



SPECIFICATIONS VOL. I

PROPERTIES & FACILITIES DEPT., OLD AIRPORT

SPECIFICATIONS

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EARTHWORK

1.0: INDIAN STANDARDS:

- | | | |
|---|-------------------------|--|
| 1 | IS:1200 (Part I) 1992 | Method of Measurement of Earthwork (4 th revision) |
| 2 | IS:3764 1992 | Safety Code for Excavation works (1 st revision) |
| 3 | IS: 9759 : 1981 | Guidelines for dewatering during construction |
| 4 | IS: 6313 (Part II) 1981 | Code of Practice for Anti-termite measures in Buildings. Part II - Pre-constructional chemical treatment measures. |

The above mentioned IS specifications and Codes of Practice have been indicated for general guidance.

However, these IS Specifications and Codes will be adopted only for those particular items in the contract where either the mode of measurement or detailed technical specifications are not laid down in the Tender.

2.0 SITE CLEARANCE:

2.1 The site shall be cleared of rubbish / debris of all kinds, loose rocks, small trees, not exceeding 30 cm in girth (measured at one meter above ground level), shrubs, stumps, grass, brush wood, undergrowth and any other vegetation, superficial earth etc. as directed by the Engineer-in-Charge. The site clearance shall be done twenty meters around the periphery of the proposed construction. Such site clearance shall be done in advance of the earth work and excavation operations and shall not be paid for.

2.2. All materials arising from site clearance shall be the property of the Corporation and shall be disposed off by the Contractor at his own cost, as herein provided. All serviceable materials shall be temporarily stacked in separate lots at the site, at places as directed by the Engineer-in-Charge. These materials shall be transported to any place within Air India premises and stacked properly as and where directed by the Engineer-in-charge. All products of site clearance which, in the opinion of the EIC are not useable, shall be carted away by the Contractor to disposal areas designated by the EIC, spread and levelled evenly in layers or the Contractor shall cart away the same outside Air India premises as directed by the Engineer-in-Charge.

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

3.0 SETTING OUT:

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

4.0 EXCAVATION:

Excavation shall include site clearance, careful removal of all the materials of whatever nature and whether dry or wet, exactly in accordance with the lines, levels, grades, curves and dimensions etc. shown on the drawings or as directed by the Engineer-in-Charge. It shall be taken to exact widths and levels of the lowest step of the foundations, footing, basement, etc. and the sides shall be left plumb where the nature of soil permits its. Any shoring, strutting, planking, bracing, timbering, cutting of extra width of excavation required for providing working space in any location, including for basement, shall be done by the Contractor at his own cost. Bottom surfaces and sides of all excavation shall be trimmed and formed to required levels, slopes, etc. as directed. The bottom surface of the excavation in rock, shall be made as level and true as possible. In the event of the Contractor excavating more in rock, below the proper levels, he shall, at his own expense, fill-up the extra portion so excavated with 1:2:4 nominal mix cement concrete well rammed in position until it is brought to the proper level. Similarly, excess width dug out in error, shall also be filled in layers, 200 mm thick each with selected soil, by the Contractor, at his own expense. The bottom surface of the excavation shall be free of loose unconsolidated material. Before laying the foundation concrete, metalling, etc. the bottom surfaces shall be sufficiently watered and thoroughly rammed.

4.2 All materials excavated of whatever kind they may be, shall be placed at a distance more than one and half meter clear of the excavation, as directed by the EIC. Rate for excavation shall also include for the sorting out of useful materials and stacking them separately as directed. Materials suitable for back filling or for other work / future use in the work shall be sorted out and stacked at convenient places by the Contractor at his own cost and any additional handling, lift, lead, transportation and all other operations required for utilizing such material for back filling in the final place of back fill or other use in the work also be included in the quoted rates. Unsuitable and surplus materials, which in the opinion of the EIC are not intended for any use in Air India premises shall be carted away and disposed off outside the Air India premises by the Contractor at his own cost.

4.3 All water, which may be accumulated in excavation during the progress of the work, from springs, rains or other causes, shall be bailed/ pumped out or otherwise removed at no extra cost till the work is completed and all such operations towards dewatering for the entire duration of the complete project, if included in Excavation and if not included in the lump sum rate quoted by the Tenderer for the item "dewatering" provided in the Schedule of quantities.

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

4.5 Pipes, cables and all underground services met during the excavation shall be properly slung or otherwise supported by the Contractor at his own cost. During excavation the Contractor should take particular care to avoid injury to personnel from live cables, etc. and to avoid damage to drains, water mains, cable and underground services. Damage, if any, shall be made good by the Contractor, at his own cost, to the

satisfaction of the Engineer-in-Charge. any other services met with during the excavation, shall be brought to the notice of the Engineer-in-Charge immediately. Any disused or duly disconnected pipe lines, cables, etc. in excavation shall be removed by the Contractor at no extra cost, as and when instructed by the EIC. Any extra excavation involved due to such operations, which are carried out with the prior permission of the Engineer-in-Charge only shall be measured under the respective items and no additional rate, other than what is quoted, shall be given for such works. All materials removed out by such operations shall be treated as excavated materials and disposed off by the Contractor at his own cost, as directed by the EIC, in the same manner as specified for excavated materials.

4.6 Any shoring, strutting, bracing, planking and timbering required for protecting the sides of excavation and for ensuring the safety of workmen and equipments shall be done by the Contractor at his own cost. He shall provide and fix the same as the work proceeds. The Contractor shall be responsible for the design of the same which shall be strong enough to resist side thrusts, ensure safety from slips, bows and damage to adjacent work and property or injury to persons. It shall be removed after all the items of work for which it is required are completed.

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

4.8 As far as possible, all back filling in the foundations, trenches, under floor / hard core, plinth, etc. shall be done from the selected materials from the excavation. Selected material filling shall be free from roots, debris or any other foreign matter. All clods of selected material shall be broken or removed. Where the excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 15 cm in size in any direction, and shall be mixed with fine materials the voids as far as possible. Only when the selected material from excavation is not adequate or suitable for back filling, approved materials from outside will be used for the purpose with the prior concurrence of the EIC.

The approved material for filling shall be generally uniform to colour, hard, free from roots, bushes, other foreign matter or any organic impurities. It shall have coarse siliceous grains, gritty to touch. The silt content i.e. fines passing through 75 micron sieve, shall not exceed 20%. The area to be filled shall be first dewatered, cleared of all debris, brick bats, etc. and the entire area, excepting for that in pits, shall be consolidated to the satisfaction of the EIC.

The filling then shall be done in layers, not exceeding 20 cm each layer. Each layer in pits as well as in plinth shall be watered well rammed and consolidated before the succeeding one is laid. The layers shall be rammed with butt end of crow bar, where the rammer cannot be used or by any other agreed method with the prior concurrence of the EIC. Back filling shall be done to the original ground level or the elevation shown on the drawings or as directed by the EIC. Back filling shall be done after the concrete or

masonry etc. has fully set and shall be done in such a manner as not to cause undue thrust on any part of the structure.

4.9 Sand filling in Plinth :

Sand : Sand shall be clean and free from dust, organic for foreign matter and corresponding to grading Zone V or IV.

Sand filling shall be done in a manner similar to filling the selected material in plinth as specified above, except that consolidation shall be done by flooding with water. The surface of consolidated sand shall be dressed to required level or slope. Concreting of floor shall not be started till the EIC has inspected and approved of sand filling.

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

5.0 **CLASSIFICATION:**

5.1 All materials involved in excavation shall be classified into (a) "all sorts of soil" and (b) "rock" as under, by the EIC and his decision shall be final and binding on the Contractor, for measurement and payment.

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

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

6.0 **BLASTING** : No blasting shall be allowed at site for excavation or for carrying out any other operation

7.0 **MEASUREMENT AND RATES** :

7.1 The classification of excavated material for measurement purposes shall be as given in specification 5.0 above.

7.2 Excavation shall be measured in cubic meters for each class of material encountered. No separate measurements shall be taken or payment made for providing (1) Fixing & removing : shoring, strutting, planking, bracing, timbering (2) Additional width excavated including for basement walls, and its waterproofing treatment for convenience of working space or for any other reason (3) back-filling with selected

excavated material, watering, consolidation of the sub-grade base and filling, etc. The driving of sounding bars or jumping small drill holes to expose the nature of sub-stratum up to a total depth one meter below the bed of excavation and distribution in 2 or 3 locations in each foundations, if required by the Engineer-in-Charge, shall be considered included in the item of work and will not be paid separately.

In particular, excavation shall be measured limited to the dimensions shown on the drawings (e.g. excavation measurement for the foundation PCC multiplied by the depth of excavation) or as directed by the EIC. Trenches with "Grips" for sockets of pipes shall be measured up to the depth exclusive of "Grips". In case of rock, the measurement shall be on stack basis less 33% for voids.

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

7.4 For backfill of spaces excavated for foundations, trenches etc. using selected excavated material which shall also include mixture of broken pieces of rock and fine material, no additional payment shall be made. The excavation rate shall be inclusive of such back fill including back fill beyond the payable volume of excavation. If instead of fully back filling with the selected excavated material, the Contractor is instructed to back-fill with approved material brought from outside, the measurement of such filling shall be the volume of payable excavation as in para 7.2 above less the volume of soling, metalling, concrete or masonry or basement construction if any etc., provided within the excavation and also less the volume of filling executed with selected excavated materials.

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

8.0 **PRE-CONSTRUCTION ANTI-TERMITE TREATMENT:**

8.1 Treatment Measures :

The work shall be carried out through an agency approved by the Engineer-in-Charge.

8.2 The formation of chemically treated soil barrier shall be accomplished in stages as the building construction work progresses and due care shall be exercised to ensure that each stage of treatment is well integrated with that previously applied so that no unprotected avenues of entry are left open to the termites.

9.0 **CHEMICALS & RATE OF APPLICATION**

9.1 **Basic Principle** : Chemicals toxic to subterranean termites may be used effectively to check termite infestation in the soil. These are useful in the treatment of new building sites and may also be used to eradicate existing infestations in buildings and to prevent re-infestation. The effectiveness and / or residual activity depends upon the choice of the chemicals, the dosages adopted and the thoroughness of application. The chemical solutions or emulsions are required to be dispersed uniformly in the soil and the required strength so as to form an effective chemical barrier which is lethal and repellent to termites.

9.2 **Soil Treatment** : Treating the soil beneath the building and around the foundations with a soil insecticide is a preventive measure. The purpose of the treatment is to create a chemical barrier between the ground from where termites come and wood work or other cellulose materials in the building. Any of the following chemicals, conforming to relevant Indian Standards in water emulsion is effective when applied uniformly over the area to be treated.

Chemical	Relevant Indian Standard	Concentration by weight percent
a) Aldine emulsifiable concentrate	IS : 1307 – 1973 *	0.5
b) Heptachlor emulsifiable concentrate	IS : 6439 – 1972 **	0.5
c) Chlordane emulsifiable concentrate	IS : 2682 – 1966 ***	1

* Specification for Aldine emulsifiable concentrate (first revision)

** Specification for Heptachlor emulsifiable concentrate

*** Specification for Chlordane emulsifiable concentrate

NOTE : The Chemicals described in this code are chlorinated hydrocarbon insecticides with a persistent action and are to be regarded as POISONS. These chemicals can have an adverse effect upon health, when the absorbed through the skin, Inhaled as vapour or spray mists or swallowed. Details of precautions for the chemical soil treatment are given in Appendix B. Persons carrying out chemical soil treatment in accordance with this code should familiarize themselves with these precaution and exercise due care when handling the chemicals whether in concentrate or in diluted form. The use of these chemicals should be avoided where there is any risk of wells or other water supplies becoming contaminated.

9.3 **ESSENTIAL REQUIREMENTS FOR BARRIER AND METHOD OF APPLICATION**

Conditions of Formation : Barrier shall be complete and continuous under the whole of the structure to be protected. All foundations shall be fully surrounded by in close contact with the barrier of treated soil. Each part of the area treated shall receive the prescribed dosage of chemicals.

Time of Application : Soil treatment should start when foundation trenches and pits are ready take mass concrete in foundations. Laying of mass concrete 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 when the soil is wet with rain or sub-soil water. The foregoing requirement applies also in the case of treatment to the filled earth surface within the plinth area before laying the sub-grade for the floor.

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

9.4 SOIL TREATMENT :

Any one of the chemical emulsions described in 9.2 shall be applied uniformly at the prescribed rate in all stages of the treatment. A suitable hand operated compressed air sprayer or watering can should be used to facilitate uniform dispersal of the chemical emulsion. On large jobs, a power sprayer may be used to save labour and time.

In the event of water logging of foundation, the water shall be pumped out and the chemical emulsion applied when the soil is absorbent.

9.5 TREATMENT FOR MASONRY FOUNDATIONS & BASEMENTS:

(a) The bottom surface and the sides (upto a height of about 300 mm) of the excavations made for masonry foundations and basements shall be treated with the chemical at the rate of 5 litres., per square mtr. surface area (see Fig.1)

(b) After the masonry foundations and the retaining wall of the basements comes up, the backfill in immediate contact with the foundation structure shall be treated @ 7.5 litres. per sq.mtr. of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and working the rod backward and forward parallel to the wall surface and spraying the chemical emulsion at the above dosage. After the treatment, the soil should be tamped in place. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the masonry surfaces, so that the earth in contact with these surfaces is well treated with the chemical (see Fig 1 & 2).

9.6 TREATMENT FOR RCC FOUNDATIONS & BASEMENTS:

The treatment described in 9.5(a) & (b) applies essentially to masonry foundations where there are voids in the joints through which termites are able to seek entry into buildings. Hence the foundations requires to be completely enveloped by a chemical barrier. In the case of RCC foundations, the concrete is dense being a 1:2:4 (cement : fine aggregates : coarse aggregates, by volume) mix or richer, the termites are unable to penetrate it. It is, therefore, unnecessary to start the treatment from the bottom of the excavations. The treatment shall start at a depth of 500 mm below the ground level except when such ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases, the depth of 500 mm shall be determined

from the new soil level, resulting from the filling or cutting mentioned above and soil in immediate contact with the vertical surfaces of RCC foundations shall be treated at the rate of 7.5 ltrs per square mtr. The other details shall be as laid down in 9.5 (b) (See Fig. 3)

9.7 TREATMENT OF TOP SURFACE OF PLINTH FILLING :

The top surface of the consolidated earth within plinth walls shall be treated with chemical emulsion @ 5 ltrs per sq.mtr. of the surface before the sand bed or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia. mild steel rod on the surface to facilitate saturations of the soil with the chemical emulsion.

