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## EARTHWORKS

1. **SCOPE**

The work under this section of the specifications consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with earthworks of all foundation for structure & services line trenches including stock piling of suitable excavated material, disposal of unsuitable and surplus excavated material in accordance with this section of specifications, the applicable drawings and subject to terms and conditions of the Contract.

1. **GENERAL**
	1. The Contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil, which might be encountered during excavation or earthworks. The Employer does not guarantee or warrant in any way that the materials to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the Report, Drawings or in any other Contract Documents or to material obtained from boring or trial holes. The Contractor shall be deemed to have made local and independent inquires as to, and shall take the whole risk of, the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive an extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.
	2. All excavations cut and fills shall be constructed to the lines, levels and gradients specified with necessary allowance for consolidation, settlement and drainage so that at the end of the Period of Maintenance the ground shall be at the required lines, levels and gradients. During the course of the Contract and during the Period of Maintenance any damage or defects in cuts and fills, in structures and other works, caused by slips, falls of wash-ins or any other ground movement due to the Contractor's negligence shall be made good by the contractor at his own cost.

# SITE PREPARATION

* + 1. The Contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the Contractor shall at his own expense rectify such error.
		2. The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Engineer.
		3. The Contractor shall construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.
		4. The Contractor shall perform a joint survey with the Engineer's Representative, of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from the Engineer before starting the earthwork.

### FOUNDATION FOR STRUCTURE

1. **Excavations**
	1. Excavation shall include the removal of all material of every name and nature. Excavations shall be carried out in accordance with excavation plans and sections shown on the Drawings.
	2. The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as directed by the Engineer. The excavation which cannot be done by mechanical means shall be done by manual tools unless otherwise specified by the Engineer, leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and backfill if approved by the Engineer shall be stockpiled within the free haulage limit of the project boundary of the works.
	3. The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Engineer full details of his proposals. The Engineer may require modifications to be made if he considers the Contractor's proposals to be unsatisfactory and the contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.
	4. For major excavations, the Contractor shall submit for the prior approval of the Engineer full details and drawings showing the proposed method or procedure, supporting and strutting, etc. The design, provision, construction, maintenance and removal of such temporary works shall be the responsibility of the Contractor and all cost in these respects shall be included in the quoted unit rate for the permanent work.
	5. The Contractor's attention is drawn particularly to his obligations under the General Conditions of Contract in respect of those works which are in close proximity to existing buildings,
	6. The Contractor shall preserve the completed excavation from damage due to slips and earth movements, ingress of water from any source whatsoever and deterioration by exposure to the sun and the effects of the weather.
	7. All excavation of every description, in whatever material encountered shall be performed to the elevations and dimensions shown on the Drawings in such a manner as to avoid interruption to work in other parts of the site. The Contractor shall be responsible for injury to the other works caused during excavation period
	8. Excavation shall extend to adequate distance from walls and footings to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces. Undercutting will not be permitted.
	9. AH excavations in foundations shall be taken to 150mm above the final excavation elevations shown on the drawings and the last 150mm shall be trimmed carefully to a smooth and level surface. Immediately after trimming to the final elevation, a layer of blinding concrete shall be placed to the thickness shown on the drawings. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by lean concrete by the end of the day. It is specifically brought to the notice of the Contractor that any excavation taken down to the trimmed elevation over-night or for any length of time thereafter uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation as directed by the Engineer and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.
	10. No excavation shall be covered nor any permanent work commenced until the foundation has been inspected by the Engineer and his permission to proceed Is given,
	11. If excavations for sub-structures are carried below the required level, as shown on the Drawings or as directed by the Engineer, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.
	12. All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient dewatering equipment for this purpose. Adequate precautions shall be taken to prevent any erosion due to undercutting from underneath the previously constructed adjoining foundations.
	13. Shoring, where required during excavation, shall be installed to protect workmen and the bank, adjacent paving, structures and utilities. The term shoring shall also be deemed to cover whatever methods the Contractor elects to adopt, with prior approval of the Engineer, for upholding the sides of excavation and also for planking and strutting to excavation against the side of roadways and adjoining properties In existing hardcore of any other material. The Contractor will be held responsible for upholding the sides of ail excavations and no claim for additional excavation, concrete or other material will be considered in this respect.

The Contractor shall locate all the existing utilities prior to starting excavation and submit to the Engineer for approval. He should coordinate with various government or other agencies in this regard.

* 1. Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be repaired by the Contractor, in coordination with relevant agency, at his own expense. Lines which are not known to the Contractor in sufficient time avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Engineer. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the Engineer in ample time for the necessary measures to be taken to prevent interruption of the service,
	2. Excavated material suitable for use as fill and backfill shall be stockpiled within free haulage limit of the project boundary as directed by the Engineer. This stockpiled material shall be transported back to places requiring fill or backfill.
	3. Excavated material unsuitable for use as fill and backfill shall be disposed off, by the Contractor at locations approved by the Engineer within specified free haulage limit.
	4. The excavation work shall include the excavation in above water table and excavation below water table. The Contractor shall submit the proposal for dewatering from the areas of excavation for the approval of the Engineer and shall provide all plant, equipment, pumps, sheeting, well points as required to keep the water table 1 meter below the deepest foundation till the completion of foundation works, all in accordance with the specification.
	5. The Contractor shall make independent enquiries and perform and make independent observations to ascertain the water table in the areas of excavations during the period when the construction works are in progress. The Contractor shall take whole risk of any nature for fluctuation of the water table from his own findings. The Employer does not bind himself in any way and shall not be responsible for any information given by him or any information, observations or values obtained from his reports, Drawings, and Documents or anywhere in this Document.
	6. Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation shall be performed to tolerances established by the Engineer as acceptable for the design and type of work involved.
1. **Fill and Backfill**
	* 1. After completion of foundation footing, foundation, walls and other construction below the elevation of the final grades and prior to start filling forms shall be removed and the excavation shall be cleaned of trash and debris.
		2. The fill/backfill shall include filling under the floors and around the foundations.
		3. The fill/backfill shall include loading, unloading, transporting, placing, stacking, spreading of earth, watering, rolling. Ramming and compacting, etc., complete as specified herein.
		4. Filling under floor shall do with approved selected material obtained from required excavation or outside sources. It shall be predominantly granular material and free from slurry mud, organic or other unsuitable matter and capable of compaction by ordinary means
		5. The Contractor shall provide the approved quality backfill and fill material required to complete the specified fill and backfill from the places designated by the Engineer. The material shall have maximum plastic index of 6 and maximum liquid limit of 25
		6. Filling in foundations shall be placed in 150mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the Engineer.
		7. Material for fill/backfill shall be as approved by the Engineer and shall be placed in layers not exceeding 150mm measured as compacted material and saturated with sufficient water and compacted to produce In-situ density not less than 95% of the maximum dry density at optimum moisture content, achieved in Test No. 15 of RS 1377 : 1975.
		8. All fill areas shall be left neat, smooth and well compacted, the top surface consisting of the normal site surface soil, unless otherwise directed.
		9. Depending on the capacity of the compacting equipment the Engineer may instruct increased thickness of successive layers to be placed.
		10. Fill shall not be placed against foundation walls prior to approval by the Engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing or as directed by the engineer.
		11. In case the Contractor has to arrange the till material from outside sources the quality of the till material will be subject to the approval of the Engineer. The Engineer shall require the Contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the Contractor.
		12. FIII/Backfill of foundations shall be carried out only after the structural works within the excavations have been inspected, tested and approved by the Engineer.
		13. Before the start of fill & backfill the Contractor shall satisfy himself as to the levels and slopes of the fills and backfills shown on the Drawings, the requirements of compaction, the possibility of settlement and all other particulars what so ever in connection of the filling works.
		14. If it is found necessary to alter the moisture content of the fill material in any way being bumpy or otherwise, then, very strict control shall he exercised over the wetting and/or the drying process and frequent moisture content tests shall be carried out,
		15. The upper 300mm thick layer of natural soil shall be scarified and compacted to 95% of modified AASHTO T-180 before tilling the area upto plinth level of the building/structures.
		16. Tolerances the surface of compacted backfill/fill shall be smooth and oven and gradual irregularity shall not vary more than 2 inches in 10 feet length and abrupt irregularity shall not be more than one inch.

### SERVICE LINE TRENCHES

1. **Excavation**
	1. All excavation shall be made to the lines, levels and grades shown on the drawings or established by the Engineer.

The sides of trench shall be as nearly vertical as practical. If found necessary by the Engineer a side slope on either side of the trench may be permitted for a trench equal to or greater than 6 feet depth so that the average width of the trench does not exceed 5 feet. Bell holes and depressions for joints shall be dug after the bottom of trench has been graded. Bell holes and depressions shall only be of such length, depth and width as required for properly making the particular type of joints as shown on the drawings or as directed by the Engineer the bottom of trench shall be properly graded and compacted with approved compacting equipment. Stones, protruding edges etc. shall be removed. When unsuitable material is encountered in the bottom of the trench, such material shall be removed to the required depth and the trench backfilled to proper grade and required level with coarse sand or other approved material.

If the Contractor excavates beyond the required depth it shall be backfilled with approved material and thoroughly compacted at the expense of the Contractor.

1. Before starting the excavation, the Contractor shall ensure the correct alignment of the pipeline on the ground the depth and width of excavation of the trench, all in accordance with the drawings and instructions of the Engineer. The Contractor shall make profile with cement concrete pillars.
2. Excavation shall be carried out true to lines, levels, grades and widths as shown on the drawings or as directed by the Engineer ensuring proper laying of the pipe line, the bedding fill, construction of chambers for appurtenances and any other structures. The trench bottom shall be graded to provide even and substantial bearing over the specified bedding and of the structure.
3. The Contractor, at his cost shall provide to the satisfaction of the Engineer all timbering, approved supports, shores and bracing to the sides of the excavated trench and foundations in such a manner so as to secure the sides of the trench and excavations from falling or adverse movement All responsibility connected with such shoring shall rest with the Contractor.
4. Without the written permission of the Engineer, not more than 100m of the trench shall be opened in advance of the completed pipeline,
5. The bottoms of all excavations shall be carefully leveled. Any pockets of soft or loose material in the bottoms of the trenches shall be removed and the cavities so formed filled with lean concrete at the Contractor's expense.
6. During excavation, material suitable for back filling shall be stockpiled in an orderly manner at sufficient distance from the excavated trenches for reuse in backfill,
7. All necessary precautions shall be taken to properly maintain the excavation while it is open and exposed. If necessary, grading shall be done to prevent surface water from flowing into trenches and any water accumulated therein shall be removed by pumping or other approved methods. If ordinary open cut excavation is not possible or advisable, sheeting and bracing shall be furnished and installed in such excavations to prevent damage and delay of work and to provide safe working conditions. Sheeting and bracing shall be removed as the work progresses.
8. If for any reason, the levels, grades or profiles of the excavations are changed adversely, the Contractor shall, at his own cost, be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the Engineer.
9. **Backfill and Compaction**
	1. Backfilling and compaction of trench bottoms shall be done in the following three stages.
		1. Prior to lowering the pipe into the trench, 150mm thick compacted layer of approved sand will be placed over properly graded and compacted bottom of the trench wherever required.
		2. Coarse sand shall be placed and compacted around and over the pipe after it has been properly laid and tested as directed by the Engineer.
		3. Backfilling of the remaining trench will be done in layers with the approved material as specified herein.
	2. The material for Backfilling required herein above will be sand as specified in the section "Concrete". The material for backfilling in stage III will be the same as that for stages I and II, if it is under paved areas. In all other cases, stage III material shall be in accordance with the following specifications. All the material shall be clean excavated earth or quarry spoil from trenches or from other approved borrow areas shall not contain stones, organic matters, cinders and refuse that would prevent proper compaction or cause subsequent settlement.
	3. The backfill material shall be placed evenly and carefully around and over the pipes in layers not exceeding 150mm. When the material has been conditioned and placed as specified, each layer shall be thoroughly and carefully rammed with tamper of adequate size and weight and watered if necessary for proper compaction. Backfill! shall he done by hand until a thickness of 300mm has been compacted over the pipe. The remaining backfill may be done with machine. The degree of compaction desired will be at least 95 percent of maximum dry density.

The Contractor shall be responsible for any damage to installations caused by his operations in compacting of backfills and any damage to the pipe and fitting shall be repaired by the Contractor at his own expense.

* 1. Backfill designated to be compacted shall be compacted to 95% in-situ density with respect to maximum density to the lines, levels and grades as shown on the drawings or established by the Engineer, The Contractor's operations in the placing of backfill designated to be compacted shall be such as will result in an acceptable gradation of material when placed for use in backfill.
	2. Prior to and during placement operations, the material shall have the optimum moisture content required for the purpose of compaction, as determined by the Engineer, and the moisture content shall be uniform throughout each layer. If the moisture content is less than optimum for compaction, or if the soil is humpy, the moisture content shall be supplemented by sprinkling and reworking the material at the site of compaction. If the moisture content is greater than optimum for compaction the material shall be dried by reworking, mixing of the dry material or other approved means.
	3. The material obtained from excavation shall be reused for backfilling brought from the stockpile with approval of the Engineer.

### DISPOSAL OF SURPLUS EXCAVATED MATERIAL

* 1. The rejected unsuitable material and surplus e excavated material shall be disposed off out of boundary limits from any lead as directed by the Engineer.
	2. The disposal of surplus/unsuitable-excavated material shall include loading, unloading, transporting, stacking, spreading and leveling as directed by the Engineer.

**\*\* END OF SECTION\*\***

TERMITE CONTROL TREATMENT

1. **SCOPE**

The scope of work for anti termite treatment includes injection of insecticide in sides and bottom of foundation trenches, spraying on stockpiled backfill material and injections of the insecticide in floor sub-grade of the building. The scope also covers treatment of all wood works with insecticides before installation in position.

1. **MATERIAL**
2. An approved emulsible concentrate insecticide shall be used for dilution with water, specially formulated to prevent infestation by termites. Fuel oil will not be permitted as diluents.
3. All mixing shall be done at site and mixing proportion of insecticide with water shall be in accordance with the approved manufacturer's recommendations and shall be verified by the Engineer.
4. Pure turpentine shall be used for dilution of insecticide, in approved proportion for application to woodwork.
5. **QUALITY ASSURANCE**
	1. In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for the work, including preparation of substrata and application.
	2. A professional operator shall be engaged who shall have license in accordance with regulations of governing authorities for application of soil treatment solution.
6. **EXTENT OF APPLICATION**
	* 1. Contractor to ensure a continuity of treatment under and around the footings and upto the slab on grade in the form of an envelop.
		2. Insecticide solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150 psi to all applications to, on or in earth.
		3. Soil treatment shall begin after all work of preparation of earth prior to installation of concrete has been done. After application, no additional earth moving or work upon sub grade should be done. No covering of earth or concrete should be applied over soil treatment until at least 24 hours after treatment has been made.
	1. Insecticide solution should not be applied during wet weather, or when the earth surface is excessively wet. Application should be made to all areas beneath concrete slabs-on-grade, including sidewalks and paving abutting buildings for distance of at least 6 feet beyond building line. Rate of application of the solution shall be as per the recommendations of the manufacturer. Insecticide shall penetrate to a depth of 1 inch. (25mm) minimum in porous earth at bottom and at least 50mm at the sides of excavations.
7. Sides of foundation excavations, grade beam, and similar areas shall be treated with solution at a rate of 0.5 lit per square feet upon inner sides of such excavations, and at all locations where concrete slabs for platforms and similar work abut the building. Similar treatment shall be made at all locations where expansion Joints, control joints, column bases and similar work occur at or below grade slabs.
8. In the areas of application signs shall be fixed to show that soil treatment has been applied. Such signs shall be removed when areas are covered by other construction.
	1. Care shall be exercised to insure that no marks or damage occurs to the finished structure as a result of the work under this section.
	2. Ali woodwork for the entire project is to be insecticide treated (before application of solignum). Insecticide shall be sprayed on all surfaces of all the wooden work viz., door frames, blocking, furring, planks, boards etc. before installation. Spraying is to be done at the site, after delivery and before installation. No spraying shall be necessary after field sawing, jointing or installation of such material.

# STANDARDS

All methods of termite protection used herein shall be in accordance with the standard practices of National Pest Control Association, U.S.A and the British Wood Preserving Association.

1. **SAMPLES AND TESTS**

The Contractor shall supply samples of all the materials to be used for insecticide control for approval of the Engineer and testing in accordance with the specified standards. Rejected materials shall be removed from the site immediately.

1. **GUARANTEE**

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests, which cause damage to wood or other organic material for 7 years from the date of acceptance of the building.

In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damaged material, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites,

\*\*\* **END OF SECTION** \*\*\*

**FORMWORK**

**1. SCOPE**

The work under this section of the Specifications consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with the supply and installation of formwork for the purpose of shuttering in concreting work, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

**2. GENERAL**

It shall be the responsibility of the Contractor to perform the work by engaging well-trained and experienced staff or by the sub contractor who shall have enough number of well-trained and experienced staff to coordinate his activities with the other operations. However the Contractor shall be responsible for the quality of work performed by the sub-contractor as per the requirements of these specifications.

## 3. MATERIALS

The Contractor shall use the following formwork materials for different purposes as stated below:

* 1. **Timber**

Form framing, sheathing and shoring.

* 1. **Plywood**

Form sheathing and panels.

* 1. **Steel**
* Heavy forms and false work
* Column and joint forms
1. **Form Ties Anchors and Hangers**

#### For securing form work against placing loads and pressures

1. **Coatings**

Facilitate form removal.

1. **Steel Joints**

For formwork support.

1. **Steel Frame Support**

For formwork support.

### DELIVERY AND STORAGEAGE

* + - 1. **Delivery**

The delivery of formwork materials shall be done in such a manner that damage can be prevented.

1. **Storage**

Formwork should be stored, after cleaning and preparing for re-use if used before in such a manner that access to all different materials is available.

Material, which can be affected by weathering, shall be stored in appropriate building or under covers and shade.

1. **WORKMANSHIP**
	1. Forms shall be used, wherever necessary, to confine the concrete and shape it to the required dimensions. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

The main architectural theme is to retain the concrete as the finished facade material. The Contractor therefore shall realize a special and perfect formwork. The drawings set out details

and locations of this special formwork. The Engineer shall refuse any formwork and any part of the building, which has been constructed with a non-approved formwork. The Engineer shall refuse any concreting which will not be perfect or may not conform to the approved model.

1. Earth cuts shall not be used as forms for vertical surfaces of reinforced concrete work unless required as such or permitted by the Engineer.
2. Mud centering shall not be permitted without the prior approval of the Engineer.
3. Formwork shall be of wrought timber, steel, plywood, proprietary building boards and such special materials, as may be shown on the drawings or approved by the Engineer, which give the required finish to the surface of concrete. Wooden formwork shall be free from loose knots and shall be well seasoned.
4. The formwork shall conform to the shape, lines and dimensions as shown on the plans, and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete, and shall be sufficiently tight to prevent loss of liquid from the concrete.

The design and Engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor.Where necessary, to maintain the specified tolerances, the formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads.

The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and benchmarks to be used as references for checking upon tolerances.

1. Requirements for 'facing materials' are given in the Section relevant to 'Finishing of Formed Surfaces'. The maximum deflection effacing material reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
2. Where natural plywood-form-finish, grout-cleaned-finish, smooth-rubbed-finish, scrubbed-finish, or sand-floated-finish is required, forms shall be smooth (faced with plywood, liner sheets, or prefabricated panels) and true to line, in order that the surfaces produced will require little dressing to arrive at true surfaces. Where any as-cast finish is required, no dressing shall be permitted in the finishing operation.
3. Where as-cast surfaces, including natural plywood-form-finish are specified, the panels of material against which concrete is cast shall be orderly in arrangement, with joints between approved relation to openings, building corners and other architectural features.
4. Where panels for as-cast surfaces are separated by recessed or otherwise emphasized Joints, the structural design of the forms shall provide for locating form ties, where possible, within the joints so that patches of tie holes will not fall within the panel areas,
5. Forms shall not be re-used if there is any evidence of surface wear and tear or defect, which would impair the quality of the surface finish. Forms shall be thoroughly cleaned and properly coated before re-use.

 The formwork shall be designed so that the soffits of slabs and sides of beams, columns, and walls may be removed first, leaving the forms to the soffits of beams and their supports in position.

1. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Unless otherwise specified in the Contract Documents chamfer strips shall be placed in the corners of forms to produce beveled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of formed joints will not require beveling unless required by the Contract Documents.
2. Positive means such as wedges or jacks for accurate adjustment and for proper removal of shores and struts shall be provided and all settlement shall be monitored during concrete placing operation. Forms shall be securely braced against lateral deflections.
3. Where concreting of thin members is required to be carried out within formwork of considerable depth, temporary openings in the sides of the formwork shall be provided where necessary to facilitate the placing and consolidation of concrete. Small temporary openings shall also be provided at the bottom of the formwork for columns, walls and deep beams to permit the cleaning out of debris and observation immediately before concrete is deposited,
4. Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameter or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view and in no case shall this distance be less than 3^ inch. (20 mm). When the formed face of the concrete is not to be permanently exposed to view, form ties may be cut off

flush with the formed surfaces.

Through bolts may be permitted provided that they are greased to allow for easy withdrawal and the holes subsequently made good. Through bolts are not to be used on water retaining structures.

1. At construction joints contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by no less than 1 inch (25 mm). The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint so as to maintain a true surface.
2. Wood forms for wall opening shall be constructed to facilitate loosening, if necessary to counteract swelling of the forms.
3. Wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.
4. Formwork shall be so anchored to shores or to other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will not occur.
5. Runways or planks for moving labor and equipment shall be provided with struts or legs and shall be supported directly on the formwork or upon the structural member without resting on the reinforcing steel.
6. All surfaces of forms and embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before placing fresh concrete.
7. Forms shall be sufficiently tight to prevent leakage of grout or cement paste. Board forms having joints opened by shrinkage of the wood shall be removed and replaced. Plywood and other wood surfaces not subject to shrinkage shall be sealed against absorption of moisture from the concrete by either (1) a field applied, approved form oil or sealer, or (2) a factory applied non-absorptive liner. When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with the concrete against which fresh concrete will be placed. Care shall be taken that such approved composition is kept out of contact with the reinforcement. Where as-cast finishes are required, materials, which will impart a stain to the concrete shall not be applied to the form surfaces. Where the finished surface is required to be painted, the material applied to form surfaces shall be compatible with the type of paint to be used.
8. For reinforced concrete, in no circumstances shall form until the concrete attains strength of at least twice the stress to which the concrete may be exposed at the time of striking

The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions, and cured under conditions of temperature and moisture similar to those obtaining in the work. Where possible, the formwork should be left for longer time, as it would assist the curing.

In normal circumstances (generally where temperatures are above 20 degree C/(168°F) and where ordinary cement is used, forms may be struck after expiry of the following periods.

|  |  |
| --- | --- |
| Walls, columns and vertical sides of beams.Side of slabs (shores of props left under).* Beams soffits (shores or props left under).
* Removal of shores or props to slabs

1. Spanning upto 13 ft. (4 meter)2. Spanning over 13 ft. (4 meter)* Removal of shores or props to beams.
* Spanning upto 20 ft. (6 meter)

2. Spanning over 20 ft. (6 meter) | 48 hours or as may be decided by the Engineer.2 Days.12 Days.12 Days16 Days18 Days28 Days |

For rapid hardening cement 3/7 of the above period will be sufficient in all cases except vertical sides of slabs, beams and columns which should be retained for a minimum of 24 hours.

The number of shores or props, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab and beams, as the case may be.Proper allowance shall be made for the decrease in rate of hardening of concrete in cold weather and the above minimum duration must be increased when the mean daily temperature is below 20 degree C.

* 1. When repair of surface defects or finishing is required at an early age forms shall be removed as soon as the concrete has harden to sufficiently to resist damage from removal operations.
	2. Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed by the specified curing.
	3. Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete.
	4. All formwork shall be removed without such shock or vibration as would damage the reinforced concrete. Before the top plank and struts are removed, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occurs with all cement in the cold weather.
	5. When reshoring or repropping is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is underway no live load shall be permitted on the new construction.

In no case during reshoring shall concrete in beam, slab, columns or any other structural member be subjected to combined dead and construction loads in excess of the load permitted by the Engineer for the developed concrete strength at the time of reshoring.

Reshores shall be placed as soon as practicable after stripping operations are complete but in no case later than the end of working day on which stripping occurs.

Reshores shall be tightened to carry their required loads without overstressing the construction. Reshores shall remain in place at least until tests representative of the concrete being supported has reached the strength specified in sub- clause 5.23 hereof.

* 1. Floors supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half the capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations re permitted.
	2. The reshoring or re-propping shall extend over a sufficient number of stories to distribute the weight of newly place construction live loads in such a manner that the design superimposed loads of the floors supporting shores or props are not exceeded.
	3. It is generally desirable to give forms for reinforced concrete an upward camber to ensure that the beams or slabs (specially cantilever slabs) do not have sag when they have taken up their deflection, but this should not be done unless permitted by the Engineer.
	4. No loads, other than man and light plant required in connection with the actual work in hand, shall be allowed on suspended floors until 28 days after concreting where ordinary Portland Cement is used and 14 days when rapid hardening Portland Cement is used.

**\*\*\* END OF SECTION\*\*\***

REINFORCEMENT

1. **SCOPE**

The work under this section of specifications consists of furnishing, cutting, fabricating, bending and placing steel reinforcement as shown on the drawings or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

1. **APPLICABLE STANDARDS**

Latest editions of the following Pakistan, British and ASTM Standards are relevant to these specifications wherever applicable,

### Pakistan Standard

PS 241 Tensile Testing of Steel.

PS244 Bend test for Steel

PS 580 Rolled deformed Steel bars (intermediate grade) for concrete reinforcement.

PS605 Rolled deformed steel bars (hard grade) for concrete reinforcement.

PS 606 Rolled deformed Steel bars (structural grade) for concrete reinforcement.

PS607 General technical delivery requirement for steel.

#### British Standard

BS 693 General requirements for Oxy-acetylene welding of mild steel.

BS 785 Hot rolled bars and hard drawn wire for the reinforcement of concrete.

BS 1856 General requirement for the metal arc welding of mild steel.

BS 4449 Hot rolled steel bars for reinforcement of concrete

BS 4461 Cold worked steel bars for reinforcement of concrete.

BS 4466 Bending dimensions and scheduling of bars for the reinforcement of concrete.

## ASTM Standard

A 305 Minimum requirement for the deformations bars for concrete reinforcement.

A 615 Deformed billet steel bars for concrete reinforcement.

ACI315 Manual of standard practice for detailing reinforced concrete structure.

ACI 318 Building code requirements for reinforced concrete.

In addition to the above, the latest editions of other Pakistan Standards, British standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other standard as may be specified by the Engineer for Special Material and construction are also relevant.

1. **MATERIAL AND SIZE OF BARS**
	1. Reinforcement for concrete shall conform to the respective Pakistan, British, ASTM, or other Standards as specified in the Drawings and in the Contract Documents or as may be specified by the Engineer.
	2. Unless otherwise specified, all plain reinforcing bars shall comply with the requirements of BS 4449 for plain mild steel bars and shall have a minimum characteristic strength of 40,000 psi.
	3. Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements of BS 4461 for deformed cold worked new stock billet steel bars and shall have a minimum characteristic strength of 60,000 psi.
	4. Reinforcement of all types is to be stored on Site in an approved manner so as to avoid damage.
	5. Steel wire mesh reinforcement shall conform to requirements of ASTM Designation A 185-64 or BS 4483, 1969: Standard Specifications for Welded Steel Wire Fabric for concrete reinforcement. It shall be used where shown on the Drawings.
	6. Reinforcement shall be free from all loose or flaky rust and mill scale, or coating, including ice, and any other substance that would reduce or destroy the bend. Reduced section steel reinforcement shall not be used.
2. **DELIVERY & STORAGE**
	1. **Delivery**

Steel reinforcement bars shall be kept in bundles firmly secured and tagged.

* 1. **Storage**

The method of storage shall be approved by the Engineer. Reinforcing bars shall be stored in racks or platforms above the surface of ground and shall be protected free from scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades of steel reinforcement shall be kept separately,

1. **BAR BENDING SCHEDULES**

The Contractor shall prepare bar bending schedules of all the reinforcing steel bars and these bar bending schedules shall be submitted to the Engineer for his approval. The Contractor shall obtain approval of the bar bending schedules before starting actual bar bending works.

1. **FABRICATING. BENDING & PLACING**
	1. All metal for reinforcement shall be free from loose mill scale, loose rust, mud, oil, grease, or other harmful matter immediately before the concrete is placed.
	2. Reinforcement is to be accurately placed as shown in the drawings, and secured against displacement by using 16 gauge G.I wire ties or suitable slips at intersections and supported from the formwork by using concrete, metal or plastic chairs and spacers or hangers of an approved pattern- Where concrete blocks are used for ensuring the cover, they shall be made of mortar not leaner than 1 part of cement to 2 parts of sand.

Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories in contact with the form work shall be galvanized or shall be made of plastic.

* 1. Bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the bar bending schedule approved by the Engineer.
	2. The cutting tolerance for all bars shall be ±1 inch. (± 25mm).
	3. Where an overall or an internal dimension of a bent bar is specified in the schedule, the bending tolerance, unless otherwise stated, shall be as in Table 1.

*Table 1 : Bending Tolerances*

|  |  |
| --- | --- |
| **Dimensions of bent bars** | **Tolerances** |
| **Over** | **Up to & including** | Plus | **Minus** |
| Inches | Inches | inches | inches |
| „ | 40 | 1/4 | 1/4 |
| 40 | 80 | 1/4 | 3/8 |
| 80 | - | 1/4 | 1 |

* 1. Bars shall be placed to the following tolerances:

|  |  |  |
| --- | --- | --- |
| 1. Concrete cover to formed surfaces
 |  |  |
| 1. Minimum spacing between bars
 |  |  |
| 1. Top bars in slabs and beams.
2. Members 8 inch deep or less
3. Members more than 8 inchbut not over 24 inch deep
4. Members more than 24 inch deep
 |  |  |
| 1. Cross wise members: speed evenly with in:
 | 2” | (50 mm) |
| 1. Length wise members:
 |  |  |

* 1. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to approval of Engineer.
	2. Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column dowels.
	3. Reinforcement shall not be bent or straightened in manner that will injure the material.
	4. No bars shall be bent twice in the same place, nor shall they be straightened after bending.

Unless permitted, by Engineer, reinforcement shall not be bent after being partially embedded in hardened concrete.

* 1. No splice of reinforcement shall be made except as shown on the working drawings.
	2. Welding shall be permitted for bars only under suitable conditions and with suitable safeguards in accordance with BS 693, BS 1856, or AWS D12.1, provided the type of reinforcement bar has the required welding properties. Tack welding may be used to fix in position bars that cross each other, only with prior approval of the Engineer.
	3. Exposed reinforcement intended for bonding with future extensions is to be effectively protected from corrosion. Protection is also to be provided to reinforcement partly built into concrete where the exposed part is to be built into later concrete.
	4. No concreting is to be carried out until the reinforcement has been checked and approved by the Engineer.
	5. Welding shall be done as in section 'Structural Steel Works'.

6.16 All detailing shall be done as per ACI standards ACI-315 and ACI-318.

Concrete clear cover for reinforcing steel shall be as follows:

***Structural Members Minimum Cover, inch***

* + 1. Concrete cast against and permanently exposed to earth 3inch (75 mm)
		2. Concrete exposed to earth or weather:

Bar Dia > 3/4" (20mm) 2 inch. (50 mm)

Bar Dia < 5/6" (16mm) 1-5/6inch. (40 mm)

* + 1. Concrete not exposed to weather or in contact with ground:

Slabs, Walls 3/4 inch (20 mm)

Beams, Columns: (Primary Reinforcement) 1-5/6 inch (40 mm

All reinforcing steel shall be held firmly in place before and during the placing of concrete by means of wires and supports adequate to prevent displacement during the course of construction.

**\*\*\* END OF SECTION \*\*\***

**PLAIN AND REINFORCED CONCRETE**

1. **SCOPE**

The work under this section of the specification consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with the supply, manufacturers, transporting, placing, consolidating and curing of plain & reinforced concrete and its constituents. Reinforcing steel does not form part of this section and is described in section "2200".

1. **GENERAL**
	1. Trades like electrical, mechanical, plumbing etc. shall be well coordinated. Contractor shall take approval of coordinated shop drawings prior to concrete pouring.
	2. Suitable templates or instructions or both shall be provided for setting out of items not placed in the forms. Embedded items and other materials for mechanical and electrical operations shall have been completed, inspected, tested and approved before concrete is placed.
	3. For special concrete finish and for special methods of construction, formwork shop drawings shall be designed and prepared by the Contractor, at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.
2. **APPLICABLE STANDARDS**

Latest editions of the following Pakistan, British and ASTM ACI Standards are relevant to these specifications wherever applicable.

* 1. **Pakistan Standards**

|  |  |
| --- | --- |
| PS233PS243PS279PS280PS281PS282PS283PS284PS285PS286 PS421 PS422 PS560PS612PS716 PS717 PS746 PS849 | Portland Cement (ordinary & rapid hardening) Natural aggregates for concrete Abrasion of coarse aggregates by the use of Los Angeles machine.Determination of aggregates crushing valueOrganic impurities in sand for concrete aggregate.Material finer than No. 200 BS test sieve in aggregates, method of test forSoundness test for aggregates by the use of sodium sulphate or magnesium sulphate. Sampling aggregates for concrete Sieve or screen analysis of fine and coarse Description and classification of mineral aggregates Sampling fresh concrete Slump test for concreteMaking and curing concrete compression test specimen in the field.Sulphate-resistant Portland cement type 'A' and sampling fresh concrete in the laboratory. MixingCompacting factor test for concrete Definitions and terminology of cements Making and curing concrete compression test cubes. |

* 1. **ASTM (American Society for Testing and Materials)**

|  |  |
| --- | --- |
| C33 C40 C87C88 C94 C 109 C 117C 123 C 125 C 127 C 128 C 131C 136C 142C 143C150C156C171C185C188 C191 C260C289C309C494C535C75C994C1190C1715D1850E11E96E154E337 | Concrete Aggregates.Organic impurities in sand for concrete. Effect of organic impurities in fine aggregates on strength of mortar. Soundness of aggregates. Ready mixed Concrete.Compressive strength of hydraulic cement mortars Material finer than No. 200 (0.075mm) sieve Light weight pieces in aggregates.Concrete and concrete aggregates. Specific gravity and absorption of coarse aggregate.Specific gravity and absorption of fine aggregate.Resistance to abrasion of small size coarse aggregate.Sieve or screen analysis of fine and coarse aggregate.Clay lumps and friable particles in aggregates. Slump of Portland Cement Concrete Portland CementWater retention by concrete curing materialSheet material for curing concrete.Air content or hydraulic cement mortar.Density of hydraulic cement.Time of setting of hydraulic cement by vicat neadle Air entraining admixture for concrete.Potential reactivity of aggregate. Liquid membrane forming compounds for curing concrete.Chemical admixtures for concrete. Resistance to abrasion of large size coarse aggregates.Aggregate sampling. Preformed expansion joint filler for concrete. Concrete joint sealer (hot poured elastic type). Preformed expansion joint filler for concrete paving and structural concrete.Concrete joint sealer (cold application type).Wire cloth sleeves for testing purposes. Water vapor transmission of materials in sheet form. Materials for use as vapor barrier under concrete slabs.Relative humidity by wet and dry bulk psychrometer. |

1. **ACI (American Concrete Institute)**

|  |  |
| --- | --- |
| 211214301304305308309315318347 | Recommended practice for selecting proportions for normal and heavy weight concrete. Quality control charts Specifications for structural concrete for building. Recommended practice for measuring, mixing, transporting and placing concrete. Hot weather concreting.Recommended practice for curing concrete. Recommended practice for consolidation of concrete Manual of standard practice of detailing reinforcement concrete structure. Building code requirement of reinforced concrete. Recommended practice for concrete formwork. |

1. **British Standards**

|  |  |
| --- | --- |
| BS 12BS 410BS 812BS 822 & 1210BS 1881BS 1348BS 3837BS 3869BS 4027CP 8110CP 114 | Portland cement, ordinary and rapid hardeningTest SieveMethods for the sampling and testing of mineral aggregates, fine sand filtersConcrete aggregate from natural sourcesMethod of testing concreteTest for water making concreteExpanded polystyrene boradsRigid expanded polyvinyl chloride for thermal insulation.Sulphate-resisting Portland cement Structural use of concrete Structural use of reinforced concrete in buildings |

In addition, the latest editions of other Pakistan and British Standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other Standards as may be specified by the Engineer for special Materials and Construction are also relevant.

### MATERIALS

* 1. **Aggregates**

Contractor shall run requisite physical and chemical tests of coarse and fine aggregates and submit to the Engineer for approval.

1. The sources of supply of all fine and coarse aggregates shall be as specified or approved by the Engineer.
2. All fine and coarse aggregates shall be clean and free from clay, loam, silt and other deleterious matter. If required, the Engineer reserves the right to have them washed by the Contractor at no additional expense. Coarse and fine aggregates shall be delivered and stored separately at site. Aggregates shall not be stored on muddy ground or where they are likely be become dirty or contaminated. They shall be placed on sloped hard strata to ensure well drained at all times.
3. Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of PS 243 and/or BS 882 and/ or ASTM C-33. Only fine aggregate of grading zones 1 to 3 (BS882) shall be used.
	* 1. Coarse aggregate shall be crush stone of hard, durable material free from laminated structure and conforming to PS 243 and/or BS 882 and/or ASTM C-33, graded as follows for use in mass concrete as in foundations:

|  |  |
| --- | --- |
| Total Passing SB Sieve76.20 mm (3 inch)38.10 mm (1 – ½ inch)19.05 mm (3/4 inch)9.52 mm (3/8 inch)4.76 mm (3/16inch) | Percent by Weight10095-10030-7010-350-5 |

Coarse aggregate for all cast-in-place concrete other than mass concrete as for foundations shall be graded with the following limits:

|  |  |
| --- | --- |
| Total Passing SB Sieve38.10 mm (1-1/2 inch)19.05 mm (3/4 inch)9.52 mm (3/8 inch)4.76 mm (3/16inch) | Percent by Weight10095-10025-550-10 |

* + 1. Wherever feasible, the nominal maximum size of aggregate for cast-in-place reinforced concrete slabs and other members shall be 3/4 inch. If there are difficulties in placing such a concrete the maximum size may be restricted to 1/2*.* Inch. Provided the requirements for strength are satisfied, as approved by the Engineer.
		2. Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the 3/4 inch maximum nominal size, the different sizes being stocked in separate stock piles and recombined in the correct proportion for each batch at the batching plant. The materials shall be stockpiled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day). The grading of the coarse and fine aggregates shall be tested at least once for every 100 tons. supplied, to ensure that the grading is uniform and same as that of the samples used in the preliminary tests.
1. **Cement**
	1. The cement shall be fresh and of approved origin and manufacture. It shall be one of the following as may be specified by the Engineer.
* Ordinary or rapid hardening portland cement complying with the requirements of P.S.232 or ASTM C-150.
* Sulphate Resisting Portland/Cement complying with the requirements of P.S.612 or BS 4027 or ASTM C-150.
	+ 1. Unless otherwise specified, Ordinary Portland Cement complying with the requirements ofBS.12 shall be used.
		2. For all fair faced concrete it will be necessary to use approved cement with a view to obtain a light shade concrete as approved by the Engineer.
		3. The Contractor shall supply to the Engineer at fortnightly intervals, test certificates with the appropriate standard in respect of the samples of cement from the work site. These tests shall be carried out in a laboratory approved by the Engineer.
		4. Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.
		5. There shall be sufficient cement at site to ensure that each section of work is completed without interruption. If the cement is supplied by the Employer, the Contractor should inform the Employer, of his requirements sufficiently in advance of its use in construction.
		6. Cement reclaimed from cleaning of bags or from leaky containers shall not be used.
		7. The contractor shall provide and erect (at his cost) a suitable plain, dry, well-ventilated, weather- proof and water-proof shed of sufficient capacity to store the cement.
		8. The cement shall be used as soon as possible after delivery and cement which the Engineer considers has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise shall be rejected and removed immediately from the site at the Contractor's expense. Any cement in containers damaged so as to allow the contents to spill or permitting access of the atmosphere prior to opening of the container at the time of concrete mixing shall be rejected and removed immediately from the site at the Contractor's expense.
		9. The mixing together of different types of cement will not be permitted.
1. **Water**

Water shall be tested in accordance with BS 3148 and shall be used only from an approved source.

The Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, the Engineer may refuse to permit its use.

1. **Additive**

All additives such as foaming and water proofing agents shall be from a manufacturer approved by the Engineer.

Air Entraining Admixtures conforming to ASTM C260. and other Admixtures conforming to ASTM C494 shall be used subject to approval of the Engineer.

###### NOMINAL CONCRETE MIXES

1. **Proportions of Mix**
	1. **Cement and aggregates:**

The cement, fine aggregate and the coarse aggregate shall be weighed separately. The proportions of cement to fine aggregate and coarse aggregate shall be adjusted so as to provide the concrete of the required crushing strength when tested as set out in Table 1

* + 1. The Contractor shall prepare mix design of various grades of concrete for the approval or Engineer prior to starting concrete works. He shall regulate and arrange mixing of the ingredients of the concrete by weigh batching. The cost of designing the mix shall be borne by the Contractor.
		2. **Water Cement Ratio:**

The quantity of water used shall be just sufficient to produce a dense concrete of adequate strength and workability for its purpose. For all external work and foundations the water/cement ratio should not exceed 0.55.

* + 1. **Workability:**

The workability shall be controlled by direct measurement of the water content, allowance being made for any water in the fine and coarse aggregates. The concrete shall be sufficiently workable to be placed and compacted, without difficulty, by the available means.

Workability shall be determined by either the slump or compaction factor tests as directed by the Engineer and these shall be performed in accordance with the methods given in PS 422 and P.S. 177 or ASTM C-143, The slump or compaction factor for each class of concrete shall be determined during the preliminary test mixes and the value obtained shall not be modified without the written consent of the Engineer, Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 3 inch or less if consolidation is to be by vibration. A tolerance of upto 1 inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, which ever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

1. **Strength requirements for concrete**
2. Concrete made with Portland cement shall comply with the strength requirements of Table 1. (Works Test).

***Table***: Strength requirements for Portland cement concrete with aggregate complying with BS 882.

|  |  |
| --- | --- |
| Class of concrete (psi) | Cube strength at 28 days (psi) |
| A | 4500 |
| B | 3750 |
| C | 3000 |
| D | 1500 |
| E | 1000 |

1. All structural concrete shall conform to BS 5328-81.
2. Unless otherwise stated, the types of concrete shall be classified on the basis of compressive strength
3. The Contractor shall provide Mix Design by weight for each class of concrete. Manufacture 12 Nos. test cubes 6" x 6" x 6" in accordance with the Mix design batching by weight and test 3 cubes each at 3,7,14 & 28 days intervals in the presence of Engineer's Representative and submit all relevant data and results of tests for approval of the Engineer. The Contractor shall obtain approval from the Engineer in writing for each Mix design before producing the actual concrete for the Works,

No payments for producing the Mix design, manufacture of test cubes and testing shall be made. The Contractor shall include this cost in the relevant item of concrete.

1. **Batching**
	* 1. All cement, including cement supplied in bulk, shall be batched by weight. A bag of cement may be taken as 110 Ibs. With the prior approval of the Engineer.
		2. Aggregates shall be batched by weight, due allowance being made for moisture content. The apparatus for weigh batching may be an integral part of the mixer or a separate unit of a type approved by the Engineer. It shall be accurate within 2% and shall be checked for accuracy at least once a month.
		3. The quantity of additives i.e. foaming and water proofing agents etc. shall be as prescribed by the manufacturer or as directed by the Engineer.
		4. Where the batching plant is of the type in which cement and aggregates are weighed in the same compartment, the cement shall be introduced into the compartment between two sizes of aggregates.
		5. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue to flow for a period, which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.
2. **Mixing**
	* 1. The concrete shall be mixed in a conforming to the requirements of BS 1305. It shall be fitted with the manufacturer's plate stating the rates, capacity and the recommended number of revolutions per minute and shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water-measuring device.
		2. Mixing shall continue for the period recommended by the mixer manufacturer or until there is apparently a uniform distribution of the materials and the mass is uniform in color, whichever period is longer. If it is desired to use a mixing period of less than 1-1/2 minute, the Engineer's approval shall be obtained in writing.
		3. Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three quarters of the required mixing time shall take place after the last of the mixing water has been added.
		4. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10 percent of their original height.
		5. Concrete shall be mixed only in quantities for immediate use. Concrete, which has set shall not be retempered, but shall be discarded.
3. **Transporting**
	1. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means which will prevent segregation or loss of or addition to ingredients. It shall be deposited as nearly as practicable in its final position so as to avoid rehandling or flowing. All skips vehicles, or containers used for transporting the concrete shall be thoroughly clean.
		1. During hot or cold weather, concrete shall be transported in deep containers, on account of their lower ratios of surface area to mass, which reduces the rate of loss of water by evaporation during hot weather and loss of heat during cold weather.
4. **Placing**
5. Before placing of concrete, formwork completed; water shall have been completed; water shall have been removed reinforcement shall have been secured in place; expansion joint material, and other embedded items shall have been kept in position; and the entire preparation shall have been approved.

No concrete is to be placed into the foundation trenches until the ground to receive the same has been examined and approved by the Engineer for this purpose.

* + 1. Concrete shall be deposited continuously, or in layer of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the Contract Documents or as approved by the Engineer. Placing shall be carried out at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened shall not be deposited. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their services unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.
		2. The actual sequence of construction proposed by the Contractor shall be subject to the Engineer's approval before construction starts on any part of the structure, and this sequence shall not be varied without the Engineer's approval.
		3. The concrete shall be placed as soon after it has been mixed as is practicable. Once the concrete has left the mixer, no more water shall be added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing is too low for it to be compacted fully and to an acceptable finish by whatever means available.

The time between mixing and placing should be reduced if the mix is richer or the initial workability of the mix is lower than normal, if a rapid hardening cement or an accelerator is used, or if the work is carried out at a high temperature or exposed to a drying atmosphere.

The Contractor shall ensure that the delay between mixing and placing does not exceed 45 minutes under any circumstances. Any concrete, which does not satisfy this requirement, shall not be used.

* + 1. The concrete shall be deposited as nearly as possible in its final position to avoid rehandling. In no circumstances may concrete be railed or made to flow along the forms by the use of vibrators. Concreting shall be carried on as a continuous operation using methods, which shall prevent segregation or loss of ingredients.
		2. The free fall of concrete shall not be allowed to exceed 5 ft. (1.5m) and where it is necessary for the concrete to be lowered more than this depth, it is not to be dropped into its final position, but shall be placed through pipes fed by a hopper. When a pipe is used for placing concrete the lower end shall be kept inside, or close to the freshly deposited concrete. The size of the pipe shall be not less than 9 inches (225mm) diameter.
		3. The workmen carrying concrete to the site, and all other workmen moving about on the reinforcement before the concrete is placed, shall move only along runways or planks placed for the purpose and no person shall be allowed to walk on the reinforcement itself.
		4. Prior to the laying of concrete on load bearing masonry walls, bearing plates and at other points, as may be directed by the Engineer, the surface will be brought to a true, hard, smooth, level surface using cement sand mortar in the ratio of 1 part of cement to 3 parts of sand. Two layers of building paper will then be laid flat to separate the concrete from the surface on which it is to be laid.
1. **Construction Joints**
	* 1. Concreting shall be carried out continuously up to construction Joints, the position and arrangement of which shall be predetermined by the Engineer.
		2. Joints not shown on the drawings shall be so made and located as to least impair the strength of the structure and shall need prior approval of the Engineer. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset a distance equal to twice the width of the secondary beam. Joints in walls and columns shall not be at the underside of floor slabs or beams, and at the top of footings or floor slabs. Beams, brackets, columns, capitals, haunches and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
		3. All reinforcing steel shall be continued across joints. Key and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys at least 1 –1/2 inch. (40mm) deep shall be provided in all joints in walls and between walls and slabs or footings.
		4. When the work has to be resumed on a surface which has hardened, such surface shall be roughened in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface. Feather edges will be avoided.
		5. The hardened concrete of construction joints and of joints between footings and walls or columns, between walls or columns and beams or floors they support, joints in unexposed walls and all others not mentioned herein shall be dampened (but not saturated) immediately prior to placing of fresh concrete,
		6. The hardened concrete of joints in exposed work, joints in the middle of beams and slabs; and joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout similar in proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 150mm thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained initial set.
		7. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle, and brushed, care being taken to avoid dislodgment of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 6 inches (150 mm) in thickness, and shall be well rammed against old work, particular attention being paid to corners and closed spots.
2. **Expansion Joints**

Expansion joints shall be provided wherever indicated on the Drawings. In no case shall the reinforcement, corner protection angles, or other embedded items be run continuous expansion joint.

All expansion joints shall be carefully placed so as not to be displaced during concreting. The method of placing the expansion joints shall be strictly in accordance with the Drawings and as approved by the Engineer. All materials for use in the expansion joints shall have, prior approval of the Engineer before placing order for supply.

1. **Embedded Items**
	* 1. The material, design and location of waterstops in joints shall be as indicated in the Contract Documents. Each piece of remolded water stop shall be of maximum practicable length in order that the number of end joints will be held to a minimum.

Joints at intersections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water-tightness fully equal to that of the continuous waterstop material, shall permanently develop not less than 50 percent of the mechanical strength of the parent section, and shall permanently retain their flexibility.

1. Electric conduits and other pipes which are planned to be embedded shall not, with their fittings, displace more than four percent of the area of the cross section of a column on which stress is calculated or which is required for fire protection. Sleeves, conduits, or other pipes passing through floors, walls, or beams shall be of such size or in such location as not to impair unduly the strength of the construction: such sleeves, conduits, or pipes may be considered as replacing structurally in compression the displaced concrete, provided that they are not exposed to rusting or other deterioration, are of uncoated or galvanized iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over 50mm and are spaced not less than three diameters on centers, Except when plans of conduits and pipes are approved by the Engineer embedded pipes and conduits other than those merely passing through, shall not be larger in out side diameter than one third the thickness of the slab, wall, or beams in which they are embedded nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits of any material not harmful to concrete and within the limitations of this section may be embedded in concrete with the approval of the Engineer provided they are not considered to replace the displaced concrete
	* 1. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.

All Contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.

* + 1. Expansion joint material, water stops and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.
1. **Precast Concrete/Precast Jali**

Precast concrete units shall be fair faced, cast to the sizes and dimensions as indicated on the Drawings. The concrete used for precast units shall conform to the specifications laid down for cast in situ reinforced cement concrete unless otherwise required and directed by the Engineer.

The Contractor shall be required to submit a sample of precast unit for the approval of the Engineer all precast units shall strictly conform to the approved sample.

Precasting platform of the size and at the location approved by the Engineer shall be constructed. The concrete in one pre- cast unit shall be placed in one operation, in accordance with the details shown on the Drawings.

The material and design of formwork and the method of pre- casting the units shall be approved by the Engineer.

The erection/installation and removal of the precast units from the precasting platform shall not be permitted until and unless they are properly cured to the satisfaction of the Engineer.

All precast units shall be smoothly finished to the required lines, grades, angles etc. Holes, grooves, pockets, hooks shall be provided as shown and/or as directed by the Engineer. The units shall be properly stacked on a platform without causing any cracks and damages. Curing of all the precast units shall be done in accordance with the relevant BSS/approval of the Engineer.

1. **Erecting Precast Units**

All the precast units shall be transported and erected into position in a manner as approved by the Engineer.

The Contractor shall submit his proposal in this regard and obtain approval from the Engineer in advance.

The units shall be embedded or otherwise installed in their permanent positions as shown on the Drawings or as directed by the Engineer.

1. **Lifting Beams**

The Contractor shall use lifting beams at his own cost, for erecting pre-cast members where the Engineer so directs. Lifting beams shall be supplied and erected by the Contractor, at his own cost, at all points where lifting is necessary for maintaining the plant but is inaccessible to mobile cranes or, alternatively, covered by overhead travelling cranes. The Contractor, however, is to supply the trolleys and erect them on the lifting beams, and to test operation of installed equipment.

1. **Cement Concrete Pavements**

For all concrete work relevant specifications of this section shall apply.

1. **Side Forms and Construction**

Side forms shall be of steel or any other suitable material and of a design as approved by the Engineer.

In general, only materials and methods that have proved their acceptability by past performance will be considered. All form shall be constructed so that they can be removed without hammering or prying against the concrete.

Horizontal joints in the forms will not be permitted. Forms shall be thoroughly cleaned and oiled with linseed/mineral oil or shall be given two coats of nitro-cellulose lacquer each time they are used.

The forms shall be set on a thoroughly compacted base true to lying and level and firmly secured in position by appropriate methods. Conformity with the alignment and levels shown on the Drawings shall be checked as and when required by the Engineer. Where necessary corrections shall be made immediately before placing the concrete; where any form has been disturbed it shall be reset and rechecked.

Pavements shall be constructed in panels of sizes as shown on the Drawings. The panels shall be laid alternately, the adjoining panels being concreted when the side forms are struck and the jointing materials placed, inspected and approved by the Engineer. Each panel is to be concreted in one operation and no interruptions shall be permitted during the operation. The concrete shall be tipped from the trolley slightly in advance of the working place and then shoveled into position. The spreading shall be carried out very carefully. Compaction shall be done by means of vibro-compactors or approved surface vibrators. If a vibro-compactor is used, it shall be operated on the concrete and will not be allowed to strike or displace the forms. The spreading and compacting of the successive layers shall proceed without interruptions and as quickly as practicable so as to ensure that the slab is monolithic throughout its depth.

The wearing surface shall be laid while the base concrete is still wet and screeded to line and level. When the initial set takes place the surface shall be troweled smooth with a steel trowel to provide a dense closed surface.

All the joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. The joint filler together with preformed groove shall provide complete separation of adjacent slabs. The joints shall all be sealed with bitumen as shown on the Drawings and as directed by the Engineer.

1. **Protection and Curing**
* **General Requirements** :

Concrete shall be protected adequately from injurious action by sun, rain, flowing water and mechanical injury, and shall not be allowed to dry from the time it is placed until the expiry of the minimum curing periods specified hereinafter. Water curing shall be accomplished by keeping the surface of the concrete continuously covering with water or with approved covering. Where wood forms are left in place for curing they shall be kept sufficiently damp at all times to prevent openings at the joints and drying out of the concrete. All portions of the structure shall be kept moist for the full curing periods, specified hereinafter.

When liquid membrane curing compound is used the surface of the concrete shall be protected from traffic or other abrasive action that may break the membrane, for the full period of curing. The membrane curing compound shall be white colored and shall be approved by the Engineer and shall comply with ASTM Designation: C 309, type 2.

* **Curing Periods:**

The curing period shall be at least 10 days, or as directed by the Engineer.

* **Removal of Forms**:

The Contractor shall exercise great care in avoiding damage to joints, arises, dowel bars etc, while removing the forms. Under no circumstances will the use of pry bars between the forms and pavement be permitted. Side forms shall not be removed until at least 40 hours have elapsed from the time of completing the concreting of the slab which they contain, in no case shall forms be removed until the concrete has hardened sufficiently to permit removal without damage to the concrete. Concrete work shall be protected from damage during the removal of formwork and from injury resulting from the storage or movement of material during construction.

1. **Finishing**

All unformed surfaces shall be finished with a wood float except as otherwise specified. Visible vertical surfaces shall have all projections and irregularities removed. The entire surface shall be rubbed if required by the Engineer, with a No. 16 carborundum brick, or other abrasive until even, smooth and of uniform appearance, and shall be washed clean. Plastering of surface, application of cement or other coating will not be permitted.

All exposed corners shall be chamfered 1 inch x 1 inch. (25x25mm) unless otherwise mentioned or show on the plans or directed by the Engineer will be covered with other materials shall be screeded without floating.

1. **Spreading, finishing and floating of concrete in pavements:**
* **General Requirements**:

The striking off, compacting and floating of concrete shall be done by mechanical methods, if approved by the Engineer. Where the Engineer determines that it is impracticable to use mechanical methods, manual methods of spreading, finishing and floating may be used on pavement lines as indicated on the Drawings.

* **Mechanical Methods:**

The concrete shall be spread uniformly between the forms, immediately after it is placed, by means of an approved spreading machine. The spreader shall be followed by an approved finishing machine equipped with two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Internal vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine or to the finishing machine. Vibrators shall not rest on new pavements or side forms or in contact with any dowel bars, and the arrangement of power supply to the vibrators shall be such that when the motion of machine is stopped, vibration shall cease. The rate of vibration shall be not less than 8000 vibrations per minute. The concrete shall be spread to full width before being struck off and compacted so that the surface will conform to the finished grade and cross-section as shown on the plans and at the same time leave sufficient material for the floating operation. The spreading & finishing machine shall move over the pavement as many times and at such intervals as may be required by the Engineer to ensure thorough compaction.

Except as otherwise specified, after the pavement has been struck off and compacted, it shall be finished with an approved longitudinal float. The Contractor may use a longitudinal float composed of one or more cutting and smoothing floats, suspended from & guided by rigid frame. The frame shall be carried by four or more visible wheels riding on and constantly in contact with the forms.

