractor shall produce a test report for each weld joint or weld repair examined, comprising:
- a sketch of all flaws
  - the location and size of each flaw
  - dB level used
  - conclusions as to acceptance or rejection of the flaw with reference to these requirements
- (d) The Engineer-In-Charge along with the Contractor shall make an initial assessment of defects against acceptance criteria. All ultrasonic reports including recommendations shall be reviewed by the Engineer-In-Charge. Acceptance criteria shall be in accordance with the approved standard. The standard on which the slag indication acceptability is to be finally determined and this is to be agreed and confirmed prior to any ultrasonic testing. When positive flaw type interpretations cannot be ascertained in any instance, the flaw shall be considered planar and in need of repair.

### 8.34 Assembly

Steel work shall be temporarily shop-erected completely or as directed by the Engineer-In-Charge, so that the accuracy of fit may be checked before dispatch. Due notice shall be given to the Engineer-In-Charge in all cases when the work is ready for inspection and the assembly shall not be dismantled until it has been inspected and approved by the Engineer-In-Charge. However, such approval shall not relieve the Contractor of his responsibility for carrying out a precise job in a workmanlike manner. The parts shall be assembled with a sufficient number of parallel drifts to bring and keep the components in place. In the case of parts drilled or punched through steel jigs with bushes resulting in similar parts being interchangeable for portions of the steel work, trial assembly shall be carried out to the extent required by IS: 1915.

All steel work, which is bolted together, shall be in perfect contact over the whole surface. All bearing stiffeners shall bear tightly at top and bottom without being drawn or caulked. When two bolted surfaces are to be in permanent contact after assembly, each shall be thoroughly scraped to remove loose scales, dirt, burrs and any foreign matter and cleaned and dried and a coat of yellow zinc chromate or other approved primer paint shall be applied after cleaning and drying. The surfaces shall be brought together while the paint is still wet.

Drilling done during assembly shall not distort the metal or enlarge the holes. Holes that must be enlarged due to miss-matching shall be reamed. Poor matching of holes shall be cause for rejection. Enlarging of holes with gas trench shall not be allowed. Enlargement of holes by gas trench shall be cause for rejection.

### 8.35 Erection

All structural steel work shall be erected in accordance with IS: 800 and IS: 1915.

### 8.36 Detailed Scheme

The Contractor shall furnish a detailed scheme for erection of structural steel work for the approval of the Engineer-In-Charge. Such scheme shall indicate the type, capacity and the quality of equipment that the Contractor proposes to deploy for handling, hoisting and erecting the steel work including staging, temporary bracing, guying etc. The scheme shall also indicate the strength and trade-wise composition of the work force and supervising personnel that the Contractor would deploy on the job.

The scheme shall be accompanied by a layout plan identifying the areas proposed for unloading, main storage, subsidiary storage, assembly and the transportation of equipment and fabricated materials between the storage and work areas. The layout shall clearly indicate the points at which proposed erection begins, the directions in which it is proposed to progress, the deployment of equipments etc. The locations and extent of site offices and stores, labour quarters if any, layout of electrical cables and water pipes from the tap-off points indicated on drawings shall also be indicated in detail on the above layout.

JAYWANT RAO  
(त. से. नि. नि. नि.)  
CHIEF MANAGER (TS-CIVIL)  
"NERS LIMITED

Any modifications to the erection programme directed by Engineer-In-Charge for the reasons of inadequacy of the quality and/or capacity of the erection equipment, temporary bracing, guying etc. or safety of the erection methods or stability of the erected portions of structures or unsuitability of the erection sequence due to interference with the work of other shall be incorporated by the Contractor and the work shall be carried out in accordance with the revised programme. The approval by Engineer-In-Charge shall not relieve Contractor from his responsibility for the safe, sound, accurate and timely erection of structural steel work as required by the Engineer-In-Charge. The Contractor shall be deemed to have visualized all erection problems prior to submission of bid documents for the work and no additional compensation shall be claimed on this account.

The Contractor shall fully mobilize at site prior to the actual operation of erection commences at site. Such mobilization shall include items like establishment of offices, stores, unloading gantry / handling equipments, labour quarters if any, electrical and water connections, compressors, all tools and tackle, rivet guns, welding sets, torque wrenches, spud wrenches, non-inflammable staging as a part of his contract and any other work that may be necessary to start the erection work. The passageways, fences, safety belts, helmets, lights and other fittings to be to the satisfaction of Engineer-In-Charge and to meet the rules of local authorities and for protection of his men and materials. A licensed electrician shall be kept on the job for full period to maintain the Contractor's electrical equipment and connection.

The Contractor shall protect all existing plant structures, piping, conduits, equipment and facilities against any damage during erection. Any damage caused by the Contractor shall be rectified entirely at the Contractor's cost to the satisfaction of Engineer-In-Charge.

When lifting and fitting steel work in position, care shall be taken that the parts thereof are not strained, twisted, bent or damaged in any manner whatsoever. Should any part be strained, twisted, bent or damaged, it shall be reinstated in a manner approved by the Engineer-In-Charge by gentle heating & bending & not by hammering. Any parts that are badly damaged shall be replaced with new materials at the Contractor's expense.

No permanent bolting or welding shall be done until proper alignment has been obtained and approved by the Engineer-In-Charge.

Any errors in the fabrication, which prevent the proper assembling and erection of the parts with moderate amount of reaming, chipping or cutting is likely to render the steel work for rejection unless corrective action, only if permitted by the Engineer-In-Charge, is taken. Any expenditure involved in executing the corrective measures shall be borne by the Contractor.

All erection holes shall be plugged either by weld or bolts, nuts, washers shall be provided as directed by the Engineer-In-Charge, without extra cost.

The Contractor shall be responsible for accurately positioning, levelling and plumbing of all steel work and placing of every part of the structure in accordance with the approved fabrications drawings to the entire satisfaction of Engineer-In-Charge.

Dispatch of materials stacking and handling

Each structural member either knocked down or a single composite each loose item (like splices pack plates etc.) shall have "Mark number" painted on each item before it is dispatched from the SHOP.

The Contractor shall deliver the fabricated steel work to the site as far as possible in the same sequence as that which he wishes to allow for the erection. Dispatches should be scheduled to avoid clustering up of the site.

### 8.37 Transportation

Loading & transportation shall be done in compliance with transportation rules. In case certain parts cannot be transported in the lengths stipulated in the drawings the position and type of additional splice joints shall be got approved by the Engineer-In-Charge.

The bolts required for erection shall be bagged according to size prior to dispatch.

जयवंत राव  
JAYWANT RAO  
उपनिर्देशक (त. से. सिविल)  
CHIEF ENGINEER (T. S. CIVIL)  
माझगांव डॉक शिफारदस्तर्ग सि. ...

The Contractor shall ensure that steel work is not damaged due to careless or haphazard stacking. The steel work shall be stacked at site in such a manner that it shall be free from dirt, oil and other injurious elements and erection marks remain visible. Stacking shall, as far as practicable be done in the sequence of erection but heavy members shall not be stacked on top of light ones. Material shall also not be stacked in the vicinity of excavations for pits, foundations etc. already done or proposed to be done.

Arrangement shall always be made at the time of handling to make sure that damage to steel work is avoided. No dragging of steel shall be permitted.

Scratched or abraded steel shall be given a coat of yellow zinc chromate primer prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged. In the event of damage due to improper stacking and careless handling, the damaged piece will be rejected and shall be replaced by the Contractor at his own expense.

### 8.38 Precautions

All operations connected with welding and cutting equipment shall conform to the safety requirements and Health Provisions in Electric and Gas welding and cutting operations.

### 8.39 Safety & Security during erection

The Contractor is entirely responsible for the safety and stability of the structure during erection.

The Contractor shall comply with IS: 7205 for necessary safety and adhere to safe erection practices and guard against hazardous as well as unsafe working conditions during all stages of erection.

During erection, the steel work shall be securely bolted or otherwise fastened and when necessary temporarily braced/guyed till the completion including those due to the wind, erection equipment and its operation etc. For the purpose of guying, the Contractor shall not use other structure in the vicinity.

No permanent bolting or welding shall be done until proper alignment has been achieved.

Proper access, platform and safety arrangement shall be provided for working and inspection (at no extra cost) whenever required.

### 8.40 Erection Clearance and Tolerances

Unless otherwise specified, the underside of base plates shall be within  $\pm 3$  mm from the elevations shown on the drawing. The lateral deviations of the base plates shall not exceed 5 mm from the theoretical centre line.

### Maximum permissible erection tolerance

#### A) Columns

|   |                                                                                                                                                         |                                                                                                                      |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| 1 | Deviation of column axes at foundation top level with respect to true axes.<br>i) In longitudinal direction<br>ii) In lateral direction                 | $\pm 5$ mm<br>$\pm 5$ mm                                                                                             |
| 2 | Deviation in the level of bearing surface of columns at foundation top with respect to true level                                                       | $\pm 5$ mm                                                                                                           |
| 3 | Out of plumbness (verticality) of column axis from true vertical axis as measured at top<br>i) Upto and including 30 m. height<br>ii) Over 30 m. height | $\pm \frac{H}{1000}$ or $\pm 25$ mm<br>whichever is less<br>$\pm \frac{H}{1200}$ or $\pm 35$ mm<br>whichever is less |

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF ENGINEER (TS-CIVIL)  
महाराष्ट्र डॉक शिपबिल्डर्स लिमिटेड  
MAHARASHTRA DOCK SHIPBUILDERS LIMITED

|   |                                                                                                                                                                             |                                                       |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| 4 | Deviation in straightness in longitudinal & transverse planes of column at any point along the height.                                                                      | $\pm \frac{H}{1000}$ or $\pm 10$ mm whichever is less |
| 5 | Difference in the erection positions of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance. | $\pm 5$ mm                                            |
| 6 | Deviation in any bearing or seating level with respect to true level.                                                                                                       | $\pm 5$ mm                                            |
| 7 | Deviation in difference in bearing levels of a member on adjacent pair of columns both across and along the building.                                                       | $\pm 5$ mm                                            |
|   | <b>Note 1 :</b> Tolerance specified under 3 should be read in conjunction with 4 & 5                                                                                        |                                                       |
|   | <b>Notes 2 :</b> 'H' is the column height in mms                                                                                                                            |                                                       |

## B) Trusses

|   |                                                                                                                                        |                                                                                                   |
|---|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| 1 | Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord.         | $\pm \frac{1}{250}$ of height of truss in mm. at centre of span or $\pm 15$ mm whichever is less. |
| 2 | Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss. | $\pm \frac{1}{1500}$ of span of truss in mm. or $\pm 10$ mm whichever is less.                    |
| 3 | Lateral shift in location of truss from its true vertical position.                                                                    | $\pm 10$ mm                                                                                       |
| 4 | Lateral shift in location of purlin from true position.                                                                                | $\pm 5$ mm                                                                                        |
| 5 | Deviation in difference of bearing levels of truss from the true difference.                                                           | $\pm \frac{1}{1200}$ of span of truss in mm or $\pm 20$ mm whichever is less.                     |

## C) Gantry girders and rails

|   |                                                                                                  |                                                                                       |
|---|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 1 | Shift in the centre line of crane rail with respect to centre line of web of gantry girder.      | $\pm$ (Web thickness of girder(mm) $\pm 2$ mm)                                        |
| 2 | Shift of alignment of crane rail (in plan) with respect to true axis of crane rail at any point. | $\pm 5$ mm                                                                            |
| 3 | Deviation in crane track gauge with respect to true gauge.                                       |                                                                                       |
|   | i) For track gauge upto & including 15 mm                                                        | $\pm 5$ mm                                                                            |
|   | ii) For track gauge more than 15 mm                                                              | $\pm (5+0.25 (S-15))$ subject to maximum $\pm 10$ mm where S in metres is true gauge. |
| 4 | Deviation in the crane rail level at any point from true level.                                  | $\pm 10$ mm                                                                           |
| 5 | Difference in levels between crane track rails (across the bay) at                               |                                                                                       |
|   | i) Supports of gantry girders.                                                                   | 15 mm                                                                                 |
|   | ii) Mid span of gantry girders.                                                                  | 20 mm                                                                                 |
| 6 | Relative shift of crane rail surfaces (at a joining) in plan and elevation.                      | 2 mm                                                                                  |

Alignment of individual beams, girders etc. shall not deviate more than  $\pm 5$  mm from the location given on the drawings.

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The actual levels of trusses, collar beams, roofing beams, purlins etc. shall not vary more than 20mm. from their marked levels. The sweep of trusses, beams etc. in the horizontal plane shall not exceed 1/1500 of their span, subject to a maximum of 10mm. The deviation of the upper chords of trusses from vertical plane through centres of supports shall be within 1/250<sup>th</sup> of the truss height. Deviation in spacing of purlins shall be within 5mm.

For Crane rail alignment, the maximum vertical and horizontal deviations permitted shall be  $\pm 2$  mm gauge variation shall also be  $\pm 2$  mm.

#### 8.41 Anchor Bolts & Foundations

The holding down and anchor bolts shall conform to the requirements laid down in IS : 5624 or as directed by Engineer-In-Charge. The Contractor shall carefully check the location and layout of anchor bolts / HD bolts embedded in foundations constructed to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundations shall be reported to the Engineer-In-Charge.

All tolerance shall be as per IS: 7215 unless stated otherwise.

Anchor bolts / HD bolts may be provided with three nuts on upper threaded portion, one of which may be used for levelling the column base to the required elevation and one will be a lock nut. All shims shall be supplied by the Contractor at his own cost.

During casting of concrete Contractor shall ensure that space between the bolts or bolts and sleeves is kept clean after removal of shuttering. Contractor shall fix timber plugs to maintain this space in a clean condition. The projecting threads of bolts shall be protected by approved wrapping materials. A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by the Contractor at no extra cost.

#### 8.42 Grouting under base plates

Grouting shall be done after erection and making proper alignment of the structural steel, unless otherwise approved by the Engineer-In-Charge. The Contractor shall furnish all shims/pack plates/wedges etc. and level all base plates to the proper elevations as shown on the fabrication drawings before grouting as specified.

