1.7) DELIVERY, STORAGE, AND HANDLING

The Contractor shall be responsible for timely ordering, scheduling, delivery, receiving, protection and installation of all materials necessary for completion of the works, on site or in transit.

A) Deliver materials to project site in manufacturer's original packaging, clearly identified as to type and location.

B) Materials shall be transported, handled and stored on the site or elsewhere in such a manner as to prevent damage, deterioration or contamination all to the satisfaction of the Purchaser. The Purchaser reserves the right to inspect any materials to be used on the works at any time and at any place of storage.

1.8) SEQUENCING

A) Coordinate work under provisions of Conditions of Contract.

B) Coordinate work with installation of dry wall partitions, masonry works, blinds, other interior works and M&E services.

PART 2 - PRODUCTS

2.1) MATERIALS

2.1.1 ACOUSTICAL MINERAL FIBRE CEILING PANELS SUSPENDED CEILING AS SHOWN ON SCHEDULE

A) Acoustical mineral fiber or stone wool ceiling panels indicated in the Room Finish Matrix shall be 600x600x15mm/1200x600x15mm thick with recessed edges (Color: white). The panels shall be able to withstand temperatures above 1000 degrees Celsius without melting. Thermal conductivity of panel may not exceed 0.034 λ W/m degrees Celsius.

B) Sound Absorption:

Frequency, Hz	100	250	500	1000	2000	4000
Absorption	0.55	0.70	0.75	0.70	0.80	0.75

C) Supporting steelwork: Galvanized steel plate profiles

D) Surface: white finish with recessed edge installation.

E) Suspension: With spring or vernier hangers.

F) Fastening: With approved metal expansion anchor or other approved fasteners and associated screws.

G) Panels: Make, Rockon or equivalent recessed edges, Fire protection class O

H) Wall Joints: Shadow angle for recessed edge panels with white enamel finis.

I) Substructure: Vertical blinds flush with the ceiling. Vertical blinds shall be fitted to all office windows.

J) The acoustical ceiling panel shall be 100% moisture resistant when exposed between temperatures of 1 to 45 degrees Celsius and will not show any visible sagging or warping. The light reflectance shall be minimum 87% with surface and edges of the acoustical ceiling panel painted originally by the manufacturer to safeguard acoustical properties.

K) The acoustical panel must be inorganic and shall not be able to disintegrate and not sustain growth of bacteria, fungus and mould. The surface colour shall be white. The panel shall have a maximum density of 120kg/m3.

L) The acoustical ceiling panel shall be easily cleaned with ordinary cleaning agents dissolved in water.

M) The suspension system shall be exposed type grid in 600x600/1200x600 (Colour: white). Suspension member shall be double web design and pre-finished in manufacturer's standard baked enamel paint finish.

N) The main tee shall have an integral reversible splice piece, with connection values for basic loads of 90kg pull out tension, and 215kg compression. The cross tee shall have a high tensile steel locking tab. Its connection values shall be for basic loads of 155kg pull out tension, and 65kg compression.

O) Grid members shall be manufactured from hot-dipped galvanized steel. The system shall be either suspended or directly fastened to the structural slab soffit above by hangers. Main tee sections shall be suspended by means of 4mm galvanized rod. Perimeter panels shall be cut on site to suit the profile of the perimeter walls.

2.1.2 <u>ACOUSTICAL CLEANROOM CEILING PANELS (MYLAR BOARD) AS SHOWN ON SCHEDULE</u>

A) Shall be Thermaclean, laminated foil-faced ceiling panel made from new generation bio-soluble mineral wool, clay and starch indicated in the Room Finish Matrix shall be 1200x600x19mm thick with square edge (Color: white).

B) Sound Absorption: As per BS EN 20354: 1993

C) Sound attenuation : As per BS EN 20140-9: 1994 Dn,c,w = 34 dB (thickness 15mm)

D) Humidity resistance panels : up to 95% RH

E) Fire Resistance : Class A

F) Weight : 4.3 kg/m2

G) Thermal conductivity : λ = 0.052 – 0.057 W/mk

H) Fire protection up to 1hr in accordance with BS476: Parts 20-23; 1987. Fire resistance F30-F120 to DIN 4102, Part 2.

I) BIO-PRUF – Surface treatment

J) Clean room standard – in accordance with ISO 14644-1, U.S. Fed. Std. 209E, VDI Guidelines 2083 Page 1.

K) Dimension Stability : Shall withstand 40 °C and 95% RH without visible sag.

L) Supporting steelwork: Galvanized steel plate profiles

M) Surface: white finish. Exposed grid installation with notched panels.

N) Suspension: With spring or vernier hangers.

O) Fastening: With approved metal expansion anchor or other approved fasteners and associated screws.

P) Panels: Make, AMF or equivalent square edges with Fire protection at BS 476 Part 6/7 Class 'O'

Q) Wall Joints: Corresponding angle for notched panels with white enamel finis.

R) Substructure: Vertical blinds flush with the ceiling. Vertical blinds shall be fitted to all office windows.

S) The light reflectance shall be minimum 90% with surface and edges of the acoustical ceiling panel painted originally by the manufacturer to safeguard acoustical properties.

T) The acoustical panel must be inorganic and shall not be able to disintegrate and not sustain growth of bacteria, fungus and mould. The surface colour shall be white.

U) The acoustical ceiling panel shall be easily cleaned with ordinary cleaning agents dissolved in water.

V) The suspension system shall be exposed type grid in 1200x600 (Colour: white). Suspension member shall be double web design and pre-finished in manufacturer's standard baked enamel paint finish.

W) The main tee shall have an integral reversible splice piece, with connection values for basic loads of 90kg pull out tension, and 215kg compression. The cross tee shall have a high tensile steel locking tab. Its connection values shall be for basic loads of 155kg pull out tension, and 65kg compression.

X) Grid members shall be manufactured from hot-dipped galvanized steel. The system shall be either suspended or directly fastened to the structural slab soffit above by hangers. Main tee sections shall be suspended by means of 4mm galvanized rod. Perimeter panels shall be cut on site to suit the profile of the perimeter walls.

2.1.3 ALUMINIUM/METAL CEILING PANELS. CLIP-0N SYSTEM AS SHOWN ON SCHEDULE

A) Supporting steel work: Galvanized steel white capped interlocking tees in 24 mm (w).

B) Surface: White finish

C) Suspension: Rigid suspension with 3mm rod hangers with adjustable clips.

D) Fastening: with approved metal expansion anchors or other approved fasteners and associated screws

E) Panels: Durlum make or equivalent

F) System: Durlum S3F flush lay-on tiles ceiling

G) Material: Galvanised steel plate approximately 0.5mm thk.

H) Grid dimension: 600 x 600

I) Edges: Panels flush recess tegular on all 4 sides

J) Design: Plain without perforation

K) Surface: Polyester powder costing in excess of 60 microns paint thickness on the surface and edges.

L) Building material raiting: A2

M) Miscellaneous: Perforated panels should be used if acoustical insulation are required. Soundtex tissue shall be laminated at the back of perforated surface panels.

N) Wall Joint: F025 aluminium wall angles with white polyester powder coated surface.

2.1.4 METAL TILE CEILING PANELS, Clip-in System

A) Supporting steel work: Galvanized steel white capped interlocking tees in 24mm(w).

B) Suspension: Rigid suspension with 3mm rod hangers with adjustable clips.

C) Fastening: with approved metal expansion anchors or other approved fasteners and associated screws

D) Panels: Durlum make or equivalent

E) System: Durlum S3F flush lay-on tiles ceiling

F) Material: Galvanised steel plate approximately 0.5mm thk.

G) Edges: Panels flush recess tegular on all 4 sides

H) Design: Plain without perforation

I) Grid dimensions: 600 x 600

J) Surface: Polyester powder costing in excess of 60 microns paint thickness on the surface and edges

K) Building material rating: A2

O) Miscellaneous: Perforated panels should be used if acoustical insulation are required. Soundtex tissue shall be laminated at the back of perforated surface panels.

L) Wall joints: F025 aluminium wall angles with white polyester powder coated surface.

2.1.5 GYPSUM PLASTER CEILING

A) The dry wall ceiling board in the Room Finish Matrix shall be 12mm thick recessed edge gypsum plasterboard. The 1.5mm deep recess on face side of the plasterboard shall allow formation of shallow channel for joint reinforcement. The thermal co-efficient of linear expansion shall not exceed 16.2×10^{-6}mm in the temperature range 4° to 38°C.

B) Install the ceiling plasterboard and framing in accordance with the manufacturer's instructions and in accordance with to the National Standards and Authorities' requirements.

C) Incorporate control joints for the gypsum plaster ceiling to permit movement and to prevent deformation and damage. Provide control joints for plaster ceilings abutting any structural element or dissimilar wall or ceiling assembly.

D) Fire rated double layer ceiling to be provided in protected corridors, the ceiling system must be walk able for maintenance of services above the ceiling system.

PART 3 - EXECUTION

3.1) EXAMINATION

The Contractor is to examine and satisfy himself of other related-trades site conditions under which, the ceiling is to be installed. Do not proceed until unsatisfactory conditions have been rectified. Beginning of installation means installer accepts existing surfaces and substrate.

3.2) INSTALLATION

A) During installation of acoustical mineral fibre ceiling panels and gypsum plasterboard the temperature shall remain stable within a range of 11 to 35°C. If there is a noticeable drop in temperature there will be a consequent increase in relative humidity (RH%) which harms the ceilings, whether already installed or not. At lower temperatures, especially lower than 11°C, slight drops in temperature cause an excessive increase in relative humidity (RH%).

B) GENERAL

(i) LIGHT FITTINGS: If the light fittings are held up by the support structure, the maximum load is 20 kg for two bearing sections and 6 kg for one or more cross-ties. Ceiling panels to be cut by Ceiling installer contractor to allow the light fittings installation by others.

(ii) CONTINUOUS LUMINOUS GROOVES: The bearing and intermediate sections shall have protruding ties without taking the presence of the luminous grooves into account, making sure to keep the minimum recommended distance between the ties.

(iii) LIGHT FITTINGS TO BE AFFIXED TO THE FALSE CEILING: The light fittings shall be affixed to the bearing sections by means of suitable fixing accessories.

(iv) AIR GRILLES: The air grilles shall always be independently fixed to the soffit, unless there are to be special installations. Ceiling panels to be cut by Ceiling installation contractor to allow the grille installation by others.

(v) CONTINUOUS VENTILATION GRILLES: See note on continuous luminous grooves.

(vi) SPRINKLER HEADS: The ceilings shall be designed for integration with fire sprinklers.

(vii) FITTING OF SMOKE DETECTORS: The smoke detectors must fit easily into all the ceilings.

(viii) SUPPORT OF SIGNS: The maximum load for signs is the same as that indicated for the light fittings.

C) Suspended ceilings shall have openings (requirements of lighting equipment and installation equipment). The Ceiling Contractor shall be responsible for providing openings.

3.3) ERECTION TOLERANCES

A) Maximum Variation from Dimensioned Position: 5mm.

B) Maximum Variation from Flat Plane: 3mm in 3m.

3.4) INSPECTION

The Contractor shall carry out the ceiling works to meet the requirements as specified in the contract documents and the drawings, failing which the works shall be rectified at the Contractor's expense.

3.5) ADDITIONAL MATERIALS

For future repairing works, the Contractor shall supply for 10% of same materials for the suspended ceiling systems used herein.

X. IRONMONGERY & DOOR HARDWARE

PART 1 – GENERAL

1.1 SCOPE OVERVIEW

1.1.1 The works in this scope includes, but are not limited to, the design, supply, delivery, installation, supervision, co-ordination, testing, commissioning, and handover in approved conditions of the Ironmongery. All labor and material, transport, plant and necessary equipment for supply and installation of the ironmongery shall be included.

1.1.2 Manufacturer/approved material indicated in the specifications are included only for reference of quality and performance required and should not be read as pertaining to any particular preference or prejudice. Alternative proposal complying or exceeding the specifications are acceptable meeting the latest standards of appropriate installation. The drawings and door schedule depict the performance requirement and the Subcontractor shall review the details against his own system and propose solutions to meet technical requirements of the project.

1.1.3 Qualifications and exceptions to this specification shall be listed and specifically and included at the time of tender. Without such exceptions, tenders shall be deemed to fully comply with the specification.

1.1.4 The Ironmongery Supplier is to coordinate with door manufacturer to provide drawings, samples, and specifications for approval. The contractor shall assume full responsibility in ensuring that the assemblies meet the performance requirements of the specifications.

1.2 PROJECT/SITE CONDITIONS OR SPECIAL CONDITION

1.2.1 Hardware shall be complete with all necessary screws, bolts, anchors or other fastenings for proper application of suitable size and type, and match hardware as to materials and finish.

1.2.2 Regulatory Requirements

1.2.2.1 Conform to applicable building code for requirements applicable to fire rated doors and frames.

1.2.2.2 Conform to the applicable sections of Chapter 5 of NFPA 101, NFPA 80, and NFPA 252.

1.2.2.3 Provide hardware which has been tested and listed by UL or FM for fire rated assemblies of types which comply with requirements of door and frame labels.

1.2.3 Certification

1.2.3.1 Ironmongery Supplier/Manufacturer and Door Contractor shall jointly inspect complete installation and certify that ironmongeries & hardware installation has been furnished and installed in accordance with manufacturer's standard & instructions.

1.2.3.2 Provide two copies of certifications to Architect.

1.2.4 The contractor shall co-ordinate with other relevant trades and is responsible for obtaining all information required to achieve good and coordinated installation.

1.2.5 The Contractor shall carry out the following obligations and duties

1.2.5.1 Obtain field measurements and setting-out of areas before commencement of works.

1.2.5.2 Make enquiry if there are any discrepancies between site conditions and approved construction drawings prior to proceeding with work.

1.2.5.3 Provide/arrange necessary evidence/documentation as may be required by the relevant authorities to demonstrate compliance with relevant codes, regulations and standards.

1.2.5.4 Allow protection to completed works including all fixings and accessories.

1.3 REFERENCES/PROJECT REQUIREMENTS

1.3.1 Tender Drawings, Door Schedule and general provisions of Contract, including General and Supplementary Conditions and Scope Description & Specifications, apply to this Section. This section shall be used in conjunction with the above documents to establish the full requirement of the project.

1.3.2 The contractor to note that client is not an approving authority for the purposes of authority requirements. client will comment on drawings and proposal by the contractor it is the sole responsibility of the contractor to meet the performance requirements and the requirements of applicable statutory institutes or standards.

1.3.3 The contractor shall comply with all relevant local codes and regulations that may apply to the works. Equivalent standard in India in cases where they exist, with prior approval can replace the standards referred to in this document. The more stringent standard always applies.

1.3.4 Additional project requirements and references:

- Latest India Code on Barrier Free Accessibility in Buildings
- ANSI/NFPA 80 - Fire Doors and Windows.
- AWI - Architectural Woodwork Institute.
- BHMA - Builders' Hardware Manufacturers Association.
- DHI - Door Hardware Institute.
- NAAMM - National Association of Architectural Metal Manufacturers.
- NFPA 101 - Life Safety Code.
- SDI - Steel Door Institute.
- NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
- NFPA 252 - Fire Tests of Door Assemblies.
- UL 10B - Fire Tests of Door Assemblies.
- UL 305 - Panic Hardware.
- Code of Practice – CP96
- All Related India Standards and Code of Practice.

1.4 SUBMITTALS & TECHNICAL REQUIREMENTS

1.4.1 **Product Data Sheet & Samples:**

1.4.1.1 Provide product data on specified hardware. Include each hardware item cut sheet bound in each hardware schedule. Identify item on sheet.

1.4.1.2 Data sheet shall include information to show compliance with technical, physical and performance requirements.

1.4.1.3 Data sheet shall include instructions for installation and maintenance of operating parts and finish.

1.4.1.4 Submit sample for **each** type of ironmongeries properly labeled and tagged mounted on standard sample boards including all accessories, attachments, and fixings.

1.4.1.5 All approved sample shall be retained by client/Architect for future reference of ironmongery types.

1.4.2 Certifications:

Submit all other relevant certificates on quality conformance form local or international testing authority.

1.4.2.1 Ironmongery Schedule:

Submit schedule at earliest possible date, particularly where acceptance of ironmongery schedule must precede fabrication of other work that is critical in project construction schedule. Include in the schedule product data, samples, shop drawings of other work that is affected by finish ironmongery and other information essential for coordinated review of ironmongery schedule.

Ironmongery Schedule should contain the following information in an organized format:

- Type, style, function and finish of each ironmongery item
- Name, model number, and manufacturer of each item
- Fastening, fixing, and other pertinent information.
- Mounting locations for ironmongery with dimensions I reference to approved shop drawings.
- Door Frame size and material
- Keying information
- System and wiring diagram for all electronic ironmongery.

1.4.2.2 Keying Schedule

- THE CONTRACTOR and approved ironmongery supplier shall co-ordinate with to develop comprehensive keying schedule for the entire project.

- The keying schedule shall contain information with regard to keying system, master keying, numbering of keys and placement of cylinders.

- Comprehensive layout drawing showing cylinder tagging and numbering in relation to keying schedule shall be submitted by THE CONTRACTOR and approved ironmongery supplier.

- The keying/cylinder system shall be of highest security level and latest technology design.

- ❖ The keying system shall have the capacity to expand for the subsequent phases of the development without having to re-key the existing locks.
- ❖ The keying system shall be submitted to client for approval including all system information and required lead time for production and replacement.
- ❖ Cylinders shall be of removable core type, and shall conform to additional client requirements.
- ❖ Submit templates of finish ironmongery for door and frames as required by the various trades involve in the work.
- ❖ Ironmongery supplier will be required to meet with client to establish quantity and types of core required.
- ❖ Coordinate the ironmongery work required with the specialty door manufacturer / suppliers, the card reader, security alarm, and fire alarm Subcontractors.

1.5 QUALITY ASSURANCE

1.5.1 Manufacturers & Suppliers: Companies specializing in manufacturing door hardware, ironmongery and security systems with minimum ten (10) years experience with a record of successful service performance for similar quantity, type, and quality to that indicated project.

1.5.2 The Manufacturer/Supplier shall be available at reasonable times during course of the work for consultation about the project ironmongery requirements to the client and the Contractor.

1.5.3 Hardware installer: Employ a qualified carpentry person to perform the work of this Section.

1.5.4 Single Source Responsibility: each type of ironmongery shall be supplied from single manufacturer without substitution unless noted otherwise "or approved equivalent" which means "or equal is approved by client".

1.5.5 Manufacturers: Items of other manufacturers than those scheduled will be considered for acceptance providing they meet the specified criteria and that the substitution requests are made in accordance with the specifications, no exceptions.

1.6 WARRANTY

1.6.1 Provide 5-year full warranty for all ironmongery. Door closers shall have 10 year full warranty. Warranty shall be signed by the Contractor and Ironmongery supplier and installer agreeing to repair or replace defective parts or workmanship.

1.6.2 Warranties to cover the cost of dismantling, removing, making new parts, making good to adjacent/surrounding surfaces, finishing and re-fixing to match existing.

PART 2 – PRODUCTS

2.1 HINGES

2.1.1 Hinges: All hinges shall be ball bearing with sufficient throw to clear door trim or wall construction, but no more than necessary. High frequency type, full mortice template butt hinge.

2.1.2 Hinges for exterior doors and security areas shall have pins held in place by a set screw which can only be removed while the door is open.

2.1.1 Provide additional hinges as required by door height in accordance with manufacturing recommendations

2.1.2 All hinges supplied shall be of the same manufacturer and available in low, medium and high frequency.

2.1.3 Unless otherwise specified, all hinges shall be of satin stainless steel Grade 304/316, full mortice template ball bearing hinges.

2.1.4 All hinges shall be supplied with wood screw for timber doors and machine screw for metal doors.

2.1.5 The centre pin of the hinges shall be fixed so that it will not be moved out-of-place from the hinges due to door misalignment.

2.2 LOCK SETS

2.2.1 Cylindrical type of weight, design, function and materials as specified. Faces shall be rabbeted, beveled or rounded as required.

2.2.2 They shall pass the fire tests of BS476 Part. Manufactured according requirements to EN12209, dimensions according to DIN 18251-1, class 3, classification 3H110B2KC20.

2.2.3 Locks shall have all functions available in one size case, manufactured from heavy gauge steel.

2.2.4 The mortice lockcases are to be tested in overseas or locally to be suitable for usage on fire-rated doors up to 4-hours irregardless of the function of the locks.

2.2.5 Detailed specification of locksets are as follows :-

- ❖ Heavy duty able to withstand heavy usages.
- ❖ Heavy duty spring follower for lever handles to prevent any form of sagging. The force exerting on the lever handle in order to activate the latch must be at least 1.5kg.
- ❖ Available in 60mm backset.
- ❖ 8mm square follower.
- ❖ Minimum 22mm throw (Double throw) for deadbolt.
- ❖ Single sided lever handle fixing if necessary.
- ❖ 17mm profile or 22mm profile cylinder hole, 72mm centre-to-centre distance from lever to cylinder.

- ❖ As for high security mortise lock, the latch must be non-reversible and should be complete in one piece latch. Reversible latch is to be use in low security area.
- ❖ Forend to be in single piece of thickness 3.4mm and material in stainless steel Grade 316.
- ❖ Gauged case to be welded directly onto forend of lockcase for security purposes.
- ❖ Forend shall be in modular size for all lock functions for easy maintenance.

2.2.6 Locksets shall be supplied complete with strike plate, cylinder escutcheon and roses, in stainless steel Grade 316, as required for the function requirement.

2.2.7 Stainless steel materials of the forend of the lockcases and lever handle must be of Grade 316 and tested accordingly to the standards DIN 50021/ASTM/B 117/JIS Z2371. The tests are to be tested by local test laboratory for the corrosion resistance of the stainless steel Grade 316 for the period of 4 years. The stainless steel materials must not rust or corrode during the first 4 years after completed installation. Proof of the test for corrosion resistance to be submitted.

2.2.8 The follower and latch of the proposed lockcase shall be tested for at least 600,000 cyclic movements, and proof of testings by independent institution shall be submitted as proof.

2.2.9 Rebated kits and striking plates shall be provided for all double leaves doors.

2.2.10 The possible functions of the locksets are :-

- ❖ Mortice Night Latch (Silent Action)
- ❖ Mortice Deadbolt
- ❖ Mortice Sashlock (A Lock With Deadbolt And A Latch)
- ❖ Mortice Nightlatch With Anti-Thrust Bolt
- ❖ Mortice Bicentric Lockset
- ❖ Narrow Mortice Deadlock
- ❖ Narrow Mortice Sashlock
- ❖ Mortice Panic Lock

2.2.11 Curved Strike Lips: Length to protect jamb trim.

2.2.12 All lock-strikes shall be with box, stainless steel dust covers and a lip of sufficient length to protect door trim and jamb.

2.2.13 Locksets shall have removable core keying and cylinder.

2.2.14 Material: All levers and handles must be of stainless steel; finish to be selected from manufacturer standard range.

2.3 DOOR CLOSERS

2.3.1 Closer Construction shall be heavy-duty type available in regular slide arm and channel. All parallel arm brackets shall be provided for door swings towards the opposite direction.

2.3.2 Door closers must not install on the outside of any exterior door.

2.3.3 Door Closer shall be fully intelligent back-check feature providing a cushion effect to prevent uncontrolled opening of the door beyond 70° with adjustable closing speed control and latching action function from 180-70° to allow easy access to handicapped person, electromagnetic hold open device, smoke detectors and concealed sequence door selector.

2.3.4 Door closer shall have an adjustable latching force to ensure that door is properly closed and latched. Door Closer and door coordinator/selector shall be approved by relevant authority

2.3.5 Door Closer shall be totally reversible without adjustment.

2.3.6 Door Closer shall match the lever/pull handle/push plate finishes of the door.

2.3.7 Provide surface units which have been independently certified to a minimum of 10,000,000 cycles, in accordance with ANSI testing procedures.

2.3.8 Conforms to most recognized International Standards such as EN 1154 and certified to ISO9001.

2.3.9 The closer shall be approved by FSSB and PSB to be used on fire doors and certified to PSB SS 332 standard.

2.3.10 Fasten all closers with through bolts

2.4 EXIT DEVICES

2.4.1 Exit Devices: UL listed for purpose intended. Operating device shall be touchbar style. Finish, function, design, lever, and trim as indicated in Hardware Sets.

2.4.2 Provide extended rods as required for each particular opening.

2.4.3 Material: Device body and components must be of stainless steel; finish to be selected from manufacturer standard range.

2.5 FLUSH BOLTS & DUST PROOF STRIKE SOCKET

2.5.1 Flush Bolt shall be of lever action type or self latching PSB approved type.

2.5.2 Provide extended rods as required for each particular opening.

2.5.3 Dust proof spring loaded strikes shall be used when the door locks into floor, except where metal threshold is used.

2.5.4 Material: Flush Bolts and Dust Proof Strikes must be of stainless steel; finish to be selected from manufacturer standard range.

2.6 DOOR STOPS

2.6.1 Door stop for doors adjacent to drywall shall be floor mounted type.

2.6.2 Door stop for doors adjacent to masonry/concrete wall shall be wall mounted type.

2.6.3 Material: door stop body must be of stainless steel; finish to be selected from manufacturer standard range. Bumper shall be of approved neoprene or rubber component.

2.7 DOOR SELECTOR

2.7.1 Door selector shall be on a non-handed type, fully automatic and available in vrying lengths.

2.7.2 Proprietary stainless steel strike plate shall be provided.

2.7.3 Material: door selector arm and body must be of stainless steel; finish to be selected from manufacturer standard range. Roller shall be of approved neoprene type.

2.8 FLOOR SPRING & GLASS DOOR IRONMONGERY

2.8.1 Floor Spring shall be of double action type.

2.8.2 All patch fittings and accessories shall come from single-supply source as the floor spring.

2.8.3 Lockset shall allow for the same cylinder profile as the rest of the whole project and form part of the master - keying schedule.

2.8.4 Stainless steel handle shall be designed and coordinated with door/curtainwall contractor.

2.8.5 Depth of floor spring shall not be more than 60mm. The Contractor shall ensure that the top level of floor spring completed is of the same level as the adjacent finished floor level (with finished).

2.8.6 All floor spring shall be provided with pressure relief valve to prevent over-loading and oil leaking.

2.8.7 Floor spring shall be provided with adjustable hold open/back check from 75 degree to 175 degree.

2.8.8 Floor spring shall have delayed closing up to 45 seconds.

2.8.9 Floor spring shall be available in closing force of 53NM, 35NM or 15NM.

2.8.10 Floor spring shall be available with interchangeable spindle from 5mm to 50mm suitable for timber, metal and glass doors.