The Contractor may use a longitudinal float which works with a sawing motion, while held in a floating position parallel to the road centre line and passing gradually from one side of the pavement to the other. Movements ahead, along the centre line of the road, shall be in successive advances of not more than half the length of the float.

Instead of using other type of longitudinal float a single machine which will affect satisfactory compaction, finishing and floating may be used. This machine may be towed by a spreading machine. This combination, finishing- floating machine shall be equipped with screeds and vibrators as hereinafter specified for spreading and finishing machine. Floating shall be accomplished by means of a non-oscillating float held in a suspended position from the frame.

If any spreading, finishing and floating equipment is not maintained in full working order or if the equipment as used by the Contractor proves inadequate to obtain the results prescribed, such equipment shall be improved or satisfactory equipment substituted or added at the direction of the Engineer.

* **General Requirement;**

The concrete shall be spread uniformly immediately after it is placed and shall be leveled and then struck-off to such an elevation that, when properly compacted, the surface will conform to the required grade and cross-section. The strike board shall be moved forward with a combined longitudinal and transverse motion, the manipulation being such that neither end is raised from the side forms during the process. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times. Prior to tamping, the concrete along the forms shall be thoroughly spaded or vibrated. The entire area of pavement shall be tamped or vibrated in a manner that will ensure maximum compaction. The concrete shall be brought to the required grade and shape by the use of a tamper consisting of a heavy plank whose length exceeds the width of the pavement by 300mm or by the use of a mechanical vibrating unit spanning the full width of the spread. The tamper shall be constructed with properly trussed rods to stiffen it and prevent sag and shall be shod with a heavy strip of metal for a tamping surface. The tamper shall be moved with a combined tamping and longitudinal motion, raising it from side form and dropping it so that the concrete will be thoroughly compacted and rammed into place. A small surplus material is compacted and rammed into front of the tamper or vibrating unit and tamping or vibrating shall continue until the true cross-section is obtained and the mortar flushes slightly to the surface.

1. **Expansion and Construction Joints**
	1. All the expansion and construction joints shall be carefully formed as shown on the Drawings or as directed by the Engineer. The joint filler together with the preformed groove shall provide complete separation of adjacent slabs or building. The preformed chase shall be thoroughly cleaned of all dust, debris, stones or other hard material.
	2. All joints are to be filled with flex cell expansion joint filler, or an approved elastic, compressible, durable, and rot-proof equivalent of sufficient rigidity to enable it to be satisfactorily installed in the joint and resist deformation during the passage of the concreting equipment. The filler is to be of the same thickness as the joint width.
	3. Construction joints shall be provided as shown on the Drawings,

The assembly and method of constructing the expansion joints/construction joints shall be subject to the approval of the Engineer.

1. **Consolidation**
	* + 1. All concrete shall be consolidated by vibration, spading, rodding or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall! have a minimum frequency of 8000 vibrations per minute and sufficient amplitude to consolidate the concrete effectively. They shall be operated by competent workmen. Use of vibrators to transport within forms shall not be allowed; vibrators shall be inserted and with drawn at points approximately 1 1/2 ft. *(1/2* meter) apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not excessive so as to cause segregation, generally from 5 to 15 sec. A spare Vibrator shall be kept on the job site during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface.
			2. If there is any tendency for the mix to segregate during consolidation, particularly if this produces excessive laitance, the mix proportions shall be modified to effect an improvement in the quality of the concrete to the satisfaction of the Engineer and in conformity with the provisions of Clause5.
			3. Vibrators shall not be allowed to touch the formwork or the reinforcing bars during consolidation operation.
			4. Mechanical vibrators shall be of a type suited in the opinion of the Engineer to the particular conditions.
			5. Over-vibration or vibration of very wet mixes is harmful and should be avoided.
2. **Curing and Protection**
	* 1. Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures and mechanical injury, and shall be maintained with minimum moisture loss at a relative constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval of the Engineer
		2. For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing:
			+ Ponding or continuous sprinkling.
			+ Application of absorptive mats or fabric kept continuously wet.
			+ Application of waterproof sheet materials approved by the engineer
			+ Application of other moisture-retaining covering as approved.
			+ Application of a curing compound conforming to ASTM C 309 type 2. The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheet which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.
				1. Moisture loss from surface placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the vertical faces of concrete shall be cured until the end of the time prescribed in sub-clause 5.13.4 by one of the methods of sub-clause.
3. Curing in accordance with sub-clause 5.13.1 & 5.13.2 above shall be continued for at least 14 days in the case of all concrete except concrete with rapid- hardening Portland Cement for which the period shall be at least 3 days. Alternatively, if tests are made of cubes kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the minimum specified works cube strength. If one of the first four curing procedures of sub-clause 5.13,2 is used initially, it may be replaced by one of the other procedures of that sub-clause any time after the concrete is one day old provided the concrete is not permitted to become surface dry during the transition.
4. When the mean daily outdoor temperature is less than 41°F then temperature of the concrete shall be maintained between 50°F - 68°F for the required curing period of sub-clause 5.13.4.

When necessary, arrangements for heating, covering insulation or housing the concrete work shall be made in advance of placement and shall be adequate required temperature without injury to Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gasses which contain carbon dioxide.

1. When necessary, provision for wind-brakes, shading for spraying, sprinkling, ponding or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operation will allow.
2. Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 37°F in any one hour or 50°F in any 24 hour period.
3. During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibrations. All finished concrete surfaces shall be protected from damage by construction equipment, materials or methods by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete. No traffic should be allowed on pavement for at least 7 days after casting.
	1. **Works in Extreme Weather**
		1. Unless adequate protection is provided and approval is obtained, concrete shall not be placed during rain.

Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.

1. When the temperature of the surrounding air is expected to be below 41 degree F during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 55 degree F for sections less than 300mm in any dimension nor 50 degree F for any other sections.
2. During hot weather, the temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 90°F. When the temperature of the concrete exceeds 90°F precautionary measures approved by the Engineer shall be put into effect. When the temperature of the steel is greater than 122°F steel forms and reinforcement shall be sprayed with water just prior to placing the concrete ingredients shall be cooled before mixing, or flaked ice or well crushed ice of a size that will melt completely during mixing may be substituted for all part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

Other precautions recommended by ACI 305 shall also be adopted.

###### TEST OF CONCRETE QUALITY

* 1. The Contractor shall provide samples of concrete for testing at the Engineer's direction. Proper facilities shall be provided for making and curing the test specimens in accordance with PS 560 and PS 849. A competent person shall be employed by the Contractor whose first duty shall be to supervise all stages in the preparation and placing of the concrete. All test specimens shall be made and site tests carried out under his direct supervision.
1. Test sample shall be taken at the mixer or as directed by the Engineer. The test specimens shall be cured in accordance with PS 560, PS 849 and BS 1881. The strength shall comply with the standard of quality specified in table 1.
2. The five test cubes are to be tested for compressive strength as specified in BS 1881. These tests shall be carried out at site or in a laboratory approved by the Engineer. Two cubes shall be tested at the age of seven days and three at 28 days and the strengths determined are to comply with the standard of quality specified. The laboratory tests shall be carried out by an independent organization, such as Government Testing Laboratory or such other undertakings approved by the Engineer. The original test reports received from the above authorities should be submitted to the Engineer.

For all grades of concrete, the appropriate strength requirement shall be considered to be satisfied if none of the strengths of the cubes is below the specified cube strength or if the average strength of the three cubes is not less than the specified cube strength and the difference between the greatest and the least strength is not more than 20% of the average.

When the results of works cube tests show that the strength of any concrete is below the minimum specified the Engineer may give instructions for the whole or part of the work concerned to be removed and replaced at the expense of the Contractor. The Contractor shall bear the cost of any other part of his, or any other contractor's work, which has to be removed and replaced as a result of the defective concrete. If any concrete is held to have failed, the Engineer may order the proportions of that class of concrete to be changed in order to provide the specified strength.

###### FINISHING OF FORMED SURFACES

1. **General**
	1. After removal of forms, the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the Contract Documents.
		1. When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 100sq.ft.in an inconspicuous location designated by the Engineer before proceeding with the finish in the specified location.
		2. Allowable deviations from plumb or level and from the alignment, profile grades, and dimensions are specified in clause 9. Tolerances for concrete construction are defined as tolerances to be distinguished from irregularities in finish as described herein. The finish requirements for concrete surfaces shall be as generally specified in this clause and as indicated on the Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skilled in concrete finishes. The Contractor shall keep the Engineer advised as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits herein after specified. Surface irregularities are classified as abrupt or gradual. Offsets caused by displaced or misplaced form sheeting or lining or sections, or otherwise defective form lumber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities, and will be tested by use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 2 meter for testing of formed surfaces and 3 meters for testing unformed surfaces.
2. **As-cast Finishes**

Unless otherwise specified or indicated on the Drawings the classes of finish shall apply as follows:

* + 1. **Rough form finish:**

No selected form facing materials shall be specified for rough form finish surfaces. The holes and defects shall be patched. Otherwise, surfaces shall be left with the texture imparted by the forms.

* + 1. **Fair face finish:**

Fair face finish applies to concrete formed surfaces, the appearance of which is considered by the Engineer to be of special importance, such as surfaces of structures prominently exposed to public inspection. Surfaces of concrete structures requiring fair face finish as shown in the Drawings. Surface irregularities, measured as described in sub-clause 7.2.1, 'Rough form finish', shall not exceed 4mm for gradual irregularities and 6mm for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints. Abrupt irregularities at construction joints and elsewhere in excess of 6mm and gradual irregularities in excess of 1/8 inch. (3mm) shall be reduced by grinding so as to conform to the specified limits. Abrupt irregularities at construction Joints shall be ground on level of 1 to 20 ratio of height to length.

Unless otherwise approved, repair of imperfections in formed concrete shall be completed within 24 hours after removal of forms. The form facing material shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, temperate concrete-form-grade hardboard, metal, plastic paper or other approved material capable of producing the desired fair face finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn edge, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. The holes and defects shall be patched. All fins shall be completely

* + 1. **Architectural Finish Concrete:**

Architectural finish to concrete formed surfaces as shown on the Drawings is required by the Engineer where the architectural appearance of surfaces of structures exposed to public view is of special consideration and importance. The Contractor shall use approved special material for formwork and design the forms in conformity with the specified architectural patterns, textures and finishes in order to obtain first class architectural finish on formed concrete surface without any defect, irregularities, blemishes, imperfections and encrustations.

**Sample approvals of precast & in-situ concrete:**

These samples will be reviewed and approved on the basis of color, dimensional accuracy, and finish of surfaces and general appearance. The same requirements for sample approval will be required for both precast and in-situ concrete exposed surfaces.

#### Forms

The contractor must maintain the forms unusually tight and braces to prevent movement, mal-alignment and bleeding that will result in sand streaks, honeycomb, fins, stain or unsightly appearance.

It wood forms are chosen to be used by the Contractor they shall be constructed of 3^ inch. (20mm) minimum thickness plywood constructed in a fashion to allow many re-uses with all surfaces sealed with a polyurethane varnish.

Edges, surfaces and corners of forms shall be sealed to prevent loss of any matrix or unequal absorption of water. Corners of wood forms shall be filled with suitable compound and ail contact surfaces sealed with a polyurethane varnish.

Re-use of forms shall be subject to approval of the Engineer.

**Curing:**

Curing shall be done in shade (out of direct sunlight) and shall be for a minimum period of 4 days.

**Finishing procedures**:

"Finishing procedures for filling air void in smooth finished concrete developed by a formed surface".

While the concrete surface is still damp (not more than three days after removal of forms), apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within any pit or blemishes in the parent concrete, avoid coating large areas of the finished surface. Before slurry has dried or changed color, apply a dry (almost crumbly) grout comprised of one part cement, of the type and brand of cement used in the original concrete, to one and one-half parts clean masonry sand with a fineness modulus of approximately 2.25 and complying with the gradation requirements of the ASTM Specifications C144. Mix proper amounts of white cement and coloring with the parent mortar to produce a satisfactory color match with the parent concrete after hardening. Use samples previously prepared.

Apply the finishing grout uniformly with damp (neither dripping wet nor dry) pads of coarse burlap approximately 6 inch square used as a float. Scrub the grout well into the pits to provide a dense mortar in all the imperfections to be filled. Allow the mortar to partially harden, from one to two hours, depending upon the weather. Avoid direct hot sunlight. If the air is hot and dry, keep the concrete surface damp during this period using a fine fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout from the small pits of holes, cut off all that can be removed with a trowel without delay: next allow the surface to dry thoroughly and rub it vigorously with clean, dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. Complete the entire cleaning and grouting operation for the grout to dry after it has been cut with the trowel, so it can be wiped off clean with the burlap.

On the day after the repair work, the concrete surfaces should again be wiped off clean with dry burlap to remove any inadvertent dust; leave no built-up surfaces on the parent surfaces. Employ, if possible, a used piece of burlap containing old hardened mortar to act as a mild abrasive. Use of find abrasive stone if needed to remove any remaining built-up film without breaking through the, surface of the original concrete. Such scrubbing should be light and sufficient only to remove excess material without working up a lather of mortar or changing the texture of concrete. Following the final bagging or stoning operation, provide a thorough wash down with stiff bristle brushes to remove all extraneous materials and spray the concrete surface with a fine fog spray periodically to maintain a continually damp condition for at least three days after application of the pit repair grout.

**Rust Stains:**

***All rust stains are to be removed employing the following procedure:***

The rust stain shall be soaked for 10 minutes with a solution of (0.055 Ib.) 25gm of sodium citrate in (0.33lb) 150gms water (brushing the solution at short intervals is satisfactory). Then the surface is sprinkled with crystals of sodium hydrosulfite and covered with a paste of Fuller's Earth and water. On a vertical surface, the paste is applied with a trowel, with the crystals first sprinkled on the paste so they will be in direct contact with the stain. The paste is allowed to dry for 10 minutes then scraped off and the treatment repeated if necessary.

**Repairing of Formed Surfaces:**

It is the intention of Specification to require forms, mixture of concrete and workmanship so that concrete surfaces, when exposed, will require no patching. Any concrete which is not formed as required and conforming to approve samples or for any reason is out of alignment or level or shows a defective surface, shall be removed from the job by the Contractor at his expense unless the Engineer grants permission to repair the defective area. Permission to patch any such area shall not be considered a waiver of the Engineer's right to require a complete removal of defective work if the repair does not, in his opinion, satisfactorily restore the quality and appearance of the surface. The Engineer shall be the sole judge of acceptability of appearance.

###### REPAIR OF SURFACE DEFECTS

##### General

Any concrete failing to meet the specified strength or not formed as shown on drawings, concrete out of alignment, concrete with surfaces beyond required tolerances or with defective surfaces which can not be properly repaired or attached in the opinion of the Engineer shall be removed at contractor's cost. The Engineer may reject any defective concrete and order it to be cut out in part or in whole and replaced at the Contractor's expense.

* + 1. All ties and bolt holes and all repairable defective areas shall be patched immediately after form removal.
	1. **Repair of Defective Areas**
		1. All honeycombed and other defective concrete shall be removed down to sound concrete. The area to be patched and an area at least 6 inch. (150mm) wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing a No. 25 BS Sieve and shall then be well brushed into the surface.
		2. The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2-1/2 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the grey Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.
		3. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
		4. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to loose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface to permit initial shrinkage; it shall be left undisturbed for at least 1 hour before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed
		5. Where as-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as-cast surfaces shall not exceed 6 sq.ft. in each 100sq.ft of as-cast surface. This is in addition to form tie patches, if the project design permits ties to fall within as-cast areas.
		6. Any patches in as-cast architectural concrete shall be indistinguishable from surrounding surfaces. The mix formula for patching mortar shall be determined by trial to obtain a good color match with the concrete when both patch and concrete are cured and dry. After initial set, surfaces of patches shall be dressed manually to obtain the same texture as surrounding surfaces.
		7. Patches in architectural concrete surfaces shall be cured for 7 days. Patches shall be protected from premature drying to the same extent as the body of the concrete.
	2. **Tie and Bolt Holes**

After being cleaned and thoroughly dampened, the tie and bolt holes shall be filled solid with patching mortar.

* 1. **Proprietary Materials**

If permitted or required by the Engineer, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendations with prior approval of the Engineer.

###### CONCRETE CONSTRUCTION TOLERANCES

Where tolerances are not stated in the specifications or drawings for any individual structure or feature thereof, maximum permissible deviations from established lines, grades and dimensions shall conform to the following. The Contractor is expected to set and maintain concrete limits. These allowable tolerances shall not relieve the Contractor of this responsibility for correct fitting of indicated materials. Those tolerances are not cumulative.

1. Variation fromthe plumb (or the specified batter for inclined walls)

|  |  |
| --- | --- |
| * 1. In the lines and surfaces of columns, piers, and walls and in arises
* In any 10 ft. (3 meter) of length or height:
* In any storey or 20 ft. (6 meter) maximum:
* Maximum for the entire length or height:
1. For exposed corner columns, control joint grooves and other conspicuous lines.
* In any bay or 20 ft. (6 meter) maximum
* Maximum for the entire length or height
1. Variation from the level or from the grades indicated on the drawings.
	* 1. In floors, ceilings, beams soffits and in arises.
* In any 10 ft. (3 meter) of length
* In any bay or 20 ft. (6 meter) maximum
* Maximum for the entire length
1. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.
* In any bay or 20 ft. (6 meter) maximum
* Maximum for the entire length
1. Variation of the linear building lines from established position in plan and related position of columns, walls and partitions.
* In any bay or 10 ft. (3 meter) maximum
* Maximum for the entire length
1. Variation in the sizes and locations of sleeves, floor openings, and wall openings.
2. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.
* Minus
* Plus

Footings * + 1. Variation in dimensions in plan
* Minus
* Plus (plus variation applied to concrete only, not to reinforcing bars or dowels).
	+ 1. Misplacement or eccentricity:

2 percent of the footing width in the direction of misplacement but not more than (applies to concrete only, not to reinforcing bars or dowels). * + 1. Reduction in thickness

Minus 5 percent of specified thickness1. **Variation in Steps**
	1. Rise

Tread1. In consecutive steps:

RiseTread1. Tolerances for Pavements
2. Departure from established alignment
3. Departure from established longitudinal grade on any time.
4. Departure from transverse template contour at transverse joints except at transverse joints.
5. Departure from transverse template contour at transverse joints
 | ¼” (6mm)3/8” (10mm)1” (25mm)¼” (6mm)½” (13mm)¼” (6mm)3/8” (10mm)¾” (20mm)¼” (6mm)3/8” (10mm)½” (13mm)1” (25mm) ¼” (6mm)½” (13mm)½” (13mm)½” (13mm)2” (50mm)1/8” (3mm)¼” (6mm)1/16” (1.5mm)1/8” (3mm)width of one traffic lane |

1. **Pavements for parking areas**

The tolerances are twice the values listed for pavements.

**ACCEPTANCE OF STRUCTURE**

* 1. **General**
1. Completed concrete work which meets all applicable requirements will be accepted subject to the other terms of the Contract Documents.
2. Completed concrete work which fails to meet one or more of the requirements and which has been repaired to bring it into compliance will be accepted subject to the other terms of the Contract Documents.
3. Completed concrete work which fails to meet one or more of the requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Specifications or in the Contract Documents. In this event, modifications may be required to assure that remaining work complies with the requirements.
	1. **Dimensional Tolerances**

10.2.1 Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of clause 9 shall be considered potentially deficient in strength and subject to the provisions of sub clause 9.4

10.2.2 Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of clause 9 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance. Permission is required if excess material is to be removed in accordance with this clause.

10.2.3 Concrete members cast in the wrong location may be rejected if the strength, appearance or function of the structure is adversely affected or if misplaced items interfere with other construction.

10.2.4 Inaccurately formed concrete surfaces exceeding the limits of Clause 9 or of Clause 5.1 of Section 'Formwork' shall be removed and replaced and those that are exposed to view, may be rejected and shall be repaired or removed and replaced if required.

* 1. **Appearance**
1. Architectural concrete with surface defects exceeding the limitations of Sub-clause 5.1 of Clause 5 of the Section, 'Formwork' shall be removed and replaced.
2. Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only be approved methods.
3. Concrete not exposed to view is not subject to rejection for defective appearance.
	1. **Strength of Structure**
		1. The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions.
* Concrete strength requirements not considered to be satisfied in accordance with Clause 6 hereof.
* Reinforcing steel size, quantity, strength, position or arrangement at variance with the requirements as listed under specification of 'Reinforcement' or in the Contract Documents.
* Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.
* Curing less than that specified.
* Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
* Mechanical injury, construction fires, accidents of premature removal of formwork likely to result in deficient strength.

- Poor workmanship likely to result in deficient strength.

* + 1. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
		2. Core tests may be required when the strength of the concrete in place is considered potentially deficient.
		3. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their result evaluated in accordance with British Standard, CP 110 or ACI 318.
		4. Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Engineer or shall be replaced, at the Contractor's expense.
		5. The Contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this section.
		6. All costs of additional testing and/or analysis which is made at the Employer request and which is not required by these Specifications, or by the Contract Documents shall be borne by the Contractor

**VAPOUR BARRIER**

Vapor barrier shall be polyethylene building film. The film shall be 200 micron thick.

The quality of material shall be approved by the Engineer prior to use in the works.

Vapor barrier shall be laid in position wherever shown on the Drawings or as directed by the Engineer.

The material shall be supplied in roils and laid by rolling over the prepared surface at the levels and position in the areas shown on the Drawings. Where Joint is necessary at the side or end of a sheet, this shall be a double weld folded joint made by placing the edges together and folding over twice continuously taking the top edge prior to concreting. The Contractor shall protect the film sheets from damages during laying and subsequent operations and shall replace at his cost all damaged film sheets to the satisfaction of the Engineer.

Manufacturer's recommendations and instructions along with the sample of material shall be submitted to the Engineer for his approval.

1. **PVC WATER STOP/HYDROFOIL**
	1. **Material**

All PVC water stops/hydrofoil shall be central bulb type from a manufacturer approved by the Engineer, The specific gravity of PVC water stop/hydrofoil shall not be less than 1.37 & full stretch Break cut intensity when tested at normal temperature shall not be less than 1878 Psi.

The material shall have a modulus of rigidity of 853 Psi at 50° F & 10544 Psi at 68° F.

1. **Placing & Connections**

In general all PVC water stops/hydrofoil shall be placed in the centre of the structural member. Each piece of the water stop-hydrofoil shall be of maximum practicable length. An ordinary sharp knife saw or any other sharp tool can be used to cut the water stop. Joints at inter sections and at ends of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective water tightness fully equal to that of the continuous water stop material and shall permanently retain their flexibility. For straight line connection melting method of connection can be used by pressing two water stops intended for connection against a heated iron or copper sheet. When they are melted, the two are combined.

After joining, the water stop should be allowed to cool.

For all other connections such as T-type or L-type, the welding method of joining should be used. Welding rod of same material as the water stop shall be used. The

Welding rod & the water stop shall be heated & melt at the same time, by means of heated air Jetting from the hot jet gun.

\*\*\***END OF SECTION**\*\*\*

**STRUCTURAL STEEL WORKS**

1. **SCOPE**

The work covered by this section, consists of supply of all material, labor, plant, equipment and appliances including welding, bolts, nuts, washers, anchor bolts, embeddedparts etc. fabrication, erection and painting in accordance with the specifications and as per drawings and as directed by the Engineer.

1. **DRAWINGS**

Design drawings shall be prepared by the Engineer and supplied to the Contractor. These shall contain main dimensions, sizes of members, typical details of joints.

Workshop drawings shall then be prepared by the Contractor from the design drawings supplied and submitted to the Engineer for approval. Fabrication shall not be commenced until approval of workshop drawings has beenobtained from the Engineer.

1. **MATERIAL**

Except otherwise stated in the drawings, the material specifications shallconform to the following. Wherever necessary the Contractor may use equivalent alternative material subject to approval of the Engineer.

* 1. Structural Steel

Structural steel for structures shall conform to the requirements of ASTM A-36 or equivalent

1. Steel Forging

Steel forging shall conform to the requirements of ASTM A235.

1. Steel Casting

Steel casting shall conform to the requirements of ASTM A27.

1. Welding

Welding Electrodes for manual shielded metal arc welding shall conform to AWS A 5.1 latest edition or the A 5.5 latest edition. Equivalent locally manufactured electrodes may be used subject to the approval of the Engineer.

1. Common Bolts, Anchor Bolts, Nuts and Washers Bolts and Nuts shall conform to the requirements of ASTM A 307.
2. High Strength Bolts

High strength carbon steel bolts including nuts and washers shall conform to the requirements of ASTM A325 latest editions and of A1SIB18.2

1. Washers

Cut Washers: Shall be of structural grade steel and shall conform to the dimension of the manufacturer's regular standard for plain washers for the size of bolts used.

1. Cast Iron

Shall conform to the requirements of latest edition of ASTM A 48.

1. **FABRICATION**
	1. Straightening of Material

Rolled material, before being worked upon must be straightened within tolerances by ASTM specifications A6 Straightening, necessarily shall be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 1100°F for A514 steel or 1200°F for other steels.

* 1. Cutting as far as possible cutting must be done by shearing. Oxygen cutting shall be done where shear cutting is not possible and shall preferably be done by Machine. All edges shall be free from gauges, notches, or burs. If necessary the same shall be removed by grinding
	2. Holes Punching Drilling. Holes shall be punched where thickness of the material is not greater than the diameter of bolt (+3 mm) where the thickness of the material is greater the holes shall either be drilled or sub-punched and reamed to size. The die for all sub-punched holes and the drillto ailsub-drilled holes shall be at least 1.58 mm smaller than the nominal diameter of the rivet or bolt. Holes for A514 steel plates over 13 mm thick shall be drilled.
	3. Welding
		1. General:

The execution and inspection of welding will be done in accordance with the provisions of the American welding society code for welding in Building construction, D1.0. No welding for piping/electrical supports shall be made transversely to any tension flanges of trusses, beams or columns.

1. Automatic sub-merged Arc Welding:

For all built-up members, i.e. sections fabricated from plates and flat bars or compound rolled sections, plate and box girders, where long continuous, welding is to be done, should be executed by Automatic submerged Arc Welding process in accordance with relevant AWS specifications.

1. Maximum and minimum size and lengths of fillet welds shall be in accordance with AISC specifications.

Surface to be welded shall be free from loose scale, slag, rust, grease, paint or any other foreign matter except mill scale, which withstands vigorous wire brushing.

* 1. Tolerances

A variation of I mm is permissible in the overall length of members with both ends finished for Contact bearing. The bearing surfaces prepared to a common plane by milling.

Members without end finished for contact bearing which are to be framed to other steel parts of the structure shall have a variation from detailed length not greater than (3 mm)

1. **SURFACE PREPARATION/PAINTING**
2. Surface Preparation

All structural steel material i.e. rolled steel sections, plates, pipes, flat bars, chequered plates shall be cleaned free from loose scale, rust, burrs slag, etc. by means of sand blasting.

1. Painting
2. Immediately after surface preparation all material shall be given one prime coat of rust preventive paint.
3. After fabrication one shop coat of prime paint and then one coat of enamel paint shall be applied.
4. One final coat of enamel paint shall be applied after erection of all components.
5. The type of primer and enamel paints to be applied shall be as specified on the drawings.
6. All other requirements for the specified paint system shall be in accordance with the paint manufacturer's specification/ recommendations.
7. The Contractor shall use the best quality of the type of paint specified and shall get the same approved by the Engineer.
8. Steel work/Surfaces not to be painted
9. Steel work to be encased/ embedded in concrete or surface in contact with concrete or grout shall not be painted, but shall be given a cement wash after sand blasting.
10. Machined finished surfaces shall not be painted but shall be coated with rust preventive compound, (approved by the Engineer) immediately after finishing. Such surfaces shall also be protected with wooden pads or other suitable means for transportation. Unassembled pins, keys, and bolt thread shall be greased and wrapped with moisture resistant paper.
11. **INSPECTION AND TESTS**
	1. Manufacturer's Work Test Certificate for all material used shall be furnished by the contractor for Engineer's scrutiny and approval.
	2. Rolling tolerance of all shapes and profile according to AISC shall be in accordance with the provisions of the American Society for Testing and Materials Designation A.6. These shall be checked by the Contractor before being worked upon and shall be rejected if found not within limits.
	3. The Contractor shall arrange for analysis and test of all material rolled locally at a testing laboratory selected by the Engineer.
	4. Inspection of Welding.

The inspection of welding shall be performed in accordance with the American Welding Society specifications, as directed by the Engineer.

1. Rejection

Materials or workmanship not in reasonable conformance with the provisions of these specifications shall be rejected at anytime during the progress of the work or the completion and erection at site.