Contractor shall keep holes on the stanchion bases for escape of air. Unless specified the grout to be used in bases shall be proportioned to 1:2 cement / sand along with non-shrinkage agents of approved quality and dosage as recommended by the manufacturers & as approved by Engineer-In-Charge & shall have a 28 days compressive strength of at least 300 kg/sq.cm. The grout mixture shall be poured continuously (without any interruption till completion) by grouting pumps from one side of the base plate. The pedestal/column surfaces, which are to receive the grout shall be thoroughly cleaned of all dirt, mud, water, oil or other extraneous matter using compressed air immediately prior to the grouting operation. The grout shall be carefully worked under the base plates and shall completely fill the space between the underside of the base plate and the concrete pedestal including voids around anchor bolts. If the bolt sleeves have been provided for the flexible positioning of bolts, neat cement grout of heavy consistency along with non shrink additives of approved make shall be poured in the sleeves so as to completely fill the sleeve hole. After the grout has had its initial set, the grout shall be cut back flush with the base plate and the surplus grout shall be removed. Before leaving the site, the Contractor shall re-tighten the nuts of all anchor bolts / H.D. bolts. The alignment of the structure shall now be rechecked and if found correct, the voids left by removal of shims/wedges/pack plates (if removed) shall be filled up with the same grout. If serious misalignment is found after checking the alignment, the grout shall be removed completely and fresh grouting to be done as explained above after carrying out appropriate corrections to the alignment. All the form work should be made water tight to prevent the leakage from the joints.

#### 8.43 STEEL REINFORCEMENT

##### 8.43.1 Standard

Steel reinforcing bars shall conform to the following standards -

- Mild steel & medium tensile steel bars - IS: 432 (Part-I)
- High yield strength deformed steel bars - IS: 1786

- Hard- drawn steel wire fabric
- Structural steel, Grade A

- IS: 1566
- IS: 2062

Binding wire shall conform to IS 280 and shall be soft drawn mild steel wire of size not less than 1.5 mm. in dia. (16 g.)

All reinforcement shall be free from loose mill scales, loose rust and coats of paints, oil, mud or any other substances, which may destroy or reduce bond.

#### 8.43.2 Supply

Supply of reinforcement for the Works shall be arranged by the Contractor as per the provisions of the tender.

#### 8.43.3 Storage

Reinforcement bars shall be kept in a clean condition out of direct contact with soil, mud, oil, water, etc. They shall be coated with cement wash before stacking to prevent formation of scale and rust. Fabricated reinforcement shall be carefully stored on timber planks / bellies, ends protected, no water shall be allowed to accumulate in the stored area, to prevent damage, distortion, corrosion and deterioration. Storage of materials shall be as described in IS 4082. The areas under storing shall be properly demarcated.

#### 8.43.4 Fabrication

Bending of reinforcement shall be in accordance with IS 2502-1963 and as shown in the Drawings and sketches and any written instructions if any. Bars shall not be bent or straightened in a manner injurious to the materials. All bars shall be bent cold except for bars over 25 mm. dia. which may be bent hot if specifically approved by the Engineer-In-Charge. Bars which depend on their strength on cold working shall not be bent hot. Bars bent hot shall not be heated beyond cherry red colour (not exceeding 645 Degree C) and after bending shall be allowed to cool slowly without quenching.

No reinforcement bar shall be bent when in position without the Engineer-In-Charge's approval, whether or not it is partly embedded in hard concrete. Spiral reinforcement shall have 1½ finishing turns at both top and bottom unless shown otherwise.

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

Cut ends of treated rods shall be given a protective coat of approved zinc paint immediately after cutting.

#### 8.43.5 Binding

All bars shall be bound tightly together where they cross, with black annealed steel binding wire. The free ends of the binding wire shall be bent inwards. The binding wire shall satisfy provisions of IS : 280.

#### 8.43.6 Placing & Fixing

The reinforcement as per the Drawings and instructions shall be placed, fixed and maintained in the forms within a tolerance of ±10 mm. for effective depth 200 mm. or less and ±15 mm tolerance for effective depth over 200 mm. during the placing and compaction of concrete.

Precast concrete blocks, MS chairs and spacers as required shall be provided to maintain the steel in position. In fair faces of concrete temporary spacers only shall be used and withdrawn as compaction of concrete proceeds.

Tack welding of crossing bars shall be done without any extra cost and only if permitted by the Engineer-In-Charge.

#### 8.43.7 Cover

Spacing of reinforcement shall be governed by Clause 25.3 and cover to reinforcement by Clause 25.4 of IS 456-2000. Increased covers, if shown on the drawings or instructed by the Engineer-In-Charge shall be provided at the respective locations. Cover to reinforcement shall be as per IS 456-2000. Fully cured cement mortar blocks of 1:2 mix shall be used as cover blocks where no grade of concrete is specified and where grade of concrete is specified it shall be as per the same strength as

that of the structural member. Any other cover blocks shall be used only on approval by the Engineer-In-Charge. However, use of pebbles or stones shall not be permitted. Where the bars cross, the outer one shall have the minimum cover.

#### 8.43.8 Splicing & Lapping

Where splicing and / or overlapping in reinforcement are required, the bars shall be provided with such splices or overlaps as are shown on the drawings or directed by the Engineer-In-Charge. Laps shall be staggered only as shown on the drawings and approved by the Engineer-In-Charge.

#### 8.43.9 Welded Laps

Butt welding of reinforcing steel bars shall be used only when specified or shown on the drawings or approved by the Engineer-In-Charge. When butt-welding is carried out, the ends of the bars shall be prepared with single 45° C and a backing plate shall be used. The minimum root face will be one quarter of the bar diameter. Welding shall be done in accordance with the recommendations of IS 2751 & 816. Electrodes shall comply with IS 814. The maximum size of electrodes shall be based on following table:

**TABLE - 12**

| Diameters of Bars in mm. | Diameters of Bars in inches | Maximum size of Electrodes | Amperage corresponding to maximum size of mm. Electrodes       |
|--------------------------|-----------------------------|----------------------------|----------------------------------------------------------------|
| 12 to 25                 | ½" to 1"                    | 10 3.25 mm. (0.128)        | } As specified by the<br>} manufacture of<br>} Electrodes<br>} |
| 25 to 32                 | 1" to 1 ¼"                  | 8 4.06 mm. (0.160)         |                                                                |
|                          | Double bevel                | 10 3.25 mm. (0.128)        |                                                                |
| 32 to 50                 | 1 ¼" to 2"                  | 10 3.25 mm. (0.160)        |                                                                |
|                          | Double bevel                | 8 4.06 mm. (0.160)         |                                                                |
| 25 to 50                 | 1" to 2"                    | 6 4.06 mm. (0.160)         |                                                                |

Before doing the welding of bars at site, the Contractor shall make minimum 3 No. joints and get them tested in an approved laboratory (including X-ray testing of welds if necessary). Only on these tests proving satisfactory, the Contractor would be permitted to weld at site.

The following precautions shall be taken while providing welded laps:

If the cold twisted deformed bar has an untwisted end at the lapping point, the said portion shall be cut off for a minimum length of 10 cm. from such end prior to welding.

Bars shall be aligned on a proper axis to avoid crookedness after welding.

The joints to be welded shall be rust free.

Weld slag shall be chipped off and removed by brush.

#### 8.43.10 Welding Contract

The welding work shall not be given to a sub-contractor who does not produce satisfactory evidence of his ability to handle the work in a competent manner. The Contractor shall also prove the ability of the operators employed by him to produce welding connection of the required strength.

The Contractor shall employ a competent welding supervisor or charge-hand to ensure that the standard of workmanship is satisfactory.

The Engineer-In-Charge shall have free access to the work being carried out by the Contractor at all reasonable times and facility shall be provided so that during the course of welding he may be able to inspect any layer of weld metal. Engineer-In-Charge shall be at liberty to reject any work not conforming to the relevant specifications, IS codes. Defective welds shall be cut out and re-welded.

#### 8.43.11 Safety requirement and health provisions

JAYWANT RAO  
मुख्य अधिकारी (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
महाराष्ट्र डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

The Contractor shall make all safety and health provisions for his welders as laid in IS: 818 - 1968 i.e. Code of Practice of safety and health requirements in electric and gas welding and cutting operation.

#### **8.43.12 Reinforcement to be clean**

All steel reinforcement before the concrete is deposited shall be clean, free of dust, loose scales, oils, rust, grease or any other deleterious materials. Particular care shall be taken to avoid contamination of reinforcement with mould oil.

#### **8.43.13 Checking Reinforcement**

No concrete shall be deposited until all formwork and reinforcement have been inspected and approved by the Engineer-In-Charge. There shall be in attendance on each concreting gang a competent steel fixer who shall ensure that the reinforcement and other embedded fittings are kept in position during placing and compaction of concrete.

The Contractor shall provide temporary gangways, platforms and other means of access to prevent men from walking on the reinforcement bats. These shall be independent of the reinforcement.

##### **8.43.13.1 Measurement**

a) Steel reinforcement shall be measured in lengths of different diameters as actually used in the work and their weight calculated on the basis of Bureau of Indian Standard's Structural Engineer's Handbook No. 1 latest issue without any allowance for rolling margin. All authorised spacer bars on supports on any saddles, forks, chairs, laps, etc. shall be measured on the actual quantity consumed in the job.

b) Wastage and unauthorised laps etc. shall not be measured for payment purpose.

c) Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement.

d) Wherever lap joints are provided by welding, the measurement shall be on linear meter of the actually welded seam length.

#### **8.43.14 Rate**

The rate for reinforcement shall include the cost of labour and materials required for all the operations described above such as cleaning of reinforcement bars, straightening, cutting, hooking, bending, binding, placing in position etc. as required or as directed including tack welding on crossing of bars in lieu of binding with wires, wastages etc.

#### **8.44 STEEL DOORS**

Steel doors, shall be of specified design and sizes and procured from approved manufactures only and shall conform to IS : 1038.

The actual sizes of units shall not vary by more than 1.5 mm. from those given in the drawings.

All fittings and fixtures shall be in oxidised brass as specified or as directed. Machine screws used shall conform to IS : 1362 in residential buildings and IS : 4218 in industrial buildings, wood screws used shall conform to IS : 451.

The framework for doors shall be strong and rigid, neat in appearance, free from any warping, buckling or any other flaws and defects. All frames shall be square and flat. Exposed welded joints shall be dressed smooth.

##### **8.44.1 Fabrication / fixing**

###### **Steel Doors**

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

All steel doors and frames shall be made of mild steel, welded without deposition of metal and properly reinforced. Corners shall be of welded construction with all joint faces welded and ground smooth.

**Collapsible Steel Gate** It shall consist of vertical double channels at 10 cm. centres. The sizes of channels T-Section for top and bottom shall be as approved by Engineer-In-Charge and/or as per drawing. The gate shall be provided with necessary bolts, butts, locking arrangement, stoppers and with brass handles on both sides. The gate shall be painted with one coat of anti-corrosive paint before erection and two coats of synthetic enamel paint of approved quality and shade.

#### **8.44.2 Wrought Iron Grill**

Grills shall be manufactured as per drawings and the welded joints shall be smooth.

#### **8.44.3 Painting**

MS shutters frames shall be cleaned (both the surfaces) with wire brush and given two coats of yellow zinc chromate primer on the both surface after fabrication conforming to IS:2074 and specifications as described under above under- Steel work specifications.

#### **8.44.4 Measurement**

The measurement for collapsible gates / steel doors shall be in Sq.m. The height of the gate shall be measured as the length of the double channels and breadth from outside of the end fixed double channels in open position, of the gate.

#### **8.45 EPOXY PAINTING:**

The whole of the steel work shall be thoroughly cleaned and all dirt, marks, grease over spills of primer paint and other foreign matter shall be removed by hand, cleaning tool (power tool cleaning) using compressed water jet etc. After this preliminary work of making good has been approved by the Engineer-In-Charge, all surfaces shall be thoroughly cleaned and when dry two finishing coats of approved paint shall be applied. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied. The paint manufacturer's instructions shall be followed strictly. Also proper attention shall be paid to the following:

- i) Proper storage to avoid exposure and extremes of temperature
- ii) Surface preparation prior to painting.
- iii) Mixing and thinning.

iv) Application of paint and the recommended limit on time intervals between consecutive coats.

v) Primers and finish coat paints shall be from the same manufacture in order to ensure compatibility. Unless specified and approved, painting colour code shall be as directed by Engineer-In-Charge. Painting work shall be carried out in accordance with IS: 8629 (Parts I to III) All preparation, priming and painting, in colours selected by the Employer, shall be deemed to be included in the Contract price. Painting shall generally be in accordance with IS: 1477 All items of equipment shall be suitably protected and packed to resist corrosion and impact damage. Machined surfaces are to be treated with a proprietary sealing agent for transportation and storage. Paint materials shall be in accordance with the appropriate Indian Standard and shall be obtained from approved manufacturers and applied in accordance with the manufacturers' instructions or as ordered by the Engineer-In-Charge. All materials shall be delivered to the Site in sealed and labelled containers. The paint for each coat shall be from the same manufacturer, compatible with the underlying coat and shall be a different colour for ease of identification. Particular regard shall be paid to the maintenance of the recommended temperature and humidity during application and curing. Painted steelwork shall not be over coated or handled until the recommended curing period has elapsed. No finished paint coating will be accepted until the specified dry film thickness has been achieved to the entire surface including edges. All steel surfaces shall be completely dry and free from oil and grease and all welds ground smooth and weld spatter removed. All fins at saw cuts, burrs and sharp edges shall be removed, and the edges shall be rounded off. The surface shall be prepared by shot/grit/slag as per manufacturer's /contractor's own standard. The surface quality shall confirm to grade SA2 as per ISO Standard 8501-1/manufacturer's specifications. For all painted items, the Contractor shall submit for approval a 'Paint System Sheet' stating full details of each paint system proposed indicating the following information, with reference to IS:1477. Surface preparation system reference together with manufacturer's brand name and product reference dry film thickness colour time to repaint Items to be painted: All existing & new structural steel member including columns, trusses, purlins, floor plates, floor gratings, stair treads, hand rails, brackets, steel inserts etc. but not limited to it shall be painted except if otherwise specified. No black bolts, nuts, washers and welds shall be painted before assembly or erection and approved by Engineer-In-Charge. They shall be thoroughly cleaned and dipped into boiling linseed oil and after erection, painted as specified herein.