9.8 TREATMENT AT JUNCTION OF THE WALL AND THE FLOOR:

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level (where it has stopped with the treatment described upto the level of the filled earth surface, to achieve described in 9.5 (b) upto the level of the filled earth surface. To achieve this, a small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor (before laying the sub-grade) and rod holes made in the channel upto the ground level 1.50 mm apart and the iron rod moved backward and forward to break-up the earth and chemical emulsion poured along the channel @7.5 ltrs per sq.mtr. of the vertical wall or column surface so as to soak the soil right to the bottom. The soil should be tamped back into place after this operation.

9.9 TREATMENT OF SOIL ALONG EXTERNAL PERIMETER OF BLDG.:

After the building is complete, the earth along the external perimeter of the building should be rodded at intervals of 150 mm to a depth of 300 mm. The rods should be moved backward and forward parallel to the wall @ 7.5 ltrs. per sq.mtr. of vertical surfaces. After the treatment, the earth should be tamped back into place. Should the earth outside the building be graded on completion of building, this treatment should be carried out on completion of such grading.

In the event of filling being more than 300 mm, the external perimeter treatment shall extend to the full depth of filling upto the ground level so as to ensure continuity of the chemical barrier.

9.10 TREATMENT OF SOIL UNDER APRON ALONG EXTERNAL PERIMETER OF BLDG.:

Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion @ 5 ltrs per sq.mtrs. of the vertical surface before the apron is laid. If consolidated earth does not allow the emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia. mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion (see Fig. 2)

9.11 TREATMENT FOR WALL RETAINING SOIL ABOVE FLOOR LEVEL:

Retaining walls like the basement walls or outer walls above the floor level retaining soil need to be protected by providing chemical barrier by treatment of retained soil in the immediate vicinity of the wall, so as to prevent entry of termites through the voids in masonry, cracks and crevices etc. above the floor level. The soil retained by the walls shall be treated @ 7.5 ltrs per sq. mtr. of the vertical surface so as to effect continuous outer chemical barrier, in continuation of the one formed under 9.5.

9.12 TREATMENT OF SOIL SURROUNDING PIPES, WASTES & CONDUITS

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

9.13 TREATMENT FOR EXPANSION JOINTS :

Expansion joints at ground floor level are one of the biggest hazards for termite infestation. The soil beneath these joints should received special attention when the treatment under 9.7 is carried out. This treatment should be supplemented by treating through the expansion joint after the sub-grade has been laid @ 2 ltrs per linear meter.

10.0 CHEMICALS :

All the required quantity of chemicals shall be procured and stored at site separately. Proper account of issue of this material and consumption with respect to area covered will be maintained as directed by EIC,

11.0 MEASUREMENTS & RATES :

The measurement shall be made in sq. mtrs. on the basis of plinth area of the bldg. at ground floor only for all operations described above. Nothing extra shall be measured. The rate shall include the cost of all materials and labour involved in all operations described above including making holes and refilling and making good the same.

APPENDIX B

(Clause 9.2)

SAFETY PRECAUTIONS**PRECAUTIONS FOR HEALTH HAZARDS & SAFETY MEASURES**

All the chemicals mentioned in 9.2 are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed. Persons handling or using these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below, particularly when handling these chemicals in the form of concentrates.

These chemicals are brought to the site in the form of emulsifiable concentrates. The containers should be clearly labelled and should be stored carefully so that children and pets cannot get at them. The containers should be kept securely closed.

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

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

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

In case of poisoning, suitable measures shall be taken for protection in accordance with IS:4015 (Part I) – 1967* and IS 4015 (Part II) 1967**

* *Guide for handling cases of pesticide poisoning : Part I
First-aid measures.*

** *Guide for handling cases of pesticide poisoning : Part II
Symptoms, diagnosis & treatment.*

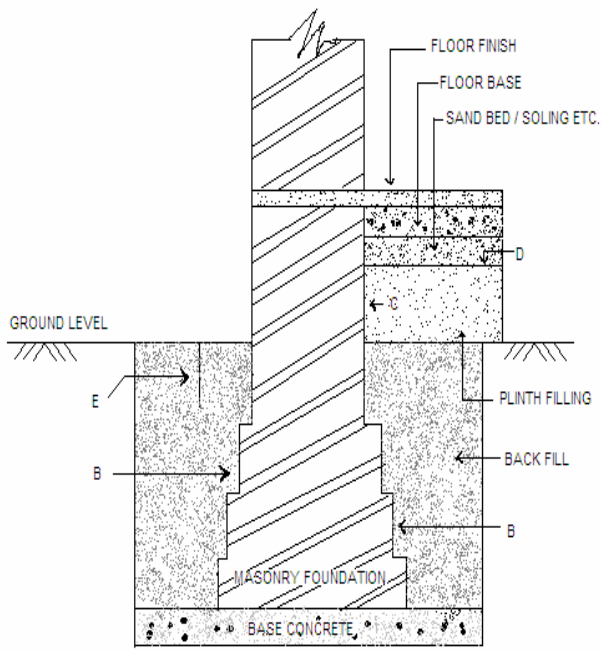


FIG. 1

TREATMENT FOR MASONRY FOUNDATIONS WITHOUT APRON

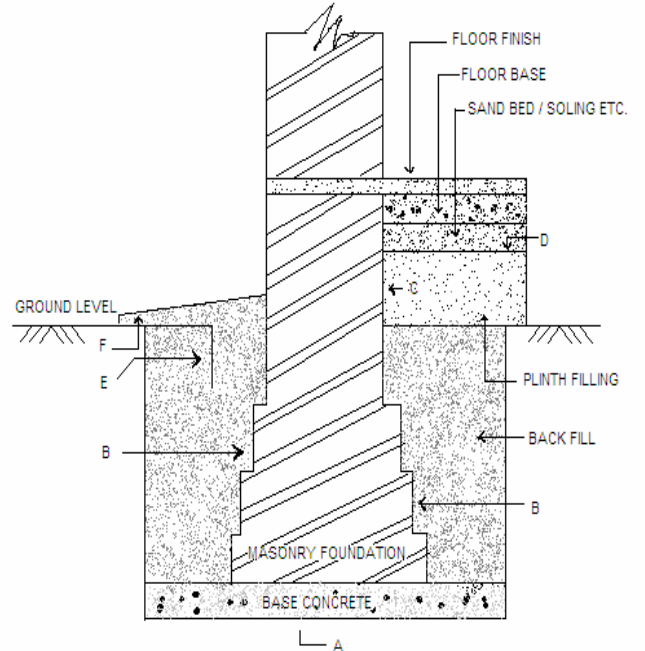
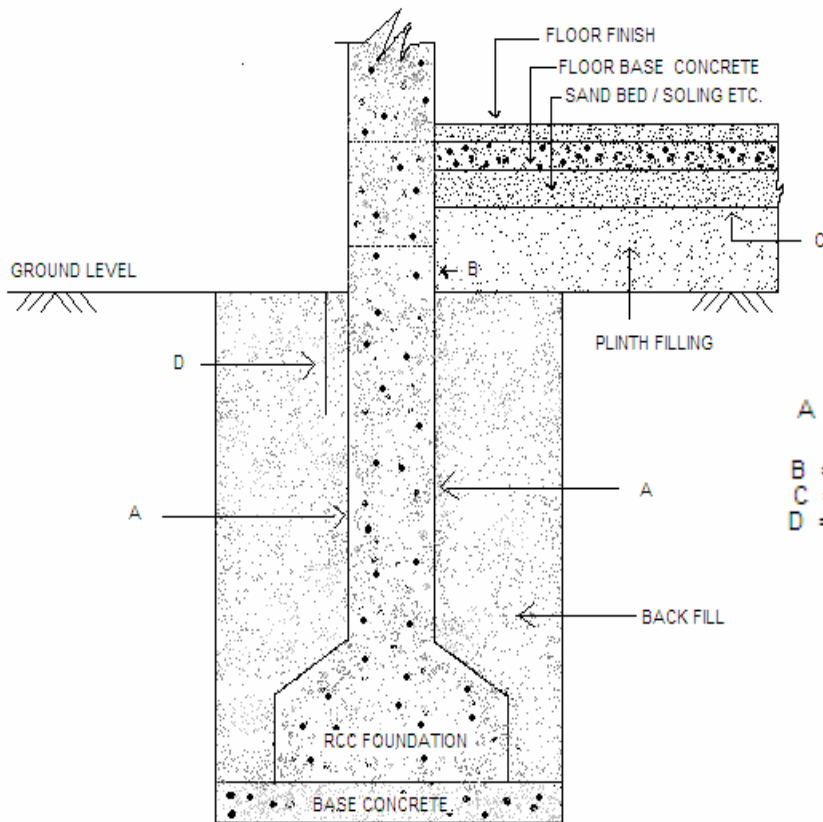


FIG. 2

WITH APRON ALONG EXTERNAL PERIMETER

- A = BOTTOM & SIDES OF TRENCHES
- B = BACKFILL IN IMMEDIATE CONTACT WITH MASONRY FOUNDATION
- C = JUNCTION OF WALL & FLOOR
- D = TOP SURFACE OF PLINTH FILLING
- E = EXTERNAL PERIMETER OF BLDG
- F = SOIL BELOW APRON



- A = BACKFILL IMMEDIATE CONTACT WITH RCC FOUNDATION
- B = JUNCTION OF WALL AND FLOOR
- C = TOP SURFACE OF PLINTH FILLING
- D = EXTERNAL PERIMETER OF BUILDING

FIG. 3 TREATMENT FOR RCC FOUNDATION

CONCRETE

1.0 INDIAN STANDARDS:

1	IS 2386 (Part I) 1963	Methods of test for aggregates for Concrete Part I Particle size and shape (Amendment no: 3)
2	IS 455 – 1989	Portland slag cement specifications (4 th revision) (Amendment no: 4)
3	IS 269 – 1989	Ordinary specification for low head Portland cement (4 th revision) (Amendment no: 6)
4	IS 1489 1991 Part I	Portland Pozzolana Cement Part I Flyash based (3 rd revision) (Amendment no: 3)
5	IS 383 1970	Aggregate coarse & fine from natural sources for concrete (2 nd revision)
6	IS 2386 (Part II) 1963	Methods of test for aggregates of concrete Part II Estimation of Deleterious materials and organic impurities (with amendment no: 1)
7	IS 456 – 2000	Code of practice for Plain & reinforced concrete (4 th Revision)
8	IS 432 (Part I) 1982	Mild Steel& medium Tensile steel bards for hard drawn steel wire for concrete reinforcement (3 rd revision)
9	IS 432 (Part II) 1982	Hard drawn steel wire for concrete reinforcement (3 rd revision)
10	IS 1786 – 1985	High strength deformed steel bards & wires for Concrete reinforcement
11	IS:2062-1992	Steel for General structural purpose (4 th Revision)
12	IS 1599 – 1985	Method of Bend Test for Steel products other than sheet, strip, wire and tube (2 nd revision)
13	IS 526 – 1959	Strength of concrete
14	IS 1199 – 1959	Method of sampling & analysis of concrete
15	IS 102602 -1982	Recommended guidelines for concrete mix design
16	IS 1489 (Part II) 1991	Calcined clay based (3 rd revision) (amendment no:1)

The above mentioned IS Specifications & Codes of practice have been indicated for general guidance.

However, these IS specifications & codes will be adopted only for those particular items in the contract where either the mode of measurement or detailed specifications are not laid down in the Tender documents.

2.0 **MATERIALS:**

2.1 Cement :

The different types of cement which may be used in the works are as follows:

- a) Ordinary Portland Cement
- b) Portland Pozzolona Cement

Compressive strength :

72 \pm 1 hour not less than 160 kg / sq.cm for OPC &

168 \pm 2 hours, not less than 220 kg / sq.cm for both OPC & PPC.

- a) Volume of one bag of 50 kg of cement is taken 0.0347 cum
- b) Cement samples taken from each consignment received at site shall be sent immediately for treating in an approved Laboratory and the certificate of test shall be obtained at Contractor's cost.

The following cement tests shall be carried out :

1. Soundness
2. Finance
3. Setting time – Initial & Final
4. Compressive strength

All cement shall be stored in a waterproof structure and prevented from damage by moisture, by suitably covering the stacks with polythene steels / tarpaulin, specially during damp weather. These structures shall be provided by the Contractor at this own cost and placed in locations approved by the EIC.

Provision for storage shall be ample enough to suit the time prescribed for completion of the work. Shipments / lots of cement as received shall be so stored as to provide easy access for identification, inspection of each shipment / lot and to allow sampling at least 12 days before use.

The Contractor shall keep an account or accurate record of delivery of cement and its issue for use in the work, or when transferred. Copies of this record shall be supplied by him regularly to the EIC.

Cement shall be used in the sequence in which it is received. No cement shall be unnecessarily stored for a long period.

Any cement which has deteriorated or which has been damaged, whether during transit to the site or at the site or otherwise, shall not be used and shall be immediately removed from the site and shall be replaced at the expense of the Contractor.

It shall be the responsibility of the Contractor to ensure the quality of cement procured by the Contractor by direct payment to Suppliers.

2.2 Aggregate:

All aggregate shall generally conform to the requirement of IS 383 – 1979 and following in particular.

Fine and coarse aggregates shall be used only from sources of supply approved by EIC. Any material which is deteriorated or has been contaminated shall not be used for concrete. All aspects of aggregate handling and storage are subject to the approval of EIC and shall be such as to minimize segregation and breakage and shall prevent contamination by grass, soil, wood, sawdust, oil, aggregates of other sizes or quality are available at site in advance of requirements. Each size of aggregate shall be stored on a separate platform or stock pile at locations to be approved by the Engineer-in-Charge and such platforms or stock piles shall be sufficiently removed from each other to prevent the materials at the edges of the piles from being intermixed. If a clean and hard surface for storage is not available, a platform of planks or a floor of bricks shall be prepared to receive the aggregates. For both fine and coarse aggregates, tests shall be carried out when required for physical characteristics, limits of deleterious substances and soundness, prior to use and also whenever the source of supply is changed. All tests shall be conducted at the Contractor's expenses at a Laboratory or in Facilities approved by the EIC.

