



**Tender Document  
for  
Construction of Corporate Office Building  
At  
Durbarmarg, Kathmandu**

**VOLUME II- SPECIFICATION**

**Nepal Electricity Authority  
Engineering Services Directorate  
Building and Physical Infrastructure Construction Project  
Durbarmarg, Kathmandu**

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**SPECIFICATION OF CIVIL WORKS**

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**A GENERAL****A1 PROVISIONS**

The Work shall be carried out according to these Specifications whether specifically mentioned elsewhere or not. No extra in any form will be paid unless it is definitely stated as an item in the Bill of Quantities.

Whenever the Specifications are not given or when the Specifications are ambiguous, the relevant Indian Standards or British Standards and further amendments will be considered as final and binding.

All Works shall be carried out simultaneously with electrical, plumbing, sanitary and other services and in co-operation with the Contractors the above services. The Work shall be carried on till it is completed satisfactorily along with the completion of other essential services. The building Contractor shall keep the other Contractors informed of the proposed program of Work, well in advance, so that the building Work is not hindered. The Contractor shall further cooperate with other Contractors in respect of any facility required by them e.g. making holes in shuttering for sanitary, pipes, electric conduits, fan hook etc. However, no extra payment shall be admissible to him for such reasonable assistance and facilities afforded to other Contractors and the building Contractors shall be deemed to have taken these factors into consideration while quoting his rates.

The Work shall be related to the drawings which the Contractor is presumed to have studied. Nothing extra will be paid for any item because of its shape, location or other difficult circumstances, even if the schedule makes no distinction, as long as the item is shown in the drawings.

The sources of materials stated in the Specifications are those from which materials are generally available. However, materials not conforming to Specifications shall be rejected even if they come from the stated sources. The Contractor should satisfy himself that sufficient quantity of materials of acceptable Specification is available from the stated or other sources.

The requirements of Specifications under (A). GENERAL (B). MATERIALS shall be fulfilled by the Contractor without extra charges i.e. the item rates quoted shall be deemed to have taken these Specifications into account.

These are requirements the Contractor shall fulfill after the issue of Letter of Acceptance but before the Date of Commencement.

**A2 DEFINITIONS****a) General**

**Acceptable/Approved (Approval)** - Acceptable to/approved (approval) by the Engineer.

**Agreed** - Agreed in writing.

**As detailed** - As detailed on the drawings.

**Authorized/ordered/rejected** - Authorized/ordered/rejected by the Engineer.

**Designated** - Shown on the drawings or otherwise specified by the Engineer or, in relation to an item scheduled in the bid documents, descriptive of an item to be priced by a bidder.

**Indicated** - Indicated in or reasonably to be inferred from the contract, or indicated in writing by the Engineer.

**Instructed/directed/permitted** - Instructed/directed/ permitted by the Engineer.

**Satisfactory** - Capable of fulfilling or having fulfilled the intended function.

**Service** - Any pipeline, cable, duct etc. for conveying or transmitting any fluid or other matter.

**Submitted** - Submitted with the tender or submitted to the Engineer, as appropriate.

**b) Tolerances**

**Deviation** - The difference between the actual (i.e., measured) size or position and the specified size or position.

**Permissible deviation** - The specified limit(s) of deviation.

**Tolerance** - The range between the limits within which a size or position must lie.

**c) Measurement and Payment**

**Bill/schedule** - The bill/schedule of quantities.

**Billed/scheduled rate** - The unit rate or price entered in the bill/schedule at which the Contractor undertakes to execute the particular work or to provide the required material, article or service, or to do any or all of these things, as set out in the item concerned.

**Billed/scheduled** - Listed in the bill/schedule of quantities.

**Fixed charge** - A charge for work that is executed without reference to time.

**Method-related charge** - The sum for an item inserted in the bill by the Contractor when tendering, to cover items of work relating to his intended method of executing the Works.

**Time-related charge** - A charge for work the cost of which, to the Employer, is varied in proportion to the length of time taken to execute the particular item scheduled.

**Value-related charge** - A charge that is directly proportional to the value of the contract.

### **A3 CONTRACTOR'S OFFICE & ACCOMMODATION**

Various works defined under this item are for the provision and maintenance of the Contractor's office, camps, stores, equipment yard, and workshops. The structure of the buildings shall be adequate, rainproof, spacious, airy and hygienic with proper lighting and toilet facilities. The area shall be kept neat and clean. Any garbage or sewage shall be disposed at a location and in a manner approved by the Engineer.

Space allocated for storage of various materials such as cement, reinforcement steel, and petroleum products etc. shall be clearly separated to avoid contamination.

Petroleum products shall be stored and handled in a way that avoids contamination of ground water. Workshops shall be installed with oil and grease traps for the same purpose.

Written information shall be given to and approval taken from the Engineer regarding proper establishment and maintenance of such camps. Failure in compliance with Engineer's instructions in respect of overall standard will lead to reduction or withholding of any payment due to the Contractor.

The Contractor shall provide at his own expense adequate temporary accommodation and toilet facilities for his Workmen and keep the same in good conditions. This may be done to suit Site conditions with the approval of Project Engineer. The above mentioned temporary structures shall be removed on the completion of Works at Contractor's own cost. All materials shall belong to the Contractor.

The Contractor shall make his own arrangement for the supply of electric power and lighting as required for construction purpose.

The Contractor shall make his own arrangement for all internal and external telephones and other communication means deemed necessary for the Works.

The Contractor shall make his own arrangement for office equipment and other consumable for his use for the Works.

### **A4 OFFICE FOR ENGINEER**

The contractor shall provide and maintain offices for the use of the Engineer and his staff if provided in the contract

### **A5 SAFETY MEASURES**

The Contractor shall be responsible for safety of all workmen and other persons entering the Works and shall at his own expense; where not stated otherwise take all measures, subject to the Engineer's approval, necessary to ensure their safety. Such measures shall include but not be limited to:

Provision of safety and emergency regulations for fire, gas, and electric shock prevention, together with rescue operation plan

Safe control of flowing water

Provision and maintenance of suitable lighting to provide adequate illumination at place of work with appropriate spares and standby unit

Provision and maintenance of safe, sound slings, pulleys, ropes, and other lifting device  
Provision of safe access to any part of the works.

Provision of notices in local dialect temporarily or permanently during construction at locations likely to be used by the public. Placement of such notices shall depend on the existence of the nature of work in the vicinity. These notices shall be in addition to any other statutory requirements demanded of the Contractor

The Contractor shall submit a proposal with detailed safety and emergency measures for the Engineer's approval. When the proposal has been approved, English and Nepali version of the regulations shall be made available to all of his Employees and the Engineer.

The Contractor shall ensure that all his Employees are fully conversant with the regulations, emergency and rescue procedures etc. and shall enforce a rule that will instantly dismiss any employee committing a serious breach of such regulations.

#### **A6 NOTICE BOARDS**

The Contractor shall erect notice boards (1.2 m x 1.8 m) at the site giving details of the Contract in the format and wordings directed by the Engineer. These boards shall be erected within 14 days after the Contractor has been given the Possession of Site

The Contractor shall not erect any advertisement sign board on or along the work. The board shall be removed by the Contractor by the end of the Defects Liability Period.

#### **A7 TEMPORARY FACILITIES**

##### **(1) Provision of Temporary Services**

When the rehabilitation or replacement of existing public utilities requires their temporary disconnection, the Contractor shall provide the affected users with temporary services in at least the same standard as the original services. For water supply he may install temporary lines or arrange for regular supply by tankers. When forced to disconnect existing sewers the Contractor shall install temporary pipes of adequate size to carry off sewage from any private sewer facilities cut off by construction work. Connections to temporary pipes shall be made immediately by the Contractor upon cutting off the existing facility. No sewage shall be allowed to flow from any severed facility upon the ground surface or into trench excavation. Pipes used in temporary sewers may be plastic or approved flexible material.

Upon completion of work the Contractor shall replace all severed connections and restore to operating order the existing sanitary facilities. The Contractor without approval of the Engineer shall operate no valve or other controls in public service facilities. All users affected by such operation shall be notified by the Contractor at least one hour before the operation and advised of the probable time when service will be restored.

##### **(2) Protection of Adjoining Property**

The Contractor shall control the movement of his crews and equipment on right-of-way including access routes approved by the Engineer so as to minimize damage to crops and property and shall endeavor to avoid marring the lands. Ruts and scars shall be obliterated and damage to land shall be corrected and the land shall be restored as closely as possible to its original conditions before final taking-over of the Works.

The Contractor shall be responsible directly to the Employer for any excessive or avoidable damage to crops or lands resulting from his operations whether on lands adjacent to right-of-way or on approved access road and deductions will be made from payment due to the Contractor to cover the amount of such excessive or avoidable damage as determined by the Engineer.

##### **(3) Reinstatement upon Completion**

Temporary facilities shall be provided by the Contractor, only for as long as required after which he shall dismantle and remove the same from their place of use as speedily as possible. The Contractor in his yard shall safely store re-usable components. The place of use shall be cleared and reinstated immediately to at least the condition existing before the temporary facilities were provided to the

satisfaction of the Engineer.

**(4) Measurement and Payment**

Unless otherwise provided in the contract, no separate measurement and/or payment shall be made for all materials and works required under this clause. All costs in connection with the work specified herein shall be considered to be included with other related items of the work in the BOQ

All provision of temporary services shall be covered by a provisional sum in the BOQ. The lump sum amounts indicated in BOQ shall be paid in pro-rata basis by dividing the total amounts by contract period in months. These payments will be incorporated in the interim certificates for payment.

**A8 PUBLICLY AND PRIVATELY OWNED SERVICES**

- (1) If any privately owned service for water, electricity, drainage, etc., passing through the site is affected by the works, the Contractor shall provide a satisfactory alternative service in full working order to the satisfaction of the owner of the services and of the Engineer before terminating the existing service.
- (2) Drawing and scheduling the affected services like water pipes, sewers, cables, etc. owned by various authorities including Public Undertakings and Local Authorities included in the contract documents shall be verified by the Contractor for the accuracy of the information prior to the commencement of any work.
- (3) Notwithstanding the fact that the information on affected services may not be exhaustive, the final position of these services within the works shall be supposed to have been indicated based on the information furnished by different bodies and to the extent the bodies are familiar with the final position. The Contractor must also allow for any effect of these services and alternations upon the works and for arranging regular meetings with the various bodies at the commencement of the contract and throughout the period of the works in order to maintain the required co-ordination. During the period of the works, the Contractor shall agree if the public utility bodies vary their decisions in the execution of their proposals in terms of program and construction, provided that, in the opinion of the Engineer, the Contractor has received reasonable notice thereof before the relevant alterations are put in hand.
- (4) No clearance or alterations to the utility shall be carried out unless ordered by the Engineer.
- (5) Any services affected by the works shall be restored immediately by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the works.
- (6) The Contractor may be required to carry out the removal or shifting of certain services/utilities on specific orders from the Engineer for which payment shall be made to him. Such works shall be taken up by the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.