अध्यक्ष (त. से. सिविल)  
JAYWANT RAO  
MANAGER (TS-CIVIL)

महानगर डॉक शिपयार्ड्स लि.  
MAGNAN DOCK SHIPYARDS LTD.

vi) The operations, workmanship, schedules and equipment for painting shall be generally comply with the requirement to IS: 1477 (Parts I & II) "Code of Practice for Finishing of Iron and Steel in Building – Painting and Allied Finishes". All painting shall be carried out by brushing, spraying and roller application of paint shall not be allowed without the written permission of the Engineer-In-Charge. No painting shall commence until the cleaned surfaces are approved by the Engineer-In-Charge. No exterior or exposed painting shall be carried out under adverse weather conditions such as rain, extreme humidity, dust storms etc. Rub down and primer application The existing steel surfaces shall be rubbed down thoroughly with emery/abrasive paper to remove dust, rust, other foreign matters and degreased, if required, in accordance with IS: 1477, cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry. Primer coat of zinc chromate primer (conforming to IS: 2074) shall be applied by brushing/spraying in a manner so as to ensure a continuous and uniform film throughout. Special care shall be taken to cover all the crevices, corners, edges etc. Each primer coat shall be air dried and shall have a **minimum film thickness of 25 microns** (tolerance  $\pm 10\%$ ) after drying, unless specified. Unless otherwise specified, paints shall conform to the relevant IS specifications. The paints which have been tested for the following qualities as per specifications given in the relevant IS codes only shall be used: - Weight test (weight for 10 litre of paint, thoroughly mixed) - **Drying time** - Consistency - Dry thickness and rate of consumption. Final paint application After the primer is dry, the surfaces shall be dusted off and one coat of Epoxy paint shall be applied by brushing/spraying so that a film free from "holidaying" is obtained. The second coat of Epoxy paint shall be applied after the first coat is hard dry. The minimum thickness of each film shall be 20 microns ( $\pm 10\%$  tolerance) after drying, unless specified. The thickness applied for each coat to be measured by DFT meter. The defect liability for the **epoxy paint** shall be min.03years. Mode of Measurement: The Paint item shall be measured in **Sqm.** No additional correction factor will be considered. Rate As specified in BOQ item for structural steel work in all respect.

## **09) FINISHING WORKS**

### **9.1 PLASTERING**

#### **9.1.1 Scope:**

This section shall cover plastering to brick masonry wall for Storage sheds, Compound walls as shown in the drawings. Before commencing the work sample of works shall be made in accordance with the specifications indicated below and got approved by the Engineer.

#### **9.1.2 Mortar:**

The mortar of specified mix shall be used. Cement and sand shall be tested as specified in the section on concrete.

#### **9.1.3 Preparation of Surface:**

- a) Joints of stonework/brick work shall be raked-out if not done properly at the time of stonework. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.
- b) Plastering work shall be started where all conduits, pipes, fittings and fixtures clamps, hooks, doors and window frames etc. are embedded, grouted and cured and all defects are removed to the satisfaction of the Engineer. Special approval shall be taken from the Engineer before commencing each plastering work. No cutting of finished plaster shall be allowed under any circumstance. No portion shall be left out initially to be patched up later on.

#### **9.1.4 Mixing**

The ingredients shall be mixed in specific proportions by volume. The mixing shall be done in a mechanical mixer or by hand mixing on watertight platform. The cement and sand shall first be mixed thoroughly dry in the mixer. Water shall then be added gradually and wet mixing continued for at least a minute until mortar attains the consistency of a stiff paste and uniform colour. Mortar shall be used within 30 minutes of addition of water. Mortar which has partially set shall not be used and removed from the site immediately.

Wherever specified, waterproofing compound of approved make shall be added to the mortar & mixed strictly in accordance with manufacturer's printed instructions.

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव उड्डाणन इलाका  
MAHAGON DOCK SHIPBUILDERS

### 9.1.5 (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.

### 9.1.6 (18/20 mm.) PLASTER:

The proportions of sand and cement & waterproof compound shall be as specified and shall cover all irregularities, undulations, depressions due to chasing etc. in the surface to be plastered. The waterproof mortar shall be applied slightly more than 18/20 mm. thick and pressed and levelled with wooden ruler or straight edge to finished thickness of 18mm/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 terrazzo, plain cement tiles, Ceramic/vitrified /stone or any type of skirting work to be finished rounded or as directed by the Engineer-in-Charge, in a separate operation after laying of floor tiles skirting.

### 9.2 PLASTER OF PARIS (POP - $\text{CaSO}_4, 1 / 2\text{H}_2\text{O}$ ) 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.

मुख्य संबंधक (त. से. सिविल)  
JAYWANT RAO  
MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लि.  
MAZAGON DOCK SHIPBUILDERS

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.

### **9.3 PAINTING:**

#### **9.3.1 Scope of work:**

The work covered under these specifications consist of furnishing the various types of paints and also the workmanship for these items, in strict compliance with these specifications, which are given in detail here-in-after with the item of schedule of quantities.

#### **9.3.2 Materials:**

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Ready mixed paints as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used. Approved paints, oils or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The materials shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnights work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

The contractor shall associate the chemist of paint manufacturers before commencement of work, during and after the completion of work who shall certify the suitability of the surface to receive painting and the paint before use etc.

#### **9.3.3 Commencing work:**

**9.3.3.1 Scaffolding:** Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being painted. Charges towards scaffolding upto 10m is added in the items hence no additional cost will be paid for the same.

Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

For painting of the ceiling, proper stage scaffolding shall be erected.

Painting shall not be started until and unless the Engineer-in-Charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work.

Painting, except the priming coat, shall generally be taken in hand after all other builder's work, practically finished.

The rooms should be thoroughly swept out and the entire building cleaned up at least one day in advance of the paint work being started.

#### **9.3.3.2 Preparation of surface:**

The surface shall be thoroughly cleaned. All dirt, rust, scales, smoke and grease shall be thoroughly removed before painting is started. Minor patches if any in plastered/form finished surfaces shall be repaired and finished in line and level in C.M. 1:1 and cracks & crevices shall be filled with approved filler, by the contractor at no extra cost to the Department. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

#### **9.3.3.3 Application:**

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its containers. When applying also, the paint shall be continuously stirred in the smaller containers so that consistency is kept uniform.

The external surfaces of the buildings under reference including the R.C.C. Jalli, fins and the panels above and below the window etc. shall be finished in different colours of approved shade. The contractor will make suitable samples at site for Departments approval before taking up the work in hand and they will be allowed to proceed with the work only after getting Departments approval for the same.

जयवंत राव  
CHIEF MAINTENANCE  
MAZAGON DOCK SHIP

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the later in the direction of the grain in case of wood. The crossing & laying off consists of covering the area with paint, brushing the surface hard for the first time and then brushing alternately in opposite directions two or three time and then finally brushing lightly in direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying will constitute one coat.

Where so stipulated, the painting shall be done with spraying. Spray machine used may be (a) a high pressure (small air aperture) type or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner. Spraying should be done only when dry condition prevails.

Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by thorough ventilation.

Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned of dust before the next coat is laid.

No left over paint shall be put back into the stock tins. When not in use, containers shall be kept properly closed.

The final painted surface shall present a uniform appearance and no streaks, blisters, hair marks from the brush or clogging of paint puddles in the corners of panels, angles of mouldings etc. shall be left on the work.

In case of cement based paints/primers, the absorbent surfaces shall be evenly damped so as to give even suction. In any weather, freshly painted surfaces shall be kept damp for atleast two days.

In painting doors and windows, the putty around the glass panes must also be painted, but care must be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out while painting. Perspect covers of electrical switch boxes have to be painted from inside by removing them. Care shall be taken while removing them in position after painting with respective approved paints. In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

The additional specifications for primer and other coats of paints shall be as in accordance to the detailed specifications under the respective headings.

Any damage caused during painting work to the existing works/surfaces shall be made good by the contractor at his own cost.

#### **9.3.3.4 Brushes and containers:**

After work, the brushes shall be completely cleaned off paint and linseed oil by rinsing with turpentine. A brush in which paint has dried up is ruined and shall on no account be used for painting work. The containers, when not in use, shall be closed, kept air tight and shall be kept at a place free from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean & can be used again.

#### **Measurement:**

Painting, unless otherwise stated shall be measured by area in square metre. Length and breadth shall be measured correct upto two places of decimal of a **metre**.

No deduction shall be made for opening not exceeding 0.05 sqm. and no addition shall be made for painting to the beading, moulding edges, jambs, soffits, sills, architraves etc. of such openings.

In measuring painting, varnishing, oiling etc. of joinery and steel work etc., the co-efficient as in the following table shall be used to obtain the areas payable. The co-efficient shall be applied to the areas measured flat and not girthed in all cases.

In case of painting of door shutter with push plates in plastic laminate, deduction will be made for area of such laminations.

Explanatory notes on the table of Co-efficient.

Where doors, window etc. are of composite types other than those included in para 47.7 (c), the different portions shall be measured separately with their appropriate co-efficient, the centre line of the common rail being taken as the dividing line between the two portions.

Measurements for doors, windows etc. shall be taken flat (and not girthed) overall including chowkhats or frames, where provided. Where chowkhats or frames are not provided, the shutter measurements shall be taken.

Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide, rails, rollers, fittings etc.

Rolling shutters of interlocked laths shall be measured for the actual shutter width and the height from bottom of opening to the centre of the shaft. No separate measurements shall be taken for painting guides and other exposed features within or outside the shutter area. The painting of top cover or hood shall however be measured separately.

Co-efficient for sliding doors shall be the same as for normal types of doors as mentioned in the table. Measurements shall be taken outside of shutters, and no separate measurements shall be taken for painting guides, rollers, fittings etc.

Measurement of painting of doors, windows, collapsible gates, rolling shutters etc. as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

The measurements as above shall be deemed to include also the painting of edges, blocks, cleats etc. for which no extra will be paid.

The co-efficient for doors and windows shall apply irrespective of the size of frames and shutter members.

When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge, and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

In the case where shutters are fixed on both faces of the frames, the measurements for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter area only excluding the frame.

Where shutters are provided with clearance at top or/and bottom, such openings shall be deducted from the overall measurements and relevant co-efficient shall be applied to obtain the area payable.

In case of trellis (or jaffri) work, the measurements shall include the painting of the frame member for which no separate measurements shall be taken. Trellis door or window shutters shall also be measured under trellis work.

Wherever air conditioning grill, lighting, fixtures etc. in false ceiling are painted along with, measurements shall be taken over all without deductions for opening in grills and no extra shall be paid for the grills. If grills, fixtures etc. are not painted, area of fixtures or grills as measured flat (not girthed) shall be deducted when it exceeds 0.05 sqm. individuals. Where walls and ceilings are painted in separate colours, the junctions of two paints shall be brought down on the walls in a straight line by about 6mm to 12mm. if so desired, if the junctions of walls and ceilings are not even. Nothing extra shall be paid to the contractor on this account. Beading wherever provided shall not be measured separately but shall be deemed to be included in the area of false ceiling etc. measured flat (not girthed).

For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or palisades.

In the case of asbestos cement corrugated or semi-corrugated sheeting and iron corrugated sheeting in roofs, side cladding etc., the work shall be measured flat (not girthed) as fixed.

For trusses, compound girders, stanchions, lattice girder and similar work, actual areas will be measured in sqm. and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads,

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)

महाराष्ट्र डॉक शिपबिल्डर्स लि.  
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branches, junctions, shoes etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

Measurements of wall surfaces and wood and other works not referred to already shall be recorded as per actual and opening exceeding 0.05 sqm. shall be deducted to get the net payable area. Length and breadth shall be measured correct upto two places of decimal of a metre and area so worked out shall be correct upto two places of decimal of a square metre.

In case the items of work requiring painting are inclusive of cost of painting, the painting carried out shall not be measured separately.

#### **9.3.3.5 Precautions:**

All furniture's, lightings, fixtures, sanitary fittings, glazing, floors etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damage done shall be made good by the contractor at his cost.

#### **RATES:**

Rates shall include cost of all labour and materials involved on all the operations described above and in the particular specifications given under the several items.

### **9.4 PAINTING**

**Painting work shall be carried out in accordance with IS: 8629 (Parts I to III)**

- All preparation, priming and painting, in colours selected by the Employer, shall be deemed to be included in the Contract price.
- Painting shall generally be in accordance with IS : 1477
- All items of equipment shall be suitably protected and packed to resist corrosion and impact damage. Machined surfaces are to be treated with a proprietary sealing agent for transportation and storage.
- Paint materials shall be in accordance with the appropriate Indian Standard and shall be obtained from approved manufacturers and applied in accordance with the manufacturers' instructions or as ordered by the Engineer-In-Charge. All materials shall be delivered to the Site in sealed and labelled containers.
- The paint for each coat shall be from the same manufacturer, compatible with the underlying coat and shall be a different colour for ease of identification.
- Particular regard shall be paid to the maintenance of the recommended temperature and humidity during application and curing. Painted steelwork shall not be over coated or handled until the recommended curing period has elapsed. No finished paint coating will be accepted until the specified dry film thickness has been achieved to the entire surface including edges.
- All steel surfaces shall be completely dry and free from oil and grease and all welds ground smooth and weld spatter removed. All fins at saw cuts, burrs and sharp edges shall be removed, and the edges shall be rounded off.
- For all painted items, the Contractor shall submit for approval a 'Paint System Sheet' stating full details of each paint system proposed indicating the following information, with reference to IS: 1477
  - surface preparation
  - system reference together with manufacturer's brand name and product reference
  - dry film thickness
  - colour
  - time to repaint

#### **9.4.1 Items to be painted**

All structural steel work and metals including floor plates, floor gratings, stair treads, hand rails,

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JAYWANT RAO  
(त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
साइमॉन्ड डॉक शिपबिल्डर्स लिमिटेड  
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brackets and steel inserts shall be painted except if otherwise specified.

No black bolts, nuts, washers and welds shall be painted before assembly or erection and approved by Engineer-In-Charge. They shall be thoroughly cleaned and dipped into boiling linseed oil and after erection, painted as specified herein.

#### Standard

The operations, workmanship, schedules and equipment for painting shall be generally comply with the requirement to IS: 1477 (Parts I & II) "Code of Practice for Finishing of Iron and Steel in Building - Painting and Allied Finishes".

All painting shall be carried out by brushing, spraying and roller application of paint shall not be allowed without the written permission of the Engineer-In-Charge.

No painting shall commence until the cleaned surfaces are approved by the Engineer-In-Charge.

No exterior or exposed painting shall be carried out under adverse weather conditions such as rain, extreme humidity, dust storms etc.

#### 9.4.2 Shop Painting

After inspection of the fabricated work and before leaving the shop, all steel work shall be thoroughly cleaned by approved means to remove all rust, loose mill scales, drift and other foreign material by hand tool cleaning, power tool cleaning, frame cleaning or sand blasting as found appropriate and approved by Engineer-In-Charge. Greasy and oily surfaces shall be cleaned with solvent and dry rags. Unless otherwise specified, the Contractor shall not flame, clean or pickle the steel work prior to painting. Painting shall generally be done immediately after the cleaning and to thorough dry surfaces as per IS: 1477.

All steel work shall be given one shop coat of approved metal primer as specified unless otherwise it shall be yellow Zinc Chromate primer conforming to IS: 2074 in two coats and shall be applied before any member of steel structure are placed on position or taken out of workshop. A primer coat shall be applied thoroughly and evenly and well worked into joints and other open spaces in order to ensure a continuous and uniform film without 'holidaying'. The primer coat shall be air dried and shall have a minimum thickness of 25 microns (tolerance  $\pm 10\%$  after drying), unless specified.

Surfaces which are inaccessible or not easily accessible after shop assembly shall receive the full specified protective treatment before assembly (This shall not apply to the interior of tube/pipe sealed hollow sections).

