

MAZAGON DOCK SHIPBUILDERS LIMITED

(Formerly known as Mazagon Dock Ltd.)

CIN : U35100MH1934GOI002079

(A Government of India Undertaking)

Shipbuilders to the Nation

Dockyard Road, Mazagon,

Mumbai 400 010.

INDIA

**Asphalting Work and Construction of storm
water drain line at East Yard, MDL, Mumbai**

VOLUME-IV

Preferred Make

&

Technical Specification

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TECHNICAL SPECIFICATIONS FOR CIVIL WORKS

1. Following are the list of preferred makes to be used in execution of works, if the same are not specified.

LIST OF PREFERRED MAKE:

S.N.	DESCRIPTION OF MATERIAL	MAKE OF MATERIALS
1.	Cement	Ultratech/ ACC / Ambuja / Birla
2.	Steel (Thermo Mechanically Treated Steel) High strength deformed bars or mild steel reinforcement (TOR-Steel)	SAIL, VIZAG, TATA, JSW, RINL, Jindal, Ispat
3.	Clay Bricks	Good quality locally available material approved by Engineer / Architect
4.	Water proofing material / compound.	Sika / Roff / Sunanda / Krishna Conchem
5.	C P Fittings / Toilet Accessories ISI Marked	Jaquar / Plumber
6.	UPVC Pipes (S/W/R Pipes)	Supreme / Finolex / Prince
7.	G.I. Pipes (B-Class)	Tata / Zenith
8.	G.I. Fittings (ISI Brand)	Unik / AMCO
9.	S.W. Pipes / Fittings & Gully traps	Perfect / Trimurti / Bharat
10.	Ball valves	Zoloto
11.	C.I. Manhole Cover	RIF / BIC / Neco
12.	R.C.C. Pipes	Indian Hume pipe
13.	PVC Fittings (Moulded)	Finolex / Prince
14.	Non-return valve	Intervalve
15.	Stoneware Pipe and fittings	Trimurti / Perfect Potters / Bharat
16.	Stoneware Pipe and fittings	Trimurti / Perfect Potters / Bharat
17.	Paint	Burger, Nerolac, Asian, Dulux, Tractor.
18.	White cement	Birla cement, JK cement
19.	Putty	Birla White Putty
20.	Red Oxide	Asian
21.	Acrylic Exterior paint	Asian Ultra/Nitcotex / Sandtex / Berger Weathershield

- Note (i) **Wherever specification of BOQ item is not mentioned; then CPWD specification shall be applicable.**
(ii) **Wherever make is specified in BOQ then manufacture's specifications & procedure shall be applicable.**
(iii) **Wherever no specifications or make is specified than work is to be carried out as per the written direction of Engineer-In-Charge**

2. GENERAL**2.1. Materials**

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

2.2. Sampling and Testing

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

The Engineer-In-Charge shall order such tests and analysis of all materials before leaving the manufacturer's premises or the source of supply and/or when brought on site as considers necessary and the Contractor shall bear the cost of all sampling and testing which is in consonance with the Indian Standards.

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

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

2.3. Storage of Materials

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

2.4. Records & Usage of Materials

The Contractor shall maintain detailed records of all materials received at Site or in his workshop and also about the consumption, balance in stock etc. and shall make such records available to the Engineer-In-Charge at all times as the latter may reasonably require.

Depending on the types of materials the same should be used in the order in which they arrive at site and as directed by the Engineer-In-Charge.

2.5. Contractor's Responsibility

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

and till its consumptions. Any material not approved for use shall be removed from the site at Contractor's cost.

2.6. Workmanship

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

2.7. Constructional Plant (s)

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

2.8. Workmen and Staff

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

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

2.9. Method of Measurement

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

2.10. Rates and Prices

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

2.11. List of Bureau of Indian Standard Codes (BIS)

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

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

	1988	Engineering Works-Part 22-Materials
3	IS : 17293-1974	Safety code for working with construction machinery
4	IS : 7969-1975	Safety code for handling & storage of building materials
5	IS : 8989-1978	Safety code for erection of concrete framed structures
6	IS : 4014 (part 2) 1967	Code of practice for steel tubular scaffolding – Part 2 – Safety regulations for scaffolding
7	IS:13416 (Part 1) 1992	Preventive measures against hazards at work places – Part 1 – Falling material hazard prevention.
8	IS : 13416 (Part 2)1982	Preventive measures against hazards at work places recommendations – Fall prevention.
9	IS: 13416 (part 3) 1994	Preventive measures against hazards at work places – Recommendations – Part 3 – Disposal of debris (MULBA)
10	IS : 13416 (Part 5) 1994	Preventive measures against hazards at work places – Recommendations – Part 5 – Fire protection

GENERAL**EARTHWORK**

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

MORTARS

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

CONCRETE WORK

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

REINFORCED CEMENT CONCRETE WORK

S. No	IS Code No	Particulars
1	432 (Part I &II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement Part-I mild steel and medium tensile steel bars
2	1200 (Part V)	Method of measurement of building and civil engineering work – concrete work (Part 5 – Form work)
3	2505	Code of Practice for bending and fixing of bars for concrete reinforcement
4	2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
5	4925	Batch plants specification for concrete batching and mixing plant
6	9103	For admixtures for concrete

BRICK WORK

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

MARBLE/GRANITE / STONE WORK

S. No	IS Code No	Particulars
1	3316 – 1974	Granite slabs

STEEL WORK

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

FINISHING

S. No	IS Code No	Particulars
1	104-1979	Specification for ready mixed paint, brushing, zinc chrome, priming (Reaffirmed 1993) (2 nd Revision)
2	109-1968	Ready mixed paint, brushing, priming plaster to Indian

		Standard colour No.361.631 white and off white (Reaffirmed 1993) (1 st Revision)
3	290-1961	Coal tar black paint (Reaffirmed 1991) Revised
4	419-1967	Putty for use on window frames (Reaffirmed 1992) (Revised)
5	428-1969	Distemper, oil emulsion, colour as required (Reaffirmed 1993) (1 st Revision)
6	1200-1976 (Part XII)	Method of measurements of building and civil engineering works: Part XII – Plastering and pointing (Reaffirmed 1992) (3 rd Revision)
7	1200-1994(Part XIII)	Method of measurements of building and civil engineering works: Part XIII – white washing, colour washing, distemping and painting of building surfaces (5 th Revision)
8	1200-1987 (Part XV)	Methods of measurements of building and civil engineering works: Part XV – Painting, polishing, varnishing etc. (Reaffirmed 1992) (4 th Revision)
9	2932-1994	Enamel, synthetic, exterior (a) undercoating (b) Finishing (2 nd Revision)
10	5410-1992	Cement paint (1 st Revision)
11	1661	Application of plaster
12	1542	Plaster for sand
13	2645	Integral waterproofing compound
14	2395 (Part I & II)	Painting workmanship

DISMANTLING AND DEMOLITION

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

3. EARTH WORKS

3.1. Earthwork in Excavation & Backfilling

General

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

Classifications

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

Earthwork will be classified under any of the following categories –

(a) Ordinary & Hard Soils

These shall include all kinds of soils containing kankar, sand, silt, moorum and / or shingle, gravel, clay, loam, peat, ash, shale etc. which can generally be excavated by spade, pick axes and shovel and which is not classified under “soft and decomposed rock” and “hard rock” defined below. This shall also include embedded rock boulders not longer than 1 metre in any direction and not more than 200mm. in any one of the other two directions.

(b) Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite and all other materials which in the opinion of Engineer-In-Charge is rock, but does not need blasting and could be removed with picks, hammer, crow bars, wedges and pneumatic breaking equipment. The mere fact that Contractor resorts to blasting for reasons of his own, shall not qualify for classification under “hard rock”.

This shall also include excavation in macadam and tarred roads and pavements and masonry to be dismantled as also rock boulders not longer than 1 metre in any direction and not more than 500 mm. in any one of the other two directions.

(c) Hard Rock

This shall include all rock occurring in large continuous masses or hard rock with or without veins, plain or reinforced concrete work to be dismantled and boulders of rock occurring in such sizes not classified under (a) & (b) above and which cannot be removed except by blasting for loosening it (although due to proximity of buildings or for any other reasons cutting by good chisels or wedges or by pavement breakers that may have to be resorted to in lieu of blasting).

Method of Excavation

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

The Contractor shall submit his proposal of the method he proposes to adopt for carrying out the excavation work efficiently and expeditiously indicating arrangements for dewatering, disposal and safety measures etc. for the approval of the Engineer-In-Charge.

This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage.

Details of Works

Dimensions / Levels

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

Shoring and strutting

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

Excavation in hard rock

Excavation in hard rock by blasting shall not be permitted. Excavation in hard rock shall be done manually by machine (chiselling), the rock shall be removed by wedging, barring, heating and quenching or by other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging etc.

Excavation to be kept dry

The Contractor shall keep all excavation free from water, whether from sub-soil or from rains or from any other source, by pumping or other approved means. When dewatering is done by pumping, the Contractor shall furnish the full details of his scheme for the approval of the Engineer-In-Charge.

Sides and bottom of excavation

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

Excess Excavation

Any excavation beyond the stipulated limits or instructions whether done through error or by accident shall be made good by filling with nominal mix of 1:2:4 concrete to required levels or with earth or murum rammed hard or with masonry as directed by the Engineer-In-Charge without extra cost.

Stacking / Removal of excavated material

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

Excavated material when stacked shall be at a sufficient distance away from the edge of the excavated pits / trenches so as not to endanger the stability of sides. It should not also obstruct free movement of men, materials and vehicles or encroach upon the area required for construction purposes.

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

Backfilling

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

If any selected fill material is required to be borrowed from Employer's properties, Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of Engineer-In-Charge. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish etc. top soil containing salts / sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by Engineer-In-Charge. Contractor shall make necessary access roads to borrow areas and maintain the same, at his own cost if such access road does not exist.

Measurements

Excavation shall be measured as net dimensions in accordance with the instruction by Engineer-in-charge/ Drawings issued specifically for excavation work for foundation / trench excavation where PCC area shall be considered for measurements of excavation. **No measurements** shall be considered for extra excavation that may be required such as **for working space**, for keeping sides of excavation straight etc. or for extra excavation that may result due to removal by blasting, mechanical equipments etc. Founding surface, if uneven, shall be made level with 1:3:6 nominal mix concrete at the Contractors expense.

The depth shall be reckoned from average G. L. of concerned pit / area.

Rates

Rate shall include all materials, labour involved in the above operations as described above including setting out works, profiles, preparing beds for foundations, site clearance, removal of slips/falls, watching and lighting wherever necessary. The rate of excavation is inclusive of dewatering to keep the bed dry irrespective of source of water (such as subsoil water, water table, tidal, rains, seepage, pipe line etc.) shoring if, and when required.

3.2. Earthwork in Filling

Material

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

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

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

Filling over areas (site gradation) / roads /pathways

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

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

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

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

The Contractor shall protect the fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the same at his own cost.

If rock obtained from excavation (which may be used for filling and levelling to indicated grades without further breaking) is permitted for filling by the Engineer-In-Charge, filling shall be done in layers not exceeding 50cm approximately. After rock filling to the approximate level, the voids in the rocks shall be filled with finer materials such as earth, broken stone etc. and the area shall be flooded with water so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm. thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 10 -12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken-up.

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

Plinth filling

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

Where specifically specified, compaction of the plinth fill shall be carried out by means of 8 -10 tonne approved type of roller. In this case fill layers can be upto a maximum of 300 mm. As rolling proceeds water sprinkling shall be done to assist consolidation. Water

shall not be sprinkled in case of sandy fill. Rolling shall commence from the outer edge and progress towards the centre and continue until compaction to the satisfaction of the Engineer-In-Charge or provides density not less than that specified in the item but in no case less than 10 passes of the roller shall be accepted for each layer. The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

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

Measurement

Filling sides of foundations- The cubical contents of bed concrete levelling course and masonry / concrete in foundations up to the ground level shall be deducted from the cubical contents of earth work in excavation for foundations already measured under the respective item of earth work to arrive at the quantity or filling sides of foundations.

Filling in plinth and under floor- Depth of filling shall be consolidated depth. The dimensions of filling shall be on the basis of pre-measurement.

3.3. Anti-termite Treatment:

Material

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

Safety Precaution

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

Application

Chemical treatment of soils for the protection of buildings from attack of subterranean termites shall be done as per IS:6313 (Part-II). Proper check should be kept to ensure that the specified quantity of chemical is used for the required area during the operations.

Time of application of Soil treatment should start when foundation trenches and pits are ready to take bed concrete/ levelling course in foundations. Laying of bed concrete / levelling course should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub- soil water. Treatment to the surface of earth filling within plinth shall also be done in the same manner before laying sub-grade for flooring. Treatment along the external perimeter of building shall be carried out after completion of the building by providing 30 mm deep holes in the soil with iron rods at intervals of about 15 cm unless otherwise specified by the manufacturer.

Disturbance

The treated soil barrier shall not be disturbed. If for some reasons the treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

The contractor shall provide 10 years guarantee bond to cover defects liability period.

3.4. Dry rubble soling

Materials

Supply of rubble stone of the specified type and size and shall be obtained from approved sources only and transporting to the site of work including all loads, lifts, handling, transportation etc.

The rubble of the specified type of stones shall be hard, tough, sound, durable, dense, clean of close texture and free from unsound material, cracks, decay and weathering. Their water absorption shall be as low as possible but not more than 5 percent.

The shape of the stones shall be as regular as can be obtained by quarrying without attempt at shaping or dressing. They shall be sufficiently flat bedded. The stone shall be broken with the smallest dimensions equal to the specified thickness of soling. The length and breadth should not generally exceed twice its thickness. Before starting collection, the contractor shall get a sample conforming to the required quality, shape and size approved by the Engineer-In-Charge who will keep it in his office for reference.

Stacking shall be done only after the quality; shape and size of rubble are approved.

The hard murum used as binding material shall be of disintegrated trap, granite, quartzite or gneiss rock freshly quarried. It shall be sufficiently hard and free from soft murum, earth, organic matter or other deleterious or soft material. The particle size of the hard murum shall generally fulfil the size (Square mesh) percentage passing through, 80mm - 95% and 25mm - 2%. **Stacking lift and lead etc. shall be as specified in the BOQ**, or as directed by the Engineer-In-Charge.

Laying Soling

The item provides for the labour for laying soling of specified type of stones in the specified thickness including preparing the sub-grade to proper sections by scrapping, dressing, compaction, etc. and hand packing the rubble chips to the required line, curve and grade and section.

The rubble supplied shall be laid with the largest face downwards and in contact with each other. The stones shall break joint as far as possible. The full thickness of the soling shall generally be made with one stone only. Unless otherwise provided in the plans or directed by the Engineer-In-Charge, the width of the soling shall be 30cm more than that of the metal above.

As the laying of rubble advances the soling shall be hand packed by wedging and packing with 80mm metal collected for the purpose in the joints of the soling and driving them by hammers in place so as to fill the voids as completely as possible. This operation of hand packing shall follow the rubble laying closely. The soling shall be laid and hand packed true to grade and section and these shall be often checked by boning rods, template boards and fish lines, etc. The grades sections etc. of the soling shall correspond to those of the surfacing coming on it.

The soling thus laid shall be finished by knocking out projecting stones and filling depressions by chips to come up to the grade and camber.

3.5. Low density polyethylene (LDPE) sheets :**Materials**

LDPE Sheets of approved quality and thickness as mentioned in the item description or as shown on the drawing shall be used.

Laying

A separation membrane to be used between the concrete floor and the sub-base shall be unless otherwise specified impermeable plastic sheeting of 150 micron thick laid in flat without creases. Before placing the LDPE sheet, the sub-base shall be prepared to the correct line and level, swept clean of all the extraneous material using air compressor. Whenever overlap of LDPE sheet is necessary the same shall be at least 300mm and any damaged sheeting shall be replaced at Contractor's expense.

3.6. Damp Proof Course**Material**

Cement concrete shall consists of specified proportion and thickness. Cement, sand, aggregate and water etc. shall be as specified under Mortars- under relevant clauses as applicable. Hot bitumen shall be of approved quality and conforming to IS: 3117 / IS: 3037. Integral cement waterproofing compound to be used shall conform to IS 2645. It shall be from approved standard manufacturers and shall be approved by the Engineer-In-Charge.

Laying

Cement concrete layer of specified proportion and thickness shall be laid. The surface of brick / concrete shall be levelled and prepared before laying the cement concrete. Edge of damp proof course shall be straight, even and vertical. Side shuttering shall be strong and properly fixed. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mix. There shall be no construction joint in the damp proof course.

Curing

Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.

Application of Hot Bitumen

Hot bitumen in specified quantity shall be applied over the dried up surface of cement concrete properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil .The hot bitumen shall be applied uniformly all over, so that no blank spaces are left anywhere.

Waterproofing Agent / Ingredients

Waterproofing agent / ingredients of approved quality shall be added to the concrete mix in accordance with the manufacturer's specification subject to approval of the Engineer-In-Charge.

4. MORTARS

4.1. Cement Standard

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

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

Supply & Storage

The cement to be used on works shall be OPC or PPC (fly ash based) as specified.

Unless otherwise specified, Ordinary Portland Cement or PPC shall be supplied in bags containing 50 Kg. each.

Stacking of cement rejected due to aging or not fulfilling IS requirements shall be at the cost of the Contractor. Cement held in storage for a period of 90 days or more shall be re-tested before use.

Tests

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

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

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

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

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

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

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

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

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

Following tests shall be conducted at site on each lot of cement delivered:

TABLE 1

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

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

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

4.2. Fine Aggregate Standard

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

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

For Mortar & Grout - IS: 2116

For Plastering - IS: 1542 (Class A grading)

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

Source

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

Storage

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

Usage

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

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

4.3. Water Standard

Water supplied shall conform to the various provisions detailed under Clause 5.4 of IS 456:2000. Broadly stated water used for mixing and curing as also for cooling / washing of aggregates shall be clean and fresh, free from oils, acids, alkalises, salts, sugar, organic

materials or other substances that may be deleterious to concrete or steel. Sea water or water from excavation shall not be used.

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

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

To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H₂SO₄. The test shall be conducted as detailed in 8 of IS 3025 (Part 23).

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

TABLE 2

SI. No.	Particulars	Tested as per	Permissible limits Max
i)	Organic	IS 3025 (Part 18)	200 mg/l
ii)	Inorganic	IS 3025 (Part 18)	3000 mg/l
iii)	Sulphates (as SO ₃)	IS 3025 (Part 24)	400 mg/l
iv)	Chlorides(as Cl)	IS 3025 (Part 32)	2000 mg/l for concrete not consisting embedded steel & 500 mg/l for reinforced concrete work
v)	Suspended matters	IS 3025 (Part 17)	2000 mg/l

Storage

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

Tests

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

4.4. Fly Ash

Material

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

Fly ash shall be protected from dirt collecting on it.

4.5. Mortar Mixing

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

Precaution

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

5. PLAIN CEMENT CONCRETE (PCC) WORKS

5.1. Cement

Cement shall be as specified under –Mortars specifications.

5.2. Aggregate

5.2.1.Coarse Aggregates

Standard

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

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

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

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

Source

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

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

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

Trade group of principal rock type as per table given below

Presence or reactive minerals.

TABLE 3

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

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

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

Storage

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

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

Usage

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

Tests

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

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

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

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

5.2.2.Fine Aggregates

Fine aggregates shall be as specified under –Mortars specifications.

5.2.3.Water

Water shall be as specified under –Mortars specifications.

5.2.4.Fly Ash :

Fly ash shall be as specified under -Mortars specifications.

5.2.5.Admixtures :

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

5.2.6.Placing of Cement Concrete

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

5.3. Formwork

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

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

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

5.4. Measurement

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

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

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

6. REINFORCED CEMENT CONCRETE

6.1. Cement

Cement shall be as specified under - Mortars specifications.

6.2. Coarse Aggregate

Coarse Aggregates shall be as specified under- Mortars specifications.

6.3. Fine Aggregate

Fine aggregates shall be as specified under- Mortars specifications.

6.4. Water

Water shall be as specified under –Mortars specifications.

6.5. Fly Ash :

Fly ash shall be as specified under –Mortars specifications.

6.6. Admixtures

6.6.1.General :

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

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

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

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

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

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

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

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

The chemical names of the main ingredients in the admixtures.

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

Values of dry material content, ash content and relative density of the admixture which can be used for uniformity tests.

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

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

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

In addition the following conditions also shall be satisfied:

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

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

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

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

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

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

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

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

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

6.6.2. Material Admixtures

Pozzolana

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

Fly ash (Pulverized fuel ash)

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

Silica fume

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

Rice husk ash

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

Metakoline

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

Ground granulated blast furnace slag (GBSS)

Ground granulated blast furnace slag obtained by grinding granulated blast furnace slag conforming to IS 12089 may be used as part replacement of Ordinary Portland cement provided uniform blending with cement is ensured.

6.7. Placing of Concrete – (Plain & Reinforced)

Grades of Concrete

Various grades of concrete shall be as per **IS 456 - 2000 (latest)** with specified characteristic compressive strength against these grades in accordance with Table 2 in the said IS. In the grade designation, letter ‘M’ refers to the mix and the number to the specified characteristic compressive strength of 15 cm. cube at 28 days expressed in N/mm². The characteristic strength is defined as the strength of material below which not more than 5 percent of the test results are expected to fall.