2.9 CYLINDER & MASTERKEY SYSTEM

2.9.1 Provide "Kaba" keyway or equivalent to match Owners requirements. Furnish all locks construction. Master keyed. Provide core type as required by owners system.

2.9.2 Cylinders shall comply with ANSI A156.6 and conform to DIN 18252 or its equivalent.

2.9.3 All cylinders proposed shall meet the degree of security desired for the installation.

2.9.4 The plug shall be made of solid brass. Cylinder shell shall be made of solid brass and finish to match the appearance of the lock which the cylinder is fitted.

2.9.5 All cylinders shall be available in at least 22 or more pins with tumblers. Each of the 22 positions consists of a security pin, a security tumbler and a spring. For added security the cylinder shall possess multi-part construction of the pin mechanism coupled with the rotation factor and off centre pin to key alignment features, and in 4 multiple rows for security reasons. Single row of pin is not acceptable.

2.9.6 The cylinders shall have detainer pins to protect against picking.

2.9.7 Cylinders shall be designed for tensile loading of 12800 Newton against wrenching and pulling of the plug within the cylinder.

2.9.8 The cylinder shall suit regular door thickness of 40 - 45mm but incremental increases shall be available for doors of thickness more than 60mm.

2.9.9 The cylinder's bodies and plugs are machined from extruded brass to a diameter of 17mm or 22mm round profile unique as compared to the conventional cylinder.

2.9.10 It is finished in nickel silver plating as standard to match most door furniture, however, other finishes are available upon request.

2.9.11 The standard length of a double cylinder with both sides keyed is 65mm which suits most doors up to 50mm thick. Extended length is available upon request for extra thick doors.

2.9.12 Where external security is vital, cylinder can be surface hardened to prevent drilling. The pins in such cylinders are also hardened.

2.9.13 The range of cylinders must be very wide. A cylinder can be found to suit most applications from door locks, roller shutter locks, furniture locks, key switches, or in certain cases special application.

2.9.14 All cylinders are factory sealed making it impossible to tamper with the permutation inside the cylinder.

2.9.15 Since a cylinder could be found to suit most applications, it is possible to master key systems comprising a variety of cylinder locks, eg. mortice locks, roller shutter locks, knobsets, padlocks, furniture locks, key switches and others being integrated into a master key system.

2.9.16 All cylinders supplied shall be under grand masterkey complete with optional construction key system. The Contractor shall liaise with his sub-contractor responsible for producing a key chart in master key system for S.O.'s approval prior to installation.

2.9.17 Cylinders shall be available in construction key system, which is incorporated into the permanent cylinder, if requested. The construction key system can be invalidated by using a special U-key or change code key and only the mastered keys will be able to activate the cylinder. Alternatively, temporary cylinders should be supplied at no costs. The main contractor shall resume the responsibility to change the temporary cylinder to the actual cylinders during handling-over stage.

2.9.18 The inserts of the master keyed cylinders should be interchangeable for replacement and security purposes.

2.9.19 The inserts of the master keyed cylinders must be suited to other cylinder types, namely rim cylinder, 17 mm profile cylinder, 22 mm profile cylinder, 36 mm profile cylinder, etc.

2.9.20 The housing of the cylinder shall be recyclable and interchangeable. These as well as other components could be kept by the user for maintenance purposes.

2.9.21 The listed security patented cylinders and padlock would be:

- Security patented thumb turn cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies.

- Security patented double cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- Security patented single cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- Security patented padlock, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies

2.9.22 The Subcontractor shall rekey construction cylinders as required to secure portions of the project for his use.

2.9.23 Provide 40 construction master keys for distribution to other trades during course of work.

2.9.24 Provide 3 change keys per lockset / cylinder.

2.9.25 Provide wall mounted key cabinet with hooks, labels, and index.

2.9.26 Provide stainless steel tamper proof key rings for each set of keys with 25% additional rings and required fastening tool.

2.10 KEYING AND MASTERKEYING (MECHANICAL LOCKSETS)

2.10.1 All cylinders shall be able to be furnished with built-in construction key system, individual key, sub-master key, master key, grand master key, great grand master key under the same system, with minimum 5 levels of master key hierarchy.

2.10.2 All keys are to be made of nickel silver, are flat, reversible and can be inserted both ways.

2.10.3 Keys shall have special key blanks and keyways for difficult unauthorised reproduction and shall have copyright for the period 2022. Patent protection shall be registered both worldwide and locally in India and the region.

2.10.4 Keys production can only be executed through authorised request from owner and the indentations on the keys are produced by CNC machine.

2.10.5 All cylinders shall be finished with 3 keys sealed with a tagged special chastity clip to be handed over to client/architect.

2.10.6 Key alike cylinders shall be furnished with 12 keys sealed with a special chastity clip.

2.10.7 6 nos each of the sub-master keys, master keys and grand master keys are to be provided in a sealed chastity clip and tagged.

2.10.8 It shall be deemed that the contractor has priced for the provision of keys and master keying system specified (minimum 5 hierarchy) in the unit rates for cylinders.

2.10.9 Each key shall have the option of including various different colours, up to 12 different colours, to the key bow as means of identification by the client. The colour to the key bow shall be able to be interchangeable with special tooling by the client themselves. The supplier shall made provision to supply the fixture to change the colour coding on the key bow.

2.10.10 The key duplication method must be by special milling method with special and controlled tool bits by the supplier. Drilling method and any other methods of key duplication is not acceptable and will be rejected. The supplier must submit samples and proof of the required key milling method in the duplication the security key.

2.10.11 Provision must be made to allow an intelligent SMART RFID chip to be incorporated into the key bow of all keys supplied.

2.10.12 The keys to the mechanical locking system should be able to be upgraded in future to incorporate and integrate with mechatronic locking system or a full electronic access control system that make use of RFID or Legic technology, without changing the existing mechanical master key system and locking hardwares, except cylinders.

2.10.13 The listed security key system to the master keyed cylinders would be:

- ❖ Security patented thumbturn cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- ❖ Security patented double cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- ❖ Security patented single cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- ❖ Security patented padlock, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies

2.11 HANDLING/DUPLICATION OF KEYS (MECHANICAL)

2.11.1 The Contractor shall maintain an updated record on site of keys issued and a copy of such record shall be submitted to client/architect. The cylinder lock shall be replaced

prior to handing over for anyone of those keys reported lost at the Contractor's expense. No duplication of keys shall be permitted without prior approval of client/architect.

2.11.2 The supplier must be present to hand over the sealed keys to the owner's representative in the presence of the main contractor, owner's representative and S.O. All documentation of the handing over process must be properly recorded.

2.11.3 Temporary or construction keys should be properly controlled by the main contractor to be issued to sub-contractors, and proper records of key withdrawals are to be maintained. These records would be requested and inspected by the end-users at any time.

2.11.4 If temporary or construction cylinders are used during the construction phase(s) of the building, the main contractor are to be solely responsible and accountable for the proper changing over of the temporary or construction cylinders to the actual master keyed cylinders. The costs of the change-over of cylinders are deemed to be part of the costs and scope of works under the main contractor. The end-user's keys are to be handed over to the end-user directly by the supplier of the master keyed system.

2.12 HANDLES

2.12.1 All levers/pull handles and accessories shall be of the same manufacturer and supplier.

2.12.2 All roses and escutcheon shall have a snap on cover of more than 8 mm in height.

2.12.3 All levers/pull handles, roses and escutcheon shall be provided with a bolt through fixing and shall be supplied with a special fixing system. This is to prevent from becoming loose after prolong usages.

2.12.4 Approved level handles bolted to rose or backplate shall open smoothly, softly and silently and yet be strong enough to prevent any form of sagging.

2.12.5 All backplates, roses and escutcheons shall be concealed fixings and squarely aligned with door leaf. The fixing screws shall be installed from behind the door or from inside the room.

2.12.6 All lever handles shall be available with the option of incorporating with radial needle bearings and not ball bearings, which is in the roses itself, for heavy duty door and excellent handle operation. The needle-bearings, integrated in the lever handles, is fixed rotating on a ground plate in stainless steel and provided with the special fixing system.

2.12.7 Wherever required, lever handle and knobs can be intermixed for inside/outside trim.

2.12.8 Specified lever handles is able to withstand very heavy weight and pressure exerting on the handles.

2.12.9 Stainless steel materials of the forend of the lockcases and lever handle must be of Grade 316 and tested accordingly to the standards DIN 50021/B 117/JIS Z2371. The tests are to be tested for the corrosion resistance of the stainless steel Grade 304 shall simulate the corrosion environment within the period of 4 years. The test certificate of the test by an independent institution shall be submitted a proof of the test. The stainless steel materials must not rust or corrode during the first 4 years after completed installation.

2.12.10 More than 5 designs of the handles should be made available for customer's selection. Designer hollow and solid handles shall be made available for the client's final selection.

2.13 PRODUCT AND FINISH

2.13.1 All appropriate hardware shall be of satin **stainless steel grade 316** uniform throughout.

2.13.2 Finish hardware shall be tarnish resistance.

2.13.3 All mortise locksets, high security cylinders, handles, exit devices, door closers, floor springs and other accessories and components shall be from the same approved supplier.

2.14 MANUFACTURER/SUPPLIER

2.14.1 Ebco

2.14.2 Godrej

PART 3 – EXECUTION

3.1 PREPARATION & INSPECTION

3.1.1 Verify that doors and frames are ready to receive work and dimensions are as instructed by the manufacturer.

3.1.2 Do not commence installation until unsatisfactory conditions have been rectified

3.1.3 Beginning of installation means acceptance of existing conditions.

3.2 DELIVERY, STORAGE, AND HANDLING

3.2.1 Deliver products to site, store and protect products in storage until installed.

3.2.2 Each individual item must be individually labeled and identify package with door number code to match hardware schedule.

3.2.3 Deliver permanent keys to client/architect direct form lock manufacturer.

3.2.4 Protect hardware from theft by cataloging and storing in secure area.

3.2.5 Install hardware only upon approval of client/architect.

3.3 SEQUENCING

Coordinate order of installation for all hardware items to eliminate conflicts of operating mechanisms. Provide general notes as to the order of installation.

3.4 INSTALLATION

3.4.1 Mount all Ironmongery units at height indicated in the drawings, except if shown or specified otherwise or to comply with requirements of governing regulations & handicapped requirements.

3.4.2 Install each ironmongery item in compliance with manufacturer's instructions, recommendations, and templates. Securely fasten all parts to be attached. Fit faces of mortised items snug and flush. Make sure all operating parts move freely and smoothly without binding, sticking, or excessive clearance.

3.4.3 Whenever cutting and fitting is required to install ironmongery onto or into surfaces which are later to be painted or finished in other way, remove and store ironmongery prior to painting or finishing. Reinstall item only when the finishes have been completed on the surface to which the ironmongery is to be installed. All buts, locks, plates, strikes, etc., shall be neatly and accurately mortised flush, properly placed and accurately aligned for smooth and quiet operation without sticking, binding, hanging, or ratting. All doors shall be hung with equal clearance at jambs and heads. Adjust all hardware properly and leave in smooth operating condition.

3.5 ADJUSTING AND CLEANING

3.5.1 Adjust and check each operating ironmongery item to ensure correct operation and function.

3.5.2 Replace units that can not be adjusted to operate as intended for the installation made.

3.5.3 Final Adjustments:

- Where ironmongery is installation is made more than 1 month prior to building acceptance or occupancy of room or area, the supplier/installer shall return to work area 1 week prior to acceptance or occupancy and make final check and adjustment of all ironmongery items.
- Clean grease, dirt or item marks and as necessary restore correct operation, function and finish.
- Adjust door control device to compensate for final balancing of the heating and ventilating equipments and difference in room air pressure.

3.6 MAINTENANCE & TRAINING

3.6.1 Prior to handing over for inspection, all projected parts and surfaces such as door levers, pull handles and others shall be properly wrapped and sealed. Should any serious scratches or other defects on the surfaces of the ironmongery be found, THE Contractor shall replace the ironmongery at his own cost.

3.6.2 Submit operation and maintenance data, Include data on operating hardware, adjustments, lubrication requirements, inspection procedures related to preventative maintenance and cleaning procedures of finishes.

3.6.3 Provide special wrenches and tools applicable to each different or special hardware components.

3.6.4 Provide maintenance tools and accessories supplied by hardware component manufacturer.

3.6.5 Training Program: The Ironmongery supplier/installer shall conduct a training program to client technical/maintenance staff within 3 months of the application of Temporary Occupation Permit. The training program should be hands-on oriented with appropriate reference to operations and maintenance training manuals to be provided. The training shall focus on the following items

- To assemble and disassemble all items supplied
- To replace faulty parts within all parts supplied
- To configure lock cylinder pinning for keys supplied
- To perform routine maintenance on all items supplied

3.6.6 This training requirement does not relieve the supplier/installer and the contractor from any warranty obligations already provided in the contract.

Y. ROLLER SHUTTERS

1.0 PART 1 - GENERAL

1.1 SECTION INCLUDES: This section includes

- ❖ Fire rated roller shutters, motorised, powder coated.
- ❖ Non fire rated roller shutters, motorised, powder coated.

1.2 REFERENCES/PROJECT REQUIREMENTS:

- ❖ Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this section.
- ❖ Requirements of the following Project Specification Sections apply to this section:
  - Section 09900 - Painting
  - M&W/EES/0021 – General Electrical Materials & Workmanships
- ❖ Additional project requirements:
  - ANSI/ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
  - ANSI/UL 325 - Door, Drapery, Gate, Louver, and Window Operators and Systems.
- ❖ Design Requirements: Design door assembly to withstand wind / suction load of 30 psf (1.44 kpa), without undue deflection or damage to door or assembly components.

1.3 SYSTEM DESCRIPTION

Electric motor operated unit with manual override in case of power failure. Fire rated doors with fusible link activated with automatically governed closing speed.

1.4 SUBMITTALS: Submit the following in accordance with Conditions of Contract and Section 01340, Shop Drawings:

- Submit shop drawings and product data under provisions of DIVISION 1.
- Provide pertinent dimensioning, general construction, component connections and details, anchorage methods, hardware location, and installation details.
- Submit manufacturer's installation instructions under provisions of DIV. 1.
- Samples: Submit two, 6" (15 cm) long samples of each type slat specified showing each type finish specified.
- Shop Drawings
  - Submit shop drawings showing elevations, locations, jamb conditions, methods of assembling and clearances required.
  - Indicate hardware installation data, thickness of materials, methods of anchoring and details of construction.
  - Note and mark sufficiently to indicate compliance with requirements of these Specifications.
  - Indicate location of motor, switches and controls.
- Operations and Maintenance Data
  - Submit manufacturer's operation and maintenance data under provisions of DIVISION 1.
  - Maintenance Data: Indicate lubrication requirements and frequency, periodic adjustments required.

1.5 QUALITY ASSURANCE:

- Verify that field measurements are as indicated on shop drawings.
- Furnish roller shutters by one manufacturer for entire project.
- Manufactures warranty: Furnish manufactures 5 years warranty against defect in product workmanship and materials.

1.6 PROJECT/SITE CONDITIONS OR SPECIAL CONDITION:

Regulatory Requirements:

- Provide SIRIM label / rated frame and assembly. Conform to applicable code for indicated hourly fire rated opening.
- Electrical Components: ULI listed.

1.7 SEQUENCING: Coordinate the work with installation of electric power, locations and size of conduit, and locations of devices.

2.1 MATERIALS

2.2.1 Curtain

- Slats: Minimum 20 gage (1.0 mm) thick slats of steel, ANSI/ASTM A526; for fire rated shutters and 1.4 mm thick Alum slats for non-fire rated shutters.
- Slat Ends: Ends of alternate slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.

- Curtain Bottom: Bottom fitted with 2 mild steel angles (not less than 38X38X3 mm) bolted together as T-shape section to provide reinforcement and positive contact with floor in closed position.

2.2.2 Side Guides: Formed steel angles for required sizes and configurations with groove 75 mm depth minimum complying with JIS G3141 SPCC-SD slot bolt holes for track adjustment.

2.2.3 DRIVE BARREL: Steel pipe complying with BS 1387 or JIS 63452 and helical steel spring system capable of producing sufficient torque to assure easy operation of curtain from any position; adjustable spring tension.

2.2.4 Housing: Min 22 gage (0.85 mm) powder coated m.s. internally reinforced to maintain rigidity and form. Provide closed end for surface mounted hoods and any portion of jamb projecting beyond wall face. Provide intermediate support brackets as required to prevent sag. Galvanised self driving screws applied for easy access maintenance.

2.2.5 Hardware

- Handle: Inside side mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position, interior handle.
- Cylinder: Furnished in DIVISION 8.
- Weather-stripping: Water and rot proof, resilient type; located along jamb edges, bottom of curtain, and within housing.
- Provide fire fly release mechanism and fusible link at rated doors.

2.2 MANUFACTURED UNITS

2.3.1 Electric Operator:

- Descriptions: UL approved in accordance with ANSI/UL 325; wall mounted.
- Electrical Requirements: Non-Fire rated doors: 230 volt, single phase, 50 Hz supply to 1/2 hp electric motor. 415 Volts, three phase, 50 Hz supplying for fire rated shutters. 24 v dc solenoid release for fire rated roller shutters to close upon receiving fire signal when there is a power failure.
- Brake: Adjustable friction clutch, double shoe brake system actuated by independent full line voltage solenoid controlled by motor starter.
- Limit Switch: Fully enclosed positive gear driven limit switch.
- Motor Controller: Fully enclosed magnetic cross line reversing starter.
- Control Station: Standard three button (open-close-stop) control for each operator; 24 volt circuit; surface mounted.
- Safety Device: Located at bottom of doors, full width; wired to reverse door upon striking object; neoprene covered to provide weather seal.
- Provide wall mounted bracket.
- Operating speed of 3m per minute (2" per second).
- Safety standard to IP54, IP55 and insulation class A.
- Manual override chain for emergency manual operation.

2.3 FINISHES:

- Curtain Slats: Powder coated.
- Steel Guides and Hood Enclosure: Powder coated.

2.0 PART 3 – EXECUTION

3.1 EXAMINATION:

- Verify surfaces and conditions are ready to receive work of this section.
- Notify Architect of any existing conditions which will adversely affect execution.
- Beginning of execution will constitute acceptance of existing conditions.

3.2 INSTALLATION:

- Install door unit assembly in accordance with manufacturer's instructions.
- Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- Secure guides to structural members only.
- Fit, align, and adjust door assemblies' level and plumb; provide smooth operation.
- Coordinate installation of electrical service.
- Coordinate installation of sealants and backing materials at frame perimeter.
- Install perimeter trim and closures.

3.3 FIELD QUALITY CONTROL: Tolerances

- Maintain dimensional tolerances and alignment with adjacent work.
- Maximum Variation From Plumb: 1/16 inch (0.16 mm).
- Maximum Variation From Level: 1/16 inch (0.16 mm).
- Longitudinal or Diagonal Warp: Plus or minus 1/8 inch (3.2 mm) per 10 ft. (3 m) straight edge.

3.4 ADJUSTING:

- Adjust work under provisions of DIVISION 1.
- Adjust door hardware and operating assemblies.

3.5 CLEANING:

- Clean work under provisions of DIVISION 1
- Clean door and components.
- Remove labels and visible markings.

Z. SANITARY FIXTURES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED:

- Water closets.

- Urinals.
- Wash basins.
- Sinks.
- Mop basins.
- Electric water coolers
- Shower

1.2 RELATED WORK:

- This Section shall be used in conjunction with, but not limited to, the other relevant specifications, drawings and Contract Documents to establish the total requirements.
- CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.
- In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Purchaser, who shall then instruct the Contractor thereon. In the event of conflict regarding requirements between this Section and any other document, the more stringent requirement shall apply unless specifically instructed by the Purchaser in writing otherwise.

1.3 REFERENCES:

- ANSI A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- ANSI A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
- ANSI A112.19.2 - Vitreous China Plumbing Fixtures.
- ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.
- ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
- ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- ANSI A117.1 - Requirements for the Physically Challenged.
- Americans with Disabilities Act Guidelines.

1.4 QUALITY ASSURANCE

- Refer to General Conditions.
- Comply with product data.
- Fixtures: By same manufacturer for each product specified throughout.
- Trim: By same manufacturer for each product specified throughout.

1.5 SUBMITTALS

- Refer to General Conditions.

- Submit shop drawings and product data.
- Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, furnished specialties and accessories; and installation instructions. Include fixtures, sizes, utility sizes, trim and finishes.
- Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, roughing-in requirement, required clearances and methods of assembly of components and anchorages.

1.6 OPERATION AND MAINTENANCE DATA

- Refer to General Conditions.
- Submit operation and maintenance data.
- Maintenance Data: Submit maintenance data for each type of plumbing fixture and accessory; including troubleshooting maintenance guide. Include this data, product data and shop drawings in maintenance manual.
- Include fixture trim exploded view and replacement parts lists.

1.7 DELIVERY, STORAGE AND HANDLING

- Refer to General Conditions.
- Deliver products to site.
- Deliver plumbing fixtures individually wrapped in factory-fabricated containers.
- Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

1.8 WARRANTY

- Refer to General Conditions.
- Provide five year manufacturer's warranty.
- Warranty: Include coverage of electric water cooler compressor.

2.0 PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - FIXTURES

1.1.1 Water closets, Urinals, Wash basins, Sinks (vitreous china/enameled cast iron).

- As Per BOQ

1.1.2 Sinks, Wash basins (stainless steel).

- As Per BOQ

2.2 ACCEPTABLE MANUFACTURERS - FAUCETS AND DRAINS (INSTITUTIONAL)

- AS Per BOQ

2.3 ACCEPTABLE MANUFACTURERS - WATER CLOSET SEATS

- As per BOQ

2.4 ACCEPTABLE MANUFACTURERS - MOP BASINS, SHOWER RECEPTORS

- Not Used

2.5 ACCEPTABLE MANUFACTURERS - ELECTRIC WATER COOLERS

- As per BOQ

2.6 WATER CLOSET (WC-1)

- Bowl: ANSI A112.19.2; wall hung siphon jet vitreous china closet bowl, with elongated rim, 1-1/2" top spud, china bolt caps; white. Model as per BOQ/Approved brand.
- Flush System: Dual flush system; Concealed Cistern with Flush Panel; Model as per BOQ/Approved brand.
- Seat: Solid white plastic, open front, extended back, self-sustaining hinge, stainless steel bolts, with cover Manufactured by approved brand. Anti-microbial plastic.
- Wall Mounted Carrier: ANSI A112.6.1; adjustable cast iron frame, integral drain hub and vent, adjustable spud. Lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.7 WATER CLOSET (WC-2) - FOR THE PHYSICALLY CHALLENGED:

- Bowl: ANSI A112.19.2; wall hung siphon jet vitreous china closet bowl, with elongated rim, 1-1/2" top spud, china bolt caps; white. Model as per BOQ/Approved brand.
- Flush System: Dual flush system; Concealed Cistern with Flush Panel; Model WH003/MB001 Manufactured by approved brand.
- Seat: Solid white plastic, open front, extended back, self-sustaining hinge, stainless steel bolts, with cover Manufactured by approved brand. Anti-microbial plastic.
- Wall Mounted Carrier: ANSI A112.6.1; adjustable cast iron frame, integral drain hub and vent, adjustable spud. Lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.8 URINAL (UR):

- Urinal: ANSI A112.19.2; vitreous china, wall hung syphon jet urinal with shields, integral trap, removable stainless steel strainer, 3/4" top spud, steel supporting hangers; white color. Model as per BOQ/Approved brand.
- Flush Valve: ANSI A112.18.1; exposed, battery powered, sensor operated flush meter, escutcheon, integral screwdriver stop, vacuum breaker, metal cover. Model as per BOQ/Approved brand.
- Wall Mounted Carrier: ANSI A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs

2.9 WASH BASIN (WB):

- Basin: ANSI A112.19.2; vitreous china Counter top WASH BASIN 650mm x 455mm x 200mm minimum, with single hole, D-shaped basin with front overflow, Model LW909KS Manufactured by approved Company.
- Grid strainer; provide chrome plated grid strainer and tail piece.
- P-Trap: Adjustable chrome plates 17 gauge 1-1/4" x 1-1/2" brass with cleanout plug and deep escutcheon. P-trap is pre-insulated. Manufactured by approved Company.
- Supply Fittings: Chrome plated rigid supplies with loose key angle stops.

2.10 LABORATORY SINKS (LS):

- Basin: To be supplied by others.
- Faucet: Deck mounted laboratory mixing faucet with rigid/ swing gooseneck with wrist blade handle. .
- Drain: Type 316 stainless steel with flat strainer and 4" tail piece.
- Trap: Chrome plated 17 gauge 1-1/2" x 1-1/2" brass with cleanout plug and deep escutcheon.
- Supply Fittings: Chrome plated rigid supplies with loose key angle stops.

2.11 SINK (Break Room):

- Double compartment 36" x 20" O.D ,depth 7.5", 18 gauge , stainless steel, self-rimming with undercoating, 1-1/2" side flanges, 4-1/2" faucet ledge, punched with three holes 1-1/2" diameter @ 4" O.C. Model Elegance Unique manufactured by Nirali.
- Faucet: ANSI A112.18.1; chrome plated brass supply with rigid/swing spout, water economy aerator 4" wrist blade handles. Model Z-831C4 manufactured by Nirali.
- Drain: stainless steel with removable crumb cup strainer, rubber seat stopper, 4" long tail piece and double compartment chrome plated continuous waste with center outlet.
- Trap: Chrome plated 17 gauge 1-1/2" x 1-1/2" brass with cleanout plug and deep escutcheon.
- Supply Fittings: Chrome plated rigid supplies with loose key angle stops. Frame: Provide mounting kit for counter top with seals.

2.12 SHOWER (SH-1)

- Base: Tiled walls and floor.
- Showerhead and valve: ANSI A112.18.1; Nickel Chrome finished hand and wall shower with 69" of flexible rubber-lined metal hose, hand spray and 48" chrome adjusting bar with hand shower slide bracket, wall spout with vacuum-breaker 2.5 gpm flow restrictor, internal check stops. Model Fixed shower head: GB 101C, Mixing valve with diverter: GB 204, Bath Spout: GB 101"Temptrol" manufactured by approved Company.
- MOP BASIN (MB-1) – Provide a Mop basin at every Janitor Closet as shown on drawings.
- Bowl: 36" x 24" x 10" white molded stone, floor mounted, with 1" wide shoulders, vinyl bumper guard and stainless steel strainer.