**A9 INSURANCE OF WORKS**

**(1) Insurance of Works**

The Contractor shall take out Insurance for the Works from approved agency/institution staff if provided in the contract

Payment

Payments made to the agency/institution and stamp charges/duties incurred if any, by the contractor in compliance of the above work shall be paid from Provisional Sum included for the item in the BOQ after submission of the insurance document to the satisfaction of the Engineer.

**(2) Third Party Insurance**

The Contractor shall take out Third Party Insurance from an approved agency/institution staff if provided in the contract

Payment

Payments made to the agency/institution and stamp charges/duties incurred if any, by the Contractor in compliance of the above work shall be paid from the Provisional Sum included for the item in the

BOQ after submission of the documents to the satisfaction of the Engineer.

**(3) Insurance of Contractor's Workmen and Employees**

The Contractor shall insure against such liability as stipulated in Part II Conditions of Particular Application.

Payment

The cost for works under this Sub-Clause shall be covered by the Contractor's overhead included in unit rates of other items in the BOQ.

**A10 ENVIRONMENTAL PROTECTION WORKS**

The environment has been defined to mean surrounding area including human and natural resources to be affected by execution and after completion of works.

The Contractor shall take all precautions for safeguarding the environment during the course of the construction of the works. He shall abide by all prevalent laws, rules and regulations governing pollution and environmental protection.

The Contractor shall prohibit employees from unauthorized use of explosives, poaching wildlife and cutting trees. The Contractor shall be responsible for the action of his employees.

The Contractor is expected to arrange and execute the Works in such a way that existing environmental conditions are not deteriorated. Borrow pits and dumping sites used by the contractor shall be reinstated at his own cost by grass and/or tree plantation.

Written instruction/approval must be given to seek from the Engineer regarding protection and reinstatement of environment throughout the Contract period. Failure in compliance with Engineer's instructions in respect of overall standard will lead to reduction or withhold of payment. Further, any serious deterioration in the environment including pollution attributable to Contractor as determined by the Engineer, may result in deduction of actual expenditures incurred in their reinstatement done through separate agency, from any money due to the Contractor.

Environmental protection works, among others, shall also include the following:

**(1) Borrow/Quarry Sites**

The Engineer shall have the power to disallow the method of construction and/or the use of any borrow/quarry area, if in his opinion, the stability and safety of the works or any adjacent structure is endangered, or there is undue interference with the natural or artificial drainage, or the method or use of the area will promote undue erosion.

All areas susceptible to erosion shall be protected as soon as possible either by temporary or permanent drainage works. All necessary measures shall be taken to prevent concentration of surface water and to avoid erosion and scouring of slopes and other areas. Any newly formed channels shall be backfilled.

Borrows/quarries shall be located away from the population centers, drinking water intakes, cultivable lands and drainage systems. The cutting of trees shall be minimized. Temporary ditches and/or settling basins shall be dug to prevent erosion. The undesirable ponding of water shall be prevented through temporary drains discharging to natural drainage channels.

Earthworks operations shall be strictly limited to the areas to be occupied by the permanent works and approved borrow areas and quarries unless otherwise permitted by the Engineer. Due provision shall be made for temporary drainage. Erosion and/or instability and/or sediment deposition arising from earthwork operations not in accordance with the Specifications shall be made good immediately by the Contractor.

The Contractor shall obtain the permission of the Engineer before opening up any borrows pits or quarries. Such borrow pits and quarries may be prohibited or restricted in dimensions and depth by the Engineer where:

- (i) They might affect the stability or safety of the works or adjacent property;

- (ii) They might interfere with natural or artificial drainage or irrigation;
- (iii) They may be environmentally unsuitable.

The Contractor shall not purchase or receive any borrow materials from private individuals unless the source of such materials has been approved by the Engineer.

At least 14 days before he intends to commence opening up any approved borrow pit or quarry, the Contractor shall submit to the Engineer his intended method of working and restoration. These shall include but not be limited to:

**(2) Disposal of Spoil and Construction Waste**

Materials in excess of the requirements for permanent works and unsuitable materials shall be disposed off in locations and in the manner as agreed with the Engineer. The locations of disposal sites shall be such as not to promote instability, destruction of properties and public service systems. Exposed areas of such disposal sites shall be suitably dressed and be planted with suitable vegetation.

The Contractor shall plan his works in such a way that there is no spillage of POL products to the surface or sub-surface water.

**(3) Provision and Maintenance of Camps, Offices, Stores, Equipment Yards**

Various works defined under this item are related to provision and maintenance of camps for work person and employees, Contractor's site offices, stores equipment yards and workshops. These camps must be adequate, rain-proof, spacious, airy and hygienic with proper lighting and materials storage facilities. The area shall be kept neat and clean.

Space allocated for storage of materials such as cement, gabion wire, reinforcing wire etc. shall in general be damp-free, rain-proof and away from petroleum products storage.

Permission may be granted by the Engineer to erect suitable camps within the right of way free of charge, if such establishments do not cause obstructions to traffic, nuisance to works execution and adverse effect to the environment.

Written information must be given to and approval be taken from the Engineer regarding proper establishment and maintenance of such camps. Failure in compliance with Engineer's instruction in respect of overall standard will lead to reduction or with holding of payment.

**(4) Provision and Maintenance of Toilets**

Provision of toilets for labor and employees shall be made to avoid public nuisance as well as pollution of water courses and air. The Contractor shall construct suitable septic tanks and/or soak pits along with room of pit-type latrines. Sufficient water must be provided and maintained in the toilets. Proper methods of sanitation and hygiene should be employed during the whole project duration.

**(5) Provision of Potable Water**

The Contractor shall supply potable water along with commencement of work to Contractor's staff and work person both at camps and construction-sites. This arrangement shall be enforced to avoid proliferation and generation of various water borne diseases.

The Contractor shall inform the Engineer regarding sources, installation and operation of supply of potable water within a week after the supply is commenced.

**(6) Provision of First Aid/Medical Facilities**

Provision of first aid/medical facilities shall be made along with commencement of work to provide quick medical service to injured/sick work person, and employees. Services shall also include on-the-way service and other arrangements required for taking them to the nearest hospital in case of emergency.

The scope of work shall include service of at least one part-time experienced health worker/health assistant with a minimum of once a week full time site visit as work assignment. The Contractor shall also supply and provide adequate medicines and facilities required for standard first aid.

The Contractor shall inform the Engineer regarding the medical facility within a week after its

establishment and operation.

**(7) Hazardous Materials**

The Contractor shall not store hazardous materials near water surfaces. The Contractor shall provide protective clothing or appliances when it is necessary to use some hazardous substances.

High concentration of airborne dust resulting in deposition and damage to crops and water resources shall be avoided. The Contractor shall take every precaution to control excessive noise resulting in disruption to wildlife and human population.

Only controlled explosives methods shall be applied and used in construction works.

**(10) Reinstatement of Environment**

The Contractor shall arrange and execute works as well as related activities in such a way that environmental conditions are reinstated. He may be required to carry out filling, removal and disposal works along with plantation of grass and trees as directed by the Engineer at his own costs at identified locations to reinstate environment.

Written instruction/approval shall be given by/sought from the Engineer regarding reinstatement of environment both during and after completion of works and up to the end of Defects Liability Period.

**(11) Measurement and Payment**

No separate measurement and payment shall be made for the works described in this Clause.

**A11 SURVEY AND SETTING OUT**

(1) During the period of Commencement of works the Contractor shall survey the construction area and confirm the levels. He shall immediately notify the Engineer of any discrepancies and shall agree with the Engineer any amended values to be used during the contract, including replacements for any stations missing from the original stations.

(2) The Contractor shall check, replace and supplement as necessary the station points and agree any revised or additional station details with the Engineer.

(3) All stations and reference points shall be clearly marked and protected to the satisfaction of the Engineer.

(4) The Contractor shall establish working Bench Marks tied with reference stations soon after taking possession of the site. The coordinates and the elevations of the reference stations shall be obtained from the Engineer. The working Bench Marks shall be near all major/medium structure sites. Regular checking of these Bench Marks shall be made and adjustments, if any, got agreed with the Engineer and recorded.

(5) The Contractor shall be responsible for the accurate establishment of the center lines based on the Drawing and data supplied. The center lines shall be accurately referenced in a manner satisfactory to the Engineer. A schedule of reference dimensions shall be prepared and supplied by the Contractor to the Engineer.

(6) The existing profile and cross-sections shall be taken jointly by the Engineer and the Contractor. These shall form the basis for the measurements and payments. If in the opinion of the Engineer, design modifications of the center lines and/or grade are advisable, the Engineer shall issue detailed instructions to the Contractor and the Contractor shall perform modifications in the field, as required, and modify the levels on the cross-sections accordingly.

**A12 AS-BUILT DRAWINGS**

Such approved Working Drawings as have been selected by the Engineer shall be correctly modified for inclusion in the As-Built Drawings incorporating such variations to the Works as have been ordered and executed. Such drawings shall show the actual arrangement of all structures and items of equipment installed under the Contract. The Contractor shall submit 1 (one) reproducible copy and 3 (three) prints of all As-Built Drawings clearly named as such to the Engineer for approval before applying for the Taking-Over Certificate for the respective Section of the Works.

During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the approval to facilitate easy and accurate preparation of the As-Built Drawing. Irrespective of the other

contractual prerequisites no Section of the Works will be considered substantially completed until the Engineer has approved the respective As-Built Drawings.

**A13 PHOTOGRAPHS**

The Contractor shall supply negatives and un-mounted positive color prints of photographs, of such portions of the works in progress and completed, as may be directed by the Engineer. The negatives and prints shall not be retouched. The negative of each photograph shall be the property of the Employer and shall be delivered to the Engineer with prints. No prints from these negatives shall be supplied to anyone without the written permission of the Engineer.

**A14 SUPPLY OF VIDEO CASSETTES**

The work consists of taking video film of important activities of the work as directed by the Engineer. during the currency of the contract and editing them to a video film of playing time between 30 minutes and 180 minutes as directed by the Engineer. It shall contain narration of activities in English and/or Nepali by a competent narrator. The edition of the video film and the script shall be approved by the Engineer. The video cassettes shall be of acceptable quality and the film shall be capable of producing color pictures.

Measurement

The measurement for this item shall be by number of sets of edited master cassettes supplied each with four copies thereof.

Payment

The contract unit rate shall include all expenses for making video films with the help of a professionally competent photographer, editing, narration and supplying the final edited master cassette along with four copies thereof.

