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

Restorative Repair /Construction of Kasara Dolphin Jetty, NY, MDL, Mumbai

Technical Specification
&
Preferred Make

INDEX
TECHNICAL SPECIFICATIONS
Contents

1. 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 shall order such tests and analysis of all materials before leaving the manufacturer's premises or the source of supply and/or when brought on site 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 at all times as the latter may reasonably require.

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 employs 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, a fully qualified and experienced Quality Control Engineer shall be employed by the Contractor and he shall be available on Site at all times when concreting operations are in progress. Operators for mixers, mechanical vibrators and personnel in-charge of placing of concrete shall be fully trained and experienced for their type of work.

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 equipments 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 Field Investigation:-Contractor has to take the Marine Bore Holes from the sea bed Soil /Weathered rock levels to approximate depth of up to 15m including existing soil & Rock sampling and conduct the tests in laboratory detailed below-a)Standard Penetration test b)Rock density test c)Rock hardness Test d)Unconfined Compression test. The test reports to be submitted to MDL.

1.12. Non Destructive Testing(NDT):- Contractor has to arrange and carryout the Non-destructive testing on existing structures of Kasara Dolphines, Cantilever beams, piles as per relevant IS codes & specifications. The NDT like Rebound hammer tests, Ultrasonic Pulse velocity test, Core Tests with 40mm dia core are to be taken at site as directed by Structural Consultant. Cores to be filled with micro-concrete. The test reports along with interpretation to be submitted to MDL. All the costs towards carrying out the tests at site including testing equipments, tools, ladders, scaffolding along with technicians, skilled / unskilled labours to be considered. No additional payment shall be made towards the same.

1.13 Existing Structural steel at site-The contractor has to dismantle the existing Structural steel at site carefully manually or mechanical means including dismembering and handover the same in the designated scrap bins in MDL Yards after weighment. The weighment receipt to be submitted to TS department.

1.14 **Marine Scaffolding** :- The contractor has to provide & erect at site in Marine Condition self supported steel H-Frame scaffolding for structural repairs/jacketing of

Dolphines/Beams in Marine Condition, with cross bracing of good quality without dents and corrosion to reach place of work including approaches, extension, working platform, ladders lifting tackle necessary wall anchors for men and materials till completion of all structural repair work and curing period etc complete. The work should be carried out with all safety measures like helmet, safety belt and adequate labour insurance **under supervision of qualified supervisor**. The elevational area of the scaffolding shall be measured for payment purpose. (Payment shall be made only once irrespective of duration of scaffolding).

2. MATERIALS:

2.1 CEMENT:

Fresh quality cement shall be procured only from approved manufacturer / supplier and shall be subject to prior approval of the Engineer-in-Charge. Following types of cement shall be used:

i) All cement used for the work shall be ordinary portland cement or such other cement as may be permitted by the Engineer-in-charge. Portland cement shall comply with the requirements of the latest issue of IS 269. High alumina cement, rapid hardening cement and Portland Slag cement etc., can be used only when permitted by the Engineer-in-charge. Such cements shall be in accordance with relevant IS Codes. Portland Pozzolana cement when permitted by the Engineer-m-charge shall conform to IS 1489 Part I but it shall not be used or RCC structural member.

ii) Cement which has remained in bulk storage at the mill for more than 6 months or which has remained in bags at the dealers storage for over 3 months, or which has been stored at project site for more than 3 months shall be re-tested before use. Cement shall also be rejected if it fails to conform to any of the requirements of these specifications.

iii) Different types of cement shall not be mixed.

2.2 FINE AGGREGATES

Fine aggregates shall consist of natural sand, manufactured sand or an approved combination thereof and shall conform to IS: 383. The grading zone of sand proposed for use shall be supplied by the contractor and got approved by the Engineer-in-Charge.

The sand shall be siliceous material, sharp, hard, strong and durable and shall be free from adherent coatings, clay, dust, alkali, organic material, deleterious matter, lumps, etc.

Either natural or manufactured sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter. Natural sand shall be washed, unless specific written authority is given by the Engineer-in-charge to use sand that meets specifications and standards of cleanliness without washing. The cost of screening and washing must be borne by the contractor. The fine aggregate shall be taken from a source approved by the Engineer-in-charge.

2.3 COARSE AGGREGATES

Coarse aggregates shall consist of hard, strong, durable particles of crushed stone and shall be free from thin elongated soft pieces, organic or other

deleterious matter. It will be from a source approved by the Engineer in charge. Coarse aggregate shall conform to IS: 383.

Coarse aggregate shall be washed if necessary to remove all vegetable and other perishable substances and objectionable amounts of other foreign matter, the cost of washing and screening being borne by the contractor.

Size of Coarse Aggregates

Following shall be the maximum nominal size of coarse aggregate for the different items of work if not specified in the item of works or their respective specifications:

Sr. No.	Item of Construction	Max. Nominal Size of Coarse Aggregate
(i)	RCC well steining concrete, RCC well curb & RCC piles in plum concrete	40 mm
(ii)	Well cap or pile cap, solid type piers, abutments and wing walls, and, footing of open foundation and general items of work in bridge and building construction.	20 mm
(iii)	RCC works in girders, deck slab, wearing coat, kerbs, light posts, ballast walls, approach slab etc. and piers, returns, wing walls and retaining walls.	20 mm
(iv)	RCC bearings, shells and other thin walled members and in zones of congestion.	20 mm
(v)	For any other item of construction not covered by items (i) to (iv)	As specified in the drawings or as desired by the Engineer-in-Charge

For heavily reinforced concrete members as in the case of ribs of main beams, the nominal maximum size of aggregate shall usually be restricted to 5 mm less than the minimum lateral clear distance between the main bars, or 5 mm less than the minimum cover to the reinforcement, whichever is smaller.

2.4 REINFORCING STEEL

Reinforcing steel shall be clean and free from loose mill scales, dust, loose rust and coats of paints, oil, grease or other coatings which may impair or reduce bond.

a) **Fe-500D** high strength deformed bars shall conform to IS: 1786, **TMT bars conforming to IS: 1786 shall only be used.**

b) Structural steel sections and plates shall conform IS: 226 and IS: 2062.

Note: The reinforcement steel to be used for the construction shall be of Grade Fe – 500D only (for all RCC structures).

2.5 WATER

Water used mixing and curing shall be free from injurious amounts of deleterious material. pH value of water shall not be less than 6. Potable water is generally considered satisfactory for mixing and curing concrete. Water shall be got tested before use in concrete and curing. The cost for the same shall be borne by the contractor. Permissible limits for solid shall be as below:

PERMISSIBLE LIMIT FOR SOLIDS

	Tested as per	Permissible limit max.

Organic	IS : 3025 (Pt.18)	200 mg/lit.
Inorganic	IS : 3025 (Pt. 18)	3000 mg/lit.
Sulphates (as SO3)	IS : 3025 (Pt. 28)	400 mg./lit.
Chlorides (as C1)	IS : 3025 (Pt. 32)	2000 mg. lit. for concrete work not containing embedded steel and 500 mg. /lit. for prestressed /reinforced concrete work.
Suspended matter	IS : 3025 (Pt. 7)	2000 mg. /lit.

2.6 ADMIXTURES

No materials other than essential ingredients i.e., cement, aggregate and water, shall ordinarily by used in the manufacture of concrete or mortar. But the Engineer-in-Charge may permit the use of approved admixtures for improving the workability of the concrete, if so specified on satisfactory evidence that its use does not in any way adversely affect the properties of concrete particularly its strength, volume changes, durability and has no deleterious effect on the reinforcement. Admixture where allowed shall conform to relevant IS: 9103.

Chloride content in admixture shall be independently tested for each batch before acceptance.

2.7 MATERIALS FOR REPAIR WORK

The use of epoxy for bonding fresh concrete used for repairs will be permitted on written approval of the Engineer-in-Charge. Epoxies shall be applied in accordance with the instructions of the Manufacture.

2.8 STORAGE OF MATERIALS

i) Cement

The contractor shall make arrangements to the satisfaction of the Engineer-in-Charge for the storage of cement to prevent deterioration due to moisture and/or intrusion of foreign matter. Bulk cement shall be stored in approved water-proof bin or silo. Bagged cement shall be stored in a suitable weather tight warehouse in a manner to provide easy access for identification and inspection of each consignment. Stored cement shall meet the test requirements as per IS-269 at any time after storage, when a retest is ordered by the Engineer-in-Charge. Each consignment shall be stacked separately with the date of receipt flagged on it, not more than 12 bags being stacked in height, the bags being arranged with headers and stretchers. Normally consignments shall be used in the order of receipt at site unless otherwise directed. In the case of large concrete pours the Engineer-in- Charge will decide on the batch of cement to be used taking into consideration the quantity of cement with particular reference to the concerned concrete pours. Any additional work in handling and storage of cement contingent upon this requirement shall be to the contractors' account and no extra claim will be entertained. Cement shall be protected from closure to moisture in transit, in storage at the works and until it enters the concrete mixers. The contractor shall keep accurate records of the deliveries of the cement and of its use in the work.

ii) <u>Aggregates</u>

Coarse and fine aggregates shall be stacked separately in such manner as to prevent contamination by foreign materials. All aggregates shall be stored on concrete or masonry platforms, each size shall be kept separate with wooden, steel, concrete, or masonry bulk heads, or shall be stored in separate stacks, taking care to prevent the materials at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart. The aggregates shall be stored in easily measurable stacks of suitable heights as may be directed by the Engineer- in-Charge.

iii) Reinforcing Steel

Reinforcing steel shall not be stored directly on the ground. These shall be stored under cover and shall be protected from rusting, oil, grease and distortions as directed by the Engineer-in-Charge.

2.9 PROPORTIONING CONCRETE

2.9.1 CONTROLLED CONCRETE

Concrete mix shall be designed for 33% higher strength than the grade of concrete specified. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available.

Except where it can be shown to the satisfaction of the Engineer-in-Charge that a supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be strictly controlled. The different sizes shall be stocked in separate stock piles. Required quantity of material shall be stock-piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the design mix.

The quantity of both cement and aggregate shall be determined by weight. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, the moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates, IS: 2386 (Part III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content.

For the minimum cement and maximum water cement ratio and minimum grade of concrete refer Table: 5 of IS-456-2000.

For adjustments to Minimum Cement Contents for Aggregates other than 20 mm Nominal Maximum Size, refer Table:6 of IS-456-2000

For Limits of Chloride Content of Concrete refer Table: 7 of IS-456-2000

Condition of Exposure:

i) **Severe - Marine Environment:** Alternate wetting and drying due to sea spray, alternate wetting and drying combined with seezing, buried in soil (having

corrosive effect); members in contact with water where the velocity of flow and the bed material are likely to cause corrosion of concrete.

ii) Moderate - Condition other than 'severe' :

a) The minimum cement content is based on 20 mm size aggregates. For larger size aggregates, it may be reduced suitably by not more than 10%. Similarly, for smaller size aggregates, it may be suitably increased, but not more than 10%.

b) The cement content shall not exceed 540 kg/cu.m. of concrete.

2.9.2**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.

GENERAL

S. No	IS Code No	Particulars
1	IS : 4082-1977	1. Carriage of materials. Recommendation of stacking and storage of construction materials at sites. (1st revision) (Reaffirmed-1990)
2	IS:1200 (Part 22)-1988	Method of Measurement of Building & Civil Engineering Works-Part 22-Materials
3	IS : l7293-1974	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.
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

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)

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)

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)

3. Specification

3.1 Chipping& Removal of Dilapidated concrete

a) Scope: To remove weak / loose / dilapidated concrete from RCC structural members by chiseling, chipping etc.

b) Tools: Electrically operated low impact chipper tools, complete with accessories, hand- tools like chisels, hammer, etc.

c) Procedure:

- Provide props & other suitable arrangements to relieve the structural member of stress and strains wherever feasible.
- Suspended or suitable type of scaffolding to be provided. The same should be safe and adequate for executing all repair operations.
- Working Platforms shall be erected suitably, if necessary.

- Provide Protective Screen or suitable arrangements to minimise falling of debris in sea.
- Mark off the area to be repaired.
- Chipping to remove all the weak / loose / dilapidated concrete from RCC structural members shall be done carefully from the damaged portions by adopting electrically operated low impact chipper tools or manual means up to the required depth till sound concrete substrate, without causing excessive vibrations or damaging the structure. All the edges and cavities shall be square shouldered. Care must be taken to avoid contact with the reinforcing steel, as both the reinforcement and the cutter could be damaged.
- Removing the excessively corroded reinforcement wherever directed by the Engineer's Representative. The reinforcement steel shall be cut / shear manually or by electrically operated cutter or any other method as approved by the Engineer's Representative. The operation shall be without causing excessive vibrations or damage to the structure.
- Cleaning the chipped surface with wire brush or buffing machine.
- Inspection, after concrete chipping & cleaning, for weaknesses and delamination of exposed surfaces shall be visually carried out. If required, additional chipping will be required to be done.
- Transporting the concrete debris and other unserviceable materials outside MDL premises as directed.