2.3 Sand (Fine Aggregates)

Sand shall be that aggregate most of which passes through 4.75 mm IS Sieve. Sand shall be of approved quality, clean, sharp and shall contain not more than 5% of deleterious materials like mica, shells, soft flaky particles, shale, organic matter. Silt shall be considered as particle passing through 75 micron sieve. Silt percentage should not be more than 5 percent by weight, if ascertained in a recognized laboratory. Silt up to 8% by volume shall be allowed provided it is not of organic origin, when tested in a field laboratory as under:

A sample of sand shall be filled in a measuring cylinder up to 100 ml, mark and clean water shall be added up to 150 ml. mark. Two pinches of common salt shall be added. The contents shall be well shaken and allowed to stand for three hours. The height of the silt shall be measured and expressed as percentage of the sand below.

Sand may be of fine gravel and river or pit sand or crushed stone or mixture of these in order to achieve the grading required as given hereinafter.

The sand shall be from source approved by the EIC and if required by him, it shall be thoroughly washed, screened and graded by the Contractor at his own expenses, to the satisfaction of the Engineer-in-charge.

It shall be within the range of grading Zone I, grading Zone II and grading Zone III as given below:

2.4 Grading of Aggregates:

Fine Aggregates : It shall be within the limits given in the following table:

IS SIEVE DESIGNATION	PERCENTAGE PASSING FOR		
	GRADING ZONE - I	GRADING ZONE - II	GRADING ZONE - III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 microns	15-34	35-59	60-79
300 microns	5-20	8-30	12-40
150 microns	0-10	0-10	0-10

NOTE : For crushed stone sands, the permissible limit on 150 microns IS sieve is increased to 20 percent. Where the grading falls outside the limits of any particular grading zone of sieves other than 600 micron IS sieve by a 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 IS sieve or to percentage passing any other Sieve size on the coarse limit of Grading Zone I.

Bulking of sand shall be allowed for (by adding sand) and ascertained as follows:

Sand from inside of stack shall be filled into a measuring box as usual and struck off flush with the top. The box shall be placed on the ground, flooded with water and tamped vigorously. The drop in level of sand shall be measured and made good by adding sand of the same height as the drop.

2.5 Coarse Aggregate :

Coarse aggregate shall be obtained from natural source such as stone, gravel, etc. crushed or uncrushed or a combination thereof and from approved quarries. This shall consist of coarse material most of which is retained on 4.75 mm IS sieve. The whole of the ingredients of the coarse aggregate shall be hard, strong, dense, durable, clean and free from veins, adherent coatings. It shall be free from soft, friable, thin, elongated or laminated pieces and shall be roughly cubical in shape. It shall be clean and free from dirt and any other deleterious matter.

Supply :

The coarse aggregate proposed to be used for the contract work shall be got approved from the EIC before the start of the work. All subsequent supplies shall preferably be obtained from the same source.

The aggregate (fine & coarse) shall not contain harmful organic impurities. The test for organic impurities, if required by EIC, shall be carried out by the Contractor at his own cost and risk in a recognized / approved laboratory.

If it is considered necessary, the EIC may instruct that the coarse aggregate be washed, screened and graded at the Contractor's expense.

Storage of Coarse Aggregate :

The material shall be stored so as to prevent contamination and aggregation.

Grading of Coarse Aggregate:

Grade coarse aggregate shall be supplied in size conforming to the following grading:

	Nominal Size	Grading Size	
1	10 mm	4.75 mm to 12.5 mm	(100% passing through 20 mm)
2	20 mm	10.00 mm to 25 mm	(100% passing through 40 mm)
3	40 mm	20.00 mm to 40 mm	(100% passing through 80 mm)

Grading of coarse aggregates shall be such that, no more than 10% shall be larger than the maximum grade size and not more than 10% shall be smaller than the minimum grading size.

In addition to sieve analysis, if required by EIC, contractor shall carry out, at his risk and cost, the following tests, in a recognized / approved Laboratory.

- a) Specific gravity & absorption
- b) Aggregate crushing value
- c) Aggregate Impact value
- d) Aggregate Abrasion value
- e) Soundness of Aggregate

2.6 Water for mixing :

Generally potable water should be used. This is to ensure that the water is reasonable free from such impurities as suspended solids, organic matter and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value, etc.

The water shall be clean and shall not contain sugar, molasses or gur or their derivatives, or sewage, oils, organic substances. If the quality of water to be used for mixing is in doubt, cubes of 75 mm in cement mortar 1:3 mix with distilled water and with the water in question shall be made separately. The latter type of cubes should attain 90% of the 7 days' strength obtained in cubes with same quantity of distilled water. Alternatively, the water shall be tested in an approved Laboratory for its use in preparing concrete / mortar.

For plain and reinforced cement concrete permissible limits for solids shall be as follows:

Organic matter	200 mg./ltr
Inorganic matter	3000 mg./ltr
Sulphates (as SO ₄)	500 mg./ltr
Chlorides (as Cl)	a) 1000 mg./ltr for RCC b) 2000 mg./ltr for PCC
Suspended matter	2000 mg. /ltr

Limits of Alkalinity :

To neutralize 200 ml of sample should not require more than 10 ml of 0.1 normal HCl using methyl orange as an indicator.

Limits of Acidity:

To neutralize 200 ml sample of water should not require more than 2 m of 0.1 normal NaOH (Caustic soda). The pH value of water shall generally be not less than 6.

2.7 Admixtures :

The use of admixtures to improved workability is allowed only if there is proved evidence that neither the strength not the other requisite qualities of concrete and / or steel accessories, grout, etc. are impaired by their use. The use of admixtures containing Calcium Chloride, Fluorides, Nitrates and Sulphates is prohibited. The Engineer's decision on all matters relating to the use of admixtures shall be final.

Admixtures shall be stored in a suitable weather proof building. Any material which as deteriorated or which has been contaminated or damaged whether during transit or at site shall not be used and shall be immediately removed from the site and replaced at contractor's expenses.

3.0 **FORMWORK & SHUTTERING / STAGING**

3.1 Formwork shall be of wooden planks, plywood and /or steel.

The term "Formwork" or "Shuttering " shall include all forms, moulds, sheetings, shuttering, planks, poles, posts, shores, struts and strutting, ties, uprights, wailings, steel rods, bolts, wedges and all other temporary supports to the concrete during the process of setting.

The formwork surfaces in contact with concrete shall be either steel plates not less than 12 gauge thick or shuttering plywood not less than 9mm thick all with steel and/or timber backing framework.

Forms shall be true to shape, lines, dimensions of the concrete work as shown in the drawings and shall be rigidly constructed so that the same are able to withstand with appreciable displacement, deflection or movement of any kind, by the weight of the

construction or movement of persons, material and plant. Faces in contact with concrete shall be free from adhering ground, projecting nails, splits or any defects.

3.2 Tolerance:

The following tolerance will normally be observed in erection of formwork, but may be varied as directed by the EIC.

For column, beam, slab or any member dimension, minus 0.0 mm plus 6 mm.

For column plumb above lowest point in the column, plus or minus 5mm.

In beam side plumb, plus or minus 3 mm.

Along any surface, whether face of column or beam or soffit of slab, a deviation from the true plane of plus or minus 5 mm in 3 meters.

3.3 The form contact surface shall be oiled with approved quality mould oil or clean diesel oil before positioning the reinforcement and avoiding contact with the steel reinforcement.

3.4 Plane surfaces shall be adequately strengthened by edge and centre bracing to prevent buckling, warping and bending when sustaining set concrete and the working loads including those due to vibration and compaction of concrete. Where necessary, adequate camber (1 in 260 to 350) shall be provided.

3.5 The staging shall be of steel props with steel headers, kickers, stiffners, ledges, joists, shoring and bracing. Bamboos shall not be used anywhere in the staging or bracing. Wooden props of average 100 mm diameter may be used for floor heights upto 3.50 m. The props shall rest squarely on firm support, if not, wooden sole plate will be laid on the ground or brick masonry and props fixed and wedged over the same. Necessary fixing with nails and wedging will be done so as to maintain the props in vertical position. Any damaged, defective or warped shuttering plywood which in the opinion of the EIC will not give required workmanship, shall not be used in works. Forms may be re-used, but before each re-use, they shall be thoroughly scraped and cleaned, joints gone over and repaired and inside rethreaded to prevent adhesion. The shape, strength, rigidity, mortar tightness and surface smoothness of form work and staging shall be maintained at all times to the satisfaction of the EIC. It shall be the Contractor's sole and ultimate responsibility to design, erect, maintain and remove the formwork and staging efficiently.

Adequate bracing, including diagonal bracing on the outside face of structure shall be provided to reduce the unsupported lengths of props so as to prevent buckling and also to cater to accidental horizontal loads and horizontal thrust due to unbalanced loading or otherwise during construction. Bracing must be shown on the drawings submitted for approval and shall take into account the sequence of dismantling shuttering according to the permissible time limit indicated in 3.15.

3.6 The Contractor shall submit formwork, staging drawings and calculations in duplicate with all requisite details for the record of the EIC well in advance of commencement of work. The contractor shall be solely responsible for all aspects of staging design and construction. The EIC may review the scheme or instruct the Contractor without claiming any extras.

3.7 Formwork shall be such that all joints are mortar tight and their removal is possible without jarring the concrete. Formwork must be so designed that they can be stripped in the order required, i.e.:

- a) Shutters to vertical (non-load bearing) faces e.g. column boxes, beam sides, wall forms,
- b) Shutters forming soffits to slabs, horizontal and inclined which carry only light load, eg. slabs, roofs, floors and canopies, etc.
- c) Soffit shutters carrying heavy load e.g. beam and girder bottoms.

The whole of the form work should be planned and definite scheme of operation worked.

3.8 Depending on the required usage, the forms to be used shall be pre-fabricated standard panels or shop built panels or built in place units., with joint pattern, etc. all as approved by the EIC.

3.9 The shuttering work shall include provision for cut outs, dowels, sleeves, sunken slabs, fixing of conduits for electrical works etc. at Contactor's Cost.

3.10 Immediately on removal of forms, RCC work shall be examined by the EIC before any defects are made good. The work that has sagged or contains honey-combing to an extent detrimental to structural safety or architectural concepts shall be rejected.

a) Surface defects of a minor nature may be accepted by the EIC and the same may be rectified as follows:

i. Surface defects which require repair when forms are removed usually consist of bulges due to movement of forms, ridges at form joints, honey-combed areas and damaged resulting from the stripping of forms. Bulges and ridges shall be removed by careful chipping and the surface is then rubbed with a grinding stone. Honey combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicular to the surface, or preferably slightly under cut to provide a key at the edges of the patch.

ii. Shallow patches shall be first treated with a coat of thin grout in cement mortar (1:1) and then filled with cement mortar (1:3) in layers not more than 10 mm thick given a scratch finish to secure bonds with succeeding layer. Curing shall be started as soon as possible, to prevent early drying.

b) The soffit of the slabs including beams shall be rendered where required, which cement mortar (1:3) (i.e. 1 Cement : 3 Fine sand) to give a smooth and even surface.

c) The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened by hacking immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. Before the surface is plastered, it shall be cleaned and wetted so as to give good bond between concrete and plaster.

Note: Rate quoted for formwork & staging shall also be inclusive of all operations mentioned above.

3.11 Special Provisions

Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings on the sides of the shuttering shall, if so directed by the EIC, be provided to facilitate the pouring and consolidation of the concrete.

3.12 Shuttering for Form Finished Concrete:

Shuttering for this purpose shall be such as to produce a first class fair face on the concrete, free from board marks or any other disfigurements and shall be used for exposed surfaces where specified. Minimum 12 mm thick marine plywood of required quality shall be used with bracing etc. as previously referred. Shuttering shall be aligned within a tolerance of 3 mm. Rendering if required shall be done at no extra cost.

3.13 INSPECTION:

Before commencing concreting the heights of floor slabs, beam bottoms, levels and slopes of slabs, specially where drainage is involved, e.g. toilets, balconies etc. and also the external architectural features for the line and level of chhajjas, projections and ledges, fins etc. to ensure compliance with elevations and architectural drawings shall be checked. Props and wedges shall be tightened. Spaces, chairs shall be provided and adequate provision made to maintain steel MS bar reinforcement in place. Walkways shall be provided so that movement of concrete from the intake point to the point of depositing and movement of labour does not disturb the reinforcement, especially the cover.

3.14 No concrete shall commence till the EIC has checked the steel, formwork and the centering and has approved the sequence of concreting, place of stoppage, etc. and has seen that forms are cleaned of dirt, wood shavings and are properly oiled.

3.15 Stripping time (using OPC)

a) Sides of foundation, columns, beams & walls	24 to 48 hrs
b) Soffits of slabs upto 4 mtrs, clear span	7 days
c) Soffits of slabs upto 5 mtrs, clear span	10 days
d) Soffits of slab above 5 mtrs & undersides of beams upto 6 mtrs span	14 days
e) Soffits of beams beyond 6 mtrs	21 days

1) For other types of cement the stripping time recommended for ordinary Portland Cement (OPC) may be suitably modified.

2) The number of props left, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab, beams or arch as the case may be together with any live load likely to occur during curing or further construction.

3.16 Mode of Measurement shall be as under:

Measurement for payment shall be taken only of surface areas of the concrete in actual contact with the form work, including curves, angles, splays, mitres, bevels for which no special measurements shall be taken for payment. Overlaps, if any, shall not be measured. Contractor's rate shall be inclusive of all work connected with the provision of formwork and staging, erection, maintenance, removal and all treatment of concrete surface such as hacking, rubbing down, rectification, etc. after removal of the formwork.

In case of opening or recess (one side not in contact with concrete) more than 0.1 sq.m. area, the surface in contact with concrete shall be paid. However, supporting shuttering shall not be paid. In case of opening or recess (one side not in contact with concrete) less than 0.1 sq.m area, the supporting shuttering shall only be paid.

The dimensions shall be measured nearest to 5 mm and should be comparable with the drawings.

4.0 **STEEL REINFORCEMENT:**

Steel reinforcement shall be :

- i) Mild Steel conforming to IS 432 (Part I) : 1982
- ii) High Yield Strength deformed bars conforming to IS 1786-1985.

The binding wire shall be conforming to IS 1786 – 1985

4.1 The following physical tests shall be carried out for every category and diameter of steel for every consignment received at site or as directed by EIC. If a particular kind and diameter of steel is more than 10 metric tones in a consignment received at a time, then additional samples shall be sent for testing:

1. Ultimate tensile stress
2. Yield stress
3. Elongation

4.2 All reinforcement brought to site shall be tested in an approved Laboratory as directed by EIC at Contractor's cost.

The weight of different diameter of steel may be tested at site if required. Bend & rebend test and retest shall be carried out, if considered necessary.