All rivets, bolts (except high strength bolts), nuts, washers etc. shall be thoroughly cleaned and dipped in boiled linseed oil.

Parts to be encased in concrete and edges and surface areas adjacent to edges to be field-welded shall be thoroughly cleaned but shall not be painted or oiled.

Parts inaccessible after assembly shall be given two coats of shop paints of approved epoxy paint of approved shades, unless specified..

Machine finished surfaces shall be protected against corrosion by a suitable coating.

Where galvanized surfaces are to be painted, they shall be cleaned and washed with a solution of copper sulphate before the application of the first coat of primer.

Steel surfaces shall not be painted within a suitable distance of any edges to be welded if the paint specified would turn out to be harmful to welders or impair the quality of the welds.

Welds and adjacent parent metal shall not be painted prior to dislagging inspection and approval by Engineer-In-Charge.

#### 9.4.3 Site Painting

After erection, the whole of the steel work shall be thoroughly cleaned and all dirt, marks, grease

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
राज्य शासन, मुंबई

overspills of primer paint and other foreign matter shall be removed by hand, cleaning tool (power tool cleaning) using compressed water jet etc. Areas, where the shop coat has suffered damage or deterioration, shall be cut back and repainted with primer in the same manner as in the shop. All exposed surfaces of metal bolt heads and connections left unpainted in the shop shall be similarly treated. After this preliminary work of making good has been approved by the Engineer-In-Charge, all surfaces shall be thoroughly cleaned and when dry two finishing coats of approved paint shall be applied. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied. The paint manufacturer's instructions shall be followed strictly. Also proper attention shall be paid to the following:

- Proper storage to avoid exposure and extremes of temperature
- Surface preparation prior to painting.
- Mixing and thinning.
- Application of paint and the recommended limit on time intervals between consecutive coats.

Primers and finish coat paints shall be from the same manufacture in order to ensure compatibility. Unless specified and approved, painting colour code shall be tentatively as follows:

|    |                                                                                                                      |                                        |
|----|----------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| 1. | Gantry girders and monorail                                                                                          | Dark green                             |
| 2. | Gantry girder and monorail stopper                                                                                   | Signal red                             |
| 3. | Building structural steel - columns, brackets, beams, bracings, roof truss, purlins, side girths, louvers, stringers | Dark admiralty grey                    |
| 4. | Pipe rack structure and trestle                                                                                      | Dark admiralty grey                    |
| 5. | Chequered plate (plain face)                                                                                         | Black                                  |
| 6. | Grating                                                                                                              | Black                                  |
| 7. | Ladder                                                                                                               | Rungs - black<br>Vertical and cage red |
| 8. | Hand railing Hand rail middle rail toe plate                                                                         | Signal red                             |
| 9. | Vertical post                                                                                                        | Black                                  |

#### 9.4.4 Rub down and primer application

The shop coated surfaces shall be rubbed down thoroughly with emery/abrasive paper to remove dust, rust, other foreign matters and degreased, if required, in accordance with IS: 1477, cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry. Primer coat of yellow zinc chromate primer (conforming to IS: 2074) shall be applied by brushing/spraying in a manner so as to ensure a continuous and uniform film throughout. Special care shall be taken to cover all the crevices, corners, edges etc. The each primer coat shall be air dried and shall have a minimum film thickness of 25 microns (tolerance  $\pm 10\%$ ) after drying, unless specified.

#### 9.4.5 Final paint application

After the primer is dry, the surfaces shall be dusted off and one coat of synthetic enamel paint of approved colour and shade (conforming to IS: 2932) shall be applied by brushing/spraying so that a film free from "holidaying" is obtained. The colour and shade of first coat of paint shall be slightly lighter than the second coat in order to identify the application of each coat. The second coat of paint shall be applied after the first coat is hard dry. The minimum thickness of each film shall be 20 microns ( $\pm 10\%$  tolerance) after drying, unless specified.

#### 9.4.6 Inspection & testing of painting material

All painting materials including primer and thinners brought to site by the Contractor for application shall be procured directly from reputed and approved manufacturers as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates shall not be accepted.

Guarantee:

The Contractor shall guarantee that the chemical & physical properties of paint materials used are

जयवंत राव  
JAYWANT RAO  
प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
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in accordance with the requisite specifications.

#### 9.4.7 Mode of Measurement

Generally Structural steel painting is included in structural steel fabrication work. If specified separately the same will be measured as per IS 1200.

Rate

As specified in structural steel work.

Structural steel work in motorized doors

- i) Horizontal moving panel sliding door

#### 9.4.8 Materials

Structural steel shall be as described under-Steel work specifications.

#### 9.4.9 Fabrication and Erection

Fabrication and erection shall be as described under -Steel work specifications and in accordance with approved fabrication drawing.

#### 9.4.10 Moving Panel

The horizontal moving panel of the door shall be suspended from 2 Nos. '4' wheel trolleys, unless specified. The trolley shall have single flanged wheels capable of moving on bottom flange of rolled steel beam. The size of beam will be ISMB 200 to ISMB 400 unless otherwise shown on the drawing or specified elsewhere.

One of the trolleys shall have all the '4' wheels driven by Electric motor through gear reduction to get travel speed of '8 to 10' mtrs. per min. the other trolley shall be idler / follower type.

Panel of the trolley drive motor shall be wall mounted with pushbuttons for selecting the direction of movement e.g. open / close. These pushbuttons shall have identification on it. In case of '2' panel door the control panel shall be one for both the motors with separate switches for moving the door panels.

Limit switches to avoid excess travel shall control the travel of door. The travel motor shall have DC disc brake to stop the travel in case of power shutoff. The drive shall have facility for manual operation in case of power failure.

Power supply to the travel drive motor shall be through festoon cable arrangement depending upon travel distance.

#### 9.5 PAINTING: -

Doors shall be sand blasted and primer coat and final coat shall be as specified in the item described and in accordance with specifications as described under -Steel work specifications.

##### 9.5.1 Measurement

Mode of measurement shall be actual structural member fixed in place and measured in running metres correct to a millimetre in case of channels / beams / channels / angels, etc while MS plates shall be measured in square meter nearest to two place of decimal and weights calculated on the basis of Bureau of Indian Standard's Structural Engineer's Handbook No. 1 latest issue correct to the nearest kilogram.

Mechanical equipment and accessories such as wheels, motors, brakes, electrical supply, power, etc. shall be measured and paid separately as described under Section - Cranes & Rails.

- a) Unless otherwise specified, weight of cleats, brackets, placing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm gussets, fish plates, etc. shall be added to the weight of respective items.
- b) No deductions shall be made for rivet / or bolt holes paints or finishes.

जयवंत राव  
JAYWANT RAO  
मुख्य अधिकारी (त. से. सि.)  
CHIEF MANAGER (T.S.-C)  
माझगांव डोंक शिपबिल्डर्स

- c) The weight of steel sheets, plates and strips shall be taken from relevant Indian Standards. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.
- d) Unless otherwise specified weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

### 9.5.2 Rate

Rate includes the cost of labour, materials, use of equipments for all the operations, as described above including painting as described above but excluding mechanical / electrical equipment and mechanical / electrical accessories, which shall be measured and paid separately.

## 10) ROOFING

Corrugated Colour coated steel sheet single skin for **Roofing/ Cladding:**

### 10.1 Material

• Manufacturer – Product reference here below given are of M/s. Interarch Building Products Private Limited. However, other similar approved manufacturer's product reference can be used subject to prior approval of Engineer-In-Charge. • Product Reference - TRACDEK, HI-RIB AZ 150 GSM SMP Galvalume • 0.50 mm (including metallic coating) cold rolled galvalume steel, 550 MPa yield stress (ASTM A 446 Grade-E) with hot dip metallic coating of AZ 150 (150 gm / sq.m, zinc / aluminium alloy coating of 55% and 45% respectively conforming to ASTM 792/AS 1397).

### 10.2 Storage on Site

Storage /stacking of the material shall generally in confirmation with IS 4082 unless otherwise specified by the manufacturer. Material shall be protected from damage while stored on site. When they are stacked for any length of time, it is recommended that cover be provided. Packs of sheets shall be kept dry in transit and on site to prevent water and / or condensation being trapped between adjacent surfaces. Packs of sheets standing on site shall be stored clear off the ground. Sheets shall be handled using clean dry gloves.

### 10.3 Paint

20 microns exterior coat of silicon modified polyester (SMP) paint system over 5 micron polyester back coat over 5 micron approved primer. Colour of the roofing and cladding sheet shall be as approved by the Employer

### 10.4 Laying and fixing

Roofing sheets shall be factory cut and supplied in required lengths (upto 12m) to suit shop drawings. Sheets shall be crest fixed to purlins with 12 x 14 x 55 mm mechanically galvanized self-drilling fasteners with EPDM seals (one fastener on each crest, unless specified). Colour caps same as that of roofing to be supplied along with fasteners. End laps of roofing to be minimum 200 mm. Cladding sheets shall be supplied in required lengths (upto 12 m) to suit shop drawings. Sheets shall be valley fixed with 12 x 14 x 20 mm mechanically Tender No: 1800000050 Page 175 of 273 galvanized Self drilling fasteners with EPDM seals (one fasteners in each valley, unless specified). Colour caps same as that of cladding to be supplied along with fasteners. End laps of cladding to be minimum 100 mm. Roofing and cladding shall generally comply with the following: • Slope of roofing shall be as shown on approved fabrication drawing. • Cut panels, sheets and flashings shall give clean true lines with no burrs. • Cut openings to minimum size necessary. • Lay panels and sheets with exposed joints of side laps away from prevailing wind unless shown otherwise on drawings. • Panel and sheet ends, laps and raking cut edges fully supported and with fixings at top of lap unless otherwise specified. • Drill holes, position at regular intervals in straight lines, centred on support bearings or as shown on the drawing. • Remove dust and other foreign matter before finally fixing panels and sheets. • After completion check fixings to ensure water tightness. • Cut edges paint to match face finish.

### 10.5 Foam fillers

for roofing Self-adhesive PU form (polyurethane) fillers shall be supplied as per manufacturer's instructions matching to the shape of roof profile and to be fixed along the ridge and eaves end of roofing.

**10.6 Finish-**The roof when completed shall be true to lines and slopes and shall be leak proof. The ridge should be notched at the crest & turned down, at the ridge the valley of the roof to be turned up to prevent entry of water & dust.

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (न. से. सिविल)  
CHIEF MANAGER (FS-CIVIL)

### 10.7 Safety Precautions

No person other than workmen employed by the roofing contractor shall be permitted access to any area over which the sheeting is being laid. Cat ladders or roof boards should in variably be used by men working on the roofs. The observations of this rule which is advocated primarily on the grounds of safety, will also avoid damage to the roofing materials. All personnel on roof top shall have safety belts tied to life-line attached from the ridge to the eaves and also any other safety as per requirement of the manufacturer's instructions.

### 10.8 Scaffolding for cladding

Only steel 'H' frames shall be used for scaffolding. The scaffolding shall be design to execute the work at 30 meters height and same shall be checked from the Engineer-In-Charge. Tender No: 1800000050 Page 176 of 273

### 10.9 Material warranty

At least minimum 10 years warranty against corrosion of material shall be given.

### 10.10 Leakages

Leakages if any, observed during contract period, including 2 years after expiry of defects liability period rectification and maintenance shall be the responsibility of the contractor at his own cost.

### 10.11 Measurements

The length and breadth shall be measured correct to a cm. Area shall be worked in sq.m. correct to two places of decimal. The superficial area of roof / cladding shall be measured net 'as laid' and paid for accordingly. Laps shall not be paid for separately. Measurement shall be taken on the flat and not girthed. Roof with curved sheets shall be measured and paid for separately. No deduction in measurement shall be made for opening up to 0.4 sq.m and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sq.m in area, deduction in measurements for the full opening shall be made. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

### 10.12 Colour coated sheet for flashing, capping & trims, etc. :

#### 10.12.1 Material

These shall be formed out of same substrates and corresponding thickness as that of the roofing / cladding sheets and shall be supplied in standard lengths of 2.5 m, unless specified in the required shapes and girths.

#### 10.12.2 Fixing

These shall be supplied in required lengths (upto 2.5 m) to suit shop drawings and shall laid / fixed as per approved fabrication drawing. These shall be stitched to the roofing / cladding with 10x12x20 mm hex-head mechanically galvanised self-drilling fasteners with EPDM seals at every 500 mm c/c, unless specified. The end laps shall be stitched at minimum every 50 mm c/c unless otherwise specifically instructed by the manufacturer.

#### 10.12.3 Finish

The edges of the flashing / capping and Trims shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets. Storage, paint, safety precautions, warrantee etc. shall be as described under roofing and cladding specifications.

#### 10.12.4 Measurement

The measurements shall be taken for net 'as laid' length along the centre line of flashing capping or Trims, correct to a cm. Laps provided in between shall not be measured.

### 10.13 2mm thick Fiber Reinforced Plastic corrugated transparent sheet

#### Materials

Manufacturer - Product reference here below given are of M/s. Interarch Building Products Private Limited. However, other similar approved manufacturer's product reference can be used subject to prior approval of Engineer-In-Charge.

#### 10.13.1 Product Reference

FRP sheets shall be supplied in 2mm thick matching to the roof profile in required length to suit approved fabrication drawing. Storage of materials, safety precautions, warrantee, leakages etc. shall be as described under roofing/ cladding specifications.

#### 10.13.2 Fixing

FRP sheets shall be fixed to purlins with 12 x 14 x 55 mm fasteners with EPDM seal and having cyclonic washers. Butyl tape shall be applied on the side/ end lap of FRP sheets and near about

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. प्र.)  
CHIEF MANAGER (T)  
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roofing sheets. Fix in profile, in accordance with manufacturer's day light system recommendations, technical manual. Fixing should not be over tightened. Overlap (side and end) as per approved drawing. **Measurement**

The length & breadth shall be measured correct to a cm up to two places of decimal. The superficial area of roofing shall be measured net 'as laid'. Laps shall not be measured separately. Measurement shall be taken on the flat and not girthed.

### **10.13.3 Rates**

The rate shall include the cost of all the materials and labour involved in all the operations described above including necessary fittings and accessories scaffolding for cladding, laps as per drawing, safety precautions, overlaps etc.,

### **10.14 Colour coated steel sheet for gutters**

#### **10.14.1 Material**

These shall be formed out of same substrates and corresponding thickness as that of the roofing / cladding sheets and shall be supplied in standard lengths of 2.5 m. in the required shapes and girths.

#### **10.14.2 Profile**

The depth, width and height should be as per the rainfall catchments area and as approved.