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

Design Mix Concrete

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

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

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

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

Nominal Mix Concrete

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

TABLE - 4

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

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

TABLE - 5

I.S. Sieve Designation	Percentage passing for single sized aggregate of nominal					Percentage passing for graded aggregate of			
	40 mm.	20 mm.	16 mm.	12.5 mm.	10 mm.	40 mm.	20 mm.	16 mm.	12.5 mm.
63 mm.	100	-	-	-	-	-	-	-	-
40 mm.	85-100	100	-	-	-	95-100	100	-	-
20 mm.	0-20	85-100	100	-	-	30-70	95-100	100	100
16 mm.	-	-	85-100	100	-	-	-	90-100	-
12.5 mm.	-	-	-	85-100	100	-	-	-	90-100
10 mm.	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm.	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36 mm.	-	-	-	-	0-5	-	-	-	-

Mix Design & Proportioning

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

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

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

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

Standard Deviation

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

Acceptance Criteria

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

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

1.2 Any individual test result complies with the appropriate limits in column 3 of Table 6.

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

- 1.3 The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm²
- 1.4 The strength determined from any test results is not less than the specified characteristic strength less 0.3 N/mm²

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

For the individual test result requirements given in col. 3 of Table 6 or in item (b) of above only the particular batch from which the sample was taken shall be at risk.

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

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

Cement content of concrete

For all grades of concrete manufactured / produced, minimum cement content in the concrete shall be 310 kg per cubic metre of concrete. Also, irrespective of the grade of concrete, the maximum cement content shall not be more than 500 kg per cub. m of concrete. These limitations shall apply for all types of cements of all strengths.

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

Approval of Design Mix

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

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

Quality Assurances Measures

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

Proportioning & Batching

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

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

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

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

Grading of Aggregate & Foreign Material Limitations

Coarse Aggregate

- Coarse aggregates shall be either in single size or graded; in both cases, the grading shall be within acceptable limits .
- The percentages of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the volumes given in table here below.

TABLE - 6

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

Fine Aggregate

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

TABLE - 7

I.S. Sieve Designation	Grading Zone-I % passing	Grading Zone - II % passing	Grading Zone - III % passing	Grading Zone - IV % passing
10 mm.	100	100	100	100
4.75 mm.	90-100	90-100	90-100	95-100
2.36 mm.	60-95	75-100	85-100	95-100
1.18 mm.	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

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

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

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

TABLE - 8

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

Water Cement Ration (W/C Ratio)

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

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

variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

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

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

Workability

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

TABLE - 9

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

a) Mixing of Concrete

All concrete whether design mix or nominal mix shall be mixed in an approved mechanical mixer. The mixer shall comply with IS : 1791 & IS : 12119. The mixer shall be fitted with water measuring (metering) devices.

Material for concrete shall be deposited into the mixer drum while it is in rotation in the following order.

Coarse aggregate, cement, fine aggregate and water

The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete should not be remixed.

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

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

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

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

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

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

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

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

b) Transporting and Placing of Concrete

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

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

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

Method of placing of concrete should be such that no segregation occurs during placing. Generally concrete shall not be dropped freely from a height of more than 1.2 meters in the works of watertight structures and 1.6 m. in all other works. When required to be

deposited from a greater height, it shall be done through a metal-lined chute with slope no flatter than 1:3 (vertical : horizontal) and not steeper than 1:2. The discharge end of the chute will be provided with a baffle plate to prevent segregation. The discharge end of the chute shall be maintained above the surface of the concrete in forms and concrete shall not be permitted to fall from the end of chute by more than 1 m. During cleaning a chute, the waste water shall be kept clear of the forms.

c) Compaction of Concrete

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

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

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

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

d) Concreting in Inclement Weather

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

e) Concreting under water

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

f) Curing

All concrete shall be protected during hardening from the harmful effects of sunshine and drying winds. All exposed surfaces of newly placed concrete shall be kept continuously in a damp or wet condition by water ponding or by covering with a canvas, hessian or similar other water absorbent materials and kept continuously wet for at least seven days from the date of placing of concrete. Likewise all formwork directly in contact with concrete

shall be kept dry. Curing compounds to provide surface coating with specking equipment may also be used if permitted by the Engineer-In-Charge. The necessary literature shall be furnished by the Contractor for the purpose.

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

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

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

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

g) Expansion Joints

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

h) Construction Joints & Keys

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

If stopping of concreting becomes unavoidable anywhere, properly formed construction joints shall be made along where the work is stopped. These joints shall be either vertical or horizontal, unless shown otherwise on drawings. In case of an inclined or curved member, the joint shall be at right angles to the longitudinal axis of the member. Vertical joints in walls shall be kept to a minimum. Vertical joints shall be formed against a stop board. Horizontal joints shall be level and wherever possible, arranged so that the joint lines coincide with the architectural features of the finished work. Battens shall be nailed to the formwork to ensure a horizontal line and if directed shall also be used to form a grooved joint. For tank walls and similar work joints shall be formed as per IS 3370. Concrete that is in the process of setting shall not be disturbed or shaken by traffic either on the concrete itself or upon the shuttering. Horizontal and vertical construction joints and shear keys shall be located and shall conform in detail to the requirements of the plans unless otherwise directed by Engineer-In-Charge. Where not described, the joint shall be in accordance with the following.

Column Joint

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

Beam & Slab Joint

Concrete in a beam shall be placed throughout without a joint but if the provision of a joint is unavoidable the joint shall be vertical and at the centre or within the middle third of the span unless otherwise shown on drawings. Where a beam intersects a girder, the

joints in the girder shall be offset a distance equal to twice the width of the beam and additional reinforcement provided for shear. The joints shall be vertical throughout the full thickness of the concrete member. A joint in a slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidably at right angles to the principal reinforcement, the joint shall be vertical and at the middle of the span.

Joints in Liquid Retaining Structures

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

Where the work has to be resumed on a surface which has hardened, any skin or laitance shall be removed and the surface roughened by hammering with an approved power-operated "bush" hammer followed by wire brushing to remove all loose practices. When using this procedure, great care shall be taken to avoid disturbing concrete matrix. The surface is then thoroughly wetted. Fresh concrete should thoroughly be vibrated near the construction joint so that mortar from the new concrete flows between large aggregates and develop proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear key may be provided. Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces.

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

i) Sampling & Testing of Concrete

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

Facilities required for sampling materials and concrete in the field, if Engineer-In-Charge so desires, shall be provided by Contractor at no extra cost. The following equipment with operator shall be made available at Engineer-In-Charge's request (all must be in serviceable conditions) –

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

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

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

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

TABLE 10

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

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

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

j) Concrete Below Specified Strength

Should the concrete tests fail to meet the minimum specified strength requirements for the respective grades of concrete, the Engineer-In-Charge may take one of the following decisions –

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

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

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

k) Repair & Replacement of unsatisfactory Concrete

Immediately after the shuttering is removed, the surface of concrete shall be carefully inspected and all defective areas called to the attention of Engineer-In-Charge who may permit patching of the defective areas or also reject the concrete unit either partially or

fully shall be attended. Rejected concrete shall be removed and replaced by Contractor at No additional expense. Holes left by bolts etc. shall be filled up and made good with mortar composed of one part of cement to one and half parts of sand passing 2.36 mm. IS sieve after removing loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of the concrete. Concrete surfaces shall be finished as described under the particular items of work.

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

Use of Epoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Engineer-In-Charge. Epoxies shall be applied in strict accordance with the instructions of the manufacturer. Only flexible epoxy shall be permitted with certain minimum solid contents as recommended by the Engineer-In-Charge. The use of epoxy if any shall be at no extra cost to the Employer.

Method of Repair

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

Before surface treatment, grouting may have to be done by equal strength shrinkable grout. Unless otherwise specified, 5 mm. thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly prod of the surrounding surface. The concrete patch shall be built up in 10 mm. thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden flat and a smooth finish obtained by wiping with hessian, a steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportions as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.

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

Curing of patched work

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

Approval by Engineer-In-Charge

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

1) Finishing

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

Finish for Formed Surfaces

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

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

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

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

Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless the drawing specifies a horizontal surface or shows the slope required, the tops of narrow surface such as stair treads, walls, curbs and parapets shall be sloped across the width approximately 1 in 30. Broader surface such as walkways, roads, parking areas and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete, sub-floors to be covered with concrete topping, terrazzo or quarry tile and similar surfaces shall be smoothing screened and levelled to produce even surfaces. Surface irregularities shall not exceed 6 mm. Surfaces which will not be covered by backfill, concrete or tiles toppings such as outside decks, floors of galleries and sumps, parapets, gutters, side walks, floors and slabs, shall be consolidated, screened and floated. Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screened surface has attained the stiffness to permit finishing operations and these shall be the minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints and edges shall be tooled as called for on the drawings or as directed by the Engineer-In-Charge.

Standard finish for exposed concrete

Exposed concrete shall mean any concrete, other than floors or slabs, exposed to view upon completion of the job.

Unless otherwise specified on the drawings, the standard finish for exposed concrete shall be a smooth finish.

A smooth finish shall be obtained with the use of lined or plywood forms having smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms the joint

marks shall be smoothed off by grinding etc. and all blemishes, projections etc. removed leaving the surfaces reasonably smooth and unmarred.

Integral cement concrete finish

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

Protection

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

Measurement

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

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

No deductions shall be made for-

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

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

- 1) Footings (sloped) –

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

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

- b) Slabs -

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

- c) Columns -

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

the column height.

d) Beams -

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

e) Lintels

The length shall be measured including the bearing lengths.

f) Chajja's

Measurement of chajjas shall be inclusive of bearings.

Rate

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

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

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

6.8. Formwork

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

Material

Formwork may be of timber, plywood, steel or other metal, plastic or concrete or any suitable material. For special finishes the formwork may be lined with plywood, steel sheets, oil tempered hard board etc. Dented steel plates will not be allowed and shall not be used at all.

Timber shall be easily workable without splitting and shall not warp when exposed to sun or rain or wetted during concreting. Plywood shall be 12 mm. thick complying with IS 4990 and steel shall be 3 mm. black sheets suitably stiffened with angles or appropriate equivalent.

Sliding forms and slip forms may be used for special purpose construction with the approval of the Engineer-In-Charge.

Design

Formwork shall be adequately designed to cater for all the vertical (dead load of wet concrete, superimposed live loads during construction, materials, equipment etc.) and lateral loads without causing displacement, deflection or movement of any kind. The Contractor shall be entirely responsible for the design and stability of formwork regardless of whether he is instructed to furnish the design calculations, drawings and other particulars of his proposal or not, and regardless of whether his proposal has been approved by the Engineer-In-Charge or not. All the expenses arising out of defective shuttering & centering resulting in dismantling / redoing the work etc. shall be to the Contractor's account. For details regarding design, detailing etc. reference may be made to IS 14687. Contractor shall submit formwork design & methodology for the approval of Engineer-In-Charge prior to execution.

Erection of Formwork

Forms shall be true to shape, lines, levels and dimensions of the concrete work as shown on the drawings and shall be rigidly constructed using adequate number of props, struts, ties, braces etc. Where props rest on natural or filled-up ground, the soil shall be thoroughly compacted to avoid any settlement. False-work shall be so constructed that vertical adjustments can be made to compensate the settlements. Wedges may be used at the top or bottom of timber shores, but not at both ends to facilitate vertical adjustments or dismantling of the formwork. No bamboos and wooden bullies shall be permitted to be used for props or cross bearers/bracings.

Proper precautions shall be taken to see that all joints in the formwork are watertight to prevent escape of slurry.

Connections in formwork shall be constructed to permit easy removal of the shuttering and shall be adequately secured by screws, bolts, clamps, wire etc. so as to be strong enough to retain the correct shape during consolidation.

Faces in contact with concrete shall be free from adhering ground, projecting nails, splits or any defects so that when stripped, any formation of blemishes is avoided. All formwork shall be carefully cleaned and thoroughly wetted or treated with an approved chemical compound. Care being taken to keep all reinforcement away from contact from such composition.

Unless specifically permitted, wire ties passing through the walls and through bolts are not permitted. For fixing of formwork, alternative arrangements such as coil nuts shall be adopted at the Contractor's cost.

Plywood shall be used for Exposed Concrete surfaces; where called for. Sawn and wrought timber may be used for unexposed surfaces. Inside faces of forms for concrete surfaces which are to be rough finished shall be planed to remove irregularities or unevenness in the face. Formwork with linings will be permitted.

All new and used form timber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness.

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

Forms for substructure concrete may be omitted when, in the opinion of Engineer-In-Charge the open excavation is firm enough to act as the form. Such excavations shall be

slightly larger than required by the drawings to compensate for irregularities in the excavation and to ensure the design requirements. No extra payments on this account will be made in any item of work.

Forms shall be so designed and constructed that their removal will not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conform to the architectural features of the structure as to location of joints and as directed by Engineer-In-Charge.

Where exposed smooth or rubbed concrete finishes are required the forms shall be constructed with special care so that the resulting concrete surface requires a minimum finish.

Bracings, Struts & Props

Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men & other materials. Bamboo's shall not be used as props or cross bracings.

The shuttering / forms for beams and slabs shall be so erected that the shuttering / forms on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of beams bottom forms shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.

Mould Oil

Care shall be taken to see that the faces of formwork coming in contact with concrete are perfectly cleaned and two coats of mould oil or any other approved material applied before fixing reinforcement and placing concrete. Such coating shall be insoluble in water, non-staining and not injurious to the concrete. It shall not become flaky or be removed by rain or wash water. Reinforcement and/or other items to be cast in the concrete shall not be placed until coating of the forms is complete. Adjoining concrete surfaces shall also be protected against contamination from the coating material.

Chamfers and fillets

All concrete and angles exposed in the finished structure shall be formed with mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 2cm x 2cm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

Vertical Construction Joint Chamfered

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

Wall Ties

Wire ties passing through the walls shall not be allowed. In their place bolts passing through sleeves shall be used.

Reuse of Forms

Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary repaired and the inside retracted to prevent adhesion, to the satisfaction of Engineer-In-Charge. Warped timber shall be resized.

Removal of Forms

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

In no circumstance shall forms be struck until the concrete reaches a strength of at least twice the stress due to self weight and any construction/erection loading to which the concrete may be subjected at the time of striking formwork.

Nor formwork shall be removed or otherwise allowed to move until concrete attains sufficient strength against own weight and external load as per the stipulations of Clause 11.3 of IS 456-2000.

The stripping of formwork shall be done without shock or vibration so that no damage is caused to newly cast concrete. Any damage resulting from premature removal of shutters or from any other cause whatsoever shall be made good by the Contractor at his own expense as directed by the Engineer-In-Charge.

In normal circumstances generally where ambient temperatures are above 15°C and ordinary port land cement is used forms may be struck after expiry of the following periods:

TABLE - 11

Type of formwork	Ordinary Portland Cement Concrete
a) Vertical formwork to columns, walls, beams	16-24 hrs
b) Soffit formwork to slabs (Props to be refixed immediately after removal of formwork)	3 days
c) Soffit formwork to beams (Props to be refixed immediately after removal of formwork)	7 days
d) Props to slabs 1) Spanning up to 4.5 m 2) Spanning over 4.5 m	7 days 14 days
e) Props to beams and arches: 1) Spanning up to 6 m 2) Spanning over 6 m	14 days 21 days

For other cements and or lower or higher temperature, the stripping time as above may be suitably modified with prior approval of the Engineer-In-Charge.

Oiling of forms

Use of form / mould oil will not be permitted on the surfaces which require painting.

Tolerances

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

Tolerances for RC buildings

- Variation from the plumb
 - In the lines and surfaces of columns, piers, walls and in arises 5 mm. per 2.5 m. but not more than 25 mm.
 - For exposed corner columns and other conspicuous lines.

In any bay or 5 m. maximum - 5 mm
 In 10 m. or more - 10 mm

- Variation from the level or from the grades indicated on the drawings –
 - In slab soffits, ceilings, beam soffits and in arises.

In 2.3m - 5 mm
 In any bay or 5 m. maximum - 8 mm
 In 10m or more - 15 mm

- For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.

In any bay or 5 m. maximum - 5 mm
 In 10m or more - 10 mm

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

- In any bay or 5 m. maximum - 10 mm
- In 10 m. or more - 20 mm.

- Variation in the sizes and location of sleeves, openings in walls and floors 5 mm. (except in the case of and for anchor bolts).

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

- Footings

- Variation in dimension in plan **(- 5 mm. + 50 mm.)**
- Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm.

- Reduction in thickness
 5% of specified thickness subject to a maximum of 50 mm.

- Variation in Steps

	<u>RISE</u>	<u>TREAD</u>
a) In a flight of stairs	3 mm.	5 mm.
b) In consecutive steps	1.5 mm.	3 mm.

i) Tolerances in other concrete structures

Variation of the constructed linear out line from established position in plan.

In 5 m.	10 mm.
In 10 m. or more	15 mm.

ii) Variations of dimensions to individual structure features from established positions

In 20 mm. or more	25 mm.
In buried construction	50 mm.

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

In 2.5 m.	10 mm.
In 5 m.	15 mm.
In 10 m. or more	25 mm.
In buried construction	Twice the above

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

In 2.5 m.	5 mm.
In 7.5 m.	10 mm.
In buried construction	Twice the above

v) Variation in cross sectional dimensions of columns, beams buttresses, piers and similar member **(- 5mm + 10 mm)**vi) Variation in the thickness of slabs, walls, arch sections and similar members.
(- 5mm + 10 mm)

Footings for columns, piers, walls, buttresses and similar members

Variation of dimensions in plan **(-10mm + 50mm)**

Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50mm

Reduction in thickness

5% of specified thickness subject to a mix of 50mm

Tolerances in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for Concrete Form-work (ACI-347).

Special Provision

Where exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the resulting concrete surfaces will required a minimum finish.

Wherever the concreting of narrow members is required to be carried out within shutters of considerable depth, temporary openings (windows) in the sides of the shutters shall, if so directed by the Engineer-In-Charge, be provided to facilitate the pouring and

consolidation of the concrete. Small temporary openings shall be provided as necessary at the bottom of shutters of columns, walls and deep beams to permit the expulsion of rubbish etc.

Measurement

a) Unless otherwise stated, shuttering shall be measured as the area of the finished structure which is required to be supported during the deposition of the concrete but no deduction shall be made for holes less than 0.10 Sq.m.

b) Shuttering to secondary beams shall be measured upto the sides of main beams but no deduction shall be made from the shuttering of the main beam where the secondary beam intersects it.

c) Shuttering to beams which intersect with stanchion casings or columns shall be measured upto them on all sides. No deduction shall be made from shuttering to stanchion or column casings at these intersections.

d) Shuttering at construction joint shall not be measured.

e) Shuttering for the cover blocks shall not be paid for separately but is included in the respective items of formwork items.

Rate

The rate of the form work includes the cost of labour and materials required for all the operations described above.

Unless otherwise specified the rate of form work shall allow for-

i) provision of required well supported false work such as staging, access and working platforms for concreting etc.

ii) provision of any dowels and inserts etc. to be left out from shuttering (dowels, inserts etc. themselves shall be paid for under respective items), provision of any holes, pockets, channels etc.

iii) removing the shuttering carefully after specified time limit or as directed.

iv) work at all depths and heights as specified in the item descriptions.

The formwork generally shall include-

i) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing etc.

ii) All supports, struts, braces, wedges as well as mud sills, foundation pads, ground improvement, temporary piles or other suitable arrangements to support the form work.

iii) Bolts, wire ties, clamps, spreaders, nails or any other to hold the sheathing together.

iv) Filletting to form stop chamfered edges of splayed external angles not exceeding 20 mm wide to beam, columns and the like.

- v) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.
- vi) Dressing with oil to prevent adhesion and
- vii) Raking or circular cutting.

Inspection of forms

Temporary openings shall be provided at the base of columns and wall forms and other places necessary to facilitate cleaning and inspection. Immediately before concrete is placed all forms shall be carefully inspected to ensure that they are properly placed, sufficiently rigid and tight, thoroughly cleaned, properly treated and free from foreign material.

When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer-In-Charge shall order all work stopped until the defects have been corrected.

6.9. Steel Reinforcement

Standard

Steel reinforcing bars shall conform to the following standards –

- Mild steel & medium tensile steel bars - IS: 432 (Part-I)
- High yield strength deformed steel bars - IS: 1786
- Hard- drawn steel wire fabric - IS: 1566
- Structural steel, Grade A - IS: 2062

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

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

Supply

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

Storage

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

Fabrication

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

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

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

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

Binding

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

Placing & Fixing

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

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

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

Cover

Spacing of reinforcement shall be governed by Clause 25.3 and cover to reinforcement by Clause 25.4 of IS 456-2000. Increased covers, if shown on the drawings or instructed by the Engineer-In-Charge shall be provided at the respective locations. Cover to reinforcement shall be as per IS 456-2000. Fully cured cement mortar blocks of 1:2 mix shall be used as cover blocks where no grade of concrete is specified and where grade of concrete is specified it shall be as per the same strength as that of the structural member. Any other cover blocks shall be used only on approval by the Engineer-In-Charge. However, use of pebbles or stones shall not be permitted. Where the bars cross, the outer one shall have the minimum cover.

Splicing & Lapping

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

Welded Laps

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

TABLE - 12

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

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

The following precautions shall be taken while providing welded laps:

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

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

The joints to be welded shall be rust free.

Weld slag shall be chipped off and removed by brush.

Welding Contract

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

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

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

Safety requirement and health provisions

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

Reinforcement to be clean

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

Checking Reinforcement

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

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

Measurement

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

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

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

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

Rate

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

6.10. Ready Mix Concrete

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

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

- The ready mixed concrete shall be Centrally Mixed Concrete unless otherwise specifically mentioned.
- Batching plant : The batching plant shall be of fully automatic central batching and mixing type conforming to the provisions of IS : 4925. The capacity of the plant shall not be less than 30 cu.m./ hour.
- The ready mixed concrete shall be manufactured strictly as per the approved mix design by Engineer-In-Charge and supplied on the basis of specified strength based on 28 day compressive strength of 15 cm cube tested in accordance with IS : 456 - 2000. For any change in quality / quantity in the ingredients of a particular concrete for which mix has been designed earlier and approved by the Engineer-In-Charge, the mix has to be redesigned and accordingly approval shall be obtained prior to use.