The strength of the high yield strength deformed steel bars conforming to IS 1786-1985, Grade 415, shall be as under:

Ultimate tensile strength shall be = 49.5 kg / sq.mm

0.2% proof stress = 42.5 kg / sq.mm

Minimum elongation on length $5.65 \sqrt{A}$: 14.5 %

Where A is cross sectional area of test piece.

4.2 The strength of Mild steel bar shall be as under:

	PROPERTY	NOMINAL SIZE FOR BARS	MILD STEEL BARS
i	Ultimate tensite stress kg / sq.mm min.	All sizes	42
ii	Yield stress kg / sq.mm min.	1) For bars upto & including 20 mm	26
		2) For bars over 20 mm upto & incl.40mm	24
		3) For bars over 40 mm	24
	Elongation percentage min. gauge length $5.65 \sqrt{A}$,		
iii	where A is cross sectional area of the test piece	For bars under 10 mm	20
		For bars 10 mm & over	23

4.4 Storage :

The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timer sleepers for the like.

If the reinforcement rods have to be stored for a long duration, the shall be coated with cement wash before stacking and/or be kept under cover or stored as directed by the EIC. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

4.5 Quality :

All steel shall be of Grade I quality unless specifically permitted by EIC. No re rolled material will be accepted. If demanded by EIC the Contractor shall submit the Manufacturer's certificates for steel. Tests on steel shall be carried out by the Contractor as per relevant Indian standards. All cost incidental to such test shall be at Contractor's expenses. Steel not conforming to specifications shall be rejected. All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by EIC. If welding is approved, the work shall be carried out as per IS:2751 according to best modern practice and as directed by EIC. Nothing extra shall be paid for welding, unless it is required in case of extension to existing RCC works. In all cases of important connections, tests shall be made to prove that the welded joints of bars are of full strength. Special precaution, as specified by EIC, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

Laps & splices for reinforcement shall be shown on the drawings. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the drawings shall be approved by EIC. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site. Unauthorized laps / splices shall not be paid for.

4.6 Bending:

Reinforcing bars supplied bent or in coils shall be straightened before they are cut to size. Straightening of bars shall be done in fold and without damaging the bars. This is considered as a part of reinforcement bending fabrication work. All bars will be accurately bent according to the sizes and shapes shown on the detailed working drawings / bar bending schedule.

Reinforcing bars shall not be straightened and re-bent in a manner that will injure the material. bars containing cracks or splits shall be rejected.

4.7 Fixing :

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the drawings by the use of cover blocks, spaces and chairs as per IS:2502 to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with annealed steel wire of 0.9 to 1.2 mm dia. The vertical distance required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

Bars crossing each other, e.g. main and distribution bars shall be tied together by annealed steel wire of dia. 0.90 to 1.2 mm in cross section. Bars which are lapped shall either be kept apart by at least 25 mm or tied together by annealed steel wire at a spacing of twice the diameter. Spacer bars, chairs shall be provided of correct diameters to separate layers of main reinforcement which shall be tied firmly as indicated above.

4.8 Cover :

Unless indicated otherwise on the drawings, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish) shall be as follows:

- a) At each end of reinforcing bar, not less than 25 mm or less than twice the diameter of the bar.
- b) For a longitudinal reinforcing bar in a column, not less than 40 mm not less than the diameter of such bar. In case of columns of minimum dimension of 20 cm or under, whose reinforcing bars do not exceed 12 mm a cover of 25 mm to be used.
- c) For longitudinal reinforcing bars in a beam, not less than 30 mm or less than the diameter of the bar.
- d) For tensile, compressive shear or other reinforcements in a slab or wall not less than 15 mm, not less than the diameter of such bar.
- e) For any other reinforcement not less than 15 mm, not less than the diameter of such bar.
- f) For footings and other principal structural members in which the concrete is deposited directly against the ground, cover to the bottom reinforcement shall

be 75 mm. If concrete is poured on a layer of lean concrete, the bottom cover maybe reduced to 50 mm.

- g) For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, grade beams, footing sides and top etc. not less than 50 mm.
- h) Increased cover thickness shall be provided as indicated on the drawings, for surfaces exposed to the action of harmful chemicals (or exposed to earth contaminated by such chemicals), acid, alkali, saline atmosphere, sulphurone, smoke etc.
- i) For liquid retaining structures, the minimum cover to all steel shall be 40 mm or the diameter of the main bar, whichever is greater. In the presence of sea water and oils and waters of a corrosive character the covers, shall be increased by 10 mm.
- j) Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by providing a dense impermeable concrete with approved protective coatings, as specified in the drawings. In such a case the extra cover mentioned in (b) & (i) above may be reduced by EIC to those shown on the drawings.
- k) The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcements for footings, grade beams and slabs on a sub-grade shall be supported on re-cast concrete blocks as approved by EIC. The use of pebbles or stones shall not be permitted.
- l) The minimum clear distance between reinforcing bars shall be in accordance with IS :456 2000 or as shown in drawing.

4.9 Measurements :

Reinforcement shall be got approved and measured by the EIC or his representative before the commencement on concreting. Measurement of reinforcement with high yield strength bars and with MS round bars will be measured separately. Measurements of lengths of bars shall be as laid including authorized taps, chairs, spacers, pins for hooks, correct to centimetre. Wastage and unauthorized bars shall not be measured.

Binding wires and locking sleeves shall not be measured for payment.

The reinforcement work, measured as above shall be measured for payment on the basis of theoretical weight per unit length as per IS 1732:1989 without any allowance for wastage, refilling margin. Machining of column bars, locking sleeves, etc. shall not be paid extra.

4.10 Rates:

The rate shall include overheads, profit and cost of materials and labour, etc. involved in all the operations specified including wastage, rolling margin, cutting fabricating, placing in position, binding wire, cover blocks etc.

5 CEMENT CONCRETE:

This shall be prepared by mixing graded stone of nominal size as specified with fine aggregate and cement in specified proportions with required quantity of water:

The concrete can be specified in two ways :

- a) by proportioning of the constituents /ingredients (nominal mix)
- b) by required strength (Design mix)

5.1 Mixing :

It shall be done in a mechanical mixer. Mixing by hand shall be employed only to specific cases with specific prior permission of EIC. Stone aggregate shall be washed with water to remove dirt, dust or any other foreign material.

5.2 Machine Mixing :

The mixer drum shall be flushed clean with water. Measured quantity of dry coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of the aggregate and then cement. In case damp sand is used, add half of the quantity of coarse aggregate and dry materials slipped into the drum. The dry materials shall be mixed for at least four turns of the drum, after which the correct quantity of water shall be added gradually while the drum is in motion, to ensure even distribution with the dry materials. The total quantity of water for mixing shall be introduced before 25% of the mixing time has lapsed and shall be regulated to achieve the specified water cement ratio. The complete contents of the mixed concrete shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed clean.

5.3 Mixing time:

The materials shall be mixed for a period of not less than 2 minutes and until a uniform colour and consistency are obtained. The time shall be counted from the moment all the materials have been put into the drum.

5.4 Hand Mixing :

Hand mixing shall be done on a smooth, clean and water tight platform of suitable size in the following manner:

- a) Measured quantity of sand shall be spread evenly.
- b) The cement shall be dumped on the sand and spread evenly.
- c) The sand and cement shall be mixed intimately with spade, turning the mixture over and over again until it is of even colour throughout and free from streaks.
- d) The sand cement mixture shall be spread out and measured quantity of coarse aggregate shall be spread on its top. Alternatively, the measured quantity of

coarse aggregate shall be spread out and the sand cement mixture shall be spread on its top.

- e) This shall be mixed at least three times by shovelling and turning over by twist from centre to side, then back to the centre and again to the sides.
- f) A hollow shall be made in the middle of the mixed pile.
- g) Three quarters of the total quantity of water required shall be added while the materials are turned in towards the centre with spades. The remaining water shall be added by a water-can fitted with rose head, slowly turning the whole mixture over and over again until a uniform colour and consistency is obtained throughout the pile.
- h) The mixing platform shall be washed at the end of the day.
- i) 5 percent extra cement shall be added, when hand mix cement is produced.

5.5 Consistency :

The quantity of water to be used for each mix of 50 kg cement to give the required consistency shall not be more than as follows:

Concrete Mix	Quantity of Water not more than for 50 kg bag of cement	
	For RCC	For PCC
1 : 1 : 2	21.0 litres	--
1 : 1 ½ : 3	24.0 litres	--
1 : 2 : 4	27.0 litres	30.0 litres
1 : 3 : 6	--	35.0 litres
1 : 4 : 8	--	45.0 litres

The quantity of water shall be regulated by carrying out regular slump tests as prescribed hereunder

Sr. No.	Works	Slump in mm	
		Vibrator used	Vibrator not used
1	Mass concrete in foundation, footings, retaining walls & pavements	10.25	50-75
2	Thin section of flooring less than 75 mm	25-40	75 – 100
3	Reinforced cement concrete work	--	Refer Clause 5.11
4	Under Water Concreting	--	100-180 Actual slump to be decided by EIC

5.6 TRANSPORTING:

Concrete shall be conveyed from the place of mixing to the place of final deposit as rapidly as practicable before the commencement of initial set, by methods which will present the segregation or loss of ingredients and in no case more than 30 minutes shall elapse between mixing and consolidation in its final position. It shall be transported in such a way as to receive minimum amount of handling and consequent loss of the fine material. Under no circumstances shall concrete that has attained in its initial act, be used.

Concrete shall not be dropped or tipped from a height which shall result in segregation of ingredients but it shall be deposited as far as possible in layers of suitable thickness. The maximum height from which the concrete may be dropped shall not exceed 2.4 m. The concrete shall be conveyed by mechanical arrangements for buildings with ground and three or more upper floors. The plant shall be of such size and design as to ensure practically a continuous flow of concrete.

5.7 PLACING / LAYING & COMPACTING :

Before the concrete is actually placed in position the insides of the forms shall be inspected to ensure that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, specially at bottom of columns to permit the removal of all sawdust, wood shavings, cigarette ends, and dirt. Openings shall be so placed that the water used to flush the forms will be drained away. No water shall be left in the forms.

The entire concrete used in work shall be laid gently (not thrown) in layers not exceeding 200 mm and shall be thoroughly vibrated by means of mechanical vibrators till a dense concrete is obtained. The EIC may however, relax the condition at his discretion in the case of certain locations or for certain items, depending upon the thickness of the members and feasibility of vibrating the same and permit hand compaction. The hand compaction shall be done with the help of tamping rods, so that the concrete is thoroughly compacted and fully worked around the reinforcement around embedded fixtures and into the corners of the form work. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation such that desecration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the entire mass being compacted at the time of placing.

Concrete shall be judged to be properly compacted when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an over surface. When this condition has been attained, the vibrator used shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibrators. In case both internal and external vibrators are being used the internal vibrators shall first be withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. Specific instructions of the make of the particular type of vibrator

used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts , i.e. within 10 minutes of addition of water to the dry schedule.

5.8 Construction Joints:

Concreting shall be carried out continuously upto construction joints which shall be pre-determined and got approved by the EIC and marked on the drawings. The location of expansion joints shall be provided as marked on the drawings. The location of expansion joints shall be provided as marked on drawings. Concreting should continue upto expansion joints. Joints in columns shall be horizontal and in beams and slabs vertical. However, beams should preferably be cast in two operations, one closely following the other. The first operation is to embed the bottom steel and completely surround it to avoid honeycombing.

When the work is to be resumed beyond the construction joints the joints shall first be roughened in slop, cleaned with a wire brush and further a coat of neat cement slurry applied if stoppage is more than 24 hours. For expansion joints where jointing material is to be embedded in the gap, the approved material shall be laid in position and concrete put against it. Water stops or other devices across expansion joints shall be carefully maintained in position during the concreting and vibration.

5.9 Curing :

Green concrete work shall be protected from rain, sun, driving winds by a suitable covering. The work should also be suitable protected from damage by rain during construction, for example, concrete steps shall be adequately protected at least one week in addition to curing period.

When required the contractor shall provide and use enough tarpaulin or other suitable materials to cover completely, or enclose all freshly finished concrete at his own cost

Within 12 hours of laying of concrete, the surface shall be cured by flooding with water or by covering with wet absorbent materials. The curing shall be done for a minimum period of ten days. In special cases, curing may have to be done for more than 10 days as required and directed by the Engineer-in-charge.

The water used for curing shall not produce any objectionable stains or unsightly deposit on concrete surface.

5.10 Slump Test:

This shall be done with a standard sheet metal cone 300 mm high 100 mm top dia. 200 mm lower dia. cleaned smooth and oiled from inside. It shall be placed on a level non-absorbent surface, filled in 4 layers, each layer being given 25 strokes with a 600 mm long and 16 mm dia. MS rod with rounded end. The top layer shall be leveled off with a trowel, flush with the top of the mould which shall be slowly and carefully lifted off. The concrete will be allowed to subside and its subsidence measured below the top of the mould and recorded in mm. A retest shall be done if subsidence is not regular.

5.11 Workability shall be controlled by slump tests as under:

Nature of Work	Slump in mm	
	with Vibrator	without Vibrator
Mass concrete, RCC in footing, rafts, etc.	10.25	70 – 90
Beams, columns, Slabs	25 - 40	100 – 125
This section or with congested steel	40 – 50	125 – 150

5.12 Testing of Concrete:

Method of sampling and testing shall be carried out as per IS 1199 – 1959 and IS 516 – 1959 in general and following in particular :

- 1) The test cubes shall be of size 150 mm x 150 mm x 150 mm
- 2) Each sample shall be made up of 6 companion cubes

Each sample shall be collected in accordance with IS 1199-1959. Half of the cubes of the sample shall be tested at 7 days and the remaining half of the cubes of the sample shall be tested at 28 days in accordance with IS 516-1959.

The sample shall be tested in an approved Institute / Laboratory / site lab. If tests are conducted in the site lab, as a check on testing equipment at site, addl. comp. cubes shall be obtained for 5% of the samples and these shall be tested at the corresponding ages in a lab, nominated by EIC.

If significant difference is noticed between two corresponding results, all further tests shall be conducted in the nominated laboratory till the testing equipment at site is properly checked and rectified. The EIC may at his absolute discretion reduce the frequency of tests, when the extent of control is ascertained and reaches an acceptable level.

5.13 Frequency of Sampling : A random sampling method shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, that is, the sampling should be spread over the entire portion of concreting and cover all mixing units.