#### **10.14.3 Fixing**

Gutters shall be fixed as per profile and drawings approved for construction. The gutter shall be fixed on MS brackets of size and location as shown on the drawings. The end laps of gutter shall be bolted with galvanized (175 gauge minimum) nuts and bolts with metallic washers to suit design

#### **10.14.4 Finish**

The edges of the gutters shall be straight from end to end and their surface should be plain of the roof. Storage, paint, safety precautions, warrantee etc. shall be as described under roofing and cladding specifications.

#### **10.14.5 Measurement**

The measurements shall be taken for net 'as laid' length along the centre line of gutters correct to a cm. Laps provided in between shall not be measured.

#### **10.14.6 Rate**

MS brackets shall be measured and paid for separately under relevant item.  
Dismantling.

### **10.15 STRUCTURAL STEEL FABRICATION AND ERECTION WORK.**

The structural steel fabrication and erection work will be required wherever the structural steel members of the workshop shed are rusted beyond repairs and mainly will consist of crane girders, walkways, bracing and purlins and runners, hand railing and other miscellaneous structures. The fabrication and erection of structural steel work shall be in compliance with:

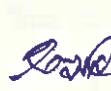
General specifications for structural steel work as per IS: 800.

Necessary drawings to be prepared by the contractor to be got approved through MDL before execution of work.

The fabrication and erection of steel work shall consist of accomplishing of all jobs including providing all labour, tools and plant, all materials and consumables such as welding electrodes, bolts and nuts (GKW Quality) Oxygen and Acetylene gases, oils for cleaning, etc., all of approved quality as per the relevant IS Specifications. The work shall be executed according to the drawings, specifications and relevant IS codes in an expeditious and workmanlike manner and of best standard to the complete satisfaction of the Engineer of MDL.

All materials shall be new and shall conform to the respective specifications as specified. The use of equivalent or higher grade or alternative materials will be considered only in very special cases subject to the approval of the Engineer of MDL.

Structural steel shall conform to IS: 226 or IS: 2062. Steel plates for crane girders shall conform strictly to IS: 2062. Bolts and nuts shall be of GKW Quality and in accordance with IS: 1363.

  
मुख्य प्रबंधक (त. रो. सिनिग)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
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The fabrication work shall be done in accordance with IS: 800, in addition to the following:

The fabrication work shall be done as per the approved fabrication drawings or as directed. The connections shall be welded or bolted as per the approved drawings or as directed. The work shall include also fabrication of built up section, if required. Any fault fabrication pointed out at any stage of the work by MDL shall be made good by the contractor at his own cost.

The structural steel member shall be cut mechanically or by oxy-acetylene flame. All edges cut by oxy-acetylene process shall be cleaned of all slag materials prior to assembly. Edge preparation for welding of members more than 10mm thick shall be done by edge cleaning machine only.

All bolt holes shall be drilled. The drilling shall be made to the diameter specified in the drawings. No enlarging of holes by filling, by man drilling or oxy-acetylene flame shall be allowed.

The assembly of structural members shall be done with proper jigs and fixtures to ensure the correct positioning of the members. The first component / assembly fabrication in such jigs and fixtures shall be inspected thoroughly by the contractor and then offered to the Engineer of MDL for approval before proceeding with the fabrication.

All welding shall be done either manually by the shielded metallic arc process. Welding shall be carried out only by fully trained and experience approved welders. All welds shall be usually made continuous and watertight. The welding electrodes shall conform to IS:816, low hydrogen type covering or equivalent. The erection work in general shall be carried out as required only after approval by the Engineer of MDL.

All scaffolding work required for the erection work will have to be made by the contractor and included in the structural steel rate.

Positioning, levelling of the structural members and their alignment shall be done in accordance with the relevant drawing and to the complete satisfaction of the Engineer of MDL.

The various parts of the steel structure shall be done so erected so as to ensure stability against inherent weight, wind and erection trusses.

All field assembly and welding shall be executed in accordance with the requirement of the relevant fabrication drawings. The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the members. For parts with sloping surfaces tapered washers shall be used.

Any faulty erection done by the contractor shall be made good at his own cost. The contractor shall satisfy himself about the levels, alignment, etc., before starting the erection work.

#### **10.15.1 Formwork**

Formwork (or shuttering) comprises of all forms and moulds made up of planks and steel sheeting etc., shores, bracings and struts, ties, anchors and hangers, steel rods, bolts and allied inserts, uprights, walling, wedges and all other temporary supports for concrete work during the process of concreting and setting.

#### **10.15.2 Material**

Formwork may be of timber, plywood, steel or other metal, plastic or concrete or any suitable material. For special finishes the formwork may be lined with plywood, steel sheets, oil tempered hard board etc. Dented steel plates will not be allowed and shall not be used at all.

Timber shall be easily workable without splitting and shall not warp when exposed to sun or rain or wetted during concreting. Plywood shall be 12 mm. thick complying with IS 4990 and steel shall be 3 mm. black sheets suitably stiffened with angles or appropriate equivalent.

Sliding forms and slip forms may be used for special purpose construction with the approval of the Engineer-In-Charge.

#### **10.15.3 Design**

Formwork shall be adequately designed to cater for all the vertical (dead load of wet concrete, superimposed live loads during construction, materials, equipment etc.) and lateral loads without causing displacement, deflection or movement of any kind. The Contractor shall be entirely

प्रबंधक राव  
JAYWANT RAO  
प्रबंधक (त. से.)  
CHIEF MANAGER (T)  
महाराष्ट्र राज्य शिपबिल्डिंग  
MAHARASHTRA STATE SHIPBUILDING  
AZAGON DOCK

responsible for the design and stability of formwork regardless of whether he is instructed to furnish the design calculations, drawings and other particulars of his proposal or not, and regardless of whether his proposal has been approved by the Engineer-In-Charge or not. All the expenses arising out of defective shuttering & centering resulting in dismantling / redoing the work etc. shall be to the Contractor's account. For details regarding design, detailing etc. reference may be made to IS 14687. Contractor shall submit formwork design & methodology for the approval of Engineer-In-Charge prior to execution.

#### **10.15.4 Erection of Formwork**

Forms shall be true to shape, lines, levels and dimensions of the concrete work as shown on the drawings and shall be rigidly constructed using adequate number of props, struts, ties, braces etc. Where props rest on natural or filled-up ground, the soil shall be thoroughly compacted to avoid any settlement. False-work shall be so constructed that vertical adjustments can be made to compensate the settlements. Wedges may be used at the top or bottom of timber shores, but not at both ends to facilitate vertical adjustments or dismantling of the formwork. No bamboos and wooden bullies shall be permitted to be used for props or cross bearers/bracings.

Proper precautions shall be taken to see that all joints in the formwork are watertight to prevent escape of slurry.

Connections in formwork shall be constructed to permit easy removal of the shuttering and shall be adequately secured by screws, bolts, clamps, wire etc. so as to be strong enough to retain the correct shape during consolidation.

Faces in contact with concrete shall be free from adhering ground, projecting nails, splits or any defects so that when stripped, any formation of blemishes is avoided. All formwork shall be carefully cleaned and thoroughly wetted or treated with an approved chemical compound. Care being taken to keep all reinforcement away from contact from such composition.

Unless specifically permitted, wire ties passing through the walls and through bolts are not permitted. For fixing of formwork, alternative arrangements such as coil nuts shall be adopted at the Contractor's cost.

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 rough finished shall be planed to remove irregularities or unevenness in the face. Formwork with linings will be permitted.

All new and used form timber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness.

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 the excavation and to ensure the design requirements. No extra payments on this account will be made in any item of work.

Forms shall be so designed and constructed that their removal will not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conform to the architectural features of the structure as to location of joints and 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 resulting concrete surface requires a minimum finish.

#### **10.15.5 Bracings, Struts & Props**

Shuttering shall be braced, strutted, propped and so supported that it shall not deform underweight and pressure of the concrete and also due to the movement of men & other materials. Bamboo's shall not be used as props or cross bracings.

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. सं. विभाग)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
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The shuttering / forms for beams and slabs shall be so erected that the shuttering / forms on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of beams bottom forms 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.

#### 10.15.6 Mould Oil

Care shall be taken to see that the faces of formwork coming in contact with concrete are perfectly cleaned and two coats of mould oil or any other approved material applied before fixing reinforcement and placing concrete. Such coating shall be insoluble in water, non-staining and not injurious to the concrete. It shall not become flaky or be removed by rain or wash water. Reinforcement and/or other items to be cast in the concrete shall not be placed until coating of the forms is complete. Adjoining concrete surfaces shall also be protected against contamination from the coating material.

#### 10.15.7 Chamfers and fillets

All concrete and angles exposed in the finished structure shall be formed with mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 2cm x 2cm. 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.

#### 10.15.8 Vertical Construction Joint Chamfered

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.

#### 10.15.9 Wall Ties

Wire ties passing through the walls shall not be allowed. In their place bolts passing through sleeves shall be used.

#### 10.15.10 Reuse of Forms

Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary repaired and the inside retracted to prevent adhesion, to the satisfaction of Engineer-In-Charge. Warped timber shall be resized.

#### 10.15.11 Removal of Forms

Contractor shall record on the drawing or in a 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 circumstance shall forms be struck until the concrete reaches a strength of at least twice the stress due to self-weight and any construction/erection loading to which the concrete may be subjected at the time of striking formwork.

Nor formwork shall be removed or otherwise allowed to move until concrete attains sufficient strength against own weight and external load as per the stipulations of Clause 11.3 of IS 456-2000.

The stripping of formwork shall be done without shock or vibration so that no damage is caused to newly cast concrete. Any damage resulting from premature removal of shutters or from any other cause whatsoever shall be made good by the Contractor at his own expense as directed by the Engineer-In-Charge.

In normal circumstances generally where ambient temperatures are above 15°C and ordinary port land cement is used forms may be struck after expiry of the following periods:

**TABLE - 11**

| Type of formwork | Ordinary Portland Cement Concrete |
|------------------|-----------------------------------|
|------------------|-----------------------------------|

जयवंत राव  
JAYWANT RAU  
मुख्य अभियंता (त. से.)  
CHIEF MANAGER  
महाराष्ट्र राज्य सरकार  
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|--------------------------------------------------------------------------------------------|--------------------|
| a) Vertical formwork to columns, walls, beams                                              | 16-24 hrs          |
| b) Soffit formwork to slabs<br>(Props to be refixed immediately after removal of formwork) | 3 days             |
| c) Soffit formwork to beams<br>(Props to be refixed immediately after removal of formwork) | 7 days             |
| d) Props to slabs<br>1) Spanning up to 4.5 m<br>2) Spanning over 4.5 m                     | 7 days<br>14 days  |
| e) Props to beams and arches:<br>1) Spanning up to 6 m<br>2) Spanning over 6 m             | 14 days<br>21 days |

For other cements and or lower or higher temperature, the stripping time as above may be suitably modified with prior approval of the Engineer-In-Charge.

#### 10.15.12 Oiling of forms

Use of form / mould oil will not be permitted on the surfaces which require painting.

#### 10.16 Tolerances

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

##### 10.16.1 Tolerances for RC buildings

- Variation from the plumb
  - In the lines and surfaces of columns, piers, walls and in arises 5 mm. per 2.5 m. but not more than 25 mm.
  - For exposed corner columns and other conspicuous lines.

In any bay or 5 m. maximum - 5 mm  
In 10 m. or more - 10 mm

- Variation from the level or from the grades indicated on the drawings –

- In slab soffits, ceilings, beam soffits and in arises.

In 2.3m - 5 mm

In any bay or 5 m. maximum - 8 mm

In 10m or more - 15 mm

- For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.

In any bay or 5 m. maximum - 5 mm

In 10m or more - 10 mm

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

- In any bay or 5 m. maximum - 10 mm
- In 10 m. or more - 20 mm.

- Variation in the sizes and location of sleeves, openings in walls and floors 5 mm. (except in the case of and for anchor bolts).

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपवर्ल्ड्स लिमिटेड  
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- Variation in cross sectional dimensions of columns and beams and in the thickness of slabs and walls (- 5 mm. + 10 mm.)
- Footings
- Variation in dimension in plan (- 5 mm. + 50 mm.)
- Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm.

- Reduction in thickness

5% of specified thickness subject to a maximum of 50 mm.

- Variation in Steps

#### RISE

#### TREAD

- |                          |         |       |
|--------------------------|---------|-------|
| a) In a flight of stairs | 3 mm.   | 5 mm. |
| b) In consecutive steps  | 1.5 mm. | 3 mm. |

- i) Tolerances in other concrete structures

Variation of the constructed linear out line from established position in plan.

In 5 m. 10 mm.

In 10 m. or more 15 mm.

- ii) Variations of dimensions to individual structure features from established positions

In 20 mm. or more 25 mm.

In buried construction 50 mm.

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

In 2.5 m. 10 mm.

In 5 m. 15 mm.

In 10 m. or more 25 mm.

In buried construction Twice the above

- 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. 10 mm.

In buried construction Twice the above

- v) Variation in cross sectional dimensions of columns, beams buttresses, piers and similar member (- 5mm + 10 mm)

- vi) Variation in the thickness of slabs, walls, arch sections and similar members. (- 5mm + 10 mm)

Footings for columns, piers, walls, buttresses and similar members

Variation of dimensions in plan (-10mm + 50mm)

Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50mm

#### **10.16.2 Reduction in thickness**

5% of specified thickness subject to a mix of 50mm 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).

#### **10.16.3 Special Provision**

Where exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the resulting concrete surfaces will required a minimum finish.

Wherever the concreting of narrow members is required to be carried out within shutters of considerable depth, temporary openings (windows) in the sides of the shutters shall, if so directed by the Engineer-In-Charge, be provided to facilitate the pouring and consolidation of the concrete. Small temporary openings shall be provided as necessary at the bottom of shutters of columns, walls and deep beams to permit the expulsion of rubbish etc.

#### 10.16.4 Measurement

- a) Unless otherwise stated, shuttering shall be measured as the area of the finished structure which is required to be supported during the deposition of the concrete but no deduction shall be made for holes less than 0.10 Sq.m.
- b) Shuttering to secondary beams shall be measured upto the sides of main beams but no deduction shall be made from the shuttering of the main beam where the secondary beam intersects it.
- c) Shuttering to beams which intersect with stanchion casings or columns shall be measured upto them on all sides. No deduction shall be made from shuttering to stanchion or column casings at these intersections.
- d) Shuttering at construction joint shall not be measured.
- e) Shuttering for the cover blocks shall not be paid for separately but is included in the respective items of formwork items.

#### 10.16.5 Rate

The rate of the form work includes the cost of labour and materials required for all the operations described above.

Unless otherwise specified the rate of form work shall allow for-

- i) provision of required well supported false work such as staging, access and working platforms for concreting etc.
- ii) provision of any dowels and inserts etc. to be left out from shuttering (dowels, inserts etc. themselves shall be paid for under respective items), provision of any holes, pockets, channels etc.
- iii) removing the shuttering carefully after specified time limit or as directed.
- iv) work at all depths and heights as specified in the item descriptions.