**A15 NOTES ABOUT MEASUREMENT AND PAYMENT****(1) Measurement**

Unless specified, all measurements shall be based on "Principals of Measurement (Int.) for works of constructions."

The tolerances specified in these Specifications are for evaluation of accuracies only based on which the work shall be accepted or rejected. However, the measurement of the work performed within the limits of tolerances shall be the measurement of actual work done in place, if their dimensions are less than what have been specified or instructed by the Engineer. If the actual work done in place is more than what has been specified or instructed by the Engineer, but within the limit of tolerances, the measurement shall be the measurement of the work what has been specified or instructed by the Engineer.

**(2) Payment**

Unless specified in the contract, the contract unit rates and/or prices for items as set out in the Bill of Quantities are the full and the final compensation to the Contractor for:

- Supply of all materials necessary to complete the item as per relevant specifications;
- Use of materials, labors, tools, equipment, machines and other resources as per need;
- All handling, packing charges and transportation;
- Cost of supervision, quality assurance, temporary and ancillary works;
- Site commissioning;
- Maintenance and making good;
- All duties and obligations as set out in the contract
- general works such as setting out, clearance of site before setting out and after completion of works
- the preparation of detailed work program
- providing samples of various materials proposed to be used
- the detailed Design and Drawing of temporary works

- testing of materials
- any other details as required by the contract
- cost of all operations like storing, erection, moving into final position, etc. necessary to complete and protect the work till handing over to the Employer;
- the cost for safeguarding the environment
- All incidental costs, not covered under above stated.

Where the Bill of Quantities does not include, no separate payment shall be made for such works. The costs in connection with the execution of the works specified herein shall be considered to be included in the related items of other works specified in the Bill of Quantities or shall be considered to be incidental to the works specified. Items specified in this Section and included in the Bill of Quantities shall be paid at the contract unit rates as agreed and shown in the Bill of Quantities.

**A16 NATIONAL SPECIFICATIONS**

Certain Specifications issued by various national or other widely recognized bodies are referred to in these Specifications. Such Specifications shall be defined and referred to as National Specifications. The Contractor may propose that the materials and workmanship be defined in accordance with the requirements of other equivalent National Specifications and he may execute the works in accordance with such National Specifications as may be approved by the Engineer. A copy of the National Specification, together with its translation into the English language if the National Specification is in another language, shall be submitted to the Engineer along with the request for its adoption.

In referring to National Specifications, the following abbreviations are used:

NS	Nepal Bureau of Standards and Metrology
IS	Indian Standards
ASTM	American Society of Testing and Materials
BS	British Standards
BSCP	British Standard Code of Practice
ISO	International Organization for Standardization
EN	European Norm
NFP	French Norm

Along with the commencement of the contract, the Contractor shall provide in his site office at least one complete set of all National Specifications referred to in these Specifications, if they are for the Sections applicable to the works. This set shall be made available for use by the Engineer.

**A17 EQUIVALENCY OF STANDARDS**

Wherever reference is made in these Specifications to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work to be performed or tested, the provisions of latest current edition or revision of relevant standards and codes in effect shall apply. Other authoritative standards which ensure a substantially equal or higher performance than the specified\*, -standards and codes shall be accepted subject to the Engineer's prior review and approval. Differences between the standards specified and the proposed alternative standards shall be fully described by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event that the Engineer determines that such proposed deviations do not ensure substantially performance, the Contractor shall comply with the standards and codes specified. No payment shall be made for adoption of higher standards.

**A18 UNITS OF MEASUREMENT, ABBREVIATIONS AND TERMINOLOGY****(1) Units of Measurement**

The Symbols for units of measurement are used in these Specifications as they are given below.

M	micron = $m \times 10$
mm	millimeter
m	meter
km	kilometer
sq. mm. or $mm^2$	square millimeter
sq.m. or $m^2$	square meter
sq. km. or $km^2$	square kilometer
ha	hectare
cu. m. or $m^3$	cubic meter
lit or l	liter
rad	radian
°C	degrees Celsius
kg	kilogram
g	gram = $kg \times 10^{-3}$
mg	milligram = $kg \times 10^{-6}$
mg/l	milligram per liter
t	ton = $kg \times 10^3$
$kg/m^3$	kilogram per cubic meter
$t/m^3$	ton per cubic meter
N	Newton
$N/m^2$	Newton per square meter
Lin. m	Linear meter
Max	Maximum
Min	Minimum

Symbols of other units, if not covered above, shall be as per SI system set out in ISO 31/1 or FPS system.

**(2) Abbreviations**

The following abbreviations are used in these Specifications.

ACV	Aggregate Crushing Value
BOQ	Bill of Quantities
CR	Crushing Ratio
dia	Diameter
DUDBC	Department of Urban Development & Building Construction
DOR	Department of Roads.
hr	Hour
LS	Linear Shrinkage
MC	Moisture Content

MDD	Maximum Dry Density
min	Minute
no	Number (units), as in 6 no.
No	Number (order) as in No 6
OMC	Optimum Moisture Content
OPC	Ordinary Portland Cement
PI	Plasticity Index
PL	Plastic Limit
PM	Plasticity Modulus (PI x % passing 0.425 mm sieve)
POL	Petrol, Oil & Lubricant
ROW	Right of Way
SE	Sand Equivalent
sec	Second
SG	Specific Gravity
SI	International Standard Units of Measurements
SSS	Sodium Sulphate Soundness test, loss on 5 cycles
STV	Standard Tar Viscosity
TS	Tensile Strength
UC	Uniformity Coefficient
UCS	Unconfined Compressive Strength
VIM	Voids in Mix
w/c	Water cement ratio
wt	Weight
%	Percent

(3) Terminology

The term "the Specifications" shall be construed as the Standard Specification and the Special Specification all together.

(4) The Sections, Clauses and/or Sub-clauses mentioned in these Specifications deem to apply those of these Specifications only, if otherwise not specified.

### **A19 PROGRAM**

The Contractor shall provide all information needed for fulfillment of the program and required in accordance with the Conditions of Contract including the sequence in which he intends to work including implementation of quality assurance plan. If the Contractor requests a change in the sequence and such change is approved by the Engineer, the Contractor shall have no claim as per the Conditions of Contract for delay arising from such revisions to the program.

The program for the construction and completion of the works shall be established using CPM/PERT techniques or equivalent. The program shall be detailed enough to give, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of critical materials and equipment, fabrication of special products/equipments if any and their installation and testing, and for all activities of the Engineer that are likely to affect the progress of work. The Contractor shall update all activities in accordance with the Conditions of Contract on the basis of the decision taken at the periodic site review meetings or as directed by the Engineer.

The program shall also include the Contractor's general requirements for any road closures pursuant to Clause A3 to be agreed in principle with the Engineer. Such agreement shall not relieve the Contractor of his responsibility to obtain specific approval for each closure or series of closures.

Any proposal for night working shall also be stated in the program.

**B QUALITY CONTROL****B1 SCOPE**

This Section covers the Quality Control System and procedures, Quality Assurance Plan, program of tests, trials, and general procedures for acceptance as well as laboratory arrangements and related facilities which are required for the selection and control of the quality of materials and workmanship.

**B2 CONTRACTOR RESPONSIBLE FOR THE QUALITY OF THE WORKS**

All materials incorporated and all workmanship performed shall be strictly in conformity with the requirements of the Specifications and the Contractor shall be responsible for the quality of the works in the entire construction within the contract.

The Contractor shall provide, use and maintain on the Site, throughout the period of execution of the contract, a laboratory with adequate laboratory equipment operated by competent staff for carrying out tests required for the selection and control of the quality of materials and for the control of workmanship in accordance with these Specifications. The list of laboratory equipment to be procured and laboratory facilities to be provided shall be as per clause B8. The Contractor shall assume that tests shall be required on all materials to be used in the works and on all finished works or part of works.

**B3 QUALITY CONTROL SYSTEM**

The Quality Control System comprises the methods, procedures and organization for the Quality Control of the works. The Contractor shall implement the Quality Control System in the following sequences:

## (1) Sequence

- a) Compliant testing for materials including laboratory trials,
- b) Compliant testing for methods and equipment prior to the commencement of the work, including site trials or trials sections,
- c) Control testing during construction,
- d) Acceptant testing on completed works or parts of the works.

The Contractor shall carry out all necessary tests and shall report to the Engineer the results of such tests before submitting materials and/or finished works or part of works to the Engineer for approval in accordance with this Specification. In certain circumstances, tests may be carried out at the place of manufacture as per the Conditions of Contracts.

For satisfying himself about the quality of the works, quality control tests shall be conducted by the Engineer himself or by any other agencies deemed fit by the Engineer. Additional tests may also be conducted where in the opinion of the Engineer such tests are needed.

Before commencement of the work, the Contractor shall demonstrate a trial run of all construction equipment for establishing their capability to achieve the laid down Specifications and tolerances to the satisfaction of the Engineer.

- (2) The supply, testing and monitoring shall be in compliance with a Quality Assurance Plan, Clause B4 and the provisions in the contract.

**B4 QUALITY ASSURANCE PLAN**

The Contractor shall submit to the Engineer for his approval, the Quality Assurance Plan (QAP) which shall be based on the detailed Program of the Works as per Clause A19 of these Specifications.

The Quality Assurance Plan shall include the following:

- (1) The Quality Control Schedule Comprising of:

- a) The recapitulative test schedule and testing program detailing the list of tests for compliance, laboratory trials, site trials and trials Sections, construction control tests and their frequencies, tests for acceptance of the completed works with their dates.
- b) Recapitulative list of "critical" acceptance testing procedures, for equipment or parts of the works which corresponds to the tasks on the Critical Path according to the construction Program.
- c) Estimate of the number of tests to be carried out, list and number of appropriate equipment to conduct them, list of tests to be conducted outside the site laboratory, if

- any, identification of the outside laboratory where proposed to carry out the test.
- d) List of staff assigned to the laboratory, their position and responsibilities in the quality control procedures, their qualification and experience, general description and detailed organization of the laboratory activities.
- (2) The list of sources of materials and/or of manufactured articles, their main characteristics, their identification mode as provided by the supplier when required; the program of supply and procurement of material and/or manufactured articles in accordance with the Program pursuant to Clause A19.
- (3) The list of tests and quality control procedures to be implemented by the Sub-contractors, if any, pointing out the "critical" acceptance testing procedures relating to the Sub-contracted works, which correspond to the tasks on the Critical Path included in the Sub-contracted works.
- The Contractor shall implement the Quality Control in compliance with the approved QAP. The Engineer's approval of the QAP shall not relieve the Contractor from his responsibility of the quality of the Works as per the Conditions of Contract and these Specifications nor shall the Engineer's approval of the QAP exempt the Contractor of any procedure to inform the Engineer in writing or request for the Engineer's approval or re-approval as specified in the Conditions of Contract and/or in these Specifications
- The Contractor shall monitor and update the QAP on the basis of the decisions taken at the periodic review meetings or as directed by the Engineer and in accordance with the program of the works as per Clause A19 and the Conditions of Contract.