3.2 Rust Removing from existing corroded rebars

a) Scope: To remove corrosion from the existing steel reinforcement of the RCC members.

b) Tools: Rotary wire brush machine, wire brushes, paint brush, abrading cloth etc.

c) Materials: Rust Remover

d) Procedure:

- Remove the rust manually/ mechanically from all round the surface along the length of reinforcement, using hand tools like chisels, hammers, wire brushes, Rotary wire brush machine, abrasion cloth/paper, etc. till such time that the steel surface is cleared of all rust that could be removed.
- Chemical rust passivator shall be brush applied over the reinforcement surface thoroughly all around the circumference and along the full length of rusted reinforcement. After the coating has cured, the surface shall be cleaned with

wire brush and all loose particles removed. The second coat, if required, the same shall be applied as per manufacturer's recommendation after the first coat is touch dry.

3.3 Rebar protective coating with zinc rich epoxy primer

a) Scope: To protect new & exposed rebars from corrosion with an Anti-Corrosive Coating.

b) Tools: Rotary wire brush machine, wire brushes, paint brush, abrasion cloth / paper, mechanical mixer, mechanical stirrer, etc.

c) Materials: Rebar protective coating with zinc rich epoxy primer approved make or equivalent

d) Key performance properties: As per approved manufacturers technical data sheet/ specifications.

e) Procedure:

- Remove the rust manually/ mechanically from all around the surface of new / exposed reinforcement bars along the length of reinforcement, using tools like wire brushes, Rotary wire brush machine, abrasion cloth/paper, etc. till such time that the steel surface is cleared of all rust.
- The components of the anticorrosion coating epoxy based zinc rich primer shall be thoroughly blended with a mechanical mixer to a uniform and homogeneous mixture. Small batches (upto 1 litre) may however be allowed by manual mixing using spatulas, palette, knives etc.
- Anticorrosive Coating shall be applied to cleaned new reinforcement before placing it in the structure. The Anti Corrosive Coating shall be brush applied or spray applied to the existing reinforcement wherever feasible, over the reinforcement surface thoroughly all around the circumference and along the full length of reinforcement and at the cut ends, ensuring that no pinholes are remaining.
- After the coating has cured, the surface shall be cleaned with soft wire brush and all loose particles removed. Apply anti corrosion coating with zinc rich epoxy primer or equivalent for active corrosion control to both the new as well old steel reinforcement, ensuring that the reinforcing steel is completely coated with the product from all around.

3.4 Providing and fixing shear connectors

a) **Scope:** Shear Connectors & Rebar connectors are used for providing a structural connection of the applied repair materials with the substrate/parent surface for transfer of forces occurring at the interface.

b) **Tools:** Caulking gun, standard power driven drilling equipment, hand operated blow out pump, brushes, epoxy dispenser and any other incidental accessories and T&P items.

c) **Materials:** shear connectors approved make or equivalent

d) **Key performance properties:** As per approved manufacturers technical data sheet/ specifications.

e) **Procedure:**

- Mark the locations of Shear / Rebar connectors as directed.
- Drill holes to specified depth and diameter in concrete at marked locations for the specified dia of shear / rebar Connectors.
- The drilled hole in dry state shall be cleaned with round brushes and by blowing air through a tube inserted in the hole and connected to hand operated blow out pump or by compressed air.
- Inject Epoxy grout, via chaulking gun inside the drilled hole to fill it from bottom of the hole and upwards.
- Placing the shear / rebar connectors in position and allowing it to remain undisturbed till epoxy is set.

3.6 Providing and fixing new rebars

a) **Scope:** Providing additional reinforcement to the existing RCC Structure for the reinforcement lost due to corrosion of rebar above 25% of its original size or providing reinforcement in new RCC members.

b) **Tools:** welding machine, generator and other incidental tools etc.

c) **Material:** HYSD reinforcement of minimum 500D grades, conforming to IS 1786 and already coated at site with Epoxy Zinc Rich Primer, Galvanised / PVC coated binding wire.

d) **Procedure:**

- The additional reinforcement shall be provided as directed by the Engineer's Representative.
- While carrying out the repairs to the existing RCC members, new rebars shall be fixed to the shear / rebar connectors (already driven into the concrete) by

welding. The new rebars shall also be welded with the old rebars. In case, welding is not feasible, binding wire will be permitted, at the discretion of the Engineer's Representative.

- The new rebars shall be secured rigidly so that the vibration resulting from the deposition of repair material shall not impair or displace them. Minimum requirement of lap length of bars and Minimum cover to the reinforcement shall be as specified in I.S. 456.
- The rebars shall be provided for new RCC members as per the direction of the Engineer's representative.

3.7 Providing and applying bond coat

a) Scope: To provide adequately strong adhesion of parent concrete with applied repair micro concrete / polymer mortar.

b) Tools: Electronic Weigh Machine (for accurately weighing different components of materials in required proportions), slow speed stirrer with 300 to 400 rpm speed, Spray equipment / brush / roller for application of polymer modified bonding cement slurry.

c) Material: Bond coat approved make or equivalent

d) Key performance properties: As per approved manufacturers technical data sheet/ specifications.

e) Procedure:

- Wash the Concrete surface with water jet and saturate the surface with water but shall be free of excess surface water.
- Bond Coat Mixing: Components of the bonding coat mix shall be weigh batched and mixed in proportions as specified by the manufacturer, in a clear container free from harmful residue or foreign particles. The components shall be thoroughly blended with a mechanical stirrer to a uniform and homogeneous mixture.
- Bond coat application: Bonding coat shall be applied by spray equipment or stiff nylon bristle brush as approved by Engineer's Representative. The bonding material shall be worked well into the surface of the parent body ensuring that no pinholes are visible.

3.8 Jacketing work with Micro – concrete - The contractor has to carryout the micro-concreting as per details below : Replacing distressed /loose/cracked /porous carbonated, loose part of concrete with free flow, high strength, non-

shrink fibrous micro-concrete of approved make including fixing slurry tight form work /shuttering across the profile of damaged structural element, pour the free flow ready mix micro-concrete after mixing with water as per manufacturer's specification in the formwork. Micro concrete should be mixed in steel tray homogeneously make up concrete is based on the type of structural element and its location. The work should be carried out with all safety measures like helmet, safety belt and adequate labour insurance under the supervision of qualified supervisor etc. complete.(**Micro concrete manufactured by Fosroc, Krishna Conchem, Sika, Sunanda, Pidilite, BASF, BECK BOND or Equivalent as approved by Engineer in charge).**

Record of micro-concrete consumption to be maintained day to day indicating the structure & location. Wastage of material inside water will not be considered. Unit for micro-concrete is Kg.

a) Scope: This specification covers the refurbishment of damaged concrete and sectional enlargement using single component, free flow microconcrete

b) Tools: High pressure (min 150bars) water jetting machine, Sand blasting, Thermometer, Wooden/Steel Trowel, Surface Spatula, Mixing Paddle, Chipping Machine, Hand Held Mixing Machine/Pan Mixer, Roller/Brush, Hammer & Chisel

c) Materials: Sectional enlargement/refurbishment of damaged concrete in old and new concrete structures should be carried out with micro concrete of approved make or equivalent

d) Key Performance properties: As per approved manufacturers technical data sheet/ specifications.

e) Procedure:

- To enhance bonding, the substrate shall be primed with bond coat.
- Shuttering moulds of plywood or steel formwork shall be used to pour microconcrete.
- In case of plywood, reuse of plywood more than 3 times shall be avoided.
- Alternatively, mould release agent shall be applied to prevent formwork loss and achieve good finish.
- The required formwork shall be properly measured, fabricated and kept ready for installation before the application of bond coat.

- Structural steel formwork should be sturdy, leak proof and should be strong enough to take the pressure of concrete and the weight and force of the vibration equipment till the concrete solidifies.
- Proper supports to the formwork shall be provided to avoid displacement during the placement of the concrete and to avoid unwanted bulging using good quality props.
- After the concrete sets, formwork shall be removed carefully without damaging the concrete.
- To facilitate easy removal of the formwork, it should be coated with a mould release agent of any make (chemical) before the concrete is placed in the mould.
- To prevent sagging/cracking of the bulk green concrete, remove the formwork minimum after 24 hours of placement.
- It is strongly recommended that only full bags are mixed. Damaged or opened bags should not be used.
- Only use clean potable water for mixing.
- Water Powder Ratio needed: The repair mortar is designed for water powder ratio as per manufacturers specification.
- Use slow speed electric drill fitted with a spiral paddle for 1-2 bags mixing. For lager batch size use a pan type mixer or tilting drum type mixer.
- Place approximately 80% of the water in the mixer. Keeping the mixer running add microconcrete slowly. Add remaining water while continuing to mix. Mix for 3 – 4minutes or until a lump free homogeneous consistency is achieved.
- Allow the mortar to rest for 2 - 3 minutes and then remix briefly, adjusting the consistency when required, without exceeding the maximum water demand.
- The minimum temperatures must be maintained during application and for at least 24 hours thereafter for optimum curing of the product.
- The prepared substrate should be pre-soaked, preferably at least 2 hours before applying microconcrete**.** The surface must be saturated dry, but without standing water.
- Place microconcrete into the formwork within 20min. after mixing by pouring or pumping.

- The mortar should continue to be placed into the pouring hopper of the formwork until completion while gently tapping with a light hammer along the sides of the formwork.
- Microconcrete can be placed in thickness ranging from 25mm to 100mm without the need of adding aggregates.
- To prevent sagging/cracking of the bulk green concrete, remove the formwork minimum after 24 hours of placement.

3.9 External area protection with anti-carbonation coatings

a) Scope: This specification covers external protection Dolphine walkway area, structures in the exposed areas above water and ground level that are exposed to the risk of deterioration from rebar corrosion caused by carbonation, chloride ion ingress, other atmospheric corrosive agents and water permeability.

b) Tools: Sand blasting, Surface Spatula, Drilling Machine, Angle Grinder, Mixing Paddle, Mechanical cutter, Utility Knife, Grooved Pressure Rollers, Roller/Brush

c) Material: Anti-carbonation coatings of approved make

d) Key performance properties: As per approved manufacturers technical data sheet/ specifications.

e) Procedure:

- Concrete must be cured and minimum 14days old.
- Substrate shall not have a moisture level >4%.
- **For exposed Concrete without existing coating:** All loose traces of dust, dust, grease oil, form release agent etc. must be thoroughly removed mechanically by scrapping, brushing, high pressure water jetting.
- Blow holes, rough or irregular/rough substrate shall be made even by the equivalent dual shrinkage compensated repair morter.
- The week cementitious slurry powder/ laitance on top of the concrete shall be suitably abraded & cleaned.
- Damaged or contaminated concrete shall be removed to obtain a keyed surface.
- **For exposed Concrete with existing coating:** Existing coating /its traces must be completely removed by suitable mechanical method to obtain a substrate suitable for coating application as above.
- Anti-carbonation coatings material is homogenized first by stirring with a clean stick before application.

- Application can be either by Hand (by roller or brush)- small quantities shall be transferred to container for use, while keeping the lid of the supplied container closed. Or by low pressure sprayer – can be directly sprayed from the supplied container or transferred to the sprayer container.
- Ideally do not apply the material when either the temperature >40□or humidity is >75%.
- Allow anti-carbonation coatings material to dry for 2-3 hrs. before the application of shrinkage compensated mortar
- Stir shrinkage compensated mortar thoroughly before application till homogeneous mixture is achieved.
- Do not dilute the material.
- The prepared surface should be air dry before the application starts.
- After the anti-carbonation coatings material is touch dry, shrinkage compensated mortar shall be applied @ 0.5Kg in two coats, to obtain a dry film thickness of 150µ.
- Apply the material either by Hand (by roller or brush) - small quantities shall be transferred to a wider container for use, while keeping the lid of the supplied container closed.
- Application shall be in two coats, the second coat only after the first coat is dry to touch and at right angles to the first. Or by airless spray equipment – can be directly sprayed from the supplied container or transferred to the sprayer container.
- The Specified WFT of 375µ shall be applied in a two coat of 185µ each after ascertaining through a trail patch it can be achieved.
- Do not apply the material when either the temperature >40□/<5□or humidity is >75%or both.
- Shrinkage Compensated mortar is self-curing. Full cure requires minimum of 7 days.

4. CONCRETE WORK

4.1 General

4.1.1 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.

4.2 Submittals

4.2.1 **Materials Reports**

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

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

4.2.1.1.2 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.

4.2.2 **Plant and Equipment**

4.2.2.1 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.

4.2.3 **Certificates**

4.2.3.1 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.

4.2.3.2 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.

4.2.4 **Schedules**

4.2.4.1 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.

4.3 **Materials**

4.3.1 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.