The formwork generally shall include-

- i) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing etc.
- ii) All supports, struts, braces, wedges as well as mud sills, foundation pads, ground improvement, temporary piles or other suitable arrangements to support the form work.
- iii) Bolts, wire ties, clamps, spreaders, nails or any other to hold the sheathing together.
- iv) Filleting to form stop chamfered edges of splayed external angles not exceeding 20 mm wide to beam, columns and the like.
- v) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.
- vi) Dressing with oil to prevent adhesion and
- vii) Raking or circular cutting.

#### 10.16.6 Inspection of forms

Temporary openings shall be provided at the base of columns and wall forms and other places necessary to facilitate cleaning and inspection. Immediately before concrete is placed all forms shall

जयवंत राव  
JAYWANT RAO  
प्रबंधक (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगाव डॉक शिपबिल्डर्स लिमिटेड  
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be carefully inspected to ensure that they are properly placed, sufficiently rigid and tight, thoroughly cleaned, properly treated and free from foreign material.

When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer-In-Charge shall order all work stopped until the defects have been corrected.

### **11) DISMANTLING & DEMOLISHING:**

The item wise detailed specifications are intended for the general description of quality, workmanship, etc. desired for the items covered in the Schedule of Items. The Specifications are not, however, intended to cover the minute details and the work shall be executed according to the relevant latest Indian Standard Codes. In absence of the later, the work shall be executed according to the prevailing local Public Works Department Practice or to the recommendations of American and British Standard Institution at the discretion of the Engineer-In-Charge.

#### **11.1 Scaffolding**

Single or double scaffolding shall be provided by the Contractor as and when required.

#### **11.2 Objective**

The desired technique to be adopted in carrying out the demolition and dismantling work of existing structure shall be such that the fragments falling out of such operation can be contained within the work area or taking suitable protection so as to prevent materials from going out. This would relieve the surrounding area from any uncertain or uncontrolled behaviour of dismantled materials.

The rubbish / materials after dismantling shall also be stored systematically and disposed off immediately outside the plant boundary in order to ensure no major formation of heaps inside / adjacent to the work site and not hamper in any way the normal business operation of the Employer. The term demolition implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on the drawings.

The term 'Dismantling' implies carefully removing without damage (up or down). This shall consist of dismantling one or more part of the structures / facilities as specified or shown on the drawings.

#### **11.3 Precautions**

All materials obtained from dismantling or demolition shall be the property of the Contractor once the materials are taken out of the boundary of MDL after completion of the necessary gate pass and other formalities. But till such time the materials shall be kept in safe custody as per the directives of the Engineer-In-Charge.

The demolition shall always be planned beforehand and shall be done in reverse order of the one in which the structure was constructed. The scheme shall be got approved from the Engineer-In-Charge before starting the work.

Necessary propping, shoring and / or underpinning shall be provided for the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever required, as per the opinion of the Engineer-In-Charge, temporary enclosures or partitions shall be provided at the Contractor's cost.

Necessary precautions shall be taken to keep down the dust nuisance.

Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roofs, masonry, etc. shall be carefully removed first. The dismantled articles shall be passed by hand, where necessary, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer-In-Charge.

Where fixing is done by nails, screws, bolts, rivets, etc. dismantling shall be done by taking out the fixed items with proper tools and not by tearing or ripping off.

Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-In-Charge within work site for verification required for gate pass and other formalities for taking outside the boundary. All unserviceable materials, rubbish, etc. shall be disposed off immediately outside the Owner's premises as directed by the Engineer-In-Charge.

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#### **11.4 General: -**

Necessary data such as building size, wall thickness, construction materials, etc. that may be required shall have to be collected by the Tenderer from MDL site at his own expenses.

#### **11.5 Information to be supplied by the Tenderer along with Tender**

The information to be provided for by the Tenderer, unless otherwise specified, shall include the following:

To submit his method of demolition duly supported by specifications and drawings and sequence of operation along with a list of equipment, plants and machineries to be employed during such operation, to meet the above mentioned objective.

#### **11.6 Work to be provided by the Contractor**

- a) To arrange all the formalities as per requirement of statutory rules, if his method involves use of explosives. He has to obtain permission from appropriate authority of buying, storing, handling & making use of explosives.
- b) To notify, the Employer for arranging to shut off all gas, water, electricity, steam and other service lines running over ground or underground. Any temporary service connections required for the demolition work shall be separately taken and arranged by the Contractor.
- c) Any preliminary work, necessary for Contractor's method of demolition.
- d) To furnish all materials, labour, tools and plant and all consumables required for this work and its related temporary work such as cordoning the area, staging etc.
- e) To furnish the details of safety measures for human life / property / structures, the Contractor proposes to take during the blasting operation of explosives, if he proposes to use on this demolition work. This should be strictly as per rules and regulations laid down by the concerned authority for explosives to be used in this work.

#### **11.7 Work by Others**

No work under this specification will be provided for by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the Contract or approved by the Engineer-In-Charge / Employer.

#### **11.8 Codes & Standards**

The demolition work shall be carried out as per Indian Standard Code of Practice No. IS 4130 - 1970 (Safety Code for demolition of buildings) or any other relevant Indian Standard Specifications and Codes of Practice. If demolition by blasting is adopted IS 4081 (Safety Code for blasting and related drilling operations) shall be followed. However, if any, particular aspect of the work is not specifically covered by any Indian Standard Specifications or any other standard practices, Engineer-In-Charge's instruction shall be followed.

#### **11.9 Execution: -**

The materials available after dismantling and demolition will be deemed to be the property of the Contractor once the material are disposed off from the plant boundary and the amount offered by the Contractor against each of the facilities / buildings / structures are received by the Employer.

It is presumed that the Contractor will adopt the most suitable method of demolition and dismantling to protect the materials and its surroundings. While doing so the Contractor shall ensure the following, which should be considered as binding towards the method and specification adopted by the Contractor:

- Total safety of the people working in the area of the Employer, other agencies employed by the Employer as well as those employed by the Contractor.
- Safety and no damage to the adjoining properties, facilities or services.

जयवंत राव  
JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CIVIL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
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- Disposal immediately after dismantling to keep the area clean after the days work and not more than one truckload being accumulated.
- No noise or dust nuisance around the area of working.
- No obstruction to vehicular / pedestrian traffic during dismantling and disposal inside the plant boundary as well as outside municipal areas.
- No hindrance in the Employer's day to day production work or other operation.
- No accidents or other hazards.

## **11.10 Blasting**

In special cases, the Contractor may be allowed to resort to controlled blasting at the sole discretion of the Employer/Engineer-In-Charge. The blasting, if allowed, will normally be for underground and foundation works. The work shall strictly be carried out as per the guidelines given below.

### **11.10.1 General guidelines for use of explosives**

In case use of explosive is adopted for demolition work, specific permission of Engineer-In-Charge will have to be taken by the Contractor for blasting and he shall also obtain a valid blasting license from the authorities concerned.

The contractor shall employ competent and experienced supervisors and licensed blaster in-charge of each set of operations of blasting as well as operations of loading, unloading and transporting of such explosives from the mezzanine, who shall be held personally responsible to ensure that all safety regulations are carried out before and during the progress of blasting and also during the transportation and handling of explosive materials.

Before any blasting is carried out, Contractor shall intimate the Engineer-In-Charge and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are withdrawn from an area within 200 metre radius from the firing points, at least 15 minutes before firing time by sounding warning whistle. The area shall be encircled by red flags. Clearance signal shall also be given by sounding a distinguishing whistle/siren.

The blasting near any existing building, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Engineer-In-Charge; a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

The firing shall be supervised by an experienced Supervisor. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole near the misfired hole (but not nearer than 600mm from it) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home by metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming, which may consist of sand or stone dust or similar inert material.

In no case shall blasting be allowed closer than 30 meters to any structures or to locations where concrete has just been placed. In the later case the concrete must be at least 7 (seven) days old.

Contractor shall preferably detonate the explosives electrically.

The explosive shall be exploded by means of primer, which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.

In dry weather, ordinary low explosive gunpowder may be used. In damp weather, high explosive like gelatine with detonator and fuse wire may be used.

The quantity and strength of explosive used, shall be such as will neither damage nor crack the other structures outside the limits of execution. All precautions, as directed by Engineer-In-Charge, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of any damage done due to negligence, the same shall be rectified by the Contractor to the satisfaction of Engineer-In-Charge at his own cost.

The Contractor shall observe rules and regulations controlling the storage and handling of explosives as exercised by the Inspector of explosives or licensing authority. The fees if any required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State or Central Government authorities and statutory bodies / regulations. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosives shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as far away as possible from the area to be blasted. The Engineer-In-Charge's prior approval shall be taken for the proposed location of the magazine and the structure of magazine shall be constructed as specified in the rules and regulations laid down by the concerned authorities. The Contractor shall build the magazine at his own cost. The contractor shall make this own arrangement for the site of this structure.

Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observances of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and / or Union Government.

Proper account of the explosive materials shall be kept at site as well as in the magazine as per the rules and regulations of the concerned authority. For this purpose, registers shall be kept by the Contractor and shall be filled and signed daily by his authorized and licensed blaster in-charge indicating therein the proper and correct account of the stock of explosive material brought in. For this purpose, day to day operation-wise entry shall be made in the registers. Misfired and unfired charges of explosive shall also be noted in the register indicating the place, for safety.

Twenty-four hours guards on duty shall be engaged by the Contractor to safeguard all kinds of explosive materials and equipment at the place of magazine as well as during the transportation period and on site when brought for using the same. Any theft, misuse or mishandling of the explosive materials shall be the responsibility of the Contractor and the Contractor shall indemnify the owner for this purpose and for the damages of any kind which may occur due to blasting of explosive in the magazine, during transportation, during handling in the work or due to any accidental cause.

The Contractor shall make his own arrangement of transportation of required quantities of explosive materials from the magazine to the work site as per the rules and regulations of the concerned authorities.

The Contractor shall have to note that live electrical circuits of high voltage may be passing overhead / underground and shall be likely to remain live at the time of operation of demolition work. The Contractor shall take all safety measures in this regard.

#### **11.10.2 Rates**

The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material out side the premises into approved dumping grounds.

### **12) SPECIFICATION FOR ROAD WORK:**

**Specifications for road work shall be as described under Ministry of Road Transport & Highways (MORTH) and as described under relevant clauses as applicable.**

#### **12.1 EARTHWORK**

जयवंत राव  
JAYWANT RAO  
मुख्य प्रबंधक (त. रो. निगम)  
CHIEF MANAGER (TS-CIVIL)  
माझगाव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

### 12.1.1 Excavation

The work to be done under this section comprise performance of all work necessary for excavation with shoring, strutting, dewatering, pumping including disposing of all surplus excavated material from the site as directed by the Engineer.

Excavation shall be carried out in any type of soil, gravel, conglomerate, soft rock, boulders, old foundation, hard rock, concrete, asphalt or stone paved surfaces old masonry or concrete (plain or reinforced) encountered within width, length and depths indicated in the drawings. Where any temporary or permanent structure like sheet piling, diaphragm wall or piles have already been taken up, all excavation work shall be from the point carried out earlier and all precaution during further excavation and or any construction operation shall be exercised not to damage such existing temporary or permanent work. Where directed by the Engineer trees encountered within the work site shall be uprooted as per approved manner and serviceable wooden logs shall be stacked at site / disposed of as directed by the Engineer. Branches of trees etc. shall be disposed of or stacked at site as directed by the Engineer. No permanent work shall be commenced in the excavated area until the foundations pits have been inspected and approved by the Engineer. The Contractor may use any suitable excavated materials for incorporation in the permanent or temporary works as may be convenient subject to compliance with the specifications. Any obstacles encountered during excavation shall be reported immediately to the Engineer and shall be dealt with as directed by the Engineer.

### 12.1.2 Site Levels

Before the work commences the Contractor shall carry out a survey of the levels of the site and obtain verification by the Engineer of these levels. Levels shall be taken on a grid to be agreed with the Engineer and the Contractor shall submit three prints of the drawing showing the site levels for record purpose.

### 12.1.3 Excavation beyond Required Limit

Any excavation beyond the required limits and against which asphalt is to be placed shall be made good with bituminous concrete of specified grades. Any excavation beyond the required limits at locations where no Bituminous concrete is to be placed will not be required to be made good with concrete unless otherwise directed by the Engineer provided always that any consequential additional work caused or necessitated by the excavation beyond limits will not be admitted for payment.

### 12.1.4 Dewatering

While execution of works, if so encountered, the Contractor shall provide for the purpose of excavation under water all the necessary dewatering equipment like well points, pumps (including stand byes), pipes, conduits, etc. and make necessary arrangement for proper drainage of the pumped water from the well points and its easy disposal without affecting the site and the adjoining areas. The Contractor at his own cost shall take any permission required for such disposal of water to other areas, from the respective authorities.

### 12.1.5 Compaction Quality: -

Compaction of earth where asphaltting work is located, the degree of compaction achieved shall be minimum 95% of maximum dry density as obtained by Proctor compaction as per IS: 2720 (Part VII). Unless otherwise specified, in roads & other areas the degree of compaction shall be 90%. For every layer, Compaction to be done by Vibratory roller of 8 to 10Tonn capacity to achieve the maximum degree of compaction.

Classification of soil

The earthwork (in the all kinds of soil) shall be classified under the following main categories.

### 12.1.6 Soil

includes various types of soils, mud concrete below the ground level, shingle and river or nallah bed boulders, soling of road, paths and hard core, macadam surface of any description, lime concrete, stone masonry below the ground level, soft conglomerate and laterite when the stone can be detached from the matrix with picks and shovel.

b) Ordinary Soils, Sand, Clay & Soft Murrum includes earth, soft murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof which can be excavated with shovels, loose application of pick axes etc.

JAYWANT RAO  
मुख्य अभियंता (त. से. सिविल)  
CHIEF MANAGER (TS-CR)  
उ. वि. वि. लिमिटेड

c) Hard soil, murrum, boulders, weathered / soft rock : All decomposed weathered rock, highly fissured rock, old masonry, boulders bigger than 0.03 cum. in volume but not bigger than 0.5 cum. and other varieties of soft rock which can be removed only with hard application pick axes, crow bars, wedges and hammers with some difficulty. The more fact that the contractor resorts to blasting and / or wedging and chiseling for reasons of his own, shall not mean the rock is classifiable as hard rock.

Note: The scope of work taking site levels, support the sides of excavation

barricades, dewatering, etc. are inclusive of excavation item, no extra payment will be given to the contractor.