**B5 TESTING PROCEDURES AND SET OF TESTS**

For ensuring the quality of the work, the materials and the workmanship shall be subjected to testing in accordance with procedures, sets of tests and frequencies as specified in Section C and respective Sections of these Specifications. The specified testing frequencies are not restrictive. The Engineer shall direct for the tests to be carried out as frequently as deemed necessary that the materials and workmanship comply with their Specifications.

Sets of tests to be carried out on the materials and the workmanship as specified in these Specifications are recapitulated in Clause B10. Where no specific testing procedure is mentioned in the Specifications, the tests shall be carried out as per the prevalent accepted engineering practice or directions of the Engineer.

**B6 LABORATORY TRIALS TO CONFIRM COMPLIANCE WITH SPECIFICATIONS****(1) Concrete**

Laboratory trials for concrete mixes as specified in Clause F shall be carried out by the Contractor to demonstrate that the composition of the mixes proposed for the concrete meets the requirements of the Specifications.

The compositions of concrete mixes which meet the specified requirements and are accepted by the Engineer shall be then used in the site trials carried out in accordance with Clause B7.

**B7 SITE TRIALS OR TRIALS SECTIONS****(1) Concrete**

Site trials for concrete mixes as specified in Clause F shall be carried out by the Contractor to demonstrate the suitability of his mixing equipment. During the site trials, compliance with the Specifications for weighing equipment, storage of ingredients, means of transport for concrete, placing, compaction and curing shall be checked by the Engineer.

During the site trial a full scale sequence including placing and compaction of concrete shall be carried out on a part of the works which will represent particular difficulties due to the presence of reinforcement, obstructions or others.

The Contractor shall allow in his program for conducting the site trials and for carrying out the appropriate tests, including the time required to obtain compressive strength test results at 28 days. The Contractor shall inform in writing the Engineer at least two weeks before the date he proposes to use the concrete mixes in the site trials with all relevant data including the trial program, the results of the laboratory trial tests for the proposed concrete mixes and

compliance tests results of all constituents i.e. cement, aggregates, water and admixtures, if any.

**(2) Other Works and Equipment**

Site trials for Pre-stressed Concrete Works, Painting of Structural Steelwork etc. are detailed in the relevant Sections of these Specifications.

Approval of the Engineer to a set of data recorded in a site trial shall not relieve the Contractor of his responsibilities to comply with the requirements of these Specifications

**B8 CONTROL TESTING DURING CONSTRUCTION**

Quality Control procedure are detailed in the relevant Sections of these Specifications

**B9 ACCEPTANCE TESTS FOR COMPLETED WORKS OR PART OF WORKS**

Acceptance tests for other works and equipment are detailed in the relevant Sections of these Specifications.

**B10 RECAPITULATIVE SCHEDULE OF TESTS**

the tests to be carried out and their frequency for the quality control of the works are detailed in the relevant Sections of these Specifications.

The following Table B10-1 recapitulates the testing schedule for the main types of works.

**TABLE B10-1: TESTING SCHEDULE**

PART OR COMPONENT OF THE WORKS	Section/ Clause No	TESTS	FREQUENCY
CONCRETE MATERIALS	F	<p>•Cement: Acceptance tests:</p> <p>CONTROL TESTS: Chemical composition Physical properties</p> <p>•Aggregates: Acceptance tests: CONTROL TESTS: Grading Silt &amp; clay content Organic Impurities Chloride content, sulphate content, Alkali reactivity Water, Admixtures</p>	<p>•Conservative samples for each supply and not less than every 200t or part of it.</p> <p>• Testing in case of non compliance of the mixes or storage on site for longer than 1 month</p> <p>•Sub-clause F35 •Each delivery and every 100 t or part of it for fine aggregate and 250 t or part of it for coarse aggregate</p> <p>•As frequently as required.</p> <p>•Sub-clause F37 and F38</p>
		<p>CONCRETE • LAB. TRIALS • SITE TRIALS • Control tests Compressive strength</p>	<p>•Sub-clause F33 • Sub-clause 600 (4) •Early works: every 6 m<sup>3</sup> of each class. When compliance is established: every 20 m<sup>3</sup> or part of it.</p>
		<p>REINFORCEMENT:</p>	<p>• Clause F14</p>



*Handwritten signature or initials.*

<b>BRICKWORKS STRUCTURES</b>	<b>FOR</b>	700	<ul style="list-style-type: none"> <li>• Quality of Bricks</li> <li>• Quality of cement and sand</li> <li>• Control tests Compressive strength of mortar</li> </ul>	<ul style="list-style-type: none"> <li>• As required</li> <li>• Every 10 m<sup>3</sup> of brick work or part of it.</li> </ul>
MATERIALS MORTAR				
<b>MASONRY STRUCTURES</b>	<b>FOR</b>	800	<ul style="list-style-type: none"> <li>• Quality of cement and sand</li> <li>• Control tests Compressive strength of mortar</li> <li>• Dismantling of masonry (1 m_1 m)</li> </ul>	<ul style="list-style-type: none"> <li>• As required</li> <li>• Every 10m<sup>3</sup> of masonry of part of it</li> <li>• Every 30m<sup>3</sup> of masonry or part of it</li> </ul>
MATERIALS MORTAR				

**B11 CONTRACTOR'S LABORATORY****(1) Laboratory Building**

The Contractor shall on his own make provide and maintain a site laboratory. Such laboratory shall have a minimum total area of 60 m<sup>2</sup> appropriately partitioned to house various laboratory instruments/equipment, office, store, and toilet. It shall have adequate electrical connections (power plugs, switches) necessary to operate the equipment in the laboratory.

The laboratory shall either be any existing building at site, rented and modified to suit the purpose or shall be a shed constructed of GI sheets and pipes/angles. The floor of the laboratory shall however be of 100 mm M15/20 concrete and the minimum height 2.7 m. The Contractor shall submit the design of the GI shed for approval of the Engineer prior to its construction.

Alternatively, it may also be constructed from shipping containers modified suitably to the Engineer's satisfaction for the purpose.

This laboratory shall be part of the Temporary Works and will be the property of the Contractor on completion of the Works.

**(2) Measurement**

Not applicable

**(3) Payment**

All expenses for testing of construction materials and works shall be born by the contractor.

**B12 LABORATORY EQUIPMENT AT SITE**

The equipment for the site laboratory and field control tests shall be provided, installed, operated and maintained by the Contractor. The equipment, material, chemical reagents may also be used by the Engineer to conduct tests according to his Quality Check Plan. Testing frequency (both laboratory and field control) shall be developed in the Quality Assurance Plan of the Contractor and Quality Check Plan of the Engineer.

After the completion of the Works, the laboratory equipment shall become the property of the Contractor.

Laboratory and field control equipment anticipated for the Works are listed in Tables B12-1 Measurement and Payment

Measurement and Payments for the work under Clause B9 will be made in relevant monthly statement on the basis of lump sum price quoted in the BOQ. It shall be paid in the following manner:

- 50% after installation of the equipment in the site laboratory to the satisfaction of the Engineer and
- the remaining 50% after 80% completion of the Works.

The cost of execution of tests either in the laboratory or in the field shall be covered by the Contractor's overhead included in unit rates of other items in the BOQ.



**TABLE B12-1: LABORATORY EQUIPMENT/FIELD CONTROL TESTING APPARATUS FOR CEMENT MASONRY AND CONCRETE WORKS**

S.No.	Designation	Quantity
1.	Slump Cone with Base and Graduated Tamping Rod	2 Sets
2.	Heavy Duty Concrete Cube Moulds, 152 mm cubes, with Base	12 Sets
3.	Concrete Cube Crushing (set) Machine with Spherically Seated Block and Platens for Mortar Test	1 Set
4.	Mortar Flow Apparatus with Cone	2 Sets
5.	Vicat Apparatus	1 Set
6.	Standard ASTM Sieves for Concrete	2 Sets
7.	50 mm size mortar mould pair	1 Set

**B13 SAMPLING AND TESTING OF MATERIAL AWAY FROM SITE**

Some tests on construction material shall be conducted periodically off the site at reputable institutions in Kathmandu as directed by the Engineer.

The frequency of tests shall be developed in the Quality Assurance Plan that shall also prescribe test results and reporting formats. However, some details on the tests are listed tentatively below under Table B13-1.

**TABLE B13-1: LIST OF TESTS TO BE CONDUCTED OFF-SITE TESTS**

(Locations subject to the approval of the Engineer)

S.No.	Description of Tests
1.	UTM Tensile Test for Re-bar
2.	Zinc Coating and Tensile test of GI wire
3.	Los Angeles Abrasion Test
4.	UTM tensile Test for Anchor Bar
5.	Specific Gravity of Aggregates

The tests listed above are subject to the Contractor's Quality Assurance Plan approved by the Engineer. The Engineer shall also determine the number of tests while executing the Works.

The Contractor shall keep records of all tests in a format approved by the Engineer. Two copies of any test results shall be forwarded to the Engineer.

**Payment**

All expenses for sampling and testing shall be born by the contractor.

**B14 SURVEY AND SETTING**

All traverse stations and reference points shall be clearly marked and protected to the satisfaction of the Engineer.

The Contractor shall provide the Engineer with all necessary assistance for checking the setting out, agreement of levels and any other survey or measurement which the Engineer needs to carry out in connection with the Works during the entire period of Contract. Such assistance shall include:

- Provision of suitably qualified surveyors to work under the direction of the Engineer as required.
- Provision of all necessary support for these surveyors including assistants, chainmen, labor, survey equipment (theodolites, levels, etc.), hand tools, pegs, and other incidental material.

The survey equipment shall be of the quality approved by the Engineer.

**B15 USE OF THE CONTRACTOR'S TEMPORARY WORKS**

Unless otherwise specified under the Contract, the Contractor shall allow the Employer, the Engineer

or the Nominated Subcontractor the use of temporary access, crossings and other Temporary Works at site insofar that such use is related with the Works.

**B16 PROVIDE AND PLACE LARGE PERMANENT SIGNS AND MARKINGS**

The Contractor shall provide and erect large permanent signs and markings in steel at locations as directed by the Engineer.

The large signs shall be of the size as indicated in the Standard Drawings of Department of Roads and shall be mounted and fixed in position as directed by the Engineer. The lettering, painting and color configuration shall conform to Standards set by Department of Roads.

The signs and marking shall be erected by embedding them one meter in a 200 mm x 200 mm hole in the ground. The bottom 600 mm shall be filled with river sand and the remaining with M15/37.5 concrete.

**B17 DAY WORK**

Not applicable.