4.3.2 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.

4.3.3 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.

4.3.4 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.

4.4 **Cement**

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

4.4.2 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.

4.4.3 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 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.

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

4.4.5 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.

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

4.4.7 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.

4.5 **Aggregates**

4.5.1 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.

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

4.5.3 Fine Aggregates

4.5.3.1 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 silicious material.

4.5.3.1.1 Silt Content

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

4.5.4 Coarse Aggregate

4.5.4.1 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.

4.5.4.2 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.

4.5.4.3 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.

4.6 **Water**

4.6.1 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.

4.6.2 Water shall be from the source approved by the Engineer and shall be in accordance with IS: 456 (latest edition)

4.6.3 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.

4.7 Steel Reinforcement

Steel reinforcement shall be of Thermo Mechanically Treated (**TMT**) **500D** bar confirming to IS 1786 (latest edition).

4.8 **Admixtures and Additives**

4.8.1 Chemical admixtures shall conform to IS 9103 & are not to be used unless permitted by the Engineer. In case their use is permitted, the type, amount, chemical property and method of use of any admixture proposed by the contractor shall be submitted to the Engineer for approval prior to the approval of the same.

4.8.2 The contractor shall further provide the following information concerning each admixture to the Engineer.

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

4.8.2.2 The chemical names of the main ingredients in the admixture.

4.8.2.3 The chloride ion content if any expressed as a percentage by weight of admixture.

4.8.2.4 Whether or not the admixture leads to entrapment of air when used in the manufacturer's recommended dosage.

4.8.2.5 Where two or more admixtures are proposed to be used in any one mix, the manufacturer's written confirmation of their compatibility.

4.8.3 In reinforced concrete, the chloride ion of any admixture used shall not exceed 2% by weight of the admixture as determined in accordance with IS: 6925 and the total chloride ion in all admixtures used in concrete mix shall not exceed 0.83 percent by weight of cement or as per latest IS code.

4.8.4 The admixtures shall conform to IS: 9103. The suitability of all admixtures shall be verified by trial mixes.

4.8.5 The addition of calcium chloride to concrete containing embedded metal will not be permitted under any circumstances.

4.8.6 Retarding admixtures when used shall be based on lingo sulphonates with due consideration to clause 5.2 and 5.3 of IS: 7861.

4.8.7 Waterproofing admixtures shall comply with IS: 2645.

4.9 **Storage**

All goods and products covered by these specifications shall be procured well in advance and stored as specified below:

4.9.1 **Storage of Cement**

4.9.1.1 Cement shall be stored on a raised floor in dry, waterproof and well ventilated shed.

4.9.1.2 Cement bags shall be stacked at least 60 cm away from external walls and in stacks of not more than ten bags to avoid lumping under pressure.

4.9.1.3 Cement stored during monsoons shall be completely enclosed in 700-gauge polythene sheet so arranged that the flap closes on the top stack. The contractor shall ensure that protective polythene sheet is not damaged at any time during use.

4.9.1.4 Cement of different types shall be stored in separate sheds or separate compartment of a shed. If different types of cement are mixed, the Engineer will have the discretion to condemn all the cement concerned.

4.9.1.5 Consignment of cement shall be used in order of delivery. A record shall be kept of the batch numbers of cement deliveries in such a form that the part of the works in which the cement is used can be readily identified.

4.9.1.6 The contractor shall be responsible for the storage of cement at the site and no claim will be entertained in the event of any damage occurring to cement due to faulty storage by the contractors or on account of his negligence.

4.9.1.7 Cement stored on site for a period longer than eight weeks shall be tested to the satisfaction of the Engineer before it is used in the works.

4.9.1.8 Cement which has so deteriorated in quality that it no longer conforms in all respects to the requirements of this specification will be condemned by the Engineer & shall not be used in the works. The contractor shall immediately remove from the site all cement, which has been so condemned

4.9.2 **Stacking of Aggregates**

4.9.2.1 Aggregates shall be stored on a suitable well drained raft of concrete, timber, metal or other approved material. The storage of aggregate on the ground will not be permitted.

4.9.2.2 Each size of aggregate shall be stored separately in such a manner as to prevent spillage and mixing of one aggregate with an adjacent aggregate. The dividing wells of any bins shall be of sufficient height & the aggregate shall be so deposited that a distance of 300 mm shall be left between the top of the division wall and any part of the aggregate stack.

4.9.2.3 When stack piling, the aggregate shall not form pyramids resulting in segregation of different size particles. The stacks shall be regular and of a height not exceeding two meters.

4.9.3 Stacking and Storage of Steel Reinforcement

4.9.3.1 Steel reinforcement shall be stored in a way as to prevent distortion and corrosion, bars of different classifications, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths and to minimize wastage in cutting from standard lengths.

4.10 **Concrete Mix**

4.10.1 Cement concrete used in the works shall be either of the two categories given below:

4.10.1.1 **Nominal Mix Concrete**

4.10.1.1.1 The proportion of aggregates and cement shall be as specified.

4.10.1.2 **Design Mix or Controlled Concrete**

4.10.1.2.1 The design mix or controlled concrete shall conform to the grades specified in item or drawings. The mix shall be designed to achieve the required strength and the ingredients shall be measured by weight in approved weigh batching equipment. Mixing of water shall be measured in graduated liter cans. In case cement is supplied packed in bags one or more complete bags of cement shall be used for each batch of concrete.

4.10.1.2.2 The controlled concrete shall meet with the strength requirement laid down in Table 2. The aggregate cement ratio and water cement ratio to be used for obtaining the specified strengths given in Table 2, shall be determined in accordance with the design of the mix. The water cement ratio shall not be more than the maximum water cement ratio specified hereinafter.

TABLE-1

Grade of Controlled Concrete	Compressive Strength of 15 cm Cubes (Kg/cm^2)			
	Laboratory Design Strength		Field Test	
	7 days	28 days	7 days	28 days
M15	143	210	105	150
M20	190	280	140	200
M25	235	345	175	250
M30	270	410	205	300
M40	360	560	270	400

4.10.1.2.3 The contractor shall be responsible for designing mixes of the specified performance to suit the degree of workability and characteristic strength, required for the various parts of the works.

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

4.10.1.2.5 The minimum cement content for various grades of concrete shall be as follows.

Grade of Concrete	Minimum cement content (Kg/m^3)	
	PCC	RCC
M 15 (1:2:4)	240	300

M 20 (1:1.5:3)	260	340
M 30 (Design Mix)	-	340
M 40 (Design Mix)		400

4.10.1.2.6 The maximum water cement ratio shall be 0.45 for M-30 & M-25 grade concrete, and 0.5 for M 20 grade concrete

4.10.2 **Strength of Nominal Mix Concrete**

4.10.2.1 The compressive strength on field tests for different nominal mixes, if adopted are given in Table - 3 below:

Table – 3

Concrete Mix (Nominal)	Compressive Strength (Kg/cm^2)	
	7 days	28 days
M - 15	105	150
M - 20	140	200

4.11 **Water Cement Ratio**

4.11.1 The quantity of water added to the cement and aggregate during mixing shall be such as to produce a concrete having sufficient workability to enable it to be properly compacted to be worked into the corners of the shuttering and around reinforcement.

4.11.2 The variation of moisture content within any consignment of aggregate and any variations due to watering, exposure to rain or drying weather shall be taken into account in determining the quantity of water to be added in concrete mix. The contractor shall carry out regular moisture content tests in accordance with IS:2386 Part III on stacked aggregate as directed by the Engineer and results submitted to him.

4.11.3 In case of nominal mix concrete the maximum water cement ratio shall be as stated in Table - 9, IS : 456 and in the case of controlled concrete the water cement ratio shall be as determined in the approved mix design subject to maximum limit as stated herein before.

4.11.4 The contractor shall exercise tight control on the water content for concrete mix.

4.11.5 When a suitable water cement ratio has been determined and approved by the Engineer, it shall be maintained throughout the corresponding part of works. Approved tests shall be undertaken periodically by the contractor to satisfy the Engineer of the maintenance of the consistency. However the amount of water added to a mix other than for fair faced concrete may be reduced below the agreed design amount with the consent of the Engineer if the contractor is able to demonstrate that such a reduction is consistent with producing concrete of the required workability and characteristic strength.

4.11.6 The contractor shall frequently test the concrete for slump cone test. The slump at the actual location of placing as measured in accordance with the methods laid down in IS: 1199 shall not be more than 75 mm and not less than 50 mm unless otherwise approved by the Engineer.

4.12 Approval of Design Mixes

4.12.1 The contractor shall submit to the Engineer for comment sufficient evidence based on trial mixes that for each grade of concrete, the intended workability,

the proposed mix proportions & method of manufactures, which will produce concrete of the required quality.

4.12.2 The contractors shall obtain from the Engineer his written approval on the mix design for each grade of concrete before any concrete of that grade is placed in the works.

4.12.3 For each grade of concrete, three separate batches of concrete shall be made by the contractor using materials typical of the proposed supply and under full scale site conditions.

4.12.4 The workability of each of the trial batches shall be determined and 3 specimen preliminary test cubes shall be tested at 7 days & 6 cubes of each set shall be tested at 28 days.

4.12.5 Following agreement with the Engineer on the trial mix proportions should the contractor wish to make substantial changes in the materials or in the proportions of the materials to be used in mix, the Engineer will require further trial mixes to be made and their results submitted for comments prior to such materials or proportions being adopted by the contractor.

4.13 Concrete Testing

4.13.1 Cube Test

4.13.1.1 The strength of concrete either in assessing the suitability of the trial mixes or when placed in the works shall be determined from 150 mm cubes made, cured, stored, transported and tested in accordance with IS:516 and as specified.

4.13.1.2 Test cubes shall be made as and when required by the Engineer as per the relevant IS Stipulation.

4.13.1.3 Test cubes shall be made under the direct supervision of the competent person appointed by the contractor to supervise all stages of the preparation and placing of concrete. They shall be made by the contractor in the presence of the Engineer and generally from concrete taken at the point of discharge from the mixer and the contractor shall provide suitable facilities in the form of a shed or other covered protection as agreed with or directed by the Engineer for the storing and curing of the test cubes during the first 24 hours after making them and until they are dispatched to the testing laboratory.

4.13.1.4 Test cubes shall be marked and dated in such a manner that the trade and the part of the works in which the concrete they represent has been placed can be readily identified.

4.13.1.5 Testing shall be done in the field laboratory only; in special case with due approval of Engineer or whenever so desired and directed by the Engineer, testing may be carried out in approved laboratory and the results shall be submitted promptly by the contractor to the Engineer without any extra cost.

4.13.1.6 When concrete of a particular grade is first used in the works, 2 cubes each shall be taken from 3 separate batches during each of the first 7 days of using that grade. Of these 6 cubes made daily, 3 cubes (each cube representing concrete made of a different batch) shall be tested at 7 days and the remaining 3 cubes shall be tested at 28 days.

4.13.1.7 If the concrete strength determined from such 28 days cube tests does not reach the characteristic strength for that grade, the materials and / or their proportions for that grade shall be modified by the contractor to the satisfaction of the Engineer.

4.13.1.8 In addition, the contractor shall at his own expense take such actions as the Engineer may consider necessary on the concrete placed in that part of the works represented by the set of cubes so found to be below the characteristic strength.

4.14 Concrete Production

4.14.1 For production of concrete, concrete batching plant of about 12-15 m^3/hr. capacity with tested and calibrated water meter, mechanical weigh batcher shall be used for production of all concrete. Necessary approval shall be obtained from Engineer before the installation of mixing arrangement is installed at site. However, the contractor, if desires so can procure ready mix concrete from the market at no extra cost subject to compliance of technical specifications as laid down in the contract agreement for various grade of concrete. Concrete mixer for production of small quantum of concrete and non-structural member can be allowed at the discretion of Engineer.

4.15 Concrete Mixing

4.15.1 All concrete in the correct proportion of ingredients approved by the Engineer, whether ordinary or controlled, shall be mixed in a batching plant for the minimum time necessary to ensure adequate quality and uniform distribution of the materials. The cement and aggregates shall normally be first mixed dry until all particles of aggregate are coated with cement after which the water shall be added along with admixture.

4.15.2 Allowance shall be made for the moisture content of the aggregates when calculating the amount of water to be added for each mix.

4.15.3 The temperature of the aggregate, water and cement when added to the mixer shall be such that the temperature of the concrete at the time of placement is less than 40^oC.

4.15.4 Materials for concrete shall be deposited into the drum while it is in rotation. Mixers shall not be loaded beyond their rated capacity and each batch shall be completely discharged from the drum before recharging takes place.

4.15.5 Facilities shall be provided to spray the mixer drum with cool water between batches and on the completion of concreting the drum shall be washed thoroughly. The surface of the mixer drum shall be maintained in a clean condition at all times.

4.15.6 Retempering and / or mixing of concrete, which has partially hardened and set will not be permitted under any circumstances.