## 12.2 WATER BOUND MACADAM SUB-BASE/BASE:

### 12.2.1 Scope:

This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, stone chips, moorum, binding material where necessary and water laid on a properly prepared sub grade / sub-base / base or existing pavement, as the case may be and finished in accordance with the requirements of these specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

### 12.2.2 Materials:

Coarse aggregates: Coarse aggregates shall be either crushed or broken stone, the aggregates shall conform to the physical requirements set forth in **Table -1**. The type and size range of the aggregate shall be specified in the Contract or shall be as specified by the Engineer. If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as **per IS: 2386 (Part5)**.

Crushed or broken stone: The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other deleterious material.

**TABLE- 1.**

### PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FROR WATER BOUND MACADAM FOR SUB-BASE/BASE COARSE

| Test |                                                   | Test Method                 | Requirements      |
|------|---------------------------------------------------|-----------------------------|-------------------|
| 1    | Los Angeles Abrasion Value                        | IS:2386 (Part-4)            | 40 per cent (Max) |
|      | Aggregate Impact Value                            | IS:2386 (Part-4) or IS:5640 | 30 per cent (Max) |
| 2.   | Combined Flakiness and Elongation Indices (Total) | IS:2386 (Part1)             | 30 per cent (Max) |

**Grading requirement of coarse aggregates:** The coarse aggregates shall conform to the grading given in **Table 2** as specified, provided, however, the use of Grading No.1 shall be restricted to sub-base courses only.

**TABLE -2**

### GRADING REQUIREMENTS OF COARSE AGGREGATES

| Grading No. | Size Range     | IS Sieve Designation | Per cent by Weight passing |
|-------------|----------------|----------------------|----------------------------|
| 2           | 90 mm to 45 mm | 125 mm               | 100                        |
|             |                | 90 mm                | 90-100                     |
|             |                | 63 mm                | 25-60                      |
|             |                | 45 mm                | 0-15                       |
|             |                | 22.4 mm              | 0-5                        |

**Note: The compacted thickness for a layer with Grading 2 shall be 150mm.**

### 12.2.3 Screenings:

Screening to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, predominantly non-plastic material such as Moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75-micron sieve does not exceed 10 per cent.

सुभाष प्रबंधक (स. से. सि.नि.न.)  
 MANAGER (TS-CIVIL)  
 माझगांव डॉक शिपयार्डर्स लिमिटेड  
 MAZAGON DOCK SHIPYARDERS LIMITED

Screening shall conform to the grading set forth in **Table -3**. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in **Table 4**. The table also gives the quantities of materials (loose) required for 10 m<sup>2</sup> for sub-base / base compacted thickness of 100/75 mm.

**TABLE -3**

**GRADING FOR SCREENINGS**

| Grading Classification | Size of Screening | IS Sieve Designation | Per cent by Weight passing the sieve |
|------------------------|-------------------|----------------------|--------------------------------------|
| A                      | 13.2 mm           | 13.2 mm              | 100                                  |
|                        |                   | 11.2 mm              | 95-100                               |
|                        |                   | 5.6 mm               | 15-35                                |
|                        |                   | 180 micron           | 0-10                                 |
| B                      | 11.2 mm           | 11.2 mm              | 100                                  |
|                        |                   | 5.6 mm               | 90-100                               |
|                        |                   | 180 micron           | 15-35                                |

**13) LIST OF MATERIALS OF APPROVED BRAND AND/OR MANUFACTURER.**

| Sr.no | Description                                                            | Approved make                                                                                                                                                                   |
|-------|------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Cement 53 Grade / 43 Grade only for Concrete works                     | Gujarat Ambuja, A.C.C., Ultra-tech, Birla                                                                                                                                       |
| 2     | Cement Portland Pozzolana (Fly ash based) for Plastering, masonry etc. | Gujarat Ambuja, A.C.C., Ultra-tech, Birla                                                                                                                                       |
| 3     | RMC Plants                                                             | Ultratech, ACC, Godrej, Lafarge, RMC India, Hella Infra Market, RDC, Ecomix, Dev RMC LLP, Manoj Infra Market RMC plant or other any plant as approved by MDL Engineer in Charge |
| 4     | White Cement                                                           | Birla / J.K. or equivalent                                                                                                                                                      |
| 5     | Mild & TOR Steel                                                       | Sail, Tisco, Rashtriya Ispat Nigam, Jindal                                                                                                                                      |
| 6     | Structural steel                                                       | SAIL/TATA/RINL/IISCO/JINDAL                                                                                                                                                     |
| 7     | Pest control                                                           | PCI/Godrej/Pecopp                                                                                                                                                               |
| 8     | White cement based putty                                               | M/s Birla white, Plasto shine wall putty, M/s Walplast products pvt. Ltd.                                                                                                       |
| 9     | Epoxy paint                                                            | Akzo Nobel/Berger/ Asian Paint                                                                                                                                                  |
| 10    | Granite                                                                | As approved by Architect                                                                                                                                                        |
| 11    | Aluminium windows                                                      | Jindal, Hindalco,                                                                                                                                                               |
| 12    | Stainless Steel                                                        | Jindal/SAIL                                                                                                                                                                     |
| 13    | Polycarbonate sheets                                                   | GE, Lexan, Danpalon, polygal                                                                                                                                                    |
| 14    | Rust Preventive                                                        | Krishna Conchem/ Sunanda/ BASF                                                                                                                                                  |
| 15    | Bonding coat                                                           | Krishna Conchem/ Sunanda speciality coating/Fosroc                                                                                                                              |
| 16    | Glass                                                                  | Saint Gobain/ Asahi India Glass Ltd / Gujarat Guardian - Modiguard                                                                                                              |
| 17    | Galvalume roof                                                         | PHENIX Infra/ Kingspan/ LLOYD Insulations ( I ) Ltd                                                                                                                             |

जयवंत राव  
 JAYWANT RAO  
 मुख्य प्रबंधक (त. से. सिविल)  
 CHIEF MANAGER (TS-CIVIL)  
 माझगांव डॉक शिपबिल्डर्स लिमिटेड  
 MAZAGON DOCK SHIPBUILDERS LIMITED

**SCOPE OF WORK**  
**&**  
**TECHNICAL SPECIFICATION**  
**FOR**

**HVAC INSTALLATION WORKS AT ANIK CHEMBUR YARD**

  
कै. श्रीनिवास  
K. SRINIVAS  
मुख्य प्रबंधक (तकनीकी सेवाएं-मैकेनिकल)  
CHIEF MANAGER (TS-MECHANICAL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZGAON DOCK SHIPBUILDERS LIMITED

## SCOPE OF WORK FOR HVAC SYSTEM

### GENERAL:

The scope of work under this tender shall comprise of the following:

- (a) Supply, installation, testing and commissioning of Four-way Inverter Cassette Air conditioner (5-star rating) at Anik Chembur Yard comprising of indoor units, outdoor units, cordless remote controllers with batteries, remote control holder, adequate length of power supply cables along with connecting pin & accessories. The preferred makes for the air-conditioners are **Mitsubishi/O'General/Daikin**.
- (b) Fabrication and installation of M.S stands, Grills, other structural work as per site requirements for installation of A.C outdoor units.
- (c) Copper refrigerant piping with insulation/nitrile rubber sleeves including clamping/supporting arrangement including making precise holes in the walls with core cutting m/c, providing sleeves and proper finishing for connectivity from indoor to outdoor units. The preferred makes for Insulation are **Superlon/K-Flex/Armacell**.
- (d) Supply and fixing of suitable L-shaped brackets duly painted/powder coated along with necessary bush and fasteners for mounting outdoor units, wherever necessary, and as directed by MDL engineer.
- (e) Supply and installation of ISI mark UPVC plumbing grade condensate drain pipe & fittings along with insulation and necessary supports & clamps etc. all complete for taking out condensate drain water from AC units up to the Ground Level. The preferred makes for UPVC pipes are **Prince/Astral/Supreme** and those for Insulation are **Superlon/K-Flex/Armacell**.
- (f) Supply and laying of 2.5 Sq mm 4 core Electrical cable for Inverter split AC & Four-way Inverter Cassette Air conditioner (from indoor units to outdoor units) all complete.
- (g) Purging with suitable **eco-friendly** gas for flushing before leak test, leak testing of copper piping & first charge of pre-filled **eco- friendly** refrigerant gas considering lengths of copper piping & A.C unit's capacity etc. all complete.
- (h) Scaffolding work is required for the above work shall be arranged by the Contractor.
- (i) The contractor shall arrange free of cost servicing to be carried out (**3 dry and 1 wet service**) by OEM's authorized Service Engineer/Technical for the completed works including indoor unit, outdoor unit, copper tubing etc. all complete at the interval of **every three months** during Defect liability period.
- (j) **Note:** - ACs quantities may be increases or decreases as per site condition at the time of execution.

  
K. SRINIVAS  
मुख्य प्रबंधक (तकनीकी सेवाएं-मैकेनिकल)  
CHIEF MANAGER (TS-MECHANICAL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

## 1. DRAWINGS AND DOCUMENTATION

- (a) Bidders are advised to visit the site and familiarize himself with the site conditions before submission of the bid. Clarifications, if any, may be discussed with the MDL Engineer-in-charge during the site visit.
- (b) After award of contract, Contractor is required to submit the **print of installation/working drawings in A3 size in 04 sets** for the above scope of work and get it approved from MDL before starting up the work. Drawings (plan and elevation) should indicate the exact locations of AC indoor units, outdoor units, capacities of the ACs, copper tubing layout from indoor to outdoor units and its size, condensate drain UPVC piping layout along with size and its looping/routing from A.C indoor units to the nearest drain point. **Drawing shall contain tabulation of all measurable items of Equipment/Materials/works.**
- (c) Installation/Working drawings shall be submitted for approval sufficiently in advance of installation of any material to allow MDL Engineer ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce installation/working drawings at the right time, in accordance with the approved program.
- (d) When MDL Engineer makes any amendment in the above drawings, the contractor shall supply 02 fresh sets of drawings with the amendments duly incorporated, for approval. The contractor shall submit further 02 sets of installation/working drawings to the Engineer for the exclusive use by the MDL Engineer.
- (e) **4 sets of prints of approved drawings in A3 size to be submitted by the Contractor to MDL.**
- (f) Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the Contractor of the responsibility or requirement to furnish material and perform work as required by the Contract.
- (g) **After completion of work, Contractor shall submit the handing over documents consisting of Handing over report, Commissioning report, Warranty report, Escalation Matrix, DOs & DONTs, Test certificate, Manual and as build drawing in A3 size in a bound book form (04 sets).**

## 2. MATERIALS, DESIGNS, INSTALLATIONS, TESTING & COMMISSIONING

- (a) Inverter split A.C units & Four-way Inverter Cassette Air conditioner shall be factory assembled, wired and tested. It shall comprise of Indoor and Outdoor Units along with all the accessories. Copper Refrigerant Piping interconnecting evaporator and Condensing Unit shall be charged with **eco-friendly** gas and be provided with suitable length of Copper Refrigerant Piping with insulation and shall be provided per Evaporator Unit.

- (b) Condensing Unit shall be suitable for outdoor installation with weather proof enclosure and shall be field serviceable.
- (c) **Contractor to select the model from the preferred list of manufacturers of the Inverter Split AC units & Four-way Inverter Cassette AC units considering the climatic conditions prevailing through the year at MDL Mumbai site.**
- (d) Copper refrigerant piping of suitable diameter compatible with the refrigerant gas & air conditioner model with insulation/nitrile rubber sleeves (19 mm thick), end connections to be installed true to line and level, jointing by brazing & adequately supported intermittently at uniform distance with appropriate clamps / support arrangement including making precise holes in walls with core cutting m/c, providing sleeves & proper finishing for connectivity from indoor to outdoor unit etc all complete as directed by MDL engineer. The alignment of copper piping in horizontal and vertical direction to be maintained.
- (e) Reputed make of ISI mark UPVC plumbing grade condensate drain pipe & fittings to be used for taking out condensate drain water from AC Units up to the Ground Level including looping/routing. The joints shall be properly sealed so that there is no water leakage. Proper grouping of condensate drain pipes & gradient to be maintained for the easy flow of condensate drain water from the A.C units to the ground level. UPVC pipelines to be adequately supported intermittently at uniform distance with clamps, pipe supports with proper alignment in horizontal and vertical direction.
- (f) Unless otherwise specified and approved, all materials and designs shall comply with the current issue of the relevant Indian or International Standard Specifications and their installation shall comply with the relevant current Indian/International Standard Codes of Practices.
- (g) Materials, designs and installations shall comply with the building regulations, local authority regulations and by-laws, Gas Safety Regulations, National Electric Codes for the Electrical Equipment of buildings, insurance company requirements and other statutory rules. All equipment and materials shall be products, which shall meet with the acceptance of authorities having jurisdiction over the work.
- (h) Each item of Equipment/Material shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in the list of preferred makes.
- (i) All equipment and materials required for installations shall be new and without blemish.
- (j) The contractor shall raise inspection call to MDL for the works undertaken at below mentioned stages –  
(i) After delivery of material at site before starting of installation works  
(ii) After testing & commissioning of the completed works.

  
K. SRINIVAS  
CHIEF MANAGER (TS-TECHNICAL)  
WAGON DOCK SHIPBUILDERS LIMITED

- (k) All the works under or in course of execution or executed in pursuance of the contract shall at all times be open to inspection & supervision of the MDL engineer / executives & the contractor at all times during the usual working hours offer assistance for the inspection of work.
- (l) The contractor shall submit supporting documents such as delivery challan(s), Test reports / certificates, packing lists, Invoice, Performance guarantee certificates & other technical documentation in requisite sets as relevant along with the invoice for the purpose of certification by MDL engineer.

### **3. PROTECTION OF MATERIALS AND WORK**

- (a) Copper tubes stored on site shall be supported clear of the ground and kept separate from all other stored ferrous materials & shall be suitably protected against the weather.
- (b) All equipment and materials, fixed or unfixed shall be protected against ingress of dirt or moisture into working parts by means of Polythene covers or other equivalent measures.
- (c) Precautions against mechanical damage by other trades shall be provided.
- (d) Precautions shall be taken and all necessary protection provided to safeguard the work during bad weather.
- (e) The inlet and discharges of all fan coils, and other terminal units shall be kept covered until all local Plastering, Purging, etc. is completed and the units are ready to run.
- (f) Equipment and material damaged shall be replaced by contractor at the discretion of the MDL engineer. Equipment and materials are subject to rejection and replacement, if in the opinion of the MDL Engineer, or in the opinion of the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use is questionable, or that its normal life expectancy has been curtailed.
- (g) The contractor shall be solely responsible to protect all the delivered materials from the time of delivery at site till satisfactory completion & handing over of the completed works from any mode/type of damage/loss that may occur during this period.