- Faucet: ANSI A112.18.1; built-in exposed wall type supply with 3" diameter cross handles, wall brace, riser supports pail hook 3/4" hose end spout, vacuum breaker.
- P-Trap: Cast iron deep seal where buried below floor slabs.
- Stops: Two chrome plated straight way valves with loose key, 1/2" I.P.S. inlet and outlet and wall escutcheon plates.
- Accessories: 2'-6" long flexible heavy duty 5/8" rubber hose, cloth reinforced with 3/4" chrome coupling at one end. Hose bracket shall be stainless steel with rubber grip. Stainless steel mop hanger with three rubber tool grips and stainless steel splash catcher.

2.13 ELECTRIC WATER COOLER (EWC-1)-FOR THE PHYSICALLY CHALLENGED

Water cooler with full stainless steel body, of size 460x580 height 1215, weight without water 50kg refrigerated with integral air cooled condenser; capacity of 40 ltrs/hr, Max. Current 3.1 amps. Refrigerant R-22, condenser: propeller type(quiet type), with thermo stat , inlet: 12.7mm BSP connection, Drain:25.4, 12.7mm BSP connection, CFC free refrigerant by Voltas

3.0 PART 3 - EXECUTION

3.1 INSPECTION

- Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Special attention shall be given to cabinet recessed openings for foot valve faucets. Coordinate these openings with Millwork Contractor by providing exact dimensions for proper mounting.
- Verify adjacent construction is ready to receive rough-in work of this Section.
- Examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
- Inspect fixtures and accessories that are to be removed and relocated. Damaged or blemished items shall be brought to Construction Manager's attention before reinstalling.

3.2 INSTALLATION

- Install each fixture with trap, easily removable for servicing and cleaning.
- Provide chrome plated rigid or flexible supplies to fixtures with loose key stops reducers and escutcheons.
- Piping exposed to view shall be chrome plated.
- Install components level and plumb.
- Install and secure fixtures in place with wall supports or wall carriers and bolts.
- Seal fixtures to wall and floor surfaces with sealant, color to match fixture.
- Mount fixtures to the following heights above finished floor: Refer to Architectural Drawings.
- Protect installed fixtures from damage during remainder of construction period.

3.3 ADJUSTING AND CLEANING

- Adjust stops or valves for intended water flow rate to fixtures without splashing, noise or overflow.
- At completion clean plumbing fixtures and equipment.
- Adjust or replace washers to prevent leaks at faucets and stops.
- Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 FIELD QUALITY CONTROL

- Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
- Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by the Construction Manager. Remove cracked or dented units and replace with new units.

3.5 FIELD INSPECTION AND REPORT

- Provide report, in accordance with Section 01400, prepared by manufacturer=s representative, stating that systems installed and services provided under this Section are in accordance with manufacturer=s recommendations and are properly operating.

3.6 FIXTURE ROUGH-IN SCHEDULE

- Refer to schedule on Drawings.

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इंडियन बैंक Indian Bank

इलाहाबाद ALLAHABAD

TECHNICAL SPECIFICATION

FOR

CIVIL & STRUCTURAL WORKS

TABLE OF CONTENT

A GENERAL

A.1 PREAMBLE

2.0 GENERAL

These Specifications cover the items of work in structural parts coming under preview of this document. All work shall be carried out in conformation with this. These specifications are not intended to cover the minute details. All codes, standard and good construction practice shall be referred to this specification be the latest thereof.

These specifications shall be read in conjunction with the Technical Specifications for various items of work. The General Contractor shall carefully acquaint himself with the general specifications, coordinate the same with any other specifications forming a part of the Contract Document and determine his contractual obligations for the execution of various items of work in accordance with good engineering practices.

2.0 REFERENCE TO THE STANDARD CODES OF PRACTICE:

2.1 All standards, tentative specifications, specifications, code of practice referred shall be the latest editions including all applicable official amendments and revisions. The contractor shall make available at site all relevant Indian Standard Codes of Practice as applicable.

2.2 In case of discrepancy between standards, codes of practice, tentative specifications, and specifications referred to, the specifications of Indian Standard Codes of practice shall govern.

3.0 SUPREMACY OF TENDER

In case of contradiction between/among two or more clauses given separately in two or more different documents, conditions of acceptance clause will be in following preference:

General Conditions of contract. Shall prevail over Drawings

Drawings shall prevail over BOQ

BOQ shall prevail over shall prevail over technical specification

4.0 DIMENSIONS

4.1 Written dimensions on drawings shall supersede measurement by scale; and drawings to a large scale shall take precedence over those to a smaller scale. Special dimensions or directions in the specifications shall supersede all others. All dimensions shall be checked on site prior to execution.

4.2 The dimensions where stated do not allow for waste, laps, joints, etc. but the General Contractor shall provide at his own cost sufficient labour and materials to cover such waste, laps, joints, etc. and the rate quoted is inclusive of such provision and no separate payment will be made for the same.

4.3 The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct, but the Contractor should verify them by himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or the description of the ground levels or strata turning out different from what was expected or shown on the drawings.

5.0 MATERIALS

5.1 QUALITY

All materials used in the Works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Engineer-in-Charge and shall comply strictly with the tests prescribed hereafter, or where tests are not laid down in the specifications, with the requirements of the latest issues of the relevant Indian Standards.

5.2 SAMPLING AND TESTING

All materials used in the works shall be subjected to inspection and tests in addition to test certificates. Samples of all materials proposed to be employed in permanent works shall be submitted to the Engineer-in-Charge for approval before they are brought to the site.

Samples provided to the Engineer-in-Charge for their retention are to be labeled in boxes suitable for storage. Materials or workmanship not corresponding in character and quality with approved samples will be rejected by the Engineer-in-Charge.

Samples required for approval and testing must be supplied sufficiently in advance 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 completion of the works.

Materials shall be tested before leaving the manufacturer's premises, quarry or source, wherever possible. Materials shall also be tested on the site and they may be rejected if not found suitable or in accordance with the specifications, notwithstanding the results of the tests at the manufacturer's works or elsewhere or test certificates or any approval given earlier.

The contractor will bear all expenses for sampling and testing, whether at the manufacturer's premises at source, at site or at any testing laboratory or institution as directed by the Engineer-in-Charge. No extra payment shall be made on this account.

5.3 DISPATCH OF MATERIALS

Materials shall not be dispatched from the manufacturer's works to the site without written authority from the Engineer-in-Charge.

5.4 TEST CERTIFICATES:

All manufacturer's certificates of test, proof sheets, etc. showing that the materials have been tested in accordance with the requirement of this specifications and of the appropriate Indian Standard are to be supplied free of charge on request to the Engineer-in-Charge.

5.5 REJECTION

Any materials that have not been found to conform to the specifications will be rejected forthwith and shall be removed from the site by the General Contractor at his own cost.

The Engineer-in-Charge shall have power to cause the General Contractors to purchase and use such materials from any particular source, as may in his opinion be necessary for the proper execution of the work.

5.6 STORING OF MATERIALS AT SITE

All materials used in the works shall be stored on racks, supports, in bins, under cover etc. as appropriate to prevent deterioration or damage from any cause whatsoever to the entire satisfaction of the Engineer-in-Charge. The storage of materials shall be in accordance with IS 4082 "Recommendation on stacking and storage of construction materials on site" and as per IS 7969 "Safety code for handling and storage of building materials". This shall include the safe custody of all materials until they are required on the works and till the completion of the works. The same shall be applicable for the materials supplied by the owner or materials supplied by any specialized firms.

The materials shall be stored in a proper manner at places at site approved by the Engineer-in-Charge. Should the place where material is stored by the General Contractor be required by the owner for any other purpose, the General Contractor shall forthwith remove the material from that place at his own cost and clear the place for the use of the owner.

5.7 WATER

5.7.1. Water for Construction

Clean fresh water (potable water) only shall be used for the works. The water shall be free from any deleterious matter in solution or in suspension.

The quality of water shall conform to IS 456.

5.7.2 Storage of water

The General Contractor shall make his own arrangements for storing water, if necessary, in drums or tanks or cisterns, to the approval of the Engineer-in-Charge. Care shall be exercised to see that water is not contaminated in any way.

6.0 WORKMANSHIP

6.1 All works shall be true to level, plumb and square and the corners, edges and corners in all cases shall be unbroken and neat.

6.2 Any work not to the satisfaction of the Engineer-in-Charge or his representative will be rejected and the same shall be rectified, or removed and replaced with work of the required workmanship at no extra cost.

7.0 INCLUSIVE DOCUMENTS

The provision of Special Conditions of Contract, General Conditions of Contract, those specified on the tender as well as execution drawings and notes or other specifications issued in writing by the Engineer-In-Charge shall from part of these specifications.

8.0 MEASUREMENT AND PAYMENTS

The methods of measurement and payment shall be as described under various items and in the bill of quantity. Where specific definitions are not given, the methods described in IS code will be followed. Should there be any detail of construction or materials which has not been referred to in specification or in the bill of quantities and drawings, but the necessity for which may be implied or inferred wherefrom, or which are usual or essential to the completion of the work in the trades, the same shall be deemed to be included in the rates and prices quoted by the contractor in the bill of quantities.

9.0 UN-ACCEPTABLE WORK

All defective works are liable to be demolished, rebuilt and defective materials replaced by the General Contractor at his own cost. In the event of such works being accepted by carrying out repairs etc. as specified by the Engineer-in-Charge, the cost of repairs will be borne by the General Contractor.

In the event of the work being accepted at the sole discretion of Engineer-in-Charge or owner by giving 'Design Concession', arising out of, but not limited to under-sizing, under-strength, shift in location and alignment, etc. and accepting design stresses in members which are higher than those provided for in the original design or by accepting materials not fully meeting the specifications etc. and if the item is so acceptable without substantially affecting the utility of the item and the structure, then the General Contractor will be paid for the works actually carried out by him at the suitable reduced rate of the tendered rates for the portion of the work thus accepted, as the Engineer-in-Charge or owner or the authority may consider reasonable.

10.00 DEWATERING SYSTEM

General Contractor shall arrange to clear water from excavation area before starting work, during execution & after completion of excavation. The excavated area shall be dewatered before pouring concrete in it. The arrangement shall be made by General Contractor to pump out the water from the area before placing reinforcement & pouring concrete for structural & non structural items as well. No extra claims shall be entertained for dewatering.

It shall be the sole and undisputed responsibility of the contractor to keep the basement dry till the completion of the project. Suitable dewatering system by pumping etc. may be required for execution of items of work below the ground level so as to keep the basement dry till the completion of the waterproofing works and till the completion of the project. The rates of all such items shall include the cost of dewatering by suitable measures as required and nothing extra whatsoever will be paid towards the cost of dewatering. The dewatering, whenever necessary shall be carried out by the General Contractor till the completion of the work.

11.0 PREPARATION OF SITE

11.1 The land described or shown on the site plan shall be cleared of all obstruction, rubbish, brush wood, jungle, mud and bamboo clumps as directed by the Engineer-in-Charge. No trees are to be cut down without the orders of the Engineer-in-Charge. Where trees or bamboo are to be cut down the roots shall be grubbed up and the excavation leveled and consolidated with good earth.

11.2 The products of the site clearing are the property of Indian Bank and unless the General Contractor is ordered to dispose of those at his own expense are to be stacked as directed by the Engineer-in-Charge.

11.3 All hollows or depressions, where existing or caused by grubbing up roots or through any other cause, shall be carefully filled up with well-rammed earth and leveled up as required.

12.0 PROTECTION OF THE ENVIRONMENT

12.1 General:

This section of the Specification sets out limitations on the Contractor's activities specifically intended to protect the environment.

The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on site or off-site are carried out in conformity with statutory and regulatory environmental requirements including (hose prescribed elsewhere in this document.

The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated.

In the event of any spoil, debris, waste or any deleterious substance from the Site being deposited on any adjacent land. the Contractor shall immediately remove ail such material and restore the affected area so its original state to the satisfaction of the Engineer.

12.2 Water Quality

The Contractor shall prevent any interference with the supply to or abstraction from and prevent any pollution of, water resources (including underground percolating water) as a result of the execution of the Works.

Areas where water is regularly or repetitively used for dust suppression purposes shall be laid to fall lo specially constructed settlement tanks to permit sedimentation of particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.

All water and other liquid waste products arising on the Site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause either nuisance or pollution.

The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer and the regulatory authorities concerned.

The Contractor shall at all times ensure that all existing stream courses and drains within, and adjacent to, the Site are kept safe and free from any debris and any materials arising from the Works.

The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollution as a result of the execution of the Works.

12.3 Air Quality

The Contractor shall devise and arrange methods of working to minimise dust, gaseous or other air-borne emissions and carry out the Works in such a manner as to minimise adverse impacts on air quality.

The Contractor shall utilise effective water sprays during delivery manufacture, processing and handling of materials when dust is likely to be created, and to dampen stored materials during dry and windy weather.

Stockpiles of friable materials shall be covered with clean tarpaulins, with application of sprayed water during dry and windy weather. Stockpiles of material or debris shall be dampened prior to their movement, except where this is contrary to the Specification.

Any vehicle with an open load-carrying area used for transporting potentially dust producing material shall have properly fitting side and tail boards.

Materials having the potential to produce dust shall not be loaded to a level higher than the side and tail boards, and shall be covered with a clean tarpaulin in good condition. The tarpaulin shall be properly secured and extend at least 300 mm over the edges of the side and tail boards.

In the event that the Contractor is permitted to use gravel or earth roads for haulage, he shall provide suitable measures for dust palliation, if these are, in the opinion of the

Engineer, necessary. Such measures may include spraying the road surface with water at regular intervals.

12.4 Noise

The Contractor shall consider noise as an environmental constraint in his planning and execution of the Works.

The Contractor shall take all necessary measures so that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimise the noise emission during construction works.

12.5 Control of Wastes

The Contractor shall control the disposal of all forms of waste generated by the construction operations and in all associated activities. No uncontrolled deposition or dumping shall be permitted. Wastes to be so controlled shall include, but shall not be limited to, all forms of fuel and engine oils, all types of bitumen, cement, surplus aggregates, gravels, bituminous mixtures etc. The Contractor shall make specific provision for the proper disposal of these and any other waste products, conforming to local regulations and acceptable to the Engineer.

12.6 Emergency Response

The Contractor shall plan and provide for remedial measures to be implemented in the event of occurrence of emergencies such as spillages of oil or bitumen or chemicals.

The Contractor shall provide the Engineer with a statement of the measures he intends to implement in the event of such an emergency which shall include a statement of how he intends to provide personnel adequately trained to implement such measures.

12.7 Measurement

No separate measurement shall be made in respect of compliance by the Contractor with the provisions of this Section of the Specification. The Contractor shall be deemed to have made allowance for such compliance with these provisions in the preparation of his prices for items of work included in the Bills of Quantities and full compensation for such compliance will be deemed to be covered by them.

A.2 MATERIALS TO BE USED IN THE WORK

GENERAL

Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these specifications.

If any material, not covered in these specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Engineer-in-Charge.

SOURCES OF MATERIAL

The General Contractor shall notify the Engineer-in-Charge of his proposed sources of materials to be used in the work with relevant test data sufficiently in advance of commencement of work and the approval of the Engineer-in-Charge obtained. If the General Contractor later proposes to obtain materials from a different source, he shall

notify the Engineer-in-Charge furnishing the relevant test data, for approval by the Engineer-in-Charge of the changed source; the General Contractor shall furnish acceptable material from any source at his own expense.

1.0 BRICKS

Burnt clay bricks shall conform to the requirements of IS:1077. except that the minimum compressive strength when tested flat shall not be less than 8.4 MPa for individual bricks and 10.5 MPa for average of 5 specimens. They shall be free from cracks and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp comers and emit a clear ringing sound when struck. The size may be according to local practice with a tolerance of ± 5 per cent.

2.0 STONES

Stones shall be of the type specified. It shall be hard, sound, free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stone with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water by more than 5 per cent of their dry weight when tested in accordance with IS:1124.

The length of stones shall not exceed 3 times its height nor shall they be less than twice its height plus one joint. No stone shall be less in width than the height and width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

3.0 CAST IRON

Cast iron shall conform to IS:210. The grade number of the material shall not be less than 14.

4.0 CEMENT

Cement to be used in the works shall be any of the following types with the prior approval of the Engineer-in-Charge

a) Ordinary Portland Cement, 33 Grade, confirming. to IS:269.

b) Rapid Hardening Portland Cement, conforming to IS:8041.

c) Ordinary Portland Cement, 43 Grade, conforming to IS:8112.

d) Ordinary Portland Cement, 53 Grade, conforming to IS: 12269.

e) Sulphate Resistant Portland Cement, conforming to IS: 12330.

Cement conforming to IS:269 shall be used only after ensuring that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 540 kg / cum. of concrete.(for Prestressed concrete) and 450 kd/cum for OPC.

Cement conforming to IS:8112 and IS:12269 may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, these cements shall be used with a certain caution as high early strengths of cement in the 1 to 28-day range can be achieved by finer grinding and higher constituent ratio of C_3S/C_2S, where C_3S is Tri calcium Silicate and C_2S is Di calcium Silicate. In such cements, the further growth of strength beyond say 4 weeks may be much lower than that traditionally expected. Therefore, further strength tests shall be carried out for 56 and 90 days to fine tune the mix design from strength considerations.

Cement conforming to IS: 12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS:456 are sulphate concentration in excess of 0.2 per cent in soil sub-strata or 300 ppm (0.03 per cent) in ground water.

Tests to confirm actual values of sulphate concentration are essential when the structure is located near the sea coast, chemical factories, agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS: 12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength.

Cement conforming to IS:8041 shall be used only for pre-cast concrete products after specific approval of the Engineer-in-Charge.

Total chloride content in cement shall in no case exceed 0.05 per cent by mass of cement Also, total sulphur content calculated as sulphuric anhydride (SO_3) shall in no case exceed 2.5 per cent and 3.0 per cent when tri-calcium aluminate per cent by mass is up to 5 or greater than 5 respectively.

5.0 COARSE AGGREGATES

For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not consist of pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali-silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, Parts I to VIII.

No aggregate which has water absorption of more than 2 % shall be used in the concrete mix. In test for soundness in accordance with IS:2386 (Part 5) after 5 cycles of testing the loss shall not be more than 12 per cent if sodium sulphate solution is used or 18 % if magnesium sulphate is used, the General Contractor shall submit for the approval of the Engineer-in-Charge, the entire information indicated in Appendix A of IS:383.

Maximum nominal size of coarse aggregate for various structural components in PCC, RCC or PSC, shall conform to Section 1700.

The maximum value for flakiness index for coarse aggregate shall not exceed 35 per cent. The coarse aggregate shall satisfy the requirements of grading given in the following table:

REQUIREMENTS OF COARSE AGGREGATE

IS Sieve Size	Per cent by Weight Passing the Sieve		
	40mm	20mm	12.5mm
63 mm	100	—	—
40 mm	95-100	100	—
20 mm	30-70	95-100	100
12.5 mm	—	—	90-100
10 mm	10-35	25-55	40-85
4.75 mm	0-5	0-10	0-10

6.0 SAND/FINE AGGREGATES

For masonry work, sand shall conform to the requirements of IS:2116. For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Where so required by the Engineer-in-Charge, sand shall be washed to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, (Parts I to VIII). The General Contractor shall submit to the Engineer-in-Charge the entire information indicated in Appendix A of IS:383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.Sand/fine aggregate for structural concrete shall conform to the following grading requirements:

Requirements of Sand

IS Sieve Size	Per cent by Weight Passing the Steve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

M -SAND:

Manufactured sand M-Sand) shall be approved grade as per the instructions of the Architect/ Site engineer /Employer. M Sand Should be strictly free from Quarry Dust. Contractor should provide sample prior to supply of M sand for the Specific works.

TYPE OF M SAND	IS CODE
Concrete M Sand	IS - 383: 1970
Brick/ Block Work M Sand	IS - 2116: 1980
Plastering M Sand	IS - 1542: 1992

II. Particulars	III. Concrete M Sand	IV. Brick/ Block Work M Sand	V. Plastering M Sand

7.0	Granule Thickness	0 - 4.75 mm	0 - 3.55 mm	0 - 2.36 mm
	Usage	RCC, Block works flooring/ Tiling	Specially formulated for Brick & Block Laying	Internal and External Plastering
	Quantity per metric ton (1000 kgs)	21.5 cft/ metric ton	21.5 cft/ metric ton	22 cft/ metric ton

REINFORCING STEEL

7.1 Cast Steel

The use of cast steel shall be limited to bearings and other similar parts. Steel for castings shall conform to Grade 280-520N of IS: 1030. In case where subsequent welding is unavoidable in the relevant cast steel components, the letter N at the end of the grade designation of the steel casting shall be replaced by letter W. 0.3 per cent to 0.5 per cent copper may be added to increase the corrosion resistance properties.

7.2 Reinforcement / Un-tensioned Steel

For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, the reinforcement / un-tensioned steel as the case may be shall consist of the following grades of reinforcing" bars.

GRADE DESIGNATION	BAR TYPE CONFORMING TO GOVERNING IS SPECIFICATION	CHARACTERISTIC STRENGTH FY MPA	ELASTIC MODULUS GPA
S 240	IS:432 Part 1 Mild Steel Bar	240	200
S 415	IS: 1786 High Yield Strength Deformed	415	200
Fe 500	IS: 1786 High Yield Strength Deformed	As per IS code	As per IS code

Other grades of bars conforming to 13:432 and IS: 1786 shall not be permitted.

All steel shall be procured from original producers, no re-rolled steel shall be incorporated in the work.

Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

Fusion-bonded epoxy coated reinforcing bars shall meet the require-ments of IS: 13620. Additional requirements for the use of such reinforcement bars have been given below:

(a) Patch up materials shall be procured in sealed containers with certificates from the agency who has supplied the fusion bonded epoxy bars.

(b) PVC coated G.I. binding wires of 18G shall only be used in conjunction with fusion bonded epoxy bars.

(c) Chairs for supporting the reinforcement shall also be of fusion bonded epoxy coated bars.

(d) The cut ends and damaged portions shall be touched up with repair patch up material.

(e) The bars shall be cut by saw-cutting rather than flame cutting.

(f) While bending the bars, the pins of work benches shall be provided with PVC or plastic sleeves.

(g) The coated steel shall not be directly exposed to sunrays or rains and shall be protected with opaque polyethylene sheets or such other approved materials.

(h) While concreting, the workmen or trolleys shall not directly move on coated bars but can move on wooden planks placed on the bars.

When specified in the contract, protective coating prescribed by CECRI shall be provided in conformance to specifications given in Appendix . The CECRI coating process shall be allowed to be implemented at the site of works provided a representative of the Institute is present throughout the duration of the coating process who shall certify that the materials and workmanship are in accordance with prescribed specifications developed by the Institute.

8.0 Structural Steel

Unless otherwise permitted herein, all structural steel shall before fabrication comply with the requirements of the following Indian Standards:

IS:226	:	Structural Steel (Standard Quality)
IS:961	:	Structural Steel (High Tensile)
IS:2062	:	Weldable Structural Steel
IS:8500	:	Weldable Structural Steel (medium & high strength qualities)
IS: 1148	:	Hot rolled rivet bars (upto 40mm dia) for structural purposes
IS:1149	:	High tensile rivet bars for structural purposes
IS:1161	:	Steel tubes for structural purposes
IS:4923	:	Hollow Steel sections for structural use
IS:11587	:	Structural weather resistant steel
IS:808	:	Specifications for Rolled Steel Beam, Channel and Angle Sections
IS: 1239	:	Mild Steel Tubes
IS: 1730	:	Dimension for Steel Plate, sheet and strip for structural and general engineering purposes
IS:1731	:	Dimension for Steel flats for structural and general engineering purposes

IS: 1732 : Dimension for round and square steel bars for structural and general engineering purposes

IS:1852 : Rolling and cutting tolerances for hot rolled steel products

STAINLESS STEEL

Stainless steel shall be austenitic chromium-nickel steel, possessing rust, acid and heat resistant properties conforming to IS:6603 and IS:6911. Mechanical properties/grade for such stainless steel shall be as specified by the accepting authority, but in no case be inferior to mild steel. Generally, stainless steel is available as per AISI grades. AISI 304 which is equivalent to grade 04Crl8Nill0 of IS:6911 satisfies the requirements of mechanical properties of structural steel. Other grades of stainless steel for specific purposes may be provided as per specific requirements. For application in adverse/ corrosive environment, stainless steel shall conform to AISI 316L or 02G17 Ni Mo2 of IS:6911.

9.0 WATER

Water shall be from the source approved by the Architect / Employer and shall be in accordance with clause 4.3 of IS:456.

Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to as certain its suitability for use in concrete for approval of the Architect / Employer No water shall be used until tested and found satisfactory. Cost of all such tests shall be borne by the contractor.

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted.

As a guide, the following concentrations represent the maximum permissible values:

(a) To neutralise 200 ml sample of water, using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.

(b) To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCl.

(c) The permissible limits for solids shall be as follows when tested in accordance with IS:3025:

SUBSTANCES	PERMISSIBLE LIMITS (MAX)
Organic	200 mg/lit
Inorganic	3000 mg/lit
Sulphates (SO_4)	500 mg/lit
Chlorides (Cl)	500 mg/lit *
Suspended matter	2000 mg/lit

In case of structures of lengths 30m and below, the permissible limit of chlorides may be increased upto 1000 mg/lit.

All samples of water (including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements stated herein.

(d) The pH value shall not be less than 6.

TIMBER

The timber used for structural purposes shall conform to IS: 883.

10.0 CONCRETE ADMIXTURES

10.1 General

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state.

Chemical admixtures are not to be used until permitted by the Architect / Employer. In case their use is permitted, the type, amount and method of use of any admixture proposed by the contractor shall be submitted to the Architect / Employer for approval.

Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and full fledged laboratory facilities for the manufacture and testing of concrete.

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

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

(b) The chemical names of the main ingredients in the admixtures.

(c) The chloride content, if any, expressed as a percentage by the weight of the admixture.

(d) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.

(e) Whether or not the admixture leads to the entertainment of air when used as per the manufacturer's recommended dosage, and if so to what extent

(f) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.

(g) There would be no increase in risk of corrosion of the reinforcement or other embedments as a result of using the admixture.

10.2 Physical and Chemical Requirements

Admixtures shall conform to the requirements of IS:9103. In addition, the following conditions shall be satisfied :

(a) "Plasticisers" and "Super-Plasticisers" shall meet the requirements indicated for "Water reducing Admixture".

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

(c) The chloride content of the admixture shall not exceed 0.2 per cent when tested in accordance with IS:6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in Section 1700 shall also be observed.

(d) Uniformity tests on the admixtures are essential to compare qualitatively the com-position of different .samples taken from batch to batch or from the same batch at different times.