4.16 Transporting

4.16.1 The period between mixing the concrete and placing it in the final position shall be kept to a minimum and the delivery of concrete shall be coordinated with the rate of placement to avoid delays in delivery and placement.

4.16.2 Concrete shall be handled from the place of mixing to the place of final deposit by methods, which prevent segregation, loss of ingredients and contamination and maintain the required workability.

4.16.3 Should any segregation have occurred in any batches arriving at the place of deposition, such batches shall be rejected and shall not be allowed to use. Where concrete is conveyed by chutes, the chutes shall be made of metal or fitted with metal linings. The approval of the Engineer shall be obtained for the use of chutes more than 3 meters long.

4.16.4 All plant and equipment used in the transportation of concrete shall be thoroughly cleaned before and after each working period and at all changes of concrete mixes.

4.16.5 All major concreting is advisable to be done by concrete pump of adequate capacity with necessary approval obtained by the contractor. If concrete pump is used, delivery system with adequate boom length, pipeline and associated items shall be obtained before installation of the concrete pump. There shall also have the provision of an approved standby system in case of any eventualities for transportation and placement of the concrete.

4.17 **Preparation Before Concreting**

4.17.1 The inside surface of the forms against which concrete is to be placed shall be clean and free from dried or hardened spattering or coatings of concrete. The forms shall be wetted before placing concrete.

4.17.2 When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and covered with a coating of freshly mixed epoxy based concrete adhesive as per manufacturer's instructions immediately before placing of concrete.

4.17.3 Before any concrete is placed on the sub grade, the sub grade shall be checked and approved for degree of compaction and alignment. The sub grade shall be kept damp ahead of concreting.

4.17.4 Concrete shall not be placed in the works until the Engineer has inspected the formwork, reinforcement, inserts and sleeves if any & given his permission to place concrete.

4.18 **Placing**

4.18.1 Concreting of any portion of the works shall be done only in the presence of the Engineer or his representative.

4.18.2 Concreting shall be carried out continuously between construction or expansion joints as agreed with the Engineer. The contractor shall closely follow the sequence of concreting instructed at site. If concreting is interrupted before reaching the predetermined joint an approved construction joint shall be provided after obtaining necessary approval from the Engineer.

4.18.2.1 Immediately before placing of concrete for columns & walls, the reinforcement within and the old concrete at the bottom of the formwork shall be given a coating of epoxy based concrete adhesive, to prevent the loss of bonding with existing surface.

4.18.2.2 Concrete shall be deposited as nearly as is practicable to its final position and shall not be dumped in a large quantity at any point to be run or worked along the formwork manually or with vibrators. Concrete shall not be deposited at a faster rate than it can be placed and compacted. Concrete shall not be placed from a height more than 1.5 m.

4.18.2.3 Concrete shall be thoroughly worked into the forms so that they are entirely filled, reinforcing bars adequately and tightly surrounded and entrained air released from the mass of concrete. Placing shall be carried with the use of vibrators in a manner approved by the Engineer.

4.18.2.4 For members having thickness more than 300 mm, the concrete shall be placed in layers not greater than 300 mm thickness and thoroughly compacted before succeeding layers are placed. Concrete shall be placed in single operation to the full thickness of slabs, beams and similar members. No concrete shall be placed on concrete which has set sufficiently to cause the formation of planes of weakness & where these are likely to occur due to

unforeseen circumstances and the procedure to be followed shall be as given earlier of this specification. As far as possible, cold joints in concrete shall be avoided.

4.19 Compaction

4.19.1 Each layer of concrete whilst being deposited shall be compacted by approved methods to form a dense material with all surface free from honeycombing, air holes or other blemishes. The contractor shall use mechanical vibration for all concrete and shall take care that internal vibrators shall not be brought into contact with the reinforcement or the formwork.

4.19.2 An adequate number of vibrators shall be used to ensure that compaction of concrete is achieved within 10 minutes of placing. Particular attention shall be given to the compaction of the concrete around the water bars to ensure that no voids or porous areas are left.

4.19.3 Compacting shall cease as soon as excess water appears on the face of concrete. Any water accumulating on the surface of newly placed concrete shall be removed by approved methods and no further concrete shall be placed thereon until such water has been removed.

4.19.4 Notwithstanding the requirements regarding mix design, should it be found that the proportion of water in the mix is such that the laitance forms before compaction (i.e. completion of expulsion of air) is complete and unacceptable, the quantity of water in the mix shall be reduced. Approved admixture / plasticizer shall be used to achieve the necessary workability, as approved by the Engineer and strictly in accordance with manufacturer's instructions. Whenever either of the aforesaid procedures are to be adopted, an additional set of 6 cubes for testing at 7 or 28 days shall be made from the adjusted mix.

4.19.5 The time elapsed between the discharge of the concrete from the mixer and the completion of compaction shall not exceed 30 minutes where concrete admixture is not used.

4.19.6 A sufficient number of spare vibrators of various capacities & types shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in use.

4.20 **Finish**

4.20.1 All concrete surfaces shall have a good, dense form finish. The top surfaces specified as smooth shall be leveled and toweled before the concrete begins to set to a smooth finish at levels and falls shown on the drawings. The toweling shall be done at such a time and in such a manner that excess of mortar is not brought to the surface of concrete nor the aggregate displaced. The top surfaces of concrete slabs specified to receive an integral finish shall be uniformly roughened by deep hacking before the finish is laid

4.20.2 Immediately after striking the formwork and removing any superficial water, honeycombed areas in normal unfinished concrete shall be inspected by the Engineer and where directed the contractor shall immediately make it good to the satisfaction of the Engineer. All air holes shall be similarly filled up.

4.20.3 The contractor shall be responsible for providing an adequate key in concrete where plastering or rendering is specified to be applied. Hacking of the concrete surface after striking the formwork will be permitted only after 3 days after the concreting is done.

4.20.4 The faces of all fair faced concrete shall be of even colour throughout, free from air bubbles, cracks, honeycombing or other blemishes and will be

inspected by the Engineer on report by the Contractor, immediately after the formwork has been struck. Such faces shall not be rubbed down or otherwise repaired to remove any defects or imperfections without the prior permission of the Engineer.

4.20.5 Concrete surface finishes shall accord to the requirements and all instructions by the Engineer with regard to the method of achieving such finishes as implemented. Wherever directed or specified, concrete surface shall be made broom finished.

4.21 Curing and Protection

4.21.1 Walling or further loading on concrete shall not be permitted for at least 48 hours after it has been placed in position, or for such additional length of time as the Engineer may direct.

4.21.2 Immediately after compaction and completion of any surface finishes, the concrete shall be protected from the evaporation of moisture by means of polythene sheeting, wet hessian or other suitable material kept soaked by spraying. As soon as the concrete has attained a degree of hardening sufficient to withstand surface damage, continuous moist curing shall be implemented and maintained for a period of at least 15 days after casting to full satisfaction of the Engineer. The curing compound shall be applied by spray/roller/brush on the concreted surface as per manufacturer's specifications & recommendations.

4.21.3 Method of curing and their duration shall be such that the concrete will have satisfactory durability and strength and members will suffer a minimum distortion, be free from excessive efflorescence and will not cause, by its shrinkage, undue cracking in the works.

4.21.4 The top surfaces of slabs and other horizontal surfaces shall be cured by ponding of water in cement mortar bunds. Steeply sloping and vertical formed surfaces shall be kept completely and continuously wet prior to and during the striking of formwork and thereafter by applying adequate water to the top surfaces and allowing it to pass down between the formwork and the concrete, if required by discharging water through hose pipes and pumps.

4.21.5 The Contractor shall give careful consideration to the curing methods and conditions for fair-faced concrete. Components which are specified to have exposed concrete finish shall receive the same curing treatment. Moreover, water used for curing shall be clean and free from deleterious materials so as not to discolour the concrete.

4.21.6 All fair faced concrete shall be protected from damage at the time of striking the formwork. All edges and surfaces of such concrete shall be protected from chipping using notched timber or aluminum corner pieces or other suitable covers, which shall be maintained, in place until the completion of the works.

4.21.7The Contractor shall be responsible for ensuring all fair faced concrete free of blemishes defect & stains and shall remove all such staining as may occur as soon as possible to the satisfaction of the Engineer.

4.22 **Internal Vibrators**

4.22.1 These should invariably be used. However, vibrators shall not be used for displacing concrete. Overloading the vibrators by placing too much concrete per vibrator, over vibrating by using too many vibrators relative to quantity of concrete shall be avoided. Segregation by excessive vibration or excessive water content should be strictly avoided. Vibrator shall be withdrawn gradually and

smoothly, and in a manner which shall not cause suction, voids or air entrapment.

4.23 **Construction Joints**

4.23.1.1 Prior to concreting, the Contractor shall submit his proposals giving the position, form and treatment of such joints to the Engineer for his approval.

4.23.1.2 Vertical construction joints shall be formed against a stop board of approved quality and horizontal construction joints shall be level.

4.23.1.3 Reinforcement shall continue through construction joints and stop boards are to be formed to suit such requirements at site. Dowel bars should be laid at construction joint for continuity of concreting for the next day.

4.23.1.4 As soon as possible after the formwork has been struck for vertical joints or after the concrete has set in horizontal joints, the surface laitance of the hardened concrete on the face of the joint shall be removed to expose the coarse aggregate in such a manner that the loosened particles of aggregate and damaged concrete are not left on the surface. The exposed face shall be swept clean of foreign matter and laitance. Immediately before placing the new concrete, a coat of epoxy based concrete adhesive shall be put over the old concrete followed for joints of thickness as per manufacturer's instructions.

4.23.2 Before next operation is started, all timber spoils, laitance, scum or loose concrete shall be removed by hacking the surface and then scrubbing off with a wire brush to remove all loose mortar or aggregates. Thereafter, before resuming concreting operation, the surface should be thoroughly cleaned and a coat of epoxy based conc. adhesive shall be applied. As an additional precaution, approved water bars (as in IS: 3370 (Part-I)-1965) shall be used, if required at such joints as per manufacturer's instruction. But sufficient care shall be taken when such water barriers are used during pouring concrete from height, so that these strips shall not get bent; and thereby restrict the passage of concrete; causing large size pores and honeycomb concrete. The rate of epoxy based conc. Adhesive is deemed to be included in the concrete item.

4.24 **Expansion Joints**

4.24.1.1 Expansion joints shall be provided where ever if required during construction stage as directed. They shall be constructed with an initial gap between the adjoining parts of the works of the width.

4.24.1.2 The contractor shall ensure that no debris is allowed to enter and be lodged in expansion joints.

4.24.1.3 Expansion joints shall be provided with approved joints filler, a joint sealing compound and in waterproof concrete a water bar.

4.24.2 **Joint fillers**:

4.24.2.1 The joints filler compound shall be easily and uniformly compressible to its original thickness, tamp able, easily cut or sawn, robust, durable, resistant to decay due to termite or weathering, unaffected by water & free of any constituent which will bleed into or stain the concrete.

4.24.2.2 The joint filler shall be of same thickness of the joint width, it shall extend through the full thickness of the concrete unless otherwise specified and shall be sufficiently rigid during handling & placing to permit the formation of straight joints.

4.24.3 **Joint Sealing Compounds**

4.24.3.1 Joint sealing compounds shall be in accordance with the IS 3037-1986 and approved by the Engineer and shall seal joints in concrete against the passage of water, prevent the ingress of grit or other foreign material and protect the joint filler. The compound shall have good extensibility and adhesion to concrete surfaces and shall be resistant to flow and weathering.

4.24.3.2 Where so specified joints shall be sealed with approved polysulphide / polyurethane, stored, mixed, handled, applied and cured strictly in accordance with the manufacturer's printed instructions. Such joints shall be formed to the correct dimensions, thoroughly cleaned and treated with recommended primer. The Contractor shall use only competent personnel experienced in the application of sealant for such work.

4.24.3.3 Whereas, rubber / bituminous based sealants shall be of an approved manufacturer. The treatment of the joint and the use of sealing compound shall be strictly in accordance with the manufacturer's printed instructions.

4.25 **Cracks**

4.25.1.1 If any cracks develop in the reinforced cement concrete construction which in the opinion of the Engineer may be detrimental to the strength of the construction, the contractor shall test the structural element in question. If under these test loads the cracks shall develop further the contractor shall dismantle the construction, cart away the debris replace the construction and carryout all consequential work thereto.

4.25.1.2 If the cracks are not detrimental to the stability of the construction in the opinion of the Engineer, the contractor shall grout the cracks with pneumatically applied mortar or epoxy grout or by other specified treatment as directed by the Engineer at his own expense and risk.

4.25.1.3 The repair work shall be carried out to the satisfaction of the Engineer. The decision of the Engineer as to the extent of the liability of the contractor in the above matter shall be final and binding on the contractor.