1. **MISCELLANEOUS STEEL WORKS**

## General

The work covered shall include furnishing, fabricating, installing and painting miscellaneous steel work including the following:

* Steel windows/ventilators Steel louvered doors
* Steel rollup shutter
* G.I. flashing
* Steel gate and steel fence Steel ladders/rungs
* Steel gratings
* Moulded steel sheet door frames Steel railing/fencing
* Steel grill Steel wire gauze

All steel fabricated items shall conform to the drawings, details and instructions of the Engineer. Contractor shall submit detailed shop/erection drawings of the above listed items to the Engineer for approval. Drawing, material, fabrication, surface preparation shall conform to the applicable requirements of relevant clauses of these specifications. Any proposed deviation due to field conditions and availability of local material shall be submitted to the Engineer for approval.

\*\*\* **END OF SECTION**\*\*\*

**BRICK MASONRY**

1. **SCOPE**

The work under this section of the specifications consists of furnishing all plant, labor, equipment, appliances and materials and performing all operations in connection with furnishing and installing brick masonry in position including Portland cement and sand for mortar & masonry, complete in strict accordance with this section of the specifications and applicable drawings and subject to the terms and conditions of the Contract.

1. **MATERIALS**
	1. Portland cement for mortar shall conform to the applicable requirements specified in the section "Plain and Reinforced Concrete".
	2. Sand for mortar shall be furnished by the Contractor and shall conform to the applicable requirements for sand specified in the section "Plain and Reinforced Concrete".
	3. Water used in the manufacture of bricks and in the preparation of mortar shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities, and will be tested and approved by the Engineer.
2. **MORTAR**
	1. Mortar for first class brick masonry, except where otherwise directed by the Engineer, shall consist of one part Portland cement to six parts of damp loose mortar sand by volume and sufficient water to produce proper consistency for the intended use. Where directed by the Engineer for increased workability, hydrated lime putty, approved by the Engineer, shall be added to the mortar but shall not exceed 25 percent, by volume of the dry cement.
	2. Methods and equipment used for mixing mortar be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer. Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of water to the mix shall be rejected. Retempering of mortar shall not be allowed.

The mixers shall be thoroughly cleaned and washed at the end of each day's work.

1. **BRICK**
	1. All bricks, except otherwise specified, shall be of first class quality made from good brick earth, free from saline deposit and shall be hand molded. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges, parallel faces and of deep red or copper color. First class bricks shall be homogeneous in texture and shall emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and modules of lime. First class brick in an oven dried condition shall not absorb more than 1/5 of its weight of water when immersed one hour in water at 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be not less than 2000 psi and not less than 1500 psi for any individual brick.
	2. All bricks shall be manufactured by the Trench Kiln Method or other standard methods approved by the Engineer. The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter. Salts shall not exceed 0.3 percent and calcium carbonate shall not exceed 2.0 percent.
	3. The moulds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. Over-size, irregular and worn moulds shall be destroyed. Each finished brick for brick masonry shall be 9 inch by 4-1/2 inch by 3 inch in size and shall weigh between 3.2 to 4.2 kilograms. All bricks shall have a "frog" 1/4 inch deep on one face.
	4. Samples of the bricks shall be submitted to the Engineer with test reports for his approval. Bricks of approved samples shall only be used in the works. If at any time, during the progress of the work, use of sub-standard material is found by the Engineer, such work shall be rejected and the Contractor shall replace the rejected work at his cost.
2. **PLACING**
	* 1. The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor the use of mixed mortar. Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work. All brick to be used in brick masonry shall be moistened with water for three to four hours before they are used by a method which will ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.
		2. Bricks shall be laid "frog" upward with mortar joints and in English and Flemish bond as shown on the Drawings or as directed by the Engineer. Both bed and vertical joints shall be 1/4 inch in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and re-pointed.
		3. Where shown on the drawing the exterior faces of the walls shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the brick work has been laid and finishing the joint with a pointing tool. Horizontal joints shall be struck to form a weathered joint and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints.
		4. The exposed faces of all brick masonry shall be thoroughly cleaned and left bare with struck joints as specified above.
3. **CURING AND REPAIR**
	1. All brick masonry shall be water cured and shall be kept wet for at least seven days by an approved method, which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements of the Specifications for water used in the manufacture of bricks.
	2. If, after the completion of any brick masonry work, the brick is not in alignment or level, or does not conform to the lines and levels shown on the Drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.
4. **SCAFFOLDING**

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the Engineer shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor in the unit rate for masonry items.

Damage to masonry from scaffolding or from any other cause shall be repaired by the Contractor at his own cost.

1. **TOLERANCES**

All brick work shall be erected plumb and true to line and level with maximum variation in any storey height or any length of wall being one mm in one meter. The maximum tolerance in the length, height or width of any single masonry unit shall be ± 1/8 inch.

1. **DAMP PROOF COURSE**
2. **In walls - Horizontal Application**

All damp proof course unless otherwise specified shall consist of class 'C' cement concrete 2 inch thick shall be laid at required levels as per drawings and instructions of the Engineer. The D.P.C shall be tamped, consolidated, levelled and edges and corners made to the requirements of the relevant drawings including finishing and curing complete. After the DPC has dried apply two coat of bitumen 10/20 grade @ 20 lb. /100 sq.ft.

1. **In walls - Vertical Application**

A damp proof course shall be applied if shown on the drawings, on wall below plinth shall consist of cement sand plaster (1:6) ¾” thick shall be applied on walls below plinth on interior and exterior faces as shown in the drawings or as directed by the Engineer. After a curing period of 3 days, hot bitumen 10/20 grade be applied on dried surface of mortar @ 20 Ib./100 sq.ft. in two coats.

1. **Under Floors**

A damp proof course if shown on the drawings shall be applied under the floors in the same way as specified under walls-horizontal application.

**\*\*\* END OF SECTION\*\*\***

**CARPENTRY AND JOINERY**

1. **SCOPE**

The work covered under this section of Specifications consists of providing all material, labor, plant, equipment, appliances and performing all operations connected with the fabrication and erection of all woodwork, mill work, construction assembly, surface finish treatment and building in of all cabinet type items, supports etc. of wood or metal and incidentals, associated woodwork appurtenances, procuring and applying preservatives, installation of "Finish Hard Ware" in connection with finish woodwork as per details shown on the Drawings or as directed by the Engineer. The scope of this section is covered with detailed specifications as laid down herein.

1. **APPLICABLE STANDARDS**

Latest editions of following British and ISO Standards are relevant to these specifications wherever applicable.

1. ISO (International Organization for Standardization)

1891 Bolts, screens, nuts and accessories-Terminology and nomenclature.

1097 Plywood - Measurement of dimensions of panels.

1098 Veneer ply wood for general use-General requirements.

2427 Veneer ply wood with rotary cut veneer for general use-Classification by appearance of panels with outer veneer of beech.

2429 Ply wood - Veneer ply wood with rotary cut veneer for general use-Classification by appearance of panels with outer veneers of brand leaved species of tropical Africa.

3804 Ply wood-Determination of dimension of test pieces

3805 Ply wood-Determination of density,

3806 Ply wood-Determination of moisture content

6442 Door leaves-Measurement of defects

6443 Door leaves-Measurement of dimensions and of defects of squareness.

6444 Door leaves-Test of behavior under humidity variations

1. **BSI (British Standards Institution**)

459 Wooden doors.

1186 Quality of timber and workmanship in joinery.

1127 Hinges

1331 Builder's hardware for housing.

1567 Wood door frames and linings nails.

1202 Nails

1203 Specifications for synthetic resin adhesive for plywood.

1204 Synthetic resin adhesives for wood.

1282 Guide to choice, use and application of wood preservatives

1494 Fixing accessories for building purposes.

1579 Connectors for timber.

3842 Treatment of ply wood with preservatives.

1. **MATERIALS**
	1. **Timber**
* All wood shall consist of cedrous deodar (referred in the document as deodar) having density of 500-600 kg/m3.
* Wood locally known as 'Partal' to be used in framing where specified.
1. **General Characteristics**

All the timber shall be in accordance with the requirements of BSI No: 1186, ‘Quality and Workmanship in Joinery’.

The whole of the timber shall be from the heart of sound and fully grown tree, uniform in substance, straight in fibber, first class quality properly seasoned, free from large or loose dead knots, open shakes and excessive sapwood. The scantlings of all timbers shall be bright, sound and square edged. The moisture content of timber shall not be more than ten (10) percent.

1. **Preservation of Wood**

Prior to installation of all finish wood works in their respective positions, preservatives shall be applied to safeguard the woodwork against fungus, termite and bores.

The preservatives shall be of the best available quality of solignam oil (clear) as approved by the Engineer. The method of application shall be strictly in accordance with the manufacturer's instructions. The treatment and application of all the preservatives shall comply with the requirements of BS-CP 98:1964.

1. **Adhesive:**

The adhesives shall conform to the requirements of BSI No. 745 "Animal Glues for Wood" or as directed and approved by the Engineer.

1. **Nails and Screws:**

All nails and screws shall comply with requirements of BSI NO. 1202 and BSI NO. 1210 respectively.

1. **Ply Wood**
	1. The plywood shall comply in all respects with BSI No. 1455:1963. All the plywood shall only be obtained from manufacturers approved by the Engineer.

Plywood used for doors, paneling and other similar works shall be to the thickness and size as shown on the Drawings or as directed by the Engineer. The grade shall be first quality and the face and back shall be free from end joints, dead knots, overlaps, patches and other surfaces shall be free, smooth for painting or polishing.

* + 1. The veneer shall be of the required thickness and quality including base veneer and shall be impregnated with an approved adhesive and machine compressed. Such machine pressed veneered wood shall be fixed on all sides of the inner core wood (softwood of approved quality) after it has been treated with water resistant hot setting glue.
1. **SAMPLES**

All samples of the material used for the work under this Section of Specification shall be approved by the Engineer and same type of material shall be used throughout the work. If the Engineer desires to get the material tested, this will be done by the Contractor at his own cost from a laboratory approved by the Engineer.

1. **FABRICATIONS**
2. **General**

Unwrought' timber shall be used. Sawing shall be done true to the size and dimensions to finally meet the requirements of specified sizes and dimensions of the finished work.

All framing shall be joined as shown on the Drawings or as directed by the Engineer. All joints shall be secured with sufficient number of nails. The Contractor shall perform all necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating and all operations required for the correct jointing. The Contractor shall also provide all metal plates, screws, nails and other fixing material that may be ordered by the Engineer for the proper execution of the joinery work. Fabrication that develop defects due to bad workmanship or unsound materials not conforming to these specifications and the directions of the Engineer, shall be cut out and replaced at Contractor's own expense before the expiry of the maintenance period.

* 1. **Doors**
		1. Verify design and size of doors required for each opening. Door thickness shall be 40 mm (1 1/2 inch.) unless otherwise indicated.
1. Fabricate flush wood doors in accordance with the following requirements.

### Cores

Edging of doors and shutters shall be of wood as shown on the drawings and cores shall be Partal wood (solid core) planed to a smooth uniform thickness. All doors and shutters shall have Deodar wood lapping on all edges as per details shown on the drawing.

## Face Panels

* Door facing on each side of door shall consist of plywood have total minimum thickness of 1/8 inch. before sanding.
* Door plywood shall be bonded to each other, and to core unit with approved adhesive and machine compressed.
1. **PROTECTION OF MATERIALS**

All materials and assembled units shall be protected from weather and stored in such a way as to prevent decay and attack by fungus and termites.

1. **WOODEN DOORS & DOOR FRAMES**
2. **Materials**
	1. First class Deodar wood as approved by the Engineer shall be used for the doorframes and full/half glazed and paneled shutters.
	2. The plywood and veneering shall be of selected best quality as approved by the Engineer.
3. **Exterior and Interior Door Frames**

All exterior and interior door frames shall be constructed 18 SWG MS sheet or of wood as shown on the drawings.

The door frames shall be secured in place by means of mild steel anchors welded/screwed in place and built into the masonry as it is being constructed. There shall be one such anchor near the top and bottom of each jamb but not over 900mm intervals between the top and bottom anchors.

1. **Exterior and Interior Wooden Doors**

The Engineer shall unless otherwise shown or specified, of the paneled type, flush and type as shown on the Drawings or as direct the exterior and interior wooden door.

**All the door shall conform to the following requirements:**

Paneled doors shall be constructed in accordance with the requirements of Part I of British Standard Specification No. 459 with the additional requirements that panels in exterior openings shall be assembled with waterproof glue, glued tacked in place. Flush door shall comply with BSI 459 Part-2 and shall consist of solid core 40mm *(1 1/2* inch.) thick shutters as shown on drawings.

1. **Door Shutters**

The shutters will be fixed to the frames with approved quality hardware schedule.

* + 1. All doors, shutters shall be fabricated in a workman- manner strictly to the correct sizes and shapes as shown on the Drawings or as directed by the Engineer.
		2. The door shutters shall have solid core as shown on the Drawings. It shall be built in sections, properly jointed and glued together, both sides being covered with plywood of the required thickness and approved quality. The surfaces shall be prepared for painting or polishing.
		3. The arrangements of inner core for solid shutters shall be approved by the Engineer. It shall be so adjusted that circulation of air is free and uninterrupted. Minute holes shall be provided in edges at suitable places to admit and exit air.
		4. Each door shall be constructed so as to permit the installation of hinges, knobs and locks in the position shown on the Drawings.
	1. Completed doors shall be sound, rigid and free from defects and warp. All edges shall have Deodar wood lipping and shall be aligned and smooth, joints shall be close fitting, hard wood doweled or mortised framed and of strength to maintain frame and of strength to maintain the structural properties of the member connected. All adjoining edges and faces shall be flush and smooth. Edges shall be rectangular and solid
1. **Fitting. Hanging and trimming**

All the doors shall be fitted, hung and trimmed as hereinafter specified and as indicated on the Drawings.

Doors shall have a clearance of 4 mm at sides and top unless otherwise directed by the Engineer and shall have 5 mm clearance at bottom. Doors shall be hung and trimmed with hardware as specified. All the locks shall be installed at the same height and shall be located at height as directed by the Engineer.

##### Hardware

Hardware shall be of approved quality and first class finished material. The Contractor shall obtain prior approval from the Engineer for quality; shape and pattern of ail the hardware materials by providing samples and shall provide and fix only the approved hardware materials.

Hardware shall be carefully and securely fitted. Upon handing over the work, hardware shall be demonstrated to operate freely. Keys shall be placed into respective locks and upon acceptance of the work keys shall be tagged and delivered to the Employer.

1. **Quality Assurance**
	* 1. **Tolerances: Doors shall be fabricated to following tolerance**
* Size: Plus or minus 1.6 mm overall dimensions
* Maximum Wrap: 3mm
* Squareness: Maximum diagonal difference 3mm (between length of diagonal measured on face of door from upper right corner to lower left corner and length of diagonal measured from upper left corner to lower right corner).
1. **Submittais**
	* + 1. Provide shop drawings showing door types, details and locations, referred to the door type and hardware group shown on door and hardware schedules.
			2. Provide certificates stating that doors were constructed timbers of the species specified having moisture content and meeting equilibrium and relative humidity requirements
			3. Submit samples of face veneers for selection of color and pattern.
2. **Product Delivery, Storage and Handling**
	* + - 1. Keep products dry, stack products off ground on level platforms, fully protected from weather, including direct sunlight.
				2. Identify type, size and location of each door in order to permit installation at correct location.
3. **Installation**
4. Install doors at correct openings and assure smooth swing and proper closer with frames.
5. Install finishes hardware in accordance with manufacturer directions.
6. **KITCHEN CABINETS/WOODEN**

# CABINETS/WARDROBES/DRESSERS/SHELVES/SEATS

All cabinet/wardrobes/dressers/shelves/seat including fittings, fixtures and hardware’s shall be supplied of approved manufacturer and shall be of best quality fabricated by using materials and details as shown on the drawings.

1. **Installation**

All cabinets, wardrobes and shelves/seat shall be installed in position by the skilled workmen specialized in the job. Works shall be executed in accordance with drawings and the Engineer's instructions.

The Contractor shall inspect delivered cabinets, wardrobes seats and shelves and related parts for indication or location, size required by field measurements, finishing hardware and similar preliminary works. Verify locations for installation, required floor and wall finishes, painting and all other related work. Cabinets/wardrobe, shelves and seats shall exactly flush the floor and wall surfaces. Cut and fit accurately scribe strips at wall surfaces and bases. Secure wall cabinet to blocking. Concealed fasteners all joints surfaces shall be smooth and even. Doors and other moving parts shall exactly fit in the frame. Refit, as necessary, to ensure proper and easy operation. Refit, if necessary, all cabinet, wardrobes and shelves hardware, test for proper operation, remove for painting and other finishing and properly replace in position with all fittings and accessories.

All work shall be thoroughly protected from damage at all times by suitable methods approved by the Engineer. Adjacent works shall similarly be protected from damage. Any damage or disfigurement shall immediately make good at Contractor's expense.

1. Cabinet work will be coordinated with Employer supplied items (if any) such as cooking range etc.
2. Kitchen cabinet work, generally al! Framing will be in treated Deodar wood with portions' etc., in best quality commercial plywood. All exposed surfaces will be covered by approved laminates. Exposed edges, if any, will be covered by polished Deodar wood lipping. Where approved counter tops for kitchen will be specified thick selected marble on painted M.S. framing.

Best quality hinges, metallic drawer guides (with bearing) and handles will be used. Samples and shop drawings to be approved by Engineer.

###### Wardrobes

Wardrobes (and similar works) will be made of deodar wood. Internal partitions will be as shown on the drawings. Shutters will have a (deodar wood) louvered front backed by laminated plywood. All louvers and exposed deodar wood edges/faces will be polished. Best quality hinges metallic drawer guiders (with bearing) handles locks catches etc., will be used. Shoe rack (inside wardrobe) will consist of 13mm dia (hollow) chrome plated M.S. rods. Samples and shop draw to be approved by the Engineer.

1. **DEFECTIVE WORK**

In the event of non-conformance to specification and drawings, the wood works shall be rejected by the Engineer and the Contractor shall remove and replace the rejected work by new work of same specifications.

1. **SURFACE PREPARATION**

The surfaces of all wood works shall be prepared in the manner as directed by the Engineer for polishing and painting.

1. **MOCK-UP SAMPLE**

After approval of shop drawings and tests etc., the contractor shall submit at his own cost one mock-up sample of each type of wood works complete with all fittings/fixtures accessories prior to the actual fabrication of the bulk.

The samples shall be returned to the Contractor for incorporation in the works after installation of at least 80% of the works.

\*\*\* **END OF SECTION** \*\*\*

# ALUMINIUM WORKS

1. **SCOPE**

The work under this section of specification includes furnishing all labor, equipment, appliances and materials and performing all operations in carrying out the work of anodized aluminum doors, windows (other than curtain wall type doors and windows) ventilators, louver and fly screen. All related items such as sealants, rubber gasket for glazing, netting, rollers, latches, fastenings, glazing, anchor bolts and all items supplied by other trades and customarily built in and/or installed in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

1. **APPLICABLE STANDARDS**

Latest editions of following ISO and British Standards are relevant to these Specifications wherever applicable.

* 1. **ISO (International Organization for Standardization**

|  |  |
| --- | --- |
| 1804 Doors6442 Door Leaves6443 Door Leaves6444 Door Leaves6612 Windows & Doors6613 Windows & Door | * Terminology
* Measurement of defects of general flatness,
* Measurement of dimensions and defects of squareness.
* Test of behavior under humidity variations (successive uniform climates)

Wind resistance tests* Air permeability test.
 |

* 1. **BSI (British Standard Institution)**

|  |  |
| --- | --- |
| 12274873 | * Hinges
* Aluminum alloy windows
 |

1. **GENERAL**
	1. Aluminum doors and windows shall be of profile, pattern and design shown on drawings and manufactured by reputable manufacturer approved by the Engineer. The contractor shall provide manufacture literature completely describing the product, instructions for installation and maintenance.
	2. All the sections used for doors, windows, ventilators & fly screens shall be of best quality aluminum products such as equal and unequal angles, channels, tubes, corrugated strips, moldings etc., in accordance with International standards conforming to ASTM B308&B221.
	3. All doors windows & ventilators shall be of type and size indicated on drawings and shall conform to the requirements shown and specified herein.
	4. Contractor shall arrange tests and analysis if directed by the Engineer of scaled models of each window type at the maker's works or any laboratory specified by the Engineer for the material supplied by him to be tested in the presence of the Engineer's Inspector, to whom test certificates, proof sheets, etc. shall be furnished. The models shall be submitted to the Engineer for approval prior to testing. Nevertheless, neither the fact that the materials have been tested in the presence of the inspector nor that the Engineer may have been furnished with test certificates in lieu of sending an inspector to the works shall affect the liberty of the Engineer to reject, after delivery of materials found not in accordance with these specifications.
	5. The contractor shall submit shop drawings, which shall show full construction details, quantities and locations, fastenings and attachment to adjacent construction and materials. Shop drawings shall be submitted at the proper time to allow for checking, revisions, and agreement and to permit manufacturer's product delivery and start of site work to suit the building program. The Contractor shall submit representative samples of finished windows, anchoring mechanism, embedded parts, fastenings, glass panes, accessories and other materials for the Engineer's approval.

After approval of shop drawings and tests etc., the contractor shall submit at his own cost one mock-up sample of each type of aluminum works complete with glazing, all component assemblymethod and required fittings and accessories prior to the actual fabrication of the bulk. The samples shall be returned to the Contractor for incorporation in the works after installation of at least 80% of the works.

Fabricate and assemble all work in the shop of the approved manufacturer to reduce field fabrication to a minimum unless otherwise directed by the Engineer.

1. The glass shall conform to specification laid down under section 'Glazing' and shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to size as shown on drawings, so as to fit the grooves in door and window members. All the glass shall be best quality of approved manufacture.
2. The structural shape of the Aluminum members shall be of uniform quality, color and temper, clean, round, commercially straight and free from injurious defects.
3. All doors, windows and ventilators shall be fabricated as a complete unit, fully airtight and watertight, including rubber gasket for glazing, rollers, latch, anodized in specified color, inclusive of glass sheet, necessary holes for fixing, door locks, door closures and window locking requirements, all as approved by the Engineer.
4. Contractor shall, on request, get certificate signed by the manufacturer stating that each lot has been sampled, tested and inspected and has met the requirements in accordance with these specifications, and the same shall be furnished to the Engineer.
5. **MATERIAL**
	1. **Frames/Shutters**

The frames/shutters of anodized aluminum doors, windows, ventilator and louvers shall be formed from rolled, strip or extruded aluminum and be as per drawing. Fastening bolts and screws shall be made from hardened aluminum.

* 1. Fasteners shall be stainless steel of a type selected to prevent galvanic action with the components fastened.
	2. Gaskets shall be vinyl glazing channel gaskets to commercial standard CS-230-60.
	3. Hardware shall be manufacturer's standard match door and windows finish.
	4. Joint sealant shall be approved elastomer.
	5. The finish shall be in approved color in accordance with the standards of Aluminum Association.
	6. Minimum coating should not be less than 23-25 micron.
1. **WORKMANSHIP**

The Contractor shall be responsible for the protection and installation of all items furnished. All items shall be installed plumb and square and shall be solidly anchored in a good workman like manner in accordance with the manufacturer's instruction and as specified herein. The Contractor shall be responsible for the protection of installed items from damage by other trades. All items shall be left in operating, neat and clean condition, free from dirt, finger marks, etc. The Contractor shall be responsible for final cleaning before the final acceptance.

The glass panes shall firmly be secured in the rebates with the rubber gasket. Ensure that the beads and grooves are clean, dry and unobstructed at the time of glazing. The complete unit shall be airtight and watertight on completion. No doors windows ventilator louvers shall be considered complete until and unless the fingerprints and other stains and marks have been removed from the surface of glass and aluminum.

1. **PRODUCT DELIVERY AND STORAGE**
	1. Deliver doors, windows, ventilator and louvers in a manner preventing damage to units. Store materials off the ground under cover in a manner preventing deterioration or damage.
	2. All embedded parts and anchor bolts shall be delivered to the site carefully and keeping the fabricated shape and configuration. All these parts shall be suitably marked for identification.
2. **ERECTION**

Raw plugs and anchoring bolts shall be embedded into the concrete or block masonry for holding the doors, windows, ventilators and louvers in their correct positions.

Care shall be taken to install the doors and windows, ventilators and louvers in line and plumb & solidly anchored in a good workman like manner in accordance with the drawings. Should any scale or scratch appears on the surface of doors, windows, ventilators the contractor shall at his own expense and louvers the contractor shall at his own expenses and at the Engineers direction have all exposed surfaces cleaned to bare bright specified color.

All works shall be installed in strict accordance with the manufacturer's instructions.

1. **PROTECTION AND CLEANING**
	* 1. Temporary protection shall be achieved by applying water-soluble protective coating capable of withstanding the action of lime mortar.
		2. Apply coating in the manufacturer's plant to the exposed surfaces of all components.
		3. Before application of coating, remove all fabrication compounds, moisture and dirt accumulations.
2. **DEFECTIVE WORK**

In the event of non-conformance to specifications and drawings the aluminum work shall be rejected by the Engineer and the Contractor shall remove and replace the rejected works by new work of same specifications.

1. **GUARANTEE**
2. The manufacturer shall furnish his standard written guarantee against leakage of rain, excessive infiltration of dust and air and all defects in materials and workmanship covering all work under this section.
3. Such guarantee shall be in addition to and not in lieu of all other liabilities, which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.

\*\*\* **END OF SECTION** \*\*\*

GLAZING

## SCOPE

The work under this section of the Specifications consists of furnishing all labor, equipment, tools, appliances, scaffoldings and providing glass gaskets, sealants, compound and other materials required for performing all operations in connection with the installation and setting of all types of glass, glazing and glass blocks complete in every respect in accordance with the Drawings or as directed by the Engineer. The scope of this section of Specifications is covered with detailed Specifications as laid down herein.

1. **APPLICABLE STANDARDS**

Latest editions of following British Standards are relevant to these specifications wherever applicable.

1. **BSI (British Standards Institution)**

### 952 Glass for glazing

 5051 Security glazing Part I & I)

###  CP.152 Glazing

1. **GENERAL**
	1. Glazing sealant shall be as recommended by the manufacturer for the particular application.
	2. Spacer shims (distance pieces) shall be elasticized polyvinyl chloride (PVC). Thickness shall be equal to space shown on drawings between glass and rebates, bead or cleat. Depth shall give not less than inch cover of glazing sealant.
	3. Contractor shall submit samples for each type of glass, minimum 4 ft. x 4 ft. in size with protective edges. Samples of glazing sealant minimum 0.1 liter of specified types shall be submitted. Samples of minimum of three glass blocks shall also be submitted.
	4. Contractor shall submit 1 feet long sample of each type of glazing gasket.
	5. Contractor shall also submit printed materials manufacturer's installation instructions for specified glazing gaskets, compounds sealants and accessories including description of required equipment and procedures and precautions to be observed.
2. **DELIVERY STORAGE AND HANDLING**
	1. Contractor shall deliver materials in manufacturer's original, unopened containers clearly labeled with manufacturer's name and address, material, brand, type, class and rating as applicable.
	2. Contractor shall store the materials in original unopened containers with labels intact/protected from ground contact and from elements which may damage glass.
	3. Contractor shall handle the materials in a manner to prevent breakage of glass and damage to surfaces.
3. **MATERIALS**
	1. **General**

Glass shall be free from all blemishes, bubbles, distortions and other flaws of any kind and shall be properly cut to fit the rebates so as to have a uniform clearance of 1.6 mm round the panes between the edges of glass and the rebates. All glass shall be best quality from reputable manufacturer (USA/Sweden) as approved by the Engineer.

1. **Glass**
	1. **Tinted/Plain Glass (Local)**

Glass for windows, and ventilators and louvers shall be of specified thickness of approved quality.

1. **Glazing Sealants and Compounds**

Contractor shall provide material colored to match frame in which glass is installed. Provide only compounds known to be fully compatible with surfaces, which they will contact as follows:

* + 1. Two component polysulfide glazing sealant.
		2. One component acrylic glazing
		3. Acrylic-latex glazing sealant consisting of modified latex rubber and acrylic emulsion, non-hardening, non- staining and non-bleeding.
		4. Cleaners, Primers and sealer as recommended by the sealant manufacturer.

# Accessories

* + - 1. **Glazing Sealant**

It shall be tape or ribbon of polymerized butyl or mixture of buty 1 and polyisolbutylene compounded with inert fillers and pigments, solvent based, 95 percent solids thread or fabric reinforced, paintable, non- staining.

1. **Setting Blocks**

It shall be chloroprene (Neoprene) 70 to 90 durometer hardness, compatible with sealant used, channel shaped and of the necessary height for proper perimeter clearance.

1. **Channels. Gaskets, and spacer's**

It shall be chloroprene (Neoprene), 40 to 50 durometer hardness compatible with sealant used.