Test Strength of Sample : The test strength of the sample shall be the average of the strength of the three specimens. The individual variation should not be more than +15 per cent of the average.

5.14 Hacking / Preparation of Surface : Projecting bars of mortar formed due to the gaps at joints in shuttering shall be removed.

The surfaces shall be scrubbed clean with wire brushes. In addition concrete surfaces shall be pock marked with a pointed tool, at spacing of not more than 5 cm centres, the pocks being made not less than 3 mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface cleaned of all oil, grease, etc. and well wetted before the plaster is applied.

5.15 Mode of Measurements : (Concrete)

In particular, the mode of measurement shall be as under:

l) For in-situ concrete

- a) Concrete in floor, paving, concrete mats below footings and plinth beams and lift shafts shall be measured in cu.m
- b) Footings shall be measured in cu.m upto bottom of pedestals, if any
- c) Columns including pedestals and capitals shall be measured in cu.m height being measured from top of footings to the top of plinth beam, for plinth column and from the top of plinth beams upto the top of upper slab for superstructure columns, and from the top of the lower slab upto the top of the upper slab for subsequent superstructure columns.
- d) Plinth beams and floor beams and tie beams shall be measured in cu.m length shall be measured between face to face of supporting columns or beams and shall include haunches, if any. Beam depth shall be from top of the slab to the bottom of the beam. When a chajja projects from the bottom of the beam, the beam depth shall be measured in cu.m length being from the face of support to the free end.
- e) Slabs, cantilever slabs shall be measured in cu.m. The length and the breadth of this slab shall be measured from the face of the beams. The area of columns shall be deducted.
- f) Chajjas shall be measured in cu.m being the product of their projected superficial areas excluding bearings when overhanging from the bottom of the beam multiplied by average depth. When chajjas bear on masonry, full bearing shall be considered. Whenever vertical fins and facias are combined with chajjas, the chajjas shall be measured through.
- g) Staircase step, waist slab and stringer beam shall be measured in cum. Landing / Mid-landing slabs shall be measured along with slabs.
- h) Walls, pardis, parapets, fins and facia shall be measured in cum.
- i) Lintels, mullions, bed-blocks, sills and copings shall be measured in cum.
- j) Canopies shall be measured in cu.m. Being the products of projected superficial areas excluding bearings like beam / cantilever beam, and the average depth. Whenever vertical fins and facia are combined with canopies, the canopies shall be measured through.
- k) The vertical fins, facia, pardis and parapet walls shall be measured in cum being the product of clear area multiplied by the average thickness.

No deductions shall be made for the following :

- i) Ends of dissimilar materials (e.g. beams, joists, posts, girders, rafters, purloins, trusses, corbels, steps etc.) up to 100 sq.cm in cross section
- ii) Openings up to 100 sq.cm.
- iii) Volume occupied by reinforcement
- iv) The volume occupied by water pipes, conduits, etc. not exceeding 100 sq.cm each in cross sectional areas.

II) For Pre-cast Concrete work:

Pre-cast concrete floor and roof units and stair units shall be measured per number for each type separately, or in cum as indicated in the Schedule of Probable Quantities.

III) For Plum Concrete Work:

Size of plum shall not exceed 200 mm in one direction.

6.0 NOMINAL MIX CONCRETE (by proportion of constituents)

Nominal mix concrete shall be prepared by mixing graded stone aggregate, fine aggregate and cement in specified proportions with required quantity of water. The grading and quantity of aggregate (stone aggregate and fine aggregate), water for consistency and the requisite minimum strength shall be as given below:

Concrete Mix	Compressive Strength (Kg. per sq.cm)	
	7 days	28 days
1 : 1 : 2	180	275
1 : 1 ½ : 3	150	225
1 : 2 : 4	120	180

The maximum water cement ratio shall not exceed 0.55 in case of Reinforced Cement Concrete and 0.60 in case of Plain Cement Concrete. The water cement ratio shall be decided for requisite consistency, for different types of work and conditions.

The proportioning may be done by volume. Boxes of suitable sizes shall be used for measuring sand and aggregate.. The internal dimensions of the boxes shall be generally 350 mm x 250 mm x 400 mm or as otherwise approved.. The unit of cement shall be a bag of 50 kg and this shall be taken as 0.0347 cum.. While measuring the aggregate, shaking, ramming or hitting shall not be done. The proportion of sand shall be on the basis of its dry volume. Suitable allowances shall be made in case of sand with inherent moisture

SAMPLING :

The frequency of sampling of concrete of each grade shall be minimum one number of same (made of 6 companion cubes) upto 30 cum of concrete. Additional samples shall be collected if required for additional quantity of 30 cu.m. concrete or part thereof. However, once the control of concrete is established, the samples shall be taken at random as directed by the EIC.

ACCEPTANCE CRITERIA

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

- a) Every sample has a test strength not less than the characteristic value : or
- b) If the concrete does not meet the strength required in (a) than 0.80 times the characteristic value at the discretion of the Designer shall be accepted as being structurally adequate. However, a rebate of 10% shall be taken over the quoted item rate.
- c) Concrete of each grade shall be assessed separately.
- e) Concrete is liable to be rejected if it is porous or honeycombed, not in verticality, level or of required size and shape.

DESIGN MIX CONCRETE**DESIGN MIX CONCRETE**

1. Design Mix Concrete shall be designed with the help of IS : 10262 – 1982 or any other competent authority. It shall comply with the requirement of IS:456:2000 and IS 1348:1980 in general and the following in particular:
2. a) Design Mix Concrete shall be specified in various grades designated as M-15, M-20, M-25, M-30, m-35, M-40 etc. in S1 Units. The 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
- b) Design Mix Concrete shall be so designed as to provide an average compressive strength sufficiently high to restrict the probability of not more than 1 test result out of 20 test results of test samples falling below the specified characteristic strength. This is target Average compressive strength.
3. a) Reinforced Cement Concrete : The minimum cement content for RCC work shall be 290 kg/cum and Maximum water / cement ratio shall be 0.55
- b) Plain Cement Concrete : the minimum cement content for PCC work shall be 250 kg/cum and maximum water / cement ratio shall be 0.60
4. Data for Mix Design :
The Engineer-in-Charge will approve the following information required to produce Mix Design of required grade:
 - a) Characteristic Compressive Strength of concrete at 28 days (*f_{ck}*)
 - b) Degree of workability desired – depending upon consistency for type of concrete (vibrated/ non-vibrated), place of concrete (slab, columns, thin sections, pre-cast for cast in-situ and the slump / compaction factor desired.)
 - c) Limitations on the water-cement ratio and minimum cement content to ensure adequate durability.
 - d) Type and size of aggregates to be used
 - e) Degree of Control :
Generally the degree of control for the initial mix design shall be taken as “Fair”, After evaluation, the mix design may be revised.

<i>Degree of Control</i>	<i>Conditions of Production</i>
Very Good	Fresh cement from single source & regular tests, weigh batching of all materials, aggregates supplied in single sizes, control of aggregate grading and moisture content, control of water added, frequent supervision, regular workability and strength tests and field laboratory facilities.

Good	Carefully stored cement and periodic tests weigh batching of all materials, controlled water, graded aggregate supplied, occasional grading & moisture tests, periodic check of workability and strength, intermittent supervision and experienced workers.
Fair	Proper storage of cement, volume batching of all aggregates, allowing for bulking of sand, weigh batching of cement, water content controlled by inspection of mix and occasional supervision and tests

Depending upon the data for mix design a somewhat higher target average compressive strength for mix design shall be calculated so that not more than one test result in 20 test results of samples may fall below the characteristic strength as per the formula given below:

$$f_{av} = f_{ck} + t \times s$$

where f_{av} = target average compressive strength at 28 days

f_{ck} = Characteristic compressive strength at 28 days

s = Standard deviation as per IS:10262 – 1082
(to be used if established standard deviation is not available)

t = statistical constant

The 't' statistical constant shall be taken at 1.65

5. Evaluation of Design Mix Concrete:

Initially the samples for testing shall be collected at a faster rate to check and establish the laboratory Design Mix.

At least 3 and preferably 4 samples shall be obtained per mix per shift of 8 working hours. Each sample shall consist of 6 cubes, half of which shall be tested at 7 days and the remaining half at 28 days.

Efforts shall be made to collect test results of 30 samples or at least test results of 15 samples as early as possible to evaluate the design mix.

The design mix concrete shall be evaluated periodically with the help of standard deviation. The standard deviation shall be computed as under:

$$\text{Standard deviation} = \sqrt{\frac{\sum \Delta^2}{\eta - 1}}$$

Where :

Δ = deviation of the individual test strength from the average strength of samples

η = number of sample test results

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

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

Attempt shall be made to obtain 30 test results at an early date and the standard deviation shall be calculated. In works where number of test samples are not expected in large number, the standard deviation shall be calculated from 15 test results.

The average of all the samples so far tested (i.e. either 30 or 15) shall not be less than :

$$f_{ck} + 1.65 - \frac{1.65 \times \text{calculated standard deviation}}{\sqrt{\text{no. of samples}}}$$

If there is significant difference in the above, necessary modification to the Mix Design shall be made.

Sampling : After the initial period, i.e. after evaluation and establishing the mix design, subject to the acceptance by the EIC, the frequency at which cubes shall be made, may be reduced to 6 cubes for each major concreting or every 40 cu.m.

Manufacture of Design Mix Concrete:

The mix required to produce, place and compact the specified grade of concrete shall be designed by the contractor and details thereof submitted to the EIC for his records alongwith the results of (1) Cement (2) Sieve analysis of aggregate, water / cement ratio, aggregate / cement ratio, compressive strength of test cubes, all calculation, tabulations, graphs, etc. and such other tests of cement, aggregates and water or on concrete as the EIC may require. Mix design shall be the Contractor's Sole and ultimate responsibility. No concreting of M15 and above shall be carried out at site till the mix design is accepted by the EIC. These details shall then be scrupulously followed for subsequent concreting operations at site till a variation of some characteristics of any ingredient is observed for till a variation in the degree of quality control necessitates a change in the mix. Full details of such changes shall be submitted to the EIC for his record.

All ingredients shall be proportioned and measured by weight. The contractor with the consent of the EIC, may suitably convert weight of the aggregates only to equivalent volumetric batching by adopting suitable boxes. The Contractor shall provide platform type weighing scale of a capacity not less than 200 kg. to weigh each bag of cement and for every tenth batch of aggregates to ensure correctness of weight. Unit of measurement for cement shall be 50 kgs by weight.

The proportioning of sand shall be on the basis of its dry volume and in case of wet sand, allowance for bulkgage shall be made.

If the aggregates are wet necessary reduction in water shall be made.

Acceptance Criteria :

I. The concrete shall be deemed to comply with the strength requirements if:

- a) every sample has a test strength not less than the characteristic value; or
- b) The strength of one or more samples though less than the characteristic value, is in each case not less than the greater of :
 - 1) The characteristic strength minus 1.35 times the standard deviation; and
 - 2) 0.80 times the characteristic strength ; and the average strength of all the samples is not less than the characteristic strength plus

$$\left[1.65 - \frac{1.65}{\sqrt{\text{no. of samples}}} \right] \text{ times the standard deviation}$$

II. The concrete shall be deemed not to comply with the strength requirements if:

- a) The strength of any sample is less than the greater of :
 - 1) the characteristic strength mix is 1.35 times the standard deviation; and
 - 2) 0.80 times the characteristic strength ; or
- b) The average strength of all samples is less than the characteristic strength plus

$$\left[1.65 - \frac{3}{\sqrt{\text{no. of samples}}} \right] \text{ times the standard deviation}$$

III Concrete which does not meet the strength requirements as specified in I, but has a strength greater than that required by II may, at the discretion of the designer, be accepted as being structurally adequate without further testing.

IV. If the concrete is deemed not to comply pursuant to II above, then that portion of concrete shall be totally rejected and the contractor shall, at his risk and cost, dismantle, remove the debris and make good damages, if caused during dismantling. The scheme of dismantling / breaking etc. shall be got approved from EIC / Designer. In the event, if it is found not possible to carry out dismantlement of the defective work, then suitable modifications to ensure safety to the structure shall be carried out at the Contractor's risk and cost.

V. Concrete of each grade shall be assessed separately.

VI Concrete shall be assessed daily for compliance.

VII. Concrete is liable to be rejected if it is porous or honey-combed; its placing has been interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified; or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the EIC.

VIII. Where the value of the average strength of the tests (preferably 30 tests or 15 tests) is less than $fck + \left\{ 1.65 - \frac{1.65}{\eta} \right\} \times s$

Then, the EIC may, at his option, accept the concrete but only at a reduced rate equal to the rate quoted less 5%

STRUCTURAL STEEL

1.0 INDIAN STANDARDS:

1	IS 2062 – 1992	Structural Steel (Standard quality) 15 th Revision
2	is 800 – 1904	Code of practice for use of Structural steel in General Building Construction (2 nd Revision)
3	IS 806 – 1968	Code of practice for use of steel tube in General Building Construction (1 st revision (Amendment no:1)
4	IS 814 – 1991 (Part I) 1991	Covered Electrodes for metal arc welding of Structural Steel (5 th Revision) for: Welding Products other than Sheet Welding Sheet
5	IS : 815 – 1974	Covered electrodes for metal arc welding of structural steel, Classification and Coding (2 nd revision)
6	IS : 817 – 1966	Training & testing of metal arc welding – Code of Practice
7	IS : 1161 – 1979	Steel tubes for structural purposes (4 th Revision)
8	IS : 1182 – 1967	Recommended practices for Radiographic examination of fusion welded butt joints in steel plates
9	IS : 1200 – 1993 Part VIII	Method of measurement of steel work and Iron work (3 rd revision)
10	IS : 1977 - 1996	Structural Steel (ordinary quality)
11	ISS:2062 : 1992	Structural Steel Weldable (4 th Revision)
12	IS : 1608 : 1995	Method of tensile testing of steel products.
13	IS : 816 – 1969	Code of practice for use of metal arc welding for general construction in mild steel
14	IS: 820	Code of practice for use of welding in tubular constn
15	IS: 822 – 1970 . . .	Code of practice for inspection of welds
16	IS: 1261 – 1959	Code of practice for seam welding of mild steel
17	IS: 1323 – 1966	Code or practice for oxy Acetylene welding for structural work in mild steel
18	IS: 819 – 1957	Code of practice for resistance spot welding for light assemblies in mild steel
19	IS : 7307 (Part II) 1974	Approved test for welding procedures Part I, fusion welding of steel
20	IS : 7310 – 1974	Approved test for welders, work to approval welding procedures Part I, fusion welding of steel
21	IS:8629 (Part I to III) 1977	Code of practices for protection of iron and steel and steel structures from atmospheric corrosion

The above mentioned IS Specifications and Code of Practice have been indicated for general guidance.