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

Dry Material Content shall be within 3 per cent and 5 per cent of liquid and solid admixtures respectively of the value stated by the manufacturer.

Ash content shall be within 1 per cent of the value stated by the manufacturer.

Relative Density (for liquid admixtures) shall be within 2 per cent of the value stated by the manufacturer.

(e) All tests relating to the concretes admixtures shall be conducted periodically at an independent laboratory and compared with the data given by the manufacturer.

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

Waterproofing admixtures shall comply with IS:2645.

11.0 REINFORCED CONCRETE PIPES

Reinforced concrete pipes for highway structures shall be of NP4 type conforming to the requirements of IS:458.

11.1 Pre-moulded joint filler:

Joint filler board for expansion joints which are proposed for use only at some abutting structures like bridges and culverts shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible ' material and complying with the requirements of IS: 1838, or BS Specification Clause No. 2630. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit on the dowel bars.

11.2 Joint sealing compound:

The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide type having flexibility, resistance to age hardening -and durability. If the sealant is of hot poured type it shall conform to AASHTO M282 and cold applied sealant shall be in accordance with BS 5212 (Part 2).

12.0 STORAGE OF MATERIALS

12.1 General

All materials may be stored at proper places so as to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The storage space must also permit easy inspection, removal and restorage of the materials. All such materials, even though stored in approved godowns/places, must be subjected to acceptance test prior to their immediate use.

12.2 Aggregates

Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard and well drained. If necessary, the ground shall be covered with 50 mm plank. Coarse aggregates, unless otherwise agreed by the Engineer-in-Charge in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more).

Aggregates placed directly on the ground shall not be removed from the stockpile with in 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

In the case of fine aggregates, these shall be deposited at the mixing site not less than 8 hours before use and shall have been tested and approved by the Engineer-in-Charge.

12.3 Cement

Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and water-tight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.

Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the General Contractor without charge to the owner.

The General Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Engineer-in-Charge at all times.

The General Contractor shall make a monthly return to the Engineer-in-Charge on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

Cement shall be stored on a raised floor in dry weather proof and draught free but well ventilated shed.

Cement bags shall be stacked close together away from external walls and in stacks not more than ten bags to avoid lumping under pressure.

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

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.

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

12.4 Reinforcement / Un-tensioned Steel

The reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms, skids, or other supports, and shall be protected from mechanical injury and from deterioration by exposure.

12.5 Water

Water shall be stored in containers/tanks covered at top and cleaned at regular intervals in order to prevent intrusion by foreign matter or growth of organic matter. Water from shallow, muddy or marshy surface shall not be permitted. The intake pipe shall be enclosed to exclude silt, mud, grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

B SITE CLEARANCE & EARTHWORK

1.0 GENERAL

1.1 All earth work shall generally comply with this specification and relevant local code of practice & standard. Unless otherwise specified, following codes/standards shall be used for earth work

IS:1200 (Part I) 1992	– Method of measurement of earthwork (Fourth revision)
IS:3764 1992	– Code of practice for excavation works (First revision)
IS:4082 1996	– Recommendation on stacking and storage of construction materials and components at site (Second revision)
IS:13416 (Part 3) 1994	– Recommendation for preventive measures against hazards at work places; disposal of debris
SP 62:1992	– Handbook on building construction practices
SP 70:2001	– Handbook on construction safety practices
IRC codes	

1.2 All earthworks shall be finished to uniform surfaces which shall conform to the following limits for the lines, grades and widths shown in the approved construction drawing:

Formation width of drains, trenches, roads & foundation pits

The widths measured on earth side from the centre line to the toe of cut and/or the top edge of fill shall not be less than the width specified in the drawings and no portion of the cut slope shall encroach within the formation width.

Formation Level of drains, trenches, roads & foundation pits

The finished surface shall not vary by more than 25mm above or below the specified levels and no points in the general surface shall vary by more than 12mm from a 3 metre straight edge laid parallel to the centre line of the drain/trench/road/foundation pit or from a template placed at right angles to the centre line.

Slopes of platform levels

At all levels, the average slope shall not be steeper than the slopes specified and no point on the completed slope shall vary from the average plane by more than 150mm in the case of earth slope in cut or 300mm in the case of fill slope.

Drainage at excavation site

The Contractor shall at all times keep the site free of standing water by means of temporary drainage. Before the conclusion of each day's work, the Contractor shall grade the site to prevent ponding of water should it rain during the night.

2.0 SITE CLEARANCE

2.1 The Construction site shall be cleared from all kind of rubbish/debris, loose rocks/boulders, trees, shrubs, stumps, grass, brush wood, undergrowth and all other vegetation including superficial earth etc. as directed by Engineer-in-Charge.

2.2 All materials arising from site clearance shall be the property of the Owner and shall not be removed from site until written approval shall be given by Owner / Engineer-in-Charge. All usable /serviceable materials shall be temporarily stacked in separate lots at the site as directed by Engineer-in-Charge and shall be transported to designated place.

2.3 All other materials from site clearance which, in opinion of Engineer-in-charge are not useable shall be carted away by General contractors to approved disposal areas.

2.4 The site clearance shall cover all operations required in full for clearing the site and its surroundings, including providing labour, materials, tools, equipments and incidentals necessary to complete the work. It will also include handling, salvaging, piling or stacking or collecting and disposing off cleared materials.

3.0 PRE-CONSTRUCTION SURVEY

3.1 Upon completion of site clearance General Contractor shall carry out a joint pre-computation survey to establish the site boundaries, global grids, existing roads, drains and other elements prior to any excavation work. Surveying work should be carried out by nominated licensed surveyor by client and survey plan need to be endorsed by licensed surveyor and submitted to client and Engineer-in-charge.

4.0 TOPOGRAPHICAL SURVEY OF SITE

4.1 General contractor shall carry out an independent topographical survey and compare the existing site levels and contours against the topographical survey plan furnished with construction drawings. Any discrepancies should be brought to Engineer-in-charge prior to commence any earth work.

5.0 CLASSIFICATION OF EXCAVATION MATERIALS

The work to be done under this section comprise supply of all labour, plant and materials and the performance of all work necessary for excavation with necessary shoring, strutting, including disposing of all surplus excavated material from the site as directed by the Architect/Employer.

All materials involved in excavation shall be classified "all sorts of soil" and "rock" as under, by the Engineer-in-charge and his decision shall be final and binding on the Contract, for measurement of excavation and payment.

"All sorts of soil" shall include dry and wet soil, sand, gravel, soft / hard compact murrum, ordinary / stiff clay, rubble soling, metalling, lime concrete, brick stone & other masonry, small size stones and other similar materials which can be excavated by excavators, spade, pick, shovel, etc. without resorting to barring, wedging, chiseling, etc. (This item includes all types of materials to be excavated excluding "Rock" as defined below). The macadam surfaces of any description (water-bound, grouted tarmac, etc.) shall also be included in this classification and measured under this item.

"Rock" shall include weathered rock or solid rock, plain cement concrete, reinforced cement concrete and all boulders, which can only be removed by barring, wedging, chiseling and blasting.

6.0 EXCAVATION

6.1 All excavation work shall include excavation, removal and satisfactory disposal of all materials from within the limits of the works. It shall also include all excavation, shaping and sloping for the construction, preparation and completion of the sub-grade, shoulders, batters, drains, intersections, approaches, ramps, etc to the required alignments, grade and cross section as designed/shown in the approved construction drawings.

The Contractor may encounter soft rock during excavation with an expectation of some hard rock in the area. The contractor shall verify at site and make himself aware of the site conditions before pricing the tenders. No additional amount would be admissible later on this account.

6.2 Unless otherwise specified or shown in the approved construction drawings, maximum slopes to cuttings shall conform to the following:

Materials	Maximum Slope (Horizontal Distance to Vertical Rise)
Sand	(3 : 1)
Loose gravel or medium clay, loam	(1½ : 1)
Shale or similar soft rock	(1 : 1)
Jointed laminated or soft rock	(½ : 1)
Massive rock	(¼ : 1)

6.3 When according to the Engineer-in-charge assessment of the type of materials at the cut site, the slopes as proposed on the approved drawings have to be re-determined, General Contractor shall cut the slope as instructed and General Contractor shall not be entitled to claim for additional work except when the re-determination is made for purposes other than to ensure the stability of the cutting. If however, the General Contractor excavates the slope of a cutting beyond the specified line and the tolerance applicable thereto, the General Contractor may be instructed to fill and make up the cutting to the required slope, in the manner as directed by Engineer-in-charge, all at General Contractor's own expense. Such a change shall not be regarded as a re-determination of the slope and no payment shall be made.

6.4 Excavation for foundation, trenches, drain pipes, etc. shall be carried out to the dimensions, depth levels as indicated in the drawing. If General Contractor excavates to any greater widths or depths than shown on the drawings for the above, then General Contractor shall fill in such depths or widths of excavation with grade M15 concrete at his own cost.

6.5 The bottoms of all excavations shall be free from mud and water, trimmed clean protected from the effects of weather and thoroughly consolidated & compacted to the satisfaction of Engineer-in-charge by rollers, rammers or other approved methods before placing any constructional material. All soft or defective portions shall be cut out and filled in with selected excavated material well consolidated in layers not exceeding 150mm-200mm thick, except for foundation which is covered in Clause above.

6.6 Where required, General Contractor shall design and provide all necessary planking, strutting and sheet piles if necessary to uphold the face of the excavation, necessary staging, etc without any additional cost. General Contractor shall ensure the safety from slips, bows and damage to adjacent work and property or injury to persons. All such shoring shall be removed after all the items of work for which it is required are completed.

6.7 All kind of excavated materials shall be placed at a distance more than two metres away from the excavation, or as directed by the Engineer-in-charge. Materials suitable for back filling or other usage shall be sorted and stacked at suitable & appropriate location as decided by Engineer-in-charge. General Contractor shall include all cost for any additional handling, lift, lead, transportation and all other operations required for utilizing such material for back filling in the final place of back fill or other use in the work.

6.8 Unsuitable and surplus materials, which in the opinion of the Engineer-in-charge should not be intended for any use in the premises; it should be carted away and disposed off outside the site by the General Contractor at his own cost.

6.9 All water, which may be accumulated in excavation during the progress of the work, from springs, rains or other causes, shall be bailed/ pumped out or otherwise removed at no extra cost till the work is completed and all such operations towards dewatering for the entire duration of the work shall be included in Excavation.

6.10 If there are any slips and bows in excavation, these shall be removed by General Contractor at his own cost. Any overhang of existing pavements, existing foundations, etc., arising due to undermining or any other causes shall be removed by General Contractor at his own cost and any damages to existing pavements etc. due to additional excavation carried out by General Contractor or due to undermining, or due to any other reason, shall be made good to the original condition by General Contractor at his own cost, as instructed by the Engineer-in-Charge.

6.11 If pipes, cables and any underground services encountered during excavation, it shall be properly supported by General Contractor at his own cost without any damaging to such services. During excavation General Contractor should provide particular care to avoid injury to personnel from live cables, etc. and to avoid damage to drains, water mains, cables and underground services. All damage shall be made good by General Contractor, at his own cost, to the satisfaction of Engineer-in-Charge.

6.12 Any live or abandoned services encountered during excavation, it should be brought to the attention of the Engineer-in-Charge immediately. All abandoned services in excavation shall be removed by General Contractor; any extra excavation involved due to such operations, which are carried out with the prior permission of the Engineer-in-Charge shall be measured under the respective items and paid as per the schedule of rates in the contract. All materials removed out by such operations shall be treated as excavated materials and disposed off by General Contractor at his own cost, as directed by Engineer-in-charge, in the same manner as specified for excavated materials.

6.13 The General Contractor shall, at his own expense, ensure that the area under excavation is securely fenced with proper warning / caution signs and illuminate with red lights at nights to avoid accidents. He shall also at his own cost take all necessary protective measures, and ensure that excavation for foundations, basements, etc. does not affect or damage any services, adjoining structures, etc. General Contractor shall be entirely responsible for any injury to lives or damage to property caused by his negligence or any accident due to his constructional operations.

7.0 REMOVAL OF ROCK AND OTHER BLASTING OPERATIONS

7.1 Should rock be met in the course of excavation, it must be removed by approved means.

7.2 Blasting will not be allowed without written permission from the Engineer-in-charge. If explosives are to be used, General Contractor shall obtain all necessary licenses from the appropriate local authorities and shall inform to all Government regulations relating to transport storage, handling and use of the explosives and shall also confirm to the rules set out by the Officer-in-Charge of respective local authority related to Arms and Explosives.

7.3 Rock is material, which in the opinion of Engineer-in-charge, can only be excavated by use of wedges or compressed air plant. Rock is to be stacked on site for measurement before being carted away. Rocks removed without prior measurement will not be paid later.

7.4 Excavation in solid rock shall mean excavation in rock found in ledges, large bounders or masses in its original position which would normally have to be loosened by pneumatic tools or if excavated by hand, by wedges and sledge hammers. All solid boulders or detached pieces or rock exceeding $0.38m^3$ in volume in trenches or exceeding $0.76m^3$ in general excavation but not otherwise shall be regarded as solid rock.

7.5 Material other than rock including but restricted to earth gravel and also such hard and complex material which can be removed by ordinary excavating machines and also boulders or detached pieces of solid rock not exceeding $0.38m^3$ in volume in trenches or $0.76m^3$ in general excavation shall be regarded as ordinary materials.

7.6 On encountering rock, General Contractor shall notify to Engineer-in-charge the existence of such material. Engineer-in-charge shall reserve the right to decide whether such material is rock or otherwise and his decision shall be final.

Ordinary Rock:

Ordinary rock may be defined as that which may be quarried or split with crow bars or picks such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level.

If required, light blasting may be resorted to, for loosening the materials, but this will not in any way entitle the material to be classified as Hard Rock.

Hard Rock

Hard Rock may be defined as : any rock or boulder for the excavation of which blasting is required such as Quartzite stone, granite, basalt reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like. Hard rock requiring blasting as described above but where blasting is

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prohibited for any reasons and excavation has to be carried out by chiseling, wedging or any other agreed method will also be regarded as Hard Rock.

In the case of hard rock, if required by the Architects, the excavated stuff shall be properly stacked or disposed of in places as directed. The quantity of these stacks shall be measured and payment will be based if necessary on the net quantities after deducting 50% of for voids from the measured quantities.

Support of Excavation

The Contractor shall adequately support the sides of excavation as may be necessary to prevent subsidence or movement of the material in which the excavation is being carried out and to ensure the safety of persons and nearby structures.

Slips

The Contractor shall take all necessary precautions to prevent slips in excavations and shall at his own expense make good any damage or defect and remove top soil dumps and any surplus material caused by slips.

8.0 REMOVAL OF SOFT SOIL AREAS OR UNSUITABLE MATERIAL

8.1 In cuttings where soft and unsuitable materials occur within one metre below the design platform levels of the sub-grade, such materials shall be removed and replaced with approved stable materials in layers not exceeding 150mm-200mm loose thickness, compacted as elsewhere specified.

9.0 APPROVAL OF EXCAVATION

9.1 General Contractor shall report to Engineer-in-charge when secured bottoms have been obtained in the excavations and are ready to receive the foundations. Any concrete or other work put in before Engineer-in-charge's approval shall be removed and replaced at General Contractor's own expense.

10.0 DISPOSAL OF SURPLUS EXCAVATED MATERIAL

10.1 Surplus excavated material arising from excavation and not required for filling, etc. shall be removed, deposited, spread, leveled and mechanically rammed and consolidated on site where directed by the Engineer-in-charge or removed off the site. General Contractor shall find his own area for dumping, which has to be approved by the Engineer-in-charge.

11.0 EARTH FILL

11.1 Approved material shall be used for fill of site, construction including embankments, and shall be free from logs, stumps, weeds and organic matter or any other deleterious matter. The filling material shall consist of suitable material all of which shall pass a125mm IS sieve and at least 95% shall pass the 75mm IS sieve.

11.2 The coefficient of uniformity shall be greater than 10. The fraction passing a 75 μm IS sieve shall be less than 20% by weight and shall have the following characteristics:

Liquid limit not exceeding 35;
Plasticity index not exceeding 12

11.3 Areas and embankments on which fills will be constructed shall first be cleared and grubbed as specified. Top soil to full depth including turf, grass, bushes shall be removed; estimated depth of top soil at various part of construction site are furnished in tender drawings. Filling shall not be placed until the approval of Engineer-in-charge has been obtained.

11.4 Embankments & site filling shall be constructed in such an order and manner that adequate drainage of the working areas is maintained throughout the construction period.

11.5 Surfaces with slopes steeper than one vertical to four horizontal shall be cut into a series of level benches before filling. Filling shall be placed in horizontal layers beginning at the lowest point in the natural surface and shall be constructed to the full dimensions of the embankment at each layer. Materials which have been loosened shall be compacted together with the filling placed in the succeeding layer. The loose thickness including the newly placed fill of the layers shall not exceed 200mm.

11.6 All fills shall be constructed in layers of uniform thickness not exceeding 200mm and each layer shall be compacted as specified in Clause "compaction of earth work". Layers of filling may be formed by equipment which will spread the material as it is dumped, or by blade or spreading by other acceptable methods so that the material is uniformly distributed.

11.7 Before beginning compaction, the material in each layer of the embankment shall be uniform in composition and moisture content. Clods of material shall be broken and the material mixed by blade, harrowing, disking or by other methods. Oversized rocks shall be broken to the specified maximum dimension of 125mm. Rock shall be placed, spread and compacted in such a manner that the interstices between the larger pieces are filled with compacted finer materials.

11.8 Unless otherwise specified or shown on the drawings, the maximum slopes for fill will conform to the following:

Material	Maximum Slope (Horizontal Distance to Vertical Rise)
Sandy loam, clay and loose sand	(3 : 1)
Ordinary lateritic earth	(1½ : 1)
Rock	(1¼ : 1)
Rock filling-hand pitched	(1 : 1)

11.9 When Engineer-in-charge re-determines a slope, the Contractor shall not be entitled to claim whatsoever, unless such re-determination is for the purpose other than to ensure the stability of the slope.

12.0 FILL ADJACENT TO CULVERTS ABUTMENTS, WING AND RETAINING WALLS

12.1 Materials adjacent to weep-holes in abutments, wing and retaining walls shall consist of clean, hard and durable broken stone, graded from 50mm to 9mm sizes of particles. The larger particles shall be placed adjacent to the weep-holes and the small particles behind and above the larger particles.

12.2 The graded broken stone shall extend horizontally at least 300mm from each weep-hole and at least 450mm vertically above the weep-hole.

12.3 In addition to the graded broken stone at weep-holes, selected fill consisting of granular material having a maximum size of 50mm, a Plasticity Index of not more than twelve (12) and having at least sixty (60) per cent retained on a No. 7 IS. Sieve (2.40mm) shall be placed adjacent to bridges, culverts and walls in accordance with the following tables:

Structure	Minimum Width of Selected Fill
Bridge abutment and wing walls	2.0 m
Culvert wing walls	H/3
Retaining walls	H/3
Barrels of box culverts	H/3
Barrels of pipe culverts	600 mm
(Where H = Height of Structure)	

12.4 Engineer-in-charge shall determine whether the material proposed by General Contractor or excavated from the site is suitable for use as selected fill. If in the opinion of the Engineer-in-charge selected material of the required quality is unobtainable from the excavation under the Contract, he may give authority for the material to be obtained from other borrowed sites with no extra payment to General contractor.

12.5 The selected fill shall be placed in layers of 150mm-200mm up to the sub-grade level. Compaction shall start at the wall and proceed away from it and shall be carried out as specified in Clause "Compaction of Earthworks".

12.6 Where the slope of the natural surface behind abutment walls and wing walls exceeds one (1) vertical to four (4) horizontal, the slope shall be cut in the form of successive horizontal terraces at least 600mm in width.

12.7 No fill shall be placed against abutments or wing walls of concrete structures within 14 days after placing concrete in the abutments or walls and in the superstructure of the adjacent span, unless the walls are properly strutted to the approval of Engineer-in-charge.

12.8 In the case of spill-through abutments, rock fill shall not be dumped against the columns but shall be built up evenly by hand placing around individual columns.

12.9 In the case of framed structures, fill at both ends of the structures shall be brought up simultaneously, the difference between the levels of the fills at the respective abutments not to exceed 600mm.

Dewatering

Generally the rate quoted shall include bailing of all remaining water which may accrue in excavation. 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 arrangements for proper drainage of the pumped water from the well points and its easy disposal without affecting the site and the adjoining areas. Any permission required for such disposal of water to other areas, shall be taken from the respective authorities by the Contractor. The Contractor shall engage the dewatering equipment in such a way that the excavated pit should always remain dry while the excavation and concrete work for column and wall foundation, slabs, column and wall upto ground floor level are carried out. The dewatering process shall be carried out till the concrete or other structures in works as mentioned above has set sufficiently and backfilling on sides

of foundation including ramming, compaction by 20cm layers is completed to satisfaction and approval of Architect / Employer, at no extra cost to the Employer. Dewatering by pumps as required at site shall be included in the rate wherever specified in the item(s) of Excavation.

13.0 COMPACTION PLANT

13.1 Compaction methods and compaction plants/machinery used shall be in accordance with the recommendation given in IRC code or equivalent local standard.

13.2 General Contractor shall provide and operate sufficient compaction plants of suitable type which shall be approved by Engineer-in-charge to compact site area, embankments, sub-grades and pavement courses in accordance with these specifications.

13.3 Any type of compacting equipment which the General Contractor may desire to use shall first have to be approved by the Engineer-in-charge before being put into service. If it fails to produce the specified compaction, it's use shall be discontinued and other approved rollers shall be provided immediately.

14.0 COMPACTION OF EARTHWORKS

14.1 Sub-grade in cuttings, areas upon which fills are to be placed and all fill material shall be compacted to the standards indicated hereunder. All compaction shall be carried out using approved mechanical plants in accordance with the recommendation given in IRC code or any other equivalent local standards.

14.2 The depth of each compacted layer shall not be greater than the maximum depth of the compacted layer stipulated for each type of compaction plant.

14.3 Earthmoving plant shall not be accepted as compaction equipment.

14.4 Alternative methods or plants may be accepted if it can be demonstrated to the satisfaction of the Engineer-in-charge at site trials that the required field density can be achieved.

14.5 Before commencement of any filling, each class of fill material to be compacted shall be tested by an accredited laboratory to establish the maximum value of the dry density that can be achieved and the optimum moisture content for compaction.

14.6 Each layer of material placed (including sub-base layers), the natural surface in areas to be occupied by fills, the natural surface at the junction of cuts and fills, materials backfilled in cutting and material replacing unstable portions of the natural surface with selected material shall be trimmed as construction proceeds and shall be uniformly compacted to the required density before the laying of the next layer is commenced. The compaction of undisturbed natural ground shall be to the required density for a depth of not less than 200mm.

14.7 The in-situ field densities of all compacted materials calculated as a percentage of the maximum dry density shall not be less than:

Within 300mm of formation level - 95 %
Below 300mm of formation level - 90 %

14.8 Notwithstanding compliance with the recommendation given in IRC code, the General Contractor shall carry out site tests at a rate of 1 test per 400 m^2 of surface area of each compacted layer to verify that the required field density is achieved, and make any adjustments to the compaction methods if necessary.

14.9 At the time of compaction of each layer, the moisture content of the material shall be adjusted so as to obtain the degree of compaction specified. When directed by the Engineer-in-charge, water shall be added to material which contains insufficient moisture for compaction. The added water shall be sprayed uniformly and thoroughly mixed with material until a homogenous mixture is obtained. Material containing excessive moisture shall not be compacted until the material has dried out sufficiently to obtain the required compaction.

14.10 Compaction shall be undertaken by any means necessary to obtain the specified compaction for the full depth of each layer in fills and for the full width of the formation over the entire length of the work. At locations where it would be impracticable to use mobile power compacting equipment, fill layers shall be compacted to the specified requirements by any means approved by the Engineer-in-charge that will obtain the specified compaction.

14.11 Construction equipment and traffic shall not be allowed on the sub-grade or fill while it is in a wet condition. Material which has become excessively wet shall be dried or removed from the site and replaced by material of suitable moisture content for compaction at the General Contractor's expense.

14.12 Filling over and around pipes, culverts, bridges and other structures shall be compacted in such a manner that will avoid unbalanced loading and that will not cause movement or place strain on any structures.

14.13 General contractor shall compact the sub-grade under the building column foundations, machine foundations and slab-on-grade to the following requirement
Compaction ratio for the final layer shall be 98%, CBR of 25% and E > 80 Mpa
Compaction ratio for the intermediate layers shall be 95%

The Contractor shall carry out following recommended tests to demonstrate that adequate compaction in accordance with the above Specifications has been carried out to the sub-grade or fill layers.

Dry Density - Moisture content of sub-grade or fill material.
In-situ Field density tests
California Bearing Ratio Tests / Proctor
Plate bearing test to ensure the design soil bearing capacity as stated in drawings.

All tests need to be carried out every 400m^2 area of compacted sub-grade at each stages of compaction for building foundation and slab-on-Grade. Number of tests shall be increased to every 400m^2 for machine foundation base.

15.0 MEASUREMENT AND RATES

15.1 Volume of consolidated filling shall be measured. The dimensions shall be measured correct to the nearest cm and cubical contents worked out in cubic metres correct to two places of decimal. The rate shall include the cost of materials and labour involved in all the operations described above.

15.2 The classification of excavated material for measurement purposes shall be as given in specification above. Excavation shall be measured in cubic meters for each class of material encountered.

15.3 Fixing & removing of shoring, strutting, planking, bracing, timbering shall not be paid separately and should be included in excavation.

15.4 Additional width excavated including for basement walls, and its waterproofing treatment for convenience of working space or for any other reason shall be considered in the pricing and additional payment shall not be claimed for such excavations.

15.5 Back-filling with selected excavated material, watering, consolidation of the sub-grade base and filling, etc. shall be measured in volume.

15.6 The driving of sounding bars or jumping small drill holes to expose the nature of sub-stratum up to a total depth one meter below the bed of excavation and distribution in 2 or 3 locations in each foundation, if required by the Engineer-in-Charge, shall be considered included in the item of work and will be paid separately.

15.7 In particular, excavation shall be measured limited to the dimensions shown on the drawings or as directed by the Engineer-in-charge. Trenches with "Grips" for sockets of pipes shall be measured up to the depth exclusive of "Grips". In case of rock, the measurement shall be on stack basis less 33% for voids.

15.8 Where excavation is in trenches or in fairly uniform ground "Dead Men" or "Tell Tales" shall be left at suitable intervals, as instructed by Engineer-in-charge, to determine the average depth of excavation. Where the ground is not uniform, levels shall be taken before the start, after the site clearance and after completion of the work and the quality of excavation shall be computed from these levels.