1. **INSTALLATION OF GLAZING**
2. Glazing shall comply with the recommendations of glass and glazing materials manufacturers.
3. Examine each piece of glass and discard and replace glass with edge damage or face imperfection. All glazing shall be wind tight and fully water tight on completion.
4. Clean glazing channels and other framing members indicated to receive glass. Remove coatings, which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are to be used. Apply primer and sealer to joint surfaces wherever recommended by the sealant manufacturer and as shown on the drawings.
5. Trim and clean excess glazing materials from surrounding surfaces immediately after installation and eliminate stains and discolorations.
6. Cure glazing sealants and compounds in compliance with manufacturer's instructions to obtain high early bond strength internal cohesive strength and surface durability.
7. While glazing operation is in progress care shall be taken to avoid breakage or damage to the glass and adjoining glazing. The Contractor shall make good at his own cost, all glass broken by his workmen while cleaning or carrying out other operations. On the completion of the glazing work, all glass that has been set by the Contractor shall, if it becomes loose, within the maintenance period, be refixed at Contractor's expense.
8. No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass ad checked by the Engineer for water tightness.
9. **PROTECTION AND CLEANING OF GLAZING**
	1. Remove all smears, labels and excess glazing sealant, leave clean inside and outside free from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with new glass at no additional expense to the Employer.
	2. All glass surfaces shall be washed clean both inside and outside within two weeks prior to final acceptance by the Employer.

**\*\*\* END OF SECTION \*\*\***

**WATER PROOFING & BUILT-UP ROOFING**

1. **SCOPE**

The works under this section of the Specifications consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in any floor and at any height in connection with installation of insulation, water-proofing and built-up roofing, including water proof treatment to foundations and basement structures complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

1. **SUBMITTAL**
	1. Shop Drawings: Shop drawings showing layout and all the details for construction.
	2. Samples of all materials proposed for use under this section shall be submitted to the Engineer for approval.
2. **MATERIALS**
	1. Bitumen 10/20 grades.
	2. Polyethylene buildings film visqueen standard or approved equal. The film shall be 0.008 inches thick.
	3. Cement and aggregates shall be in accordance with specifications Section 2300 for "plain and reinforced concrete".
	4. Mud mortar composed of stiff clay mixed with an equal bulk of chopped rice husk/bhoosa.
	5. Brick ties conforming to specifications section 4200.
3. **DELIVERY STROAGE AND HANDLING**

Materials shall be protected from damage during loading shipment delivery and storage non-staining materials shall be used for blocking and packing.

1. **PREPARATORY WORK**
	1. All scuppers and roof drains shall be placed and metal flashing, cant strips flanges etc. shall be provided in time to be installed along with the roofing assembly.
	2. All surfaces, to be treated shall be dust free and dry. Application of roof finishes shall not start unless the preparatory work has been inspected and approved by the Engineer.
2. **APPLICATION OF ROOFING**
	* 1. Roofing shall not be applied during rain or while surfaces are damp, it shall be applied only to surfaces that are clean and dry.
		2. Mopping of surface with bitumen shall be performed so that the surface shall be completely covered. Coats of bitumen shall be as specified in drawings. All bitumen shall be applied with mops except that the hot surfacing application shall be poured from a dipper.
		3. Polyethylene sheet shall be laid in position wherever shown in drawings. Where joint is necessary at the side or end of the sheet, this shall be a double weld folded joint made by placing the edges together and folding over twice continuously taking the top edge prior to plastering or screeding. The contractor shall protect the sheets from damages during laying and subsequent operation and shall replace at his own cost all damaged sheets to the satisfaction of the Engineer.
		4. Mud mortar/concrete screed of specified thickness as indicated on drawing shall be laid in slope.
		5. Brick tiles of specified size laid over prepared base to be grouted and flush pointed with cement sand mortar.
3. **WATER PROOFING & BUILT UP ROOFING**

The water proofing treatment to reinforced cement concrete roof slabs shall be done as specified and as indicated on the drawings.

\*\*\* **END OF SECTION** \*\*\*

# CEMENT PLASTER

1. **SCOPE**

The work under this section of the Specifications consists of furnishing all plant, labor, equipment, appliances, and materials and in performing all operations in connection with providing and installation of cement plaster, and specified external rendering complete in strict accordance with this section of the Specifications and the applicable drawings and subject to the terms and conditions of the Contract. The scope of this section of Specification is covered with detailed Specifications as laid down herein.

1. **APPLICABLE STANDARDS**

Latest editions of following Pakistan, British & ASTM standards are relevant to these specifications wherever applicable.

1. **Pakistan Standard**

PS 232 Ordinary Portland Cement

1. **ISO (International Organization for Standardization)**

R 597 Definitions and terminology of cement.

R 679 Method of testing strength of cements, compressive and flexural strength of plastic mortar (Rilem - (embureau method).

R 680 Chemical analysis of cement & main constituents of Portland Cement.

R 681 Chemical analysis of cements-mixer Constituents of Portland cement.

R 682 Chemical analysis of cements - determination of sulphur as sulphide.

1. **ASTM (American Society for Testing and Material)**

C 144 Aggregate for Masonry mortar

C 631 Bonding compounds for interior plastering

1. **BSI (British Standards Institution)**

812 Methods for sampling and testing of mineral aggregates, sands and fillers.

1199 Sands for external renderings Internal plastering with lime and Portland cement and floor screeds.

1. Metal lathing (steel) for plastering.
2. External rendered finishes.

5492 Internal plastering.

1. **GENERAL**
2. Except as may be otherwise shown on surfaces specified, all plaster work, both internal and external shall be Ordinary Portland Cement plaster of the required thickness as shown on the drawings.
3. Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the Contractor to make sure that other contractors carry out all such work before starting of plasterwork. Chiseling and repairing of cement plaster shall not be permitted without the approval of the Engineer.
4. Sample of materials shall be submitted to the Engineer for his approval prior to use in the works.
5. **MATERIAL**
6. Cement for plaster shall be Ordinary Portland Cement (BS 12 or PS 232) or Sulphate Resisting Cement (BS 4027 or P.S. 612) as specified and shall conform to requirements specified in the section "Plain and Reinforced Concrete".
7. Sand for plaster shall comply with the requirements of BS 1199, BS 1200 or the Pakistan Standard "Sand for Plaster" as directed by the Engineer.
8. Water for plaster shall conform to requirement section for "Plain and Reinforced Concrete"
9. All materials and workmanship for plaster not explained in these Specifications, shall comply with the requirements of relevant BS CP 211 and CP 221 as directed by the Engineer.
10. External rendered finishes should comply with appropriate clauses of BS 882.

**PROPORTIONING AND MIXING**

1. Measurement of materials by volume shall be by containers of known capacity to maintain consistent proportions. No lumpy or caked material shall be used. Mixing equipment boxes and tools shall be clean. Materials shall be proportioned as specified on the Drawings or as directed by the Engineer. Mixing shall be continuous until all ingredients are evenly distributed and thoroughly mixed. Only limited water shall be added for proper workability and such quantity of mortar shall be prepared which can be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other time more than that stipulated above is expressly prohibited. Retempering shall not be permitted and all mortar, which has begun to stiffen, shall be discarded.
2. Plaster ingredients shall be thoroughly mixed either by hand on a clean cement concrete platform or by a mechanical mixer, as directed by the Engineer.
3. Water Proofing Plaster 3/4 inch. (20mm) thick 1:4 cement sand plaster mixed with approved water proofing agent.
4. **PREPARATION OF SURFACE TO BE PLASTERED**
5. Concrete surface to be plastered shall be cleaned to remove all grease, form oil and other surface impurities, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface of all concrete ceilings, beams and columns shall be lightly hacked by approved means to give the required key for plastering.
6. All masonry surfaces to be plastered shall be cleaned to remove all matter which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface shall be washed with clean water and kept damp for 24 hours before further surface thus prepared shall be treated uniformly cement and sand slurry. The slurry to be used shall be one part cement to one sand by volume with water added to make a stiff creamy mix. Spatter dash of slurry shall be applied on surface to receive plaster and be left to cure for three days.
7. **APPLICATION OF PLASTER**
8. The plaster shall not have wavy surface and shall be perfectly in plumb. The edges and corners shall represent a straight line. The plaster shall be kept wet continuously for at least ten (10) days. No extra payment shall be allowed for jambs, junctions, corners, edges, round surfaces or plaster required due to any unevenness in the work done by the Contractor. The plaster work is to cover all conduits, pipes etc fixed in the walls and ceiling. Wherever specified, metal lath shall be nailed firmly before plastering is commenced. The plaster surface shall be tested frequently with a 10 ft. (3 meter) straight edge and plumb bob.
9. Plaster containing cracks, blisters, pits, discoloration or any defects shall not be acceptable. Any plaster giving hollow sound or loose plaster shall be removed and replaced with plaster in conformity with these specifications and as additionally directed by the Engineer.

Contractor shall cut out and patch all defective work at his own cost. All damaged plaster shall be patched as directed by the Engineer. Patching plaster shall match appearance of and shall be finished level with adjoining plaster.

1. **CLEANING AND PROTECTION**
2. Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer. As each room or space is completed al! Rubbish, debris, scaffolding and tools should be removed to leave the room clean.
3. Prior to plastering all aluminum windows, finished metals should be covered by sheet of plastic or tarpaulin to protect it from damage.
4. Protect finished plaster from injury by any source. Contractor shall also protect walls, floors and work of other trades from plaster materials.
5. **TOLERANCES**

Surfaces of plaster work shall be finished with a true plane to correct line and level unless otherwise specified and with walls and reveals plum and square

Maximum permitted tolerances shall not exceed 1/8 inch.(3mm) in 6ft. (2 meter) variation from plumb or level in any exposed line or surface and 1/16 inch.(1.5 mm) variation between planes of abutting edges or ends.

\*\*\* **END OF SECTION** \*\*\*

# MARBLE WORK

1. **SCOPE**

The work under this section of specifications, consists of providing all material, labor, plant, equipment, appliances and performing all operations required for providing and installing marble natural stone slab and tile finishes in floor and special aglow marble stone in floor & skirting, where shown on the drawings, complete in strict accordance with this section of the specification and the applicable Drawings.

1. **SUBMITTALS**

Submit three range samples 12"x12" in size of each type of marble showing color, grade, finishing and texture for approval.

1. **DELIVERY, STORAGE AND HANDLING**

Materials shall be protected from damage during loading, shipment, delivery and storage. Non-staining materials for blocking and packing shall be used. Stack marble units at site in accordance with manufacturer's recommendations and as required to prevent staining, scratching, etching or breakage.

1. **MATERIALS**
	1. **General**

The marble/stone work of all types should be consistent in type, color range and texture.

Provide slabs or tiles of specified sizes in floor and wall areas as shown on drawings.

Provide marble/stone of specified thickness. Saw-cut the back surfaces that are meant to be concealed in finished work.

Provide irregular shaped units, staircase units and skirting base units to the profiles of required, with arises sharp true and matched at joints, polish exposed edges.

1. **Marble/Stone Type**

All marble/stone types are to be selected and approved by the Engineer for quality, color and texture as:

1. Marble of local origin, first class quality and high class finish acceptable to the Engineer.
2. Stone: As approved by the Engineer.
3. **Beds and Backings**

Where applicable, standard cementitious screed and mortar beds and backings, mixed and proportioned by volume shati be as follows:

Grey ordinary Portland Cement: 1 part

Sand: 4 parts

Water: Clean, fresh and free from delerterions substances.

1. **Adhesives. Grouts and Sealants**

Proprietary adhesives, joint grouts and sealants of approved type as required and recommended by the manufacturer for specific application shall be used. The color of the joint grout and the sealants shall match with the color of stone/marble.

1. **EXECUTION**
2. **Flooring, Skirting and Stair**

Apply cement slurry coat over surfaces of concrete substrate immediately prior to placing setting bed. Limit area of application to avoid premature drying out. Install setting bed of required thickness and set marble/stone units before initial set occurs. Apply a thin layer of cement paste to bottom of each unit. Set, tamp and level units immediately. Set units in required pattern with uniform joint widths.

Joints as soon as possible after initial set. Force grout into Joints, strike flush and tool slightly concave.

Remove mortar and grout from surfaces while still moist and as the work progresses. Do not permit traffic on finished surface during setting and for a minimum of 24 hours after final pointing of joints

1. **Repair and Cleaning**

Remove and replace marble/stone units, which are broken, chipped, stained or otherwise damaged. Where directed, remove and replace units, which do not match adjoining stonework or are not in line and level as shown on Drawings. Provide new matching units, install and point joints to eliminate evidence of replacement. Repoint defective and unsatisfactory joints to provide neat, uniform appearance.

Clean stonework not less than 6 days after completion of work, using clean water and bristle brushes. Do not use wire brushes, acid or caustic type cleaning agents or other cleaning compounds which may be detrimental to the marble/stone finish or joint grout.

* 1. **Protection**

Provide covers, boards, supports and all other necessary materials to protect finished work from collapse, deterioration, discoloration or damage during installation and until contract completion.

1. **Polishing**

The finished surface shall be provided with two applications of approved wax polish or as approved by Engineer.

\*\*\* **END OF SECTION** \*\*\*

# FLOOR AND WALL FINISHES

1. **SCOPE**

The work under this section of the Specification consists of furnishing all plant, labor, equipment, appliances and materials and performing all operations in connection with the installation of cement concrete floors and floor finishes including bases, skirting and Dado, complete in strict accordance with this section of the specifications and the applicable drawings.

1. **APPLICABLE STANDARDS**

Latest editions of following Pakistan, ISO, British & ASTM standards are relevant to these specifications wherever applicable.

1. **Pakistan Standard**

P.S. 232 Ordinary Portland Cement

1. **ISO (International Organization for Standardization**

R 680 Chemical analysis of cements Main constituents of Portland Cement.

R 681 Chemical analysis of cements Minor constituents of Portland cement.

1. **ASTM (American Society for Testing and Materials)**

C 482 Bond strength of ceramic tile to Portland cement.

C 648 Breaking strength of ceramic tile.

C 650 Resistance of ceramic tile to chemical substances.

C 798 Color permanency of glazed ceramic tile.

E 84 Surface burning characteristics of building materials

1. **BSI (British Standards Institutions)**

882 Pt.2 Course and fine aggregates from natural sources.

1199 Sands for external renderings, internal plastering with lime and Portland cement and floor screeds.

1201 Pt.2 Aggregates for granolithic concrete floor finishes.

1281 Glazed ceramic tiles and tile fittings for internal walls.

5442 Classification of adhesives for use in Construction pt-1 Adhesives for use.

203 Tile flooring

204 In-situ Floor Finishes.

209 Pt.1 Care and Maintenance of floor surface, wooden flooring.

## MATERIAL

* 1. Cement

Cement shall be ordinary Portland cement conforming to BS 12 or PS232.

1. Sand

All fine sand shall be as specified or approved by the Engineer and stored on properly constructed paving or as directed by the Engineer. The grading shall conform to BS 882 Grading Zone 1 and 2 of which the gradation limits are as follows:

|  |
| --- |
| *Percentage (by weight) passing* |
| **BS Sieve** | **Grading Zone 1** | **Grading Zone 2** |
| 3/8" (9.53mm) 3/16" (4.765mm) No. 7 No. 14 No. 25 No. 52 No. 100 | 10090-100 75-100 55-90 35-598-300-10 | 100 90-100 60-9530-7015-34 5-20 0-10 |

1. Coarse Aggregate;

Coarse aggregate shall be obtained from approved source crushed, angular in shape and shall have granular, crystalline or smooth surface free from friable, flaky and laminated pieces, mica and shale. It shall not contain matters injurious to concrete. All coarse aggregate shall conform to BSS NO.882 and shall be graded as follows:

|  |  |
| --- | --- |
| **BS Sieves**1" (25.40mm) 3/4" (19.05mm) 3/8" (9.53mm) 3/16" (4.765mm) | **% Passing by weight**100 90-100 20-55 0-10 |

The aggregate shall be stored on properly constructed paving or as directed by the Engineer.

There shall be a physical partition between the stockpiles of coarse and fine aggregate. If required aggregates shall be washed and screened to the satisfaction of the Engineer. Sieve analysis of all the aggregates to be used in the works shall be carried out as and when required by the Engineer.

Any aggregates not found to be of the specified/approved standard shall be rejected by the Engineer and all such rejected material shall be removed from site without delay.

Floors sub-base or base constructed with rejected aggregates shall be dismantled and rebuilt at the expense of the Contractor.

1. Not Used
2. Water

Water used for mixing concrete, curing or any other operation of the works specified herein shall be fresh, clean and free from organic or inorganic matters in solutions or in suspension. Only water of the approved quality shall be used for all constructional purposes:

1. Ceramic tiles

Ceramic tiles snail be local, best quality white or any other color. The size of tiles shall be as specified and shall conform to BS 1281 as per samples. The Engineer can select different color and designs of the approved tiles for use in different locations, if not specified.

1. Terrazzo Tiles

Terrazzo tiles shall be first grade mechanically compressed types conforming to PS-531. Tiles shall be of specified sizes with a topping of 10mm thickness composed of 1:2 cement marble chips, the base being 1:2 cement mortars. The color quality and size of chips shall be as per Engineer's approval.

1. Cleaning Compound

The compound used for all cleaning of terrazzo shall be an approved neutral chemical cleaner free from acid and alkali or any other material that will affect the color or otherwise damage the terrazzo and shall not affect the conductivity of terrazzo floors.

1. Vitrified Clay Tile

Vitrified clay tiles of specified size shall be first quality of local manufacture approved by the Engineer.

1. **CEMENT CONCRETE FLOORING**

The materials for C.C flooring shall be same as already specified under Clause 3, "Materials".

1. Composition of Concrete

Concrete shall be composed of Portland cement, sand, coarse, aggregate and water, all well mixed and brought to the proper consistency. The Contractor shall mix the ingredients as specified. The proportions of the various ingredients shall be determined from time to time during the progress of the work and tests shall be made of samples of the aggregates and the resulting concrete. The mix proportions and appropriate water-cement ratio will be determined on the basis of the production of concrete having required workability, density, impermeability, durability and required strength.

1. Mixing Concrete

The concrete ingredients shall be mixed in a batch mixer for not less than 1-1/2 minutes after all ingredients, except the full amount of water, are in the mixer. The Engineer reserves the right to increase the mixing time when the charging and mixing operations fail to produce a concrete batch in which the ingredients are uniformly distributed and the consistency is not uniform. The concrete shall be uniform in composition and consistency from batch to batch except when changes in composition or consistency are required. Water shall be added prior to, during and following the mixer charge. Excessive over mixing requiring addition of water to preserve the required concrete consistency will not be permitted. The concrete ingredients shall be mixed by volumetric measurement in purpose made boxes approved by the Engineer.

1. Construction

The base course of the floor shall comprise of brick ballast of 2 inches (approx. 50 mm) mesh size. The base course shall be thoroughly compacted by suitable power rammers to the total consolidated thickness as shown on the Drawings. The interstices shall be filled with smaller size brick. The base course shall be blinded with sand and the whole surface watered- Over the well compacted base course, a layer of concrete of the required grade and thickness shall be laid, in panels of the sizes as indicated on the Drawing or as approved by the Engineer.

After the C.C bed has been cured, as directed by the Engineer, it shall be roughened and well watered before floor finishing is laid. The floor finish shall comprise of cement concrete of required grade and shall be laid in panels to the required thickness as shown on the Drawings or as directed by the Engineer. The concrete after laying will be thoroughly rammed and mortar worked up to the top and smoothed with a steel trowel. The edge of each section into which the floor is divided should be defined by wooden screeds of the approved width and of a depth equal to the depth of the floor concrete.

Freshly placed concrete floor and completed floor portions as finished shall be protected to prevent loss of water by covering with damp hessian, damp sand or other approved material, and shall be kept constantly damp for a period of four days. The concrete shall be allowed to dry out slowly over a period of three days after wet curing is completed.

1. **INSTALLATION OF TILE FLOORING**

The contractor should note that all tiles before installation should be sorted out in a proper way acceptable to the Engineer, no under/ over sized and damaged tile should be used.

When setting out the tiles, care shall be taken to establish the correct elevation for the floor. A gauge rod shall be used, indicating the overall measurement of a given number of tiles with specified joint width to reduce cutting.

After the floor has been machine finished, it should be covered with white, non-staining sand or rags to protect it while other work is being done. After removal, the floor shall be thoroughly scrubbed.

1. General

The base shall be prepared by laying cement concrete of specified grade and of thickness as specified or as shown on the drawings.

The curing period of the setting bed shall be as directed by the Engineer. As large an area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be less than *1/2"* (12.5 mm).

Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust, oil and other objectionable matters. Tiles shall be laid out from the center line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut tiles.

Joints between the tiles shall be of uniform width. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Tiles shall be laid to the straight edges.

1. Terrazzo Tiles

The terrazzo tiles will be laid to the required lines, levels and grades over a setting bed of cement sand mortar comprising of 1 part of cement and 4 parts of sand by volume.

After seven days, the terrazzo tile floors shall be Machine grounds to a true even surface using various grades of abrasive stores, as required and directed by the Engineer. After the first grinding the floor shall be grouted with the same color composition as used for its manufacture. The grout shall be of the consistency of thick cream and shall be brushed over the floor to fill in the joints andafter 72 hours the grouting coat shall be removed by grinding till a smooth and even surface is obtained. Areas and portion of the floor inaccessible for the grinding machine shall be ground and rubbed by hand. The final gloss shall be given by polishing the surface to the satisfaction of the Engineer.

1. Ceramic Tiles

The ceramic tiles shall be laid to the required lines, levels and grades over a setting bed of cement sand mortar comprising of one part of cement and 4 parts of sand by volume and the Joints filled with neat white or grey cement including vertical and horizontal covers. The tile floor shall be kept wet for at least 72 hours and no traffic should be allowed on the tiles during curing period.

1. Cement Concrete/Vitrified Tiles

The cement concrete and vitrified clay tile shall be laid to the required, lines, levels and grades over a setting bed of cement sand mortar comprising of 1 part of cement and 4 parts of sand by volume.

1. **TERRAZZO FLOORING CAST IN SITU**
	1. Mix The terrazzo mixes shall be composed by weight as follows:

Plain terrazzo for all floors and bases indicated as terrazzo and not otherwise specified, shall be composed of one part cement, white or grey, and 2 parts of marble chips of the sizes and colors hereinafter specified.

1. Preparation for Terrazzo

The grade and thickness of concrete as shown on the Drawings shall be laid as underbed to receive terrazzo. The surface of the bed shall be roughened for bonding with the terrazzo finish. If the surface is too smooth it shall be roughened with a toothed chisel and, prior to laying the terrazzo the bed shall be cleaned of all dirt, oil grease and extra loose material.

1. Division Strips

Terrazzo floors and bases shall be divided by glass/marble strips. The division strips between fieldwork and borders shall have exposed tops in full width of the strips. The division strips shall be set immediately after the spreading of the underbid, the strips being partially embedded therein, securely anchored to the sub-floor and grouted solid.

All division strips shall be set, straight to lines and to the proper level to ensure that the tops of the strips will show uniformly after grinding and smoothening operations are completed and joints and intersections shall be fitted tight. Strips shall be braced to prevent bulging during the placing of terrazzo.

Unless otherwise shown on the drawings, the divisions in field work of large areas shall not exceed 3 feet x 3 feet and in small areas shall not exceed 2 feet x 2 feet.

Edging strips shall be placed at door ways between terrazzo and types of flooring and along the edges of all terrazzo bases or borders and adjoining other types of floor finishes or floor covering. The edging strips at door ways shall be placed in line with the step face of doors. All edging strips shall be anchored and grouted solid in the underbed or to the concrete sub-floor and braced to prevent bulging as specified for division strip.

1. Laving Terrazzo
	1. The sub-surface shall be swept clean, thoroughly moistened, but not saturated, and slashed with a coating of neat cement grout. The underbed consisting of specified cement concrete screed shall be spread and brought to a level not less than 1/2" inch. (12mm) below the finished floor level. The dividing strips shall be installed in the green underbed. The terrazzo mix shall be spread, tamped and rolled into a compact mass not less than specified thickness. After rolling additional aggregate mix shall be sprinkled over the surface to fill up all depressions, to take up excess moisture and to permit the terrazzo to be trowelled to a level, dense and even surface, slightly above the finish line of floor. This level shall allow for surface grinding necessary to expose the specified areas of aggregate, and to produce smooth, levels, floors free of waves and depressions.
	2. Seasoning

The completed terrazzo shall be allowed to season for 6 days during which time it shall be kept moist and free of traffic. The curing shall be accompanied by (1) covering with approximately 1 inch (25 mm) thickness of sand; or (2) sprinkling with water at every 10 hour interval.

1. Surface

Following the curing period, the terrazzo shall be machine ground to a true, even surface using a No. 24 grit followed by a No. 80 grit or finer abrasive stone. After the first grinding, the floors shall be thoroughly grouted with the same cement and color composition as specified for the matrix of the terrazzo mix. The grout shall be of the consistency of thick cream, and shall be brushed over the floor to eliminate all pits and thoroughly fill the surface for final grinding.

1. Finishing

Not less than 72 hours after application, the grouting coat shall be removed by grinding. In the later stages of grinding, the grit stones or other abrasive used in the grinding machine shall be of a grain or fineness that will give the surface smooth finishes. Small areas, inaccessible portions and corners, which cannot be reached by the grinding machine, shall be ground and rubbed by hand.

1. Protection

The walls and all surfaces of the finished work of other trades shall be properly protected from damage and spoiling during the process of grinding and washing of the terrazzo. After the finish grinding has been completed and the surface treatment applied, the terrazzo work shall be covered and protected with material approved by the Engineer until completion of the work of all other trades.

1. Cleaning and Coating

Prior to placing the protective covering, the terrazzo floor shall be approved by the Engineer. After the work all other trades has been completed and the protective covering removed, all terrazzo work shall be washed with cleaning where necessary to remove any stains or cement smears. The terrazzo shall be allowed to dry thoroughly and shall be given a sealing application of preservative material. The sealing material shall be applied in accordance with the manufacturer's directions, leaving all terrazzo work in clean condition as approved by the Engineer.

1. Dado/Skirting

The ingredients of Dado/skirting shall be one part of cement and two parts of marble chips varying from Nos. zero to 2. Skirting shall be laid over a base of plaster of specified thickness. The thickness of dado/skirting layer shall be as specified. The surface shall be ground and polished to the satisfaction of the Engineer.

\*\*\* **END OF SECTION** \*\*\*

**PAINTING**

1. **SCOPE**

The work under this section of the Specifications consists of furnishing all materials, plant, labor, equipment, appliances and performing all operations in connection with surface preparation, mixing, painting concrete works, gates, frames, walls, ceilings and all such surfaces as shown on the Drawings and/or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

1. **APPLICABLE STANDARDS**

Latest editions of following British Standards are relevant to these specifications wherever applicable.

1. **BSI (British Standards Institution)**
2. Specification for mineral solvents (white spirits and related hydrocarbon solvents) for paints and other purposes.
3. Lead-based priming paint for woodwork.
4. Lead based priming paint for iron and steel.
5. Sprayed metal coatings.

## Paint colors for building purposes

CP231 Painting of building.

CP.3012 Cleaning and preparation of metal surfaces.

1. **GENERAL**
	1. Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 "Painting of Building" as applicable to the work.
	2. The Contractor shall repair at his own/expense all damaged or defective areas of shop-painted metal work and structural steelwork. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned to being embedded in concrete
	3. Except as otherwise specified, all concrete and plastered surfaces are to be painted.
	4. The Engineer will furnish a schedule of colors for each area and surface. All colors shall be mixed in accordance with the manufacturer's instructions
	5. Colors of priming coat (and body coat where specified, shall be lighter than those of finish coat. The Engineer shall have unlimited choice of colors.
	6. Samples of all colors and finishes shall be prepared in advance of requirement so as not to delay work and shall be submitted to the Engineer for approval before any work is commenced. Any work done without such approval shall be redone to the Engineer's satisfaction, without additional expense to the Employer Samples of each type of paint shall be on separate 1 ft. x 1 ft. x 1/8 inch tempered hard hoard panels. Manufacturer's color chart shall be submitted for color specifications and selection.
2. **MATERIALS**
	* 1. All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of approved manufacturers.
		2. Colors shall be pure, non-fading pigments, mildew-proot sun-proof, finely ground in approved medium. Colors used on plaster and concrete surfaces shall be lime-proof. All materials shall be subject to the Engineer's approval.
		3. Approved quality Distemper paint shall be used for painting where specified on the drawings as directed by the Engineer,
		4. The plastic emulsion/weather shield paint or similar as approved by the Engineer shall be used where specified on the drawing as directed by the Engineer,

All material shall be delivered to site in their original unbroken containers or packages and bear the manufacturer's name, label, brand and formula and will be mixed and applied in accordance with his directions.