However, these IS Specifications and Codes will be adopted only for those particular items in the Contract where either the mode of measurement or detailed technical specifications are not laid down in the tender documents.

STRUCTURAL STEEL WORK:

2.0 Fabrication & Erection of Steel structures for all general purposes

The Contractor shall, at his own cost be responsible for the supply, delivery, loading, unloading, fabrication, erection, fastenings and fittings of every type described in or implied by this specification, whether shown on Contract Drawings, or not; and shall carry out every detail required for complete works, in position and in perfect state. In case structural steel is available with Air India, the same will be issued at the rates mentioned in the Contract Administration Proforma.

Shop Drawings :

From the Design Drawings prepared by the Corporation / Structural Designer, the Contractor shall prepare and submit in advance shop drawings giving complete information necessary for the fabrication of the structure, including the location. They should clearly indicate the shop welds and field welds.

The shop drawings shall also contain a diagram indicating distinct identification marks to each separate piece of steel work and a table indicating material shapes, sizes and weights of each such piece of steel work and assembly location.

The Contractor shall submit the approved shop drawings in triplicate to Air India for information and record or approval (Concerned Structural Designer)

3.0 MATERIALS:

3.1 Rolled Sections & Plates:

All Structural steel to be procured by the Contractor shall conform to the requirements of IS: 226 – 1975 Structural Steel (Standard Quality).

3.2 Bolts & Nuts:

All bolts and nuts shall conform to the requirements of IS: 1367.

3.3 Electrodes:

The Electrodes shall conform to the requirements as specified and shall conform to IS: 814-1974 specifications for covered electrodes for metal arc welding of structural steel.

The size of the electrode shall be designated by the diameter of the core wire expressed in mm. The electrodes shall be of three types :

Normal penetration electrodes including hydrogen controlled electrodes for welding mild steel.

Deep penetration electrodes.

Hydrogen controlled normal penetration electrodes for welding medium tensile steel.

4.0 FABRICATION

4.1 General for steel work :

Fabrication in general shall conform to the requirements of IS:800-1962 "Code of practice for use of structural steel in general building construction."

4.2 Straightening:

All steel members before being laid off or worked shall be straight and free from twists. Where rectification is necessary, it shall be effected by cold working and by applying pressure. It shall not be done by hammering or any other method that will impair the strength of the metal. Material with sharp kinks or bends shall be rejected.

4.3 Cutting:

1) Cutting shall be effected by shearing, chopping, sawing or gas cutting and shall be clean, reasonably square and free from distortion, including removing all burrs. The edges shall be ground before fabrication / erection.

2) The steel sections as specified or required shall be cut to correct lengths and measured with a steel tape. Cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member, except when permitted by the Structural designer.

3) For gas cutting high tensile steel, sufficient metal shall be left over beyond the required profile so that all metal that has been hardened by flame is removed later by machining.

4) Except where the material is subsequently joined by welding, no load transmitting surface shall be gas cut.

5) Plates in fabrication work shall be planed at ends and edges except where flats with square edges are used. Plates specified to be planed, milled or chipped shall be cut in the first instance to such a size as to allow 3 mm to be planed, milled or chipped, from the sides and ends.

6) Edge preparation for surfaces to be welded shall be carried out by grinding, planing or milling and not be shearing or chopping

7) Great accuracy shall be observed in the fabrication of various members, so that these can be assembled proper

4.4 Making Holes:

1) Templates shall be made to correspond to each member and holes shall be marked accurately on them and drilled. Holes for bolts shall not be formed by gas cutting process. The ends of the steel members shall also be marked for cutting. The base of steel columns and the position of anchor bolts shall be carefully set out.

2) Holes through more than one thickness of structural, where possible, be drilled after the members are assembled and tightly clamped or bolted together.

3) Drilled or reamed holes shall be cylindrical and perpendicular to the surface. Finished holes shall not be more than 1.5 mm larger than the specified dia. of the bolts / HD bolts, upto and including 25 mm nominal diameter. For larger sizes the finished holes shall not be more than 2.00 mm larger than the specified dia. of the bolts / HD bolts. Holes for turned and fitted holes shall be drilled or reamed to a diameter equal to the nominal diameter of the shank or barrel.

4) When the holes are drilled in one operation through two or more separable parts, these parts shall be separated after drilling and burrs removed.

5) Matching holes for bolts / HD bolts shall register with each other so that a gauge 1.5 mm or 2 mm depending on bolt size, less in diameter than the diameter of the hole shall pass freely through the assemble members in a direction at right angles to the member surface.

6) All holes, whether for shop or field connection, shall be accurately centred and matched so as to render reaming or drilling unnecessary during erection. Members with poorly matching holes shall be rejected

7) Holes for counter sunk bolts shall be made in such manner that their heads sit flush with the surface after fixing

4.5 Bolting:

1) The nominal length of the bolt shall be the distance from the underside of the head to the other end of the shank and nominal diameter shall be diameter of shank above the screwed thread. The bolts shall be of such length as to project at least one clear thread beyond the nuts when fixed in position.

2) When nuts or bolts heads bear on tapered surfaces washers with corresponding taper shall be provided to give satisfactory bearing.

3) Bolts shall be provided with a washer of sufficient thickness so as to avoid any threaded portion failing within the thickness of the parts bolted together.

4.6 Welding:

1) Welding shall be in accordance with the Indian Standards as applicable.

2) For welding of any particular type of joint the Contractor shall submit welder's certificate acceptable to the EIC of having satisfactorily completed appropriate tests as described in the relevant Indian Standards:

a) IS:7307 (Part I) 1974 (b) IS : 7310 (Part I) 1974

3) Unless otherwise stated, all welds shall be electric metal arc welds.

- 4) All welding procedure shall be arranged to suit the details of joints indicated on the drawings and the position in which welding is carried out shall be such as to ensure that the weld is fully and satisfactorily deposited throughout the length and thickness of all the joints.
- 5) Members to be welded shall be securely held in their relative position during welding, either by jigs or tack welding or any other means and distortion of finished parts shall be minimised.
- 6) Profiles of fusion faces may be prepared by shearing, chipping or by gas cutting. In all cases, the faces should be dressed by chipping, filing or grinding and made regular.
- 7) The surface to be welded and the adjoining metal for a distance of at least 20 mm shall be cleaned free of rust, scale, paint, etc.
- 8) Each bead of metal shall have the slag removed by light hammering and wire brushing before the next bead is deposited. The weld must show a good clean contour and on a cut specimen good fusion with the parent metal.
- 9) Before applying paint or any other treatment as specified, the weld shall be carefully chipped, flux removed and wire brushed.
- 10) Gas welding shall not be permitted for structural steel work.
- 11) The work shall be done as shown on the shop drawings indicating details of the joints to be welded, type of welds, shop and site welds, as well as types of electrodes to be used.
- 12) As far as possible, every effort shall be made to limit the welding that must be done after the structure is erected, so as to avoid the improper welding that is likely to be done due to heights and difficult position on scaffolding, etc.

4.7 Welding process for structural steel work :

- a) Welds shall be made in the flat position wherever practicable.
- b) All lengths of weld, voltage and amperage of electrode suited to the thickness of material, type of groove and other circumstances of the work.
- c) The sequence of welding shall be such that where possible the members which offer the greatest resistance to compression are welded first.
- d) The welds shall be free from cracks, discontinuity in welding and other defects such as :
 - 1) Undersize
 - 2) Oversize
 - 3) Undercutting
 - 4) Over-cutting in the case of fillet welds

- e) All defective welds considered harmful to the structural strength shall be cut out and re-welded.
- f) In case of welded butt joints in steel of thickness 50 mm, the weld joints shall be subjected to radiographic examination and / or ultrasonic test. All tests shall be at Contractor's cost.
- g) All welds shall be cleaned of slag and other deposits after completion. Till the work is completed and approved, painting shall not be done.

5.0 **INSPECTION & TESTING OF WELDS:**

Visual Inspection:

Visual inspection shall be done for all welding of structural steel works in addition to Dye penetration test at places directed by EIC at Contractor's cost. The dye penetration inspection shall be carried out as specified in IS:822-1970,

Dimensions of weld deposit : The size of the weld shall be specified.

Shape of profile : Shall be uniform

Uniformity of surface – the height & spacing of the ripples shall be uniform

Degree of Under cut : Welded joints shall be free from undercut, but slight intermittent occurrence maybe disregarded provided such under cut is not in the form of sharp notch.

Freedom from surface defects: Surfaces of the weld shall be free from porosity, cavities, burrs and scales.

Inspection of weld fracture gives information concerning degree of fusion, degree of root penetration, gas cavities and quality of weld metal.

Degree of Root penetration : Butt & fillet welds : The defects are most likely to occur at the roof of the weld. A close examination of the roof of weld shall be made. In butt welds the penetration should extend to the underside of the plates producing a penetration head of the right size. In fillet welds, with good root penetration the weld metal should reach the corner.

Dye penetration inspection shall be carried out as specified in IS :822-1970.

Ultrasonic test of the welded joints, if required, shall be arranged by the Contractor at no extra cost.

The testing of welds for minor nature of structural work shall be carried out at the direction of the EIC. / Structural designer, when required, with magnetic particle radiographic test. This test shall be done as per Is: 1182-1967. The cost shall be borne by the Contractors.

6.0 ERECTION :

Steel work shall be hoisted and erected carefully without damage to itself or to other structure and equipment and without injury to workmen. This shall be done with suitable equipment, including derricks, lifting tackles, winches, ropes, etc. The scheme of hoisting and erection shall be submitted by the contractors on the award of work to him and shall get it examined and approved by the EIC / Structural Engineer / Consultant at site. The Contractor shall be fully responsible for carrying out the work in a safe manner, without any accidents.

Setting Out :

The positioning and levelling of all steel work, the verticality of stanchions and the placing of every part of the structure with accuracy shall be in accordance with the approved drawings and to the satisfaction of the EIC.

Security during erection :

a) During erection, the steel work shall be securely bolted or otherwise fastened and when necessary temporarily braced, to provide all load to be carried out by the structure during erection, including those due to erection equipment and its operation.

b) Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in the members. Structures or part of it in position shall be properly secured. Final permanent bolting/welding shall be done only after proper alignment has been obtained by the Contractor and approved by the EIC.

c) Trusses above ten meters in a span shall not be slinged at apex but shall be slung at two mid points of rafters, or otherwise as directed in the erection scheme by design Engineer/ Consultant.

7.0 Testing & Inspection :

All supplies of structural steel and other materials shall be supported by the manufacturer's test Certificates showing that they conform to the relevant specifications. Irrespective of these certificates the EIC may require sampling and testing to be carried out on any item received at site. No extra cost of such sampling and testing shall be borne by Air India Ltd.

It shall be distinctly understood that testing and inspection by the EIC do not absolve the contractor of his liability to fulfil his contractual obligations.

8.0 Painting :

All structural steel works shall be painted with Red Oxide Zinc Chromate Primer and two coats of Synthetic Enamel Paint.

Storage of Paint:

Paint shall be stored in a sealed containers in a store under joint control, where it is not exposed to extreme temperatures below 4° C & above 30 ° C. Any special storage conditions recommended by the manufacturer shall be observed.

Paint which has not been used within the “shelf life” period from the date of manufacturer as specified on the containers shall be discarded.

Paint from Painters’ Kettles shall be returned to store at the end of each working period where it shall be kept in a closed container. Before it is re-issued for use, it shall be thoroughly mixed and no fresh paint or thinners shall be added.

Surface Preparation:

Before application of Primer to any untreated steel surface, the surface shall be properly prepared as follows:

a) Wire Brushing:

Wire brushing shall be carried out to the extent necessary to remove all loose rust, dirt, loose mill scale. Grease and oil shall be cleaned with white spirit.

b) Surfaces already painted in workshop or elsewhere shall be cleaned of all dust immediately prior to the application of further coats of paint. Any loose paint and rust shall be removed by wire brushing. Areas contaminated by oil and grease shall be cleaned with white spirit. Where required by EIC the whole surface shall thereafter be cleaned by washing down with a solution of an approved liquid detergent, followed by rinsing with fresh clean water and allowed to dry thoroughly before paint is applied.

c) Steel work surfaces which will have concrete cast against them shall be left unpainted. The surfaces shall be thoroughly wire brushed to remove loose rust, mill scale and surface contamination.

Application of Paint:

a) All paint supplied to the painters is ready for application, hence the addition of thinners or of any other material thereafter is prohibited. Instructions given by the paint manufacturer shall be strictly followed. All paint shall be purchased from approved manufacturers. The synthetic enamel paint shall be of approved shade and colour. No further coat shall be applied unless the previous one has been seen and approved. by the EIC. The approved paint manufacturers are Asian Paints, British Paints and Jenson & Nicholson.

b) All painting shall be carried out by skilled painters under competent supervision.

c) Paint shall be applied to a dry surface which has been prepared and cleaned as described before. The interval between preparation of the metal surface and

the application of the first primer coat shall be 2 hours in normal dry weather and one hour in humid conditions.

d) Paint shall not be applied under the following conditions:

- i) When the ambient temperature falls below 4° C or the relative humidity rises above 90% or such lesser relative humidity specified by the paint manufacturer
- ii) During rain, dust- storms
- iii) When condensation has occurred or is likely to occur on the steel metallized surface.

e) Unless other wise agreed by the EIC, each coat of paint (consisting of minimum two horizontal strokes and two vertical strokes of paint with brushes) shall be applied to produce a continuous film of paint of uniform and even thickness. As soon as the first priming coat has dried, an extra stripe coat of paint shall be applied by brush to edges, corners, bolt heads and welds using zinc chromate. Successive coat shall be applied when the previous one is thoroughly dry.

f) In order to obtain the dry film thickness specified, the Contractor shall ensure that the coverage rate given by the paint manufacturer will enable this thickness to be attained.

g) Unless otherwise agreed by the EIC, the paint system shall be applied under cover in controlled conditions.

h) No paint shall be used after the expiry of the “pot-life” stipulated by the manufacturer, and paints of limited “pot-life” shall not be mixed with fresh paint or have thinners added to them.

i) In accessible portion of structural members should be painted following the usual sequential procedure before the structure is hoisted / erected to formal position.