15.9 For backfill of spaces excavated for foundations, trenches etc. using selected excavated material which shall also include mixture of broken pieces of rock and fine material, no additional payment shall be made. The excavation rate shall be inclusive of such back fill including back fill beyond the payable volume of excavation. If instead of fully back filling with the selected excavated material, the General Contractor is instructed to backfill with approved material brought from outside, the measurement of such filling shall be the volume of payable excavation above less the volume of soling, metalling, concrete or masonry or basement construction, etc if any, provided within the excavation and also less the volume of filling executed with selected excavated materials.

15.10 Measurement of the volume of filling in plinth, below floor, sub-grade and similar locations whether with selected excavated materials or approved materials brought from outside shall be specified area multiplied by actual consolidated depth of fill. The fill shall be leveled / finished to the profile as directed. The quoted rates for excavation and filling shall include the cost of labour, plant and equipments, tools, safeguards and incidentals necessary to complete the work to the specifications.

16.0 DRAINAGE OF EXCAVATIONS

16.1 The General Contractor shall arrange for the rapid dispersal of water shed on to the site from any source. Where practicable, the water shall be discharged into the permanent outfall for the drainage system. Adequate means for trapping silt on temporary systems discharging into permanent drainage systems shall be provided.

16.2 Where necessary, temporary water courses, ditches, drains, pumping or other means of maintaining the earthworks free from water shall be provided. The General Contractor shall also maintain a sufficient minimum surface cross fall at all times and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

17.0 POST-CONSTRUCTION SURVEY

17.1 The Contractor shall submit post-construction survey plan certified by a registered surveyor showing as-constructed levels of roads, platforms, embankments, drainage, etc. of earthwork carried out at 10m grids.

17.2 After the site clearance operations have been carried out the limits of excavation shall be set to true levels, lines, curves, slopes, grades and sections, etc. as shown on the drawings or as directed by the Engineer-in-Charge.

18.0 SITE/POLLUTION CONTROL MEASURES

18.1 General Contractor shall implement effective erosion and sediment control measures (ECM) in accordance with the local authority requirements. ECM proposals shall be prepared by General Contractor and approved by the local Authority or Engineer-in-charge and implemented prior to commencement of site works. The ECM shall be regularly maintained to ensure their effectiveness during the course of construction works.

18.2 General Contractor shall implement comprehensive pest, Dogs, birds control, and surveillance for the site, including all necessary measures to prevent the site from being favorable to the breeding or harbouring of vectors and mosquito or other harmful to human. These shall be carried out regularly throughout the construction period in accordance to the local Authority requirements.

19.0 QUALITY ASSURANCE / QUALITY CONTROL / QUALITY DOCUMENTS

General contractor shall submit the following documents before commencement of any work

19.1 **Method Statement**
General Contractor shall prepare and submit a method statement including at least the following information as relevant to the Engineer-in-Charge prior to commencement of work:

Proposed excavation method, machinery and compaction plant
Maximum depth of each compacted layer
Minimum number of passes per layer
Method of slope protection & treatment
Proposed temporary works for deep excavation
Dewatering control
Inspection & test plan

19.2 **Sequence of cut & fill earth work**
General contractor shall submit a detail plan showing the zoning of earthwork with sequence and duration of earth works to Engineer-in-Charge for approval prior to the start work unless otherwise agreed.

19.3 **Additional Site Investigation and Factual Report**

General contractor shall study the site soil investigation report enclosed with contract and request to carry out additional borelogs if required with valid reason to Engineer-in-Charge's review and approval. There shall be no additional time given for conducting such extra soil investigation work and it should be within the contract period and General Contractor's own expense.

19.4 **Temporary Work design and details**

Before commencement of Work, General Contractor should submit a design calculation and detail drawings of proposed shoring system including shoring material, waler sizes & levels, strut size & level, connection detail of strutting elements, etc with sequence of excavation and backfilling to Engineer-in-Charge's review and approval.

If open cut shall be proposed General Contractor shall submit a calculation showing the stability of the slope with suitable soil parameters.

19.5 **Fill Material Samples**

At least 04 days before filling work commences, General Contractor shall submit full details of the sources and types of the proposed filling materials together with 25kg representative samples of each type from each source.

General contractor shall deliver the samples to an accepted accredited laboratory, with sufficient representative of samples of each material for the specified tests, at a rate of one set of tests per sample.

19.6 **Testing of Fill Materials**

General Contractor shall arrange for the following tests on all proposed fill materials at the rate of one test for each representative samples to be carried out at approved testing agency:

Soil Classification

Determination of the particle size distribution

Determination of the plasticity index (of material passing the 425 micron IS sieve; % of material retained to be reported)

Determination of the dry density / moisture content relationship of granular soil (vibrating hammer method)

Determination of the California Bearing Ratio

When directed, tests need to be carried out for all imported fill for compliance with specified limits on contamination to ensure that material is 'clean' relative to the proposed end use. General Contractor shall propose and submit the specific criteria, schedule and timing of tests required to Engineer-in-Charge's acceptance.

C ANTI TERMITE TREATMENT

1.0 SCOPE

1.1 The work of pre-constructional anti-termite treatment covered under this specification consists of the soil treatment with approved chemicals in water emulsion in foundation trenches for columns, plinth beams, brick wall, lift pits, machine foundation, trenches, steps, ramps etc. and on top surface of plinth filling, slab on grade, at junction of walls and floors, in expansion joints etc. in stages as detailed in this specification and drawing.

2.0 APPLICABLE CODES & SPECIFICATIONS

2.1 The relevant I.S specifications, standards and codes given below are made a part of this specification. All standards, specifications, code of practices referred to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

2.2 List of Indian Standards

IS: 6313 (Part I)	- Code of Practice for Anti-termite Measures in Buildings Constructional Measures
IS: 1200 (Part I)	- Method of measurement of buildings and civil engineering works.
IS: 6313 (Part II)	- Pre-constructional Chemical Treatment Measures
IS: 8944	- Specification for Chloropyrifos Emulsifiable Concentrates
IS: 4015 (Part I)	- Guide for Handling cases of Pesticide Poisoning First Aid Measures
IS: 4015 (Part II)	- Symptoms, Diagnosis and Treatment

3.0 GENERAL

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

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

3.3 The pre-constructional soil treatment is required to be applied during the construction stages of the sub-structure up to plinth level. The contractor has to be watchful of the various stages of sub-structure works and arrange to carry out the soil treatment in time after proper co-ordination with inter-discipline and other contractors if any, working at site.

3.4 Unless otherwise stipulated, the anti-termite treatment will be carried out as per IS 6313 (Part-II) and / or as per direction of Engineer-in-Charge.

4.0 SITE PREPARATION

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

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

4.1.2 Remove all concrete formwork if left anywhere, leveling pegs, timber off cuts and other building debris from the area to be treated.

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

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

4.1.5 On clays and other heavy soil where penetration is likely to be slow and on sloping sites, where runoff of the treating solution is likely to occur, the surface of the soil should be scarified at least to a depth of 25mm.

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

5.0 CHEMICAL TO BE USED

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

6.0 MOUND TREATMENT

6.1 For a mound volume of about one cubic metre, four litres of an emulsion in water with 0.50 percent Chloropyrifos shall be used. Other chemicals with technical data sheet shall be submitted to Engineer-in-Charge if General Contractor desires to use any other brands.

7.0 SOIL TREATMENT

7.1 Chlorpyriphos emulsifiable concentrates chemical (IS: 8944) with 1.0 % in water emulsion shall be effective when applied uniformly over the area to be treated. General Contractor may propose alternate to Engineer-in-Charge.

8.0 MODE AND RATE OF APPLICATION

8.1 The chemical emulsion as stated above will be applied uniformly by spraying at the prescribed rates as detailed below in all the stages of the treatment unless follow the manufactures' recommendation:

8.1.1 **Treatment in Foundation Trenches:**
In case of normal wall load bearing structure, column pits, wall trenches and basement, the treatment shall be @ 5 (five) litres per square metre of surface area of the bottom and sides to a height of at least 300 mm. After the foundation works, the sides shall be treated @ 15 (fifteen) litres per square metre at vertical surface of sub-structure on each side.

After the earth filling is done, treatment shall be done by rodding the earth at 150 mm center to center close to wall surface and spraying the chemical with the above dose i.e., 15 (fifteen) litres per square metre. In case of framed structure, the treatment shall start at a depth of 500 mm below ground level. From this depth the backfill around the columns, beams and R.C.C basement walls shall be treated @ 15 (fifteen) litres per square metre of the vertical surface and @ 5 (five) litres per square metre for the horizontal surface at the bottom in the trenches/pits.

8.1.2 **Treatment on Top Surfaces of Plinth Filling:**
The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 (five) litres/square metre of the surface area before sub-base to floor is laid. If filled earth has been well rammed and the surface does not allow the emulsion to seep through; holes up to 50 mm to 75 mm deep 150mm centre to centre both ways shall be made with crowbars on the surface to facilitate saturation of the soil with the emulsion.

8.1.3 **Treatment at Junction of Walls and Floors:**
Special care shall be taken to establish continuity of the vertical chemical barrier on the inner wall surfaces from the finished ground level (or from level where the treatment had stopped) up to the level of the filled earth surface. To achieve this a small channel 30 x 30 mm shall be made at all the junctions of wall / column with floor (before laying sub-grade) and rod holes made in the channel up to the finished ground level at 150 mm apart and the iron rod moved backward to forward to break the earth and chemical emulsion poured along the channel @ 15 (fifteen) litres (or as recommended quantity) per square metre of the vertical wall / column surfaces so as to soak the soil right up to the bottom. The soil shall be tamped back into place after this operation.

8.1.4 **Treatment of Soil along External Perimeter of Building**

After the building is complete, provide holes in the soil with iron rods along the external perimeter of the building at intervals of about 150 mm and depth 300 mm and filling these holes with chemical emulsion at the rate of 7.5 litres per sqm.

8.1.5 **Vertical Surface**

In the event of the depth of the wall filling being more than 300 mm, the external perimeter treatment shall be extended to the full depth of filling upto the G.L. so as to ensure continuity of the chemical carrier. Treatment of soil under apron (plinth protection) along external perimeter
of building, to surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litre per sqm. of the vertical surface before the apron is laid. if consolidated earth does not allow the emulsion to soak through, holes upto 50 to 75 mm centre both ways may be made with 12mm diameter mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

8.1.6 **Treatment for Expansion Joints:**
The soil beneath the expansion joints shall receive special attention when the treatment under 8.1.1 above is in progress. This treatment shall be supplemented by treating through the expansion joint after sub-grade has been laid at the rate of 2 (two) litres per metre length of expansion joint.

8.1.7 **Treatment of soil surrounding pipes and conduits**

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of the entry shall be loosened around each such pipe, or conduit for a distance of 150 mm and to a depth of 75mm before treatment is commenced when they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75 mm for the distance of over 300mm from ground level.

9.0 PRECAUTIONS DURING TREATMENT

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

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

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

10.0 PRECAUTIONS FOR HEALTH HAZARDS AND SAFETY MEASURES

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

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

10.3 Particular care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water especially before eating and smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water. If chemicals splash into the eyes, they shall be flushed with plenty of water and immediate medical attention should be sought.

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

10.5 Care should be taken in the application of soil toxicants to see that they are not allowed to contaminate wells or springs, which serve as sources of drinking water.

11.0 GUARANTEE

11.1 The contractor has to furnish the guarantee for 10 (ten) years from the date of completion of work stating that in case of re-appearance of termites within the building area due to defective materials or workmanship or due to any other reasons, the contractor will carry out the necessary post constructional treatment to keep the entire area free from termite once again, without any extra cost to the client during the guarantee period. Such a guarantee shall be directly given by the specialist agency to the employer in all forms approved by the Engineer

12.0 MODE OF MEASUREMENT

12.1 The payment will be made on the basis of plinth area measurements at ground floor only for all the stages of treatment in square metre rounded off to two places of decimals.

12.2 Rate includes the cost of materials, labour and all tools, consumables, spares for complete operation.

D REINFORCED CONCRETE

1.0 GENERAL

1.1 The quality of materials, method, control of manufacture and transportation of all concrete work in respect of mix whether reinforced or otherwise shall confirm to the applicable portion of these specification.

1.2 Engineer-In-Charge shall have the right to inspect the source of materials, layout and operation of procurement and storage of materials, the concrete batching and mixing equipments and the quality control system.

Such an inspection shall be arranged by General Contractor and Engineer-In- Charge's approval shall be obtained prior to starting of concrete work.

2.0 SCOPE

2.1 This specification covers the general requirements for concrete to be used in this project using on-site production facilities including requirements in regard to the quality, quantity, handling, storage of ingredients, proportioning, batching, mixing, and testing of concrete and also requirements in regard to the quality, storage, cutting, bending and fixing of reinforcement in position.

This also covers the transportation of concrete from mixer to the place of final deposit and placing, curing, protecting, repairing and finishing of concrete.

3.0 APPLICABLE CODES & SPECIFICATION

3.1 The following specifications, standards and codes are made a part of this specification. All standards, tentative specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments, revisions and additional publications. In case of discrepancy between this specification and those referred to herein this specification shall govern.

3.2 List of Indian Standards

IS: 269	- Specification for ordinary, rapid hardening and low heat Portland cement
IS: 383	- Specification for coarse & fine aggregate from natural source or concentrate
IS: 456	- Code of practice for plain and reinforced concrete
IS: 515	- Specification for natural and manufactured aggregate for use in mass concrete
IS: 516	- Method of test for strength of concrete
IS: 650	- Specifications for standard sand for testing of cement
IS: 1199	- Method of sampling and analysis of concrete
IS: 1200 (Part-II)	- Method of measurement of building works
IS: 1791	- Specification for batch type concrete mixers.
IS: 2386 (Part-I)	- Method of test for aggregates for concrete; Particle size and shape.
IS: 2386 (Part-II)	- Method of test for aggregates for concrete: Estimation of deleterious materials and organic impurities
IS: 2386 (Part-III)	- Method of test for aggregates for concrete: Specific gravity, density, voids, absorption and bulking.

IS: 2386 (Part-IV)	- Method of test for aggregates for concrete: Mechanical properties.
IS: 2386 (Part-V)	- Method of test for aggregates for concrete: Soundness.
IS: 2386 (Part-VI)	- Measuring mortar making properties of fine aggregates.
IS: 2386 (Part-VII)	- Method of test for Alkali aggregates reactivity.
IS: 2438	- Specification for roller pan mixer.
IS: 2505	- Specification for immersion type concrete vibrators.
IS: 2506	- Specification for screed board concrete vibrators.
IS: 2514	- Specification for concrete vibrating table.
IS: 2645	- Specification for integral cement water proofing compound.
IS: 3025	- Methods of sampling and test (physical and chemical) for water used in industry.
IS: 3366	- Specification for pan vibrator.
IS: 3370 (Part-I)	- Code of practice for concrete structures for the storage of liquids: General.
IS: 3370 (Part-II)	- Code of practice for concrete structures for the storage of liquids: Reinforced concrete structure.
IS: 3385	- Code of practice for measurement of Civil Engineering works
IS: 3414	- Code of practice for design and installation of joints in buildings
IS: 3558	- Code of practice for use of immersion vibrators for consolidating concrete
IS: 3935	- Code of practice for composite construction
IS: 4031	- Method of physical test for hydraulic cement
IS: 4656	- Specification for form vibrator.
IS: 7861 (Part-I)	- Code of practice for extreme weather concreting (for hot weather concreting).
IS: 8112	- Specifications for high strength ordinary Portland cement (Grade 43).
IS: 10262	- Code of practice for design mix
IS: 12269	- Specifications for high strength ordinary Portland cement (Grade 53)
IS: 13311 (Part-I)	- Non-destructive testing of concrete: Method of test for ultrasonic pulse velocity.
IS: 13311 (Part-II)	- Non-destructive testing of concrete: Method of testing by rebound hammer.

4.0 MATERIALS FOR STANDARD CONCRETE

4.1 The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland cement; clean sand, natural coarse aggregate, clean water, ice, an admixture, if specifically called for on drawings or schedule of quantities.

4.2 Cement

4.2.1 Unless otherwise specified or called for by Engineer-In-Charge cement The cement used shall be one of the following types:

a. Ordinary Portland Cement conforming to IS : 269

b. Portland Pozzolana Cement conforming to IS : 1489

(Fly ash based meeting the 28 day strength requirement of OPC 53 grade cement) in 50 kg bags. The use of bulk cement will be permitted only with the approval of Engineer-In-Charge. Changing of brand or type of cement within the same structure will not be

permitted. In case it is required to change the brand of cement in the same structure, prior permission shall be obtained from the Engineer-In-Charge.

4.2.2 If demanded a certified report attesting to the conformity of the cement to IS specifications by the cement manufacturer's chemist shall be furnished to Engineer-In-Charge.

4.2.3 General Contractor will have to make his own arrangements for the storage of adequate quantity of cement. Cement in bulk may be stored in bins or silos, which will provide complete protection from dampness, contamination and minimize cracking and false set. 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.

4.2.4 All cement shall be fresh when delivered and at ambient atmospheric temperature. Cement bags shall be stored in dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to use and shall be removed from site.

4.2.5 The storage bins and storage arrangements shall be such that there is no dead storage. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be approved by the Engineer-In-Charge. Consignment of cement shall be stored as received and shall be consumed in the order of their delivery.

4.2.6 Cement held storage for a period of Ninety (90) days or longer shall be tested before use in work. Should at any time the Engineer-In-Charge have reason to consider that any cement is defective, then irrespective of its origin and / or manufacturer's test certificate, such cement shall be tested immediately at a National Test Laboratory or such approved laboratory and until the result of such test are found satisfactory, it shall not be used in any work.

4.2.7 In fare 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.

4.2.8 With each and every delivery of cement the contractor shall provide the manufacturers certificate that the cement conforms to the relevant Indian Standard.

4.3 Aggregates

4.3.1 Aggregate in general designates both fine and coarse inert materials used in the manufacture of concrete. Fine Aggregate is aggregate most of which passes through 4.75 mm IS sieve. Coarse Aggregate is aggregate most of which retained on 4.75 mm IS sieve.

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

4.3.3 Aggregates shall consist of natural sand, crushed stone and gravel from source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durability against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and/ or durability of concrete.

4.3.4 The grading of aggregate shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mixed design" and preliminary test on concrete specified herein after.

4.4 Sampling and Testing

4.4.1 Samples of the aggregates for mixed design and determination of suitability shall be taken under the supervision of the Engineer- In-Charge and delivered to the laboratory, well in advance of the scheduled placing of concrete.

4.4.2 Records of tests, which have been made on proposed aggregates and on concrete made from this source of aggregates, shall be furnished to the Engineer- In-Charge in advance of the work for use in determining the aggregate suitability.

4.5 Storage of Aggregates

4.5.1 All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates.

4.5.2 Contamination with the foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate must be specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregates from the bins or stock piles.

4.5.3 Coarse aggregate shall be piled in layers not exceeding 1.20 metres in height to prevent coning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started.

4.5.4 Aggregates that have become segregated shall be rejected. Rejected material after re-mixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

4.6 Specific Gravity

Aggregate having a specific gravity below 2.60 (saturated surface dry basis) shall not be used without special permission of the Engineer- In-Charge.

4.7 Fine Aggregate

4.7.1 Fine aggregate except as noted above and for other than lightweight concrete shall consist of natural river sand (suitable for concrete), crushed stone sand or crushed gravel sand stone dust confirming to IS 383. The sand shall be clean, sharp, hard, durable, chemically inert and free from dust, vegetable substances, adherent coating, clay, organic matter, alkalis, mica, salt or other deleterious substances which can be injurious to the setting qualities / strength/ durability of concrete. No creek / sea sand shall be allowed.

4.7.2 Machine made sand will be acceptable provided the constituent rock / gravel composition is sound, hard, dense, non-organic, uncoated and durable against weathering.

4.7.3 Sand shall be prepared for use by such screening or washing or both as necessary to remove all objectionable foreign matter while separating the sand grains to the required

size fractions. Sand with silt content more than 3 % will not be permitted for use unless the same is washed and silt content is brought within 3% by weight.

4.7.4 The percentage of deleterious substances in sand delivered to the mixer shall not exceed the following:

Sl. No	Substances Percent by weight	Uncrushed : Crushed
1.	Material finer than 75 micron I.S. sieve	3.00% : 15.00%
2.	Shale	1.00% ---
3.	Coal and Lignite	1.00% : 1.00%
4.	Clay lumps	1.00% : 1.00%
5.	Total of all above substances including items 1 to 4 for uncrushed sand and items 3 & 4 for crushed sand.	5.00% : 2.00%

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

Sl No	I.S. Sieve Designation	Percentage passing for			
		Zone I	Zone II	Zone III	Zone iV
1	10 mm	100	100	100	100
2	4.75 mm	90-100	90-100	90-100	95-100
3	2.36 mm	60 -95	75-100	85-100	95-100
4	1.18 mm	30-70	55-90	75-100	90-100
5	600 micron	15-34	35-59	60-79	80-100
6	300 micron	5-20	8-30	12-40	15-50
7	150 micron	0-10	0-10	0-10	0-15

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

4.7.7 The sand shall have a fineness modulus of not less than 2.2 or more than 3.2. The fineness modulus is determined by adding the cumulative percentage retained on the IS sieve (4.75 mm, 2.36 mm, 1.18mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.

4.8 Coarse Aggregate

4.8.1 Coarse aggregate for concrete except as noted above and for other than lightweight concrete shall confirm to IS 383. This shall consist of natural or crushed stone and gravel, and shall be free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkalis, mica, organic matter or other deleterious matter.

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

4.8.3 Crushed rock shall be screened and/or washed for the removal of dirt or dust coating if so demanded by the Engineering- In-Charge.

4.8.4 Coarse aggregates shall be either in single size or graded. In both cases grading shall be within the following limits

Sl No	IS sieve Designation	Percentage passing for single sized aggregate of nominal size				
		40 mm	20 mm	16 mm	12.5 mm	10 mm
1	63 mm	100	-	-	-	-
2	40 mm	85-100	100	-	-	-
3	20 mm	0-20	85-100	100	-	-
4	16 mm	-	-	85-100	100	-
5	12.5 mm	-	-	-	85-100	100
6	10 mm	0-5	0-20	0-30	0-45	85-100
7	4.75 mm	-	0-5	0-5	0-10	0-20
8	2.36 mm	-	-	-	-	0-5

Sl No	IS sieve Designation	Percentage passing for graded aggregate of nominal size			
		40 mm	20 mm	16 mm	12.5 mm
1	63 mm	100	-	-	-
2	40 mm	95-100	100	-	-
3	20 mm	30-70	95-100	100	100
4	16 mm	-	-	90-100	-
5	12.5 mm	-	-	-	90-100
6	10 mm	10-35	25-55	30-70	40-85
7	4.75 mm	0-5	0-10	0-10	0-10
8	2.36 mm	-	-	-	-

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

4.8.6 The maximum size of coarse aggregate shall be the maximum size specified above but in no case greater than ¼ of the minimum thickness of the member provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of form.

4.8.7 Plums above 160 mm and up to any reasonable size can be used in plain mass concrete work of large dimensions up to a maximum limit of 20% by volume of concrete when specially approved by the Engineer-In-Charge.

4.8.8 For heavily reinforced concrete members the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the main reinforcing bars or 5 mm less than the minimum cover to the reinforcement whichever is smaller.

4.8.9 The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per IS 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of its oven dry weight in air as determined by IS 2386.

4.8.10 The percentage of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following:

Sl No	Substances	Percentage by weight of aggregates	
		Uncrushed	Crushed
1	Material finer than 75 micron I.S. sieve.	3.00	3.00
2	Coal and lignite.	1.00	1.00
3	Clay lumps.	1.00	1.00
4	Sift fragments.	3.00	-
5	Total of all above substances.	5.00	5.00

4.9. **Water**

4.9.1 Water used for both mixing and curing shall be free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

4.9.2 Potable water is generally satisfactory for mixing and curing of concrete. In case of doubt the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS 456.

4.9.3 The sample of water taken for testing shall be typical for the water proposed to be used for concrete, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

4.9.4 Average 28 days compressive strength of at least three 150 mm size concrete cubes prepared with water to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS 516.

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

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

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

4.9.8 To neutralize 100 ml sample of water, using Methyl Orange as an indicator, it should not require more than 25 ml of 0.02 normal H2SO4. The details of test shall be as given in 8 of IS 3025 (Part 23).

4.9.9 The percentage of solids, when tested in accordance with the IS 3025 shall not exceed the following

Sl No	Substances	Tested as per	Permissible percentage
1	Organic	IS: 3025 (Part 18)	0.02% (200 mg/litre)
2	Inorganic	IS: 3025 (Part 18)	0.30% (3000 mg/litre)
3	Sulphates (as SO3)	IS: 3025 (Part 24)	0.04% (400 mg/litre)
4	Chlorides (as Cl)	IS: 3025 (Part 32)	0.20% (2000 mg/litre) for concrete not containing embedded steel and 0.05% (500 mg/litre) for reinforced concrete works.
5	Suspended matter	IS: 3025 (Part 17)	0.20% (2000 mg/litre)

4.9.10 P.H. value of water shall generally be not less than 6.

5.0 DESIGN MIX CONCRETE

5.1 All reinforced concrete in the work shall be "Design Mix Concrete" as defined in IS 456 considering as 'severe' environment and cost of design mix shall be included in the item rate and no separate payment shall be made on account of this. All "Design Mix Concrete" work to be carried out under these specifications shall be in grades designated as per table below.

Use of mineral admixtures like fly ash, GGBFS, etc. shall not be permitted in the design mix unless otherwise special permission is given by the Engineer-in- Charge. Cement shall be Ordinary Portland Cement – 43 grade or Portland Pozzolana Cement (Fly ash based meeting the 28 day strength requirement of OPC 43 grade cement) only.

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm Cube at 28 days in N/mm2
Ordinary Concrete	M-10	10
	M-15	15
	M-20	20
Standard Concrete	M-25	25
	M-30	30
	M-35	35
	M-40	40
	M-45	45
	M-50	50
	M-55	55
High Strength Concrete	M-60	60
	M-65	65
	M-70	70
	M-75	75
	M-80	80

Notes

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

2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified characteristic compressive strength of 150 mm size cube at 28 days in N/mm2.

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

5.2 Mix Design

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

5.2.2 Since different cements and aggregates of different maximum size, grading, surface texture, shape and other characteristics may produce concretes of different compressive strength for the same free water cement ratio, the relationship between strength and free water cement ratio should preferably be established for the materials actually to be used. In the absence of such data, the preliminary free water cement ratio (by mass) corresponding to the target strength at 28 days may be selected from the relationship shown in Fig.1 of IS 10262 at page 7.