1. **DELIVERY STORAGE AND CONTAINER SIZES**

Paints shall be delivered to the site in sealed containers which plainly show the type of paint, color (formula or specifications number) batch number, quantity, date of manufacture, name of manufacturer and instructions for use. Pigmented paints shall be supplied in containers not larger than 20 liters. All materials shall be stored under cover in a clean storage space which should be accessible at all times to the Engineer. If storage is allowed inside the building, floors shall be kept clean and free from paint spillage.

1. **SURFACE PREPARATION**
2. All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning, the surfaces shall be cleaned by scrapping, chipping, blasting, wire brushing or other effective means as approved by the Engineer.
3. In the event the surfaces become otherwise contaminated in the interval between cleaning and painting, recleaning will be done by the Contractor at no additional cost.
4. All the surfaces to be painted shall be free from dust, dirt, fungus, lichen, algae etc. Ud paint, varnish and lime wash should always be removed by scraping and washing.

No work in this section shall be allowed until all surfaces or conditions have been inspected and approved by the Engineer.

1. **APPLICATION**
	1. All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workman like manner, leaving the finished surface free from drips, ridges, waves, laps, and brush marks. All paints shall be applied under dry and dust free conditions, Unless approved by the Engineer paint shall not be applied when the temperature of the metal or of the surrounding air is below 7 degrees centigrade, Surfaces shall be free from moisture at the time of painting,

All primary paint (Alkali Resistance) shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measures shall be taken to prevent segregation of the paint in the container during painting operation,

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment.

Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation, Only as much material should be mixed as can be used up in one hour. Over-thinning will not be permitted. After the first coat the surfaces will be soaked evenly four or five times and the second coat shall be applied after leaving for at least overnight-

1. Where shown on Drawings all exterior finishes shall be painted witli weather resistant paint in approved colors as per manufacturer's specifications.
2. Plastic emulsion paint of the approved make and shade shall be applied to surfaces as shown on Drawings or as specified by the Engineer.
3. Polyvinyl Distemper of the approved make and shade shall be applied to surfaces as specified.
4. Polishing

After fine sanding by a skilled operator, one coat of clear polish should be rubbed in by hand using a cloth or pad, be allowed to dry and huffed up with worn fine sand paper or atcol wool to remove lalsed grain. A second coat of clear polish should then be applied.

1. **JOB CONDITIONS**
	* 1. Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10 degree C or above and less than 43 decree C. No painting shall be done above 90% relative humidity.
		2. Adequately protect all finished work.
		3. Remove and replace all items of finish hardware, device plates, accessories, lighting fixtures or other removable items
		4. In no case shall any finish hardware or other finished item that is already fitted into place be painted, unless otherwise specified
2. **QUALITY ASSURANCE**

All paint for any one surface shall be top quality, of one manufacturer of the specified. Deep tone accent colors shall be used and the unavailability of final coat colors may be the basis for rejecting materials for any one surface.

\*\*\* **END OF SECTION** \*\*\*

**PLUMBING**

1. **SCOPE**

The work under this section consists of providing all material and equipment and performing all the work necessary for the execution and completion including testing and commissioning of all systems of plumbing works as shown on the Drawings and/or as specified herein and/or as directed by the Engineer, The systems included in plumbing works are as follows:

1. Cold and Hot Water Supply
2. Sanitary Drainage
3. Fire Protection
4. Roof Drainage

All the above named systems shall be completed in all respects including extension of these internal systems upto the specified limits outside the building as indicated on the drawings.

1. **GENERAL**

All the materials and equipments shall be of the specifications mentioned herein and the Contractor shall submit the sample, necessary catalogues. Sketches the name of manufacturer and guarantee if necessary before installation. The system shall be installed after the approval of the Engineer. All material and equipment shall be new and unused.

Any material or labor which is usually furnished as a part of the specified equipment and which is necessary for its proper completion and best operation shall be furnished as a part of this Contract without any additional cost whether or not shown in detail on the drawings or described in detail, in the specifications,

Approval of material and equipment by the Engineer shall not absolve the Contractor of the responsibility of furnishing the same of proper size, quantity, quality and all performance characteristics to efficiently fulfill the requirements and intent of the Contract Documents.

The Contractor shall be responsible for his work until its completion and final acceptance, and shall replace any of those that may be damaged, lost or stolen without any additional cost.

All openings left in floor for passage of lines of water supply, soil, waste, vent, etc. shall be covered and protected.

All open ends of pipes shall be properly plugged to prevent any foreign material from entering the pipe.

Misuse of plumbing fixtures to be installed under this Contract is prohibited during the currency of the contract.

All metal fixture trimmings shall be thoroughly covered with non r.onusive grease which shall be maintained until all work is completed. Upon the completion of work, all fixtures and trimmings shall be thoroughly cleaned, polished and left in first class condition.

Before erection, all pipes, valves, fittings, ale. shall be thoroughly cleaned of oil. grease or other material.

All special tools for proper operation and maintenance of the equipment provided under this Contract shall be delivered at no additional cost.

The Contractor shall allow in his bid for cost of all cutting, making holes and subsequent making it good to the desired finish as per approval of the Engineer. No separate payment shall be made for this item,

The Contractor shall allow in his bid for the cost of providing protective painting or coating as specified in the relevant sections and no claim shall be entertained for this item.

All pipes shall be properly installed as shown on the drawings and/or as directed by the Engineer, and shall be as straight as possible forming right angles and parallel lines with the walls and other pipelines The position, gradients, alignment and inverts shall be as shown on the drawings and/or as directed by the Engineer.

The arrangement, positions and connections of pipe fittings and appurtenances shall be as shown on the drawings. Special precautions shall be taken for the installation of concealed pipes as shown on the drawings and/or as required. Should it be necessary to correct piping so installed, the Contractor shall be held liable for any injury caused to other works in the correction of piping. The Contractor shall closely coordinate with other works during the entire stage of execution.

A minimum distance between different services shall be maintained as shown on the Drawings and/or as approved by the Engineer.

Pipes should be installed in such a manner that minimum distance should always be maintained between pipe and wall, beams, columns, etc. Pipes shall be supported on hangers and brackets as shown on the drawings or as directed by the Engineer.

Waste-water outlet from each fixture shall be individually trapped.

Each vent terminal shall extend to the outer air and be so installed as to minimize the possibilities of clogging and the return of foul air to the building.

When the roughing-in is completed, the plumbing system shall be subjected to test prior to concealing the roughing-in, in order to ascertain that all threads and connections are watertight.

Cast iron soil and drainage fittings for change in direction shall be used as follows: -

* Vertical to horizontal:

Short sweep or long-turn for diameter 3 inches and larger: long sweep or extra- long-turn for less than 3 inches, dia.

* Horizontal to vertical:

quarters bond or short turn. All fittings with hubs shall be aligned so that the hub faces upstream.

No drainage or vent piping shall be drilled.

All exterior openings provided for the passage of piping shall be properly sealed with snugly fitting collars of metal or other approved rodent-proof material securely fastened into place

Joints at the roof, around vent pipes, shall be made water-tight by the use of lead, copper, galvanized iron, or other approved flashings or flashing material. Exterior wall openings shall be made watertight.

Each length of pipe and each pipe fitting, trap, fixture, and device used in *a* plumbing system shall have cast, stamped or indelibly marked on it the maker's mark or name, the weight, type, and classes of the product, when such marking is required by the approved standard.

Where different sizes of pipes, or pipes and fittings are to be connected, the proper size increasers or reducers or reduced fittings shall be used between the two sizes.

Any fitting or connection which has an enlargement, chamber, or recess with a ledge, shoulder, or reduction of pipe area that offers an obstruction to flow through the drain pipe is prohibited

Each fixture trap shall have a water seal of not less than 2 inches and not more than 4 inches.

Full S, hell, crown vented traps and traps/depending for their seal upon the action of movable parts are prohibited.

No fixture shall be double trapped. Where fixture comes in contact with wall and floors, the joint shall be watertight Piping in ground shall be Icjid on a firm bed for its entire length, Piping in the plumbing system shall be installed without undue strains and stresses. Vertical piping shall be securely held to keep the pipe in alignment and carry the weight of the pipe and contents Horizontal piping shall be supported to keep it in alignment and prevent sagging. Hangers and anchors shall be of metal of sufficient strength to maintain their proportional share of pipe alignments and prevent rattling. Hangers and anchors shall be securely attached to the building under construction. It must be clearly understood that the Contractor shall be fully responsible for hangers and supports and shall obtain prior approval of design as to the shape, material, dimensions, spacing etc.

Piping in concrete or masonry walls or footings shall be placed or installed in sleeves, which will permit access to the piping for repair or replacement. Roof drain leaders installed inside columns shall be permanently embedded in concrete.

1. **COLD & HOT WATER PIPES AND PIPE FITTINGS**
	1. Scope

The work under this section of the specifications consists of providing all plant, equipment, appliances, material and labor for proper supply and installation of G.I. Pipes and pipe fittings for cold and hot water supply including jointing, clamping, cleaning, painting etc. both above ground and underground and embedded in walls as shown on the Drawings or as specified herein.

* 1. G.I- Cold and Hot Water Pipes & Fittings
		1. **Material**

The galvanized pipes shall be of medium quality shall conform to British Standard Specifications 1387 for "Steel Tubes and Tubulars suitable for screwing to BS 21 pipe threads".

All screwed tubas and sockets shall have BS pipes thread in accordance with BS 21. In order to prevent damage to the leading thread, the ends of the sockets shall be chamfered internally.

A complete and uniform adherent coating of zinc will be provided fur galvanized pipes,

Every tube shall be tested at the manufacturers’ works to a hydraulic test pressure of 4.90 MPa and shall be maintained at the test pressure sufficiently long for proof and inspection.

Tubes which are bundled shall be secured together by rope or soft iron or other suitable material.

The threads of ail tubes shall be effectively covered with a good quality grease or other suitable compound, and each tube above 2 inches, nominal bore shall have a protecting ring affixed to the unsocketed screwed end.

All pipe fittings upto 6 inches dia. shall be of malleable cast iron, best quality imported.

1. **Installation**

The run and arrangement of all pipes shall be as shown on the Drawings and as directed during installation. All vertical pipes shall be erected plumb and shall be parallel to wall and other pipes. All horizontal runs of piping shall be kept in contact with walls. If required to change the location etc during the currency of the work, the Contractor will do so at no additional cost.

Screwed joints in G.l. pipes shall be made perfectly tight, without the use of any filler except approved jointing compound or tape. Wherever required to make flanged joints, they shall conform to BS 10 Table D.

Furnish and install all pipe passing through floors and walls with sleeves of G.I. sheet, 18 gauge, the inside dia. of which shall be at least 1/2 inches greater than the outside of the pipe passing through it. Sleeves in exterior walls and pits shall have anchor flanges and space between pipe and sleeve shall be caulked and sealed watertight. At waterproof locations, an approved waterproof type pipe sleeve shall be / provided.

All embedded cold & hot water supply piping shall be painted with two coats of enamel paint over a coat of red oxide primer and wrapped with approved anti-corrosion polyethylene tape.

1. **Pipe Work Supports**

All supports, clips, steel rods and hangers shall be of mild steel painted with two coats of approved metallic zinc primer.

All clips and brackets shall be equipped with 1/3 inches sectional rubber liners,

Pipe work supports shall be installed in order to allow free movement due to expansions and contraction. Supports shall be arranged adjacent to Joints, changes of direction and branches.

Each support shall carry the overall weight of pipe work and water to be borne by it. The intervals between pipe supports shall not exceed the following:

|  |
| --- |
| **Maximum interval between supports (feet)** |
| Steel pipes |
| Nominal dia. (inch) | Horizontal Bare | Horizontal Insulated | Vertical |
| ½¾11 ¼1 ½22 ½34568 | 68991011121213141616.5 | 68991011121213131415 | 68991213141415161820 |

Single pipes hung from floor slabs shall be supported on rod hangers. Where two or more pipes are involved a channel or angle from shall be fitted to the underside of slab by two hangers and the pipes shall be supported from the channel iron by rod hangers and flat iron hands.

All hanger rods shall have double nuts and beveled washers to allow the hanger rod to swing.

Multiple pipe runs along walls shall be supported on purpose made substantial angle and channel frames securely fixed to the wall, floor and ceiling as necessary. All pipes shall be arranged to slide on the steel supports and U-bolts shall be provided to form a rigid guide.

Exposed pipe work shall be supported on channel, angle iron or with U-bolts to form a rigid guide.

All U-bolts, except used as anchors, shall have a pair of nut and washers on each leg with the supporting steel flange clamped tight between the pair of nuts to form a rigid guide and allowing the pipe to slide axially. U-bolts shall be provided on alternate pipe bracket.

Small paperwork running along skirting shall be supported by standard built-in or screw-on type clips.

Pipes shall be individually supported. Pipes shall not hang from other pipes.

Points at which pipes pass through walls, floors, connections to plant, equipment and heat emitters, etc. do not constitute points of supports for the pipes.

Vertical pipes shall be supported at the base or at anchor points to withstand the total weight of the riser; Brackets from risers shall not be used as a means-of support for the riser.

Supports for insulated water pipe work shall be arranged that the supporting steel work does not come into contact with the pipe surface.

1. **Testing and Commissioning**

All water distribution system shall be tested whole or in part to - 1-1/2 times the working pressure. The test pressure will be maintained for two hours and there should be no leakage in the system. Defects revealed by the test shall be repaired and the whole test redone until the system proves to be satisfactory-After all the pipes and fixtures have been properly laid and tested, they shall be flushed clean with water and then disinfected with water solution of chlorine of at least 50 ppm strength for a contact period of 6 hours The system will be finally flushed with clean water.

1. **SOIL. WASTE. VENT & RAIN PIPES & PIPE FITTINGS**
2. **Scope**

The work under this section of the specifications consists of providing all plant, equipment, appliances, material and labor for supply and proper installation of soil, waste, and vent pipes and / pipe fittings including, clamping, cleaning, painting etc., as shown on the drawings or as specified herein.

1. **Cast Iron Soil, Waste & Rain Water Pipes and Fittings**
	1. Material

The cast iron pipe shall conform to British Standard Specifications No. 416 for "Cast Iron spigot and socket soil. waste rain water and ventilating pipes and fittings" with socket and spigot or hub less ends. Cast iron pipe below ground shall conform to BS. 437 "cast iron spigot and socket drain pipe and fittings" with socket and spigot ends. The joint shall be lead caulked.

Cast iron pipes shall be sand casted and centrifugally (spun) cast as per requirement. The quality of material shall be according to BSS No. 1452 for Grade 10.

The contractor shall supply coated pipes and fittings. The coating composition shall be of tar basis or a mixture of natural bitumen with a suitable hardener and natural asphalt. The coatings shall be smooth, tenacious, sufficiently hard, not to flow when exposed to a temperature of 63°C and not so brittle at zero degree centigrade that it chips soft when scribed lightly with the point of a pen knife.

Every pipe shall be tested at the manufacturer's work to a hydraulic test pressure of 0.07 MPa. Every pipe and fitting shall ring clearly when tested for soundness by being struck all over with a light hammer.

1. Installation

All cast iron soil pipes and fittings shall be installed to the lines and grades shown on the drawings or as directed by the Engineer. When required to be installed above ground floor level, suitable and substantial number of hangers and supports of approved type and make shall be provided. No piping shall be hung from the piping of other systems. Clamps shall be provided on not more than 5 feet centers or a minimum of one hanger per each length of pipe whichever is smaller. Where excessive numbers of fittings are installed, additional clamps will be provided.

All steel clamps, hangers and support etc. shall be given one coat of red oxide primer and two coats of synthetic enamel paint. All exposed C.I. soil/vent pipes shall be painted with two coats of synthetic enamel paint. Materials for painting shall be of product of well known manufacturer. The instructions of the manufacturer regarding all painting work shall strictly be adhered to. Caulked joints for cast iron bell-and-spigot soil pipe shall be firmly packed with oakum or hemp and filled with molten lead not less than 1 inch deep and not to extend more than 1/8 inches below the rim of the hub. Rubber ring joints shall also be allowed. No paint, varnish, or other coatings shall be permitted on the jointing material until after the joint has been tested and approved.

Pipes passing through walls, floors, etc. shall be provided with sleeves of approved design. All vent pipes to be installed in the system shall be provided with approved cow! and with at least 2'-6" rise above the roof.

1. Testing and Commissioning

The testing of drainage system shall be done as specified in the section 5180 of Testing and Commissioning.

The Contractor shall also be responsible for the repair of this work & other trades work that may be damaged or disturbed by the tests.

Defective work shall be replaced with new work without extra cost to the Employer. Tests shall be repeated until all worse are completed for the satisfaction of the Engineer.

1. **Asbestos Cement Soil, Waste, Ventilation & Rain Water**

# Pipes and Fittings

1. Material

Asbestos Cement non-pressure pipe shall conform to ISO 391: 1982. The pipe shall have socket and spigot end. The fitting to be used with AC pipe shall be of centrifugally spun cast iron, and shall conform to BS-416. Every pipe shall be tested at the manufactures work to a hydraulic test pressure of 0.05 mpa. Every pipe and fitting shall ring clearly when tested for soundness when struck by all over with light hammer.

1. Installation

All Asbestos Cement pipes and Cast Iron fittings shall be installed to the lines and grades shown on the drawings or as directed by the Engineer. Suitable and substantial number of hangers and supports of approved type and make shall be provided. All exposed Asbestos Cement pipe and fittings shall be painted with two coat of synthetic enamel paint of approved manufacturer. No piping shall be hung from the piping of other systems. Clamps shall be provided on not more than 5 feet centers or a minimum of one hanger per each length of pipe whichever is smaller. Where excessive numbers of fittings are installed, additional clamps will be provided.

All steel clamps, hangers and support etc. shall be painted with one coat of red oxide primer and two coats of synthetic enamel paint.

Caulked joints of Asbestos Cement bell-and-spigot pipe and fittings shall be firmly packed with oakum or jute rope soaked in plastic bitumen and filled with cement mortar not less than 1" deep.

1. Testing and Commissioning

Testing of drainage system shall be done as specified in section 5180 of Testing and Commissioning.

The Contractor shall also be responsible for the repair of this work & other trades work that may be damaged or disturbed by the tests.

Defective work shall be replaced with new work without extra cost to the Employer. Tests shall be repeated until all works are completed to the satisfaction of the Engineer.

## PLUMBING FIXTURES

1. Scope

The work under this sactiun of the specifications consists of providing all material and labor for supply and proper installation of plumbing fixtures of wash basins, kitchen sinks, laboratory sinks, water closets, urinals, etc along with all their accessories, water inlet connection, waste outlet connection etc complete in all respect as specified herein or as shown on the Drawings and/or as directed by the Engineer.

1. Materials and Installation
	1. General Requirements

Materials shall conform to the latest referenced standard specifications and other provisions stipulated herein and shall be new and unused.

All fixtures shall be of high class quality and finish and shall be of approved manufacture.

Prior to procurement of the materials, the Contractor shall be required to prepare and submit to the Engineer for his approval, a complete schedule of materials to be used in the works together with a list of the names and addresses of the manufacturers and the trade names of the materials. The schedule shall include diagrams; drawings and such other technical data as may be required by the Engineer to satisfy himself as to the suitability, durability, quality and usefulness of the material to be purchased.

Approval of the schedule shall not be construed as authorizing any deviations from the specifications unless the attention of the Engineer has been invited to the specific changes. If the material or equipment offered under this provision is, in the opinion of the Engineer, equal to or better than specified, it will be given consideration.

Plumbing fixtures shall have smooth impervious surfaces, be free from defects and concealed fouling surface. They shall be true to line, angles, curves and color etc. Normally they shall be of local make and of the best quality available, provided

All taps and cocks to be installed with plumbing fixtures shall be chrome plated (CP) and shall be of appropriate class to work without damage or leakage on the specified pressure of potable water system.

When any fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture cannot rise in the over flow when the stopper is closed or remain in the overflow when the fixture is empty.

Plumbing fixtures shall be installed in a manner to afford easy access for cleaning. The space between the fixture and the wall shall be closely fitted and pointed so that there is no chance for dirt or vermin to collect.

When practical, all pipes from fixtures shall be run to the nearest wall.

Where fixture comes in contact with wall and floors, the joint shall be watertight.

Wall hung fixtures shall be rigidly supported by metal supporting members so that no strain is transmitted to the connections. Flush tanks and similar appurtenances shall be secured by approved non-corrosive screws or bolts.

Fixtures shall be set level and in proper alignment with reference to adjacent walls. No water closet shall be set closer than 1.25 ft. from its centre to any side wall. No urinal shall be set closer than 1.0 ft. from its centre to any side wall or partition or closer than 24 inch. centre to centre,

The supply lines or fittings for every plumbing fixture shall be so installed as to prevent back flow.

All cuttings, making holes etc and making it good shall be included in the work.

1. Water Closets

Squatting type water closet of Vitreous China shall be of approved color, manufacture and size. It shall be installed as a complete unit including cast iron P-trap, 1/2 inch. CP tee stop cock with wall cups, plastic water inlet connection pipe. Plastic water flush tank with all internal fittings, installed at low level including inter connecting flush piping and sealing material etc. with all other minor accessories.

1. Water Closets (European Type)

European type water closet of vitreous China with close coupled flush tank shall be of approved color, manufacturer & size.

Trap shall be cast integral with pan. The seat shall be of smooth non- combustible non-absorbent materials like Bakelite and of the open front type fixed to the pan with hinges.

The fittings shall also include 1/2 inch. tee stopcock, with wall cover, plastic water inlet connection pipe nuts bolts etc. required for installation.

1. **Sinks**

Sink shall be stainless steel of approved make single bowl with integral drain board of specified size. It shall be installed as a complete unit with 1/2*"* dia. cold and hot water C.P mixer, CP brass strainer, CP brass waste outlet and uPVC waste pipe, heavy cast iron brackets with bolts screws etc. Joints, jointing and sealing material, etc., with all other minor accessories.

1. **Shower**

Shower head shall be local best quality chromium plated adjustable type installed on the wall at suitable height, complete with cold and hot water mixer and all accessories such as chromium plated extension pipe, C.P. brass escoutcheon etc. It shall be mounted on the wall at a suitable height near the shower head complete with all accessories.

1. **Testing and Commissioning**

All fixtures shall be tested for soundness, stability or support and satisfactory operation

1. **MISCELLANEOUS ITEMS**
2. Scope

The work under this section of the specifications consists of providing all material and labor, equipment, appliances etc., for supply and proper installation of miscellaneous plumbing items valves, cocks, floor traps, floor drain, clean outs, mirror, electric water cooler, gas water heater, float valve, foot valve, irrigation outlet etc. as specified, herein or as shown on the Drawing or as directed by the Engineer. The Contractor shall furnish appropriate catalogues and literature and obtain approval of the Engineer before purchase,

1. Material and Installation
	1. Bronze Valves

All valves of 100 inch. dia meter and smaller shall be of bronze unless otherwise specified conforming to BS 5154 and shall be of appropriate class for the working pressure of the system on which they are installed. Open and shut indicators shall be marked on the spindle. The ends may be screwed or flanged.

1. Taps and Cocks

All the taps and cocks shall be of brass, gunmetal or other equally suitable corrosion resisting alloy conforming to BS 1010 and shall be imported in addition be chrome plated. The nominal size specified shall be the nominal bore of the seating. The area of the waterway throughout the body shall be not less than the area of a circle of diameter equal to the nominal size of tap/cock. Washers for cold water cocks shall be of specially selected leather, rubber asbestos composition or other equally suitable material. Every tap/cock shall be tested, complete with its component parts, to a hydraulic pressure of at least one and half times working pressure. During test it shall neither leak nor sweat.

1. Floor drains

Floor drains shall be of cast iron or of other anti-corrosive metal. They shall have minimum water seal of 3/4 inch. and shall be provided with removable metal strainers. The traps shall be of self-clearing type. The open area of the strainer shall be at least equal to the cross section area of the drain line to which it connects. Floor drains shall have provision for connection above the water seal. Floor drain shall be well set in position so that there is no leakage at the joint between trap and the floor.

1. Cleanouts

Clean outs shall be of the same nominal size as that of the pipe on which it is installed. Cleanout shall consist of tapped heavy duty cast iron ferrule caulked into cast iron fitting and heavy duty brass tapered even plug. Cleanouts shall be turned up through floors by long sweep fittings, wherever the space so permits. Top finish of cleanout shall be flush with the floor by means of finished metal plate secured in position and screwed firmly to the plug.

Cleanout shall be so installed that there is a clearance of at least 12 inches for pipes less than 3 inches diameter and at least 18 inches for pipes of 3 inches and larger diameter, for the purpose of rodding.

1. Floor Traps

Floor traps shall be of cast iron or of other corrosive metal, They shall have minimum water seal of ^ inch, and shall be provided with removable nickel bronze strainers, The traps shall be of self cleaning type. The open area of the strainer shall be greater than the cross section area of the drain line to which it connects. Floor traps shall be well set in position so that there is no leakage at the joint between trap and the floor.

1. Float Valve

Float valve shall be of copper alloy, piston type and conform to BS 1212. Float shall be of copper conforming to BS 1968. where required or indicated on the drawing

1. Foot Valve

Foot valve shall be installed on the suction line of the pumps where required or indicated on the drawing. Foot valve shall be of brass, and shall be provided with integral strainer. Foot valve shall be provided with a spring loaded vertical check disc with gasket for tight shut-off.

1. Floor Gully

Floor Gullys shall be of cast iron or of other anticorrosive metal, and provided with removable nickel bronze strainers. The openarea of the strainers shall be greater than the cross section area of the drain line to which it connects. Floor gullys shall be well set in position so that there is no leakage at the joint between gully and the floor. Therefore floor gully where required or indicated on the drawing.

1. Gully Traps

Gully traps in block masonry chamber as shown on the drawing shall be provided with a P-trap having a 1 inch. inches minimum water seal and a cast iron frame and cover of size 12" x 12" and shall be internally plastered with pudio as approved by Engineer.

1. **Cowel**

All vent pipe terminating above the building shall be provided with best quality cast iron cowel and a stainless steel clamp for clamping of water proofing membrane as approved by the Engineer.

1. Orifice Plates

Where the static pressure at any connection exceeds limits an orifice plates shall be installed prior to the valve to reduce the water flow so that pressure dose not exceed the required limit. The orifice plate shall be constructed of 12mm thick stainless steel plate and shall be installed between two steel flanges. Size of orifice shall be as obtained from the Engineer prior to fabrication.

1. **ROOF DRAINAGE**
	1. Roof Drains

Roof drains shall be of bitumen coated cast iron. They shall have dome shaped strainers extending above the roof surface. Bottom of strainer shall be flush with the roof surface. Strainer shall have an available inlet area, above roof level, of not less than 1-1/2 times the area of the down-pipe to which the drain is connected. The connection between roof and roof drain shall be made watertight by the use of proper flashing material.

* 1. Rain Water Shoe

Rain water shoe shall be of bitumen/asphalt coated cast iron, anti-splash type to B.S. 416. The grade of shoe shall be same as that for rain water pipe to which it connects. The shoe shall be fixed 12 inches above the surface to which it discharges freely.

1. **UPVC PIPE & FITTINGS**
	1. UPVC Waste and Vent Pipes & Fittings

Unplasticized PVC pipes for waste and vent shall be non-pressure pipes conforming to BS-4514. Fittings and specials for use with UPVC pipes shall conform to BS-4346 with elastomeric (Rubber ring) or solvent cement joint to BS-4346, Clamps hangers and supports shall be as required for G.I. pipes.

\*\*\***END OF SECTION**\*\*\*

**TESTING AND COMMISSIONING**

1. **SCOPE OF WORK**

The work under this section of specifications includes visual inspection, furnishing all plant, labor, equipment, appliances and materials and performing all operations required in connection with testing and commissioning of all water line, drainage system and fixture etc. in parts and as a whole as specified herein or as shown in the Contract Documents or as directed by the Engineer.

1. **GENERAL**

The testing shall include a complete visual inspection of the whole plumbing and fire fighting system and verification or performance as stipulated in the material specification and of correct functioning of the electrical and control systems.

All supply documents, operating instructions, acceptance documentation and maintenance regulations shall be checked to ensure that they correspond with equipment described and also all certificates such as that of the inspection authorities, test certificates and data about quality, temperature and pressure shall be submitted.

1. **FIXTURES AND FITTINGS**
	1. Test Program

The type and the catalogue number of the sanitary fixtures shall be checked.

All equipment in general including the accessories shall be checked for service ability, correct operation and freedom from damage.

The flow and water capacity shall be checked on the full connection of lavatories, showers, WC's, etc. and also the draining capacity shall be measured at the same time.

1. **POTABLE WATER SUPPLY SYSTEMS HOT & COLD)**
	1. Test Program

The method of laying and sealing the water connection lines to the buildings and through walls shall be checked.