**B18 REPORTS**

The Contractor shall prepare and submit four copies of Progress Report on a monthly basis. The Reports shall highlight the targeted and achieved progress, problems at site, and brief description of the claims during the month and the Engineer's response, and other information relevant to the Project. It shall be supplemented with necessary charts, tables, data, and at least 36 photographs.

On completion of the Works, the Contractor shall prepare and submit a Completion Report that shall deal comprehensively on all aspects covered in the Monthly Report. Additional information such as improvement in construction methods/techniques, lessons learnt from the Project, important considerations for maintenance, etc. should also be highlighted.

**B19 SITE DIARY**

The Contractor shall keep Site Diaries wherein full details of the work carried out during each day shall be fully recorded. The diaries shall be available for inspection by the Engineer any time during normal office hours. The Site Diaries shall include:

- Weather Conditions, rainfall/snowfall, and river water level
- Description, quantity, and location of work performed
- Shifts and working hours
- Number and category of workers working at site
- Plant in use and idle, or broken down
- Test carried out and results
- Inspection carried out by the Engineer
- Site instructions
- Visitors
- Accidents

**Measurement and Payment**

The cost for works under Sub B14 &16 shall be covered by the Contractor's overhead included in unit rates of other items in the BOQ.

**C CONSTRUCTION MATERIALS AND TESTING****C1 SCOPE**

This section covers the general requirements relating to materials, the specific requirements for basic materials, the tests and methods of testing which are required for the selection and quality control of materials.

**C2 QUALITY OF MATERIALS**

The materials supplied and used in the works shall comply with the requirements of these Specifications. They shall be new, except as provided elsewhere in the contract or permitted by the Engineer in writing. The materials shall be manufactured, handled and used skillfully to ensure completed works to comply with the contract.

**C3 SOURCES OF MATERIALS**

The use of any one kind or class of material from more than one source is prohibited, except by written permission of the Engineer. Such permission, if granted, shall set forth the conditions under which the change may be made. The sources or kinds of material shall not be changed without written permission of the Engineer. If the product of any source proves unacceptable, the Contractor shall make necessary arrangements for the supply of acceptable material. Any claims for compensation associated with such arrangements or changes shall not be considered, unless the source of the unacceptable material is designated in the contract as a source of material.

When any manufactured product, either new or used, is to be furnished by the Employer, the location at which such material shall be delivered to the Contractor shall be designated in the contract. In such cases, the Contractor shall haul the materials from the designated delivery point to the point of use. The compensation for such hauling shall be included in the contract unit rate for placing the materials in the finished work.

**C4 INSPECTION AND ACCEPTANCE OF MATERIALS**

Final inspection and acceptance of materials shall be made only at the site of the work. The Engineer reserves the right to sample, inspect, and test the materials throughout the duration of the works and to reject any materials which are found to be unsatisfactory.

A preliminary inspection of materials may be made at the source for the convenience and accommodation of the Contractor, but the presence of a representative of the Engineer shall not relieve the Contractor of the responsibility of furnishing materials complying with their Specifications.

The representative of the Engineer shall have free entry at all times to those parts of any plant which concern production of the materials ordered.

**C5 MATERIALS AND MANUFACTURED ARTICLES****(1) Order for Materials and Manufactured Articles**

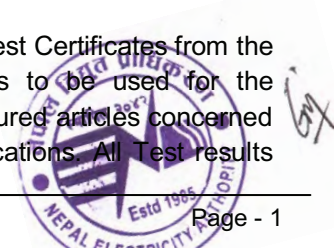
The Contractor shall, before placing any order for materials and manufactured articles for incorporation in the Works, submit to the Engineer the names of the firms from whom he proposes to obtain such materials and manufactured articles, giving for each firm a description of the materials and manufactured articles to be supplied, their origin, the manufacturer's specification, quality, weight, strength and other relevant details. The Contractor shall submit the samples of such materials and manufactured articles when requested by the Engineer and when appropriate, manufacturer's certificates of recent test carried out on similar materials and manufactured articles shall also be submitted.

**(2) Storage**

All materials and manufactured articles shall be stored on site in a manner acceptable to the Engineer. The Contractor shall carefully protect all work, materials and manufactured articles from the weather and vermin.

**(3) Test Certificates**

When instructed by the Engineer, the Contractor shall submit to him all Test Certificates from the suppliers/manufacturers of the materials and/or manufactured articles to be used for the contract. Such certificates shall certify that the materials and/or manufactured articles concerned have been tested in accordance with the requirements of these Specifications. All Test results



shall be enclosed along with such certificates. The Contractor shall provide adequate means of identifying the materials and/or manufactured articles delivered on the site with the corresponding certificates.

**C6 DEFECTIVE MATERIALS**

All materials not conforming to the requirements of the contract shall be rejected whether in place or not. They shall be removed immediately from the site unless otherwise permitted by the Engineer. Even after rectification of the defects no rejected material shall be used in the work unless approved by the Engineer in writing. Upon failure of the Contractor to comply promptly with any order of the Engineer given under this Clause, the Engineer shall have authority to cause the removal and replacement of rejected material and to deduct the cost thereof from any monies due to the Contractor.

**C7 TRADE NAMES AND ALTERNATIVES**

For convenience in designation in the contract, certain articles or materials to be incorporated in the work may be designated under a trade name or the name of a manufacturer and his catalogue information. The use of an alternative article or material which is of equal or better quality and of the required characteristics for the purpose intended shall be permitted, subject to the following requirements:

- (1) The proof as to the quality and suitability of alternatives shall be submitted by the Contractor. He shall also furnish all information necessary as required by the Engineer. The Engineer shall be the sole judge as to the quality and suitability of alternative articles or materials and his decision shall be the final and binding upon the Contractor.
- (2) Whenever the specifications permit the substitution of a similar or equivalent material or article, no tests or action relating to the approval of such substitute material shall be made until the request for substitution is made in writing by the Contractor accompanied by complete data as to the equality of the material or article proposed. Such request shall be made well in advance to permit approval without delaying the work.

**C8 FOREIGN MATERIALS**

- (1) General - Materials which are manufactured, produced or fabricated outside Nepal shall be delivered at a point in Nepal as specified in the contract where they shall be retained for a sufficient time to permit inspection, sampling, and testing. The Contractor shall not be entitled to an extension of time for acts or events occurring outside Nepal and it shall be the Contractor's responsibility to deliver materials obtained from outside Nepal to the point of delivery in Nepal. The Contractor shall supply the facilities and arrange for testing required at his own cost. All testing by the Contractor shall be subject to witnessing by the Engineer.

The Contractor shall furnish to the Engineer a "Certificate of Compliance" with the specifications from the manufacturer, producer or fabricator of foreign material where required. In addition, certified mill test reports clearly identifiable to the lot of material shall be furnished where required in these Specifications or otherwise requested by the Engineer. Where structural materials requiring mill test reports are obtained from foreign manufacturers, such materials shall be furnished only from those foreign manufacturers who have previously established, to the satisfaction of the Engineer, the sufficiency of their in-plant quality control, as deemed necessary by the Engineer or his representative, to give satisfactory assurance of their ability to furnish material uniformly and consistently in conformance with their Specifications. At the option of the Engineer, such sufficiency shall be established whether by submission of detailed written proof thereof or through in-plant inspection by the Engineer or his representative.

If the welding of steel for structural steel members or the casting and pre-stressing of pre-cast pre-stressed concrete members is to be performed outside of Nepal, the following requirements shall apply:

- (2) Such fabrication shall be performed only within the plants and by fabricators who have previously established, to the satisfaction of the Engineer, that they have the experience, knowledge, trained manpower, quality control, equipment and other facilities required to produce the quality and quantity of the work required. At the option of the Engineer, prequalification of the plant and fabricator shall be established either by the submission of detailed written proof thereof or through in-plant inspection by the Engineer or his representative, or both.
- (2) The Contractor shall make written application to the Engineer for approval for such foreign

fabrication at the earliest possible time and in no case later than 60 calendar days in advance of the planned start of fabrication. The application shall list the specific units or portion of a work which shall be fabricated outside of Nepal.

- (3) The Contractor shall advise the Engineer, in writing, at least 20 calendar days in advance of the actual start of any such foreign fabrication.
- (4) All documents pertaining to the contract, including but not limited to, correspondence, tender documents, working drawings and data shall be written in the English/Nepali language and all numerical data shall use the metric system of units of measurement.

### **C9 DEFINITION OF GENERAL TYPES OF MATERIALS**

The following definitions shall apply to materials in this Section and other relevant Sections.

- (1) "Topsoil" shall mean the top layer of soil that can support vegetation. It shall include all turf acceptable for turfing.
- (2) "Suitable Material" shall comprise all that is acceptable in accordance with the contract for use in the works and which is capable of being compacted to form a stable fill having side slopes as indicated in the Drawing. The material used in fill (except rock fill) shall not contain rock fragments with dimensions of more than 75 mm.
- (3) "Unsuitable Material" shall mean other than suitable material and shall include:
  - (a) Material from swamps, marshes or bogs;
  - (b) Peat, logs, stumps, perishable material, organic clays;
  - (c) Material susceptible to spontaneous combustion;
  - (d) Material in a frozen condition;
  - (e) Clay of liquid limit exceeding 70 and/or plasticity index exceeding 45.

Materials stated above in d), if otherwise suitable shall be classified suitable when unfrozen.

- (4) "Well Graded Granular Material" consisting of gravel and/or sand shall conform to Clause F9.
- (5) "Rock fall", coarse alluvial material shall be loose soils such as moraines, debris, or alluvial material containing large blocks or large boulders. Individual blocks or boulders of hard materials greater than 0.3m<sup>3</sup> each in volume, shall be classified as hard material.

### **C10 SIEVES**

IS sieves shall be used for all tests. Based on IS-460 the standard sieves series shall be as follows:

125; 90; 75; 63; 50; 45; 40; 37.5; 31.5; 25; 22.4; 20; 19; 16; 12.5; 11.2; 10; 9.5; 8; 6.3 ;5.6; 4.75; 4.00; 2.8; 2.36; 2; 1.7; 1.4; 1.18; 1; 0.85; 0.71; 0.6; 0.5; 0.425; 0.400; 0.300; 0.250; 0.212; 0.180; 0.150; 0.125; 0.090; 0.075 mm.