5.2.3 Alternately, the preliminary free water cement ratio (by mass) corresponding to the target average strength may be selected from the relationship in Fig. 2 of IS 10262 page at 8, using the curve corresponding to the 28 days cement strength to be used for the purpose. Other relevant items to the used with design of mix should strictly confirm to the relevant clauses and appendices of IS 10262. The calculated mix proportions shall be checked by means of trial batches. The contractor should refer to the item No.4 at page 12 and the Appendix 'D' (clause No. 4.1) of IS 10262 for neat illustration. The contractor may refer Appendix 'C' (clause 3.8) at page 16 of IS 10262 for an example illustrating the mix design of M-20. The free water cement ratio selected as above should be checked against the limiting water cement ratio for the requirement of durability and the lower of the two values should be adopted.

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

5.2.5 While fixing the value for water cement ratio for 'Design Mix' assistance may be derived from the standard graph showing the relationship between the 28 days compressive strength of concrete mixes with different water cement ratios and the 7 days compressive strength of cement tested in accordance with IS 269 and IS 8112.

5.2.6 It will be contractor's sole responsibility to establish the concrete mix designs for different grades of concrete specified in the work consistent with the workability required for nature of work an also taking into consideration the assumed standard deviation which will be

expected at site or by establishing the standard deviation based on 30 test results at site for each grade of concrete so as to produce concrete of required strength, durability and surface finish. The materials and proportions used in making the tests to be carried out either at site or under laboratory, conditions shall be similar in all respects to those to be actually employed in the works as the object of these tests is to determine the proportions of cement, aggregates and water necessary to produce the concrete of the required consistency to give such specified strength.

5.2.7 Minimum cement content in the concrete shall be 300kg/m^3

5.3 **Standard Deviation**

5.3.1 Standard deviation of concrete of each grade shall be determined separately. When results of sufficient number of tests (at least 30) are not available, then the value of standard deviation given in the table below may be assumed for design 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 designed properly.

5.3.2 Assumed Standard Deviation:

Sl No	Grade of concrete	Assumed Standard Deviation in N/mm2
1	M-10	3.5
2	M-15	
3	M-20	4.0
4	M-25	
5	M-30	5.0
6	M-35	
7	M-40	
8	M-45	
9	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.

5.3.3 Standard Deviation Based On Test Results

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

The calculation of the standard deviation shall be brought up to date after every change of mix design and at least once in a month.

5.3.4 Determination Of Standard Deviation

Concrete of each grade shall be analyzed separately to determine its standard deviation.

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

Estimated Standard Deviation (S) = $\{X^2 / (n-1)\}^{½}$
Where X = Deviation of the individual test strength from the average strength of a sample and
n = Number of sample test results.
When significant changes are made in the proportion of concrete (for example changes in materials used, mix design, equipments or technical control), the standard deviation value shall be separately calculated for such batches of concrete.

5.4 Proportioning

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

5.4.2 The cement shall be measured by weight for design mix. Every facility should be provided to the Engineer-In-Charge for sampling and inspection of stored cement at site of work.

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

5.4.4 **The water cement ratio (W/C)** is defined as the weight of water in mix (including the surface moisture of the aggregate) divided by the weight of cement in the mix. The actual water cement ratio to be adopted shall be determined in each instance by the General Contractor and approved by the Engineer-In-Charge.

5.4.5 The water cement ratio specified for use by the Engineer-In-Charge shall be maintained. The contractor shall determine the water content of the aggregate as frequently as directed by the Engineer-In-Charge as the work progresses and as specified in IS 2386 (Part-III) and the amount of mixing water added at the mixer shall be adjusted as directed by the Engineer-In-Charge so as to maintain the specified water cement ratio. To allow for the variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

5.5 Consistency and Slump

5.5.1 Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined the consistency of mix shall be

maintained throughout the progress of the corresponding parts of the work and approved tests e.g. slump tests, compacting factor test etc. in accordance with IS 1199, shall be conducted from time to time to ensure the maintenance of such consistency.

5.5.2 The following tabulation gives a range of workability which shall generally be used for various types of construction unless otherwise instructed by the Engineer-In-Charge

5.5.2.1 Workability of Concrete:

Sl No	Placing conditions	Degree of workability	Value of workability
1	Blinding concrete' shallow sections, pavements using pavers.	Very low	0.75 - 0.80 compacting factor
2	Mass concrete; lightly reinforced sections in slabs, beams, walls, columns, floors, hand placed pavements, canal lining; strip footings	Low	Slump of 25 – 75 mm
3	Heavily reinforced sections in slabs, beams, walls, columns, Slip form work; Pumped concrete	Medium	Slump of 50– 100 mm. Slump of 75 – 100 mm
4	Trench fill; In-situ piling. Tremie concrete	High / Very high	Slump of 100 – 150 mm

5.6 Batching and Mixing of Concrete

5.6.1 The material and proportions of concrete ingredients as established by the preliminary tests for the mix design shall be rigidly followed for all concrete works on the project and shall not be changed except when specifically permitted by Engineer-In-Charge.

5.6.2 Concrete shall be produced only by weigh batching the ingredients. The mixer and weigh batcher shall be maintained in clean serviceable condition. The accuracy of weigh batcher shall be periodically checked. They shall be set up in level on a firm base and the hopper shall be loaded evenly. The needle shall be adjusted to zero when the hopper is empty. Fine and coarse aggregates shall be weighed separately unless otherwise stated.

5.6.3 Volume batching will not be permitted. However Engineer-In-Charge may permit volume batching by subsequent conversion of weights of ingredients into their equivalent volumes in respect of their bulk densities only in the case of small and less important pours involving concrete of not more than 0.25 cubic metre on the day when other pours involving weigh batching are not likely to be taken up.

5.6.4 The concrete shall be of strength as stipulated in the respective items. All concrete shall be mixed in mechanically operated batch mixers complying with IS 1791 and of approved make with suitable provision for correctly controlling the water delivered to the drum.

5.6.5 The quantity of water actually entering the drum shall be checked with the reading of the gauge or valve setting when starting a job. The test should be made while the mixer is running.

5.6.6 The volume of the mixed material shall not exceed the manufacturer's rated mixer capacity. The batch shall be charged into the mixer so that some water will enter the drum

in advance of cement and aggregate. All water shall be in the drum by the end of the first 15 seconds of the specified mixing time.

Each batch shall be mixed until the concrete is uniform in colour for a minimum period of two minutes after all ingredients are in the drum.

5.6.7 The entire contents of the drum shall be discharged in one operation before the raw materials for the succeeding batches are fed into the drum.

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

6.0 SAMPLING AND TESTING OF CONCRETE

6.1 If the Engineer-In-Charge desires facilities required for sampling materials and concrete in the field shall be provided by the General Contractor at no extra cost. The following equipments (in serviceable condition) with operator shall be made available at Engineer's request

No.	Equipments	Requirement
1.	Cast Iron cube moulds of 150 mm size	As required
2.	Slump cone complete set with tamping rod	1 set
3.	Laboratory balance to weight up to 5 kg. With sensitivity of 10 gm.	1 No.
4.	Laboratory balance of 2 kg. Capacity and sensitivity of 1 gm.	1 No.
5.	IS sieves for coarse and fine aggregates	1 set.
6.	A set of measure from 0.1 litre to 5 litres.	1 set.
7.	Electric oven with thermostat up to 120 degree centigrade.	1 No.
8.	Flakiness gauge	1 No.
9.	Elongation index gauge	1 No.
10.	Sedimentation pipette	1 No.
11.	Pyconometer	1 No.
12.	Calibrated glass jar of 1 litre capacity	2 Nos.
13.	Glass flasks and metal containers	As required.
14.	Chemical reagents like Sodium Hydroxide, Tannic Acid, Litmus papers etc.	As required.

6.2 The concrete test cubes will be tested at approved laboratory. The contractor shall make all arrangements to cure, store of concrete cubes and transport the same to the laboratory at his own cost as directed by the Engineer-In-Charge.

6.3 Sampling and Strength Test of Concrete

6.3.1 The samples from fresh concrete shall be taken as per IS 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS 516.

6.3.2 In order to get a relatively quicker idea of the quality of concrete optional test on beams for modulus of rupture at 72 (+/-)2 hrs. or at 7 days or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose the value given in table below may be taken for general guidance in case of concrete made with ordinary Portland cement. In all cases, the 28 days compressive strength specified

shall alone be the criterion for acceptance or rejection of the concrete. If however, from test carried out in particular job over a reasonably long period, it has been established to the satisfaction of the Engineer-In-Charge that a suitable ratio between 28 days compressive strength and the modulus of rupture at 72 (+/-)2 hrs. or 7 days or compressive strength at 7 days may be accepted. The Engineer-In-Charge may suitable relax the frequency of 28 days compressive strength, provided the expected strength values at the specified early age are consistently met.

Test cubes shall be made as, where and when the Architect / Employer may require.

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 Architect / Employer generally from concrete taken at the point of discharge from the mixer and hut or other covered protection as agreed with or directed by the Architect / Employer 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.

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.

Testing shall be done at an approved laboratory or at the site itself and the results shall be submitted promptly by the contractor to the Architect / Employer.

6.3.3 Optional Test Requirement of Concrete:

Sl No	Grade of Concrete	Minimum Compressive Strength on 150 mm Cube (7 days)	Min. Modulus of Rupture By Beam Test at	
			72 (+/-) 2 hrs.	7 days
1.	M-10	7.00 N/m2	1.20 N/mm2	1.70 N/mm2
2.	M-15	10.00 N/m2	1.50 N/mm2	2.10 N/mm2
3.	M-20	13.50 N/m2	1.70 N/mm2	2.40 N/mm2
4.	M-25	17.00 N/m2	1.90 N/mm2	2.70 N/mm2
5.	M-30	20.00 N/m2	2.10 N/mm2	3.00 N/mm2
6.	M-35	23.50 N/m2	2.30 N/mm2	3.20 N/mm2
7.	M-40	27.00 N/m2	2.50 N/mm2	3.40 N/mm2

6.3.4 Frequency of Sampling

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

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

No.	(c) Quantity of concrete	(d) Number of Samples
1.	1.00 to 5.00 m3	One
2.	6.00 to 15.00 m3	Two
3.	16.00 to 30.00 m3	Three
4.	31.00 to 50.00 m3	Four

5.	51.00 m3 and above	Four Plus one additional sample for each additional 50 m3 part thereof.

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

6.3.4.3 Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork or to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS 9013. The specimen shall be tested as described in IS 516.

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

6.3.6 Slump test shall be carried out as often as demanded by the Engineer-In-Charge and invariably from the same batch of concrete from which the test cubes are made. Slump test shall be done immediately after sampling.

6.3.7 Standard Deviation shall be vide clause '5.3' of this specification.

7.0 ACCEPTANCE CRITERIA

7.1 The concrete shall be deemed to comply with the strength requirement if:

7.1.1 The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of table below.

7.1.2 Any individual test result complies with the appropriate limits in col. 3 of table below.

Specified Grade	Mean of the Group of 4 Non-overlapping consecutive test results in N/mm2	Individual Test Results in N/mm2
(1)	(2)	(3)
M15	> fck + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm2) or, fck + 3 N/ mm2, whichever is greater	> fck – 3 N/mm2
M 20 or above	> fck + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm2) or, _ fck + 4 N/ mm2, whichever is greater	> fck – 4 N/mm2

7.2 If the concrete is deemed not to comply pursuant to 7.0 above, the structural adequacy of the part affected shall be investigated and any consequential action as needed shall be taken.

7.3 Concrete of each grade shall be assessed separately. Concrete shall be assessed daily for compliance.

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

CONCRETE MIXING

All concrete, whether ordinary or controlled, shall be mixed in an approved mixer 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.

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

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 deg. C and during cold weather it shall not be below 4.5 deg. C. Concrete damaged by frost shall be removed and work redone.

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.

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 down. The surface of the mixer drum shall be maintained in a clean condition at all times.

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

8.0 ADMIXTURES

8.1 Admixture may be used in concrete only with the approval of the Engineer-In-Charge based upon evidence that with the passage of time neither the compressive strength nor its durability reduced. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used such as in mass concrete works it shall be dissolved in water and added to the mixing water in an amount not exceed 1.5 percent of the weight of the cement in each batch of concrete. When admixtures are used the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instructions and in the manner and with the control specified by Engineer-in-Charge. The cost of admixtures shall be included in the item rate and no extra amount shall be paid on this account.

8.2 Where specified and approved by Engineer-In-Charge neutralized vinsol resin or/ and other approved air entraining agent may be used to procedure the specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard 6-260 air entraining admixture of concrete. The recommended total air content in the concrete is 4% + 1%. The method of measuring air content shall be as per IS 1199.

8.3 Retarding Admixtures

Where specified and approved by the Engineer-In-Charge retarding agents shall be added to the concrete mix in quantities specified by Engineer- In- Charge.

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

8.5 Water Proofing Agent
Where specified and approved by Engineer-In-Charge chloride and sulphide free waterproofing agent shall be added in the quantities specified by Engineer-In- Charge.

8.6 Other Admixtures
Engineer-In-Charge may at his discretion instruct General Contractor to use any other admixture in the concrete.

9.0 TESTS

If the Engineer-In-Charge desires he may order tests to be carried out on cement, sand, course aggregate, water etc. in accordance with the relevant Indian Standards.

9.1 Tests on cement shall include
(i) Fineness test,
(ii) Test for normal consistency,
(iii) Test for setting time,
(iv) Test for soundness,
(v) Test for compressive strength,
(vi) Test of heat of hydration (by experiment and by calculation) in accordance with IS 269

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

9.3 Tests on coarse aggregate shall include:
(i) Sieve analysis,
(ii) Specific gravity and unit weight of dry, loose and rodded aggregate,
(iii) Soundness and alkali aggregate reactivity,
(iv) Petrographic examination,
(v) Test for deleterious materials and organic impurities,
(vi) Test for aggregate crushing value.

9.4 Tests on aggregate shall be carried out for all the materials in accordance with the specifications and relevant code of practice the contractor at an approved test laboratory.

10.0 INSPECTION AND TESTING OF STRUCTURES

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

10.2 In case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength tests the contractor may be asked to carry out compressive strength test of concrete on the basis of core test, ultrasonic test and/ or load test.

10.3 In case of results of cube strength are observed to be lower than the required designed strength at 28 days as per specifications, ultrasonic test shall be carried out by the digital ultrasonic concrete tester by an approved agency at the cost of the contractor.

10.4 In case the ultrasonic test do not satisfy the requirement as above the Engineer-in-Charge will be at liberty to reject the concrete and the contractor has to dismantle and redo the same to the satisfaction of the Engineer-in-Charge at the contractor's own cost.

10.5 The unit rate for concrete shall be all inclusive of making preliminary mix design and test cubes, works cubes, testing them as per specifications, slump test, optional tests etc. However, the Engineer-in-Charge will witness the same and the General Contractor will have to make arrangement for transportation of the cubes to the approved laboratory.

10.6 In case cube tests give unsatisfactory results the General Contractor should also conduct conclusive tests such as ultrasonic pulse test, core test etc. to prove the suitability of concrete. The cost of the conclusive tests shall have to be borne by the contractor.

10.7 If the results of ay test prove unsatisfactory or the structure shows signs of weakness, undue deflection or faulty construction the contractor shall remove and rebuild the member(s) involved or carry out such other remedial measures as may be required by the Engineer-In-Charge. The contractor shall bear the cost of so doing unless the failure of the member(s) to fulfill the test conditions is approved to be solely due to faulty design. The cost of all tests shall be borne by the contractor.

11.0 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION AND APPROVAL

11.1 Before the concrete is actually placed in position the insides of formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection especially at bottom of columns and wall forms to permit removal of saw dust, wood shavings, binding wire, rubbish, dirt etc. Such openings/ holes shall be later suitably plugged.

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

11.3 Slots, openings, holes, pockets etc. shall be provided in concrete work in the positions indicated in the drawings or as directed by the Engineer-In-Charge.

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

11.5 Prior to concrete placement all works shall be inspected and approved by the Engineer-In-Charge and if found unsatisfactory concrete shall not be poured until all defects have been corrected at contractor's cost.

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

11.7 Rain or Wash Water

11.7.1 No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rains shall be entirely removed if there is any sign of cement and sand having been washed away from the concrete mixture.

11.7.2 Before leaving unattended the work shall be covered with tarpaulins immediately after the concrete has been placed and compacted to safe guard against damages, which may be caused by rain.

11.7.3 Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over / around freshly placed concrete suitable drains and sumps shall be provided.

11.8. Bonding Mortar

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

11.9 Transportation

11.9.1 All buckets, containers or conveyers used for transport the concrete shall be mortar tight. All means of conveyance shall be adopted to deliver the concrete of the required consistency and plasticity without segregation or loss of slump whatever method for transportation is employed.

11.9.2 Chute shall not be used for transport of concrete without the written permission of the Engineer-In-Charge and concrete shall not be re-handled before placing. Maximum height of pour should be limited to 1.0m.

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.

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.

Should any segregation have accrued in any batches arriving at the place of deposition, such batches be deposited and thoroughly turned over by hand before placing in the works.

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. Water used for this purpose shall be discharged well clear of formwork or the concrete already in place.

11.10 Contaminated Concrete

11.10.1 Concrete must be placed in its final position before it become too stiff to work.

11.10.2 On no account water shall be added after the initial mixing.

11.10.3 Concrete which has become stiff or has been contaminated with foreign materials and which has not been placed within half an hour of mixing water with cement shall be rejected and disposed off as directed by the Engineer-In-Charge.

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

12.0 PROCEDURE FOR PLACING OF CONCRETE

12.1 Before any concrete is placed the entire placing programme consisting of equipment, layout, proposed procedures and methods shall be submitted to Engineer-In-Charge for approval if so demanded by the Engineer-In-Charge and no concrete shall be placed until Engineer-In-Charge's approval has been obtained. Equipment for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials considering the size of the job and placement location.

12.2 Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within 30 minutes of leaving the mixer and once compacted it shall not be disturbed.

12.3 In all cases the concrete shall be deposited as nearly as practicable directly in its final position and shall not be re-handled or caused to flow in a manner which may cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible and in narrow forms General Contractor shall provide suitable drop and Elephant Trunks to confine the movement of concrete. Special care shall be taken where concrete is dropped from a height especially if reinforcement is in the way particularly in columns and thin walls.

12.4 Except when otherwise approved by Engineer-In-Charge concrete shall be placed in the shuttering by pumps or cranes or other approved implements and shall not be dropped from a height more than one metre or handle in a manner which will cause segregation.

12.5 The following specification shall apply when placing of concrete by use of mechanical equipment is specifically called for while inviting bids or is warranted considering the nature of work involved:

12.6 Concrete placed in restricted forms by borrows, buggies, cars, sort chutes or hand shoveling shall be subjected to the requirement for vertical delivery of limited height to avoid segregation and shall deposited as nearly as practicable in it's final position.

12.7 Concreting once started shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 150 mm to 900 mm as directed by the Engineer-In-Charge. These shall be placed as rapidly as practicable to prevent the formation of cold joints or planes of weakness between each succeeding layers within the pour. The thickness of each layer shall be such that it can be

deposited before the previous layer has stiffened. The bucket loads or other units of deposit shall be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum of shoveling. Any tendency to segregation shall be corrected by shoveling stones into mortar rather than mortar onto stones. Such a condition shall be corrected by redesign of mix or other means as directed by Engineer-In-Charge.

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

13.0 COMPACTION

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

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

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

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

13.5 Formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur they shall be dug out, reform and refilled to a sufficient depth and shape for thorough bonding as directed by Engineer-In-Charge.

13.6 Bleeding or free water on top of concrete being deposited into the forms shall be caused to stop the concrete pour and the condition causing this defect corrected before any further concreting is resumed.

The time elapsing between the discharge of the concrete from the mixer and the completion of compaction shall not exceed 30 minutes.

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

14.0 CONSTRUCTION JOINTS AND KEYS

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

14.2 If stopping of concreting becomes unavoidable anywhere a properly formed construction joints shall be made where the work is stopped.

14.3 Joints shall be either vertical or horizontal unless otherwise shown on drawing. In case of an inclined or curved member the joints shall be at right angles to the axis of the member. Vertical joints in walls shall be kept to a minimum.

14.4 Vertical joints shall be formed against a stop board and horizontal joints shall be level and wherever possible arranged so that the joint lines coincide with the architectural features of the finished work.

14.5 Batten shall be nailed to the form work to ensure a horizontal line and if directed shall also be used to form a grooved joint. For tank walls and similar work joints shall be formed as per IS 3370.

14.6 Concrete that is in the process of setting shall not be disturbed or shaken by traffic either on the concrete itself or upon the shuttering.

14.7 Horizontal and vertical joints and shear keys shall be located and shall confirm in details to the requirements of the plans unless otherwise directed by the Engineer-In-Charge.

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

14.9 Beam and Slab Joints - Concrete in beam shall be placed throughout without a joint but if the joint is unavoidable the same shall be vertical and at the centre or within the middle third of the span unless otherwise shown on drawings. The joint shall be vertical throughout the full thickness of the concrete member. A joint in a slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidably at right angles to the principal reinforcement the joint shall be vertical and at the middle of the span.

14.10 Vertical construction joints in water tight construction will not be permitted unless indicated on the drawings. Where a horizontal construction joint is required to resist water pressure special care shall be taken in all phases of its construction to ensure maximum water tightness.

15.0 DOWELS

15.1 Dowels for concrete works not likely to be taken up in the near future shall be wrapped in tar paper and burlap.

16.0 MASS FOUNDATIONS

16.1 Mass foundation shall be poured in lifts not exceeding 1.5 m in height unless otherwise indicated on the drawings or approved by Engineer-In-Charge.

17.0 TREATMENT OF CONSTRUCTION JOINTS ON RESUMING CONCRETING

17.1 A dryer mix shall be used for the top lift of horizontal pours to avoid laitance. All laitance and loose stones shall be thoroughly and carefully removed by wire brushing/ hacking and surface wash.

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

18.0 CURING, PROTECTING, REPAIRING AND FINISHING

18.1 All concrete shall be cured by keeping it continuously damp for a period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays or by ponding of water, continuously saturated coverings of sacking, canvas, hessian or other absorbent materials or approved effective curing compounds (for vertical members and slab-on-Grade) applied with spraying equipment capable of producing a smooth even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter.

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

18.3 Curing With Water

18.3.1 Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete following a lapse of 10 to 12 hours after laying of concrete in normal weather and in hot weather not more than lapse of 4 hours. Date of casting shall have to be marked, as directed by Engineer-in-charge, on the exposed surfaces of the concrete so as to enable easy monitoring of the curing period.

18.3.2 The curing of horizontal surface exposed to the drying winds shall be however begin immediately after the concrete has hardened. Water shall be applied to unformed concrete surfaces within one hour after concrete has set. Water shall be applied to formed surface immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

18.3.3 The quality of curing water shall be the same as that used for mixing concrete.

18.3.4 Curing shall be assured by use of an ample water supply under pressure in pipes with all necessary appliances of hose, sprinklers and spraying devices. Continuous fine moist spraying or sprinkling shall be used unless otherwise specified or approved by the Engineer-In-Charge.

18.3.5 For curing of concrete in pavements, side-walks, floors flat roofs or other level surfaces the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer-In-Charge. Special attention shall be given to edges and corners of the slab to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

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

19.0 FINISHING OF CONCRETE

19.1 This specification is intended to cover the treatment of concrete surface for all structures. Areas requiring special finish not covered by this specification shall be clearly indicated on the drawings and special specification shall be furnished.

19.2 When specified on the drawings an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded as specified on the drawings and as per IS 2571.

19.3 The surface shall be compacted and then floated with double power floating machine. The surface shall be tested with a straight edge to meet the requirement and any high and low spots eliminated.

19.4 Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the concrete finish to absorb moisture or to stiffen the mix.

19.5 A rubbed finish shall be provided only on exposed concrete surfaces as specified on the drawings.

19.6 Upon removal of forms all fins and other projections on the surfaces shall be carefully removed, offsets leveled, voids and /or damaged sections immediately saturated with water and repaired by filling with concrete or mortar of the same composition as was used in the concrete.

19.7 The finished surfaces shall present a uniform and smooth appearance.

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

20.0 CONCRETE FINISHES

20.1 Unless otherwise specified concrete finishes shall confirm to the following specifications

20.1.1 Finish F1, F2 and F3 shall describe formed surfaces.

20.1.2 Finish U1, U2 and U3 shall describe unformed surfaces.

20.1.3 Offsets or fins caused by disposed or misplaced from sheathing, lining or form sections or by defective form lumber shall be referred to as abrupt irregularities.

20.1.4 All other irregularities shall be referred as gradual irregularities. Gradual irregularities shall be measured as deviation from a plane surface with a template 1500 mm long for formed surface and 3000 mm long for unformed surfaces.

20.2 Formed Surfaces

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

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

20.2.3 Finish F3 shall apply to all formed surfaces exposed to view or where shown in the drawings or specified by the Engineer-In-Charge. Finish F3 shall include all measures specified for Finish F2 and in addition filling air holes with mortar and treatment of the entire surface with sack rubbed finish. It shall also include clean up

of loose and adhering debris. Where a sack rubbed finish is specified the surfaces shall be prepared within two days after removal of the forms.

20.2.3.1 The surface shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part of cement to one and half parts of fine sand (minus No.16 mesh) by volume. Only sufficient mixing water to give the mortar a workable consistency shall be used.

20.2.3.2 The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids.

20.2.3.3 The mortar rubbed in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean so that the surface presents a uniform appearance without air holes, irregularities etc.

20.2.4 Curing of the surface shall be continued for a period of ten days.

20.3 Unformed Surfaces

20.3.1 Finish U1 shall apply to all unformed surfaces for which the finish U2, U3 or any other special finish is not specified and shall include screeding the surface of the concrete to the required slope and grade.

20.3.1.1 Unless the drawing specifies a horizontal surface or shows required the slope the top of the narrow surfaces such as stairs, treads, walls, curbs and parapets shall be sloped approximately 10 mm per 300 mm width.

20.3.1.2 The surfaces to be covered by back fill or concrete sub floors to be covered with concrete topping, terrazzo and similar surfaces shall be smooth screeded and leveled to produce even surface, irregularities not exceeding 6 mm.

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

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

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

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

21.0 MODE OF MEASUREMENTS

21.1 The concrete as actually done shall be measured for payment. Any work done excess over the specified dimensions for the section shown in the drawing or as required by the Engineer-In-Charge shall not be measured for payment.