Visual inspections shall be made of the entire network for the water systems with regard to laying, fixing, suspension of pipes and fixtures, particularly the arrangements of the fixed points and the separation of the individual connections in the various parts of the system.

The satisfactory function of all valves, air relief valve check-valves, pressure reducers, thermostats, pumps, etc., shall be checked. The test programme shall also cover.

* Checking of type, thickness and professional laying of the piping insulation
* Checking number, form and inscription of the equipment labeling.
* Checking of all pipe and flanged connections to devices, water-heaters, drainage and vents for symmetry and lack of strain.
* Performance of pressure test for the entire network, including fixtures.
	1. Hydraulic Pressure Test

On completion of the pipe work installation or sections thereof as required, pressure test shall be made before the application of insulation. The pressure tests shall be taken by sectors. All equipment and accessories shall be provided and the Engineer shall be given notice that the work is ready for testing. Tests shall be made by pumping up the system to the required pressure then closing the valves between the pump and the section under test. The valve shall remain closed for the duration of the test and the pump shall be disconnected. Test pressure, as detailed below shall be applied as detailed for a period two hours or longer, at the discretion of the Engineer. If, at the end of period, there is no drop in pressure and no evidence of leak or other faults, the test will be considered satisfactory. Should any fault be revealed by the test, leaks are to be recorded, Faults shall be made good and the pipe work retested as many times as necessary until satisfactory results are obtained.

After all the pipes and fixtures have been properly laid and tested, they shall be flushed clean with water and then disinfected with water solution of chlorine of at least 50 PPM strength for a contact period 6 hours. The system will be finally flushed with clean water.

1. Test Pressure and Procedure

Fill pipes slowly with potable water to exclude all air. Apply test pressure of 1.5 times the maximum working pressure. There must be no measurable loss of pressure for at least 30 minutes.

1. **DRAINAGE SYSTEMS**
	1. Test Program

Check the piping by means of the separation system, In relation to the specified capacity.

Check each connection for dimension and draining capacity.

Check the drain line for laying, fixing, and compliance with specification.

Check the practical arrangement of the fixtures, fixing points, suspensions, cleaning openings, vents, pit covers and ground inlets.

Check all the covers and openings, paying special attention to the separation system for waste/sewage and the storm water.

#### Generally provide clean water and apparatus for testing

1. Test Methods
	1. Water Testing

All the openings in the piping system shall be tightly closed by inserting testing plug. The highest point will be left open to supply water and may be raised if necessary by temporary jointing, develop a minimum static head of 05 bars for of water at each section of the system. Water is filled to the point of overflow and any drop in the level of water will indicate a leak that will be found by inspection. The water level will be checked for no drop for at least 15 to 30 minutes. Higher stacks will be tested in sections, starting from the top section and then connecting top section to next lower section.

* 1. Timing

Testing shall be carried out as soon as practicable after completion of each drainage stack. All concealed work shall be tested before being finally enclosed.

1. **FIRE FIGHTING SYSTEMS**
	1. Stand Pipe System

#####  Test Program

Visual inspections shall be made of the entire network for the standpipe' system with regard to laying, fixing, suspension of pipes, particularly the arrangements of the fixed points and the separation of the individual connections in the vinous parts of the system, Where required or indicated on the drawing

The satisfactory function of all valves, air relief valve check valves, and pressure qauqes shall be checked,

The test programme shall also cover:

* Checking number, form and inscription of the labeling.
* Performance of pressure test for the entire network
	1. Hydraulic Pressure Test

# As described for potable water supply system

* 1. Test Pressure and Procedure

## As described for potable water supply system

**\*\*\*END OF SECTION\*\***

**DISINFECTION**

1. **SCOPE OF WORK**

The work under this section of specifications includes furnishing all plant, labor, equipment, appliances and materials and performing all operations required in connection with disinfecting of all potable water lines in parts and as a whole as specified herein or as shown in the Contract Documents or as directed by the Engineer.

1. **DISINFECTION**

After successful completion of pressure tests the entire potable water distribution system in the building shall be thoroughly flushed with water to remove all entrained dirt and mud before disinfecting of the system. The disinfecting chemical shall preferably be hypochlorite solution. However, bleaching powder may be used as alternate material with the approval of the Engineer. Use of gaseous chlorine shall not be allowed for disinfecting.

The chlorine solution shall be introduced into the system until the system is filled with the solution and all entrapped air is expelled from the system. The solution shall be retained in the system for at least 24 hours.

At the end of the period solution will be tested for chlorine residua, which shall not be less than 10 PPM of chlorine throughout the system,

The disinfections process shall be repeated if chlorine required is less than 10 PPM at any location of the system.

After successful completion of disinfection the system shall be flushed with potable water until the residual chlorine is reduced to less than 1 PPM.

During disinfection period all the valves and faucets shall be opened and closed several times to ensure that all parts of the valves are also disinfected.

\*\*\* **END OF SECTION**\*\*\*

**CONCRETE PIPES AND PIPE FITTINGS**

1. **SCOPE OF WORK**

The work covered by this section of the specifications consists of furnishing all concrete pipes and pipe fittings, plant, labor, equipment. Appliances and materials and in performing all operations required for installing the Concrete Pipes in strict accordance with the specifications of this section and applicable drawings and subject to the terms and conditions of the contract.

1. **MATERIALS**
	1. General

Materials shall conform to the latest referred standard specifications and other provisions stipulated herein and shall be new and unused. Prior to procurement of the materials, the Contractor shall be required to prepare and submit to the Engineer for his approval a complete schedule of materials to be used in the works together with a list of the names and addresses of the manufacturers and the trade names of the materials. The schedule shall include diagrams, drawings and such other technical data as may be required by the Engineer to satisfy himself .is to the suitability, durability, quality and usefulness of the material intended to be purchased.

1. Concrete Pipes and Pipe Fittings

All concrete pipes and pipe fittings shall conform to ASTM designation C-14 Class 3. It must be clearly noted that all concrete pipes and pipe fittings shall be manufactured with sulphate resisting cement.

1. **LAYING AND INSTALLATION**
2. Transportation

Pipes shall be handled with special care during transportation to the site of work. Pipes shall be properly secured to minimize their movement. Cranes shall be preferably used for loading and unloading of pipes. Hooks shall be well padded to prevent pipe damage.

1. Storage

Pipes should be carefully stored to prevent damage; pipes should not rest directly on ground. Solid timbers base should be set on ground for pipe stacking. Pipes should not be stacked so high as to over load the bottom. The height of stack shall be further limited by the head room available for any fitting gear used on site. Pipe sockets should not normally rest on other pipes in the stack. The end pipes in the bottom row should be securely locked; wedges should be firmly anchored to prevent collapse of the stack.

1. Inspection of Pipe before Laying

Each pipe shall be carefully examined for soundness and cleanliness immediately before laying; any defective and damaged pipe should be rejected and removed from site.

1. Laying

Laying shall start from down stream. Each length of Concrete Pipe shall be in a straight line and to the true alignment, position, gradient, and the inverts as shown on the Drawings, unless otherwise directed in writing and set out by the Engineer. The Contractor shall check and satisfy himself as to the correctness of the final gradient, position, and slope of the complete Concrete Pipe before commencing the laying operation.

The Contractor shall maintain the inside of the pipe free from foreign materials and in a clean condition until the work is completed and approved by the Engineer.

Care shall be taken to avoid abrasion of the pipe. The full length of each section of pipe shall rest solidly up on the prepared bed. Pipes that have the alignment, grades or joints disturbed after laying, shall be removed and repaid by the Contractor at his own cost. Pipe shall not be laid in water. The pipes shall be encased in Reinforced Cement Concrete as shown on the drawings.

1. Collar Joint

The collar joint shall be made in the following manner:

The collar is slipped over, clear of the end of the pipe already laid. The next pipe is brought forward against the first pipe. The two ends when butted together concentrically shall leave a groove, in between this groove a jute or hemp gasket soaked in neat cement slurry or bitumen compound is caulked in place. The collar is then slipped back over the pipe ends. The remaining annular space between the collar and the outside of the pipe is filled with 1:1 cement sand mortar and pressed lightly. Every joint is finished off smooth inside and the interior cleared of all dirt, excess cement mortar and superfluous material.

\*\*\* **END OF SECTION** \*\*\*

**FOUNTAIN FITTINGS ACCESSORIES AND RECIRCULATING PUMPS**

1. **SCOPE OF WORK**

The works covered under this section of the specifications includes furnishing all plant, equipment, appliances, labor and materials for installation of Fountain fittings accessories and recirculating pump set complete in all respect to work as a system.

Note. The work does not include civil works of the Fountain.

1. **FOUNTAIN FITTINGS & ACCESSORIES**

Fountain fittings include inlet fittings including fountain nozzles, outlet fittings, drain and overflow fittings, make-up water connection.

Fountain nozzles shall be of polished copper alloy (Brass or Bronze) or stainless steel or as shown on drawings. For this purpose the contractor shall submit catalogues of reputed manufacturers of fountain fittings showing various kinds of nozzles, and their spray patterns. The Engineer shall then select the type of nozzles whereupon the Contractor shall submit to the Engineer a sample of the same for the latter's approval. Fountain nozzles at various locations shall be of following make or equivalent as shown on relevant drawings.

Outlet fittings shall be grated. Drain and overflow fittings shall be trapped if connected to sanitary sewer system.

1. The Inlet fittings shall be of polished copper alloy (brass or bronze) connected to the discharge end of the fountain-recirculating pump.
2. The outlet fittings shall be of polished brass connected to the suction end of the fountain-recirculating pump. The drain and overflow fittings shall be connected to the sanitary drainage system.
3. The pressure at the fountain nozzle will be controlled by globe valve installed on the pump discharge pipe to the fountain.
4. The make-up water fitting will be of galvanized steel connected from water line
5. **FOUNTAIN RECIRCULATING PUMP**

The fountain-recirculating pump shall be ready to use non-clogging centrifugal type pump with motor. The components of the pump shall be stainless steal, guaranteeing safe and trouble free operation.

Casing - Fine grained gray cast iron

Impeller - Bronze

Shaft - Stainless steel

Shaft Sleeve - Bronze or stainless steel

Electrical motor shall be horizontal, totally enclosed fan cooled squirrel cage, induction type the motor shall be single or three phases depending upon the horsepower/kilowatt of the motor.

Motor shall be provided with protection against overload, over- heating.

**\*\*\*END OF SECTION\*\*\***

GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS

1. **SCOPE OF WORK**

The works related to the electrical system which are included in the scope of this Contract are shown on the Drawings, stated in the Specifications and Bill of Quantities and explained in these specifications. The works shall broadly include but not limited to the following:

* LT Distribution Boards Internal Illumination (Electrification)
* Internal Power Distribution
* Earthling
* Provision of Telephone & TV outlets.

The Contractor shall also be responsible to supply any other equipment not specifically mentioned in these Documents but which is necessary for proper operation of the works/system included in the scope of this Contract. The Contractor shall solely be responsible for ensuring proper functional requirements of various equipment and shall be responsible for furnishing any additional piece of equipment and for making modification in the equipment as desired and/or approved by the Engineer to achieve proper co-ordination with various equipments offered in the bid and also with those installed by others.

1. **RULES & REGULATIONS**

The entire electrical installation/work shall be carried out by licensed Contractor, authorized to undertake such work under the provisions of the Electricity Act 1910 and The Electricity Rules 1937 as adopted and modified upto date by the Government of Pakistan.

All works shall be carried out in accordance with the latest edition of the Regulations of the Electrical Equipment of Buildings issued by the Institute of Electrical Engineers-London, the Contract Documents, The Electricity Rules 1937 and bye-laws that are in force from time to time. Any discrepancy between these Specifications and any other rules and regulations shall be brought to the notice of Engineer for his instructions and decision of the Engineer shall be final and conclusive.

The Contractor on behalf of the Employer shall submit application for electrical connection and shall be responsible for completing all formalities and submitting the test certificates as per prevailing rules and regulations, and shall have the installation passed by the Government Electric Inspector of that region. All requirements of the Electric Inspector and the electric Supply Company (WAPDA or KESC) shall be complied with.

1. **AMBIENT CONDITIONS**

All material and equipment supplied and installed shall be designed, manufactured and tested to meet the following ambient conditions unless specifically stated otherwise for any material/ equipment

|  |  |
| --- | --- |
| Maximum indoor ambient temperature Minimum indoor ambient temperature Maximum outdoor ambient temperature Minimum outdoor ambient temperature Maximum Relative humidity Maximum Altitude of project | 50 Degree Celsius Zero Degree Celsius 50 Degree CelsiusZero Degree Celsius 90 Percent30 meters above the mean sea level. |

1. **STANDARDS**

The latest standards and codes of reputable organizations shall be applicable for the material and equipment specified herein and for installation work. Such organizations to be BSS, VDE, etc. In case the Specifications laid down herein differ from those given in the standards, then the equivalent or better specifications shall govern. Wherever applicable the equipment shall also conform to the requirements of Pakistan Standard Institution (PSI). Contractor shall maintain at the site office one copy of the standards/codes applicable to the works.

1. **SYSTEM DATA**

Unless otherwise specified elsewhere, all equipment and material shall be designed to operate satisfactorily with the following minimum requirements without any deating.

|  |  |
| --- | --- |
| 1. Voltage rating of equipment
2. Frequency
 | LT:400 V 3 phase **&** ± 10% 230V 1 phase ±10%50Hz + 2HZ |

1. **SHOP DRAWINGS AND DATA TO BE FURNISHED**

# BY THE CONTRACTOR

The shop drawings and/or technical data to be furnished by the Contractor for each electrical equipment shall include, but not limited to the following;

1. Structural drawings showing foundations, RCC details, dimensional plans, elevation and sections on a suitable scale.
2. Electrical drawings showing:
	* Line diagrams of switchboards, distribution boards, and motor control centers with detailed wiring diagrams, elevations/internal component layout and other standard details
	* Complete tender drawings with necessary execution details such as no. of wires, size of conduit, etc.
3. Technical literature and manufacturer's characteristic data with the description of materials and weights of all equipment as instructed by the Engineer.

At least three (3) copies of the shop drawings and/or technical data of the equipment shall be submitted to the Engineer for checking and approval.

1. **MANUFACTURER'S INSTRUCTIONS**

The Contractor shall supply to the Engineer in properly bound form six (6) copies of manufacturer's instruction manuals for installation, testing, commissioning, operation and maintenance of the specified equipment including manuals of spare parts and tools of the equipment. At least two copies of the documents shall be submitted in original. The installation instructions shall be submitted 2 weeks prior to commencement of installation of each equipment, and operation and maintenance instruction at the time of commissioning. If the Contractor fails to provide the documents the Engineer shall withhold issuance of requisite certificates and deduct suitable amount from the payments to the Contractor.

1. **GUARANTEE**

The Contractor shall furnish written guarantee of the manufacturer or supplier with respect to satisfactory performance of each equipment. Guarantee shall be given for replacement and repair of part or whole of the equipment, which may be found defective in material or workmanship. The guarantee shall cover the duration of Maintenance Period as defined in the Conditions of Contract. This guarantee shall not relieve the Contractor of his obligations and he will be fully responsible for the repair or replacement of any defective material in time, so as not to cause any undue delay in carrying out the repairs and/or replacements.

1. **MARKINGS**

The Contractor shall provide "Danger Boards" and "Shock Charts" wherever required to comply with the requirements of local Electricity Rules and according to normal practice.

1. **ASSOCIATED CIVIL WORKS**

Except where separately stated in the Bill of Quantities the cost of all civil works associated with any BOQ Item of electrical works, such as excavation and backfilling of earth, compaction of the earth, foundation pads, chiseling, making openings, etc. shall be included in the price quoted against respective items -No separate payment for such works will be made. Such works will also include repair of any damage to civil works caused by the Contractor during electrical installation.

1. **INSTALLATION INSTRUCTIONS - GENERAL**

The Contractor shall furnish all labor, materials, tools and equipment required to install, connect, test and commission all electrical equipment specified herein, whether or not such equipment is furnished by him or by others.

For all equipment to be installed by the Contractor, the Contractor shall supply and install all erection materials such as foundation bolts, washers, nuts, etc. as required and without any additional costs.

The Contractor shall set out the works himself as per Specifications and Drawings and shall properly position the equipment on specified foundation/location. In general, the manufacturer's instructions for installation shall be followed. Any defect or faulty operation of equipment due to the Contractor not following the manufacturer's instructions shall be corrected and repaired by the Contractor at his own cost.

For any deviation from the working drawings that are deemed necessary by the Contractor due to site conditions, he shall submit the details and obtain the Engineer approval before starting such works.

1. **FACTORY TESTS**

All type and routine tests on transformer, switchgear and all other equipment shall be performed at the manufacturer's works in the presence of the Engineer or his Representative. Type tests may be waived off in case test certificates are submitted as certified by the Engineer approved standard laboratory of international repute; but merely producing the test type certificates will not relieve the manufacturer to carry out the required standard/routine tests.

The Contractor shall inform the Engineer about the date and time of test of each equipment at least two weeks in advance the witnessing of test by the Engineer or his representative shall not absolve the Contractor from his responsibility for the proper functioning of the equipment, and for furnishing the guarantees referred to in clause 8.0. All test results shall be supplied in quadruplicate. All expenses for carrying out the tests and witness by the Engineer shall be borne by the Contractor and deemed to have been included in the tender bid.

1. **TESTING-GENERAL**
	1. **Scope**

Upon completion of the installation, the Contractor shall perform field tests on all equipment, materials and systems. All tests shall be conducted in the presence of the Engineer for the purpose u1 demonstrating equipment or system compliance with Specifications. The Contractor shall submit for Engineer's approval complete details of tests to be performed describing the procedure, test observations and expected results.

The Contractor shall furnish all tools, instruments, test equipment. materials, etc , and all qualified personnel required for the testing, setting and adjustment of ail electrical equipment and material including putting the same into operation,

All tests shall be made with proper regard for the protection of the personnel and equipment and the Contractor shall be responsible for adequate protection of all personnel and equipment during such tests. The cost of any damages or rectification work due to any accident during the tests shall be the sole responsibility of Contractor.

The Contractor shall record all test values of the tests made by him on all equipment. Four (4) copies of all test data and results certified by the Engineer shall be given to the Engineer for record purposes. These shall also include details of testing method, testing equipment, diagrams, etc.

The witnessing of any tests by the Engineer does not relieve the Contractor of his guarantees for materials, equipment and workmanship, 'or as any other obligations of Contract.

1. **Insulation Resistance Test**

Insulation resistance test shall be made on all electrical equipment by using 500 volts for circuits up to 250 volts and 1000 volt for circuits between 250 and 500 volts. For testing of 11 kV circuits, up to 5 kV shall be used; the exact voltage shall be as advised by the equipment manufacturer unless otherwise advised by the Engineer.

The insulation resistance values of cables, transformer, switchgears, etc., shall be as per BSS, IEEE, NEC, ICEA and Pakistan Electricity Rules.

Before making connections at the ends of each cable run or joint between cables, the insulation resistance test of each cable section shall be made. H.T. cables shall be subjected to high voltage test as per recommendations of standard to which the cable is manufactured. Each conductor of a multicore cable shall be tested individually with each of the other conductor of the group and also with earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced and tests repeated on new cable. If cable joint is provided, then each cable section shall be tested, and joint made only after the tests have been made satisfactorily. Finally the completed cable length including the joints shall be tested.

The transformer and switchgear shall be given an insulation resistance measurement test after installation, but before any wiring is connected. Insulation tests shall be made between open contacts of circuit breakers, switches and between each phase and earth.

If the insulation resistance of the circuit under test is less than the specified value, the cause of the low reading shall be determined and removed. Corrective measures shall include dry- out procedure by means of heaters, if equipment is found to contain moisture. Where corrective measures are carried out, the insulation resistance readings shall be taken after the correction has been made and repeated twice at 12 hours interval. The maximum range for each reading in the three successive tests shall not exceed 20% of the average value. After all tests have been made, the equipment shall be reconnected as required.

1. **Earth Resistance Test**

Earth resistance tests shall be made by the Contractor on the earthling system, separating and reconnecting each earth connection.

If it is indicated that soil treatment or other corrective measures are required to lower the ground resistance values, the Engineer will determine the extent of such corrective measures.

The electrical resistance of the ECC together with the resistance of the earthling leads measured from the connection with earth electrode to any other position in the complete installation shall not exceedone ohm.

Earth resistance test shall be performed as per Electrical Inspector's requirements. Where more than one earth electrode is installed, the earth resistance test of each electrode shall be measured by means of resistance bridge instrument.

The complete lightning protection system shall be tested for continuity and earth resistance. The combined earth resistance at any point in the lightning protection system shall not exceed10 ohms.

1. **Switchgear**

Each circuit breaker shall be operated electrically and mechanically. All interlocks and control circuits shall be checked for proper connections in accordance with the wiring diagrams given by the manufacturer.

The Contractor shall properly identify the phases of all switchgear and cables for connections to give proper phase sequence.

Trip circuits shall be checked for correct operation and rating of equipment served. The correct size and function of fuses, disconnect switches, number of interlocks, indicating lights, alarms and remote control devices shall be in accordance with approved manufacturer drawings. Nameplates shall be checked for proper designation of equipment served. Protective relays shall be tested and set at site prior to commissioning of the equipment.

1. **Transformer Tests**

In addition to the insulation resistance test of the transformer, a polarity and phase rotation test shall also be made. Buchholz relay shall be tested for proper operation. Di- electric test shall be carried out on transformer oil prior to putting the same in operation.

1. **Special Systems' Tests**

The special systems such as Telephone, Intercom, public address, etc., shall be tested according to the procedures laid down in the respective sections of the technical specifications. However, any specific tests recommended by the manufacturer shall also be carried out as approved by the Engineer.**Completed Tests**

After any equipment has been tested, checked for operation., and is accepted by the Engineer, the contractor shall be responsible for the proper protection of that equipment so that subsequent testing of other equipment do not cause any damage to the already tested equipment.

1. **Expenses**

All expenses, I-e., traveling, boarding, and lodging for carrying out the tests and witnessing by the Engineer shall be borne by the contractor and are deemed to have included in the BOQ rates of the respective equipment (s) by the contractor.

**\*\*\* END OF SECTION \*\*\***

LT DISTRIBUTION BOARDS

1. **SCOPE OF WORK**

The work under this section consists of manufacturing, fabricating, supplying, installing, testing, and commissioning of all material and services of the complete Low Tension (LT) Distribution Boards as specified herein, shown on the Tender Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other services for exact location and position of the electrical lines and equipment.

The Low Tension Distribution Board with accessories shall also comply with the General Specifications for Electrical Works, and with other relevant provisions of the Tender Document,

1. **GENERAL**

The Low Tension Distribution Board shall be sheet steel fabricated suitable for recessed mounting, totally enclosed, dust and damp proof. It shall be complete in all respect with material and accessories, factory assembled, tested and finished according to the Specifications and to the normal requirements-Trie Low Tension Distribution Board shall be dead front and front operation type and shall:

* Have a rated service short circuit breaking capacity, Ics at 400 V AC as shown on drawing/BOQ.
* Be suitable for 415/230 Volts, 3 phase 4 wires, 50 Hz system.
* Be designed for flush mounting of all instruments on the front side.
* Have incoming and outgoing cable termination arrangement, terminal, block/line up terminals.
* Be provided with stainless steel name plate on the front side of door
* And wiring diagram on inside of door.
* Have all incoming and outgoing connections from top or bottom according to site requirements.
* Have door grounded by flexible copper strip/cable.
* Comply with requirements of IP40 for indoor and IP55 for outdoor units.
1. **APPLICABLE STANDARDS/CODES**

The latest editions of the following standards and codes shall be applicable for the materials specified within the scope of this section:

IEC 51 - Direct setting electrical measuring instruments

IEC 73 - Colors for indicator lights and push buttons.

IEC 157/158 - Low voltage switchgear and control gear.

IEC 439 - Low Voltage Switchgear and Control gear Assemblies.

BS 4752 - Circuit Breaker.

BS 88 - HRC fuses.

BS 89/90 - Ammeters and Voltmeters.

BS 3938 - Low voltage current transformers-

BS 3245 - Bus Bars.

1. **MATERIAL**
	1. Sheet Metal Work

The Low Tension Distribution Board shall be fabricated from electro galvanized/zinc coated sheet stool. All the components shall be installed on a common component mounting plate inside the enclosure and protected from the front with screwed sheet steel dead front cover plate. The door and dead front cover shall be made of 14 SWG sheet steel. The door shall be fully gasket with hinges on the left hand side and locking handle on the right hand side for fastening the door. The locking handle should be detectable. The dead front assembly shall be fastened to enclosure by means of self- locating fasteners for quick and easy fixing.

The distribution board shall be supplied complete with all installation materials as recommended by the manufacturer. The incoming and outgoing cable connections shall be according to the wiring requirements. If required, an adapter box for accommodating the cables and conduits may be provided. The box shall be of the same material and finish as the DB.

The cabling inside the DB shall be suitably harnessed by means of straps or cords. An earth bar or terminal strips shall be provided for connection of incoming and outgoing earth conductors. The earth bar or terminals shall be permanently connected to the body of DB at two points. Flexible copper strip shall be provided for earthing of the door of DB.

Neutral bus assembly shall consist of outgoing screw terminals with one terminal for each MCB.

All holes, cutouts, etc., shall be tool or jib manufactured and free from burrs and rough edges. Removable glad plates shall be provided at both the top and bottom-All metal work of the DB shall be cleaned down to bare shining metal phosphates and the surfaces chemically prepared for powder coating. Then these shall be coated with powder of color RAL 7032 and then baked in oven. The thickness of powder coating shall not be less than 120 microns.

Each breaker shall have a circuit identification label fitted below the breaker perture of the protective cover.

A clean plastic pocket shall be provided at the back of the front access for placing wiring diagram.

Labels described shall have block letters (7 mm high) on a while background, to be made from trifoliate and boo fixed with screws.

1. **Components**

The Low Tension Distribution Boards shall be provided with components as specified, as shown on the Tender Drawings and required for the satisfactory operation of the distribution board and of the electrical system.

### Typical component specifications are given below: -

1. **Bus Bars**

The Bus bars shall be made of 99.9% pure high conductivity annealed electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colors applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be green.

The bus bars shall be for three phase, neutral and earth and shall be of appropriate size to meet the electrical and mechanical requirements of the system. The temperature rise shall not exceed 30°C at rated current.

1. **Molded Case Circuit Breaker (MCCB)**

The MCCBs shall be molded case triple pole 440 volts or single pole 250 volts of current ratings as shown on the drawings. These shall have fixed magnetic short circuit and adjustable/fixed thermal overload protection.

The MCCBs shall be installed such that their switching levers are accessible through the front plate for operation. Circuit numbers/designation on all circuits shall be conspicuously marked to facilitate connection and maintenance.

The single and triple pole MCCBs shall have short circuit rupturing capacity suitable for the distribution system as approved by the Engineer or as shown on the drawings. The MCCBs shall be suitable for working on lighting and power circuits.

The breaker shall have quick make, quick break toggle mechanism with positive 'ON', 'OFF' and 'Tripped' positions.

Trip mechanism shall be trip free on over load or short circuit, ensuring that the breaker will not remain close even when the operating handle is manually held closed or with circuit breaker handle locked in the 'ON' position during short circuit or continuous over load. Automatic tripping shall be indicated by a handle position between the manual 'ON' and 'OFF' positions,

1. **Load Break Switches (LBS)**

The load break switches shall be triple pole, molded type and suitable for 400 V, 50 HZ a.c. systems. The operating lever shall have a spring controlled toggle mechanism.

1. **Earth Leakage Circuit Breakers (ELCB)**

ELCBs shall be current operated type with tripping current as shown on drawings and tripping time not more than 0.1 seconds.

1. **Ammeters and Voltmeters**

All meters shall be flush mounting, moving iron, spring controlled. The front dimensions shall be 96 x 96 mm.

The meters shall be of accuracy class 1.5 according to BS-89 and 90 The ammeter shall be suitable for connection to 5 Amps secondary of current transformers or directly through shunt as shown on drawings. The ammeters and voltmeters shall have measuring range as indicated on the drawings. A red mark shall be provided at the working voltage on the scale of all voltmeters,

1. **Current Transformers**

Air-cooled, ring type current transformers shall be provided having transformation ratio as indicated on the drawings. The current transformers shall be of suitable burden having accuracy class 1.0 according to BS 3938. The current transformers shall have 5 amps secondary.

1. **Selector Switches**

Ammeter and voltmeter selector switches shall be complete with front plate and grip handle. R-Y-B and OFF position for ammeters and RY-YB-BR-RN and OFF position for voltmeters shall be marked on the respective selector switches.

The selector switches for controls shall be rotary cam type, having required number of positions. It shall be provided complete with knob and front piate showing all positions as required.