4.26 Load Testing on Completed Structures

4.26.1.1 During the period of construction or within the defect liability period as the case may be, the Engineer may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:

4.26.1.2 Unsatisfactory values of the Cube strength of the grade of concrete specified.

4.26.1.3 Premature removal of formwork.

4.26.1.4 Inadequate curing of concrete.

4.26.1.5 Over loading during the construction of the structure or part thereof.

4.26.1.6 Carrying out concreting of any portion without prior approval of the Engineer.

4.26.1.7 Honey combed or damaged concrete, which in the opinion of the Engineer is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.

4.26.1.8 Any other circumstances attributable to alleged negligence of the contractor which in the opinion of the Engineer may result in the structure or any part thereof being of less than the expected strength.

4.26.1.9 All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the Engineer. Such tests should be carried out only after expiry of minimum 28 days or such longer period as directed by the Engineer.

4.26.1.10 The structure should be subjected to a load equal to full dead load plus 1.25 times the imposed load. This load shall be maintained for a period of 24 hours before removal. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members as directed.

4.26.1.11 The deflection due to the superimposed load shall be recorded by sufficient number of approved deflectometers capable of reading up to 1/500 of a cm and located suitably under the structure as directed by the Engineer. If within 24 hours of the removal of the superimposed load, the structure does not recover at least 75% of the deflection under the superimposed load, the test loading shall be repeated after a lapse of 72 hours. If the recovery after the second test is less than 80% of the maximum deflection shown during the second test, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

4.26.1.12 If the maximum deflection in mm, shown during 24 hrs. under load is less than $40l^2 / D$, where l is the effective span in m; and D, the overall depth of the section in mm, it is not necessary for the recovery to be measured and the recovery provisions as stated above.

4.26.2 The part of the work failed in test shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Engineer. Moreover, such remedial measures shall be carried out to the complete satisfaction of the Engineer.

4.26.2.1 In addition to the above load tests, non-destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the Contractor at his own expense if so desired by the Engineer. Such tests shall be carried out by an agency approved by the Engineer and shall be done under expert guidance using only recommended testing equipment. The acceptance criteria for these tests shall be in accordance to IS: 1959 and IS:456.

4.27 **Non-Destructive Test**

4.27.1.1 Non-Destructive Test for the structural members under doubt about their strength are required to be done as per BOQ items & as per relevant IS codes. Non-Destructive Test include Ultrasonic Pulse velocity (IS: 13311, Part-1) & rebound hammer IS: 13311 (Part-2), Core test. The necessary arrangement will have to be done by contractor to carryout/conduct the tests. The test reports needs to be submitted to MDL.

4.27.1.2 All costs involved in carrying out the Load Tests and Non-destructive Test and other incidental expense there to shall be borne by the contractor regardless of the result of the tests. The Contractor shall take down or cut out and reconstruct the defective work or shall make the remedial measures instructed at his own cost.

4.28 **Supervision**

4.28.1.1 All concreting work shall be done under strict supervision of qualified and experienced representatives of the Contractor as well as those of the Engineer. The contractor's supervisor who is in charge of concreting work shall be

experienced & skilled in this class of work and shall personally supervise all the concreting operations at all stages.

4.29 **Special attention shall be paid to the following**

4.29.1.1 Proportioning, mixing and quality testing of the materials with particular control on the water cement ratio.

4.29.1.2 Laying of material in place and thorough compaction of the concrete to ensure solidity and freedom from voids and honeycombing.

4.29.1.3 Proper curing for the requisite period.

4.29.1.4 Reinforcement positions are not disturbed during concreting & consolidation by vibration.

4.30 **Quality Control**

4.30.1.1 The Engineer reserves the right to make changes in the mix proportions including the increased cement content or / and a change in the Contractor's control procedure, should the quality control during progress of the works prove to be inadequate in his opinion and the contractor shall carry out the same. Any extra cost due to change in mix proportions shall be deemed to have been included in relevant item rates.

4.30.1.2 All the concrete work shall be true to level, plumb & square within the acceptable tolerance. The corners, edges and rises in all cases shall be unbroken and finished properly and carefully.

5. SPECIFICATION FOR TESTING CONCRETE

5.1 Cement

5.1.1.1.1 The Contractor shall make his own arrangement for procurement of cement. Cement should be of Ultratech, ACC, Gujarat Ambuja or equivalent brand Ordinary Portland cement conforming to IS 8112 – 1989 (Grade 43 or higher).

5.2 Concrete:

5.2.1.1 Controlled concrete shall be based on a mix design carried out in a laboratory, approved by MDL, and shall conform to IS 456-2000. The requirements of sampling and testing shall be as given in these specifications.

5.2.2 Design Mix Concrete:

5.2.2.1 As the guarantor of quality of concrete used in the construction, the Contractor shall carryout the mix design and the mix so designed (not the method of design) shall be approved by the Employer within the limitation of parameters and other stimulations laid down by IS: 456-2000.

5.2.2.2 The mix shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than appropriate value given in Table I below. The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times the standard deviation.

5.2.2.3 Mix design done earlier not prior to one year may be considered adequate for later work provided there is no change in source and quality of the materials.

Table I: Grades of Concrete

Table I Grades of Concrete

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm Cube at 28 days in N/mm^2
(1)	(2)	(3)
	M 10	10
Ordinary Concrete	M 15	15
	M 20	20
	M 25	25
	M 30	30
Standard Concrete	M 35	35
	M 55	55

Notes:

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

ii. For concrete of compressive strength greater than M 55, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.

5.3 Standard Deviation

5.3.1 The standard deviation for each grade of concrete shall be calculated separately.

5.3.2 Standard deviation based on test strength of sample.

5.3.2.1 Number of test results of samples – The total number of test strength of samples required to constitute an acceptable record for calculation of standard deviation shall not be less than 30. Attempt should be made to obtain the 30 samples, as early as possible, when a mix is used for the first time.

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

5.3.2.3 Standard deviation to be brought up to date – The calculation of the standard deviation shall be brought up to date after every change of mix design.

5.3.3 Assumed Standard Deviation

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

Table II Assumed Standard Deviation	
Grade of Concrete	Assumed Standard Deviation (N/mm2)

M 10	3.5
M 15	
M 20	4.0
M 25	
M 30	5.0
M 35	
M 40	
M 45	
M 50	

Note:

The above values correspond to the site control having proper storage of cement; weigh batching of all materials; controlled addition of water; regular checking of all materials; aggregate grading and moisture content; and periodical checking of workability and strength. Where there is deviation from the above, the values given in the above Table shall be increased by 1 N/mm2.

5.4 **Specimen**

5.4.1 Test specimens shall be cubes whose sizes shall be as given below.

Minimum size of Coarse Aggregate	Size of specimen cubes in cm.
Not exceeding 20 mm	10 x 10 x 10
Greater than 20 mm but not exceeding 40 mm	15 x 15 x 15

5.4.2 Sampling of Concrete

5.4.2.1 Samples for concrete for test specimens shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle during discharge. The sample of concrete from which test specimens are made shall be representative of the entire batch. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharging stream of concrete, stacking the sampling operation until the entire batch is discharged. The sample thus obtained shall be transported to the place of moulding of specimen, and to counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for further reference. In the case of paving concrete, samples may be taken from the batch immediately after deposition on the sub-grade. At least five samples shall be taken from different positions of the pile and these samples shall be thoroughly mixed before being used to form the test specimens.

5.4.2.2 Sampling to be done as per relevant Indian standard codes for day to day concreting and to be tested in the approved NABL laboratory in presence of Structural Consultant representative. For different grades concreting sampling to be taken separately as per IS code standards. The test reports to be submitted immediately to MDL. An amount of 10% of concrete work done value will be provisionally retained from RA Bills for awaited 28days test reports. The same will be released on submission of satisfactory test reports.

5.4.3 Preparation of Test Specimens

5.4.3.1 The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. From the samples of concrete, the test specimen shall be immediately moulded by one of the following methods.

5.4.3.1.1 When the job concrete is compacted by ordinary methods, the 1st specimen shall be moulded by placing the test concrete in the mould in layers, each approximately one-third of the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 25 times with a 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in a uniform manner over the cross section of the mould and shall penetrate into the underlying layer. The bottom layer shall be rodded throughout its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined metal plate. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or overflow from the top of the mould.

5.4.3.1.2 When the job concrete is placed by vibration and the consistency of the concrete is such that the 1st specimen cannot be properly moulded by hand rodding as directed under (i) above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in the mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall be of appropriate size and shall penetrate only the layer to be compacted. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for the top layer, the mould shall be filled to the extent that there will be no mortar loss during vibration. After vibrating the second layer, enough concrete shall be added to bring the level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified under (a) above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or overflow from the top of the mould.

5.5 Method of Testing

5.5.1 The tests shall be made at the age of the concrete corresponding to that for which the strengths are specified.

5.5.2 Compression tests shall be made immediately upon removal of the concrete test specimens from the curing tank i.e. the test specimens shall be loaded in

damp condition. The dimensions of the test specimens shall be measured in millimeters accurate to 0.5 mm.

5.5.3 The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to the sides of the specimen as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of the test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

5.5.4 The load shall be applied axially without shock at the rate of approximately 140 kg/cm^2 per minute. The total load indicated by the testing machine at failure of the test specimen shall be recorded and the unit compressive strength calculated in kg/sq.cm. Using the area computed from the measured dimensions of the test specimen. The type of failure and appearance of the concrete shall be noted.

5.6 Standard of Acceptance

5.6.1 The standard of acceptance shall be as described below:

5.6.1.1 Three test specimens shall be made for each age at which tests are required. The average of strength of the three specimens may be accepted as the compressive strength of concrete, provided the difference between the maximum and minimum strengths of the three specimens does not exceed 15% of the average strength. If the difference exceeds 15% of the average strength, repeat tests shall be made unless the minimum strength is greater, than the strength specified.

5.6.1.2 In order to get a relatively quicker idea of the quality of concrete, compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose, the values given in Table above may be taken for general guidance in the case of concrete made with ordinary Portland cement. In all cases, the 28 days compressive strength specified in Table above shall alone be the criterion for acceptance or rejection of the concrete. If, however, from tests carried out in a particular job over a reasonably long period, it has been established to the satisfaction of the Engineer –in-charge that a suitable ratio between 28 days compressive strength and the 7 days compressive strength exists, the compressive strength at 7 days may be accepted, and the Engineer-in-charge may suitably relax the frequency of 28 days compressive strength specified provided the expected strength values at the specified early age are consistently met.

5.6.1.3 If the average strength of the sample concrete is less than the specified strength, the work for that day shall be accepted at reduced rate, provided the average strength of sample concrete is not less than 75% of the specified strength. The Engineer-in-charge shall determine the reduced rate and the quantity of the day's work for which the rate is to be reduced. If the strength of sample concrete is less than 75% of the minimum specified strength after 28 days, the Engineer-in-charge shall reject the defective portion of the work done during the day along with the other concrete work structurally affected by the defective portions and get it dismantled.

Note: Six cubes shall be made for a test and 3 out of these shall be tested after 7 days, the remaining 3 cubes shall be tested after 28 days. The result of the 28 days test shall be taken into account while reducing the rate of rejecting the concrete represented by the sample. The result of the test conducted by the approved testing laboratory shall be taken as final and binding on the Contractor.

6. Reinforcement Work

6.1 Steel reinforcement shall be of Thermo Mechanically Treated (**TMT)500D** bar confirming to IS 1786 (latest edition).

6.1.1 **Bar-Bending Schedules**

6.1.1.1 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. The BBS to be prepared by contractor's representative and approved by representative of Structural Consultant prior to laying of steel at site.

6.1.2 **Bending and Cutting of Reinforcing Steel Bars**

6.1.2.1 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.

6.1.3 **Laps**

6.1.3.1 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. The location and type of welding shall be as approved by the Engineer and as shall be done in accordance with IS: 2751.

6.1.3.2 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.

6.1.4 **Chairs etc.**

6.1.4.1 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 shall be provided by the Contractor as shown in the drawing and as instructed by the Engineer.

6.1.5 **Placing in Position**

6.1.5.1 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.

6.1.5.2 Tack welding shall also be permitted in lieu of binding with steel wire if approved by the Engineer.

6.1.5.3 The bars shall be kept in position by the following methods.

6.1.5.3.1 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.

6.1.5.3.2 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.

6.1.5.3.3 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.

6.1.5.3.4 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.

6.1.6 **Storage of Steel Reinforcement**

6.1.6.1 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.

6.1.7 **Approval of Reinforcement**

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

7. READY-MIXED CONCRETE

7.1 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.

7.2 **Approved Plant**: **Ready mixed concrete conforming to IS 4926:2003 shall be supplied from Ultratech, ACC, Godrej, Lafarge RMC plants or other any plant as approved by MDL Engineer in Charge.**

7.3 MATERIALS

7.3.1 **Selection and Approval of Materials**

7.3.1.1 Materials used should satisfy the requirements for the safety, structural performance, durability and appearance of the finished structure, taking fill 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.