### **C11 SOILS AND GRAVELS**

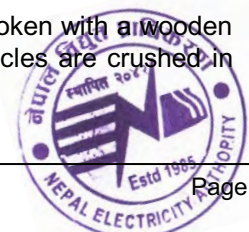
#### **(1) Sampling and Samples**

Sampling of soils and gravels shall be carried out as specified or as directed by the Engineer. Samples shall be prepared for testing as indicated in IS 2720 part I, except that:

- a) The mass (in g) of a sample required for sieve analysis is about 400D, D being the maximum particle size (mm).
- b) Sample containing particles larger than 19 mm size shall be prepared for compaction and CBR tests as described hereunder, provided the proportion in weight of such particles is less than 30% :

An adequate quantity of representative material shall be sieved over the 50 mm and 19 mm sieve. The material passing the 50 mm sieve and retained on the 19 mm sieve shall be weighed and replaced with an equal mass of material passing the 19 mm sieve and retained on the 4.75 mm sieve. The material for replacement shall be taken from the remaining portion of the main sample.

When preparing gravel samples, the aggregations of particles shall be broken with a wooden or rubber hammer or pestle. Care shall be taken that no individual particles are crushed in the operation.



**(2) Standard Methods of Testing**

Tests on soils and gravels shall be performed in accordance with the standard methods given in Table C11.2-1

**TABLE C11.2: TESTS PROCEDURES APPLICABLE TO DISTURBED/UNDISTRIBUTED SAMPLES OF SOILS AND GRAVELS**

	Tests		Test procedure
Determination of:			
i)	Moisture Content	IS 2720	Part 2 (Oven-drying method)
ii)	Liquid Limit	IS 2720	Part 5 (Cone Penetrometer or by Casagrande Apparatus)
iii)	Plastic Limit	IS 2720	Part 5
iv)	Plasticity Index	IS 2720	Part 5
v)	Linear Shrinkage	IS 2720	Part 20
vi)	Specific Gravity of Particles	IS 2720	Part 3
vii)	Particle Size Distribution	IS 2720	Part 4
viii)	Organic Matter Content	IS 2720	Part 22
ix)	Total Sulphate Content	IS 2720	Part 27
x)	pH Value	IS 2720	Part 26 (Electrometric Method)
xi)	Mica Content	-	Manual mineralogical counting
xii)	Density-Moisture Content relationship (2.5 kg rammer)	IS 2720	Part 7
xiii)	Density-Moisture Content relationship (4.9 kg rammer)	IS 2720	Part 8
	xiv) California Bearing Ratio	IS 2720	Part 16
xv)	Sand Equivalent	IS 2720	Part 37 (Mechanical Shaker or Manual Shaker method)
xvi)	Field Dry Density	IS 2720	Part 28/Part 29
xvii)	Unconfined compression test	IS2720	Part 10
xviii)	Consolidation test	IS2720	Part 15
xix)	Direct shear test	IS2720	Part 13
xx)	Triaxial test	IS2720	Part 11,12
xxi)	Hydrometer analysis	IS 2720	Part 4
xxii)	Vane shear test	IS 2720	Part 30

It is further specified that:

- Wherever in the text of these Specifications and the Special Specification the term "x% of the MDD (IS 2720 Part 27 or IS 2720 Part 28) is used it shall mean that a standard of compaction shall be achieved such that the dry density of the compacted material is x% of the maximum dry density determined from the respective tests. Samples for the compaction tests shall be taken before compaction of the layers begins unless in the opinion of the Engineer the compactive effort proposed or applied by the Contractor is such that the material characteristics have changed in which case the samples for the tests shall be taken after all compaction is complete.
- Compaction tests: when the material is susceptible to crushing during compaction, a separate and new sample shall be used in the determination of each point on the moisture/density curve.
- The dry density of material placed in the works shall be determined by the Sand Replacement Method unless the Engineer directs to use a nuclear method or other method. In the case of nuclear method, tests shall be done at least at the same

frequency required when using the Sand Replacement Method, but at each nuclear densometer test location the average of three readings taken at positions rotated by 90° shall be used. A check/comparison test using the Sand Replacement Method shall be carried out at 10 test interval.

Initial calibration of the nuclear density testing equipment shall be done by carrying out at least fifty tests in parallel with the Sand Replacement Method for each different material encountered. The check tests shall be used to update the initial calibration of the nuclear density testing equipment.

**C12 STONE, AGGREGATE, SAND AND FILLERS****(1) Sampling and Preparation of Samples**

Sampling shall be carried out as per ASTM-D75 and the samples shall be prepared in accordance with IS 2386 or according to sampling procedures specified for the Standard Methods of testing given in Table C12-1.

**(2) Standards Methods of Testing**

Tests on stone, aggregate, sand and filler shall be performed in accordance with the standard procedures given in the Table C12-1.

**TABLE C12-1: TESTS PROCEDURES APPLICABLE TO STONE AGGREGATE AND FILLERS**

Tests	Test Procedure	
Determination of:		
i) Particle Size Distribution (Gradation)	IS 2386	Part i
ii) Clay, Silt, Dust in Aggregates	IS 2386	Part 2
iii) Flakiness index	IS 2386	Part i
iv) Specific Gravity	IS 2386	Part 3
v) Moisture Content	IS 2386	Part 3
vi) Bulk Density, Voids & Bulking	IS 2386	Part 3
vii) Soluble Chloride Content	BS812	Part 117
viii) Mica Content	Manual mineralogical counting	
ix) Water Absorption	IS 2386	Part 3
x) Crushing Ratio	Manual counting &	weighing
xi) Los Angeles Abrasion	IS 2386	Part 4
xii) AIV - ACV	IS 2386	Part 4
xiii) Polished Stone Value	IS 2386	Part 4
xiv) Degradability Test	NFP94-067 ■	
xv) Sodium Sulphate Soundness	IS 2386	Part 5
xvi) Alkali Aggregate Reactivity Test	IS 2386	Part 7
xvii) Deleterious Substances	IS 2386	Part 2
xviii) Sand Equivalent	IS 2720	Part 37
xix) Crushing Strength of stone	IS 2386	Part 4

**C13 CEMENT**

Ordinary and High Strength Portland Cement (OPC and HSPC), Portland Slag Cement (PSC), Portland



Pozzolana Cement (PPC) shall be sampled according to IS 3535 and tested according to IS 4031.

Chemical and physical requirements for Ordinary Portland Cement, High Strength Portland Cement, Portland Slag Cement and Portland Pozzolana Cement shall be in accordance with IS 269, IS 8112, IS 12269, IS 455, IS 1489 respectively.

The requirements on their physical characteristics shall be as given in Table C13-1

**TABLE C13-1: REQUIREMENTS ON THE PHYSICAL CHARACTERISTICS OF CEMENT**

S.N.	Physical characteristics	OPC/PSC	HSPC	Test Procedure
i)	Fineness, m <sup>2</sup> /kg: (by Blaine's Air Permeability method)	225	225	IS-4031 Part 2
ii)	Setting Time: (a) Minimum Initial Setting Time (minutes) (b) Maximum Final Setting Time (minutes)	45 600	45 600	IS 4031 Part 5
iii)	Soundness by Lechatelier method, mm, maximum	10	10	IS 4031 Part 3
iv)	Compressive Strength: Minimum Average Compressive Strength of three mortar cube(N/mm <sup>2</sup> ) (a) 3 days (b) 7 days (c) 28 days	16 22 33	27 37 53	IS 4031 Part 6

#### **C14 LIME**

Limes shall be sampled and tested in accordance with BS 890 and shall comply with all requirements specified therein.

Lime for treatment of road materials shall be Hydrated Calcium Lime or Quicklime and, unless otherwise specified, shall comply with the requirements given in Table C14-1.

**TABLE C14-1: REQUIREMENTS OF LIME FOR TREATMENT OF ROAD MATERIALS**

S. No.	Characteristics	Hydrated lime	Quicklime
i)	Fineness Residue on 0.212 mm sieve - Maximum Residue on 0.075 mm sieve - Maximum	1% 10%	10% 50%
ii)	Chemical requirements Free lime content - Minimum Hydrated lime content - Maximum	50%	60% 5%

#### **C15 LIME TREATED MATERIALS**

##### **(1) Sampling**

Sampling and preparation of samples of lime treated material shall be carried out as specified or as instructed by the Engineer except that:

Samples containing particles larger than 19 mm shall be prepared for compaction and CBR tests as specified in Sub-clause C11 (1)b). (The fraction coarser than 19 mm shall be replaced by an equal weight of material passing through 19mm sieve and retained on 4.75 sieve).

##### **(2) Standard Methods of Testing**

The tests on lime treated materials shall be performed in accordance with the Standard methods given in Tables C15.2-1 and C16-1.

**TABLE C15.2-1: ADDITIONAL TESTS PROCEDURES APPLICABLE TO LIME TREATED MATERIALS**

Tests	Test Procedure
Determination of:	
(i) Unconfined Compressive Strength (UCS)	BS1924-Part2
(ii) Effect of immersion on UCS	BS 1924 -Part 2
(iii) Lime Content	BS 1924-Part 2

**C16 CONCRETE**

Sampling and testing on concrete shall be carried out in accordance with the standard methods given in the Table C16-1.

**TABLE C16-1: TESTS PROCEDURES APPLICABLE TO CONCRETE**

Tests	Test Procedures
Determination of:	
(i) Air contents of fresh concrete	BS 1881-106
(ii) Density of hardened concrete	BS 1881-114
(iii) Compressive strength of concrete cubes	BS 1881-116
(iv) Tensile splitting strength	BS 1881-117
(v) Flexural strength	BS 1881-118
(vi) Compressive strength of concrete cores	BS 1881-120
(vii) Water absorption	BS 1881-122
(viii) Mixing and sampling fresh concrete in laboratory	BS 1881-125
(ix) Normal curing of test specimens (20° C method)	BS 1881-111
(x) Accelerated curing of test specimens	BS 1881-112
(xi) Making test cubes from fresh concrete	BS 1881-108

Non destructive tests shall be carried out in accordance with the standard method and recommendations given in Table C16-2 as and when required.

**TABLE C16-2: NON-DESTRUCTIVE TESTS APPLICABLE TO CONCRETE**

S.N.	Tests	References to Test Procedures
i)	Method of testing hardened concrete for other than strength	BS 1881-5
ii)	Guide to the use of nondestructive methods of test for hardened concrete	BS 1881-201
iii)	Recommendation for surface hardened testing by rebound hammer	BS 1881-202
iv)	Recommendation for measurement of velocity of ultrasonic pulses in concrete	BS 1881-203
v)	Recommendation on the use of electromagnetic cover meters	BS 1881-204
vi)	Recommendation for the assessment of concrete strength by near to surface tests.	BS 1881-207

The test specimens shall be cured at a temperature of  $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$ . Water to be used in concrete shall be tested as specified in BS 3148.

The total chloride content, expressed as chloride ion, arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following limits, expressed as a percentage of the weight of cement in the mix :-

For pre-stressed concrete, steam cured concrete or concrete containing sulphate resisting or super-sulphated cement : 0.1 per cent

For any other reinforced concrete : 0.4 per cent

The total sulphate content expressed as  $\text{SO}_3$  of all the ingredients in a mix including cement, water and admixtures shall not exceed 0.4 per cent by weight of the aggregates or 4.0 per cent of the weight of the cement in the mix, whichever is the lesser.