### **4. INSTALLATION LIAISON**

- (a) The Contractor is responsible for the co-ordination of all installation work on site. The Contractor shall plan his installation before the work is commenced and to ensure correct installation to the design intent during the course of construction. Any work which has to be re-done due to negligence in this respect, will not constitute an extra work & also shall not be entitled for Extension of Time to the

  
K. SRINIVAS  
CHIEF MANAGER (TS-MANUFACTURING)  
ON DOCK SHIPBUILDERS LIMITED

Contract.

- (b) Contractor has to depute experienced and knowledgeable engineer/supervisor in the field of HVAC who can co-ordinate, execute the work and take site decisions without any delay.
- (c) Particular care shall be taken to obtain uniform and tidy arrangements of wall mounted indoor and outdoor units.
- (d) Where the work of the Contractor has to be installed in co-ordination with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment.

**5. OPERATION & MAINTENANCE MANUAL**

- (a) Upon practical completion of the works, 04 copies of operation & maintenance manual shall be provided. The manual shall contain full operating and maintenance instructions presented in a form to deal systematically with AC units. The manual may contain manufacturer's standard operating and maintenance instructions and leaflets where these are applicable.
- (b) The contractor shall furnish Guarantee / warrantee certificate(s) of each Air Conditioner Unit, duly signed & stamped by the authorised dealer/bidder manufacturer, effective from the date of satisfactory completion & acceptance of the completed works by MDL.

**6. GENERAL INSTRUCTIONS:**

- (a) The Bill of Quantities must be read with the scope of work, Conditions of Contract, Drawings and the Specifications and the Contractor shall be deemed to have examined the Scope of Work, Drawings, Specifications, Conditions of Contract and to have visited the Site and acquainted himself with the Works to be done and the way in which they are to be carried out and all factors affecting the execution of the Works and the Costs thereof including temporary works if required to complete the works.
- (b) All work shall be measured net as it is finished and/or fixed in the Works and no allowance shall be made for wastage notwithstanding any general or local custom. Any items of work not covered in the scope shall be measured as per specifications for works methods laid down in relevant Indian Standards or as decided by the MDL Engineer.
- (c) The quantities set down against the items in the Bill of Quantities are an approximate estimate of the quantity of each kind of work included in the tender and are given for the convenience of forming a common basis for tendering. They are not to be taken as a guarantee that the quantities scheduled will be carried out or required or that they will not be exceeded. MDL reserves the right to delete any item indicated in the bill of quantities at any time.

quantities shall therefore not be considered as representing the final

के. श्रीनिवास  
K. SRINIVAS  
CHIEF MANAGER (TS)  
हार्बर डॉक शिपबिल्डिंग लिमिटेड  
ON DOCK SHIPBUILDERS LIMITED

measurements, it being the intention of the Contract (except where otherwise specifically stated) that the actual quantities of work ordered and carried out shall be jointly measured on completion by the MDL Engineer or his authorised representative and the Contractor and valued and paid for at such prices and rates entered by the Contractor in the Bill of Quantities.

- (e) The rates and prices set down against the items are to be the full inclusive value of the finished work shown on the Drawing and/or described in the Specifications or which can reasonably be inferred there from and to cover the cost of every description of Temporary Works executed or used in connection therewith (except those items in respect of which specific provision has been separately made in the Bill of Quantities) and all the Contractor's obligations under the Contract including testing, giving samples and all matters and things necessary for the proper execution, completion and maintenance of the Works. No claim for additional payment shall be allowed for any error or misunderstanding by the Contractor of the work involved.
- (f) The Specifications and the various Sections in the Bill of Quantities are intended to cover the supply of all the materials and the execution of all works necessary to complete the Works. Should there be any details of Materials or Construction which have not been referred to in the scope of work, specifications, Bill of Quantities or the Tender Drawings, but the necessity for which may reasonably be implied or inferred there from, or which are usual, or essential to the completion of all works in all trades, the same shall be deemed to be included in the rates and prices quoted in the Bill of Quantities. The rates and prices shall cover the items as described in the scope of work, Bill of Quantities, tender drawings and other terms and conditions of the contract.
- (g) The Contractor's unit rates and prices in the BOQ shall include
- (i) All equipment, apparatus, material, indicated in the BOQ, Scope of Work, Drawings, Specifications in connection with the item in question and also associated labour as well as any additional equipment, apparatus, material, consumables usually necessary to complete the system even though not specifically shown, described or otherwise referred to and also associated labour.
  - (ii) It also includes delivering the material, item to the specified storage area at Site. Installation of the same in the specified location as per Drawing & as specified, testing and commissioning as per Specification and direction of the Engineer' at Site.
  - (iii) The unit price shall be deemed to include everything necessary to complete the work covered by this item in accordance with the scope of work, BOQ description, Specifications and Drawings.
  - (iv) The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.
  - (v) All equipment, machinery, apparatus and materials required as well as the cost of any tests which the Engineer may request in addition to the tests generally required to prove quality and performance of A.C units. Further, if any equipment, machinery, apparatus and materials found to not comply/fulfil satisfactory performance/duty during such testing, then cost of replacing such materials.

  
K. SRINIVAS  
मुख्य प्रबंधक (तकनीकी सेवाएं-मैकेनिकल)  
CHIEF MANAGER (TS-MECHANICAL)  
माझगांव डोंक शिपवर्कर्स लिमिटेड  
MAZAGON DOCK SHIPWYER'S LIMITED

- (vi) Use of any tools, equipment, machinery, lifting tackle, ladders consumables etc. required by the Contractor to carry out his work.
- (vii) All the necessary measures to prevent the transmission of vibration. Storage and insurance of all plant and equipment, apparatus and materials.

## 7. **MEASUREMENTS:**

a) **UNITS OF MEASUREMENT:** The units of measurement used in this Bill of Quantities are in metric units as follows:

(i) **Linear:** Linear metre, centimetre or millimetre abbreviated to 'RM', 'cm' or 'mm' respectively.

(ii) **Numbers:** Numbers abbreviated to No's or No.

b) **INVERTER SPLIT AIR CONDITIONER & FOUR WAY INVERTER CASSETTE AIR CONDITIONER:** For measurement and certification of work for Supply & Delivery of wall mounted Inverter Split Air conditioner & Four-way inverter cassette at site, Contractor & MDL engineer will jointly verify the quantities by opening the boxes/package and verify the same with technical details furnished, damage due to transportation and handling etc. before starting the installation work.

Contractor to make all the arrangement for opening and closing of boxes/packages and store the same in proper manner after inspection.

c) **REFRIGERANT PIPING:** Copper piping shall be measured in running meters as actually installed along the centre line of the pipe line including pipe fittings.

Copper piping work for refrigerant would be measured in running meters in one direction from indoor unit up to outdoor unit considering **suction & discharge tubing as one combined set** & excluding the length of copper pipe supplied by the Air conditioner manufacturer as part of the AC unit package. Suction & discharge piping will not be measured separately one from another for certification of work done.

d) **UPVC PIPING FOR CONDENSATE DRAIN:** UPVC piping shall be measured in running meters as actually installed along the centre line of the pipe line including pipe fittings.

## 8. **Technical Specification**

|             |                                    |
|-------------|------------------------------------|
| Capacity    | 1.5 TR (Inverter Cassette AC type) |
| Star rating | 5 star                             |
| Type of AC  | Inverter Split & Inverter Cassette |
| Refrigerant | R32 Eco friendly                   |

*Handwritten signature and stamp:*  
 K. Srinivasulu Reddy  
 Manager (Technical)  
 Dock Shipbuilders Limited

|              |                        |
|--------------|------------------------|
| Condenser    | Copper                 |
| Power Supply | 230V/50HZ/single phase |

## **11. LIST OF PREFERED MAKE FOR MECHNICAL ITEMS**

| ITEMS                                      | PREFERRED MAKES             |
|--------------------------------------------|-----------------------------|
| Inverter Split Air Conditioners            | Mitsubishi/O'General/Daikin |
| Four-way Inverter Cassette Air conditioner | Mitsubishi/O'General/Daikin |
| Insulation/nitrile rubber sleeves          | Superlon/K-Flex/Armacell    |
| UPVC plumbing drain pipe                   | Prince/Astral/Supreme       |

  
 के. श्रीनिवास  
 K. SRINIVAS  
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## SOW FOR VENTILATION SYSTEM

Below points to consider while executions of work

### 1. System Design & Engineering

- Submission shop drawing for execution.
- Calculation of ventilation requirements (air changes per hour, CFM).
- Design of **exhaust air** and **fresh air** ducting layout.
- Selection and sizing of fans, ducts, dampers, and accessories.
- Preparation of **shop drawings** and **coordination drawings**.
- Submission to mdl engineer approval.

### 2. Supply of Equipment & Materials

Supply of all required materials including but not limited to:

- **Exhaust Fans** (centrifugal type)
- **Fresh Air Fans / Supply Air Fans**
- **GI Ducting** with necessary gauges
- **Volume Control Dampers (VCD)**
- **Canvas Connections**
- **Air Louvers / Grilles / Diffusers**
- **Bird Screens and Weather Louvers**
- **Duct Supports, Hangers, and Fasteners**

### 3. Installation Work

- Fabrication and installation of **ducting network** as per approved drawings.
- Installation of **exhaust fans and fresh air fans** with vibration isolators.
- Fixing of **grilles, diffusers, and louvers**.
- Installation of **dampers and access doors**.
- Structural supports and hangers for ducting and equipment.
- Sealing of duct joints to prevent air leakage.

  
K. SRINIVAS  
मुख्य प्रबंधक (तकनीकी सेवाएं-मेकेनिकल)  
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महागंगा डॉक शिपबिल्डर्स लिमिटेड  
GON DOCK SHIPBUILDERS LIMITED

#### 4. Electrical Work (if included)

- Power cabling from panel to fans.
- Installation of **isolators / starters / control panels**.
- Earthing and safety compliance.

#### 5. Testing & Commissioning

- Checking air flow and fan performance.
- Measurement of **air volume (CFM)** at grilles/diffusers.
- Balancing of air distribution.
- Rectification of leaks or noise issues.
- Final system commissioning.

#### 6. Documentation & Handover

- Submission of **as-built drawings**.
- Operation & maintenance manuals.
- Test reports and commissioning reports.
- Training to client/maintenance staff.

#### 7. Warranty & Maintenance

- Warranty for fans and equipment (usually **12 months**).
- Defect liability support during warranty period.

  
K. SRINIVAS  
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CHIEF MANAGER (TS-MECHANICAL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED

## SCOPE OF WORK

### **Fire Fighting System at Anik Chembur Yard:**

1) Supply, Installation, Testing, and Commissioning in position approved make **G. I. 'C' class** pipes conforming to IS 1239 with welded joints and all necessary fittings like elbows, bends, couplings, tees, reducers as required including Dually painted with one coat of yellow primer & 2 coat of Enamel Paint (Fire Red), fabricating & fixing supports with hitech 10mm 'U' bolts for pipes (suspended) supports as per requirement as per direction of Engineer in Charge.

a) 150 mm dia

b) 80 mm dia

2) Supply, Installation, Testing, and Commissioning in position approved make **Butterfly valves** of , Black Nitrile Body rubber gasket, flanges, nuts, bolts, washers etc. complete as per direction of Engineer in Charge.

a) 150 mm dia

b) 80 mm dia

3) Supply, Installation, Testing, and Commissioning in position approved make SS 63mm dia. **Single Hydrant valves** as per IS 5290, Cast Iron Wheel, Rubber Washer, on the wet riser with flanged tee at each Floor Mid landing with all necessary nut bolts and gaskets etc complete as per direction of Engineer in Charge.

4) Providing, fabricating & fixing **Hose Box** for 15M long delivery hose 63mm dia with adapter, branch pipe and nozzle and storing them in metal cabinets of size 750 X 600 X 250MM with lockable glass shutters and fixing the metal cabinet at ground level in a location where it can be easily spotted, etc complete as per direction of Engineer in Charge.

5) Providing, fabricating & fixing in position approved make **M.S./CRCA cabinet** for housing Floor Hydrant valve, hose pipe, hose reel and branch pipe (size W 600 mm x H 750mm ) made from 16 SWG sheet and angle iron 25 mm x 25 mm x 4 mm having front doors with viewing glass (250x900mm).

6) Supply, Installation, Testing, and Commissioning in position approved make fire fighting R.R.L. **Hose pipe**, 63mm dia, 15m in length, fitted with necessary accessories, etc complete as per direction of Engineer in Charge.

7) Supply, Installation, Testing, and Commissioning in position approved make SS metal **Branch Pipe** of 63 mm dia fitted with 20 mm dia detachable hexagonal nozzle fitted with necessary accessories, etc complete as per direction of Engineer in Charge.

8) Supply of 50 kg Mechanical Foam fire extinguishers

50 Kg ABC Fire Extinguishers

  
K. SRINIVAS  
मुख्य प्रबंधक (तकनीकी सेवाएं/टेक्निकल)  
CHIEF MANAGER (TS-MECH/TECHNICAL)  
महाराष्ट्र डॉक शिपबिल्डर्स लिमिटेड  
MAHARASHTRA DOCK SHIPBUILDERS LIMITED



**Shed For AIP Project near Shed No. 6 for Thermax and annexe area for Texol at Anik Chembur Yard**

**BRIEF SCOPE OF WORK (Electrical):**

1. Excavation of trench for cable laying where ever required and back filling of the excavated area clearing the site by removing the debris and making the area as it was.
2. Supply, Laying, Glanding and Termination of LT Cables over walls with clamping or through Hume pipes in excavated trench.
3. Supplying & erecting cast iron cable indicator plate buried along with route of cable.
4. Supply, Installation, Testing and commissioning of Flame proof LT panel & Out Door Type Panel as per SLD and details provided.
5. SITC of flameproof distribution boards
6. Supply installation, testing and commissioning of Flame proof LED flood lights in Hydrogen Area and weather proof LED flood lights in the outside area of the shed.
7. Supply, installation, testing and commissioning of flame proof Junction Box
8. Installation of cable trays for laying of the cables with proper dressing of the cables with PVC ties.
9. Rerouting of existing cables over cable trays or in a new/existing trench.
10. Supply and erection of Maintenance Free earthing pits for Equipment and lightening arrestor for shed. Erection of copper /aluminium earthing strip.
11. Testing and commissioning all the equipment's which are in the MDLs scope for this project.

  
19/12/2020  
MAHESH D. SURANT  
MANAGER (TS-ELECTRICAL)  
MAZAGON DOCK SHIPBUILDERS LIMITED

  
S.R. CHAVAN  
मुख्य प्रबंधक (विभाग प्रमुख-तकनीकी सेवाएँ-इलेक्ट्रिकल)  
CHIEF MANAGER (HOS-TS-ELECTRICAL)  
माझगांव डॉक शिपबिल्डर्स लिमिटेड  
MAZAGON DOCK SHIPBUILDERS LIMITED