7.3.2 Cement

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

7.3.2.2 Mineral Admixtures — Use of mineral admixtures shall be permitted in accordance with the provisions of Is 456.

7.3.3 Aggregates

7.3.3.1 Aggregates used for concrete shall be in accordance with the requirements of 1S 456. Unless otherwise agreed testing frequencies for aggregates shall be as given in Annex B.

7.3.4 Chemical Admixtures

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

7.3.4.2 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.

7.3.4.3 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.

7.3.4.4 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.

7.3.4.5 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.

7.3.5 Water

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

7.3.5.2 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.

7.3.5.3 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.

7.4 GENERAL REQUIREMENTS

7.4.1 Basis of Supply

7.4.1.1 Ready-mixed concrete shall be supplied having the quality and in the quantity in accordance with the requirements agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with the requirements of 1S456.

7.4.1.2 All concrete will be supplied and invoiced in terms of cubic meters (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

7.4.2 **Transport of Concrete**

7.4.2.1 General

7.4.2.1.1 Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re-handling or moving the concrete horizontally by vibration. If required by the purchaser the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser to place the concrete as rapidly as possible. The purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 min of arrival on site.

7.4.2.1.2 Concrete shall be transported in a truck-mixer unless the purchaser agrees to the use of non-agitating vehicles. When non-agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

7.4.2.2 Time in Transport

7.4.2.2.1 The general requirement is that concrete shall be discharged from the truck-mixer within 2 hrs of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced.

7.4.2.2.2 The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.

7.4.2.2.3 Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

7.5 SAMPLING AND TESTING OF READY-MIXED CONCRETE

7.5.1 Point and Time of Sampling

7.5.1.1 For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (see Annex C). The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility

from supplying concrete as per the requirements given in this standard or otherwise agreed to where so permitted in the standard.

7.5.2 Workability

7.5.2.1 The test for acceptance is to be performed upon the producer's delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producers' vehicle is delayed on site due to lack of preparedness on behalf of the purchaser, then the responsibility passes to the purchaser after a delay of more than 30 min. The workability shall be within the following limits on the specified value as appropriate:

Slump:	± 25 mm or ± 1/3 of the specified value, whichever is less.
Compacting factor :	± 0.03, where the specified value is 0.90 or greater, ± 0.04, where the specified value is less than 0.90 but more than 0.80, and ± 0.05, where the specified value is 0.80 or less.

7.5.2.2 Flow table test may be specified for concrete, for very high workability (see IS 9103). Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

7.5.3 Specified Strength

7.5.3.1 Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his own sampling and testing or may enter in to an arrangement with the producer to provide his testing requirements.

7.5.4 Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready mixed concrete industry method of production control, should be one sample for every 50 m3of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456).

7.5.5 In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at 72 + 2 h or at 7 days or compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose, the value should be arrived at based on actual testing. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.

7.5.6 The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m3 or 50 batches, whichever is the greater frequency.

7.5.7 **Additional Compliance Criteria**

Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance, frequency of assessment, method of test and significance of result.

8 PAINTING OF CONCRETE MASONRY & PLASTERED SURFACES

8.1 MATERIALS

8.1.1 All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

8.2 WORKMANSHIP

8.2.1 CONTRACTOR shall obtain the approval of the ENGINEER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

8.2.2 Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata.

8.2.3 The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

8.2.4 Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

MEASUREMENT

8.2.5 Measurement shall be in **Sq.M.** correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter's cradle etc. including all safety precautions to be taken during the execution of work.

9 APPLICABLE CODES AND SPECIFICATIONS

9.1 The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

9.2 MATERIALS

9.2.1 IS: 269 - Specification for 33 grade ordinary Portland cement (If specially intended to be used as per drawings/ specifications)

9.2.2 IS: 455 - Specification for Portland slag cement.

9.2.3 IS: 1489 - Specification for portland-pozzolana cement.

9.2.4 IS: 8112 - Specification for 43 grade ordinary Portland cement.

9.2.5 IS:12330- Specification for sulphate resisting Portland Cement

9.2.6 IS:383 - Specification for coarse and fine aggregates from natural sources for concrete.

9.2.7 IS: 432(Parts I & II) - Specification for mild steel and medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

9.2.8 IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement.

9.2.9 IS: 1566 - Specification for hard-drawn steel wire fabric for concrete reinforcement.

9.2.10 IS: 2062 – Steel for general structural purposes.

9.2.11 IS: 9103 - Specification for admixtures for concrete.

9.2.12 IS: 2645 - Specification for integral cement water proofing compounds.

9.2.13 IS: 4990 - Specification for plywood for concrete shuttering work.

9.3 MATERIAL TESTING

9.3.1 IS: 4031(Part 1 to 13) - Methods of physical tests for hydraulic cement.

9.3.2 IS: 4032 - Method of chemical analysis of hydraulic cement.

9.3.3 IS: 650 - Specification for standard sand for testing of cement.

9.3.4 IS: 2430 - Methods for sampling of aggregates for concrete.

9.3.5 IS: 2386(Part 1 to 8) - Methods of test for aggregates for concrete.

9.3.6 IS: 3025 - Methods of sampling and test (physical and chemical) water used in industry.

9.3.7 IS:6925 - Methods of test for determination of water soluble

9.4 MATERIAL STORAGE

9.4.1 IS: 4082 - Recommendations On Stacking And Storing Of Construction Materials At Site.

9.5 CONCRETE MIX DESIGN

9.5.1 IS: 10262 - Recommended guidelines for concrete mix design.

9.5.2 SP: 23(S&T) - Handbook on Concrete Mixes.

9.6 CONCRETE TESTING

9.6.1 IS: 1199 - Method of sampling and analysis of concrete.

9.6.2 IS:516 - Method of test for strength of concrete

9.6.3 IS:9013 - Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.

9.6.4 IS: 8142 - Method of test for determining setting time of concrete by Penetration resistance.

9.6.5 IS:9284 - Method of test for abrasion resistance of concrete

9.6.6 IS: 2770 - Methods of testing bond in reinforced concrete.

9.7 EQUIPMENT

9.7.1 IS: 1791 - Specification for batch type concrete mixers.

9.7.2 IS: 2438 - Specification for roller pan mixer.

9.7.3 IS: 4925 - Specification for concrete batching and mixing plant.

9.7.4 IS: 5892 - Specification for concrete transit mixer and agitator.

9.7.5 IS: 7242 - Specification for concrete spreaders.

9.7.6 IS: 2505 - General Requirements for concrete vibrators: Immersion type.

9.7.7 IS: 2506 - General Requirements for screed board concrete vibrators.

9.7.8 IS: 2514 - Specification for concrete vibrating tables.

9.7.9 IS: 3366 - Specification or pan vibrators.

9.7.10 IS: 4656 - Specification for form vibrators for concrete.

9.7.11 IS: 11993- Code of practice for use of screed board concrete vibrators.

9.7.12 IS: 7251 - Specification for concrete finishers.

9.7.13 IS: 2750 - Specification for steel scaffolding.

9.8 CODES OF PRACTICE

9.8.1 IS: 456 - Code of practice for plain and reinforced concrete.
9.8.2 IS: 3370(Parts I TO IV) - Code of practice for concrete structures for storage of Liquids.
9.8.3 IS: 3935 - Code of practice for composite construction.
9.8.4 IS: 2502 - Code of practice for bending and fixing of bars for concrete reinforcement.
9.8.5 IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
9.8.6 IS: 2751 - Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
9.8.7 Specification for welding cold worked bars for reinforced concrete construction.
9.8.8 IS:3558 - Code of practice for use of immersion vibrators for consolidating concrete.
9.8.9 IS:3414 - Code of practice for design and installation of joints in Buildings.
9.8.10 IS:4326 - Code of practice for earthquake resistant construction of building.
9.8.11 IS: 13920 – Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
9.8.12 IS: 4014(Parts I & II) - Code of practice for steel tubular scaffolding.
9.8.13 IS: 2571 - Code of practice for laying in-situ cement concrete flooring.
9.8.14 IS: 7861 - Code of practice for extreme weather concreting. Part-I Recommended practice for hot weather concreting. Part-II Recommended practice for cold weather concreting.

9.9 CONSTRUCTION SAFETY

9.9.1 IS: 3696(Parts I & II) - Safety code for scaffolds and ladders.
9.9.2 IS: 7969 - Safety code for handling and storage of building materials.
9.9.3 IS: 8989 - Safety code for erection of concrete framed structures.

9.10 MEASUREMENTS

IS:1200 (Part 1 to 23) - Method of measurement of building and engineering works

10.1 1 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.

10.12 M.S. Tubular Hand Railing

Material

M.S. tubes for hand railing shall be 50mm outer diameter, unless specified of mild steel medium grade conforming to IS: 1239, vertical rolled steel angles etc. confirming to IS-808.

Toe/Base plates shall be of mild steel conforming to IS: 226

Fabrication : Hand railing shall be fabricated strictly as per the "Approved for Construction" fabrication drawings prepared by the Contractor based on design drawings and standards. All tubes shall be straight and without any dents / deformations. Tubes shall be cut and ends shall be prepared to a neat and workman like finish. All elements shall be directly welded. Tubes shall be cold bent to shape and curvature in case of discontinuous ends of handrails. Lower ends of vertical posts shall be cut and splayed (for grouting in pockets provided in the concrete members). For removable type of hand railing, suitable base plates (with provision for bolting) shall be welded to the lower end of vertical posts. For the environmental protection of the structural steel, the entire fabricated steel shall be hot dip galvanized, internally and externally, having a uniform thickness of 65 microns.

Erection / Fixing

Hand railing shall be fixed to the bearing members as indicated in the drawing and as directed by the Engineer-In-Charge.

Measurement

The Actual length of structural steel tubes/ angles etc. to be measured and weight to calculated in Kg to the nearest two decimals.

11. DISMANTLING & DEMOLISHING

11.1 GENERAL:

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.

11.3 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.

The contractor has to demolish existing dilapidated RCC work by mechanical means ,stack the serviceable and unserviceable material separately including cutting the reinforcement bars and dispose of rubbish /malba, waste material by mechanical means including loading, unloading transportation to dumping ground as directed by Engineer in Charge for all the lead sand lifts. All the debris material to be cleared from site after completion of work.

11.4 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 of.

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.

11.5 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.
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

The works to be carried out with due safety precautions using all the PPE like safety shoes, helmet, safety belts etc. to workers, Engineers at site.MS Double scaffolding (H frame) as per specification to be erected prior to commencement of dismantling of Walkway slab in between Dolphines near Kasara Basin.

Site Engineers has to obtain permission from appropriate authority of MDL Safety department prior to commencement of work on day to day basis.

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 dismantling work shall be separately taken and arranged by the Contractor.

Any preliminary work, necessary for Contractor's method of demolition.
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.

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.

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 Rates

The rate shall include the cost of all labour involved and tools used in demolishing and dismantling. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material outside the premises into approved dumping grounds.

11.11-Shear Connectors-The contractor has to make 10/12 mm dia holes using heavy duty electrically operated hammer drills in the concrete of RCC members to a depth of about 75 mm at 500 mm c/c or at suitable grid in zig-zag fashion, clean the holes using air jet and fix pre-fabricated 100 x 50 mm L-shape 8mm dia rebar using Anti Corrosive protective coating so that 75 mm out of 100 mm is inserted inside the concrete and 25 mm remain outside along with 50 mm bend as directed by Structural consultant. The shear connectors are used to tie the additional reinforcement bars.

12. CENTERING AND SHUTTERING WORK

12.1 General: All the formwork shuttering and centering shall be of structural steel. Shuttering for structural members to be designed by representative of contractor and approval to be given by Structural consultant.

All structural steel centering & shuttering to be used in connection with reinforced work shall be strongly and firmly erected. The members should be in one plane and not bend. They shall be quoted with mineral oil or other suitable materials to prevent the concrete adhering. The slabs centering shall be covered with double wazed water proofing paper or as directed if found necessary by the Engineer. Nothing extra will be paid for this.

The false work should be properly strutted and braced in at least two directions and strong enough so as to be perfectly rigid and unyielding during the operation of filling and ramming the concrete. The structural members should be of sufficient thickness and scantlings of such a good quality as not to warp, deform or deflect the concrete. The whole arrangement regarding the dimensions and construction of the false work shall be to the entire approval of the Engineer and shall be of proper size so as to bring out the completed work of the required dimensions.

Before filling the forms care shall be taken to see that the reinforcements are in their proper and ultimate positions and thoroughly secured from being disturbed during the filling and ramming of the concrete and that the moulds are absolutely free from dried up cement or concrete, any dust, pieces of wood, rags and projecting nails.

The arrangement of the forms and centering shall be such that the slab centering and sides of beams and column forms may be removed first allowing the bottoms of beams and girders to be supported for longer time.