- Since the ready mixed concrete is a tailor made concrete, certain precautions are necessary for the concrete mix. Some of these are as listed below :
- Minimum quantity of cement and the details regarding proportioning and works control shall be in accordance with IS : 456-2000.
- The air content of the concrete shall not be more than 2% in any case. This shall be established by necessary testing at worksite.
- The dosage of the admixture shall be given at the batching plant only. Subsequent dosage of admixture shall not be permitted thereafter unless otherwise permitted by the Engineer-In-Charge.

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

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

Placing of Concrete :

When placing of concrete by manually the following shall apply –

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

When placing concrete by mechanical equipment, the following shall apply

Central-bottom-dump buckets which provide for positive regulation of the amount and rate of deposition of concrete in all dumping position shall be employed. Concrete shall be discharged by a vertical drop into the middle of bucket or hopper. In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and shall be opened slowly to avoid high vertical bounce. The height of drop of concrete shall not exceed 1 m. Dumping in a manner which would result in segregation of concrete ingredients shall not be permitted.

If pumps & pneumatic placers are used for conveying and placing concrete

Concrete mix with desired slump shall be appropriately designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping is started. Care shall be taken to minimize frictional losses.

Before commencing to pump concrete, the pipeline shall be "Lubricated" with two batches of 1:2 cement and sand mortar. If required, sponge balls to be placed in pipes before grouting. Adequate emergency for washing / cleaning of pumps and pipelines to be made for efficient working. Supports to the pipes should be firmly ensured.

Manufacturers' instructions regarding pipeline layout, concrete quantity etc. shall be taken to avoid problems as blockages and excessive wear etc.

Pipe dia to be adequate and minimum pipe dia. to be three times the maximum aggregate size of the concrete mix. The pipe should be as far as possible rigid to avoid increased frictional losses and cleaning problems. Aluminium pipes shall not be used under any circumstances.

Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 cm to 90 cm such that the formation of cold joints, of planes of weaknesses between each succeeding layer within the pour are avoided. 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 shovelling.

Freshly laid concrete shall not be wheeled over or walked over or otherwise disturbed.

When depositing concrete adjacent to a construction joint, special care shall be taken not to disturb the dowels or other reinforcing bars projecting from the existing concrete.

In vertical members like walls, columns, pardis etc. where the full height is not being poured in one continuous operation, the surface of each lift shall be finished horizontal and any laitance removed between the period of initial and final set.

Admixtures

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

- Certificate conforming that the use of a particular brand of admixture shall not be harmful to concrete in any way.
- Certificate conforming the exact dosage of admixture of a particular brand
- Certificate stating the specific purpose for which the admixture is to be used.
- Special precautionary measures to be taken in the manufacturer of concrete when using the particular brand of admixture.
- Certificate conforming that the admixture conforms to specifications of IS 9103 or to ASTM – C 260, ASTM – C 10, ASTM – C 595 or to ASTM-C 618.

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

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

All test shall be done in the presence of a representative nominated by the Engineer-In-Charge and a representative of the concrete manufacturer / Contractor when tests are performed at the site laboratory. All observations and reports of test shall be jointly

signed by the two representatives before the test results are submitted to the Engineer-In-Charge for approval.

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

Sampling & testing for quality control of concrete

Fresh concrete

Fresh concrete shall be tested for

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

Slump

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

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

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

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

- point of discharge from delivery trucks
- final placement location

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

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

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

For all slump checks in the field at least two recordings shall be made and the average value taken as the recorded slump.

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

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

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

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

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

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

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

6.11. Industrial Vacuum Dewatered Flooring

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

Laying of Concrete

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

- Cutting and filling sealant of grooves / sawed joints / strips for placing land ties etc. shall be as shown on approved drawings, as instructed by the process agencies subject to prior approval of Engineer-In-Charge.
- Application of non-metallic floor hardener of approved makes / unless otherwise specified at 7 Kg/Sq.m. shall be sprinkled over green concrete in alternate bags and

trowel simultaneously. Floor laid is to be trowel to acquire desired smooth finish with power trowel.

- When initial setting of concrete is reached, from next day onwards curing with water shall be carried out for minimum seven days.

6.12. Pre-cast Cement Concrete Jali

Material-

The jali shall be of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 6 mm nominal size) conforming to the specification as described under Clause No. 3005.1, reinforced with 1.6 mm thick mild steel wire, unless otherwise specified.

Fixing

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

Measurements

The jali shall be measured for its gross superficial area.

Rate

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

6.13. Encasing Rolled Steel Section

Before concrete work is started, the Engineer-In-Charge shall check that all rolled steel sections to be encased, have been erected truly in position. The sections shall be unpainted and shall be wire brushed to remove the loose rust/scales etc. Encased steel sections shall be jointed with M.S. reinforced bars / links as shown on the drawings and as directed by the Engineer-In-Charge. The reinforced bars / links shall be in conformation with the specifications as described under Clause 3005.9 above.

Concreting

Concrete shall be of specified grade in the item description. Consistency of concrete, placing of concrete and its compaction, curing, finishing and strength of concrete shall be in accordance with the specification as specified of this Section under relevant clauses as applicable. The mix shall be poured around the steel sections and around the wrapping by vibrating the concrete into position.

Measurement

The length shall be measured correct to one cm and other dimensions correct to 0.5 cm. The cement concrete shall be measured as per gross dimensions of the encasing exclusive of the thickness of plaster. No deductions shall be made for the volume of steel sections, expanded metal, mesh or any other reinforcement used therein. However, in case of boxed stanchions or girders, the boxed portion only shall be deducted.

Reinforcement shall be measured and paid separately. The description shall include the bending of the fabric as necessary, raking or circular cutting and waste shall be included in the description.

Rate

The rate shall include the cost of materials and labour required for all the operations described above except the cost of reinforcement. The cost of providing and erecting steel section and wire hangers reinforcement shall be paid for separately.

7. BRICKWORK

Materials

Bricks used for masonry work shall conform to IS 1077 except that sizes shall be as per the approved local bricks. The crushing strength shall be as specified in IS 3495.

Bricks shall be of uniform size shape and colour. They shall be well burnt and free from cracks, twists, stones, floats or nodules of lime and other defects. They shall have sharp and square edges and parallel faces, sound texture, uniform colour and they shall give a ringing sound when struck with a mallet. No brick shall absorb on average water more than 20% of its dry weight in 24 hours.

Brick shall be procured from source/s to be approved by the Engineer-In-Charge.

It shall not break when struck against each other and dropped flat from a height of one meter on ground.

Mortar- The mortar for the work shall be as specified under - Mortars specifications.

Laying

All the masonry work shall be carried out to specified dimension, lines and levels indicated on the drawings or as directed by the Engineer-In-Charge and a good bond shall be provided throughout the work both longitudinally and transversely.

Double scaffolding of adequate strength shall be provided for all types of loads likely to come on them during construction. No holes allowed in masonry for scaffolding.

During rains and frosty weather, the work shall be carefully covered so as to prevent any mortar being washed away.

Any anchors, wall plugs, accessories, flashings and other items required to be built in with masonry shall be provided in their correct position as the masonry work progresses.

Before new work is started, all loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

Brick Work Proper

Every brick shall be thoroughly soaked in water before using in work. Before starting the brick masonry the concrete surfaces e.g. plinth beams, columns, slabs, chajjas, lofts etc. shall be thoroughly hacked and washed to remove all mud, dirt, loose particles etc. and a thin coat of cement slurry shall be applied over concrete surfaces when fresh masonry is to be started on or against old masonry, the surface of the old masonry shall be thoroughly cleaned and washed to remove all moss deposits loose mortar mud and dirt etc.

Brickwork shall be laid in English Bond with frog upwards unless otherwise specified. In exposed brickwork, selected bricks of the specified class shall be used for the face work. No half or quarter brick shall be used except as closures. Nor more than ten courses shall be raised in a day and no part of the work shall be raised more than 1 m. above another at any time.

The size of the brick shall be 22.5 x 11.5 x 7.5 cm. unless otherwise specified; but tolerance upto ± 3 mm. in each direction shall be permitted, However, bricks conforming in size to IS 1077 could be used. Bricks shall be provided with frogs. Only full size bricks shall be used for masonry work. Brick bats shall be used only with permission of the Engineer-In-Charge to make up required wall length or for bonding. Sample bricks shall

be submitted to the Engineer-In-Charge for approval and brick supplied shall confirm to approved samples. If demanded by Engineer-In-Charge, brick sample shall be tested as per IS 3495 by the Contractor at no extra cost to Employer. Brick rejected by Engineer-In-Charge shall be removed from the site of works within 24 hours.

Each brick shall be set with both bed and vertical joints filled with mortar as per IS 2250. Joints shall not be less than 6 mm. and not more than 10 mm. in thickness and are to be full of mortar, close, well finished and neatly struck. All joints shall be adjusted to their final position in the wall while the mortar is still soft and plastic. All joints shall be raked out by raking tools when mortar is still green to a depth of 12 mm. to ensure good key to plaster or pointing. Where plastering or pointing is not required to be done, the joints shall be uniform in thickness, struck flush and finished at the time of laying.

The face of brick work shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If the mortar in the lower course has begun to set, the joints shall be raked out to a depth of 12 mm. before another course is laid.

Miscellaneous inserts in masonry e.g. sleeves, wall ties, anchors, conduits, structural steel, steel lintels etc. shall be installed by the Contractor. Openings etc. shall be provided as shown on the drawings. Chases, pockets etc. shall be provided as shown on the drawing to receive windows, louvers, doorframes, circular openings for exhaust fans etc.

Curing shall constantly keep the brick masonry moist on all faces for a minimum period of seven days. Brickwork done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on curing period.

7.1. Half Brick Work

Material

Bricks and mortar shall be as specified under -Brick work specifications.

The reinforcement used for the half brick work shall be as specified under- Reinforced Cement Concrete specifications. All steel reinforcement before the concrete for RC stiffeners / patli is deposited shall be clean, free from dust, loose scales, oils, rust, grease or any other deleterious materials. Particular care shall be taken to avoid contamination of reinforcement with mould oil.

Cement concrete – The cement concrete work for RC stiffeners/ patli of specified grade shall be as specified under - Reinforced Cement Concrete specifications.

Laying- Generally shall be laid in the same manner as described under- Brick work specifications.

Half-brick work shall be carried out in panels and with horizontal stiffeners of 75 mm. thick unless otherwise specified 900mm at vertical intervals, with MS 2 No. 6mm. dia. Reinforcements laid in 1:2:4 nominal mix concrete properly filled as per specifications. These shall be securely anchored at their end where the partitions end. The free ends of the reinforced shall be keyed into the mortar of the main brick work to which the half brick work is joined. The mortar used for reinforced brick work shall be rich dense cement mortar of mix 1:4 .Over laps in reinforcement, if any shall not be less than 30cm The mortar interposed between the reinforcement bars and bricks shall not be less than 5mm. The mortar covering in the direction of joints shall not be less than 15mm

Measurement

The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m where half brick wall is joined to the main walls one brick greater thickness and measurements for half brick wall shall be taken for its clear length from the face of the thicker wall.

In case of half brick masonry with RC stiffeners / patlis etc., stiffeners including reinforcement, shuttering etc. shall not be measured for separately.

Deductions shall be as described under –Brick work specifications.

Rate

The rate includes the cost of the materials & labour involved in all the operations described above including RC stiffeners & reinforcement, double scaffolding, curing etc.

8. STONE WORKS**8.1. Materials**

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

Rubble

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

Stone metal (for Roads /path ways)

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

8.2. Laying

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

8.3. Pre-cast Block Masonry Work**Material**

Solid concrete block shall confirm to IS 2185 (I) – latest grade D (5.0) but shall have minimum compressive strength of 5 N/mm² & density not less than 1800 Kg per cub.m. Water absorption average Value of min. 3 units shall not be more than 10% by mass. Mix design for the blocks shall be got prepared from approved lab & further got approved from the Engineer-In-Charge.

Only factory made properly cured concrete blocks shall be used. Manually compacted / hand compacted blocks shall not be permitted at any case. The face of masonry units shall be flat and rectangle, opposite face shall be parallel, and all arises shall be square. The bedding surface shall be at right angles to faces of the block. Storage and stacking as described under relevant IS codes or as directed.

Testing of blocks and frequency shall be as per IS codes. Standard deviation shall be worked out as periodically & mix design shall be reviewed accordingly. The maximum variation in the length of units shall not be more than ± 5 mm and maximum variation in height and width of unit ,not more than ± 3 mm.

Mortar shall be as described under - Mortars specifications. The mortar used for solid block masonry work shall be rich dense cement mortar of mix 1:4.

Work Procedure for block masonry:

Before commencement of work contractor shall ensure that the blocks are semi dry. They should not be soaked in water at the time of use.

Blocks in successive courses should be laid in such a manner that vertical joints are staggered uniformly. Precast half-length closers (cut from full size blocks) shall be used. For battered faces, bedding shall be at right angles to the face unless otherwise directed. Care shall be taken during construction to see that edges of blocks are not damaged.

Two top layers of masonry work shall be constructed after 8 days period from successive course of masonry work. After the construction of balance two layers, the gap between RC work & masonry work shall be filled with metal or grit with proper hammering / cement mortar.

For 10 cm thick Block masonry RC horizontal stiffeners 10 cm thick at every 1.0 meter height or as indicated in the drawing at vertical intervals, with MS 2 No. 6 mm. dia. reinforcements laid in 1:2:4 concrete properly filled as per specifications.

Racking should be done up to depth 12 mm., then remove all excess mortar from masonry wall surface.

In one day's work allow mason to do the masonry work up to 1.0 meter height only

The blocks shall be cast in full / half & quarter length to avoid breakage during construction.

Curing

Newly laid masonry shall be thoroughly cured for 10 days and shall be protected from the effects of sun, rain etc. by suitable covering.

Measurement

The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m where partition block wall is joined to the main walls one block greater thickness and measurements for 10 cm thick block wall shall be taken for its clear length from the face of the thicker wall.

In case of 10 cm thick block masonry, with RC stiffeners / patlis etc. Stiffeners including reinforcement, shuttering etc. shall not be measured separately.

Deductions in Block work shall be as described under -Brick work specifications.

Rate

The rate includes the cost of the materials and labour involved in all the operations described above including RC stiffeners and reinforcement, curing etc and double scaffolding unless specified.

9. MARBLE/ GRANITE STONE WORKS**9.1. Materials**

Marble slabs / Granite slabs shall be of the best quality and in sizes and thickness as approved by the Engineer-In-Charge. The specified thickness shall be taken at the thinnest part.

They shall be hard, dense, uniform and homogenous in texture having clean crystallizing grain and free from all defects and cracks. The edges shall be machine cut true and square and surface shall be machine polished to an even and perfectly plain surface.

Marble slabs shall confirm to IS 1130 – 1969.

Granite slabs shall confirm to IS 3316 – 1974.

Before starting the work, the Contractor shall get approval of samples of marble/ granite stones from the Engineer-In-Charge. Approved samples shall be kept in the custody of the Engineer-In-Charge and marble/ granite supplied / used on the work shall strictly conform to the samples approved by the Engineer-In-Charge with regard to soundness, colour, veining and general texture.

Stones to be used for skirting and dado shall be from the same stock and shade as used for floors. Tolerance in thickness of stone shall be ± 3 mm.

9.2. Flooring/ dado/ skirting**General**

The surfaces to be laid with flooring or dado shall be thoroughly hacked, joints of masonry racked, cleaned of all mortar scales and concrete lumps and loose materials etc. and washed to remove mud, dirt, oil, grease etc. from the surface and shall be thoroughly wetted.

All stones shall be laid in a pattern given on the drawings or directed by the Engineer-In-Charge.

All stones in floor shall be truly and evenly set and pressed in position to obtain uniform plane surface. The skirting tiles shall be in true plane, level and plumb.

Flooring /dado work shall not be started unless and until the surface is approved by the Engineer-In-Charge.

9.3. Marble / Granite Stone work in steps / platforms / frames etc.**Materials**

Material and general specifications shall be as described under –granite/ Marble flooring specifications except joint shall be permitted only at curvature or when width / length is more than 0.6 / 2 metres respectively. No of joints in each direction shall not be more than one for every 2 metres. Additional joints shall be provided as shown in the drawing subject to approval of Engineer-In-Charge. Finishing/ polishing if not possible with machine can be done by standard practices, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean.

9.4. Cudappa/ Granite/ Marble stone window framing**Materials**

Cudappa/Granite/ Marble stones / strips shall be of the best quality, sizes and thickness as specified and approved by the Engineer-In-Charge. The specified thickness shall be taken at the thinnest part. General specifications shall be as described under –Flooring specifications.

As sample of window framing shall be prepared and it shall be kept on worksite after being approved by the Engineer-In-Charge.

Mortar

The mortar used for jointing shall be as described under –Marble/ Granite Flooring specifications.

Laying

The stone shall be wetted before laying. The framing (about 200mm wide) shall be made by using 2 No. strips of suitable size stuck together with adhesive chemical to form a rebate of minimum 100mm for sliding and openable windows while one strip for Fixed ventilators/ Louvered windows. Laying / fixing of window framing shall be as described under - Marbles/ Granite flooring specifications. In case spans are more, where so desired the stones shall be secured to each other by means of copper pins 75mm long and 6mm diameter or as specified or as directed.

Joints

All joints shall be full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and re-laid. No joints in between are permitted unless otherwise specifically approved by the Engineer-In-Charge the framing stone shall be in single piece. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5mm in the face joint the top 6mm depth shall be filled with mortar.

Curing

The work shall be kept constantly moist on all faces for a period of at least seven days.

Finishing

Finishing shall be as described in the item description. Unless other wise exposed edges to be rounded off / chamfered and polished as specified or directed. When factory made finished slabs are used, no further polishing is required.

Protection and scaffolding

Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed. Green work shall be protected from rain by suitable coverings. The work shall also be suitably protected from damage during construction.

10. STEEL WORKS

10.1. Structural Work in built-up section (Welded/ bolted)

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

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

- Material movement / storage of material
- Fabrication scheme considering space constraints
- Scheme for erection to be done at about 30 mtr. height for trusses
- Retractable Roof work
- Sliding Motorized Doors work
- Structural steel work of Blasting Chamber.
- Necessary Safety precautions as per prevailing rules.
- Security formalities to be maintained being a MDL area.

General

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

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

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

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

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

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

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

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

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

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

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

give all reasonable assistance required in connection with the inspection and testing of the work.

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

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

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

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

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

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

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

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

Materials -

Unless specified other wise various materials shall conform to the following IS Codes and Standards –

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

Supply

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

Receipts and storing of materials

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

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

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

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

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

Shop Drawings

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

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

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

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

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

Laying Out

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

Fabrication

Standard

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

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

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

Templates

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

Connections

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

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

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

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

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

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

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

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

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

Straightening

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

Rolling and Forming

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

Cutting

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

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

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

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

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

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

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

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

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

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

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

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

Machining

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

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

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

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

Splicing

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

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

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

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

Bolting

All turned and fitted bolts shall be parallel throughout the barrel and within the tolerance of only minus (-1/8) mm. unless otherwise specified and faces of heads and nuts bearing on steel work shall be machined. All such bolts shall be provided with washers not less than 6 mm thick so that when the nut is tightened, it shall not bear on the unthreaded body of the bolt. In all cases, where the full bearing area of the bolt is to be developed, the threaded portion of the bolt should not be within the thickness of the parts bolted together. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers of suitable thickness shall be provided for all heads and nuts to afford a seating square with the axis of the bolt.

10.2. Welding

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

Welding Procedures

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

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

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

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

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

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

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

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

The welding procedure adopted and the consumables used shall be specifically approved by Engineer-In-Charge. Welding electrodes used shall conform to IS : 814 (latest) and shall

be supplied by manufacturer approved by the Engineer-In-Charge. Any electrode which has part of its flux coating broken or is damaged shall be rejected.

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

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

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

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

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

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

- e) Any other special features like assembling similar members back to back or stress relief.

Sequencing of welding

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

Preparation of fusion faces

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

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

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

Gaps for Joints

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

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

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

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

Fillet Welds

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

<u>Angle between fusion faces</u>		<u>Throat thickness</u>
60 Deg. C	90 Deg. C	48 mm
91 Deg. C	100 Deg. C	16.5 mm
101 Deg. C	106 Deg. C	15 mm.
107 Deg. C	113 Deg. C	14 mm
114 Deg. C	120 Deg. C	12.5 mm.

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

Butt Welds

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

Quality of Weld

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

Faulty Works

In the event of excessive convexity, weld size is to be reduced by removing the excess weld metal. In the event of faulty work the defective portions shall be cut out and re-welded. Where serious under-cutting occurs, additional weld metal shall be deposited to make good the reduction. In case of members getting distorted due to heat of welding, the members are to be straightened out by mechanical means or by careful applications of limited amount of heat when temperature of the areas affected more than 65° C.

Protection

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

Tolerances

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

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

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

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

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

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

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

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

10.3. M.S. Gratings

Categories

Category 'A' : Fabricated by the Contractor as per design drawings / standards.

Category 'B' : Ready made bought out from an approved manufacturer.

Material

Gratings shall be of mild steel flats with mild steel rounds as per detailed drawings forwarded to Contractor.