21.2 Dimensions of length, breadth and thickness shall be measured correct to nearest centimeters except for the thickness of slab, which shall be measured to nearest 5 mm.

21.3 Areas shall be worked out to nearest 0.01 square metre and the cubic contents of consolidated concrete shall be worked out to nearest 0.001 cubic metres.

21.4 For the purpose of measurements and payments for all concrete works IS 1200 (Part-II) shall be referred.

22.0 MOCK UP & REPAIR METHODS

22.1 General Contractor shall carry out a mock-up Slab-on-Grade not less than 36.0 sqm area with expansion and contraction joints with floor hardener for Engineer-in-Charge & owner's approval.

22.2 General Contractor should maintain the same quality of the work & finishes throughout the construction for all RCC members.

22.3 General Contractor shall submit a proposal for concrete repair method and technical specification of the material intended to be used to Engineer-in-Charge for his approval.

22.4 Approved method should be followed for any concrete repair works including honeycomb and floor cracks if any. Floor cracks more than 0.3mm width and more than one metre long need to be repaired using approved method.

CONTRACTION JOINTS

Contraction joints required will be as shown on the drawings.

Contraction joints shall not be hacked, wetted or mortared before concrete is placed against them.

EXPANSION JOINTS

Expansion joints shall be provided where shown on the drawings. They shall be constructed with an initial gap between the adjoining parts of the works of the width specified in the drawings.

The contractor shall ensure that no debris is allowed to enter expansion joints.

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

OPEN JOINT FILLERS

Where shown on the drawings, open joints in the structure shall be filled with h one of the following of expansion joint fillers:

a. In internal areas a material conforming to IS:1838 containing bitumen emulsion fibres or cork granules bound together with natural resin.

b. In external areas a material comprising closed cell rubber or containing cork granules bound together with natural resin.

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

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 and placing to permit the formation straight joints.

JOINT SEALING COMPOUNDS

Joint sealing compounds 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.

Polysulphide joints where specified on the drawings shall be sealed with polysulphide liquid polymer, stored, mixed, handled applied and cured strictly in accordance with the manufacturer's written instructions. Such joints shall be formed to the correct dimensions, thoroughly cleaned and treated with recommended primer strictly in accordance with the manufacturer's written instructions prior to sealing. The contractor shall use only competent personnel experienced in the application of polysulphide for such work.

Where specified in the drawings, rubber/bituminous based sealants shall be of an approved manufacture. The treatment of the joint and the use of sealing compound shall be strictly in accordance with the manufacturer's written instructions.

P.V.C WATER BARS/WATERSTOP

Where water bars are shown on the drawings, the joints shall incorporate an approved PVC external type water bar complete with all necessary moulded or prefabricated intersection pieces assembled in accordance with the drawings with bends and butt joints in running lengths made by heat welding in an electrically heated jig.

Jointing and fixing of water bars shall be carried out strictly in accordance with manufacturer's written instructions.

The water bars shall be installed so that they are securely held in their correct position during the placing and compacting of the concrete.

Where reinforcement is present adjacent to water bars, adequate clearance shall be left between the reinforcement and water bars, to facilitate compaction of the concrete. Double headed nails may be used in the edge of the water bar outside the line of the external grooves for fixing purposes, but no other holes shall be permitted through the water bars.

INSERTS

The contractors shall fix all necessary inserts such as steel plates, pipe sleeves, bolts etc, and make holes, pockets, dowels etc., in the formwork to enable efficient fixing of supports, brackets, ceilings, precast members etc. as indicated on the drawings, called for in the schedule of quantities or as required by the Architect / Employer.

In-situ concrete inserts shall be as per IS:1946 and of a type approved by the Architect / Employer.
Nothing extra over and above the precision as per the priced schedule of quantities shall be paid to the contractor on this account.

With the prior agreement of the Architect / Employer expansion type fasteners may be used by the contractor in hardner concrete.

CRACKS

If any cracks develop in the reinforced concrete construction which in the opinion of the Architect / Employer be detrimental to the strength of the construction, the contractor at his

own expense shall test the structural element in questions. If under these test loads the cracks shall develop further the contractor at his own expense shall dismantle the construction. Carry away the debris replace the construction and carryout all construction work there to at no extra cost.

If the cracks are not detrimental to the stability of the construction in the opinion of the Architect / Employer the contractor at his own expense shall grout the cracks with commercially applied mortar or epoxy grout. At his own expense and care shall also make good all other building work such as plaster moulding, surface finish of floors, roofs, ceiling etc, which if the opinion of the Architect / Employer have suffered damage either in appearance of stability owing to such cracks. The repair work shall be carried out as the satisfaction of the Architect / Employer. The decision of the Architect / Employer as to the extent of the liability of the contractor in the matter shall be final and binding on the contractor.

LOAD TESTING ON COMPLETED STRUCTURES

During the period of construction or within the defect liability period the Architect / Employer may at his discharge order the load testing of any completed structure and thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:

a. Results of comprehensive strength on concrete test cubes.

b. Premature removal of formwork.

c. Inadequate curing of concrete.

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

e. Carrying out concreting of any portion without prior approval of the Architect / Engineer-in-charge.

f. Honey combed or damaged concrete which in the opinion of the Architect / Engineer-in-charge, 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.

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

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

The structure should be subjected to a super imposed load equal to 1.25 times the specified superimposed load assumed in the design. This load shall be maintained for a period of 24 hours of the removal of 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.

In such cases the part of the work concerned 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 Architect / Employer. However, such remedial measures shall be carried out to the complete satisfaction of the Architect / Employer.

All costs involved in carrying out the tests and other incidental expense thereto 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 take the remedial measures instructed, at his own cost.

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 Architect / Employer. Such tests shall be carried out by an agency approved by the Architect / Employer and shall be done under expert guidance using only recommended testing equipment. The acceptance criteria for these tests shall be mutually agreed between the Architect / Employer and the Contractor.

All concreting work shall be done under strict supervision of the qualified and experienced representatives of the Contractor as well as those of the Architect / Employer. The contractor's Architect / Employer and supervisor who are in-charge of concreting work shall be skilled in this class of work and shall personally superintend all the concreting operations.

Special attention shall be paid to the following:

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

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

c. Proper curing for the requisite period.

Reinforcement position are not to be disturbed during concreting and consolidation by vibration.

E PLAIN CEMENT CONCERTE FOR GENERAL WORK

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

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

3.0 The proportion of cement, sand, aggregate for concrete of proportion 1:4:8, 1:3:6, 1:2:4 by volumes shall generally consist of quantities as given below:

Proportion of ingredients	Quantity of materials used per bag of cement			
	Cement	Sand	Coarse aggregate	Water
1:4:8	1	130 ltrs	272 ltrs	39 ltrs

1:3:6	1	102 ltrs	204 ltrs	34 ltrs
1:2:4	1	68 ltrs	136 ltrs	30 ltrs

4.0 The quantity of water used shall be such as to produce concrete of consistency required by the particular class or work and shall be decided by the use of slump cone. Sufficient care should be taken to see that no excess quantity of water is used. The final proportion of the aggregates and the quantity of water shall be decided by the Engineer-in-Charge on the basis of test in each case. The slum shall be specified for each class of work and shall in general be as follows:-

Type of Concrete Mix	slump (Millimetres)
Mass Concrete	50
Roads and pavements, hand finished	100
Roads and pavements, machines finished	25
Floor paving	50

5.0 All plain concrete shall be preferably mixed in a drum type power driven machine with a loading hopper, which will permit the accurate measure of various ingredients. If hand mixing is authorized, it should be done on a watertight platform.

The mixing of each batch in the concrete mixer shall continue for not less than 2 minutes after the materials and water are in the mixer. The volume of mixed materials per batch shall not exceed the manufacturer's rated capacity of the mixer. The mixer shall rotate at a peripheral speed of about 60 metres per minute.

6.0 Concrete shall be poured and consolidated in its final position within half an hour of mixing. The re-tempering of concrete, which has partially hardened, that is remixing with or without additional cement, aggregate or water shall not be permitted.

7.0 Concrete in c.c. 1:2:4 will be required to be vibrated with mechanical vibrators or other means as directed by the Engineer-in-Charge.

8.0 The concrete shall be cured for minimum 10 days. Measurements for the work done shall be exact length, breadth and depth shown or figured on the drawings or as instructed by the Engineer-in-Charge and after the concrete is consolidated. No extra shall be paid for excess quantity resulting from faulty workmanship.

F READY MIXED CONCRETE (R.M.C.)

1.0 SCOPE

Supply of ready-mixed concrete shall be as specified in IS 4926-1976.
Strength of RCC design mix shall be specified in the item.

2.0 TERMINOLOGY

2.1 For the purpose of this standard the definitions in 2.2 to 2.5 shall apply.

2.2 Ready-mixed Concrete
Concrete delivered at site in plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden.

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

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

2.5 Truck–Mixer
A mixer generally mounted on a self-propelled chassis capable of mixing the ingredients of concrete and of agitating the mixed concrete during transportation.

3.0 TYPES OF MIXING

3.1 For the purpose of this standard, the ready-mixed concrete shall be of the following type, according to the method of production and delivery as specified in 3.2

3.2 Centrally Mixed Concrete – Concrete produced by completely mixing cement, aggregates, admixtures, if any and water at a central mixing plant and delivered in containers fitted with agitating devices.

4.0 MATERIALS

4.1 Materials such as cement, coarse & fine aggregates, water & admixture, etc. shall confirm to the specifications mentioned in the RCC works. Use of mineral admixtures like fly ash, GGBFS, etc. shall not be permitted unless otherwise specifically permitted by Engineer-in-charge. Cement shall be Ordinary Portland Cement – 43 grade/ Portland Pozzolana cement (Fly ash based meeting the 28 day strength requirement of OPC 43 grade cement) only.

5.0 BASIS OF SUPPLY

5.1 Ready-mixed concrete shall be manufactured and supplied on the specified strength based on 28 days compressive strength of 15 cm cubes tested in accordance with IS: 456-2000.

5.2 The responsibility for the design of mix shall be that of the manufacturer and the concrete shall confirm to the requirements as specified in 7.

6.0 GENERAL REQUIREMENTS

6.1 Ready-mixed concrete shall generally comply with the requirements of IS: 456 considering as 'severe' environment.

6.2 Minimum quantity of cement and the details regarding proportions of aggregates control shall be in accordance with IS: 456.

6.3 Concrete shall be delivered to the site of work and discharge shall be complete within ½ hour (when the prevailing atmospheric temperature is above 20° C) and within 2 hours (when the prevailing atmospheric temperature is at or below 20° C) of adding the mixing water to the mix of cement and aggregate or of adding the cement to the aggregate whichever is earlier.

6.4 Sampling and Testing

6.4.1 Adequate facilities shall be provided by the manufacturer for purchaser to inspect the materials used, the process of manufacture and methods of delivery of concrete. He shall also provide adequate facilities for the purchaser to take samples of the materials used.

6.4.2 Sampling and testing of concrete shall be done in accordance with the relevant requirements of IS: 456-2000, IS: 1199-1959 and IS: 516-1959.

6.4.3 Testes for consistency or workability shall be carried out in accordance with the requirements of IS: 1199-1959 or by such other method as may be agreed between the purchaser and the manufacturer.

6.4.4 The compressive strength and flexural strength tests shall be carried out in accordance with requirements of IS: 516-1959 and the acceptance criteria for concrete supplied on the basis of specified strength shall conform to the requirements of IS: 456.

6.4.5 All cost of the tests carried out in accordance with requirements of this specification shall be borne by the General Contractor.

6.4.6 The manufacturer shall keep batch records of the quantities by mass of all solid materials, of total amount of water used in mixing and of the results of all tests. If required by the purchaser, the manufacturer shall furnish certificate, at agreed intervals, giving this information.

6.4.7 Concrete supplier should send a printed delivery order with the concrete truck for each & every trip showing the grade of concrete, design slump, mixing time, etc. and should not use any pre-printed delivery orders.

7.0 CONCRETE MANUFACTURED AND SUPPLIED ON THE BASIS OF SPECIFIED STRENGTH

7.1 The manufacturer shall supply the following information for guidance of the supplier for approval:

a) Type of cement to be used.
b) Maximum size and type of aggregates.
c) Type of admixtures to be used.
d) Minimum accepted compressive strength or flexural strength or both, determined from samples of plastic concrete taken at the place and time of delivery, in accordance with requirements of IS: 456-2000.
e) Slump or compacting factor or both, or other requirement for consistency or workability at the place and time of delivery of the concrete.
f) Ages at which the test cubes or beams are to be tested and the frequency and number of tests to be made shall be as required by the purchaser.

7.2 Tolerances

Concrete shall be deemed to comply with the requirements of this specification, if the results of the tests where applicable, lie within the tolerances specified in 7.2.1.

7.2.1 Consistency or Workability – The slump (average of two tests) shall not differ from the specified value by + 10 mm for a specified slump of 75 mm or less and + 25 mm when the specified slump is greater than 75 mm. The compacting factor average of two tests shall

be within + 0.03 of the value specified. The test for consistency or workability shall be completed within 15 minutes of the time of receipt of the ready-mixed concrete at site.

8.0 PLACING OF READY-MIXED CONCRETE

The ready-mixed concrete shall be placed in the required location/position, level, heights, etc. by using pumping arrangement method/mechanically as directed by the Engineer–in-Charge.

G FORM WORK

1.0 SCOPE

1.1 Formwork shall consists of shores, bracings, side of beams and columns, bottom of slabs, etc. including ties, anchors, hangars, inserts, etc. complete which shall be properly designed and planned for the works.

1.2 Formwork shall be so constructed that up and down vertical adjustments can be made smoothly. Wedges may be used at top or bottom of shores, but not at both the ends to facilitate vertical adjustment for dismantling of the formwork.

2.0 APPLICABLE CODES AND SPECIFICATIONS

2.1 The relevant IS specification, standards and codes given below are made a part of this specification. All standards, specifications, code of practices refer to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

No.	IS No.	IS Particulars
1.	IS: 303	Plywood for general purpose
2.	IS: 1200 (Part V)	Method of Measurement of building and civil engineering work (Form work)
3.	IS: 2750	Specification for steel scaffolding
4.	IS: 3696	Safety code for scaffolds and ladders
5.	IS: 4014 (Part I)	Code of Practice for steel tubular scaffolding
6.	IS: 4014 (Part II)	Code of Practice for steel tubular scaffolding
7.	IS: 4990	Specification for plywood for concrete shuttering work

3.0 DESIGN OF FORMWORK

3.1 Design and engineering of the formwork as well as its construction shall be the responsibility of the General Contractor. If so instructed, the drawings and calculations for the design of the formwork shall be submitted well in advance to the Engineer-in-charge for approval before proceeding with the work at no extra cost. Engineer-in-charge's approval shall not relieve the General Contractor of the full responsibility for the design and construction of the formwork.

3.2 The design shall take into account all the loads vertical as well as lateral that the forms will be carrying including live load and vibration loads.

3.3 Depending upon the height of the staging suitable vertical and horizontal cross bracings shall be provided.

3.4 General Contractor shall note that no concrete work of floor, beam, slab including roof slab will be permitted unless the staging work is inspected and the approval in writing for its soundness is given to the Engineer-in-charge prior to commencement of concrete work.

4.0 TOLERANCES

4.1 Tolerance is a specified permissible variation from lines, grade or dimensions given in the drawings. No tolerance specified for horizontal and vertical building lines or footings shall be considered to permit encroachment beyond the legal boundaries. Unless otherwise specified, following tolerances shall be permitted -

4.1.1 Tolerance for RCC Building

4.1.1.1 Variation from the plumb

No.	Building Members	Tolerances
1.	In the line and surface of columns, piers, walls and buttresses	5 mm per 2.50 M but not more than 25 mm
2.	For exposed corner columns and other conspicuous lines	In any bay or 5 M maximum: (+/-) 5 mm. In 10 M or more: (+/-) 10 mm

4.1.1.2 Variation from the level or frame the grade indicated in the drawings

No.	Building Members	Tolerances
1.	In slab soffits, ceilings, beam soffits and staircases	In 2.50 M : (+/-) 5 mm In any bay or 5 M maximum: (+/-) 8 mm. In 10 M or more: (+/-) 15 mm
2.	For exposed lintels, parapets, horizontal grooves and other conspicuous lines	In any bay or 5 M maximum: (+/-) 5 mm. In 10 M or more: (+/-) 10 mm

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

No.	Building Members	Tolerances
1.	In any bay or 5 M maximum	(+/-) 5 mm
2.	In 10 M or more	(+/-) 20 mm

4.1.1.4

No.	Building Members	Tolerances
1.	Variation in the sizes and locations of sleeves, openings in walls and floors except in the case of anchor bolts	(+/-) 5 mm

4.1.1.5

No.	Building Members	Tolerances
1.	Variation in cross sectional dimensions of	and walls (-) 5 mm and (+) 10

	columns and beams and thickness of slabs	mm.

4.1.1.6 Footings:

No.	Building Members	Tolerances
1.	Variation in dimension in plan	(-) 5 mm and (+) 50 mm.
2.	Misplacement or eccentricity in the direction of misplacement	0.02 times the width of the footing in the direction of the deviation but not more than 50 mm
3.	Reduction in thickness	(+/-) 0.05 times the specified thickness

4.1.1.7 Variation in steps

No.	Building Members	Tolerances
1.	In a flight of stairs riser	(+/-) 3 mm
2.	In a flight of stairs tread	(+/-) 5 mm
3.	In consecutive steps riser	(+/-) 1.5 mm
4.	In consecutive steps tread	(+/-) 3 mm

4.1.2 Tolerances in other Concrete structures

4.1.2.1 All structures

No.	Building Members	Tolerances
1.	Variation of the constructed linear outline from established position in plan	(+/-) 10 mm in 5 M (+/-) 15 mm in 10 M or more
2.	Variation of dimensions to individual structure features from established positions in plan	(+/-) 25 mm in 20 M or more (+/-) 50 mm in buried construction
3.	Variation from plumb, specified batter or curved surfaces of all structures	(+/-) 10 mm in 2.50 M (+/-) 15 mm in 5 M (+/-) 25 mm in 10 M or more (+/-) Twice the above amounts in buried construction
4.	Variation from level or grade indicated on drawings in slabs and beams soffits, horizontal grooves and visible arises	(+/-) 5 mm in 2.50 M (+/-) 10 mm in 7.5 M or more (+/-) Twice the above amounts in buried construction
5.	Variation in cross sectional dimensions of columns, beams, buttresses, piers and similar members	(-) 5 mm and (+) 10 mm
6.	Variation in the thickness of slabs, walls, arch sections and similar members	(-) 5 mm and (+) 10 mm

4.1.2.2 Footings for columns, piers, walls, buttresses and similar members

No.	Building Members	Tolerances
1.	Variation in dimension in plan	(-) 10 mm and (+) 50 mm.
2.	Misplacement or eccentricity in the direction of misplacement	0.02 times the width of the footing in the direction of the

		deviation but not more than 50 m
3.	Reduction in thickness	(+/-) 0.05 times the specified thickness

4.1.2.3 Tolerances in other types of structures shall generally conform to those given in clause 2.4 of recommended Practice for Concrete Formwork (ACI 347).

5.0 TYPE OF FORMWORK

5.1 Formwork may be of timber, plywood, metal, plastic or concrete. For special finishes the formwork may be lined with plywood, steel sheets, oil tempered hard board, etc. sliding forms and slip forms may be used with the approval of Engineer-in-Charge

6.0 FORMWORK REQUIREMENTS

6.1 Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for on the drawings. Ample studs, waler, braces, ties, straps, shores, etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Form shall be strong enough to permit the use of immersion vibrators; in special case form vibrators may also be used. The shuttering shall be close boarded. All forms should not have any warps or other surface defects in contact with concrete; seasoned, free from sap, shakes, loose knots, worm holes for timber forms and shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete.

6.2 Metal Forms shall be used for exposed concrete surface where called for. Sawn and wrought timber or metal may be used for unexposed surfaces. Inside faces of forms for concrete surface, which are to be rubbed finished shall be planed to remove irregularities or unevenness in case of timber form in the face. Formwork with lining will be permitted.

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

6.4 Shores supporting successive stories shall be placed directly over those below or be so designed and placed that the load will be transmitted directly on them. Trussed supports shall be provided for shores that can be secured on adequate foundation.

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

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

Forms for substructure concrete may be omitted in the opinion of the Engineer-in-charge the open excavation is firm enough to act as the form. Such excavation shall be slightly

larger than that required by drawings to compensate for irregularities in excavation and to ensure the design requirement.

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

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

7.0 BRACINGS, STRUTS AND PROPS

7.1 Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bracings.

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

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

7.4 If the shuttering for a column is erected for the full height of the column, one side shall be left open and built upon sections as placing of concrete proceeds or windows may be left for pouring concrete from sides to limit the drop of concrete to one meter or as directed by the engineer-in-charge.

8.0 FORM OIL

8.1 Use of the form oil shall not be permitted on the surface that requires painting. If the contractor desires to use form oil on the inside of form work of the other concrete surfaces, a non staining mineral oil or other approved oil 'CEMOL-35' of M/s Hindustan Petroleum Co. Ltd. or equivalent may be used provided it is applied before placing of reinforcing steel and embedded parts.

8.2 All excess oil on the form surfaces and any oil on metal or other parts to be embedded in the concrete shall be carefully removed. Before treatment with oil forms shall be thoroughly cleared of dried splatter of concrete from placement of previous lift.

9.0 CHAMFERS AND FILLETS

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

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

10.0 WALL TIES

10.1 Wall ties passing through the walls shall not be allowed. Also through bolts shall not be permitted. For fixing of formwork alternate arrangements such as coil nuts shall be adopted at the contractor's cost.

11.0 REUSE OF FORMS

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

12.0 REMOVAL OF FORMS

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

12.2 In no circumstances shall form struck until the concrete reaches a strength of at least twice the stress due to self weight and any construction/erection loading to which the concrete may be subjected at the time of striking of formwork. The strength referred to shall be that of concrete using the same cement and aggregates and admixture, if any, with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work.

12.3 In normal circumstances where the ambient temperature does not fall below 15°C and where Ordinary Portland Cement is used and adequate curing is done the stripping time is to be followed as specified in IS: 456-2000 (clause 11.3).

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

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

12.6 Tie rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structure shall be loosened not sooner than 16 hours not later than 24 hours (in case the conditions in 12.3 are satisfied) after the concrete has been deposited. Ties except those required to hold the forms in place may be removed at the same time. Ties withdrawn from walls and grade beams shall be pulled towards the inside face. Cutting ties back from the faces of forms and grade beams will not be permitted. Work damaged due to premature or careless removal of forms, any undulation in exposed concrete surface due to sag / settlement or movement of supports found after removal of shuttering shall be reconstructed or rectified to the satisfaction of the Engineer-in-charge by the General Contractor at his own risk and cost. Abrupt changes in surface of concrete, mortar fins at formwork joints shall be made even by chipping, grinding and finishing with cement mortar, curing, etc. as directed by Engineer-in-charge at his own cost.

13.0 MODE OF MEASUREMENT

13.1 The net area of exposed surfaces of concrete members as shown in the drawings coming in contact with form work shall be measured under item of form work in square meter.

13.2 The dimensions of the formwork shall be measured correct to a centimeter.

13.3 No deductions shall be made from the shuttering for openings/obstructions up to an area of 0.10 m2 and nothing extra shall be paid of forming such opening.

13.4 For the purpose of measurements for formwork IS: 1200 (Part V) shall be referred.

14.0 SPECIFICATION FOR STAGING WORK

14.1 General Contractor shall note that only steel tubular staging (acrow type or equivalent) shall be used for all RCC beams, slabs, etc. at all floor levels and the same shall be designed by him and the detailed drawings and the design calculations shall be submitted for the approval of Engineer-in-charge at least two weeks in advance of the scheduled date of its erection at site.

14.2 Depending upon the height of the staging, suitable vertical and horizontal cross bracings shall be provided. The General Contractor shall note that no concreting of floor beams, stairs and slabs including roof slab will be permitted unless the staging work is inspected and approval in writing for its soundness by the Engineer-in-charge is given prior to the commencement of concreting.

H RUBBER / P.V.C. WATER STOPS

1.0 GENERAL

1.1 The corrugated Rubber/PVC water stops with centre bulb of specified width, shall be of approved manufacture and shall satisfy all the normal tests such as tensile strength, elongation etc.

2.0 SAMPLE

2.1 A sample of Rubber/PVC water stops shall be got approved from the Engineer-in-charge before procurement of bulk quantity.

3.0 PLACING IN POSITION

3.1 The water stops shall be provided in available maximum length and as far as possible, jointing shall be avoided. All the joints when unavoidable, shall be field jointed for water tightness as per manufacturers specifications and recommendation.

3.2 The water-stops shall be positioned with suitable temporary supports so as to render adequate rigidity to the water stops while concreting. The exposed surfaces of water stops revealed after first concreting shall be cleaned thoroughly of all the droppings, mortar splashing, timber scantlings sticking etc. before the next pour of concrete is taken up in hand. Any damage caused to water stops shall be made good by the contractor at his own cost as per manufacturer's specification and recommendation.

3.3 All corners pieces and laps should be factory made and no modification will be permitted at site.

4.0 MODE OF MEASUREMENT

4.1 The mode of measurements shall be in running meter, of water stop actually laid without any allowance for laps, wastage etc., measured correct to one centimetre.

4.2 Rate shall include supply, transport, fixing, welding, supporting arrangements, cleaning etc. all as described above.

I STEEL REINFORCEMENT

1.0 GENERAL

1.1 Steel reinforcement bars, if supplied or arranged by the General Contractor, shall be either plain round mild steel bars grade – I or medium tensile steel bars as per IS: 432 or hot rolled mild steel and medium tensile deformed as per IS: 1139 or Thermo-mechanically treated (TMT) bars - high yield strength deformed bars as per IS: 1786 as shown and specified on the drawings and shall be manufactured by M/s SAIL or TISCO and shall be rolled from their own plants and from virgin material. Materials manufactured by their authorized conversion agents and re-rollers shall not be accepted.

Documentary evidence of purchasing steel produced from these manufacturers and their manufacturing test certificate shall be submitted. The third party test shall be carried out as directed in line with the relevant Indian standards and cost of which shall be included in the item rate and no separate payment shall be made on account of this.