12.2 REMOVAL OF CENTERING

In no case shall the centering of any concrete work be removed without obtaining the special permission of the Engineer or his Assistant.
Proper care shall be exercised while removing the centering to avoid jarring the structure or throwing heavy form from the floor.
Generally nothing less than the following times should elapse between the filling in of the concrete and removal of the forms: -

Type of formwork	Minimum period before striking formwork
Vertical formwork to columns, beams and slabs	16-24 hrs.
Soffit formwork to slabs (Props to be re-fixed immediately after removal of formwork.)	3 days
Soffit formwork to beams (Props to be re-fixed immediately after removal of formwork.)	7 days
Props to slabs Spanning up to 4.5 m	 7 days
Type of formwork	**Minimum period before striking formwork**
Spanning over 4.5 m	14 days
Props to beams and arches Spanning up to 6.0 m Spanning over 6.0 m	 14 days 21 days

After removal of the centering any roughness or irregularity on the exposed surface of the work shall be made good by thin grouting of cement or a cement wash and the whole surface shall be so finished as to present an even and uniform appearance. No plastering will be permitted on the surface.

12.3. Removal & refixing the existing Fenders, Rubber tyre etc.: -
It consists of removal of existing fenders, rubber tyres etc.of any type including cutting/removal of bolts, chains etc.by manually or gas cutting without causing any damage to existing main structure, storage the same properly to nearby area inside MDL and refixing the same along with requisite bolts /anchor rods ,grouting materials like GP2 etc after completion of entire work.

12.4 **Anti-Corrosive treatment** to existing corroded steel :- The contractor has to carryout the Anti-corrosive treatment to exposed reinforcement portion with one coat of **alkaline rust convertor** "feovert / rusticide or equivalent on exposed reinforcement after cleaning the surface by wire brush ,chipping to remove loose rust ,followed by two coats of rust preventing coating of **IPNETRB(CBRI)/POLYALK FIXOPRIME** or equivalent rebar protection coating on exposed reinforcement and concrete and penetrating **corrosion inhibitor EPCO KP-100/POLYALK CP113** or equivalent over adjoining concrete surface prior to jacketing the area. For Beam

/Column/Piles/Wall/Peripheri of Dolphine.

13- **Bond Coat:** The contractor has to provide & apply one coat of structural grade epoxy bond coat by brush conforming to ASTM-C-882-87 to the prepared concrete surface to be repaired / strengthened. This is applied prior to the application of polymer repair mortar / epoxy mortar / Micro concrete to have monolithic action between old concrete surface and new concrete surface.
Epoxy bond coats should be of make Fosroc, Krishna Conchem, BASF, Sika.

13.1 Grout Injection- The contractor has to carry out the work by providing and injecting approved grout in proportion recommended by the manufacturer into cracks/honey-comb area of reinforced concrete **in Beams & Dolphins** by suitable gun/pump at required pressure including cutting of nipples after curing etc. complete as per directions of Engineer-in-Charge.(The payment shall be made on the basis of actual weight of approved grout injected in **Kg**. Record to be maintained day to day along with location and structure.) Epoxy injection grout in concrete/RCC work of approved make. Manufacturers for Epoxy grout Fosroc, Sika, BASF or equivalent.

14. POLYMER MODIFIED MORTAR

POLYMER MODIFIED MORTAR(PMM) in proportion of 1(Polymer) : 5(Cement) : 15 (Quartz sand) by weight with water cement ratio of 0.35 including application of bonding coat using brush in ratio of 1 (Polymer) :1 (Cement) : 0.35 (water) by **weight** including cleaning of surface with air mixed with water under pressure, and subsequent layer up to 30mm(15mm+15mm i.e. two coats of 15mm thick) after hardening complete as directed (Polymer manufactured by Krishna Conchem, Sunanda, Pidilite, Fosroc or equivalent as approved by Engineer.)

The material used shall be as per specification and the contractor shall use only the material so approved.

The items to be used shall comply with all requirements as specified in and the material purchased shall be in the original manufacturer's sealed manner.

Mortar mixes

Mix polymer components in clean container free of harmful residue of foreign particles. Temperature from preparation of polymer mortar to application should be between 0 to 40 degree centigrade, otherwise as recommended by manufacturer.

Thoroughly blend polymer with a mechanical mixer to uniform and homogeneous mixture.

The proportion of mixing the polymer for modification shall be decided by the use of the modified mortar. For use in cover core replacement or incase of sections replacement the percent of polymer can be limited to 15%. In case sand used for polymer modification contain silt or clay beyond 3%, then to be checked for silt content.

Polymer Modified Mortar application. Modified mortar shall be prepared by first mixing all dry components in dry state. Mix required quantity of polymer with water as per manufacturer's specification. Mix the dry system and polymer and water mixture. Mix thoroughly by workable mix. For 1 bag of cement required quantity of polymer shall be used given in table and 3 part of river sand by volumetric.

Apply polymer-modified mortar to concrete surface by hand packing. Thickness shall be within the limits instructed by the Engineer-In charge. Additional layers shall be applied to build up the damaged concrete section complete in line and level.

Work polymer modified mortar into place and consolidate thoroughly so that all contact surfaces are wet by the mortar and entrained air is reduced to the level recommended by manufacturer.

Finish surface of polymer modified mortar to texture, color, and smoothness required for the specific application. This mortar coat should be finished by application of plain cement mortar in 1:3 using 53-grade cement. No water curing shall be applied to polymer modified mortar surface. However, over coat of plain cement mortar shall be cured with water as required after 12 Hrs.

Upon completion of finishing operations, allow mortar to cure in accordance with normal curing practices for polymer modified mortars.

Cleanup

Protect concrete surfaces, beyond limits of surface receiving polymer-modified mortar, against spillage.

Safety - Polymer materials may be skin irritants or sensitizes to many people. Accordingly, advise applicators to avoid contact with eyes and skin, inhalation of vapours, and ingestion. Make protective and safety equipments available on site. Read all label warnings by manufacturer. Make application in accordance with applicable safety laws.

CURING

All polymer treated surfaces can either be immediately covered with plain cement mortar and then cured after 12 hours or the surfaces can be left to naturally cure without sprinkling water for two days and then covered with plaster.

All plastered surfaces shall be water cured for seven days with the first two days the curing being done every five to six hours. When the atmospheric temperature of the site exceeds 40 degrees Celsius then curing shall be resorted to as many times as required to keep the surface moist or to ensure the mortar temperature does not rise.

Measurement of PMM work

All polymer Modified Mortar works shall be measured in **Kg**.

Joint filling: - Post curing, cleaning, the contractor has to carry out the work of providing & laying Nitoseal 21 (I) or Choksey chemicals Ltd. or approved equivalent make polysulphide sealant for joint filling including hacking/chiseling concrete as directed and instructed by Engineer/Client. 5 x 25 mm for contraction or construction joints of cast in situ slab and Dolphine joint.

Hot dip Galvanizing for Ladder & Railings- Providing and fixing heavy duty hot dip galvanized steel for Ladder and Railings with supporting frames all as shown in the drawings. Includes fixing the support to the reinforced concrete slab/beams using bolts, nuts etc.

It includes providing & Fixing Ladder & Railing using hot dip galvanized steel, pipes and fixed with hot dip galvanized brackets of suitable design.

Measured and paid for in weight tonnes.

15. PILE FOUNDATION

15.1 This work shall consist of construction of piles for structures in accordance with the details shown on the drawings and conforming to the requirements of these specifications.

The construction of pile foundations requires a careful choice of the piling system depending upon sub–soil conditions and loading characteristics and type of structure. The permissible limits of total and differential settlements, unsupported length of pile under scour, impact/entanglement of floating bodies and any other special requirements of project are also equally important criteria for selection of the piling system. The method of installing the piles, including details of the equipment shall be submitted by the Contractor and got approved from the Engineer.

The contractor has to carry out the piling work by providing, driving with hydraulic piling rigs with power units and installing driven cast-in-situ reinforced cement concrete piles of grade M-40 (Min. Cement consumption -400Kg/Cum of Concrete)of specified diameter and length below pile cap, to carry safe working load as the same will be informed during joint discussion with user department after placement of order, using tremmie concreting incl. boring the pile upto required depth and chiseling through local boulders ,old foundation or hard strata etc. met with at intermediate level and also chiseling through the bearing rock to ascertain the pile resting on required strata as per design, excluding the cost of steel reinforcement but including the length of pile to be embedded in the pile cap etc. all complete including cost of mobilizing /demobilizing /maintaining the requisite equipment, temporary works, if any required for completion of work for **600mm dia** pile.(Length of pile for payment shall be measured from top of shoe to the bottom of pile cap). Socket length i.e. Embedment in the rock to be done as per GFC drawings issued by Structural Consultant. Rock samples to be kept for every pile for different depths. Bore log data to be maintained by contractor's representative and checked by representative of Structural Consultant.

The work shall be done as per IS: 2911 except as modified herein.

15.2 MATERIALS

15.2.1. The basic materials shall confirm to the specifications for materials given in Section 400. The specifications for steel reinforcement, structural concrete, and structural steel to be used in pile foundations shall be as given in the relevant sections.

15.2.2. Concrete in Piles

Grade of concrete to be used in cast-in-situ piles shall be as specified in the drawing and the cement content shall not be less than **400 kg per cubic meter of concrete.** Maximum water cement ratio shall be 0.5 for cast-in-situ piles and 0.45 for precast piles.

The minimum slump of concrete for bored cast-in-situ piles shall be 150 mm to 200 mm. The slump should not exceed 200 mm in any case.

Concrete mix should have homogeneous mixture with required workability for the system of piling adopted. Suitable and approved admixtures may be used in concrete mix where necessary.

Where piles are exposed to action of harmful chemicals or severe conditions of exposure due to presence of sulphate, chloride etc. it may be preferable to opt for higher grades of concrete restricting water cement ratio to 0.45. Special types of cement, such as sulphate resistant cement may be used where considered appropriate.

15.3. **TEST PILES**

15.3.1 Test piles which are shown on the drawings or specified in the contract or installed by the Contractor on his own to determine the lengths of piles to be furnished shall conform to the requirements for piling as indicated in these specifications, if they are to be incorporated in the completed structure.

Test piles that are to become a part of the completed structure shall be installed with the same type of equipment that is proposed to be used for piling in the actual structure.

Test piles which are not to be incorporated in the completed structure shall be removed to at least 1000 mm below the proposed cut-off level of pile and the remaining hole (if any) shall be backfilled with earth or other suitable material.

The piles shall be load tested in accordance with provisions laid down in this section.

CAST-IN-SITU CONCRETE PILES

Cast-in-situ concrete piles shall be installed by making a bore into the ground by removal of material. Cast-in-situ concrete piles shall be cast in metal shells which may remain permanently in place.

The metal casing shall be of 6mm thick and 600 diameter and strength to hold its original form and show no harmful distortion after it and adjacent casings have been driven and the driving core, if any, has been withdrawn.

MS Liner- The contractor has to provide and install in position permanent MS liner for piles of 600mm diameter & fabricated from 6mm thick plate as per detailed drawing and design including cutting ,bending to the required shape ,welding along with bottom shoe etc. as directed by Engineer in charge. Measurement for MS liner will be considered up to cut off level only. Unit will be in Kg.

Liner or bore-hole which is improperly located or shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Engineer at the cost of the Contractor.

Wherever practicable, concrete should be placed in a clean dry hole. Where concrete is placed in dry and there is casing present, the top 3 m of the pile shall be compacted using internal vibrators. The concrete should invariably be poured

through a tremie with a funnel so that the flow is directed and concrete can be deposited in the hole without segregation.

The casing of cast-in-situ piles shall not be allowed to be withdrawn.

Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting shall be avoided.

The concrete shall be properly graded, shall be self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silty clays and other soils with the tendency to squeeze into the newly deposited concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.

The placing of concrete shall be a continuous process from the toe level to the top of the pile. To prevent segregation, a tube or tremie pipe as appropriate shall be used to place concrete in all piles.

To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.

For bored cast-in-situ piles, casting/liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length shown on the drawing or as approved by the Engineer. Materials inside the casing shall be removed progressively by air lift, grab or percussion equipment or other approved means.

For piles used in soils liable to flow, the bottom of the casting shall be kept enough in advance of the boring tool to prevent the entry of soil into the casing, thus preventing the formation of cavities and settlements in the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joint of the casing shall be made as tight as possible to minimise inflow of water or leakage of slurry during concreting.

Boring shall be carried out using rotary or percussion type equipment. Unless otherwise approved by the Engineer, the diameter of the bore-holes shall be not more than the inside diameter of the liner.

Prior to the lowering of the reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials. Cover to reinforcing steel shall be maintained by suitable spacers.

The diameter of the finished pile shall not be less than that specified and a continuous record shall be kept by the Engineer as to the volume of concrete placed in relation to the length cast.