Mild steel flats shall conform to IS: 226

Mild steel rounds shall conform to IS: 432 - Grade I

Fabrication Drawings

Fabrication and erection drawings shall be prepared by the Contractor on the basis of "Approved for Construction" (AFC) design drawing issued to the Contractor. These drawings shall be prepared by Contractor or by an agency approved by the Engineer-In-Charge.

Fabrication of Category 'A' Gratings

These shall be fabricated strictly as per the "Approved for Construction" fabrication drawings prepared by the Contractor based on design drawings and standards. All units shall be given distinct erection marks in accordance with the marking drawing.

Fabrication of Category 'B' Gratings

These shall be as per manufacturer's details designed to carry loads as specified in the design drawing supplied to the contractor. The deflection shall not exceed span / 200 or 6mm whichever is minimum. The maximum clear size of voids in the grating be limited to 30mm x 55mm. The contractor shall make necessary notches / opening in the gratings as shown in the drawings. All edges affected by such notches / openings shall be suitably stiffened by welding additional flats of the requisite size. All units shall be given distinct erection marks in accordance with the marking drawings. Before procurement the contractor shall submit the design calculations, drawings and manufacturer's literature / catalogues and get the same approved by the Engineer-In-Charge.

Erection / Fixing

Gratings shall be fixed to the bearing members by welding / clamping / bolting as indicated in the drawings.

Painting

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

Measurement

Payment shall be made on the basis of admissible weight in metric tons of the gratings accepted by the Engineer-In-Charge. The weight shall be calculated on the basis of IS Hand Book. Manufacturer's catalogues / charts shall be adopted in case of gratings of category 'B'. No allowance in weight shall be made for rolling tolerances

Rate

The rate shall include supplying, fabricating, erecting MS gratings (of the specified category) including transporting, handling, cutting to required size and shape, making holes/notches / opening of required size and nosing, smoothening the edges, fixing by welding / bolting / screwing, preparing detailed fabrication drawings, surface cleaning, removal of rust, scale, grease and applying two coats of yellow zinc chromate primer etc. all complete as specified.

11. FINISHING WORKS**11.1. Cement Plastering**

Cement plaster shall be of 6, 12, or 20 mm thick as specified in the respective item.

Materials

Cement mortar shall be as described under- Mortar specifications. However, cement used in the plaster shall be Portland Pozzolana Cement (PPC) Fly ash based conforming to IS: 1489 (Part-I.) unless other wise specified. Only river washed sand shall be used. Pan type mixer for mortar should preferably be used.

Application

Unless otherwise specified all plaster work shall be carried out in accordance with IS 1661.

The thickness and proportion of cement mortar shall be as specified or directed.

Unless permitted otherwise by the Engineer-In-Charge, only double scaffolding of adequate strength shall be provided by the Contractor. No holes shall be made in the masonry for supporting the scaffolding. Scaffolding members shall not be tied to windows, doors, other members provided in the walls.

No plastering work shall commence until the surface preparatory work is approved by the Engineer-In-Charge.

The sand shall be as approved by Engineer-In-Charge and in accordance with IS 1542 specification for plaster.

Preparation of Surface

Joints of all masonry work shall be carefully raked out for a depth of about 12 mm. without causing any damage to the masonry. Surfaces of concrete work shall be thoroughly roughened with chisel by pricks prior to application of plaster. For materials, which are not able to receive plaster directly, the necessary procedures shall be carried out as per the directions of the Engineer-In-Charge

All surfaces shall be thoroughly cleaned of all dirt, soot, oil, grease and any other material preventing proper bonding etc. and any efflorescence shall be removed by brushing and scraping. The surface shall then be soaked with water for at-least 6 hours prior to application of plaster to ensure proper adhesion between the surface and plaster. If any surfaces become dry in spots, such area shall be moistened again to restore uniform suction.

Procedures / Precautions Applicable to Workmanship

Plaster work shall proceed from top to bottom in one operation on an entirely unobstructed surface or on areas upto break against openings.

Long straight edge shall be used to ensure perfectly even surface. All corners, angles and junctions shall be truly vertical and horizontal as the case may be and shall be carefully and neatly finished. All soffits, exposed angles with door and window frames shall be carefully finished. Internal angles shall be rounded if so directed and arises shall be rounded, splayed or beaded as directed. The mortar shall adhere to the surface intimately when set and there should be no hollow sound when struck.

All plaster work shall be kept cured for a minimum period of 10 days after the application of finishing coat to prevent excessive evaporation. Matting of gunny bags should be hung over the outside of the plaster in a hot dry weather.

1st Coat

The thickness shall be about 12 mm. thick in case of brick walls, RC walls and columns and 6 mm. thick for ceiling, soffit of beams etc. Before this coat hardens, the surface shall be cross scratched to provide a mechanical key for the 1st coat. The cross-scratch shall be horizontal as far as possible to aid curing which will be done for at least 2 days immediately following the application.

Chicken Mesh

Chicken wire mesh of 22 gauge unless specified at junction of RCC and masonry work 15 cm. (at 6") overlap on either side shall be fixed with nails.

Finish Coat

At least a period of 3 days should elapse between the application of the first coat and the finish coat. Finish coat shall be applied as specified in the item description unless other wise, stated neeru finish shall apply as described under the neeru finish specifications given below.

Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expenses by such means as the Engineer-In-Charge may approve. The Dates on which the plastering is done shall be legibly marked on the various sections so that for the specified period it can be watched.

Measurement

For plastering, the measurement shall be on area superficial for the unfinished surfaces as actually covered. Length and breadth shall be measured correct to a cm and its area shall be calculated in Sq.m. correct to two places of decimal. Dimensions before plastering shall be taken.

The areas shall include (all the actual pointed / plastered areas for jambs, sills, soffits of openings etc.

No deductions shall be made for ends of joints, beams etc.

No extra shall be allowed for beaded, chamfered or rounded arrises or curved angles.

Rate

The rate shall include the cost of all labour and materials involved in all the operations described above excluding chicken mesh, which shall be measured separately.

11.2. Neeru Finishing :

Materials

Lime shall be of best quality hydraulic lime properly burnt and from approved sources and shall be slaked with fresh water on site. It shall be free from un-burnt kankar, ashes and

other impurities including salt. Lime shall be stored safely in weatherproof sheds, filled in bags. It shall not be stacked against the walls of the shed. It should be used as soon as possible.

Instant Neeru

Instant neeru shall conforming to IS 712 and mix /slurry shall be prepared as per the recommendation of the manufacturer's specification subject to approval of the Engineer-In-Charge.

Application

The 'Neeru' as prepared above shall be applied to the prepared surface with a steel trowel to a thickness not exceeding 3mm and rubbed and polished to a perfectly smooth and even finish working from top to bottom. While towelling is going on soap stone powder contained in thin muslin bags shall be dusted over the surface and worked in.

The surface of the under coat on which the punning is to be done shall be left rough. The punning shall be applied, when the under coat is still green. The mortar for punning shall be applied in a uniform layer slightly more than 3mm thick between gauged pads, with which to ensure an even and uniformly thick surface by frequent checking with a wooden straight edge. It shall be finished to an even and smooth surface with trowels.

All corners, arises, angles and junctions shall be truly vertical and horizontal as the case may be and shall be carefully and neatly finished. Rounding or chamfering corners, arises, junctions etc. where required, shall be punned without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the size required.

No portion of the surface shall be left out initially to be patched up later on.

Thickness

The thickness of the finished punning shall not be less than 3mm thick.

Scaffolding, Finishing, Precaution and Curing

Specifications for these shall be as described under-Plastering specifications.

Measurement

Included in plastering work wherever specified.

Rates

Included in plastering work wherever specified.

11.3. Chicken mesh 22 SWG :

Materials

Chicken wire mesh shall be 22 gauge of approved manufacturers, unless specified.

Fixing

The chicken wire mesh shall be provided at the junction of RCC and masonry work 150mm over lap on either side fixed with 'U' nails. 150mm centre to centre before plastering the junction.

Measurement

Length and breadth shall be measured correct to a centimetre (cm) and its area shall be calculated in Square metres (Sq.m.) correct to two place of decimal.

11.4. Plaster of Paris Finishing (POP) :**Material**

The Plaster of Paris shall be of calcium-sulphate semi-hydrate variety. Its fineness shall be such that when sieved through a sieve of IS sieve designation 3.35 mm for 5 minutes after drying the residue left on it shall not be more than by 1% by weight. It shall not be too quick setting. Initial setting time shall not be less than 13 minutes. The average compressive strength of material determined by testing 5 cm cubes after removal from moulds, after 24 hours and drying in an oven at 40° C till weight of the cubes is constant & shall not be less than 84 kg per square metre.

Application

The 'POP' as prepared above shall be applied to the prepared surface with a steel trowel to a thickness not exceeding 6mm and rubbed and polished to a perfectly smooth and even finish working from top to bottom. While towelling is going on soap stone powder contained in thin muslin bags shall be dusted over the surface and worked in.

The surface of the under coat on which the punning is to be done shall be left rough. The punning shall be applied, when the under coat is still green. The mortar for punning shall be applied in a uniform layer slightly more than 6mm thick between gauged pads, with which to ensure an even and uniformly thick surface by frequent checking with a wooden straight edge. It shall be finished to an even and smooth surface with trowels.

All corners, arrises, angles and junctions shall be truly vertical and horizontal as the case may be and shall be carefully and neatly finished. Rounding or chamfering corners, arrises, junctions etc. where required, shall be punned without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the size required. No portion of the surface shall be left out initially to be patched up later on.

Thickness

The thickness of the finished punning shall not be less than 6mm thick, unless specified.

Scaffolding, Finishing, Precaution and Curing

Specifications for these shall be as described under- Plaster specifications.

11.5. Sand Faced Cement Plaster:**General**

This shall be done in two coats. Backing coat shall be 12 mm. thick in 1:4 cement mortar with 2% by weight of cement of approved integral cement waterproofing admixture added to it, unless specified. The second and finishing coat shall be 8 mm. thick in 1:3 CM, unless specified.

Materials

Cement mortar shall be as described under- Mortar specifications. However, cement used in the plaster shall be Portland Pozzolana Cement (Fly ash based) conforming to IS: 1489

(Part - I) unless other wise specified Only river washed sand shall be used. Pan type mixer for mortar shall preferably be used.

Integral waterproofing compound conforming to IS: 2645 and of approved brand and manufactured, enlisted by the Engineer-In-Charge from time to time shall be used. The Contractor shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement that does not run out separately when water is added.

Chicken wire mesh 22 gauge at junction of RCC and masonry work 150 mm. (at 6") overlap on either side shall be fixed with nails. (*Chicken wire Shall be measured separately under relevant item*)

Application

This shall be applied in 2 coats. The first coat or the base coat shall be approximately 12 mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows etc. The base coat shall be splashed on to the prepared surface with heavy pressures, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The base coat shall be cured for at least seven days.

For backing coat about 15 cm. x 15 cm. plaster patches shall be prepared as gauges at convenient distance apart to ensure even plastering in one plane. The mortar shall be firmly applied with somewhat more than the required thickness and well pressed into the joint and on the surface by wooden floats to produce an even and uniform surface. The surface shall be roughened with wire brushes to give a good bond to the finishing coat. The backing coat shall be cured for 4-5 day.

For the finishing coat, sand used shall be screened to pass through 3 mm. mesh sieve (all material passing through 1.5 mm. mesh sieve shall be eliminated). The coat shall be applied uniformly with wooden float and the entire surface shall be rubbed with approved sponges (e.g. wooden float lined with cork) to expose the sand grains uniformly and predominantly, while finishing steel trowel shall not be used and overworking shall be avoided.

Measurement

Measurement shall be as described under- Plastering specifications.

Rate

The rate shall include the cost of all labour and materials involved in all the operations described above including integral waterproofing compound but excluding chicken mesh which shall be measured separately.

11.6. Rough Cast Cement Plaster:

Materials

Cement mortar shall be as described under – Sand faced plaster specifications .

Application

This shall be done in two operations, backing coat of 12 mm. thick in 1:4 CM is done in an identical manner as for sand-faced cement plaster. As soon as the backing coat is only

slightly set (i.e. when it is still essentially in a plastic state), the finishing coat 13 mm. thick in 1:1:2 proportion (1 cement: 1 of graded sand:2 of gravel generally 8 mm. to 12 mm. in size) shall be dashed by means of trowels against the backing coat such that the dispersion of gravel shall be uniform and it shall be seen predominantly on the surface.

11.7. Waterproof Cement Plaster :
Materials

Cement mortar shall be as described under – Sand faced plaster specifications.

Application

Application shall be as described under- Sand faced plaster specifications.

Finish coat

When the plaster has been brought to a true surface with wooden straight edge it shall be uniformly treated over its entire area with paste of neat cement and rubbed smooth, so that the whole for surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sq. m. Smooth finishing shall be completed with trowel immediately and in no, case later than half an hour of adding water to plaster mix.

The first coat shall be evenly dampened and 5 mm thick finish coat shall be well smooth after floating it with a coat of Portland Cement. The use of dry cement shall not be permitted.

Integral waterproofing compound conforming to IS: 2645 and of approved brand and manufactured, enlisted by the Engineer-In-Charge from time to time shall be used. Applications shall be as described under sand faced plaster specifications.

11.8. Grooves in Plaster :
Materials/mortars

Materials /mortar shall be as described under –Plastering specifications.

Application

The horizontal and vertical grooves shall be exactly to the required depth and width as shown in the drawings and shall be in perfect lines without any break in continuity. The grooves shall be neatly finished with extreme case.

Plasterwork shall follow following steps and work shall commence only after approval of the Engineer-In-Charge. .

- Surface shall be properly cleaned.
- Plaster area shall be provided with level pads or spots allowing working & checking with 2 - 3m. straight edge. Depth of plaster shall not be less than 8mm. at any point.
- Required concealing services work shall be completed and tested prior to start of plasterwork.
- No further cutting of masonry shall be allowed.
- Repairs carried out to masonry or concealing work shall be cured and dry.
- Surface shall be sufficiently damp / wet.
- Plaster pads shall be checked for plumb & level and approved by Engineer-In-Charge.

Corners, external or internal shall be finished along with finished coat. It is advisable to have rounded corners.

Plaster shall be cured for 14 days by wet curing except in neeru finish plaster.

Plaster shall be levelled and lined by Aluminium hollow section of 2-3 m. long. (This will give even and levelled surface). There shall not be more than 2 mm. difference in level when checked with 3 m. straight edge. It is important enough pressing and beating is done to achieve compact filling of joints and area shall be fully compacted.

Finishing of plaster may be carried out with wooden float (randhaas) or trowelled smooth with sheet metal trowels as specified. Care shall be taken to avoid excessive trowelling and overworking the wooden float.

All corners, internal or external, shall be truly vertical or horizontal. These shall be finished with a proper template to achieve best workmanship for rounding and chamfering as specified or directed.

Plaster shall be cut to correct horizontal or vertical line at the end of the day or if work required to be suspended for any reason.

Area of plaster is advisable to be limited to 15 Sq.m. To avoid cracks due to thermal movements of dissimilar material in contact, it is advisable to provide joints, treated with groove or any other detail suggested by the Engineer-In-Charge. These joints if not specified shall be treated with 100 mm. wide reinforcing chicken mesh fixed over joints by G.I. nails and area plastered.

11.9. Cement Pointing Materials

Materials shall be as described under-Mortar specifications.

Mortar

Cement & fine sand (washed, if necessary) are mixed in the specified proportion using sufficient water to produce a smooth paste of homogeneous mix and uniform colour. Waterproofing compound, as approved by the Engineer-In-Charge, shall be added as per manufacturers specifications. Mixing platform shall be clean and impervious and shall be so arranged that no deleterious extraneous material shall get mixed with mortar nor the mixing water of the mortar shall flow out.

Preparation of Surface

All joints to be pointed shall be raked out to a depth not less than the width of the joint, preferably when the mortar is green. Projections of stones shall be chiselled, if necessary. The raked surfaces shall be thoroughly cleaned of all dust, loose particles and efflorescence materials with stiff wire brushes and washed with water and kept well wetted before pointing. The entire area shall be protected by a removable / non-staining coating of suitable approved material.

Pointing

Mortar prepared as above shall be well pressed into the joints with a pointed trowel and rubbed smooth either flush sunk or raised, according to the type of pointing required. The mortar shall not be spread over the corner, edges or surface of the masonry. All superficial mortar shall be removed with a trowel. The surface of the masonry shall be cleaned and no stain shall be allowed to remain. Pointing shall be of uniform appearance with sharp, clear and regular lines.

Curing

Pointed surfaces shall be kept wet continuously for a minimum period of seven days, during which period it shall be suitably protected from all damage.

Bad Workmanship

Should the mortar perish or deteriorate through neglect of watering or any other default and if the work is not done neatly and as specified above, the pointing shall be removed and redone by the Contractor at his own cost when instructed by the Engineer-In-Charge.

Measurements

For pointing, the area of masonry surface actually pointed shall be measured net.

11.10. White / Colour Washing:**Materials**

The materials for preparing lime wash shall be freshly burnt fat lime of good quality free from unburnt stone or other foreign matter. Lime shall be of "C" type as mentioned in IS 712.

Lime shall be slaked on the spot, mixed and stirred thoroughly with sufficient quantity of water (about 4.5 litres per Kg. of lime) to make a thin cream. This shall be allowed to stand for a period of 24 hours and then strained through a clean coarse cloth. Clean gum dissolved in hot water shall then be added in the proportion of 4 gm. of gum Arabic to one litre of lime cream to prevent lime wash coming off easily when rubbed.

Indigo (Neel) up to 3 gm per Kg of lime dissolved in water shall be added and stirred well. Water at 5 litres per Kg. of lime is then added to produce a milky solution.

Alternatively ready made whiting (ground white chalk) complying to IS 63 can be used. In this case whiting shall be dissolved in sufficient quantity of warm water to form thin slurry, which shall then be screened through a clean coarse cloth. 2 gm. of gum and 0.4 gm. of copper sulphate dissolved separately in hot water shall be added for every litre of the slurry, which shall then be diluted with water to the consistency of milk for use. Rice size may be allowed instead of gum.

Colour wash shall be lime wash as above to which a solution of water and lime fast pigment, boiled if directed, shall be gradually added and stirred until the required tinge is available.

Preparation of surface

The surface shall be prepared by removing all mortar dropping and foreign matter and thoroughly cleaned with wire or fibre brush or other means to be approved by the Engineer-In-Charge. All loose pieces and scales shall be stuffed with mortar and cured.

Application

Lime wash shall be applied with a brush. Each coat must be allowed to dry and shall be subject to an inspection before the next coat is applied. When dry, the surface shall not show any signs of cracking and shall present a smooth and uniform finish easily when rubbed with a finger. Patchy or streaky work will be rejected. No colour wash shall be done with a sample of the colour wash to the required tint or shade unless it is approved by the Engineer-In-Charge.

Precautions

Doors, Windows, floors etc., shall be protected from being splashed upon. Any splashing and droppings shall be removed and surfaces cleaned.

Scaffolding

Single or double scaffolding shall be provided by the Contractor as and when required.

Measurements

Cornices and other such wall or ceiling features, shall be measured along the girth and included in the measurements.

The number of coats shall be 3 coats unless otherwise specified. The item to include removing nails making good holes, cracks, patches etc. not exceeding 50 sq.m. each with material similar in composition to the surface to be prepared.

11.11. Painting

All the water base and oil base paints such as distemper, cement paint, enamel paint, flat oil paint etc. shall be of approved manufacturers and shall conform to the respective IS Codes and Standards.

Colour and Shade shall be as approved by the Engineer-In-Charge.

Supply

All paint materials shall be supplied to the Site in the manufacturer's sealed and branded containers. Any containers reaching site with broken seals are liable for instant rejection by the Engineer-In-Charge.

Storage

All paint materials shall be stored in cool dry conditions clear of other stores to the satisfaction of the Engineer-In-Charge.

Usage

The mixing of materials of different brands before or during application shall not be permitted.

Brushes, pails, kettles and other implements and tools used in painting or preparation of the work shall be clean and free from foreign matter.

The instructions of the manufacturer shall be followed regarding preparation of surface and application of priming and finishing coats. In any event the following engineering practices shall always be followed while carrying out work as specified in IS 2395 Part-I & Part-II.

- a) No exterior or exposed painting shall be carried out under adverse weather conditions such as rains, extreme humidity, dust storms etc.,
- b) The work shall preferably be carried out in shade to avoid blistering or wrinkling due to direct sunlight.
- c) All surfaces to be painted shall be free of loose matter, efflorescence, dust etc. before application of each coat.
- d) No paint shall be applied to works, which are internally or superficially damp.

Preparation of Surfaces

General

All surfaces requiring paint shall be thoroughly cleaned of all dirt, dust, grease or oil before spotting or priming. Oil or grease film shall be washed off with an acid that is non-injurious to the surface or shop primers and rinsed off completely with plain or soapy water. Surfaces shall be dry unless dampening is required for a particular finished material.

Before starting the work, the Contractor shall obtain the approval of the Engineer-In-Charge regarding the soundness and readiness of the surface to be painted on.

Masonry, Concrete and Plastered Surfaces

Surface shall be free from all efflorescence, mildew, loose paint or other foreign and loose materials. Surface with mildew or efflorescence shall be treated as follows:

- All mildewed surfaces shall be treated with an approved fungicide such as ammonical wash consisting of 7 gm. of copper carbonate dissolved in 80 ml. liquor ammonia and silica fluoride solution and allowed to dry thoroughly before paint is applied.
- All efflorescence shall be removed by scrubbing and affected surfaces shall be treated with a solution of muriatic acid in water (1:6 to 1:8) and washed fully with clean water and allowed to dry thoroughly.

Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surfaces uniformly textured. Where this type of re-surfacing may lead to the finishing paint being different in shade from the original surface, the surfaced area shall be treated with minimum one coat of cement primer, which shall be continued to the surrounding area from a distance of 100mm.

The plastered surface shall be carefully rubbed smooth and thoroughly cleaned with clean fresh water.

Metal

All metal surfaces shall be absolutely clean, dry and free from wax, grease or dried soap films. Grease shall be removed by proprietary brands of approved solvent cleaner or other solutions or detergents. In addition all steel and iron surfaces shall be free from dust, rust and scales. This shall be done by wire brushing and scraping. All galvanised surface shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in ship coats shall be touched with the same quality of paint as the original coat. The cleaning and operation of priming paint at site shall be carried out after the erection of steelwork.

As required single or double scaffolding or ladder shall be used without damaging or scratching the surfaces to be painted.

11.12. Plastic Emulsion Paint :

Materials, surface preparation, Application, Equipment and protection, cleaning etc. shall be as described under- Painting specifications. The plastic emulsion paints is not suitable for application on external, wood, and iron surface, which are liable to heavy condensation. These paints are to be used on internal surfaces except wooden and steel. Plastic emulsion paints as per IS: 5411 of approved brand and manufacture and of the required shade shall be used.

Application

The paint is mixed thoroughly adding about 50% water and then strained through a cloth. The paint is then applied on wall and allowed to dry thoroughly. A putty is prepared by mixing whiting and paint and is filled wherever necessary in holes depressions etc.

For the second coat only about 15 to 20% water is added.

(The correct quantity of water to be added shall be as per manufacturer's instructions)

The number of coat shall be two unless otherwise specified in the item. The paint will be applied in the usual manner with brush, spray, or roller. The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non- absorbent surfaces.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance. Painting on old surface shall be as described for new work except that the surface before application of paint shall be flattened well to get the proper flat velvety finish after painting.

11.13. Oil Paint :

Materials, surface preparation, application, equipment & protection, cleaning etc. shall be as described under-Painting specifications.

Application

Unless otherwise specified, paint shall be applied with brushes. The contents of the drum and tins shall be well stirred before using and occasionally during the use to prevent sedimentation at the bottom.

Priming coat

The priming coat shall be made up of materials depending on the surfaces to be plastered and specified or recommended by the manufacturer.

The primer shall be ready mixed primer of approved brand and manufacture and shall be compatible with finished painting scheme.

Where primer for wood work is specified it shall be prepared as per manufacturers specifications. The wood work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness surface shall be rubbed down smooth with sand paper and shall be well dusted. Appropriate filler material conforming to IS: 345 with same shade as paint shall be applied .

Finishing coat

Unless otherwise specified, the finishing shall be done in at least two coats of paint. The last coat shall give a flat, semi glossy or glossy finish as directed by the Engineer-In-Charge.

11.14. Synthetic Enamel Paint :

In regards to materials, surface preparation, application, equipment & protection, cleaning etc. shall be as described above. Synthetic enamel paint conforming to IS:2932 shall be of approved brand and manufacture and of required shade.

Application

Priming coat

Primary coat shall be of ordinary paint of shade to match with the top coat as recommended by the same manufacture. As top coat shall be used. Under coat shall be allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure smooth and even surface, free from brush marks and all loose particles brushed off.

Finishing coat

It shall be applied on properly primed surface. Subsequent coat shall not be applied till the previous coat is dry. The previous coat shall be lightly sand prepared for better adhesion of subsequent coats.

Top coats of synthetic enamel paint of desired shade shall be applied after the under coat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

Unless otherwise specified, the finishing shall be done in at least two coats of paint. The last coat shall give a flat, semi glossy or glossy finish as directed by the Engineer-In-Charge. If, however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

11.15. Waterproof Cement Paint :

In regards to materials, surface preparation, application, equipment & protection, cleaning etc. shall be as described above. The cement paint shall be conforming to IS : 5410 of approved brand and manufacture and of required shade.

Application**Priming coat**

Cement primer coat is used as a base coat on wall finish. The cement primer is composed of a medium and pigments which are resistant to alkalies present in the cement in wall finish and provides a barrier for the protection of subsequent coats. Primer coat material shall be as per recommendation of finish coat material. Primer coat shall be preferably applied by brushing and not by spraying on the clean dry and smooth surface. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before subsequent coat.

Finishing coat

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. Cement paint shall be mixed with water in two stages and strictly as per manufacturer's instructions.

The surfaces shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours), the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

Water proof cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, paints etc.

Rate

The rate shall include the cost of all labour and materials involved in all the operations described above including scaffolding, unless specified. **Quoted rate shall be inclusive of Cement primer coat unless separate item is specifically provided for.**

12. DISMANTLING & DEMOLISHING

The item wise detailed specifications are intended for the general description of quality, workmanship, etc. desired for the items covered in the Schedule of Items. The Specifications are not, however, intended to cover the minute details and the work shall be executed according to the relevant latest Indian Standard Codes. In absence of the later, the work shall be executed according to the prevailing local Public Works Department Practice or to the recommendations of American and British Standard Institution at the discretion of the Engineer-In-Charge.

12.1. Scaffolding

Single or double scaffolding shall be provided by the Contractor as and when required.

12.2. Objective

The desired technique to be adopted in carrying out the demolition and dismantling work of existing structure shall be such that the fragments falling out of such operation can be contained within the work area or taking suitable protection so as to prevent materials from going out. This would relieve the surrounding area from any uncertain or uncontrolled behaviour of dismantled materials.

The rubbish / materials after dismantling shall also be stored systematically and disposed off immediately outside the plant boundary in order to ensure no major formation of heaps inside / adjacent to the work site and not hamper in any way the normal business operation of the Employer.

The term demolition implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on the drawings.

The term 'Dismantling' implies carefully removing without damage (up or down). This shall consist of dismantling one or more part of the structures / facilities as specified or shown on the drawings.

12.3. Precautions

All materials obtained from dismantling or demolition shall be the property of the Contractor once the materials are taken out of the boundary of MDL after completion of the necessary gate pass and other formalities. But till such time the materials shall be kept in safe custody as per the directives of the Engineer-In-Charge.

The demolition shall always be planned beforehand and shall be done in reverse order of the one in which the structure was constructed. The scheme shall be got approved from the Engineer-In-Charge before starting the work.

Necessary propping, shoring and / or underpinning shall be provided for the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever required, as per the opinion of the Engineer-In-Charge, temporary enclosures or partitions shall be provided at the Contractor's cost.

Necessary precautions shall be taken to keep down the dust nuisance.

Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or demolishing roofs, masonry, etc. shall be carefully removed first. The dismantled articles shall be passed by hand, where necessary, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer-In-Charge.

Where fixing is done by nails, screws, bolts, rivets, etc. dismantling shall be done by taking out the fixed items with proper tools and not by tearing or ripping of.

Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-In-Charge within work site for verification required for gate pass and other formalities for taking outside the boundary. All unserviceable materials, rubbish, etc. shall be disposed off immediately outside the Owner's premises as directed by the Engineer-In-Charge.

12.4. General

Necessary data such as building size, wall thickness, construction materials, etc. that may be required shall have to be collected by the Tenderer from MDL site at his own expenses.

12.5. Information to be supplied by the Tenderer along with Tender

The information to be provided for by the Tenderer, unless otherwise specified, shall include the following :

To submit his method of demolition duly supported by specifications and drawings and sequence of operation along with a list of equipment, plants and machineries to be employed during such operation, to meet the above mentioned objective.

12.6. Work to be provided by the Contractor

- a) To arrange all the formalities as per requirement of statutory rules, if his method involves use of explosives. He has to obtain permission from appropriate authority of buying, storing, handling & making use of explosives.
- b) To notify, the Employer for arranging to shut off all gas, water, electricity, steam and other service lines running over ground or underground. Any temporary service connections required for the demolition work shall be separately taken and arranged by the Contractor.
- c) Any preliminary work, necessary for Contractor's method of demolition.
- d) To furnish all materials, labour, tools and plant and all consumables required for this work and its related temporary work such as cordoning the area, staging etc.
- e) To furnish the details of safety measures for human life / property / structures, the Contractor proposes to take during the blasting operation of explosives, if he proposes to use on this demolition work. This should be strictly as per rules and regulations laid down by the concerned authority for explosives to be used in this work.

12.7. Work by Others

No work under this specification will be provided for by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the Contract or approved by the Engineer-In-Charge / Employer.

12.8. Codes & Standards

The demolition work shall be carried out as per Indian Standard Code of Practice No. IS 4130 - 1970 (Safety Code for demolition of buildings) or any other relevant Indian Standard Specifications and Codes of Practice. If demolition by blasting is adopted IS 4081 (Safety Code for blasting and related drilling operations) shall be followed. However, if any, particular aspect of the work is not specifically covered by any Indian Standard Specifications or any other standard practices, Engineer-In-Charge's instruction shall be followed.

12.9. Execution

The materials available after dismantling and demolition will be deemed to be the property of the Contractor once the material are disposed off from the plant boundary and the amount offered by the Contractor against each of the facilities / buildings / structures are received by the Employer.

It is presumed that the Contractor will adopt the most suitable method of demolition and dismantling to protect the materials and its surroundings. While doing so the Contractor shall ensure the following, which should be considered as binding towards the method and specification adopted by the Contractor:

- Total safety of the people working in the area of the Employer, other agencies employed by the Employer as well as those employed by the Contractor.
- Safety and no damage to the adjoining properties, facilities or services.
- Disposal immediately after dismantling to keep the area clean after the days work and not more than one truckload being accumulated.
- No noise or dust nuisance around the area of working.
- No obstruction to vehicular / pedestrian traffic during dismantling and disposal inside the plant boundary as well as outside municipal areas.
- No hindrance in the Employer's day to day production work or other operation.
- No accidents or other hazards.

12.10. Blasting

In special cases, the Contractor may be allowed to resort to controlled blasting at the sole discretion of the Employer/Engineer-In-Charge. The blasting, if allowed, will normally be for underground and foundation works. The work shall strictly be carried out as per the guidelines given below.

General guidelines for use of explosives

In case use of explosive is adopted for demolition work, specific permission of Engineer-In-Charge will have to be taken by the Contractor for blasting and he shall also obtain a valid blasting license from the authorities concerned.

The contractor shall employ competent and experienced supervisors and licensed blaster in-charge of each set of operations of blasting as well as operations of loading, unloading and transporting of such explosives from the mezzanine, who shall be held personally responsible to ensure that all safety regulations are carried out before and during the progress of blasting and also during the transportation and handling of explosive materials.

Before any blasting is carried out, Contractor shall intimate the Engineer-In-Charge and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are withdrawn from an area within 200 metre radius from the firing points, at least 15 minutes before firing time by sounding warning whistle. The area shall be encircled by red flags. Clearance signal shall also be given by sounding a distinguishing whistle / siren.

The blasting near any existing building, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Engineer-In-Charge; a trench shall have to be cut by chiselling prior to the blasting operation separating the area under blasting from the existing structures.

The firing shall be supervised by a experienced Supervisor. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole near the misfired hole (but not nearer than 600mm from it) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home by metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming, which may consist of sand or stone dust or similar inert material.

In no case shall blasting be allowed closer than 30 meters to any structures or to locations where concrete has just been placed. In the later case the concrete must be at least 7 (seven) days old.

Contractor shall preferably detonate the explosives electrically.

The explosive shall be exploded by means of primer, which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.

In dry weather, ordinary low explosive gunpowder may be used. In damp weather, high explosive like gelatine with detonator and fuse wire may be used.

The quantity and strength of explosive used, shall be such as will neither damage nor crack the other structures outside the limits of execution. All precautions, as directed by Engineer-In-Charge, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of any damage done due to negligence, the same shall be rectified by the Contractor to the satisfaction of Engineer-In-Charge at his own cost.

The Contractor shall observe rules and regulations controlling the storage and handling of explosives as exercised by the Inspector of explosives or licensing authority. The fees if any required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State or Central Government authorities and statutory bodies / regulations. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc. No explosives shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as far away as possible from the area to be blasted. The Engineer-In-Charge's prior approval shall be taken for the proposed location of the magazine and the structure of magazine shall be constructed as specified in the rules and regulations laid down by the concerned authorities. The Contractor shall build the magazine at his own cost. The contractor shall make this own arrangement for the site of this structure.

Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observances of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and / or Union Government.

Proper account of the explosive materials shall be kept at site as well as in the magazine as per the rules and regulations of the concerned authority. For this purpose, registers shall be kept by the Contractor and shall be filled and signed daily by his authorized and licensed blaster in-charge indicating therein the proper and correct account of the stock of explosive material brought in. For this purpose day to day operation-wise entry shall be made in the

registers. Misfired and unfired charges of explosive shall also be noted in the register indicating the place, for safety.

Twenty four hours guards on duty shall be engaged by the Contractor to safeguard all kinds of explosive materials and equipment at the place of magazine as well as during the transportation period and on site when brought for using the same. Any theft, misuse or mishandling of the explosive materials shall be the responsibility of the Contractor and the Contractor shall indemnify the owner for this purpose and for the damages of any kind which may occur due to blasting of explosive in the magazine, during transportation, during handling in the work or due to any accidental cause.

The Contractor shall make his own arrangement of transportation of required quantities of explosive materials from the magazine to the work site as per the rules and regulations of the concerned authorities.

The Contractor shall have to note that live electrical circuits of high voltage may be passing overhead / underground and shall be likely to remain live at the time of operation of demolition work. The Contractor shall take all safety measures in this regard.

12.11. Rates

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

13. MISCELLANEOUS

13.1. Bitumen: Bitumen for filling joints shall conform to IS 3117 / IS 3037.

13.2. Jointing Materials Joint Filler

Performed joint filler shall be of bituminous material, non-extruding and resilient type and conform to IS 1838.

Sealing Compound

Sealing compounds shall be of an approved brand and shall conform to Grade "A" of IS 1834. They shall have good adhesive properties free from any corrosive effect and shall not slump in vertical or inclined joint, nor shall they bleed into or corrode the materials with which they are in permanent contact.

13.3. Pipe Sleeves for conduits / pipe crossing etc. Materials

Material of the pipe sleeves shall be as described in the item description(BOQ) conforming to the relevant IS Standard. Length and diameter of the pipe to be provided shall be as described in the item description of the BOQ.

Making holes / chases in the concrete / masonry

Holes / chases of required size shall be done carefully during construction as shown on the drawing or as specified in the item description or as directed by the Engineer-In-Charge. Any damage to the adjoining portion or to any other item shall be made good at contractor's cost as directed by the Engineer-In-Charge.

Embedding pipe sleeves

After insertion of pipe sleeves, the holes / chases shall be repaired with cement concrete 1:2:4 and the surface finished to match with existing surface. The top and bottom shall be finished properly to make the joint leak proof by cement grouting of areas around. Conduits, pipes etc. and provision of chicken mesh there on prior to plastering. The specifications for cement concrete work and finishing etc. shall be same as described under - Cement Concrete Work specification.

13.4. Factory made Precast concrete paver blocks : Materials

Cement

The cement used in the manufacture of high quality factory made precast concrete paving block shall be conforming to IS 12269 latest (53 grade) ordinary Portland cement or IS 8112 (43 grade ordinary Portland cement). The minimum cement content in concrete used for making paver blocks should be 400 kg/cu.m.

Aggregates

The fine and coarse aggregates shall consist of naturally occurring crushed or uncrushed materials, which apart from the grading requirements comply with IS 383 (latest). The fine aggregates used shall contain a minimum of 25 % natural silicon sand. Lime stone

aggregates shall not be used. Aggregates shall contain no more than 3% by weight of clay and shall be free from deleterious salts and contaminants.

Water

The water shall be clean and free from any deleterious matter. It shall meet the requirements stipulated in IS: 456-2000.

Other materials

Any other material/ingredients used in the concrete shall conform to latest IS specifications.

Paver Block Characteristics

The factory made precast concrete paver block (conforming to IS 2745-1974), shall have a size of 200 x 100 x 100 mm and shall have a 6 mm peripheral chamfer on the top edges. The maximum dimensional deviation from the stated size shall be as follows –

Length/Width	+/- 2 mm
Thickness	+/- 3 mm

The average compressive strength of precast blocks when tested in accordance with the relevant IS Code shall not be less than 45 N/sq. mm. For every 1000 sq.m. of laid area, minimum 6 Nos. blocks shall be tested.

Sand (conforming to relevant IS Code) bedding shall have a compacted thickness of 50 mm. The sand for this purpose shall be clean, sharp and containing not more than 5 % silt and clay.

The concrete pavers should be perpendicular after release from the mould and the same should be retained until the laying.

The surface should be of anti-skid and anti-glare type.

The paver should have uniform chamfers to facilitate easy drainage of surface run off.

The pavers should have uniform interlocking space of 2 mm to 3 mm to ensure compacted sand filling after vibration on the paver surface.

The concrete mix design should be followed for each batch of materials separately and automatic batching plant is to be used to achieve uniformity in strength and quality.

The pavers shall be manufactured in single layer only.

Skilled labour should be employed for laying blocks to ensure line and level for laying, desired shape of the surface and adequate compaction of the sand in the joints.

The pavers are to be skirted all round with kerbing using solid concrete blocks of size 100 mm x 200 mm x 400 mm or as directed by the Engineer-In-Charge. The kerbing should be embedded for 100 mm depth. The concrete used for kerbing shall be cured properly for minimum 7 days.

Laying

Priming

It will be the responsibilities of the Contractor to ensure that the manhole / pipeline cable trenches / circular drainage system etc. raised to driveway level using the requisite materials as per instruction of Engineer-In-Charge. The areas of potholes / deep depressions at the isolated locations also have to be filled up before laying the paver blocks. No extra pavements will be made for this purpose.

It will be the responsibility of the Contractor to ensure that undulations on the pavers blocks are eliminated after the traffic is allowed on it. Proper slope for drainage of water needs to be ensured by the Contractor. All necessary materials, tools, tackles are required to be arranged by the Contractor.

Bedding sand course

The bedding sand shall consist of clean well graded sand passing through 4.75 mm sieve and suitable for concrete. The bedding should be from either a single source or blended to achieve the following grading –

<u>In sieve size</u>	<u>% Passed</u>
9.52 mm.	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm.	60-100
600 microns	25-60
300 microns	10-30
150 microns	5-15
75 microns	0-10

Contractor shall be responsible to ensure that single-sized, gap-graded sands or sands containing an excessive amount of fins or plastic fins are not used. The sand particles should preferably be sharp not rounded as sharp sand possess higher strength and resist the migration of sand from under the block to less frequency areas even though sharp sands are relatively more difficult to compact than rounded sands, the use of sharp sands is preferred for the more heavily trafficked driveways. The sand used for bedding shall be free of any deleterious soluble salts or other contaminants likely to cause efflorescence.

The sand shall be of uniform moisture content and within 4% - 8% when spread and shall be protected against rain when stock piled prior to spreading. Saturated sand shall not be used. The bedding sand shall be spread loose in a uniform layer as per drawing. The compacted uniform thickness shall be of 50 mm and within tolerance of ± 5 mm. Thickness variation shall not be used to correct irregularities in the base course surface.

The spread sand shall be carefully maintained in a loose dry condition and protected against pre-compaction both prior to and following screeding. Any pre-compacted sand or screeded sand left overnight shall be loosened before further laying of paving blocks take place.

Sand shall be slightly screeded in a loose condition to the predetermined depth only slightly ahead of the laying of paving unit.

Any depressions in the screeded sand exceeding 5 mm shall be loosened, raked and re-screeded before laying of paving blocks.

Laying of interlocking paver blocks :

Paver blocks shall be laid in herringbone laying pattern throughout the pavement. Once the laying pattern has been established, it shall continue without interruption over the

entire pavement surface. Cutting of blocks, the use of infill concrete or discontinuities in laying pattern shall not be permitted other than at approved locations.

Paver blocks shall be placed on the uncompacted screeded sand bed to the nominated laying pattern, care being taken to maintain the specified bond throughout the job. The first row shall be located next to an edge restraint. Specially manufactured edge paving blocks are permitted or edge blocks may be cut using a power saw, a mechanical or hydraulic guillotine, bolster or other approved cutting machine.

Paver blocks shall be placed to achieve gaps nominally 2 to 3mm wide between adjacent paving joints. No joint shall be less than 1.5mm not more than 4mm. Frequent use of string lines shall be used to check alignment. In this regard the "laying face" shall be checked at least every two metres as the face proceeds. Should the face become out of alignment, it must be corrected prior to initial compaction and before further laying job proceed.

In each row, all full blocks shall be laid first. Closure blocks shall be cut and fitted subsequently. Such closer blocks shall consist of not less than 25% of a full block .

To infill spaces between blocks upto a gap of 50mm, concrete having screened sand, coarse aggregate mix and strength of 45 N/sq. mm shall be used. Within such mix the nominal aggregate size shall not exceed one third the smallest dimension of the infill space. For smaller spaces dry packed mortar shall be used of required strength.

Except where it is necessary to correct any minor variations occurring in the laying bond, the paver blocks shall not be hammered into position. Necessary care shall be taken to avoid premature compaction of the sand bedding when working adjustment of paver blocks,

Initial Compaction

After laying the paver blocks, they shall be compacted to achieve consolidation of the sand bedding and brought to design levels and profiles by not less than two (2) passes of a suitable plate compactor.

The compactor shall be a high-frequency, low amplitude mechanical flat plate vibrator having plate area sufficient to cover a minimum of twelve paving blocks. Prior to compaction all debris shall be removed from the surface.