Storage of Painted Steel Work:

Painted metallized MS sheets which are to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner to ensure that the metallized surface is not damaged and that no pools of water or dirt accumulates on the surfaces. Suitable packing shall be laid between the layers of stacked materials.

9.0 Shop Erection:

When so indicated on the drawing or when directed by the EIC, the whole or portion of steel work shall be temporarily shop erected to test the accuracy of fabrication before despatch.

10.00 Measurements :

All structural steel members as fixed in position shall be measured by net weight, of steel, worked out from the finished item of steel section. Steel members, cleats, anchor bolts, etc. shall be measured at site in running metres correct to a millimetre and the weights shall be worked out correct to the nearest kilogram on the basis of weights in the relevant Indian Standard tables. The connecting plates, base plates, distance pieces, gusset plates etc. shall be measured in sq.m. as fixed at site. The weight shall be worked out correct to the nearest kg. and shall be added to the structural weights. No allowance shall be made for wastage, rolling margin weights of nuts, bolts, welds, packing pieces, washers etc. and no deductions shall be made for bolts.

11.0 Rates:

The rate shall include for overheads, profits and cost of all materials and labour involved as described and specified, inclusive of supply of steel items, loading-unloading, fabrication, shop drawings, cutting, drilling holes, bolting, welding, grinding, provision of jigs and fixtures, scaffolding, provision of adequate welding equipments, consumables, welder's testing equipments as specified above, testing of welding, rectification, erection, painting etc. complete.

WATERPROOFING

1.0 Indian Standards :

- 1 IS : 702 – 1988 Specifications for Industrial bitumen
- 2 IS : 1322 – 1993 Bitumen Felts for Waterproofing and Damp Proofing
- 3 IS : 3384 – 1986 Specifications for Bitumen primer for use in waterproofing and damp-proofing (first Revision)

The above mentioned IS Codes of Practice have been given for general guidance.

However, these IS Codes will be adopted only for those particular items in the contract where either the code of measurements or detailed technical specifications are not laid down in the Tender Documents.

2.0 All waterproofing work shall be carried out by the main contractor through a specialised Waterproofing agency as specified in the tender. The work shall be carried out strictly in accordance with the instructions of the manufacturer of the waterproofing materials used in waterproofing treatment and the contractor shall be responsible for the proper production of record of ingredients used and the performance of the waterproofing work done.

The entire work shall be covered by a performance guarantee for waterproofing for the period mentioned in the description of item.

The guarantee shall also be ensured by retaining 10% of the value of waterproofing work done, including treatment of expansion joints for a period of three years in case of bitumen tarfelt treatment and for five years in case of cement based waterproofing treatment. If there is no leakage noticed during the above specified period, the amount retained shall be returned.

The Contractor shall promptly attend to any leakage or dampness seen or communicated during the period and satisfy the Dept. that the same has been rectified; if required, by conducting a test by storing 75 mm water over the roof for 10 days.

If the Contractor fails to carry out the waterproofing rectification, the dept. will, after giving 10 days notice to the Contractor, get the work carried out by another agency at the Contractor's risk and cost.

The Contractor may give a Bank Guarantee in lieu of the amount of 10% referred to above.

WATERPROOFING PERFORMANCE TEST:

After completion of waterproofing treatment, it shall be tested for waterproofing by storing water for 10 days, to the following depths:

75 mm over exposed horizontal surface.

Upto brim in case of water tanks, lift pits

Bone dry surfaces of all underground structures shall have to be demonstrated by the contractor.

The rate for the waterproofing work to be carried out under the contract shall include all labours, materials, tools, plants, equipments, transport and all the operations required for carrying out and completing the work, whether spelt out in detail or not, but including removing all loose materials, loose scales, mortar droppings and oil, grease etc. and removing all debris / rubbish outside AI premises, curing where required and testing to the satisfaction of the EIC.

3.0 **WATER PROOFING WITH BITUMEN FELT:**

Waterproofing treatment shall be four course or six course as described.

MATERIALS:

The self finished felt shall be approved brand and manufacture of types 3, Graded, Hessian base felt conforming to IS :1322 -1970.

WEIGHTS:

The total weight of the finished bitumen felt in dry condition with mica dusting powder in the manufactured bitumen felts shall not be less than 22.3 kgs per 10 sqm

SAMPLING:

All rolls from the same batch manufactured in one consignment shall constitute a lot.

The number of rolls to be taken from a lot shall depend upon the size of the lot as follows:

NO OF ROLLS IN THE LOT	NO. OF ROLLS TO BE SELECTED	PERMISSIBLE NO. OF DEFECTIVE ROLLS
Up to 100	0	0
101 to 150	0	0
151 to 300	1	0
301 to 500	2	1
501 to 1000	3	2
1001 to 3000	5	3
3001 & Above	8	5

NOTE 1: All the rolls taken as per Col.2 shall be inspected for width, length and visible external defects.

These rolls shall be taken at random from the lot. From each of the rolls, one piece 3m long and full width of the felt shall be cut out for preparing test specimens. First 2 m of the roll shall not be selected for this purpose. The length of felt selected shall be free from abnormal defects and shall be truly representative of the whole consignment. In case the material has stuck together no heat shall be applied to separate the layer, but the whole roll shall be sent for testing.

CRITERIA FOR CONFORMITY :

The lot shall be considered to be in conformity with the requirements of the standard, if:

The number of rolls found defective with respect to width, length and visible external defects, does not exceed the corresponding number given in Col.3 of Sampling.

3.1 BONDING MATERIALS :

This shall be blown type bitumen conforming to IS : 702 – 1988 and IS grade 85/25 of approved quality.

		1 st Course Kg/sq.m	3 rd Course Kg/sq.m	5 th Course Kg/sq.m
1	Four Course Treatment	1.45	1.45`	--
2	Six Course Treatment	1.45	1.20	1.45

3.2 STONE GRIT AND PEA-SIZED GRAVEL:

Stone Grit shall be 6m and down size. Pea sized gravel shall be hard, round and free from dust, dirt, etc. Grit and gravel shall not be spread over vertical or sloping faces of flashing and at drain mouths. At these places, the surfaces should be painted with two coats of bituminous solution. Stone grit or pea sized gravel for final course of four or six course treatment shall be 0.06 cu.m. per sq.m.

PREPARATION OF SURFACES:

The surfaces to be treated shall have a minimum slope of 1:120. This grading shall be carried out with cement concrete or cement plaster with coarse sand as ordered, to the average thickness required and finished smooth. Grading work shall be paid for separately.

The junction between roof and vertical faces of parapet walls, chimneys, etc. shall be cased by running triangular fillets 7.5 cm x 7.5 cm size in cement concrete. At drain mouths, fillets shall be cut back and rounded for all owing for waterproofing treatment. Cement Concrete in fillet shall be 1:2:4 {1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm (nominal size)}.

Where the parapet height is 450 mm or less, the waterproofing treatment shall be carried out over the top of the parapet wall to its full thickness.

For carrying over and tucking in the waterproofing felts into parapet wall of height more than 450 mm, chimney stack etc. a horizontal groove of 65 mm deep, 75 mm wide, with it slower edge at minimum 150 mm above the graded roof surface shall be cut out nearly and finished smooth inside with cement mortar (1:4).

The triangular fillet 75 mm x 75 mm and the cutting & finishing of the groove shall not be measured or paid for extra. No deduction will be made, however, if the groove has already been provided in an existing building.

Where expansion joints are provided, the construction of dwarf walls and RCC slab, etc., covering the dwarf walls shall be carried out by the same agency and shall be paid separately.

The graded roof surface, concrete fillets, and faces of walls shall be thoroughly cleaned with wire brushes and all scales, mortar droppings, etc. removed. Any cracks in the roof shall be cut into "V" section and filled up flush with cement mortar 1:4 or blown up type petroleum bitumen 82/25 grade. Cleaning of surface or treating the cracks shall not be paid for separately.

4.0 **PAINTING OF ROOF SLAB WITH HOT BITUMEN:**

4.1 The surface to be painted should be absolutely dry and shall be cleaned with wire brushes. All scales, mortar droppings, loose materials shall be removed.

4.2 **PAINTING WITH BITUMEN :**

Surface prepared shall be painted uniformly with bitumen of approved quality of 80/100 etc. after heating it to the required temperature. The cost of bitumen shall be continued at least 15 cms along vertical surface along roof slab and up to drip course in case of parapet wall.

Immediately after painting, dry clean sharp and coarse sand shall be evenly spread at 60 dm³ per 10 sqm of surface to be treated.

Measurement shall be in sq.mts and length and breadth to be measured correct to a cm.

Rate shall include the cost of all materials, labour involved in all the operations described and waterproofing performance test.

4.3 **PRIMING COAT:**

If directed the priming coat of bitumen shall be applied to the cleaned slab. This shall be paid for separately.

4.4 **LAYING :**

Blown type petroleum bitumen of IS grade 85/25 shall be heated to 180° C and conveyed to the roof in buckets or pouring can in weighed quantities.

The roof surface shall be cleaned dry. Laying shall be commenced at the lowest level and worked up to crest. Each length of the felt laid, shall be rolled half its length. Hot bitumen shall be poured on the roof across the full width of the rolled felt and the felt rolled out and pressed down. When the first half of felt has been bonded, the other half is rolled up and then unrolled and pressed on the hot bitumen the same way. Subsequent strips shall be laid similarly with end laps of 10cm and side laps of 7.5 cm. All over laps shall be firmly bonded with hot bitumen.

The third layer of bitumen in the four course treatment shall be carried out in a similar manner after flashing has been completed, followed by the final course of gravel or grit as specified in 3.2

4.5 SIX COURSE TREATMENT:

In six course treatment, the third and fourth layers of bitumen and self finished felt shall be laid in manner described above. The laps in fourth layer shall be staggered from those in second layer. The fifth layer of bitumen shall be carried after the flashing is done, followed by the final course of gravel or grit as specified in 3.2

Waterproofing treatment shall be carried over the drain outlets and 10 cms into drain pipes or outlets.

The flashing shall consist of the same four or six course treatment except that the final course of stone grit or pea sized gravel shall be replaced by an application of additional coat of bitumen on the vertical and sloping faces of the flashing.

The upper edge of the flashing felt shall be well tucked into the flashing grooves in the parapet etc. to a depth of minimum 65 mm. The flashing treatment shall be held in place in grooves with wood edges at intervals and grooves filled up with cement mortar (1:4) and the surface finished smooth with the wall. After curing, when dry, the exposed plaster joints of grooves shall be painted with bitumen and the vertical and sloping surface of the flashing shall be painted with two coats of bitumen.

4.6 MEASUREMENTS :

Length and breadth shall be measured correct to a cm. The area shall be worked out in sq.m. correct to two places of decimal.

Measurement shall be taken over the entire treated area of roofing and flashing treatment, including flashing over low parapet walls, expansion joints, etc. overlaps and tucking into flashing grooves shall not be measured.

Vertical & sloping surfaces of waterproofing treatment shall also be measured under the four or six course treatment, though the final course of grit or gravel is replaced by bitumen primer.

No deductions for openings or for roof lights, chimney stacks etc. shall be made for areas upto 0.4 sqm. nor anything shall be paid for forming such opening.

For openings in excess of 0.4 sq.m. deductions in measurement shall be made for full openings and nothing shall be paid for making such openings.

4.7 RATE:

The rate shall include the cost of all labour and materials involved in all the operations described including the performance test.

5.0 FLAT BRICK TERRACOTA TILE WATERPROOFING TREATMENT:

The work is to be carried out on the brick bat lime concrete laid on terrace, measured and paid for separately.

The flat tiles shall be machine pressed flat earthen ware tiles, quality and make approved by EIC. The tiles shall be 20 mm thick and of the sizes as approved by EIC. The tiles shall be laid on 12 mm thick cement mortar (1:3) with neat cement slurry. The joints of 3 mm thickness approx. shall be properly pointed in neat cement slurry. The whole surface shall be properly watered and cured. The tiles shall be carried at an angle of 45° at the joints with vertical walls.

Where the treatment consists of two layers, the second layer shall be laid similar to the first with joints in the two layers properly staggered. The terrace shall be tested for waterproofing by keeping 75 mm standing water on completed work for ten days. The soffit of the slab should not show any dampness or leakage.

MEASUREMENT:

The measurements shall be length and breadth measured correct to a centimetre between finished / plastered walls. The watta of 45° tiles shall not be measured separately.

RATE:

The rate shall be for cost of all materials and labour involved in all the operations as described and specified above and including satisfactory testing.

6.0 CHINA MOSAIC WORK:

China Mosaic work shall be prepared from broken pieces of white glazed tiles or mixture of white and colour glazed tiles. No piece shall be more than 40 mm and smaller than 10 mm in any direction.

LAYING:

15 mm thick screed consisting of 1 part cement : 4 part sand shall be laid on top of roof slab. Before the screed is about to set, a floating coat, 3mm thick of cement mortar (1 cement : 4 fine sand) shall be laid on the screed. Whilst the floating coat is green, the broken pieces of glazed tiles, thoroughly soaked in water, shall be set flat, as closely as possible. The surface shall then be rolled lightly with a wooden roller to ensure proper setting of the pieces in the floating coat and also squeezing of the mortar into joints.

The surface shall be cleaned with sawdust and kept wet for a minimum of 10 days and thoroughly cleaned on completion. Junctions with the wall shall be curved to 75 mm radius and top edge of curving carried at least 50 mm up the abutting wall. The top edge shall be finished in neat horizontal line and tucked in a groove in the wall 65 mm deep. Bell mouth around rain water pipe inlets etc. wherever required for effective drainage, shall be formed in China Mosaic finish. The surface shall be even and uniform on completion.

MEASUREMENTS:

Length and breadth of the China Mosaic work shall be measured correct to a cm. The area shall be worked out in sqm correct to two places of decimal.

Deductions shall be made for opening of recesses, roof lights, shafts, chimney, stacks, etc. The rate shall include all materials, labour for all the operations described including making grooves in parapet wall and making good etc. and the waterproofing performance test.

7.0 TREATMENT TO CRACKS:

The work shall be carried out by cutting out cracks to V section , minimum 6 mm wide on top, cleaning out with wire brush, filling with cement and sand slurry (1:1) with approved waterproofing compound mixed with cement by weight as specified by the manufacturer and curing as required.

The measurements shall be in running metres measured correct to a centimetre.

The rate shall include labour and materials required for all operations described.