### **C17 REINFORCING STEEL**

All reinforcement for use in the Works shall be tested for compliance as specified in Clause F14 in a Laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. The sampling and frequency of testing shall be as set out in the NS 84-2042 and NS 191-2045. In addition to the testing requirements described above, the Contractor shall carry out additional testing as instructed by the Engineer.

### **C18 TESTING OF WELDS**

(1) The tests shall be carried out by the methods described in BS 709. The following requirements shall also be met with.

#### **(a) General**

In any respect the test results of welded joints shall not be inferior to the British Standard test requirements for the parent material.

#### **(b) Procedure Trials**

(i) Tensile and Bend Test

Should any one of the weld joint pieces selected for transverse tensile and transverse and longitudinal bend test fail to comply with the requirements applicable to the parent metal of the joint, 2 additional test pieces shall be taken from the joint material represented by the test. Both the test pieces shall comply with the requirements in order to qualify for the acceptance.

(ii) Charpy V-notch Tests

Should the average impact value obtained from any set of 3 Charpy V-notch tests on specimens fail to comply with the requirements, 3 additional test pieces from the same sample shall be tested. The average of the 6 test results shall comply with the test requirements in order to qualify for acceptance.

(iii) Revised Procedures

In the event of failure to meet the requirements, the Contractor shall carry out further trials, using revised procedures, and further tests to the satisfaction of the Engineer.

#### **(c) Production Tests**

(i) Tensile and Bend Tests

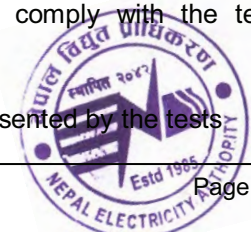
Should any one of the weld joint test pieces selected for transverse tensile and transverse bend tests fail to comply with the test requirements applicable to parent metal of the joint represented by the test, additional specimens shall be taken from the same production test plates and the test shall be repeated. Should any of the additional tests fail to comply with the requirements, the joint shall be rejected.

(ii) Charpy V-notch Tests

Should the average impact value obtained from any set of 3 Charpy V-notch specimens selected fail to comply with the test requirements, 3 additional test pieces from the same production test plates shall be tested. Should the average of the 6 results fail to comply with the test requirements the joint shall be rejected.

(iii) Re-welding and Re-Testing

In the event of failure to meet the test requirements the welded joint represented by the tests



shall be completely cut out. The joint shall then be re-welded and the test repeated.

(iv) Non-destructive Testing

A method of non-destructive testing agreed with the Engineer shall be used for the examination of butt welds in tension members.

### **C19 PAINTS FOR STRUCTURAL STEELWORK**

The Contractor shall submit the proposal to the Engineer about the paint system to be used in the Works. The system shall comply with as defined at least by the following information, supported by the paint manufacturer's data sheets:

- Type of system, composition of each component,
- Minimum thickness of each coat,
- Drying time at 10°C and 20°C within a range a relevant hygrometric conditions, including handling conditions, minimum and maximum time of overlap,
- Type of painting method and thinner content, (airless spray, brush, roller etc.)
- Thinner type,
- Blending ratio,
- Maximum time limit of use, by 75% of relative humidity and for a relevant range of temperature and hygrometric conditions,
- Ripening time for a relevant range of temperatures and at least for 20°C and 30°C.
- Weather conditions constraint for painting and drying, including minimum and maximum ambient temperature and temperature of surfaces to be painted.

### **C20 BRICKS**

Bricks shall conform to NS-1-2035 with the exceptions specified in Sub-clause G21.

### **C21 MORTAR**

Mortar shall comply with Sub-clause G22.

### **C22 REINFORCED CONCRETE PIPES**

Reinforced concrete pipes shall comply with the requirements of NS 80-2042/IS 458:1988.

### **C23 HIGH DENSITY POLYTHENE PIPES**

High density polythene pipes shall comply with the requirements of NS 40-2040.

### **C24 GEOTEXTILES**

Geotextiles used shall be made of polyethylene or polypropylene or polyester or similar fibers, either woven or non-woven. Unless otherwise shown on the Drawing, the geotextiles shall:

- a) sustain a load of not less than 10 kN/m at break and have a minimum failure strain of 10 percent when determined in accordance with BS: 6906 or shall have a grab tensile strength more than 0.4 kN/m and grab elongation corresponding to this limit in accordance with ASTM D4632.
- b) have apparent opening size as shown on the Drawing. If no size is shown on the Drawing, then the apparent size shall be 0.1 mm.
- c) allow water to flow through it at right angles to its principal plane, in either direction at a rate of not less than 50 liters/sq.m./sec. under a constant head of 100 mm, determined in accordance with BS: 6906 (Part 3) or ASTM D4491, unless otherwise shown on the Drawing. The flow rate determined in the test shall be corrected to that applicable to a temperature of 15°C using data on variation in viscosity of water with temperature.
- d) have a minimum puncture resistance of 200 N when determined in accordance with ASTM D 4833.
- e) have a minimum tear resistance of 350 N when determined in accordance with ASTM D 4533.

### **C25 TIMBER FOR STRUCTURAL WORKS**

Timber used for structural works shall comply with IS:883.



**C26 MANHOLE COVERS AND FRAMES**

Manhole covers and frames shall be of cast iron and shall comply with IS: 1726-1991. For manholes constructed in carriageway and shoulders, heavy duty circular covers and frames shall be used. In footpaths, medium duty circular covers shall be used. In other locations light duty covers and frames shall be used.

**C27 PRE-CAST CONCRETE CHANNELS**

Pre-cast concrete channels, kerbs, edging, quadrants and gutters shall comply with the requirements of IS: 5758-1984.

**C28 CAST IRON DRAINAGE GRATINGS**

Cast iron gratings for drainage purposes shall comply with the requirements of IS: 5961 -1970.

**C29 MEASUREMENT AND PAYMENT**

If otherwise not specified in the contract, no separate measurement and payment shall be made for sampling, samples and testing of materials, trials and construction control/process control testing. It shall be deemed to have included in the rates of the relevant items for complying with the requirements of this Section C.



**D SITE CLEARANCE****D1 CLEARING****(1) Scope**

This Section covers the removal of topsoil, vegetation, boulders of size up to 0.25 cu.m, surface obstructions, and demolition and removal of structures including their basements (if any) not directly associated with or incidental to any excavation necessary for the construction of the works covered by the contract. Conservation of the top soil and flora is also covered under this section. The prepared surface shall be finished to line, grade and slope suitable and as required by the Engineer.

All material from site clearance shall be the property of the Employer and depending on its nature shall, as directed by the Engineer, be either

- a. Stockpiled for future reuse.
- b. disposed by controlled burning.
- d. disposed by tipping or side casting with all lift within 30m.

Topsoil, referred to in this Clause shall mean the top 100 mm layer of soil with roots and organic matter, which is capable of vegetation support.

**(2) Description of Work****(a) Clearing**

Clearing shall consist of the cutting, removing and disposal of all trees, bushes, shrubs, grass, weeds, other vegetation, anthills, rubbish, fences, top organic soil not exceeding 150 mm in thickness and all other objectionable material, resulting from the clearing and grubbing. It shall also include the removal and disposal of structures that obtrude, encroach upon or otherwise obstruct the work.

The moving of a certain amount of soil or gravel material may be inherent to or unavoidable during the process of clearing and no extra payment shall be made for this. Clearing shall include the removal of all rocks and boulders of up to 0.15 m<sup>3</sup> in size exposed or lying on the surface.

**(b) Grubbing**

In the site all trees up to 300 mm girth, stumps and roots shall be removed to a depth of not less than 900 mm below the finished level and a minimum of 500 mm below the original ground level whichever is lower.

Except in borrow areas the cavities resulting from the grubbing shall be backfilled with approved material and compacted to a density not less than the density of the surrounding ground.

**(c) Conservation of Top Soil**

Where suitable topsoil exists within the limits of the area to be cleared and grubbed, the Contractor shall, if ordered by the Engineer, remove the topsoil together with any grass and other suitable vegetation. If not used immediately, the topsoil shall be transported and deposited in stockpiles for later use.

**(d) Conservation of Flora**

Where provided for in the contract, certain designated flora encountered in the road reserve and borrow areas shall be carefully protected by the Contractor. In his tendered rate for Site Clearance, he shall include for the careful removal and planting of the flora in a protected and fenced-off area and, on completion of the road, for the replanting of the flora in suitable positions in the road reserve in accordance with the Engineer's instructions.

**(3) Execution of Work****(a) Areas to be Cleared and Grubbed**

Stumps, embedded logs, roots and all other vegetation growth and accumulated rubbish of

whatsoever nature and all other objectionable material shall be completely removed to a depth as specified in Sub-clause D1(2)(a) & (b).

Normally the portions of the road reserve that fall within the limits of the road prism, as well as



certain borrow areas shall be cleared and/or grubbed. Where the road reserve is to remain unfenced, the full width of the road reserve shall be cleared and/or grubbed except for such trees designated by the Engineer to be left standing and uninjured.

The Contractor shall mark the boundaries of the area for clearing and grubbing and seek the approval of the Engineer before commencement of the work. The Engineer shall designate in detail the exact areas to be cleared and grubbed and the time at which it shall be done.

(b) Cutting of Trees

The Contractor shall take the necessary precautions to prevent damage to structures and other private or public property. If necessary, trees shall be cut in sections from the top downwards. The branches of trees to be left standing shall be trimmed so as not to intrude into a space of 7 m above the roadway.

Such individual trees as the Engineer may designate and mark in white paint shall be left standing and uninjured. In order to minimize damage to trees that are to be left standing, trees shall be felled towards the center of the area being cleared, if so required by the Engineer.

Permission for cutting trees must be obtained from the competent authority who may require that trees be numbered, measured and marked in the presence of officials from that authority. Cutting of such trees shall then be carried out by the Contractor and the timber stored at designated locations within the Right of Way.

Felling and cutting of trees on the site and piling them off the site shall conform to the requirements of the competent authority.

All tree trunks and branches in excess of 150 mm in diameter shall be cleaned off, secondary branches cut into suitable length and stacked at sites indicated by the Engineer. Such timber shall not be used by the Contractor for any purpose and shall remain the property of the Employer.

All timber except such timber as can be used and all brush, stumps, roots, rotten wood and other refuse from the clearing and grubbing operations shall be completely removed from within the Right of Way.

(c) Dealing with Anthills

Where anthills are encountered within the limits of the road prism, they shall be excavated to a depth of not less than 750 mm below the finished road level and the material carted to spoil. Cavities resulting from the clearance of anthill material shall be backfilled with approved material and compacted to a density not less than that of the surrounding ground.