Compaction shall proceed as closely as possible following laying and prior to any traffic. Compaction shall not, however, be attempted within one metre of the laying face. Compaction shall continue until lipping has been eliminated between adjoining blocks. Joints shall then be filled and re-compacted as described above. All work further than one metre from the laying face shall be left fully compacted at the completion of each day's laying.

Any blocks that are structurally damaged prior to or during compaction shall be immediately removed and replaced.

Sufficient plate compactors shall be maintained at the paving site for both bedding compaction and joint filling.

Joint filling and final compaction :

As soon as possible after compaction and in any case prior to the termination of work on that day and prior to the acceptance of vehicular traffic, sand for joint filling shall be spread over the pavement.

Joint sand shall pass a 2.36 mm (No. 8) sieve and shall be free of soluble salts or contaminants likely to cause efflorescence. The same shall comply with the following grading limits –

<u>In sieve size</u>	<u>% passing</u>
2.36 mm.	100
1.18 mm	90-100
600 microns	60-90
300 microns	30-60
150 microns	15-30
75 microns	10-20

The Contractor shall supply a sample of the jointing sand to be used prior to delivery and such materials to site for incorporation into the works. Certificates of test results issued by a recognized testing laboratory conforming that the samples conform to the requirements of this specifications shall accompany the sample.

The jointing sand shall be broomed to fill the joints. Excess sand shall then be removed from the pavement surface and the jointing sand shall be compacted with not less than one (1) Pass by the plate vibrator and joints refilled with sand to full depth. This procedure shall be repeated until all joints are completely filled with sand. No traffic shall be permitted to use the pavement until all joints have been completely filled with sand and compacted.

Both the sand and paver blocks shall be dry when sand is spread and broomed into the joints to prevent premature setting of the sand.

The difference in level (lipping) between adjacent blocks shall not exceed 3mm with not more than 1% in any 3 m x 3 m area exceeding 2 mm. Pavement which is deformed beyond above limits after final compaction shall be taken out and reconstructed to the satisfaction of the Engineer-In-Charge.

Edge Restraint

Edge restrains need to be sufficiently robust to withstand override by the anticipated traffic to withstand thermal expansion and to prevent loss of the laying course material from beneath the surface course. The edge restraint should present a vertical face down to the level of the underside on the laying course.

The surface course should not be vibrated until the edge restraint together with any bedding or concrete hunching has gained sufficient strength. It is essential that edge restraints be adequately secured.

Sampling and testing

Frequency of testing shall be minimum 6 samples per 1000 Sq.m. laid area. Sampling for testing of paver blocks shall be done in accordance with following –

Method of Sampling

Before laying paver blocks, each designated section comprising not more than 50,000 blocks shall be divided into ten approximately equal groups. Nine blocks shall be drawn from each group.

Marking and Identification

All samples shall be clearly marked at the time of sampling in such a way that the designated section of part thereof and the consignment represented by the sample are clearly defined.

The sample shall be dispatched to the approved test laboratory taking precaution to avoid damage to the paving in transit. Protect the paving from damage and contamination until they have been tested. The samples shall be stored in water at $20^{\circ}\text{C} + 5^{\circ}\text{C}$ for 24 hours prior to testing.

Compressive Strength

The average compressive strength of the 100 mm. thick paver blocks tested shall be 45 N/Sq. mm. Testing for compressive strength shall be undertaken in accordance with the following -

Testing Machine

The testing machines shall be of suitable capacity for the test and capable of applying the load at the rate specified. It shall comply as regards repeatability and accuracy with the requirements of relevant IS Specification.

Procedure

The sample specimens shall be tested in wet condition after being stored for at least 24 hours in water maintained at a temperature of $20^{\circ}\text{C} + 5^{\circ}\text{C}$ before the specimens are submerged in water, the necessary area shall be determined.

The plates of the testing machine shall be wiped clean and any loose grit or other material removed from the contact faces of the specimen. Plywood normally 4 mm. thick shall be used as packing between the upper and lower faces of the specimen and the machine plates and these boards shall be larger than the specimen by a margin of at least 5 mm at all points. Fresh packing shall be used for each specimen tested. The specimen shall be placed in the machine with the wearing surface in a horizontal plane and in such a way that the axes of the specimen are aligned with those of the machine plates. The load shall be applied without shock and increased continuously at the rate of Approximately 15 N/sq. mm per minute until no greater load can be sustained. The maximum load applied to the specimen shall be recorded.

Calculation of corrected strength

The compressive strength of each block specimen shall be calculated by dividing the maximum load by full cross section area and multiplying by an appropriate factor as given below:

TABLE 15

Work thickness	size	Correction Factors	
		Plain block	Chamfered block
60		1.00	1.06
80		1.12	1.18
100		1.18	1.24

Compressive strength calculations

The average corrected compressive strength for the designed block section shall be calculated.

Water Absorption

Testing for water absorption shall be in accordance with IS: 2185: 1979: (Specifications for Concrete Masonry Blocks) as follows –

2% absorbed after 10 minutes
5% absorbed after 24 minutes.

Method for the determination of water absorption

The test specimens shall be completely immersed in water at room temperature for 24 hours.

The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water.

They shall be removed from the water and allowed to drain for one minute.

Visible surfaces water being removed with a damp cloth and immediately weighed.

Subsequent to saturation, all specimens shall be dried in a ventilated oven at 100 to 115 Dec. C for not less than 24 hours and until two successive weightings at intervals of 2 hours show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.

Calculate the absorption as follows:

Absorption, kg/cu.m 1000) $= \frac{A - B}{A - C} \times$	Where A = Wet mass of unit in Kg B = Dry mass of unit in Kg and C = Suspended immersed mass of unit in Kg
Absorption, percent 100 $= \frac{A - B}{B} \times$	

Rates

The rate shall include the cost of all materials and labour involved in all the operations described above including the cost of cleaning of compacted sand bedding below including sampling and testing. The rate shall also allow for using different coloured paver blocks of unshaped as per drawing or as directed by the Engineer-In-Charge.

14. SERVICES MISCELLANEOUS WORKS**14.1. Cutting Holes in walls up to 30 cm x 30 cm**

Square holes of size as specified or as directed by the Engineer-In-Charge shall be cut in the masonry. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-In-Charge. All dismantled material shall be removed from the site.

Masonry Work:

Brick work etc. shall be made good by using the same class of brick, tile or stone masonry as was cut during the execution of work. The mortar to be used shall be cement mortar 1:4 (1 cement: 4 fine sand) or as directed by the Engineer-In-Charge.

Finishing

Cement mortar in 1:4 mix (1 cement: 4 sand) shall be used for plastering or pointing, as may be required. Sand shall be fine or coarse as used in the original work. The surface shall be finished with two or more coats of white wash, colour wash, distemper or painting as required but where the surface is not to be white washed, colour washed, distempered or painted, it shall be finished smooth with a floating coat of neat cement or as required to match with the surrounding surfaces.

14.2. Cutting holes in RCC floors (up to 15 cm x 15 cm):

Square holes of size as specified shall be cut in RCC floor and roofs for passing drain pipe etc. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-In-Charge. All the dismantled material shall be removed from the site.

Cement concrete:

After insertion of drain pipe etc. the hole shall be repaired with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and the surface finished to match with the existing surface. The top and bottom shall be finished properly to make the joint leak proof. The specifications for cement concrete work and finishing etc. shall be the same as detailed under relevant sub-heads.

14.3. Cutting chases in masonry walls:

Making chases:

Chases are made in the walls for housing GI pipes etc.

Cutting of chases in one brick thick

As far as possible, services should be planned with the help of vertical chases. Horizontal chases should be avoided.

The depths of vertical chases and horizontal chases shall not exceed one third and one sixth of the thickness of the masonry respectively.

When narrow stretches of masonry (or short lengths of walls) such as between doors and windows, can not be avoided, they should not be pierced with openings for soil pipes or waste pipes or timber joints etc. Where there is a possibility of load concentration, such narrow lengths of walls shall be checked for stresses and high strength bricks mortar or concrete walls provided, if required.

Horizontal chases when unavoidable should be located in the upper or lower one third of height of storey and note more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked & kept within the permissible limits.

Vertical chases should not be closer than 2 m. in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.

Masonry directly above a recess, if less than 30 cm. (Horizontal dimension) should be supported on lintel. Holes in masonry may be provided upto 30 cm. Width x 30 cm height without any lintel. In the case of circular holes in masonry, no lintel should be provided upto 40 cm in diameter.

Filling Chases

After G.I pipes etc. are fixed in chases, the chases shall be filled with cement concrete 1:3:6 (1 cement: 3 coarse sand : 6 graded stone aggregate 20mm nominal size) or cement mortar 1:4 (1 cement : 4 coarse sand) as may be specified or otherwise directed by the

Engineer-In-Charge and made flush with the masonry surface. The concrete surface shall be roughened with wire brushes to provide a key for plastering.

Measurements:

Chases shall be measured in running meter correct to a cm.

14.4. Embedding pipes in masonry (upto 150 mm dia)

Pipe shall be embedded in masonry during construction of the building. A hole of size upto 20 cm x 20 cm as directed shall be kept in the masonry. The pipes shall be centrally placed in the hole and shall be fixed by filling the stacks with cement concrete around. The holes shall be provided at correct positions as shown in the drawing or as directed by the Engineer-In-Charge.

Embedding pipes:

Pipes shall be embedded in masonry with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size). Where the wall thickness is 20 cm the cement concrete shall be made flush with the masonry surface on both sides and the surface roughened with wire brushes to receive plaster. Where the thickness of wall is more than 20 cm, the other side shall be covered with the same class of brick, tile or stone masonry etc. as provided in the adjoining portion or the main building. This masonry shall be paid for separately, under the relevant item.

14.5. Dry stone pitching

As far as possible it should be ensured that one rainy season has elapsed before pitching or any kind of stone work is commenced, so that the embankment has time to settle, and loose spots in the cutting, if any, show up.

The sides and bottom of the drain or the sides and top of embankment, as the case may be, shall be brought to the required profile, slope and gradient and shall be compacted to a firm and even surface. If the situation demands, and where so required by the Engineer-In-Charge in consideration of the nature of the surface, the necessary back filling may be done with small broken stone, murum, gravel or ballast well consolidated to proper profile. In case the soil is unreliable and if the nature of the work requires it, a 75 mm thick layer of gravel or ballast may be provided over the prepared surface and well consolidated..

Pitching:

Pitching shall be of 22.5 cm depth, unless specified otherwise. Profiles shall first, be put up by means of pegs and strings or by placing stones, at interval of not more than 15 meter. Stone shall then be laid closely in position in between the profile and firmly embedded with joints staggered and with exposed faces true to line, gradient and in uniform slope throughout.

The cross bands of approximately 22.5 cm width through bond stones equal to the full depth of pitching, shall be provided at an interval of approximately 3 m centre to centre both longitudinally and transversely.

The interstices between adjacent stones shall be filled in with stones of proper size, well driven in with crow bars to ensure tight packing and complete filling of all interstices. Such filling shall be carried on simultaneously with the placing in position of the large stones and shall in no case be permitted to fall behind. Final wedging shall be done with the largest sized chip particles, each chip being well driven home with a hammer so that no chip is possible of being picked up or removed by hand.

Measurements:

The exposed finished surface shall be measured after the pitching has been done. The length, width and side slope shall be measured correct to a cm. The area of pitching for drains shall be calculated in sq.m by multiplying the perimeter (bed width plus side slopes) by the length of the pitching.

Rate:

The rate shall include the cost of the materials and labour involved in all the operations described above, except pitching stone which shall be paid for separately. The back filling done, if any except when done with earth as material obtained locally, shall be paid for separately.

14.6. Sand Cast Iron or Centrifugally Cast (Spun) Iron Pipes and Fittings

Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 1729. Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 3989.

The fittings shall conform to the same I.S. specifications to which the pipe itself conforms in which they are connected.

The pipes shall have spigot and socket ends, with head on spigot end in case of sand cast iron pipes and without head on spigot end in case of cast iron (Spun) pipes. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and shall be free from cracks, taps, pinholes and other imperfections and shall be neatly dressed and carefully fettled. All pipes and fittings shall ring clearly when struck with a light hand hammer.

The ends of pipes and fittings shall be reasonably square to their axis. The sand cast iron pipes shall be 1.5/1.8/2.0 metre in length including socket ends, cast iron (Spun) pipes shall be 1.5/1.75/2.0/2.5/3.0 metre in length excluding socket ends, unless shorter lengths are either specified or required at junctions etc. The pipe and fittings shall be supplied without ears, unless specified or directed otherwise.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fitting being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar or other suitable base. The coating material shall have good adherence and shall not scale off. In all instances where the coating material has tar or similar base it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree centigrade but not so brittle at a temperature of 0 degree centigrade as to chip off when scribed lightly with a pen knife.

The standard weights and thicknesses of pipes and their tolerances shall be as prescribed standard.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerance in weights & thicknesses shall be the same as for straight pipes.

The access door fittings shall be designed so as to avoid dead spaces in which filth may accumulate. Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be water tight.

14.7. MANHOLES

At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 30 m.

Manholes of different types and sizes as specified shall be constructed in the sewer line at places and to such levels and dimensions as shown in the drawings or as directed by the Engineer in Charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.

Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

Sewers of unequal sectional area shall not be jointed at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least $\frac{2}{3}$ the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and junction must be made with care so that flow in main is not impeded.

No drain from house fittings, e.g. gully trap or soil pipe, etc. to manhole shall normally exceed a length of 6 m unless it is unavoidable.

Manholes 90 x 80 cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes 1.2 m x 90 cm are generally constructed for main drainage work for depths less than 1.5 m.

Manhole 1.4 m x 90 cm is of the arched type and is generally constructed for main drainage works where depth is 1.50 m or more. The width of manholes shall be increased more than 90 cm on bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side channel is minimum 20 cm.

Manholes 1.4 m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450 mm in the same manner as in the case of rectangular manholes.

Before deciding size of manholes, Local Municipal Bye Laws shall be consulted. As a general guide some typical type designs of manholes followed have been as per CPWD specification. When manholes are constructed on foot path, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

14.7.1. Excavation

The excavation for manhole shall be true to dimensions and levels shown on the plans or as directed by the Engineer-in-Charge.

14.7.2. Bed Concrete

The manhole shall be built on a bed of cement concrete 1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate 40 mm nominal size) unless required by local authorities. The thickness of the bed concrete shall be 20 cm for manholes up to 4.25 m depth and 30 cm for depths beyond 4.25 m unless otherwise specified or directed by the Engineer-in-Charge. In bad ground, special foundation as suitable shall be provided.

14.7.3. Brick Work

The brick work shall be with class 75 bricks in cement mortar 1:4 (1 cement: 4 coarse sand). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof. For arched type and circular manholes, brick masonry in arches and arching over the pipes shall be in cement mortar 1.3 (1 cement: 3 fine sand). In the case of manholes of circular type the excess shaft shall be corbelled inwardly on three sides at the top to reduce its size to the cover frame to be fitted.

The walls shall be built of one brick thickness for depths up to 4.25 m. Below a depth of 4.25 m in ordinary subsoil the wall thickness shall be increased to one and half brick and at 9.75 m below ground two brick thick walls shall be built.

14.7.4. Plaster and Pointing

The walls of the manholes shall be plastered inside with 12 mm thick cement plaster 1: 3 (1 cement: 3 coarse sand) finished smooth. In the case of arched type manhole the walls of the manhole shall be plastered inside all-around only up to the crown level, and flush pointed for the shaft with cement mortar 1:2 (1 cement: 2 fine sand). Where the saturated soil is met with, also the external surface of the walls of the manhole shall be plastered with 12 mm thick cement plaster 1: 3 (1 cement: 3 coarse sand) finished smooth up to 30 cm above the highest sub-soil water level with the approval of the Engineer-in-Charge. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer's specifications. In case Local Authorities/Bye Laws specify richer specifications, the same shall be adopted.

For earth work excavation, bed concrete brick work, plaster and pointing, R.C.C. work and refilling of earth, respective specifications shall be followed.

14.7.5. Benching

The channels and benching shall be done in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement. The depth of channels and benching shall be as given in Table below.

14.7.6. Foot Rests

All manholes deeper than 0.8 m shall be provided with M.S. foot rests. These shall be embedded 20 cm deep in 20 x 20 x 10 cm blocks of cement concrete 1:3:6 (1 cement: 3 coarse sand 6 graded stone aggregate 20 mm nominal size). The concrete block with M.S. foot rest placed in its centre shall be cast in situ along with the masonry and surface finished with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth.

TABLE 26

<i>Sizes of drain</i> mm	<i>Top of channel lilt the</i> <i>above bed concrete</i> cm	<i>Depth of benching at side</i> <i>above bed concrete</i> cm
100	15	20
150	20	30
200	25	35
250	30	40
300	35	45
350	40	50
400	45	55
450	50	60

Foot rests which shall be of 20 x 20 Sq. M.S. bars as specified in CPWD specifications shall be fixed 40 cm vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top foot shall be 45 cm below the manhole cover.

Foot rests shall be painted with coal tar, the portion embedded in the cement concrete block t painted with thick cement slurry before fixing.

14.7.7. Manhole Covers and Frames

The frame of manhole shall be firmly embedded to correct alignment and levels in R.C.C. slG plain concrete as the case may be on the top of the masonry. After completion of the work, man covers shall be sealed by means of thick grease.

14.7.8. Measurements

Manholes shall be enumerated under relevant items. The depth of the manhole shall be reckc from the top level of C.1. cover to the invert level of channel. The depth shall be measured correct em. The extra depth shall be measured and paid as extra over the specified depth.

14.7.9. Rate

The rate shall include the cost of materials and labour involved in all the operations described above but excludes the cost of (i) excavation, (ii) M.S. foot rests and (iii) 12 mm thick cement plaster with water proofing material applied at the external surface of the manhole if required. These items shall be paid for separately under relevant items of work.

Payment for extra depths of manholes shall be made separately under relevant items of work.

15. EXTERNAL DRAINAGE & SEWAGE DISPOSAL

15.1. General Scheme

The contractor shall install a drainage system to effectively collect; drain and dispose all soil and waste water from various parts of the buildings, appurtenances and equipment. The piping system shall finally terminate and discharge into the Municipal sewer / Sewage treatment plant. The piping work mainly consists of laying of Salt glazed stoneware pipes, reinforced cement concrete pipes and cast iron soil pipes as called for. Unless otherwise stated or permitted by Engineer-In-Charge, all piping shall be installed at depth at least 60 cm below finished ground level. The disposal system shall include construction of gully traps, manholes, intercepting chambers as indicated. The piping system shall be vented suitably at the starting point of all branch drains, main drains, the highest / lowest point of drain and at intervals as shown. All ventilating arrangements shall be unobstructive and concealed. The work shall be executed strictly in accordance with IS: 1742. The sewage system shall be subject to smoke test for its soundness as directed by the Engineer-In-Charge. Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:3:6 all round with the prior approval of the Engineer-In-Charge.

15.2. Piping Material

15.2.1. Stoneware Pipes

Stoneware pipes shall be perfectly salt glazed, sound, free from cracks, deformities and imperfections in glazing. They shall be cylindrical, straight and of standard nominal diameter, length and depth of socket. They shall be made of hard burnt stoneware of dark grey colour and thoroughly glazed and shall give a sharp clear note when struck with a light hammer. The pipe shall conform to the requirements of Indian Standards IS: 651 & the sizes and make specified in the Bill of Quantities.

15.2.2. Stoneware Gully Trap

Gully trap shall be stoneware as specified above. These shall be sound and free from visible defects such as any type of crack. The glaze of the traps shall be free from cracks. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.5 kg and the frame not less than 2.7 kg. The grating cover and frame shall be of good casting and shall have truly square machined seating faces.

15.2.3. Cast Iron Pipes

Cast iron pipes and fittings shall conform to IS:3989 in the documents.

15.2.4. Cast Iron Manhole Cover and Frame

The Cast Iron Manhole Cover and Frame shall conform to IS: 1726 and the grade and types have been specified in the Bill of Quantities. The cover and frames shall be cleanly cast & they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage or other causes. Covers shall have a raised checkered design on the top surface to provide an adequate non-slip grip.

The sizes of covers specified shall be taken as the clear internal dimensions of the frame.

The covers and frames shall be coated with a black bituminous composition. The coating

shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

15.3. Laying and Jointing of Pipes

15.3.1. General

All the material shall be new of best quality conforming to specifications and subject to the approval of the Engineer-In-Charge. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes, catch basins etc. shall be confirmed by the Engineer-In-Charge before the actual execution of work at site. All work shall be executed as directed by the Engineer-In-Charge.

15.3.2. Alignment and Grade

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Engineer-In-Charge from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes.

The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed in the trench for its length and places shall be excavated to receive collar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Engineer-In-Charge. All pipes shall be laid atleast 60 cms below the finished ground level or as called for on the drawings.

15.3.3. Setting out Trenches

The contractor shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings.

The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by the Engineer-In-Charge.

15.4. Trench Excavation

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the Engineer-In-Charge. In soft and filled in ground, the Engineer-In-Charge may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by the Engineer-In-Charge. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities shall be adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Engineer-In-Charge. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations. All excavated earth shall be kept clear of the

trenches to a distance equal to 75 cms.

15.5. Obstruction of Roads

The contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Engineer-In-Charge in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

15.6. Protection of Pipes etc.

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the contractor with the written consent from the Owner.

15.7. Trench Back Filling

Refilling of the trenches shall not be commenced until the length of pipes therein has been tested and approved. All timbering which may be withdrawn safely, shall be removed as filling proceeds. Where the pipes are unprotected by concreted haunching, selected fine material shall be carefully hand-packed around the lower half of the pipes so as to buttress them to the sides of the trench.