8.0 SHALLOW SUMP FOR RAIN WATER OUTLET:

Shallow sump near rain water outlet shall be constructed before parapet is built and shall be of size specified with cement concrete 1:2:4 mix.

A PVC sheet 1 m x 1 m x 400 microns shall be laid and cement concrete of minimum thickness of 3 cms laid over it with its top surface lower than the level of adjoining roof surface by not less than 20 mm. The concrete shall be of size more than 45 cm x 45 cm to allow for waterproof terracing, to overlap its through edges by min 7.5 cm and shall be sloping towards the outlet. The concrete shall be rendered with 12 mm thick cement plaster 1:3 while cement concrete is still green.

The measurements shall be in numbers.

The rate is for each completed sump of specified size including cost of materials, labour involved in forming sump and outlet opening.

9.0 WATERPROOF TREATMENT WITH ACRYLIC BASED CHEMICAL OR CEMENT BASED WATERPROOF AGENT:**9.1 Preparation of Surface :**

The roof surface shall be cleaned with wire brushes and gunny cloth. All scales, mortar falling, loose material etc. shall be removed to base slab surfaces. All cracks shall be made in to "V" grooves 25 mm wide at top and 12 to 20 mm deep and cleaned.

9.2 LAYING:

The entire work shall be carried out as per instructions of the manufacturer of the approved waterproofing agent.

A layer of neat cement slurry mixed with waterproof agent shall be laid in convenient lengths and widths. Bricks on edge or broken brick pieces shall be laid in CM 1:4 (1 cement : 4 sand) with waterproof agent. The brick pieces / brick on edge shall be wetted thoroughly before use. Cement Mortar 1:4 shall be filled in the joints and a little above. Waterproofing agent of approved make shall be added at 1% weight of cement in case of acrylic based chemical waterproofing agent in slurry and mortar and properly mixed with cement specified by the Manufacturer before mixing the same with sand. The brick on edge or brick bat work as above shall be laid to proper levels and slopes as required, directed and / or as shown on drawings. Minimum 25 mm thick jointless waterproofing layers of cement mortar 1:4 (1 cement : 4 sand) with waterproof agent, shall be laid over the brick bat work and finished smooth with a layer of neat cement slurry mixed with waterproof agent. If directed, string marks showing 300 mm x 300 mm square shall be marked properly. The slope of the finished terrace shall not be less than 1 in 50, unless a flatter slope is expressly permitted by the EIC in writing. The roof surfaces shall slope from all sides towards the rain-water outlets.

The treatment shall be properly rounded at junction of walls, etc. and carried out above 300 mm above the level of waterproofing treatment. The edge of the treatment along parapet shall be tucked into a groove 65 mm deep into the parapet. The treatment shall be continued near rain water outlet etc. The entire treatment shall be properly cured for a period of 2 weeks by ponding method.

Normally the proportion of acrylic based chemicals is one percent by weight of OP Cement and for other waterproofing compound 2% by weight of cement.

The Contractor shall give complete details of waterproofing treatment proposed by him, including the waterproof compound he proposes to use. These details shall include roof fill materials, waterproofing compound, minimum & maximum thickness of slurry, joints thickness, mortar on top of total treatment.

The Contractor shall ensure that sufficient slope for effective drainage is provided within the average thickness of waterproofing treatment proposed by the Contractor. In case the average thickness has to exceed that specified, the fact shall be specifically brought to the notice of the EIC.

The entire work shall be covered by a guarantee for waterproofing for a period of 10 years as specified in 2.0 above.

9.3 MEASUREMENTS:

The measurements shall be for length and breadth measured correctly to a cm in flat area in plan between finished surface. The rounding at the junction between roof and parapet wall or any other vertical surfaces where such treatment is carried upto 300 mm shall not be measured and shall be taken as included in the rate for the above item. The areas will be worked out in sq.m. correct to two places of decimal. If the average thickness carried out is greater than that specified, no extra payment will be proportionately made for adjusting the thickness. The additional thickness of bricks bat coba, if required to be provided for adequate slope, shall be measured in cu.m and paid separately.

No deduction shall be made for openings upto 0.02 sq.m. such as rain water outlet etc. but the same shall be finished as directed by EIC.

9.4 RATE :

The rate shall include cleaning and preparation of surface, rounding at corners upto a height of 300 mm above average finish level waterproof treatment, making grooves, etc. and the performance test.

10.0 **BRICK BAT CONCRETE** :

10.1 The work shall be carried out in correct line, level and slope. This shall be carried out

(a) When the thickness of cement based waterproofing treatment exceeds the specified thickness or

(b) elsewhere in bathrooms, toilets, etc. to fill up the voids.

10.2 Measurements shall be in cubic metre, being the product of length, breadth and thickness, measured correct to a cm.

11.0 **WATERPROOF CEMENT PLASTER:**

11.1 The work shall be carried out in correct line and level in CM 1:4 (1 cement:4 sand) minimum 15 mm thick as backing coat with approved waterproofing compound, mixed with cement by weight as specified by manufacturer and finished with 6 mm thick uniform grained sand faced plaster coat including curing with 5 years performance guarantee for terrace parapet or external walls or concrete surfaces.

11.2 Measurements shall be in sq.mtrs.

11.3 Rate shall be including material, labour required to carry out complete work.

12.0 **INJECTION / PRESSURE GROUTING WATERPROOF TREATMENT:**

12.1 SURFACE PREPARATION :

The surface to be treated shall be cleaned of all scales, loose materials, and wire brushed clean. All cracks apparent and construction joints shall be made in to V grooves 25 mm at top and above 20 mm deep and treated with cement slurry 1:1 (1 cement : 1 sand) with approved waterproof compound mixed with cement by weight as specified by the manufacturer of the compound.

Holes of about 25 mm dia. to receive funnel or pipe nozzles and 25 to 40 mm deep shall be chiselled at about 1.5 m or less centre to centre as required, in the entire floor and walls to be treated. Nozzles shall then be fixed in these holes and grooves.

After the nozzles are set for minimum 24 hours neat cement slurry mixed with waterproofing compound, by weight of cement, as specified by the manufacturer of the compound, shall be injected through these nozzles, by low pressure, gravity for the slurry

to run through the minutest cracks and pores in the entire structure. The process shall be continued till the surface to be treated is bond dry and shall not show any dampness at all.

The nozzles shall then be removed and the holes properly filled up.

13.0 BOX TYPE WATERPROOF TREATMENT WITH STONE SLABS:

13.1 The treatment shall be minimum 75 mm in thickness and shall be carried out entirely as per specialized waterproofing agency's manufacturer's specifications and shall be generally as follows:

13.2 FOR BOTTOM OF BASEMENT SLABS ETC.

The treatment shall be carried out before laying the raft slab, basement slab, lift pit slab, etc. This shall be laid on 1:3:6 bedding course. The bedding course shall be measured and paid for separately.

A 25 mm thick layer of cement mortar 1:4 (1 cement : 4 fine sand) with waterproofing compound mixed with cement by weight as specified by manufacturer shall be evenly laid as backing course. Rough stone slabs of Shahabad Tiles minimum 20 mm thick shall be laid firmly over this with gaps of about 15 mm to 20 mm in between and properly set. The joints thus left are raked out to full depth and cement slurry admixed with waterproofing compound is grouted in these joints. A protective layer of 25 mm thick in CM 1:4 (1 cement : 4 fine sand) with waterproofing compound as above is laid over this, with stone chips embedded at random. The total thickness of waterproofing treatment shall be 75 mm. The treatment shall be extended 150 mm beyond the external face of the raft or walls, and shall be properly cured at every stage and after curing is ready to receive the raft and other slabs.

13.3 FOR VERTICAL WALLS OR BASEMENT ETC.

The surface to be waterproofed shall be properly hacked and roughened. Rough stone slabs about 20 mm thick shall be placed vertically in position with the help of cement paste applied to the internal face of vertical joints leaving a gap of about 20 mm between the external face of RCC wall and internal face of rough stone. The stones are held side by side leaving hardly any gap between the edges. In order to fix the bottom most layer of stones, a groove about 25 mm deep shall be made in the bottom and the stones fixed in it to ensure water tightness at the junction of the walls and the raft. Maximum 2 or 3 horizontal layers of rough stones are laid at a time. A coat of rough cement plaster 1:4 (1 cement : 4 sand) with water proofing compound is applied to the external face of rough stone. After the plaster layer is set, the gap between wall and stone layer is filled with a grout made up of cement slurry with water proofing compound as per Manufacturer's specifications. The treatment shall be continued upto 300 mm above the final made up ground level.

The proportion of acrylic based waterproofing, chemicals shall be 1% by weight of cement and 2% in case of cement based waterproofing compound.

Continuous pumping and bailing out water shall be ensured till RCC raft is laid and till the treatment to walls is completed.

The back filling should not contain stones, boulders and such other material which will cause damage to waterproofing treatment.

The internal treatment to walls shall be similar for walls and slabs and shall be laid after the raft slab or lift pit slab is laid. This shall be carried out if ordered by the EIC. The internal treatment shall be finished smooth. The whole work shall be properly cured at every stage.

13.4 MEASUREMENTS:

It shall be in sq.m. correct to two places of decimals; Length and Breadth of treated area being measured correct to a cm. The external treatment shall be measured independently of internal treatment.

13.5 RATE:

The rates shall cover all materials and labour etc. required for all the operations involved in the work.

13.6 PERFORMANCE GUARANTEE:

The Contractor shall give 10 years performance guarantee for the waterproofing work carried out by them.

14.0 WATERPROOFING TREATMENT TO BASE OF WATER STORAGE TANKS,ETC.

14.1 Surface preparation is as per 6.0 with double layer of cement based waterproofing treatment

A layer of 25 mm thick cement mortar 1:3 (1 cement : 3 fine sand) shall be then laid with approved waterproofing compound in the proportion as per Manufacturer's specifications, nominal 25 mm size stone aggregates or gravel shall be embedded at random about half depth into the layer, while still green. After this is properly cured, a second layer 25 mm thick cement mortar 1:3 layer with waterproof compound, as above, is laid and finished smooth with neat cement also with waterproofing compound. The whole treatment shall be properly cured.

The entire treatment shall be covered with performance guarantee of 10 years.

14.2 MEASUREMENT :

For double layer treatment shall be in sq.mt measured flat between the finished surface; length and breadth being measured correct to a centimetre.

14.3 RATE:

The rate shall include all materials, labour, etc. required for carrying out the treatment as above by preparation of surface, cutting and filling cracks, removing the debris, curing, waterproofing compound etc.

15.0 WATERPROOF PATENT STONE FOR TANK BOTTOM, ETC.

15.1 The patent stone in cement concrete 1:2:4 and 4 mm thick, finished smooth shall be carried out as per the specifications of the item in relevant section, except that the waterproofing compound, by weight, shall be mixed with cement as specified by the manufacturer.

Waterproof cement plaster for interior of water tank. The thickness of plaster shall be min. 20 mm. The specifications shall be same as per plaster finish smooth under relevant section. The work shall cover preparation of surface, waterproofing compound etc.

15.2 RATE:

The rate shall include all materials, labour etc. required for carrying out the treatment as described above, including performance guarantee for ten years

16.0 CEMENT BASED WATERPROOFING TO TOILET / BATHROOM SLABS ETC.

16.1 The surface shall be cleaned of all loose scales, mortar, fallings, etc. by wire brushing and gunny cloth. All cracks shall be cut into V form, cleaned and filled in with cement mortar 1:1 slurry with approved waterproofing compound at 2% by weight of cement. A 20mm thick layer of cement mortar 1:3 shall then be laid and gravel or stone aggregate of 12 m nominal size of fairly uniform size hand set in it while the cement mortar is still green with hand pressure. A final layer of 25 mm thick cement mortar 1:3 shall then be laid over it, compacted with trowels, finished smooth. In all cement based waterproofing compound, as specified by the specialized waterproofing agency shall be mixed. The whole works shall be cured properly for 10 days. The joints with walls shall be rounded 150 mm above the waterproofing treatment level. This treatment is used in bathrooms, equipment floor, office buildings, etc.

16.2 MEASUREMENTS:

Superficial flat area of the treatment carried out shall be measured in sq.mt, correct to two places of decimals, length and breadth being measured correct to a cm. The measurements of rounding shall not be taken along the walls.

16.3 RATE :

The rate shall include all materials, labour involved in all the operations described.

16.4 The waterproofing treatment shall carry performance guarantee of 10 years.

17.0 POLYSULPHIDE JOINTS:

17.1 The top 12 mm thick and 20 mm deep strip in the horizontal and vertical expansion joints in slabs, beams, columns, walls, etc. shall be filled properly with patented polysulphide compound as per manufacturer's instructions.

17.2 For expansion joints, the joint filled shall be packed firmly to close all gaps or voids.

17.3 APPLICATION :

The resin shall be thoroughly mixed with the curing agent and shall be either directly poured or applied with special gun to fill up the joint. The joints are finished flush with the surface.

The expansion joints exposed inside the building at any floor level shall be covered with thin aluminium flat (20 gauge) or asbestos cement strip of min. available thickness or wooden beading etc. as directed by EIC. The width of such covering shall be sufficient to cover the entire joint and allowance for fixing nails / screws. The fixing of such strip shall be at one only to allow for the movement at the joint. Alternatively, the strip can be fixed from both sides but the holes on one side to be oval shape to allow unrestricted movement of structural member and to avoid shearing of the flat. Aluminium angles of suitable size, may also be provided, if the joint is at the corner, but shall be fixed on one side only.

17.4 MEASUREMENTS:

Measurements shall be in running metres of the length of polysulphide joint work carried out and measured correct to a cm.

17.5 RATE:

Rate shall include all materials, labour etc. required for all operations of work as specified including covering with aluminium, asbestos, wooden members as described in the item.

18.0 GRADING ROOF:

The specification shall be for 1:2:4 cement concrete as covered under relevant section. The concrete shall be laid in level or grade as directed. The measurements shall be in cubic metres.

18.1 RATE:

The rate shall include all materials, labour etc. required in all operations as described.

19.0 CEMENT WATTA:

19.1 This is provided at the junction of horizontal and vertical surfaces to prevent entry of water. The surface, about 250 mm to 350 mm wide on both surfaces, shall be cleaned of all grease, oil, etc. The cement watta is triangular in cross section of each side averaging to 250 mm to 350 mm in cement mortar 1:3 (1 cement : 3 sand) finished neat with floating coat of neat cement, cured etc. Approved waterproofing compound shall be mixed with cement as directed by manufacturer by weight all complete as directed by Engineer-in-Charge.