1. **Air Break Contactors**

The contactor shall be air break, triple pole, 400 volts. Each contactor shall be provided with a 230 volt operating coil, one 6 watt, 230 volt red colored signaling lamp, control fuse and two normally open and two normally closed type auxiliary contacts wired up to terminals for electrical interlocking.

1. **Push Buttons**

Push Button shall be momentary contact type and suitable for flush mounting on the door of panel and on remote area. The push button for ON and OFF switching shall be spring loaded.

1. **Indicating Lamps**

Indicating lamps shall be suitable for flush mounting, complete with base and 230 volts incandescent lamp. It shall have rosettes of suitable colors as approved by the Engineer.

1. **TESTS AND INSPECTION**

The following tests and inspections shall be performed in accordance with relevant engineering standards:

(a) Visual inspection of appearance, construction, dimensions and workmanship.

1. Mechanical operating test.
2. **INSTALLATION**

The location of distribution boards are shown diagrammatically on the drawings. The actual location shall be determined at site, keeping in view the site conditions and other equipment, as approved by the Engineer.

Low tension distribution board for recessed mounting in wall shall be installed such that the door shall finish flush with the surface of wall. The recess mounted distribution board shall be installed before the plastering of walls. The DB shall be protected to avoid any damage due to the civil work.

All loose parts dispatched separately with the DB shall be installed as per manufacturer instructions and all adjustments or setting shall be made as required. All screws, nuts and bolts used for fixing the distribution board shall be galvanized.

The location of distribution boards are shown diagrammatically on the drawings. The actual location shall be determined at site, keeping in view the site conditions and in coordination with other equipment.

The distribution boards installation shall include connecting all incoming and outgoing cables. The cable entry in the boards shall be provided from top or bottom as required.

The distribution boards shall be tested as per instructions contained in article "Testing" of General Specifications for Electrical Works

\*\*\* **END OF SECTION** \*\*\*

## LIGHT FIXTURES

1. **SCOPE OF WORK**

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories of the complete Light fixtures as specified herein and/or shown on the drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact locations and positions of the light fixtures,

The lighting fixtures with accessories shall also comply with the General Specifications for Electrical Works, and with other relevant provisions of the Tender Document.

1. **GENERAL**

The description of light fixtures is given in the bill of quantities, and stated on the drawings, and all relevant material are described in this Section. The determination of quality is based on certified photo-metric data covering the coefficient of utilization, light distribution curves, construction material, shape, finish, operation, etc.

The Contractor shall submit at least two samples of each and every light fixture specified and obtain approval of the Engineer before purchasing. The quality and finishes of the local make light fixtures (if mentioned in BOQ) shall be same as that of standard manufacturer. The accessories such as ballast, lamp/starter holders, starters, lamps, igniters etc. for all type of light fixtures shall be of Philips make or approved equivalent, Approved equivalent against those specified will be accepted if the specified one Is/will not be available. For any substitution the Engineer's approval is necessary.

All fixtures shall be finished in standard color schemes as mentioned in the manufacturer's catalogue for respective fixtures, unless specifically stated in the Specifications, Drawings or Bill of Quantities or directed by Engineer.

Normally the light fixtures are not part of this contract. However, only the bulb-holder shall be installed using the brass socket for the incandescent

1. **APPLICABLE STANDARDS/CODES**

The latest editions of the following standards/codes shall be applicable to the material specified within the scope of this section:

|  |  |
| --- | --- |
| 1EC 81& BS 1853IEC 82 &BS2818IEC 155 & RS 3772IEC 400IEC 566, BS 367,7 3767/4017IEC 598 | Tubular fluorescent lamps Ballast for tubular fluorescent lamps Starters for fluorescent lampsLamp holders and starter holders for fluorescent lampsCapacitors for use in TL, HP mercury and LP sodium vapors discharge lamp circuits Luminaries |

1. **MATERIAL**
	1. **Fluorescent Light Fixtures**

The fluorescent light fixtures shall have lamps and ballasts of proper rating as shown on the drawings. Each lamp shall be provided with independent ballast.

The fluorescent lamps shall be tubular, 1224/610mm long, for 36/18 watts respectively as specified. The fluorescent color shall be cool daylight characteristics with an average output of 2500 lumens (± 5%) for 36 watts and 1030 lumens (5%) for 18 watts after 100 burning hours. The ballast shall be polyester filled type, totally enclosed and suitable to operate up to 250 VAC. The power loss shall not be more than 9 watts for 40/36 watts ballast. A wiring diagram, wattage, voltage and current figures shall be printed on the body of the ballast.

The lamp holders shall be rotary lock-in type. The starters shall be glow type with radio interference suppressor/by-pass capacitor. The internal wiring of the fluorescent light fixtures shall be done with heat resistant wires at the manufacturer's factory. All light fixtures shall be provided with power factor improvement capacitor to give a minimum power factor of 0,90. Connectors suitable for connecting 2.5 sq.mm cable conductors shall be provided for supply connections.

The body of the fluorescent light fixtures shall be minimum 24 SWG sheet steel, derusted, degreased, finished in heat resistant paint, stove enameled, appropriate size bushed wire entry holes, fixing holes, and earth terminal shall be provided.

The light fixtures shall be furnished with Perspex diffusing panels "040 opal acrylic" (minimum sheet thickness 3mm), polystyrene louvers or metal grid louvers or mirror optic reflectors, etc. as specified on the drawings or in BOQ. The louvers shall be secured firmly and in level. The polystyrene, louvers shall be white Egg Crate or as approved by the Engineer. The louvers shall be in one section and not in pieces. An earth terminal for connection to 2.5 sq.mm cable conductor shall be provided.

The design of light fixture for recess mounting shall be coordinated with the design of false ceiling prior to commencement of manufacture. Shop drawings shall be submitted for approval of Engineer.

1. **Incandescent Light Fixtures**

The incandescent light fixtures shell be as stated on drawings and bill of quantities. The light fixture shall be finished in standard colors unless otherwise stated on drawings or directed by engineer, All incandescent light fixities shall be of International standard and quality, the type of fixtures with manufacturer catalogue reference are given on the fixture schedule and in bill of quantities. Equivalent fixture may be acceptable provided that the contractor submits for review all necessary data indicating photometric curves to show that the fixture proposed are of the same type, construction and quality.

The lamps for incandescent light fixtures shall be GLS lamps and shall be supplied and installed according to the wattage as indicated on drawings.

Weather proof bulkhead incandescent light fixture shall comprise of cast aluminum body and gasket clear glass cover secured to the body by means of wing nuts/screws to give a weatherproof and water tight fit- The gasket shall be weather resistance type. A **G.I.** wire guard shall be provided on the glass cover. The lamp holder shall be of bi-pin brass having porcelain outer ring.

The glass shade of the light fixtures shall be opal white or clear and free from any air bubbles or voids. The shade may be spherical, cylindrical, flattened bottom or any other shape as specified in the drawings or BOQ. The glass shall be opal white or clear as furnished by the manufacturer with the light fixture unless specified.

1. **LIGHT FIXTURE INSTALLATION**
2. **General**

The mounting heights of light fixtures are indicated on the drawings, and positions of fixtures are according to the mentioned scale. The Contractor must ensure that the light fixtures are installed uniformly with respect to the dimensions of the area. Any modifications due to site conditions may be made with the approval of Engineer. All fixtures shall be carefully aligned before fixing in position,

The wiring between ceiling rose or terminal box and the fixture shall be carried out with 3-core 0,75 sq.mm and 1 sq.mm flexible copper conductor PVC/PVC cable respectively for circuits protected by 10 amps and 15/20 amps mcbs. The wiring inside light fixture body shall be done with heat resistant cables or PVC insulated cable in heat resistant sleeves as approved by the Engineer.

Glasses, shades, reflectors, diffusers, etc, must be in a clear condition after installation. All light fixtures shall be earthed by an earth wire connected to the earth terminal in the fitting,

1. **Fluorescent Light Fixtures**

The fluorescent light fixtures on the surface of ceiling shall be installed with the back of the body flush with the ceiling surface, and in a manner so as to facilitate wiring. Nylon plugs and galvanized steel bolts or screws shall be used for fixing the light fixture to the ceiling. For light fixtures installation on false ceiling the installation method/detail shall be coordinated with ceiling design and submitted for approval of Engineer. Care shall be taken to prevent the weight of the fixture from being transferred to the false ceiling.

Pendant light fixtures shall have two holes in the top of each casing for supporting to the ceiling by a 3/4" dia. galvanized pipe or any other standard method as approved by the Engineer. Wiring from ceiling rose to the fixture shall be installed through the pipe. Proper arrangements such as long threads with check nuts, etc. for minor adjustment in the mounting heights of the fixtures shall also be provided.

1. **Incandescent Light Fixtures**

The incandescent light fixture shall be installed on the surface of celling or wall by means of nylon plugs and galvanized steel screws, such that their back finish flush with the surface for exposed conduits and flush with outlet box for concealed conduit system. Wherever convenient, screws for fixing light fixtures shall be screwed into the holes of the outlet box. The light on false ceiling shall be installed in a manner as described for fluorescent light fixture.

**\*\*\*END OF SECTION \*\*\***

## WIRING ACCESSORIES

1. **SCOPE OF WORK**

The work under this Section consists of supplying, installing, and commissioning of all material and services of the complete switches, switch sockets, etc., as specified herein, as shown on the Tender Drawings and explained in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact location and position of all electrical equipment.

The wiring accessories shall also comply with the General Specifications for electrical works and with other relevant provisions of the Tender Documents.

1. **GENERAL**

The locations of the wiring accessories such as sockets, switches etc. are tentatively shown on the drawings. The Contractor shall ensure the exact positions and locations of wiring accessories in coordination with other services drawings, as per site requirements and as directed by the Engineer. The Contractor shall be responsible for proper functioning of wiring accessories after installation and commissioning.

1. **APPLICABLE STANDARDS/CODES**

The latest edition of following standards & codes shall be applicable for the materials specified within the scope of this section:

BS 3676 - Switches for domestic and similar purposes.

BS 2135 - Capacitors for radio interference suppression.

BS 67 - Ceiling roses.

BS 115 - 3 pin plugs, socket outlets and socket outlet adapter.

PS 116 - Two and three terminal ceiling roses,

1. **MATERIAL**
	1. Switches - Indoor type

Switches for controlling light and fan points shall be single pole, rated for 10 Amps, 250 volts AC. The body of the switches shall be of Bakelite with white faceplate suitable for flush mounting on a sheet steel outlet box. The switches shall be piano type having silver tipped contacts and shall operate with snap action.

Unless otherwise specified wherever switches control only the light points, these shall be plate type gang switches installed on common outlet boxes. Where specified metal front plates shall be used with single grid type switches. The plate shall be finished in specified color or as otherwise directed by the Engineer. The bell push switches shall be spring-loaded type with the identification symbol embossed on it. Two-way switches shall be used to control lights from two different locations as shown on the drawings.

The switches shall be manufactured by Switch kid, Busch or approved equivalent.

1. Switch-Socket Units

Switch socket units shall he combined 2 and 3 pin 5 Amp or 3 pin 15 Amp 250 volt AC, molded type with switch and socket on white face plate conforming to the requirements stated above for switches Indoor type. The outlets shall be heavy duty type suitable for mounting on sheet steel outlet box. The 3 pin 15 amps sockets shall have shrouded live contacts and designed such that the earth pin of plug is engaged to socket earth before making of live contacts.

Where metal plate switches are installed, the switch socket units shall also be provided with front plate of similar design.

1. Sheet Steel Box

The sheet steel boxes for installation of switches, fan regulators, dimmers and socket outlets shall be made of 16 SWG sheet steel having appropriate dimensions. The box shall have suitable arrangement for receiving the conduit(s). An earth terminal shall be provided for connecting at least three earth wires of 4-sq.mm size.

The outlet box shall be given two coats of anti-rust red oxide paint before installation and one coat of enamel paint after installation.

1. Ceiling Rose

The ceiling rose shall be suitable for 5 amps 250 volts single phase ac. It shall have white plastic molded base plate, copper or brass terminals for connecting at least two wires of 2.5 sq.mm size. The ceiling rose shall have a cover with cable inlet hole suitable for multicore PVC insulated and PVC sheathed cable.

# INSTALLATION

1. General

The mounting heights of all wiring accessories fixtures are stated on the drawings. In case the mounting height is not mentioned, the instructions of the Engineer shall be obtained before fixing.

1. Switches, and Switch Sockets

All wiring accessories shall be installed on 1.63 mm (16 SWG) thick sheet steel box recessed in wall. Sheet on sheet steel box shall be by means of flat head galvanized screws sunk in the plastic plate so as to finish flush with the surface. The edges of the plastic plate shall be champhered.

Where switches and fan regulators are required to be installed together, these shall be grouped and suitably installed on common plastic sheet fixed on appropriate size sheet steel box.

\*\*\* **END OF SECTION**\*\*\*

CONDUITS AND PIPES

1. **SCOPE OF WORK**

The work under this section consists of supplying, installing and commissioning of all material and services of the complete Conduits and Pipes as specified herein and/or shown on Tender Drawings and stated in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at Site with other services for exact route, location and position of the electrical lines.

The conduits and pipes with accessories shall also comply with the General Specifications for Electrical Works, and with other relevant provisions of the Tender Document.

1. **GENERAL`**

The extent of works shown on the drawing does not indicate the exact position of conduits and pipes. The Contractor shall ensure exact location and route of conduit and pipes in coordination with other services drawings, as per site requirements and as directed by the Engineer.

The quality and material for the accessories of conduits and pipes such as sockets, elbows, bushings, bends, inspection/pull boxes, round boxes, etc., necessary for the completion shall be similar to that of conduits or pipes. All the accessories shall be supplied by the Contractor without any extra cost and deemed to have been included in the price of conduits/pipes.

1. **APPLICABLE STANDARD/CODES**

The latest edition of the following standards and codes shall be applicable for the materials specified within the scope of this section:

BS 31 - Steel conduits and accessories.

BS 4607 - PVC conduits and accessories.

BS 3595 - PVC Pipes and accessories.

BS 1378 - Galvanized Iron pipes & accessories.

1. **MATERIAL**
	1. PVC Conduits and Accessories

The PVC conduits and accessories for lighting and power circuits shall be furnished by the Contractor as shown in the drawings or given in BOQ. The PVC bends shall have enlarged ends to receive conduit without any reduction in the internal diameter at joint. Manufactured smooth bends shall be used where conduit changes direction. Bending of conduits by heating or otherwise will be allowed in special situations only, for which the consent of the Engineer shall be required. The use of sharp 90 degree bends and tees will not be allowed for concealed wiring.

The round PVC junction boxes for ceiling light or fan points shall have minimum dimensions of 63 mm diameter and depth. The junction boxes for wall light points shall have minimum dimensions of 63 mm diameter and 38 mm deep. Round junction boxes shall be provided with one piece PVC cover plate fixed to the box by means of brass screws.

The PVC conduits and accessories shall be from approved manufacturers.

1. Inspection and Adaptable Boxes

Inspection/Pull boxes and adaptable boxes shall be provided in conduit runs wherever required to facilitate pulling operation. The drawings are diagrammatic and do not indicate the position and spacing of inspection/pull boxes or adaptable boxes. However, these shall meet the following requirements: -

# Inspection/Pull Boxes

The rectangular inspection/pull boxes shall be made of 16 SWG heavy gauge sheet steel of suitable design to receive conduits. The box shall be painted inside and outside with black enamel paint over a base coat of red oxide primer paint. The minimum length of the box shall not be less than four times the cable manufacturer recommended bending radius of the cable. All concealed type boxes shall have a white plastic sheet of appropriate size fixed to the box by means of galvanized screws.

If the spacing between the end points of conduit run with respect to bends exceeds the following, an inspection/pull box of suitable size according to the number and size of cables and as approved by the Engineer shall be provided:

* + - Straight run without bend : Max. spacing 30 meters
		- Run with one 90° bend : Max. spacing 20 meters
		- Run with two 90° bends : Max. spacing 15 meters

Adaptable Boxes:

Adaptable boxes shall also be made of 16 SWG sheet steel and painted and finished to the same quality as the Lighting distribution boards. The adaptable box shail preferably be fixed adjacent to the DB and have suitable dimensions to match the installation with DB. However, in any case, the depth of adaptable box shall be according to number & size of cables & conduits and shall not be less then the following:

* + - Conduits upto 25 mm dia : Min. depth = 50 mm
		- Conduits upto 38 mm dia. : Min. depth = 65 mm
		- Conduits upto 50 mm dia. : Min. depth = 90 mm
		- Conduits more than 50 mm dia : Min. depth = 2 x dia.
			1. Galvanized Iron (G.l.) Pipes and Accessories

The G.I. pipes shall be made of mild steel, galvanized inside and outside by hot-dip galvanizing process. The pipes shall be free from stains, burrs or any other defect. The accessories for G.I. Pipes such as sockets, bends, etc. shall be also galvanized inside and outside and of same quality and specifications as the pipes.

These pipes shall be installed for crossing of cables above nallas and culverts and at entry into building. The pipes and accessories shall be provided with one thick coat of bituminous paint on the outer surface prior to installation. All pipes shall be secured in position by means of galvanized clamps, supports, etc.

G.I. pipes and accessories shall be from the approved manufacturers.

1. PVC Pipes and Accessories

The PVC pipe shall be rigid. All pipes shall be minimum Class 'D' (Working pressure - 12 bar), unless otherwise stated on Drawings or Bill of Quantities. The buried PVC pipe should be able to withstand the external load acting upon it by continuous movement of heavy duty vehicles such as trucks, cranes, fork-lift, etc. Where pipe changes direction, manufactured smooth bends shall be used.

Bending of pipes by heating or otherwise will be allowed in special cases only. Bending by heating shall be carried out by first filling the pipe with sand inside and then immediately removing the sand. The use of sharp 90 degree bends and tees will not be allowed. The bends shall conform to same specifications as given for PVC conduits. For jointing of pipe all precautions and procedures recommended by manufacturer shall be followed.

The pipes and accessories shall be from the approved manufacturers.

1. **INSTALLATION**
2. Concealed Conduits

Where concealed conduit system is stated on drawings, the conduit shall be installed concealed in roof, wall, column, etc. Conduits shall be laid under floor only where specifically stated, the entire conduit system shall be installed and checked before wiring is carried out, Any obstruction found shall be cleared before the installation of cable.

When concealed, the conduit shall have a minimum of 32 mm cover of concrete measured from the top of conduit to finished surface. In the reinforced cement concrete (RCC) work the conduit shall be laid before pouring of concrete. Under no circumstances shall chases be made in the RCC structure for concealing conduit and accessories after pouring of concrete. The conduit shall be supported on top of bottom reinforcement of slab. All outlet boxes to be firmly supported and installed such that they finish flush with the soffit of slab or beam.

Where conduits have to be concealed in cement concrete (CC) work after concreting or in block masonry, chase shall be made with appropriate tools and shall not be made deeper than required. The conduit shall then be fixed firmly in the recess and covered with cement concrete mixture. The work of cutting in the cement concrete work or block masonry work shall be coordinated with the civil work. The Contractor shall obtain approval from the Engineer before starting chasing and cutting.

The termination of conduits at or near the equipment switchboard is shown diagramatically on the drawings. The exact locations of the termination shall be coordinated with the equipment switchboard tobe installed. Any extensionof conduit to suit the site condition shall be made without any extra cost. Conduit ends pointing upwards or downwards shall be properly plugged in order to prevent the entry of foreign materials. All openings through which concrete may leak shall be carefully plugged and boxes shall be suitably protected against filling with concrete. At all terminations of conduit, sharp edges of conduit ends shall be prevented to avoid the cutting or damaging of wires or cables during pulling through the conduits.

Under floor conduit shall be installed at a minimum depth of 2 inch from the finished floor level or as shown on the drawings. The conduits shall be installed empty, before finishing of floor or in RCC work, with an 18 SWG steel wire drawn through the conduit for pulling cable. No conduits shall be laid under floor in bathroom.

Wherever the conduit lengths cross the expansion joint either along the columns or slab, suitable arrangement shall be provided so that when the conduit lengths in the expansion joint are stressed, the conduit shall not crack or break

1. Surface Conduits

The surface conduits shall be installed where shown on drawings only. The conduits shall be installed parallel or perpendicular to the surface of wall, structural members, ceiling, etc., by means of steel saddles and clamps of approved design. The conduits shall be kept at least 150 mm away from parallel runs of flues, steam pipes and hot water pipes.

The saddles shall be installed on surface by means of nylon or wooden plugs and galvanized screws. Appropriate size of holes in structure shall be made by drilling, the thickness of saddles shall not be less than 6mm and clamps shall be of 16 SWG sheet steel. The surface conduits shall be supported at a maximum of one meter spacing along horizontal and vertical runs. All accessories for complete installation of conduit system shall be provided by the Contractor.

The pull boxes, etc. as stated for concealed conduits shall also be applicable for surface conduit system. The entire steel conduit system along with the accessories shall be painted with one coat of black enamel paint after installation.

1. Steel Conduits and Accessories

The steel conduits and accessories are required to be installed on surface or concealed as shown on the drawings. Wherever possible the conduit(s) shall run on ceiling/beams on the appropriate routes as approved by the Engineer. The conduit(s) down to switches, socket outlets and other instruments shall be concealed in walls. The installation instructions for surface and concealed conduits given in this section are also applicable to the installation of steel conduits and accessories.

1. Galvanized Iron Pipes

The galvanized iron (G.I.) pipes shall be installed at a minimum depth of 900 mm measured from the top of pipes to finished ground level. The pipe shall be laid and checked for soundness before completion of civil works. The G.I. pipes at the entrance of the buildings shall be installed at locations as shown on the drawings.

At all joints the pipes shall be firmly screwed and cotton yarn with water-proof compound shall be used to make the joint water-proof.

At each termination, the pipe end shall have threads and socket screwed on thread for installing soft metal bush. The soft metal bush shall be of approved quality and shall be male type.

The installation of pipes shall he complete in all respects including its fixing at terminations before the work is started. All sharp edges and burrs shall be removed by using reamer or any approved device.

The pipe shall be checked before installation of uable for any obstruction. If found, it shall boo cleared without damaging the installation. All pipe ends shall be plugged to prevent entry of water, rodents etc.

1. PVC Pipe & Accessories

Rigid PVC pipes shall be installed under roads paved areas, at crossing with other services and at cable entering building as shown on the drawings. The depth of the pipe shall very according to the conditions at site, and approval of Engineer shall be obtained prior to installation; in general the pipes shall be installed underground at the following depths measured from the top of the pipe:

* + Under roads/pavement : 900mm below finished surface.
	+ When crossing outer : 250/500 mm vertical/horizontal services clearances with concrete cover

The trench of required dimensions shall be excavated and the bottom of trench cleaned and leveled. A 75mm bed of fine sand shall be provided over which the PVC pipes installed after proper alignment. Where two or more pipes are installed in the same trench the clearance between pipes shall not less than 50mm. After laying of pipe the trench shall be backfilled with clean screened earth in layers of 75mm, each layer properly tamped and compacted.

Where underground cables enter connection terminal boxes the PVC pipe shall be installed on surface by means of galvanized steel clamps at a maximum internal of 450mm.

After installation, the ends of the pipe shall be plugged with material impervious to water and chemicals.

All joints shall be sealed adequately to prevent entry of foreign elements.

The installation of pipes shall be completed in all respects including its fixing at terminations, before cabling work is started. All sharp edges and burrs shall be removed by using reamer or any approved device. The pipe shall be through cleaned of dirt and dust from inside; the pipes shall be installed in proper coordination with other works.

**\*\*\* END OF SECTION \*\*\***

**MISCELLANEOUS ITEMS**

1. **SCOPE OF WORK**

The work under this section consists of supplying, installing, testing and commissioning of all material and accessories for Miscellaneous Items as specified herein and/or shown on the drawings and given in the Bill of Quantities.

The Contractor shall discuss the electrical layout with the Engineer and co-ordinate at site with other for exact locations and positions of the Miscellaneous Items.

The Miscellaneous Items with accessories shall also comply with the General Specifications for Electrical Works and with other relevant provisions of the Tender Document.

1. **GENERAL**

The Miscellaneous Items as described in this section shall comply with other sections of these specifications as applicable. No specific reference to any manufacturer has been made and the Contractor shall ensure that all the miscellaneous items be supplied/fabricated from the reputable manufacturers, who have already supplied/fabricated similar items.

1. **APPLICABLE STANDARDS/CODES**

The latest editions of the following standards/codes shall be applicable to the material specified within the scope of this section:

BS 4752-1 - Circuit Breakers.

BS 4934 - Safety requirements for electric fans and regulators.

BS 5060 - Performance of circulating fans and their regulators.

1. **MATERIAL**
	1. Metal Enclosed Switch Fuse Unit & MCB Units

The single pole & neutral 250 volts and triple pole 500 volts switch fuse or MCB units are used for supplying single phase/three phase power control for the apartments/houses installed near supply company meter-boards or required for equipment as specified and as shown on the drawings.

The handle of the switch shall be so interlocked that it would be not be possible to open the cover without putting the handle in the "OFF" position.

The switch fuse unit shall be of FICO make or approved equivalent,

1. Ceiling Fan

Ceiling fan shall be capacitor type; suitable for 250V AC The air displacement shall be 12,000 cfm for 56" (1422 mm) sweep and 10,000 cfm for 48" (1219 mm) sweep at maximum speed. The fan motor shall be capacitor type and bearing shall be groove type to give noiseless operation. The complete fan with blades and canopy shall be finished in white color.

The fan hook shall be made of 16 mm diameter mild steel rod. It should be in the form of a loop about 75 mm long and about 50 mm wide. The rod should be bent to have at least 200 mm extension on both sides fur tying to reinforcement steel of slab.

Normally fans are not part of this contract. However, for regulating the speed of the fan, tan dimmers shall be provided having electric circuit, Dimmer shall be so designed that it shall not interfere with electronic equipment or fluorescent light fixtures.

1. Exhaust Fans

Exhaust Fans shall be three-blade type of metal construction, mounted on steel mounting plate with Orifice ring.

Fans shall be direct driven and supplied complete with electric motor, backdraft dampers and anti-vermin screen.

The bearings shall be ball, roller or sleeve type of permanently lubricated and sealed type.

Wheels shall be heavily and rigidly constructed and accurately balanced both statically and dynamically and be free from objectionable vibration or noises.

1. Manholes with Cl Cover & Frame

Manholes for electric power cables or telephone cables shall be constructed in accordance with the standard Specifications of Civil works. The work shall also include making of concrete chambers and concrete benching in manholes, complete as shown on the drawings. Top of the cover shall be roughened in an approved pattern. The cover shall tightly fit in the frame and shall be watertight. The manhole shall have appropriate identification code as instructed by Engineer.

Cl covers complete with frame shall be of the size specified on the drawings. The specified size means the clear opening. The cover shall be of 100 kg weight or as approved by the Engineer. Suitable locking and lifting arrangement shall also be provided. The frame shall be set in place at the time of pouring of concrete so that the cover shall tightly fit in the frame.

## INSTALLATION

1. General

The mounting heights, depths and other dimensions of all the Miscellaneous Items are stated on the drawings or in general notes. In case of any discrepancy, the instructions of the Engineer shall be obtained before fixing the item.

1. Metal Enclosed Switch Fuse Unit & MCB Units

The metal enclosed switch fuse or MCB unit shall be installed on wooden box with screws or some suitable arrangements as approved by Engineer.

1. Ceiling Fan

Fan hook shall be installed in the RCC ceiling and to the reinforcement before pouring of concrete.

The installation of fan shall include fixing of blades, down- rod, clamp, canopy, including testing and commissioning. The down rod shall be of required length having long threads and shall be provided with check nuts to secure it firmly with the clamp and the body of the fan. A split pin shall be provided both at the fan body end and at the clamp for safety. Any scratches on the body of the fan or fan rod appearing during installation shall be cleaned and painted properly with the same quality paint as provided by the manufacturer.

Wiring between the ceiling rose and the fan terminals shall be carried out with three core 0.75 sq.mm PVC insulated, PVC sheathed flexible copper conductor cable.

1. Exhaust Fan

The propeller exhaust fan shall be installed in the opening already made in the wail and shall be firmly fixed by means of flat head galvanized screws,

Wiring between the ceiling rose and the fan terminals shall be three core 1.0 sq.mm PVC insulated PVC sheathed flexible cables.

1. Manholes with Cl Cover & Frame

The manholes shall be constructed according to the Specifications of the civil works and standard practice. Proper curing of the concrete shall be done for at least 15 days. Before constructing, the Contractor shall submit shop drawing of manhole showing steel reinforcement, embedded pipes, clearances, etc. for approval of the Engineer. Quality of cement used in the manhole shall be sulphate resistant.

**\*\*\*END OF SECTION \*\*\***