The refilling shall then be continued to 150 mm over the top of the pipe using selected fine hand packed material, watered and rammed on both sides of the pipes with a wooden hammer. The process of filling and tamping shall proceed evenly in layers not exceeding 150 mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line. In gardens and fields the top solid and turf if any, shall be carefully replaced.

15.8. Contractor to ensure Settlement and Damages

The contractor shall at his own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths, gardens, open spaces etc. in the public or private areas caused by his trenches or by his other excavations and he shall be liable for any accident caused thereby. He shall also, at his own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion of the Engineer-In-Charge he fails to make good such works with all practicable dispatch, the Engineer-In-Charge shall be at his liberty to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

The contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled, surplus soil shall be immediately removed, the surface shall be properly restored and roadways and sides shall be left clear.

15.9. Removal of water from Sewer, trench etc

The contractor shall at all times during the progress of work keep the excavations free from water which shall be disposed by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any road or streets, nor cause any interference with the use of the same by the public.

If any excavation is carried out at any point or points to a greater width of the specified cross section of the sewer with its cover, the full width of the trench shall be filled with concrete by the contractor at his own expense and charges to the requirements of the Engineer-In-Charge.

15.10. Route Markers

Markers indicating the particular service shall be provided along with the routes of pipe trenches. Markers shall be of mild steel indicating the type of service installed and the direction of flow painted on it. The markers shall be set firmly in a concrete base and installed at all corner and turning points. Over straight runs, markers shall be spaced centre to centre at 50 meter centre (generally).

15.11. Laying and Jointing of Cement Concrete pipes

Cement concrete pipes shall be laid and jointed as described in IS:783. After setting out the pipes, the collar shall be centered over the joint and a few skins of spun yarn soaked in a neat cement wash shall be inserted in the groove at the end of the pipe and two adjoining pipes butted against each other. After setting out the pipes, the collar shall then be slipped over the joint, covering equally both the pipes. Spun yarn soaked in neat cement wash shall be passed round the pipes and inserted in the joint by means of caulking tools from the ends of the collar. More skins of yarn shall be added and well rammed above.

Cement mortar with one part of cement and two parts of sand shall be slightly moistened and must in no account be soft or sloppy and shall be carefully inserted by hand into the joint and more cement mortar be added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall be finished off neatly outside the collar on both sides at an angle of 45 degree, any surplus mortar projecting inside the joint is to be removed and to guard against any such projection, sack or gunny bags shall be drawn past each joint after completion. Cement mortar joint shall be cured for seven days.

15.12. Fixing Of Stoneware Gully Trap

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-In-Charge. The gully traps shall be fixed on cement concrete foundation [wherever required] 65cm square and not less than 10 cm thick. The mix for the concrete will be 1:4:8. The jointing of gully outlet to the branch drain shall be done similar to the jointing of S.W. Pipes described earlier. After fixing and testing gully and branch drain, a brick work of specified class in cement mortar 1:5 shall be built with a half brick masonry work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber and trap shall be filled in with cement concrete 1:3:6. The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside the cement mortar 1:3 finish with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

CI cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top cover shall be so as to prevent the surface water from entering the gully trap.

15.13. Construction of Manhole

Where manholes are to be constructed, the excavation, filling back and ramming, disposal of surplus earth, preparation of bottom and sides etc. shall be carried out as described earlier under trench excavation. Manhole shall be sized and depths as called for in the drawings and Bill of Quantities.

The manhole shall be normally constructed as per detail drawing having lean mix concrete provided for leveling pores with 230mm thick BB masonry for shade walls usually plastered smooth from inside and outside and top of manhole provided with RCC slab as shown in the drawing along with cast iron or fibre reinforced concrete manhole frame and cover as specified or directed by Engineer-In-Charge. The bottom of the chamber will be provided with lean mix concrete for providing benching of suitable size and shape. The surface of benching shall be finished smooth with neat cement. The cost of benching, plaster and neat cement finishing shall deemed to have been included in the quoted rate of the manhole. Manholes with left more than 900 mm shall be provided with suitable size of cast iron rungs as indicated in the drawing and as specified in the item. These rungs will be paid separately as per rates shown in the Bill of Quantities.

Above the horizontal diameter, the sides of channel shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. Rungs of cast iron or mild steel of suitable dimensions shall be provided in all manholes over 800 mm depth. These rungs shall be set at 30 cms interval in two vertical runs at 380 mm apart horizontally. The top rung shall be 450 mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard IS:4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75 mm radius with cement plaster 20 mm thick. The benching at the side shall be carried out in such a manner so as to provide no lodgment for any splashing in case of accidental flooding. Manhole cover with frame shall be cast iron of an approved make. The covers and frame shall generally be double seal as specified in the Bill of Quantities.

15.14. Drop Connection

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 45 cms of the required sizes. Drop connections from gully traps to main sewer in rectangular shall be made inside the manholes and shall have HCI special types door bend on to top and heel rest bend at bottom connected by a HCI pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with at least one clamp for each drop connection. All joints shall be lead caulked joints 25 mm deep.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall with HCI / CI class LA pipe, connection, vertical pipe and bend at the bottoms. The top of the tee shall be finished upto the surface level and provided with a CI hinges type frame & cover 30 cms x 30 cms. The connection and tee upto the surface chamber of the tee.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections. They shall be paid for under the relevant soil and waste pipes.

15.15. Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all

sewage & water if encountered in making the connection without additional cost.

15.16. Shifting of Excavated Surplus Material

Contractor shall make his own arrangement to shift the surplus excavated material within the site limits as directed by Engineer-In-Charge.

15.17. Testing

All lengths of the sewer and drain shall be carefully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subject to a test pressure of 1.5 metre head of water. The test pressure will however, not exceed 6 metres head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time permit.

Sewer lines shall be tested for straightness by:

- (a) Inserting a smooth ball 12mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end.
- (b) Means of a mirror at one end and a lamp at the other end. If the pipe is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.
- (c) The contractor shall alternatively give a smoke test to the drain and sewer at his own expense and charge, if directed by the Engineer-In-Charge.
- (d) A test register shall be maintained which shall be signed and dated by contractor, Engineer-In-Charge.

Contractor to provide :

The Contractor shall provide and maintain at site throughout the period of works the following at his own cost and without extra charge, the cost being held to be included in the Contract Rates :

- 1) All labour, materials, plant, equipment and temporary works required to complete and maintain the works to the satisfaction of the Engineer-In-Charge.
- 2) Lighting for night work; if required and also whenever and wherever required by the Engineer-In-Charge.
- 3) Temporary fences, guards, lights and protective work necessary for protection of workmen, supervisors, engineers or any other persons permitted access to the site.
- 4) All equipment, instruments and labour required by the Engineer-In-Charge for measurement of the works.
- 5) A testing room of not less than 20m² equipped with the following, and labour and materials required for carrying out tests therein :
 - i) Set of standard sieves for testing, grading of sand.
 - ii) Sieves with opening respectively of 4.75 mm, 10 mm, 20 mm and 40 mm for testing grading of aggregates.
 - iii) Balance, capacity up to 10 kg, reading to 5 gm.

- iv) Electric Thermostat controlled oven and pans for drying of sand and aggregates.
 - v) Glass measuring flasks of ½, 1 and 2 litre capacity and graduated cylinders for testing silt content.
 - vi) Flask for determining moisture content of sand.
 - vii) Slump cone with rod for slump test.
 - viii) Minimum 12 steel moulds for 150 mm x 150 mm x 150 mm concrete test cubes. It may be necessary to provide more steel cube moulds depending upon concreting programme.
 - ix) Vibrator with 25 mm dia needle for compaction of concrete in test cubes and also vibrating table.
 - x) Work benches, shelves, desks, sinks and any other furniture and lighting as required by the Engineer-In-Charge.
 - xi) Where concrete cube testing facilities from recognized institute near the site are not available or if the size of the project is large enough or if directed by the Engineer-In-Charge, the Contractor should provide at site concrete cube testing machine of adequate capacity to be able to test concrete cubes of grades M50 and below, at his own cost.
- 6) Any of equipment not specifically mentioned above which can reasonably be held necessary for the completion and maintenance of the works to the satisfaction of the Engineer-In-Charge.

SECTION - II

SPECIFICATIONS FOR ASPHALTING WORK

Specifications for road work shall be as described under Ministry of Road Transport & Highways (MORTH) and as described under relevant clauses as applicable.

1. EARTHWORK

1.1 Excavation

The work to be done under this section comprise performance of all work necessary for excavation with shoring, strutting, dewatering, pumping including disposing of all surplus excavated material from the site as directed by the Engineer.

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

1.2 Site Levels

Before the work commences the Contractor shall carry out a survey of the levels of the site and obtain verification by the Engineer of these levels. Levels shall be taken on a grid to be agreed with the Engineer and the Contractor shall submit three prints of the drawing showing the site levels for record purpose.

1.3 Excavation beyond Required Limit

Any excavation beyond the required limits and against which asphalt is to be placed shall be made good with bituminous concrete of specified grades. Any excavation beyond the required limits at locations where no Bituminous concrete is to be placed will not be required to be made good with concrete unless otherwise directed by the Engineer provided always that any consequential additional work caused or necessitated by the excavation beyond limits will not be admitted for payment.

1.4 Dewatering

While execution of works, if so encountered, the Contractor shall provide for the purpose of excavation under water all the necessary dewatering equipment like well points, pumps (including stand byes), pipes, conduits, etc. and make necessary arrangement for proper drainage of the pumped water from the well points and its easy disposal without affecting the site and the adjoining areas. The Contractor at his own cost shall take any permission required for such disposal of water to other areas, from the respective authorities.

1.5 Compaction Quality

Compaction of earth where asphaltting work is located, the degree of compaction achieved shall be minimum 95% of maximum dry density as obtained by Proctor

compaction as per IS: 2720 (Part VII). Unless otherwise specified, in roads & other areas the degree of compaction shall be 90%.

1.6 Classification of soil

The earthwork (in the all kinds of soil) shall be classified under the following main categories.

a) Soil includes various types of soils, mud concrete below the ground level, shingle and river or nallah bed boulders, soling of road, paths and hard core, mecadam surface of any description, lime concrete, stone masonry below the ground level, soft conglomerate and laterite when the stone can be detached from the matrix with picks and shovel.

b) Ordinary Soils, Sand, Clay & Soft Murrum includes earth, soft murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof which can be excavated with shovels, loose application of pick axes etc.

c) Hard soil, murrum, boulders, weathered / soft rock : All decomposed weathered rock, highly fissured rock, old masonry, boulders bigger than 0.03 cum. in volume but not bigger than 0.5 cum. and other varieties of soft rock which can be removed only with hard application pick axes, crow bars, wedges and hammers with some difficulty. The more fact that the contractor resorts to blasting and / or wedging and chiseling for reasons of his own, shall not mean the rock is classifiable as hard rock.

Note: The scope of work taking site levels, support the sides of excavation, barricades, dewatering, etc. are inclusive of excavation item, no extra payment will be given to the contractor.

2. **Hard Core Soling (Trap rubble stone Soling)**

The hard core shall consist of layers of uniform thickness of trap stone rubble (of size 150 mm to 230 mm) or any other approved stone carefully set as close as possible on ground properly formed for the purpose. The packing shall consist of large stones. The interstices between the rubble stones shall be filled up with stone chips, spalls, and oversized metal removing the projection of the upper part of the packing so as not to loosen the hard core soling. Also spreading approved hard murrum or soil collected/stacked during excavation etc, complete, the hard-core soling should be thoroughly rammed, watered, settled to place and made compact.

All above work to be carry out as per MOST specification (latest Edition).

3 **WATER BOUND MACADAM SUB-BASE/BASE:**

Scope:

This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, stone chips, murrum, binding material where necessary and water laid on a properly prepared sub grade / sub-base / base or existing pavement, as the case may be and finished in accordance with the requirements of these specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

Materials:

3.2.1 Coarse aggregates: Coarse aggregates shall be either crushed or broken stone, The aggregates shall conform to the physical requirements set forth in **Table -1**. The type and size range of the aggregate shall be specified in the Contract or

shall be as specified by the Engineer. If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as **per IS: 2386 (Part5)**.

3.2.2 Crushed or broken stone: The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other deleterious material.

TABLE- 1.
PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE COARSE

Test		Test Method	Requirements
1	Los Angeles Abrasion Value	IS:2386 (Part-4)	40 per cent (Max)
	Aggregate Impact Value	IS:2386 (Part-4) or IS:5640	30 per cent (Max)
2.	Combined Flakiness and Elongation Indices (Total)	IS:2386 (Part1)	30 per cent (Max)

3.3 Grading requirement of coarse aggregates: The coarse aggregates shall conform to the grading given in **Table 2** as specified, provided, however, the use of Grading No.1 shall be restricted to sub-base courses only.

TABLE -2
GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size Range	IS Sieve Designation	Per cent by Weight passing
2	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5

Note: The compacted thickness for a layer with Grading 2 shall be 120mm.

3.4 Screenings: Screening to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, predominantly non-plastic material such as Murrum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent.

Screening shall conform to the grading set forth in **Table -3**. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in **Table 4**. The table also gives the quantities of materials (loose) required for 10 m² for sub-base / base compacted thickness of 100/75 mm.

TABLE -3
GRADING FOR SCREENINGS

Grading Classification	Size of Screening	IS Sieve Designation	Per cent by Weight passing the sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95-100
		5.6 mm	15-35
		180 micron	0-10
B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 micron	15-35

TABLE -4
APPROXIMATE QUANTITIES OF COARSE AGGREGATES AND SCREENINGS
REQUIRED FOR 100/75 MM COMPACTED THICKNESS OF WATER BOUND
MACADAM (WBM) SUB-BASE/BASE COURSE FOR 10M² AREA

Classification	Size Range	Compacted thickness	Loose Qty.	Screenings			
				Stone screening	Crushable Type such as Moorum or Gravel	Grading Classification	Loose Qty.
				For WBM sub-base/base course (Loose Qty)	Grading Classification & Size		
Grading 1	90 mm to 45 mm	100	1.21 to 1.43 m ³	Type A 13.2 mm	0.27 to 0.30 m ³	Not uniform	0.30 to 0.32
Grading 2	63 mm to 45 mm	75 mm	0.91 to 1.07 m ³	Type A 13.2 mm	0.12 to 0.15 m ³	-do-	0.22 to 0.24 m ³
-do-	-do-	-do-	-do-	Type B 11.2 mm	0.20 to 0.22 m ³	-do-	-do-

3.5 Binding material: Binding material to be used for water bound macadam as a filler material meant for preventing raveling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS:2720 (Part 5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75mm and 100mm compacted thickness of water bound macadam will be 0.06-0.09 m³/10 m² and 0.08-0.10 m³/10 m² respectively.

The above-mentioned quantities should be taken as a guide only, for estimation of quantities for construction, etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as moorum or gravel.

Note: Quantity of coarse aggregate, screening and binding material required for the compacted thickness 120mm WBM should be taken proportionately with respect to clause 3.2 of this specification.

3.6 Construction Operations:

3.6.1 Preparation of base: The surface of the sub-grade/sub-base/base to receive the water bound macadam course shall be prepared to the specified lines and cross fall (camber) and made free of dust and other extraneous material. Any dust or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base/base/surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course Specifications.

3.6.2 Spreading coarse aggregates: The coarse aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base to proper profile by using templates placed across the road/area about 6m apart, in such quantities that the thickness of each compacted layer is not more than 100mm for Grading 1 and 75mm for Grading 2 and 3, as specified in Table-4. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread

the aggregates uniformly so as to minimize the need for manual rectification afterwards. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. No segregation of large or fine aggregates shall be allowed and the coarse aggregate, as spread shall be of uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved drawings. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operations.

3.6.3 Rolling: Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 8 to 10 tonnes capacity or tandem or vibratory rollers of 8 to 10 tonnes static weight. The type of roller to be used shall be approved by the Engineer based on trial run.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub grade is soft or yielding or when it causes a wave-like motion in the sub grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired crossfall (camber) and grade. In no case shall the use of screenings be permitted to make up depressions.

Material, which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates.

3.6.4 Application of screenings: After the coarse aggregate has been rolled as specified in **3.6.3**, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall be screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

3.6.5 Sprinkling of water and grouting: After the screenings have been applied, the surface shall be copiously sprinkled with water have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub grade does not get damaged due to the addition of excessive quantities of water during construction.

3.6.6 Application of binding material: After the application of screenings as specified in 3.6.4 and 3.6.5, the binding material where it is require to be used (Clause 3.5) shall be applied successively in two or more than layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms and wave ahead of the wheels of the moving roller.

3.6.7 Setting and drying: After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface.

The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

3.7 Reconstruction of defective macadam:

The finished surface of water bound macadam shall conform to the tolerance of surface regularity as prescribed in **Table-5**. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to sub grade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and re-compacted. In no case shall depressions be filled up with screening or binding material.

**TABLE -5
PERMITTED TOLERANCES OF SURFACE EVENNESS FOR WBM COURSES**

Sl. No.	Size range of coarse aggregate	Longitudinal profile measured with a 3 meter straight edge		Cross profile
		Max. Permissible undulation	Maximum number of undulation permitted in any 300 meter length exceeding	Max. Permissible variation from specified profile under a camber template
		mm	12mm	mm
1	90-45 mm	15	30	12

3.8 Measurements for payment:

Water bound macadam shall be measured as finished work in position in cubic metres.

Rate:

The Contract unit rate for water bound macadam sub-base / base course shall be payable in full for carrying out the required operations including full compensation

for all components listed in Clause 3.1 to 3.6 **including arrangement of water used in the work as approved by the Engineer.**

Note: All above work to be carry out as per MOST specification (latest Edition).

4 TACK COAT:

4.1 Scope: This work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface/ WBM preparatory to another bituminous construction over it.

4.2. Materials

4.2.1 Binder: The binder used for tack coat shall be bituminous emulsion as specified in the BOQ of the work.

4.3. Construction Operation

4.3.1 Equipment: The tack coat distribution shall be a self propelled or towed bitumen pressure sprayer, equipped for spaying the material uniformly at a specified rate. Hand spraying the materials uniformly at a specified rate. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips, shall be sprayed with a pressure hand sprayer, or as direction by the Engineer.

4.3.2. Preparation of base: The surface on which the tack coat is to be applied shall be cleaned of dust, dirt and any extraneous material before the application of the binder, by using a mechanical broom/high pressure air jet or any other approved equipment/method as specified by the Engineer.

4.3.3. Application of tack Coat: Binder may be heated to the temperature appropriate to the grade of cutback used and approved by the Engineer and sprayed on the base at the rate of 0.75 kg per square meter area. The normal range of spraying temperature for a bituminous emulsion shall be 20°C-70°C and for a cutback, 50°C-80°C if RC-70/ MC-70 grade is used. It shall be the responsibility of the Contractor to carefully handle the inflammable bituminous cutback material so as to safeguard against any fire mishap. The binder shall be applied uniformly with the aid of either self-propelled or towed bitumen pressure sprayer with self-heating arrangement and spraying bar with nozzles having constant volume or pressure system, capable of spraying bitumen at specified rates and temperature so as to provide a uniformly unbroken spread of bitumen. Work should be planned so that no more than the necessary tack coat for the day's operation is placed on the surface. After application and prior to succeeding construction allow the tack coat to cure, without being disturbed, until the water/cutter has completely evaporated, as determined by the Engineer. No vehicles shall be allowed on the tack coat other than those essential for the construction.

4.4 Measurement for Payment: Tack coat shall be measured in terms of surface area of application in Square Meters.

Note: All above work to be carry out as per MOST specification (latest Edition).

5 BITUMINOUS MACADAM:

5.1 Scope: This work shall consist of construction, in a single course having average 75mm thickness or in multiple courses of compacted crushed aggregates premixed with a bituminous binder, to serve as base/binder course, laid immediately after mixing, on a base prepared previously in accordance with the requirement of these Specifications and in conformity with the lines, grades and cross-sections

Materials:

5.2.1 Bitumen: The bitumen shall be paving bitumen of penetration grade as specified in the BOQ of the work and complying with Indian Standard Specification for Paving Bitumen, IS:73 and of the penetration indicated in Table-6 of this Specifications.

**TABLE -6
COMPOSITION OF BITUMINOUS MACADAM**

Mix designation	Grading 1	Grading 2
Nominal aggregate size	40mm	19 mm
Layer Thickness	80-100 mm	50-75 mm
IS sieve (mm)	Cumulative Percentage by wt of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content % by Wt of total mixture	3.1-3.4	3.3-3.5
Bitumen grade	As specified in item specification of BOQ or as directed by Engineer In-charge	As specified in item specification of BOQ or as directed by Engineer In-charge

5.2.2 Coarse aggregates:

The coarse aggregates shall be generally as specified in **Clause 3.2.1 of specifications**, except that the aggregates shall satisfy the physical requirements of Table-7.k shall consist of construction, in a single course, of

5.2.2.1 The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, and durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. When the Contractor's selected source of aggregates have poor affinity for bitumen, as condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer's recommendations, without additional payment. Before approval of the source, the aggregates shall be tested for stripping. The aggregates shall satisfy the physical requirements specified in Table 7 for dense bituminous macadam.

5.2.2.2 Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75mm sieve shall have at least two fractured faces.