Before concreting under water, the bottom of the hole shall be cleaned of drilling mud and all soft or loose material very carefully. In case a hole is bored with use of drilling mud, concreting should not be taken up when the specific gravity of

bottom slurry is more than 1.2. The drilling mud should be maintained at 1.5 m above the ground water level.

Concreting under water for cast-in-situ concrete piles may be done either with the use of tremie method or by the use of an approved method specially designed to permit under water placement of concrete.

General requirements and precautions for concrete under water are as follows:

The concreting of a pile must be completed in one continuous operation. Also, for bored holes, the finishing of the bore, cleaning of the bore, lowering of reinforcement cage and concreting of pile for full height must be accomplished in one continuous operation without any stoppage.

(a) The concrete should be coherent, rich in cement with high slump and restricted water cement ratio.
(b) The tremie pipe will have to be large enough with due regard to the size of aggregate. For 20 mm aggregate the tremie pipe should be of diameter not less than 150 mm and for large aggregate, larger diameter tremie pipes may be necessary.
(c) The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of water and concrete.

(d) The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

(e) The pipe should be concreted wholly by tremie and the method of deposition should not be changed part way up the pile to prevent the laitance from being entrapped within the pipe.

(f) All tremie tubes should be scrupulously cleared after use.

(g) The minimum embedment of cast-in-situ concrete piles into the structure supported by pile shall be 150 mm. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete. The clear cover between the bottom reinforcement in structure supported by pile from the top of the pile shall be not less than 25 mm. The reinforcement in the pile shall be exposed for full anchorage length to permit it to be adequately bonded into the pile cap. Exposing such length shall be done carefully to avoid damaging the rest of the pile. Defective piles shall be removed or left in place as judged convenient without affecting the performance of adjacent piles or pile cap. Additional piles shall be provided to replace the defective piles.

15.4. Driving Equipment

Piles casings shall be driven with any type of drop hammer, diesel hammer or single-acting steam or compressed air hammer, provided they penetrate to the prescribed depth or attain the designed resistance without being damaged. The

weight or power of the hammer should be sufficient to ensure a penetration of at least 5 mm per blow, unless rock has been reached. It is always preferable to employ the heaviest hammer practicable and to limit the stroke, so as not to damage the pile. The minimum weight of the hammer shall be 2.5t. In the case of precast concrete piles the mass of the hammer shall be not less than 30 times the mass of 300 mm length of pile.

Stream or air hammers shall be furnished along with boiler or air compressor of capacity at least equal to that specified by the manufacturer of the hammers. The boiler or air compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of steam, air or diesel hammers shall be maintained in first class condition so that the length of stroke and number of blows per minute, for which the hammer is designed, will be obtained. Inefficient steam, air or diesel hammers shall be removed from the work.

15.4.1. DRIVING

15.4.2 General Procedure

Details of the equipment and the method proposed for driving the pile casing shall be submitted with the tender for scrutiny and approval of the Engineer. Piles casing shall be installed from firm ground or from temporary supports or from fixed platform. The arrangement shall provide sufficient rigidity to ensure accuracy of pile casing driving under all conditions of tide, stream flow or hammer drop.

During driving the top of pile casing shall be protected by a suitable helmet of substantial steel construction. The helmet shall provide uniform bearing across the top of the pile casing and shall hold the pile casing centrally under the hammer. No pile casing shall be driven unless inspected and approved by the Engineer.

Pile casing shall be driven from a fixed frame of sufficient rigidity to ensure accuracy of driving within specified tolerances. Forces producing undue bending or torsional stresses in piles shall not be applied during driving. The force of the hammer shall be directed centrally and axially during driving.

The stroke of a single acting or drop hammer shall be limited to 1.2 m unless otherwise permitted by the Engineer. A shorter stroke may be necessary when danger of damaging the pile casing is.

Pile casing s shall not be bent or sprung into position but shall be effectively guided and held on-line during the initial stages of driving. Attempts to correct any tendency for the pile to run off-line by the application of significant horizontal restraint will not be permitted. Shortly after the commencement of driving and at regular intervals throughout the driving operation, checks shall be made to ensure that the pile frame does not exert any undue lateral force on the pile due to restraint within the helmet.

If the indications are that a pile casing will finish outside the specified tolerances, driving operations on that pile casing will cease. The pile casing shall be withdrawn, the hole filled and the pile casing re-driven at no extra cost.

To avoid the possibility of premature “set-up” pile casing driving shall be continuous in the later stages, without any deliberate stops. (Delays of an hour or less may lead to significant “set-up” in piles i.e. resistance to further driving increases after driving is stopped).

If any pile casing is damaged in any way during driving, it shall be repaired or replaced as directed by the Engineer, at no extra cost. If during driving, the head

of a pile is damaged to the extent that further driving is not possible, the head shall be cut off and driving continued. The cost of cutting off shall be borne by the Contractor and where, as a result of such cutting off the head, the pile is too short, the Contractor, shall, at his own cost, supply and splice on sufficient length of pile to restore the pile to its correct length.
Pile casings shall be driven to level required and specified on the drawing whichever gives the lowest toe elevation. The Engineer's decision in these matters shall be final.

15.4.3.1 IMPORTANT CONSIDERATIONS/ INSPECTIONS

Bored Cast-in-situ Piles

15.4.3.1. Tremie of 150 mm to 200 mm diameter shall be used for concreting. The tremie should have uniform and smooth cross-section inside, and shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal. Other recommendations for tremie concreting are:
The sides of the bore-hole have to be stable throughout.
The tremie shall be water-tight throughout its length and have a hopper attached at its head by a water-tight connection.
The tremie pipe shall be large enough in relation to the size of aggregates. For 20 mm aggregate the tremie pipe shall be of diameter not less than 150 mm and for larger size aggregate tremie pipe of larger diameter is required.
The tremie pipe shall be lowered to the bottom of the bore-hole, allowing water or drilling mud to rise inside it before pouring concrete.
The tremie pipe shall always be kept full of concrete and shall penetrate well into the concrete in the bore-hole with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.
15.4.3.1.2 For very long or large diameter piles, use of retarding plasticiser in concrete is desirable.
15.4.3.1.3 **Pile Integrity test**: - For RCC piles, it may be essential to conduct non-destructive pile integrity tests to evaluate integrity of the pile. Pile integrity test is to be done using Low strain /Sonic Integrity test/Sonic Eco test method in accordance with IS 14893 including preparation of pile top by removing soil, mud, dust & chipping lean concrete lumps etc. & use of computerized equipment and high skill trained personnel for conducting the test at site. The test reports needs to be submitted to MDL.
15.4.3.1.4 Where possible, it may be desirable to grout the base of pile with cement slurry under suitable pressure after concrete in the pile attains the desired strength. For this purpose, conduit pipes with easily removable plugs at the bottom end should be placed in the bore along with reinforcement cage before concreting.

15.5 TOLERANCES

15.5.1 Permissible Tolerances for Bored Piles

(a)Variation in cross-sectional dimensions	: + 50 mm, -10 mm
(b)Variation from vertical or specified rake	: 1 in 50
(c)Variation in the final position of the head in plan	: 50 mm
(d)Variation of level of top of piles	: +/- 25 mm

15.5.2 Dynamic Load Test:

The contractor has to carry out the routine vertical load test for 1.5times safe load carrying by means of High Strain Dynamic load test including provision and erection of crane hammer drop mechanism,acceration and displacement velocity transducers to record both force and velocity including excavation ,dewatering ,preparation of pile head including building up of pile ,additional reinforcement if any etc.all complete as per approved method as per ASTM D4945-89,submission of test reports, specifications and as directed by Engineer In Charge. The dynamic load test to be carried out on working pile only. All the requisite factors like man, material & equipments to be considered while quoting the rates. No additional charges will be paid.

15.6 TESTS AND STANDARDS OF ACCEPTANCE

The materials shall be tested in accordance with these Specifications and shall meet the prescribed criteria.

The work shall conform to these Specifications and shall meet the prescribed standards of acceptance.

15.6.1. MEASUREMENTS FOR PAYMENT

For bored concrete piles of specified cross-section, the measurement shall be the length in metres of the accepted pile that remains in the finished structure complete in place. Reinforcement in cast-in-situ bored concrete piles shall be measured for payment as per Section 1200.

Routine and Initial Pile Load Tests shall also be measured for payment as per Bill of Quantities.

For installation of the pile by boring the measurement shall be the length in metre that remains in the finished structure complete in place, limited to that shown on the drawings or instructed by the Engineer. No distinction shall be made for penetration through hard strata or rock and socketing into rock.

For steel casing as shown on the drawing to be permanently left in place, the measurement shall be by weight in tones that remains in the finished structure complete in place, limited to that shown on drawings or instructed by the Engineer.

15.6.2 RATE

The contract unit rate for cast-in-situ bored piles shall include the cost of concrete and all other items. The contract unit shall also include costs of all labour, materials, requisite marine equipments and all other incidentals involved in conducting routine and initial pile load tests including installation of piles for initial load tests.

The contract unit for installation of piles shall include full compensation for furnishing all labour, materials, tools and equipment, and incidentals for doing all the works involved in making bores for cast-in-situ bored concrete piles, cutting off pile heads, all complete in place to the specified penetration of piles. Providing

temporary liner/casing and its withdrawal and placing reinforcement in position shall also be deemed to be included in the rate for installation of piles and no additional payment shall be made for the same.

The contract unit rate for permanent liners shall include cost of all labour, fabrication and placing the steel liner to the required depth incl.all the requisite equipments as instructed by the Engineer.

15.6.3 **All materials shall be procured by the contractor as specified in the Technical Specification / Bill of Quantities, at his own cost and the price quoted shall be deemed to be inclusive of all applicable taxes, duties, transportation, storage, royalties, handling, etc. The contractor should produce original challans / bills of the materials and its quantity brought to the site as and when required by MDL.**

16. Appointment of Consultant:- The Contractor has to appoint the Licensed Structural Consultant for design of structural members based on interpretation & reports of Non Destructive testing (NDT) carried out and field investigation on Marine boreholes, submit the method statement for execution, issue of GFC drawings, supervision, issue of Stability certificate etc. complete including proof checking & approval by third party IIT/VJTI/IRS & submission along with Design calculations.

Structural consultant shall be responsible for technical matters, supervision, monitoring of progress, inspection, joint measurement, certification of work and preparation of As-built drawings.

17. The works include the cost towards mobilizing the requisite suitable equipments, its maintenance, temporary works, obtaining statuary permission for the equipments to carry out the entire repairs /restoration works including loading/unloading of the dismantled structure and installing new structure by concreting till completion of the repair/restoration work of Kasara Dolphine Jetty. The contractor has to quote the rates considering all the above requirements and inspecting the site conditions.

18. Wearing Course-Anti-skid compound-

The contractor has to carry out the work of providing & applying of **Anti-skid compound** of Fosroc or equivalent make as per manufacturer's specifications to walkway slab including cleaning, surface preparation by manually or mechanical means etc. complete as directed.

19 Documents to Be Submitted By Contractor for Handing Over

After successful completion of the project as desired by the Employer/Consultants you shall submit 4 sets of Handing over Documents neatly bound to corporate standards along with two soft copies in CD.

20. LIST OF PREFERRED MAKE- CIVIL WORK

Sr. No.	DESCRIPTION	APPROVED MAKES
1	Cement	ULTRATECH/ AMBUJA/ BIRLA/ACC

2	Reinforcement Steel – Thermo Mechanically treated steel (**Fe 500D grade)**	Tata-TISCON/SAIL/ RINL VIZAG/JSW/ISPAT
3	Structural Steel	TATA / SAIL / JINDAL/ VIZAG/JSW
5	Ready Mix Concrete Suppliers	ULTRATECH / ACC / GODREJ/Novoko or any other approved by Engineer In Charge.
6	Polymers Modified mortar	Sunanda/ BASF/ Krishna Conchem
7	Epoxy Grouting Material	Sunanda / BASF/ Fosroc
8	Micro concrete	Sunanda/ BASF/Krishna Conchem
9	Rust remover, passivator	Sunanda/ BASF/Krishna Conchem
10	Corrosion inhibitor	Sunanda/ BASF/Krishna Conchem
11	Anti-Corrosive Coating	Sunanda/ BASF/Krishna Conchem
12	Epoxy bond Coat	Fosroc, Krishna Conchem, BASF, Sika
Note :	i)Brand deviation if any, needs to be tested for cement, reinforcement steel and structural steel prior to using it for construction only if above approved makes are not available and after Prior confirmation/approval from Engineer In-charg ii)Brand deviation if any, for other finishing items can be changed only if above approved makes are not available and after Prior confirmation/approval from Engineer In-charge. iii) Whenever specification of BOQ item is not mentioned; then CPWD specification shall be applicable. (iv)Wherever make is specified in BOQ then manufacture's specifications & procedure shall be applicable. (v)Wherever no specifications or make is specified than work is to be carried out as per the written direction of Engineer-In-Charge.	