1.2 Wire mesh or fabric shall be in accordance with IS: 1566.

1.3 Substitution of reinforcement will not be permitted except upon written approval from Engineer-In-Charge.

2.0 SCOPE

2.1 This specification covers the general requirements for quality, storage, bending and fixing of reinforcement.

3.0 APPLICABLE CODES AND SPECIFICATIONS

3.1 The relevant IS specification, standards and codes given below are made a part of this specification. All standards, specifications, code of practices refer to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

1.	IS: 432 (Part I)	Mild Steel and Medium Tensile Steel bars and Hard drawn Steel Wires for concrete reinforcement
2.	IS: 432 (Part II)	Mild Steel and Medium Tensile Steel bars and Hard drawn steel wires for concrete reinforcement
3.	IS: 1139	Specification for Hot Rolled Mild steel, Medium steel and HYSD bars for concrete reinforcement
4.	IS: 1200 (Part VIII)	Method of Measurement of Building and Civil Engineering work (Steel and Iron works)
5.	IS: 1566	Hard drawn Steel Wire fabric for concrete reinforcement

6.	IS: 1599	Method for Bend Test
7.	IS: 1608	Method of Tensile Testing of Steel Products
8.	IS: 1786	High Strength Deformed Steel and Wires for concrete reinforcement
9.	IS: 2502	Code of Practice for Bending and Fixing of Bars for concrete reinforcement

4.0 STORAGE

4.1 The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber slippers or the like. The reinforcement shall be coated with cement wash before stacking to prevent scale and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.0 QUALITY

5.1 All steel shall be of grade-I quality unless specifically permitted by the Engineer-In-Charge. No re-rolled material will be accepted. General Contractor shall submit the manufacturer's test certificate for steel.

5.2 Random test on steel supplied by the General Contractor may be performed by Engineer-in-Charge as per relevant IS. All cost incurred to such tests shall be at the contractor's expenses. Steel not conforming to the specifications shall be rejected.

5.3 All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substance that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated.

5.4 Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-charge. If welding is approved the work shall be carried out as per IS: 2751, according to best modern practices and as directed by the Engineer-in-charge.

5.5 In all cases of important connections, test shall be made to prove that the joints are of the full strength of the bar welded. Special precaution as specified by the Engineer-in-charge shall be taken in the welding of cold work reinforcing bars and bars other tan mild steel.

6.0 LAPS

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

7.0 BENDING

7.1 All bars shall be accurately bent (cold) according to the size and shape shown on the detail working drawing / bar bending schedule. They shall be gradually bent by machine or approved means.

7.2 Reinforcing bars shall not be straightened and re-bend in the manner that will injure the material. Bars containing cracks and splits shall be rejected. They shall be bent cold except bars above 25 mm in diameter which may be bent hot, if specifically approved by Engineer-in-charge.

7.3 Bars which depend for their strength on cold working shall not be bent hot. Bars bent hot shall not be heated beyond cherry-red color (not exceeding 645° C) and after bending shall be allowed to cool slowly without quenching.

7.4 Bars incorrectly bent shall be used only if the means used for straightening and re-bending be such as shall not in the opinion of the Engineer-in-charge injure the material.

7.5 No reinforcement bars shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by the design shall not be used.

8.0 FIXING

8.1 The reinforcement shall accurately be fixed by any approved means and maintained in the correct position as shown in the drawing by use of blocks, spacers and chairs as per IS: 2502 to prevent displacement during placing and compaction of concrete.

8.2 Bars intended to be in contact at crossing point shall be securely bound together at all such points with 1.6 mm diameter annealed soft iron wire.

8.3 The vertical distance required between successive layers of bars in beams or similar members shall be maintained by provision of mild steel spacer bars at such intervals that the main bar do not perpetually sag between adjacent spacer bars.

9.0 COVER TO REINFORCEMENT

9.1 Unless indicated otherwise on the drawing, clear concrete cover for reinforcement (exclusive of plaster or decorative finish) shall be as per the provisions of IS: 456.

10.0 INSPECTION

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

11.0 MODE OF MEASUREMENT

11.1 The actual quantity of reinforcement bars embedded in concrete as specified in the drawing and as approved by the Engineer-in-charge irrespective of the level or height at which the reinforcement bars are placed shall be measured for payment.

11.2 The reinforcement bars shall be measured in length nearest to a centimeter for different diameters and their weight shall be calculated based on the standard weights as per Indian Standard.

11.3 Wastage, unauthorized overlap and annealed steel binding wires shall not be measured for payment.

11.4 Pins, chairs and spacers wherever required shall be provided As directed by the Engineer-in-charge and measured separately and paid for.

11.5 The rate for reinforcement item shall include the cost of labour and materials required for all operations described above including transportation, cleaning, straightening, cutting, bending, placing in position and binding of reinforcement bars and wastage, etc.

J STRUCTURAL STEEL

1.0. SCOPE

1.1. This specification covers requirements for the supply wherever, fabrication and delivery of structural steel and miscellaneous steel items for the work.

1.2. This specification also covers redesign wherever necessary, design of all connections and published members, preparation of all shop fabrication drawings, inspection and painting of structures by the fabricators.

2.0. APPLICABLE CODES AND SPECIFICATIONS

2.1 Unless otherwise specified herein, the design, materials and workmanship shall conform to the latest edition of the one or as many as applicable of the following standards or their approved equivalents.

2.2. All standards, specifications and code of practices, referred to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

2.3. List of Indian Standards :

IS. 226	:	Structural steel (standard quality)
IS. 808	:	Rolled steel beams, channel and angles sections.
IS. 1099	:	Structural steel (ordinary quality)
ASTM 06	:	General requirements for delivery of rolled steel plates, sheet piling and bars for structural use.
IS. 1367	:	Technical supply conditions for threaded fasteners.
IS. 3757	:	High tensile friction grip fasteners for structural engineering purposes.
IS. 814	:	Specifications for covered electrodes for metal arc welding for mild steel.
IS. 3613	:	Acceptance tests for wire flux combination for submerged-arc welding.
AWS. A-5.1	:	Specification for mild steel covered arc welding electrodes.
AWS.A-5-17	:	Specification for hard mild steel electrodes and submerged arc welding.
IS. 1052	:	Specification for rolling and cutting tolerances for hot rolled steel products.
IS. 2074	:	Ready mixed paint, red oxide zinc chrome, priming.
IS. 102	:	Ready mixed paint, brushing, red lead, non-setting, priming.
IS. 300	:	Code of practice for use of structural steel in general building construction.
IS. 875	:	Code of practice for structural safety of building : Loading standards.
IS. 1893	:	Recommendations for earthquake resistant design of structures.
IS. 816	:	Code of practice for use of metal arc welding for general construction.

IS. 4353	:	Recommendations for submerged arc welding of mild steel and low alloy steel.
IS. 823	:	Code of procedure for manual metal arc welding of mild steel.
IS. 817	:	Codes of practice for training and welding of metal arc welders.
IS. 1182	:	Recommended practice for radiographic examination of fusion-welded butt joints in steel plates
IS. 5334	:	Codes of practice for magnetic particle flaw detection of welds
ASTM E. 94	:	Recommended practice for radiographic testing.
ASTME. 109	:	Dry powder magnetic particle inspection.
ASTME. 130	:	Wet magnetic particle inspection.
ASTME. 165	:	Liquid penetrant inspection.
IS. 1477	:	Code of practice for painting of ferrous metals in building all allied finishes.
IS. 1161	:	Steel Tubes for structural purposes
IS:1363	:	Hexagon Head Bolts, Screws and Nuts of product (Part I to III)
IS. 1852	:	Rolling and Cutting Tolerances for Hot Rolled Steel Products
IS. 3502	:	Steel Chequered Plate
IS. 3757	:	High Strength Structural Bolts
IS. 1200	:	Method of Measurement

3.0. STEEL MATERIALS

3.1. Structural steel shall be procured by the contractor conforming to relevant IS codes and manufactured by M/s SAIL or TISCO and shall be rolled from their own plants and from virgin material. Materials manufactured by their authorized conversion agents and re-rollers shall not be accepted. Documentary evidence of purchasing steel produced from these manufacturers and their manufacturing test certificate shall be submitted. The third party test shall be carried out as directed in line with the relevant Indian standards and cost of which shall be included in the item rate and no separate payment shall be made on account of this.

3.2. General Contractor shall take proper care of the steel delivered to site/fabrication yard and protect the same from weathering and damage. Any such materials rendered unserviceable or damaged while in the contractor's custody shall be replaced by contractor at his own cost as directed by the Engineer-in-Charge.

3.3. General Contractor's stock material may be used provided the mill test reports identified with the materials, satisfactorily demonstrate specified grade and quality. Also all such materials supplied by contractor shall be in a sound condition of recent manufacture, in full length, free from defects, loose mill scale, slag intrusions, laminations, pitting, flaky rust etc. and be of full weight of thickness specified.

3.4. Unidentified steel material may be used only with prior permission from Engineer-in-charge, in writing, for short sections of minor importance or for small unimportant welds and connections where in the opinion of the Engineer-in-charge the quality of such material would not adversely affect the strength and / or durability of the structure. Engineer-in-charge may also permit use of such material for other work if adequate and

random samples taken out and tested to demonstrate conformity with specification & requirement for work in view.

3.5. General Contractor shall submit the fabrication drawing for the Engineer-in-charge's approval before fabrication commences and make any modification therein as directed by the Engineer-in-charge. Approval by the Engineer-in-charge of any of the drawings shall not relieve the Contractor from the responsibility for correctness of engineering & design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The Engineer-in-charge's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

3.6. Approved design drawings will be furnished to the contractor and all drawings so furnished shall form a part of this specification. Contractor shall consult these in detail for all the information contained therein; which pertains to and is required for his work.

3.7. The Engineer-in-Charge reserve the right to make changes, revisions to drawings even after release for preparation of shop drawings, which are very likely to be made to reflect additional data/details received and more updated requirements.

3.8. Revisions in drawings and any new drawings made to include additional work by the Engineer-in-charge shall be considered a part of this specification and contract and the contractor shall have no extra claims on this account.

3.9. Unless otherwise specified, the drawings and specifications are intended to include every thing obviously requisite and necessary for the proper and entire completion of the work and job shall be carried out accordingly for the completeness as required.

3.10. Design drawings prepared by the Engineer-in-Charge will show all the dimensions and if necessary clearance of structure, landings where necessary, size of each member, definite location of openings at various levels and all other information necessary to enable the General Contractor in prepare drawings for fabrication and erection.

3.11. It shall be clearly understood that the Engineer-in-charge's drawings are design drawing and are not intended to show detailed connection, thickness of members, cuts, notches, bends and such other details.

3.12. In the case of variation in drawings and specifications the decision of the Engineer-in-Charge shall be final.

3.13. Should General Contractor in the execution of his work, find discrepancies in the information furnished by the Engineer-in-charge he shall refer such discrepancies to the Engineer-in-Charge before proceeding with the work.

4.0. FABRICATION

4.1 All workmanship and finish shall be of the best quality and shall conform to the best-approved method of fabrication.

4.2. All materials shall be finished straight and shall be machined true and square where so specified. All holes and edges shall be free of burrs.

4.3. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished.

4.4. Standard fabrication clearance as detailed in American Institute of steel construction manuals shall generally be followed unless otherwise directed approved.

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

4.6. Shop connections shall be effected by welding as specified on the Engineer-in-Charge's design drawings.

4.7. Rolled materials before being worked shall be straightened unless otherwise required/specified.

4.8. If straightening or flattening is necessary it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mangle or leveling rolls and structural shapes by the use of mechanical or hydraulic bar straightening machines.

4.9. Heating or forging shall not be resorted to without the prior approval of the Engineer-in-charge in writing.

4.10. Cutting may be by shearing, cropping, sawing or machine flame cutting. All reentrant corners shall be shaped notch-free to a radius of at least 12 mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

4.11. The korf on machine flame cut edges shall be removed. Where machine flame cutting is permitted for high tensile steel, special care shall be taken to leave sufficient metal and all flame hardened material shall be removed by machining/edge planning.

4.12. Hand flame cutting shall be undertaken only if so permitted by Engineer-in-charge and only be carried out by an expert in such work. Hand flame cut edges shall be ground smooth and straight.

4.13. Edge planning of sheared, chopped or gas cut edges is not intended unless the sheared, chopped or gas cut edges are such as to warrant it or specifically called for.

5.0. WELDING

5.1. Welding procedure shall be submitted to Engineer-in-charge for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS 817, IS: 7310 (Part 1) and IS: 7318 (Part 1). All weld shall be inspected welder's supervisor and punched on welded element for record.

5.2. Electrodes for structural welding works shall comply with the requirements of IS: 226 and / or BS: 634 or AWS: A-5.1 and shall be of approved make.

5.3. The electrodes shall be suitable for use in the position and type of work as laid down in the above specifications and as recommended by the manufacturer.

5.4. Electrodes of classification AWS E 60 XX and C 70 XX shall be used for welding steel conforming to I.S. 226 and I.S. 2062 and of classification AWS E 70 XX for steel conforming to I.S. 961. Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 32 mm and above.

5.5. Joints in materials above 20 mm thick and all the important connections shall be made with low Hydrogen electrodes of AWS E 7016 or E 7010 classification.

5.6. The filler wire and flux combination for submerged arc welding shall conform to the requirements for the desired application as laid down in I.S. 3613. The weld metal deposited by the submerged arc process shall have mechanical properties not less than that specified for American Welding Society's classification 5.17 E 60 for steel to I.S. 226 and I.S. 2042 and AWS classification 5.17 E 70 for steel to IS: 961.

5.7. Electrode Flux covering shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Covered electrodes for manual-arc welding shall be properly stored to an oven prior to use in a manner recommended by the manufacturer and only an hour's quota shall be issued to each welder from the oven.

5.8. Electrodes larger than 5mm diameter shall not be used for root-runs in butt welds.

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

5.10. All welds shall be made only by welders and welding operators who have been properly trained and previously qualified by tests to perform the type of work required as prescribed in the relevant applicable standards.

5.11. All welds shall be free from defects like blowholes, slag inclusions, lack of penetration, under cutting, cracks etc. All welds shall be cleaned of slag or flux and show uniform sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

5.12. Fusion faces and surfaces adjacent to the joint for a distance of at least 50 mm on either side shall be absolutely free from grease, paint, loose scales, moisture or any other substance which might interfere with welding or adversely affect the quality of the weld.

5.13. Joint surfaces shall be smooth, uniform and free from fins, tears, laminations etc.

5.14. Preparation of fusion faces shall be done in accordance with the approved fabrication drawings by shearing, chipping, achining or machine flame cutting except that shearing shall not be used for thickness over 8 mm.

5.15. In the fabrication of cover plated beams and built up members all shop splices in each component part shall be made before such component part is welded to other parts of the member. Wherever weld reinforcement interiors with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

5.16. The members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated by more than 3 mm. If the separation is 1.5 mm or greater the fillet weld size shall be increased by the amount of separation. This shall only apply if the surfaces are completely sealed by welds. In all other cases the fit-up shall be close enough to exclude water after painting.

5.17. The separation between faying surfaces of lap joints and butt joints with backing plate shall not exceed 1.5 mm. A butting part to be butt-welded shall be carefully aligned and the correct root gap maintained throughout the welding operation.

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

5.19. Pre-qualified procedures recommended for appropriate welding standards and known to provide satisfactory welds shall be followed. For non-standard procedures, qualification testes are prescribed in IS: 823 shall be made to verify the adequacy of the procedures. A welding procedure shall be prepared by the General Contractor and submitted to the Engineer-in-charge for approval before the welding starts. This shall include all the details of welding procedures with reference to the provisions of IS: 823 and IS: 4353. Approval of the welding procedure by the Engineer-in-charge shall not relieve the contractor from his responsibility for correct & sound fabrication without distortion to the finished structure.

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

5.21. Voltage and current (and polarity if direct current is used) shall be set according to the recommendations of the manufacturer of the electrode being used and suitability to thickness of material, joint form etc.

5.22. The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided.

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

5.24. In joints connected by fillet welds the minimum sizes of single run fillet welding or first runs and minimum full sizes of fillet welds shall conform to the requirement of IS: 816 and IS: 823.

5.25. All complete penetration butt welds made by manual arc welding except when produced with the aid of backing material or welded in flat position from both sides in square-edge material not over 8 mm thick with root opening not less than one-half the thickness of the thinner part joined shall have the root of the initial layer gouged and on the back side before welding is started from that side and shall be so welded as to secure sound metal and complete fusion throughout the entire core section.

5.26. Butt welds shall be terminated at the ends of joint in a manner that will ensure their soundness. Where abutting parts are 20 mm or more in thickness run-on and run-off plates with similar edge preparation and having a width not less than the thickness of the thicker part joined shall be used. These extension pieces shall be approved upon completion of the weld and the ends of the weld made smooth and flush with the abutting parts. Where the abutting parts are thinner than 20 mm the extension pieces may be omitted but the ends of the butt welds shall then be chipped or gouged out to sound metal and side welded to fill up the ends to the required reinforcement.

5.27. Each layer of a multiple layer weld except root and surface runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

5.28. No welding shall be done on base metal at a temperature below 5°C. Base metal shall be preheated as required to the temperature given in the table below prior to tack welding or welding. When base metal not otherwise required to be preheated is at a temperature below zero degree centigrade it shall be preheated to at least 20oC prior to tack welding or

welding. Preheating shall bring the surface of the base metal within 75 mm of the point of welding to the specified preheat temperature and this temperatures shall be maintained as minimum inter pass temperature while welding is in progress.

5.29.

Thickness of thickest part at point of welding	Min. Preheat & Inter pass Temp.			
	Other than low Hydrogen welding electrodes		Low Hydrogen welding electrodes	
	I.S : 226 I.S : 2062	IS : 961	IS: 226 IS: 2062	IS: 961
Upto 20mm	None	Welding with this process not allowed	None	10 DC
20mm to 40mm	65 DC		10 DC	65 DC
40mm to 63mm	110 DC		95 DC	110 DC
Over 63mm	150 DC		110 DC	150 DC

5.30. Minimum preheat for IS. 226 steel in thickness up to 80 mm shall be 10 degree centigrade.

5.31. Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 75 mm and above.

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

5.33.1 Proposed preheating in components such as flanges and presetting of joints to offset expected distortion.

5.33.2 Make up of sub-assemblies proposed to be welded before incorporation in final assembly.

5.33.3 Proposed joint forms, classification of wire and flux or covered electrodes, welding process including fitting and welding sequence with directions in which freedom of movement is to be allowed.

5.33.4 Proposed number, spacing and type of strong backs and details of jigs and fixtures for maintaining proper fit-up and alignment during welding.

5.33.5 Any other special features like assembling similar members back to back or stress relief.

5.34 If so desired by the Engineer-in-Charge mock-up welding shall be carried out at General Contractor's cost to establish the efficiency of the proposed programme, with any modification suggested by the Engineer-in-charge in limiting distortion or/ and residual stress to acceptable levels.

5.35. All welds shall be inspected for flaws by any of the methods described under the clause of 'Inspection' given below in this specification. The choice of the method adopted shall be determined by Engineer-in-charge.

5.36. General Contractor shall quote separately for carrying out such tests as called for in the schedule of quantities. Contractor shall be paid only for tests, which establish soundness of welds. In case the tests wherever defective work such tests will be at the contractor's cost and contractor shall correct such defects at his own cost and prove the soundness of rectified work.

5.37. The correction of defective welds shall be carried out as directed by the Engineer-in-charge without damaging the parent metal. When a crack in weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the Engineer-in-charge shall be used to inspect that the whole of the crack and material up to 25 mm beyond each end of the crack has been removed. Cost of such test & operation incidental to correction shall be on contractor's account.

6.0 TOLERANCES

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

6.2 No rolled or fabricated member shall deviate from straightness by more than 1/1000th of the length or 10 mm whichever is smaller.

6.3 The length of members with both ends finished for contact shall have a tolerance of (±) 1 mm.

6.4 Members without ends finished for contact bearing shall have a tolerance of (±) 1.5 mm for members up to 10 metres long and a tolerance of (±) 3 mm for members over 10 metres in length.

6.5 Lateral deviation between center line of web plates and center line of flange plate at contact surface in the case of built up sections shall not exceed 6 mm.

6.6 The combined warpage and filet of flanges in welded built up sections shall not exceed 1/200th of the flange width or 3 mm whichever is smaller.

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

6.8 Deviations from the specified depth of welded girders measured at the center line of the web shall not exceed (±) 3 mm up to a depth of 1000 mm, (±) 5 mm for depths above 1000 mm up to 2000 mm and (+) 0 mm and (-) 5 mm for depths over 2000 mm.

7.0 END MILLING

7.1. Column ends bearing on each other or resting on based plates and compression joints designed for bearing shall be milled true and square to ensure proper bearing and alignment.

7.2. Base plates shall also have their surfaces milled true and square.

8.0 INSPECTION

8.1. General Contractor shall give due notice to the Engineer-in-charge/QA in advance of the works getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Engineer-in-charge's approval/inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Engineer-in-charge/QA; if it fails to confirm to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the

Engineer-in-Charge/QA may make because of defective or unsatisfactory materials and/or workmanship.

8.2. No materials shall be painted or dispatched to site without inspection and approval by the Engineer-in-charges unless such inspection is waived in writing by the Engineer-in-charge.

8.3. Shop inspection by the Engineer-in-charge or his authorized representative on submission of test certificates and acceptance thereof by the Engineer-in-charge shall not relieve contractor from the responsibility of furnishing material conforming to the requirements of these specifications nor shall it invalidate any claim which the Engineer-in-Charge may make because of defective or unsatisfactory material and of workmanship.

8.4. General Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. General Contractor's inspection work shall be under the control of a competent and approved independent testing agency whose primary responsibility is inspection reporting to Engineer-in-Charge.

8.5. For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to the Engineer-in-charge.

8.6. The inspection and tests on structural steel members shall be as set forth below:

8.7 If mill test reports are not available to any steel material the same shall be rejected and removed from the site.

8.8. The under mentioned tests shall generally required for the work and will not be paid extra.

8.8.1. Magnetic Particle Test:
Where root and intermediate passes of weld is examined by magnetic particle testing such testing shall be carried out throughout. It's entire length shall be in accordance with ASTM specification E-109. In the case of completed welds such tests shall be carried out in accordance with ASTM specification E-109 0r E-130 as decided by the Engineer-in-charge. If heat treatment is performed the completed weld shall be examined after the heat treatment. All defects shall be replaced and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the Engineer-in-charge.

8.8.2. Liquid Penetrant Inspection:
In the case of welds examined by liquid penetrant inspection such tests shall be carried out in accordance with ASTM E-164 or I.S. 3650. All defects shown shall be repaired and rechecked.

8.8.3. Radiographic Inspection:
All full strength butt welds shall be fully tested with radiograph in accordance with the recommended practice for radiographic testing as per ASTM E-94 and Part U.W. 51 ASME Code Section VIII.

8.8.4 Dimension, Workmanship & Cleanliness:
The structural steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish, painting where specified are in accordance with the requirements shown on contractor's approved shop drawings and Engineer-in-charge's drawings.

8.9 Inspection or Test failure

8.9.1. In the event of any failure of structural steel members to meet an inspection or test requirement, General Contractor shall notify to Engineer-in-charge or his authorized representative. Contractor must obtain permission from Engineer-in-charge before repair is undertaken.

8.9.2. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by Engineer-in-charge.

8.9.3. Engineer-in-charge has a right to specify additional inspection or testing, as he deems necessary and the additional cost of such testing will be borne by the General Contractor.

8.9.4. General Contractor shall maintain records of all inspection and testing which shall be made available to Engineer-in-charge or his authorized representative.

9.0 DRILLING HOLES FOR OTHER WORKS

9.1. Holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled in contractor's shop as part of this contract. The information for which will be supplied by Engineer-in-charge before fabrication of the steel.

10.0. HANDLING AND STORAGE

10.1. No dragging of steel shall be permitted. All steel shall be stored 300 mm above ground on suitable packing to avoid damage in the order required for erection and with erection marks visible. All storage areas shall be prepared and maintained by General Contractor.

10.2. Steel shall not be stored in the vicinity of area where the excavation or grading will be done and if stored temporarily, this shall be removed by General Contractor well before such excavation and /or grading commencing in a safe distance to avoid burial under debris.

10.3. Scratched or abraded steel shall be given a coat of the primer specified on drawings for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

10.4. After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

10.5. Structural steel frames shall be erected to plumb and true. All steel columns and beams/trusses shall be checked for plumb and level individually before and after connections are made. Temporary bracings may be introduced wherever necessary to take care of all loads to which the structure may be subjected including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

11.0. INSPECTION AT SITE

11.1. Engineer-in-charge or their authorized representatives shall have free access to all parts of the job during erection and all erection shall be subject to their approval. In case of

faulty erection, all such dismantling and re-erection required will be at General Contractor's cost. No paint shall be applied to field welds until these have been approved by Engineer-in-charge.

12.0. PAINTING

12.1. All fabricated steel material except those galvanized shall receive protective paint coating as specified on design drawings.

12.2. Paint shall be stirred frequently to keep the pigment in suspension. All paint delivered to the fabrication shop shall be ready mixed in original sealed containers as packed by the paint manufacturers and no thinners shall be permitted. No painting shall be done in frosty / foggy weather or when the humidity is high enough to cause condensation of the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is 5 degree centigrade or lower.

12.3 The surface of steel work to be painted shall be thoroughly cleaned of all mill scale, rust, grease, dirt and other foreign matter by hand tool cleaning, power tool cleaning, flame cleaning or sand/ shot blasting as indicated on drawings. In power brushing sufficient care shall be taken not to burnish mill scale to a slick finish to which paint may not adhere properly.

12.4. The paint treatment as specified on drawings shall be applied either by brushing or spraying on the thoroughly cleaned and dry surface. Airless spraying shall be done if so specified.

12.5. Surfaces inaccessible after assembly shall receive and additional coat of the specified paint prior to assembly.

12.6. Surfaces to be welded after erection shall receive one coat of shop paint. Such paint shall be removed, before field welding if any, for a distance of at least 50mm on either side of the joint.

12.7 Except for encased steelwork, all steel shall be sand blasted to SA 2.5 and protected with 1 coat of primer and 3 coats of approved epoxy paints as follows:

Prime coat	One shop coat of approved zinc chromate primer, 50 microns Dry Film Thickness (DFT) or approved equivalent. One similar coat, but of different colour shall be applied at site.
Under coat	One undercoat, 50 microns DFT, of approved brand or equivalent.
Middle coat	One middle coat of 50 microns DFT, of approved brand or equivalent.
Finish coat	One finish coat of approved epoxy coat to 50 microns DTF, or equivalent.

12.8 For galvanized steelwork if required to paint, thorough washing with an approved etching solution shall be applied to prior to proceed with the above application.

12.9 All connections, contact surfaces, site weldings shall be prepared and painted to the same standard as the adjacent steel.

13.0 BOLTING