**TABLE- 7
PHYSICAL REQUIREMENTS FOR COURSE AGGREGATE FOR BITUMINOUS
MACADAM.**

Property	Test	Specification
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (Combined)	Max 30%
Strength	Los Angeles Abrasion Value ³	Max 40%
	Aggregate Impact Value ⁴	Max 30%

Durability	Soundness	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixture	Minimum Retained Coating 95%
Water Sensitivity	Retained Tensile Strength	Min 80%

5.3 Fine aggregates: The fine aggregates shall be as specified in MOST specifications.

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36mm sieve and retained on the 75-micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter.

5.4 Aggregate grading and binder content: When tested in accordance with IS:2386 Part 1(Wet sieving method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in **Table -6** for grading 1 to 2 as specified in the Contract the type and quantity of bitumen and appropriate thickness are also indicated for each mixture type.

5.5 Proportioning of Material: The aggregate shall be proportioned and blended to produce a uniform mixture complying the requirement of **Table no.-7** the binder content shall be within the tolerance of +/- 0.3 % by wt. of total mixture.

5.6 Preparation of the base: The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross-sections and a priming coat where needed shall be applied as directed by the Engineer.

5.7 Tack coat: A tack coat as per **Clause 4.2.** of the specification shall be applied over the base, if required or directed by Engineer.

5.8 Preparation and transport of mix: Bituminous macadam mix shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Hot mix plant shall be of suitable capacity preferably of batch mix type. Total system for crushing of stone aggregates and feeding of aggregate fractions in required proportions to achieve the desired mix, deployed by the Contractor must be capable of meeting the overall Specification requirements under stringent quality control.

The temperature of binder at the time of mixing shall be in the range of 150C to 163°C and that of the aggregate in the range of 155°C- 163°C, provided that the difference in temperature between the binder and aggregate at no time exceeds 14°C. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particles of the aggregates are coated uniformly, and the discharge temperature of mix shall be between 130°C to 160°C.

The mixture shall be transported from the mixing plant to the point of use in suitable tipper vehicles. The vehicles employed for transport shall be clean and be covered in transit if so directed by the Engineer.

5.9. Spreading: The mix transferred from the tipper at site to the paver shall be spread immediately by means of self-propelled mechanical paver with suitable screeds capable of spreading, tamping, and finishing the mix true to the specified lines, grades and cross-sections.

5.10. Compaction: After the spreading of mix, rolling shall be done by 8 to 12 tonnes rollers or other approved equipment. Rolling shall start as soon as possible after the material has been spread, as the rolling is to be completed in limited time frame. The roller shall move at a speed not more than 5 km/h. Rolling shall be done with care to avoid unduly roughening of the pavement surface. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except that on per elevated and uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement. The initial or breakdown rolling shall be done with 8 to 12 tonnes static weight smooth wheel roller (3 wheels or tandem), as soon as it is possible to roll the mix without cracking the surface or having the mix pick up on the roller wheels, The second or intermediate rolling shall follow the break-down rolling with vibratory roller or static roller of 8 to 12 tonnes static weight as possible to the paver and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while material is still workable enough for removal of roller marks, with 8 to 12 tonnes roller. When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding mix material. The rolling shall then be continued till the entire surface has been rolled to 95 per cent of the average laboratory density (obtained from Marshall specimens compacted as defined in Table- 8, there is no crushing of aggregates and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. The roller wheel shall be kept damp if necessary to avoid bituminous material from sticking to the wheels and being picked up. In no case shall fuel, lubricating oil be neither used for this purpose, nor excessive water poured on the wheels. Rolling operations shall be completed in every, respect before the temperature of the mix falls below 100°C. Roller(s) shall not stand on newly laid material while there is a risk that surface will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

5.11. Measurements for Payment: The work shall be measured as finished work in cubic metres. Same shall be verified with quantity of bituminous macadam brought at site in Metric Tonnes.

Note: All above work to be carry out as per MOST specification (latest Edition).

6 BITUMINOUS CONCRETE.

6.1. Scope: This clause specifies the construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single compacted layer shall be 40mm in thickness.

6.2. Materials:

6.2.1. Bitumen: The bitumen shall be paving bitumen of Penetration grade as specified in the BOQ of the work and complying with Indian Standard Specification for Paving Bitumen, IS:73 and of the penetration indicated in Table-8, for bituminous concrete, or as otherwise specified in the Contract

**TABLE 8
COMPOSITION OF BITUMINOUS CONCRETE PAVEMENT LAYERS**

<i>Grading</i>	1	2
Nominal aggregate size	19mm	13mm
Layer Thickness	50-65mm	30-45mm
IS Sieve¹ (mm)	<i>Cumulative % by weight of total aggregate passing</i>	
45		
37.5		
26.5	100	
19	79-100	100
13.2	59-79	79-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix ²	5.0-6.0	5.0-7.0
Bitumen grade (pen)	As specified in item specification of BOQ or as directed by Engineer In-charge	As specified in item specification of BOQ or as directed by Engineer In-charge

Notes: 1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.
2. Determined by the Marshall method.

6.2.2. Coarse aggregates: The course aggregates shall be generally as specified in Clause 4.3, except that the aggregates shall satisfy the physical requirements of **Table 9**.

**TABLE 9
PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR BITUMINOUS
CONCRETE PAVEMENT LAYERS.**

<i>Property</i>	Test	Specification
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index	Max 30%(Combined) ²
Strength	Los Angeles Abrasion Value	Max 30%

	Aggregate Impact Value	Max 24%
Polishing	Polished Stone Value	Min 55
Durability	Soundness	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures	Minimum retained coating 95%
Water Sensitivity	Retained Tensile Strength	Min 80%

6.2.3. Fine aggregates: The fine aggregates shall be all as specified in Clause 5.2 of this specification.

6.2.4. Filler: Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement as approved by the Engineer. The filler shall be graded within the following limits:

**TABLE 10
GRADING REQUIREMENT FOR MINERAL FILLER**

IS sieve (mm)	Cumulative % passing by Wt of total aggregate
0.6	100
0.3	95-100
0.075	85-100

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. When the coarse aggregate is grave 1, 2 per cent by total weight of aggregate shall be Portland Cement or hydrated lime and the percentage of fine aggregate reduced accordingly. The cement or hydred lime not required when the limestone aggregate is used. Where the aggregate fail to meet the requirement of water sensitivity in **Table no. -11** then 2 percent by total wt aggregate of hydrated lime shall be added without additional cost.

**TABLE- 11
PHYSICAL REQUIREMENTS FOR COURSE AGGREGATE FOR BITUMINOUS
CONCRETE PAVEMENT LAYER**

Property	Test	Specification
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (Combined)	Max 30%
Strength	Los Angeles Abrasion Value ³	Max 30%
	Aggregate Impact Value ⁴	Max 24%
Polishing	Polished stone value	Min 24%
Durability	Soundness	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixture	Minimum Retained Coating 95%
Water Sensitivity	Retained Tensile Strength	Min 80%

6.2.5. Aggregate grading and binder content: When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and find aggregates and

added filled shall fall within the limits shown in Table -9 for grading 1 or 2 as specified in the Contract.

6.3 Mixture Design:

1. Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 12.

TABLE 12
REQUIREMENTS FOR BITUMINOUS PAVEMENT LAYERS

Minimum stability (kN at 60°C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Per cent air voids	3-6
Per cent voids in mineral aggregate (VMA)	As per Table no. 13
Per cent voids filled with bitumen (VFB)	65-75
Loss of stability on immersion in water at 60°C (ASTM D 1075)	Min. 75 per cent retained strength

The requirements for minimum percent voids in mineral aggregate (VMA) are set out in **Table 13**.

TABLE -13
MINIMUM PERCENT VOID IN MINERAL AGGREGATE (VMA)

Nominal Maximum Particle Size (mm)	Minimum VMA, Percent rated to Design Air Void, Percent		
	3.0	4.0	5.0
9.5	14	15	16
12.5	13	14	15
19.0	12	13	14
25.0	11	12	13
37.5	10	11	12

6.4 Binder content: The binder content shall be optimized to achieve the requirements of the mixture set out in Table 12. The binder content shall be as per specification of contract.

6.5. Job mix formula: The procedure for formulating the job mix formula shall be generally as specified in Clause 6.5.1 and the results of tests enumerated in Table 12 as obtained by the Contractors.

6.5.1 : Job Mix Formula: The Contractor shall inform the Engineer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the following details:

- (i) Source and location of all materials;
- (ii) Proportions of all materials expressed as follows where each is applicable.
 - (a) Binder type, and percentage by weight of total mixture;
 - (b) Coarse aggregate/Fine aggregate/Material filler as percentage by weight of total aggregate including mineral filler;
- (iii) A single definite percentage passing each sieve for the mixed aggregate;

- (iv) The individual grading of the individual aggregate fractions, and the proportion of each in the combined grading.
- (v) The results of tests enumerated in Table 12 as obtained by the Contractor;
- (vi) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch.
- (vii) Test results of physical characteristics of aggregates to be used;
- (viii) Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mixture and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.

The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the Engineer for approval before the placing of the material.

6.5.2 Plant trials – permissible variation in job mix formula: The requirements for plant trials shall be specified in the MOST specification.

6.5.2.1. Laying trials: The requirements for laying trials shall be all as specified in the MOST specification.

6.6 Construction Operations:

6.6.1 Preparation of base: The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clauses 5 and 9 of this specification, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

6.6.2 Tack coat: Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of Clause 4 of this specification.

6.6.3 Mixing and transportation of the mixture: The provisions as specified in Clauses 501.3 and 501.4 of MOST specification (latest Edition) shall apply.

6.6.4 Spreading: The general provisions of Clauses 501.5.3 and 501.5.4 MOST specification (latest Edition) shall apply.

6.6.6 Rolling: The general provisions of clauses 5.10 of this specification and 501.7 of MOST specification (latest Edition) shall apply, as modified by the approved laying trials.

6.7 Surface Finish and Quality Control: The surface finish of the completed construction shall conform to the requirements of Clause 7 of this specification. All materials and workmanship shall comply with the provisions set out in Section 900 of MOST specification (latest Edition).

6.8 Measurement for Payment: The work shall be measured as finished work in cubic metres. Same shall be verified with quantity of bituminous Concrete brought at site in Metric Tonnes.

Note: All above work to be carry out as per MOST specification (latest Edition).

7 QUALITY CONTROL FOR ASPHALT WORKS:

General:

7.1. All materials to be used, all methods adopted and all works performed shall be strictly in accordance with the requirements of specified in the tender. The Contractor shall set up a field laboratory at locations approved by the Engineer and equip the same with adequate equipment and personnel in order to carry out the test for Bitumen Content.

7.2. The Contractor shall carry out quality control tests on the materials and work to the frequency stipulated in subsequent paragraphs. In the absence of clear indications about method and / or frequency of tests for any item, the instructions of the Engineer shall be followed.

7.3. For satisfying himself about the quality of the materials and work, quality control tests will also be conducted by the Engineer (by himself, by his Quality Control Unit or by any other agencies deemed fit by him), generally to the frequency set forth herein under. Additional tests may also be conducted where, in the opinion of the Engineer, need for such tests exist.

7.4. The Contractor shall provide necessary co-operation and assistance in obtaining the samples for tests and carrying out the field tests/ lab test as required by the Engineer from time to time. This may include provision of labour, attendants, assistance in packing and dispatching and any other assistance considered necessary in connection with the tests.

7.5. The Contractor shall carry out modifications in the procedure of work, if found necessary, as directed by the Engineer during inspection. Works falling short of quality shall be rectified / redone by the Contractor at his own cost, and defective work shall also be removed from the site of works by the Contractor at his own cost.

7.6. The cost of laboratory / field test , essential supplies like water, electricity, sanitary services and their maintenance and cost of all equipment, tools, materials, labour and incidentals to perform tests and other operations of quality control according to the Specification requirements shall be deemed to the incidental to the work and no extra payment shall be made for the same.

7.7. For testing of samples granular materials, and mixes, bituminous materials and mixes, aggregates, cores, etc., samples in the required quantity and form shall be supplied to the Engineer by the Contractor at his own cost.

7.8. Bitumen, and similar other materials where essential tests are to be carried out at the manufacturer's plants or at laboratories other than the site laboratory, the cost of samples, sampling, testing and furnishing of test certificates shall be borne by the Contractor. He shall also furnish the test certificates to the Engineer.

7.9. The method of sampling and testing of materials shall be as required by the "Handbook of Quality Control for Construction of Roads and Runways" (IRC:SP:11), MOST Specifications and specification of tender. Where they are contradicting, the Specifications as directed by Engineer shall be followed. Where they are silent, sound engineering practices shall be adopted. The sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the Contractor.

8 DEFECTIVE MATERIALS

All materials which the Engineer / his representative has determined as not conforming to the requirements of the Contract shall be rejected whether in place or not; they shall be removed immediately from the site as directed. Materials, which have been subsequently corrected, shall not be used in the work unless approval is accorded in writing by the Engineer. Upon failure of the Contractor to comply with any order of the Engineer / his representative, given under this Clause, the Engineer / his representative shall have authority to cause the removal of rejected material and to deduct the removal cost thereof from any payments due to the Contractor.

9 CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY

9.1. General

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer, subject to the permitted tolerances described hereinafter.

9.2. Horizontal Alignment

Horizontal alignments shall be reckoned with respect to the centre line of the road work. The edges of the road work as constructed shall be correct within a tolerance of +/- 10mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be +/- 25mm.

9.3. Surface Levels

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances mentioned in **Table 14**.

**TABLE 14
TOLERANCES IN SURFACE LEVELS**

1.	Sub grade	+20 mm -25 mm
2.	Sub-base + 10mm (a) Flexible pavement	-20 mm
3.	Base-course for flexible pavement (a) Bituminous course (b) Other than bituminous (i) Machine laid	+6 mm -6 mm +10 mm -10 mm +15 mm
4.	Wearing course for flexible pavement (a) Machine laid	+6 mm -6 mm

**TABLE 15
MAXIMUM PERMITTED NUMBER OF SURFACE IRREGULARITIES**

Irregularity	Surface of carriageways and paved shoulders				Surfaces of laybys, service areas and all bituminous base courses			
	4mm		7mm		4mm		7mm	
Length (m)	300	75	300	75	300	75	300	75
Roads of lower category	40	18	4	2	60	27	6	3

The maximum allowable difference between the road surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

for pavement surface (bituminous and cement concrete)	3mm
for bituminous base courses	6mm
for granular sub-base / base courses	8mm
for sub-bases under concrete pavements	10mm

10 RECTIFICATION

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

- (i) Subgrade: Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of Clause 305 of MOST Specification (latest Edition).
- (ii) Granular Sub-base: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of Clause 401 MOST Specification (latest Edition).
- (iii) Water Bound Macadam / Wet Mix Macadam Sub-base/Base: Where the surface is high or low, the top 75mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 404. This shall also apply to wet mix macadam to Clause 406 MOST Specification (latest Edition).
- (iv) Bituminous Constructions: For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recomposing to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of bituminous layer is involved, the area treated shall not be less than 5 m in length and not less than 3.5 m in width.

11 QUALITY CONTROL TESTS DURING CONSTRUCTION

11.1. General

The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the preceding Clauses.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended in Tables 15 and 16 may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer.

TABLE 15

CONTROL TESTS AND THEIR MINIMUM FREQUENCY FOR SUB BASES AND BASES (EXCLUDING BITUMEN BOUND BASES)

Sl. No.	Type of Construction	Test	Frequency (min)
1.	Water Bound Macadam	(i) Aggregate Impact Value	One test per 200m ³ of aggregate/ change of source
		(ii) Grading	One test per 100 m ³ /change of source
		(iii) Flakiness Index and Elongation Index	One test per 200m ³ of aggregate/ change of source

		(iv) Atterberg limits of binding material	One test per 25 m ³ of binding material
		(v) Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 100 cubic metre of aggregate

11.2 Tests on Bituminous Construction

11.2.1. Test and frequency: The tests and their minimum frequencies for the different types of bituminous works shall be as given in Table 16. The Engineer may direct additional testing as required.

11.2.2. Acceptance criteria: The acceptance criteria for tests on density and Marshall stability shall be subject to the condition that the mean value is not less than the specified value plus:

$$1.65$$

$$1.65 - (\text{No. of samples})^{0.5} \text{ times the standard deviation}$$

TABLE 16
CONTROL TESTS FOR BITUMINOUS WORKS, AND THEIR MINIMUM FREQUENCY

Sl. No.	Type of Construction	Test	Frequency (min)
1.	Prime coat / Tack coat / Fog spray	(i) Quality of binder	Number of samples per lot and tests as per IS:73, IS:217 and IS:8887 as applicable.
		(ii) Binder temperature for application	At regular close intervals.
		(iii) Rate of spread of Binder	One test per 500m ² and not less than two tests per day.
2.	Bituminous Macadam	(i) Quality of binder	Same as mentioned under Serial No. 1
		(ii) Aggregate Impact Value / Los Angeles Abrasion Value	One test per 50m ³ of aggregate.
		(iii) Flakiness Index and Elongation Index	-do-
		(iv) Stripping value	Initially one set of 3 representative specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregates
		(v) Water absorption of aggregates	-do-
		(vi) Water sensitivity of mix	-do-
		(vii) Aggregate grading	One test per 100 m ³ of aggregate
		viii) Soundness (Magnesium and Sodium sulphate)	Initially, one determination by each method for each source of supply, then as warranted by change in the quality of the aggregate.
		(ix) Percentage of fractured faces	When gravel is used, one test per 50 m ³ of aggregate.

		(x) Binder content and aggregate grading	Periodic, subject to minimum of two test per day as per laying /application with Extraction apparatus and sieve analysis.
		(xi) Control of temperature of binder & aggregate for mixing & of the mix at the time of laying and rolling.	At regular close intervals.
		(xii) Rate of spread of binder	Regular control through checks of layers thickness
		(xiii) Density of compacted layer	One test per 250 m ³ of area
3.	Bituminous Concrete	(i) Quality of binder	Same as mentioned under Serial No.1
		(ii) Aggregate Impact Value/Los Angeles Abrasion Value	Same as mentioned under Serial No.2
		(iii) Flakiness Index and Elongation Index	Same as mentioned under Serial No.2
		(iv) Stripping Value	Same as mentioned under Serial No.2
		(v) Soundness (Magnesium and Sodium Sulphate)	Same as mentioned under Serial No.2
		(vi) Water absorption of aggregates	Same as mentioned under Serial No.2
		(vii) Mix grading	One set of tests on individual constituents and mixed aggregate from the dryer for each 400 tonnes of mix subject to a minimum of two tests per plant per day.
		(viii) Stability of Mix	For each 400 tonnes of mix produced, a set of 3 Marshall specimens to be prepared and tested for stability, flow value, density and void content subject to a minimum of two sets being tested per plant per day.
		(ix) Water sensitivity of mix (Retained Tensile Strength)	Same as mentioned under Serial No.2
		(x) Swell test on the mix	As required for the Bituminous Concrete
		(xi) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling	At regular close intervals.
		(xii) Control of binder content and grading of the mix	One test for each 400 tonnes of mix subject to a minimum of two tests day, as per laying /application with Extraction apparatus and sieve analysis..
		(xiii) Rate of spread of	Regular control through

		mixed material.	checks on the weight of mixed material and layer thickness.
		(xiv) Density of compacted layer	One test per 250 m ² area
		(xv) OMC & MDD	One test per 250 m ² area

12 ROAD MARKINGS STRIPS

The colour width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC : 35, and as specified in the drawings or as directed by the Engineer-in- Charge.

12.1 Materials

Road markings shall be of ordinary road marking paint (retro-reflective), hot applied thermoplastic compound as specified in the item.

12.2 Hot Applied Thermoplastic Road Marking

General

- (i) The thermoplastic material shall be homogenously composed of aggregate, pigment, resins and glass reflectorizing beads.
- (ii) The thermoplastic compound shall be screeded/extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- (iii) The thermoplastic material shall conform to ASTM D36/BS-3262-(Part I).
- (iv) The material shall meet the requirements of these specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.
- (v) Marking : Each container of the thermoplastic material shall be clearly and indelibly marked with the following information: 1. The name, trade mark or other means of identification of manufacturer. 2. Batch number 3. Date of manufacture 4. Colour (White or yellow) 5. Maximum application temperature and maximum safe heating temperature.
- (vi) Sampling and Testing : The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Engineer-in-Charge a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

12.3 Preparation

- (i) The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- (ii) After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

12.4 Properties of Finished Road Marking

- a) The stripe shall not be slippery when wet.
- b) The marking shall not lift from the pavement in freezing weather.
- c) After application and proper drying, the stripe shall show no appreciable deformation or discolouration under traffic and under road temperatures upto 60oC.
- d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic.
- e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- f) The colour of yellow marking shall conform to IS Colour No. 356 as given in IS 164.

12.5 Application

Marking shall be done by fully /semi automatic paint applicator machine fitted with profile shoe, glass beads dispenser, propane tank heater and profile shoe heater, driven by experienced operator as specified in item. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer-in-charge. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer or otherwise directed by the Engineer-in-Charge for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

The pavement temperature shall not be less than 10oC during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed.

The minimum thickness specified is exclusive of surface applied glass beads.

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

12.6 Measurements for Payment

The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any) correct upto the two places of decimal.

12.7 The rate include the cost of all materials, labour and equipments required in all the above operations.

13 KERB CHANNEL OF CEMENT CONCRETE**Base :**

The base of the channel to be of the 75 mm compacted thick dry brick ballast 40 mm nominal size well rammed and consolidated and grouted with fine sand.

Kerb channel shall be provided in cement concrete of specified grade. These shall be cast in-situ of specified size as given in the item. Top surface of channel to be finished smooth.

Measurements :

Cement concrete channel shall be measured in metre of length of the completed channel correct upto two places of decimal.

Rate :

The rate includes the cost of all the materials, labours and tools required in all the operations described above.