Where directed by the Engineer, the area covered by anthills shall be treated, after excavation and before backfilling of cavities, with an approved ant control chemical. Payment for such treatment shall be made in the manner specified in the contract.

(d) Disposal of Material

Material obtained from clearing and grubbing shall be disposed off in borrow pits or other suitable places and be covered up with soil or gravel as directed by the Engineer. The burning of combustible material shall not, normally, be permitted and may only be done with the prior written approval of the Engineer.

Where fences have to be taken down, fencing wire shall be neatly wound into reels and all such wire, together with all fence posts and other serviceable material from structures, etc., shall be stacked at sites indicated by the Engineer.

(e) Re-clearing of Vegetation

When portions of the road reserve, borrow or other areas have been cleared in accordance with the Specifications, but in the course of time, vegetation grows again during construction, the Engineer may, if he considers it necessary, order that the area be re-cleared.

Before the bottom layer of the embankment is made, the Contractor shall grub up and remove any vegetation that may in the meantime have grown on the surfaces previously cleared and grubbed.

Such re-clearing of areas previously cleared includes the removal and disposal of grass, shrubs and other vegetation in the same manner as for the first clearing operation. No separate payment

shall be made for re-clearing of vegetation.

**(4) Measurement**

Clearing and grubbing executed as per this Specification shall be measured in square meter. Cutting trees including removal of stumps and their roots of girth above 300 mm and backfilling to required compaction shall be measured in number according to the sizes given below:

a Above 300 mm to 600 mm. b Above 600 mm to 900 mm. c Above 900 mm to 1800 mm. d Above 1800 mm.

For this purpose girth shall be measured at a height 1 meter above ground.

Cutting of trees up to 300 mm girth including removal of stumps and roots and backfilling of holes with compaction shall not be measured separately.

**(5) Payment**

Clearing and grubbing and cutting trees shall be paid at their respective contract unit rates which shall be the full and the final compensation to the Contractor. The contract unit rate for cutting of trees of girth above 300 mm shall also include handling, salvaging, piling and disposing off the cleared materials with all leads and lifts.

**(6) Measurement**

Prior to commencement of dismantling, the work of dismantling structures shall be measured in the units given below:

Type of Work	Unit
Dismantling brick/stone masonry/ concrete (plain and reinforced)	cu. m.
Dismantling gabion	cu. m
Dismantling steel structures	t
Dismantling timber structures	cu. m
Dismantling pipes, guard rails, kerbs and gutters	r. m
Utility services	Lump sum
Pavement	cu. m

Associated works like disposal, stockpiling, marking and numbering, etc. shall not be measured separately.

**(7) Payment**

The various dismantling works shall be paid at their respective contract unit rates which shall be the full and the final compensation to the Contractor as per Clause A15 and for the cost of all operations involved for completion of this item.

## **E EARTHWORKS**

### **E1 SCOPE**

This Section covers the works related to the excavation for foundation, backfilling, excavation for drains, etc. The Contractor shall examine the Site and ascertain for himself the nature thereof and the types of materials to be excavated.

### **E2 DEFINITIONS AND GENERAL REQUIREMENTS**

- (1) Earthwork includes two types of operations i.e. (i) earth excavation and disposal of the excavated materials (ii) earth excavation and use of excavated materials. The use of excavated materials may be in the form of backfilling, filling other areas as required.

Earth excavation and disposal implies excavation of all types of materials including part of the structures below ground level except for otherwise specified, shaping the exposed surface of excavation as specified or directed by the Engineer, removal, hauling and disposal of the excavated material at the locations and in the manner as specified or directed by the Engineer.

Excavation and filling implies excavation of materials and shaping the exposed surface of excavation as stated above, removal, hauling and use of the excavated material at the location and in the manner as specified or directed by the Engineer.

Excavation and disposal shall include:

- (i) Excavation and disposal of any type of material indicated on the Drawing.
  - (ii) The excavation and disposal of existing surfacing,
  - (iii) Excavation and disposal of unsuitable materials.
  - (iv) Excavation for foundation and disposal of materials.
- (2) The following definitions of earthwork materials shall apply to this and other Clauses of these specifications, if otherwise not specified.
- (i) "Topsoil" shall mean the top layer of soil that can support vegetation. It shall include all turf acceptable for turving.
  - (ii) "Rock material" shall comprise material, which in the opinion of the Engineer can be removed either with drilling and blasting with explosives or continuous manual chiseling or mechanical chipping with pneumatic tools.
  - (iii) "Common material" shall comprise all material that is not classified as rock material. Common material shall include soil mixed with boulders that need not to be blasted.
  - (iv) "Suitable Material" shall mean all excavated material that can be used as construction material in the Works in accordance with these Specifications.
  - (v) "Unsuitable materials" shall mean material other than suitable material. Material from swamps, marshes, bogs, organic material, silt, and clay or their mixture, discarded top soil etc. in general are unsuitable material.

Classification of common and rock material made by the Engineer shall be final and binding on the Contractor.

Measurement will be limited to the lines, grades, slopes, and dimensions shown on the drawings or as directed by the Engineer.

Original lines and levels of surfaces for measurement of depth shall be determined by Contractor and submitted to the Engineer for approval before commencement of excavation and will be arithmetic mean of representative levels taken at suitable intervals prior to the execution of all earthworks.

- (3) No excavated suitable material other than surplus to requirements of the contract shall be removed from the site except on the direction of the Engineer. Should the Contractor be permitted to remove suitable material from Site to suit his operational procedure, then he shall make good at this own expense any consequent deficit of filling arising there from.
- (4) Material in surplus to the total requirements of works, and all unsuitable materials shall, unless the Engineer permits otherwise, be run to spoil dumps.
- (5) Where the excavation reveals a combination of suitable and unsuitable materials the Contractor

shall carry out the excavation in such a manner that the suitable materials are excavated separately for use in the works without contamination by the unsuitable materials.

- (6) The Contractor shall make his own arrangements for the stockpiling of top-soil and/or suitable material.
- (7) At all times the Contractor shall ensure that earthworks are not damaged by weather or traffic. In the event of such damage, the Engineer may withdraw approval from the affected works until the Contractor has carried out repairs to restore the works to their original condition.

Earthworks for preparation of plinth of building and mass excavation for preparation of formation level are incorporated under this Clause. The item covers all depths and water conditions for common material.

### **E3 EARTHWORK IN EXCAVATION IN FOUNDATION**

#### **1 Earthwork in excavation in the Formation:**

Due to uneven topography of the Site, the leveled ground shall be prepared with the formation level as indicated in the drawings or to such lesser or greater extent as the Project Engineer may advice. Excavated earth shall or shall not be placed within the premises of the project boundary. The Project Engineer may direct the Contractor to place excavated earth at particular filling area or to be dispose off.

#### **2 Earthwork in Excavation in Foundation:**

Foundation trench shall be due to the exact width and depth and levels as indicated in the drawings or to such lesser or greater extent as the Engineer may advice. Sides of trenches shall be vertical. In case the soil does not permit vertical sides, the Contractor shall protect side with timber shoring. Excavated earth shall not be placed within 1.5 meter of the edge of the trench. The Project Engineer may direct the Contractor to place excavated earth at a particular site up to 30 meter away from the building. The bottom of the trench shall be perfectly leveled both longitudinally and transversely. The bed shall be lightly watered and well-rammed. Excess digging if done through mistake shall be filled with 1:4:8 concrete. Water, if any accumulated in the trench, shall be baled out and all necessary precaution taken to prevent surface water from entering the trench. Soft and defective spot in the trench shall be dug out and removed and filled with concrete or materials prescribed by the Project Engineer. If rocks or boulders are found during excavation, they should be removed and the bed trench shall be leveled and made hard by consolidating the earth, at no extra cost. Above mentioned items or any variation thereof from the Bills of Quantities shall be measured and valued by the Engineer as a variation. After the completion of foundation masonry, the remaining portion of the trench not filled by masonry shall be filled up with earth in layers of 15cm, watered and well-rammed. Such filling shall be free from rubbish, refuse matters and clods, surplus earth, if any shall be removed and site shall be leveled and dressed.

Trenches shall be measured as per drawings and rate shall be for complete Work including trench filling, for 30 meter lead and 1.5 meter lift including all tools and plants required for the completion of the work, removal of boulders, side shoring, pumping, and filling in voids by mass concrete (1:4:8).

No excavation or foundation work shall be filled in or covered up before the inspection and approval of the Project Engineer.

The starting level for excavation shall be deemed to be ground level or such level as may be specified by the Project Engineer, before the commencement of the Work.

### **E4 EXCAVATION FOR FORMATION OF PLINTH OF BUILDING AND PARKING WORKS**

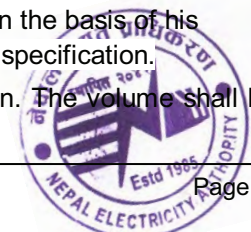
This Clause deals with excavation for formation of plinth of buildings and Parking. All suitable material shall be used insofar as practicable in the construction

#### **Measurement**

Measurement of all works will be made in m<sup>3</sup>.

Measurement for payment under the contract will be limited to the lines, grades, slopes and dimensions shown on the Drawings or as determined by the Engineer as the work proceeds on the basis of his evaluation of the soil/rock characteristics and site-conditions set elsewhere in this specification.

All required and accepted excavation shall be measured from its original position. The volume shall be



determined in cubic meters by average area method to be computed from the original and final cross-sections of the completed works as per the drawings or as directed by the Engineer. Where it is not practicable to use the above method of measurement, the Engineer may use volumetric method or any other method that in his opinion is best suited for accurate assessment.

Any over-excavation shall be reinstated at the risk and cost of the Contractor as directed by the Engineer.

**Payment**

Payment for work under these clause will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**E5 BACKFILL****1 General**

This work is related to all types of structures that require filling with specified material in the remaining volume or space of excavation left unoccupied by any permanent construction.

Activities involved are collection and transportation of suitable material from local borrow pits or hill side excavation, placing the specified backfill material in layers, removal of foreign material if any, watering, compacting to required density, lines and levels as indicated in the drawings or as directed by the Engineer.

Compaction shall proceed after the Contractor together with the Engineer identify the optimum thickness of each layer of suitable material, its optimum moisture content, and the corresponding number of passes required for a roller to arrive at the corresponding OMC. Prior to the start of works, the contractor shall prepare a trial stretch to establish the above parameters and shall repeat it as often as necessary due to change in layer thickness, borrow pits, and /or change in equipment. The Contractor may use the Standard Specifications for Roads and Bridge Works of HMG, MWOT, DOR as guide for the above purpose.

Backfill, classified according to their nature, are presented in the following Sub-Clauses.

**2 Backfill in Plinth of Building and Parking**

This work shall consist of filling for construction of embankment for plinth of building, road works and parking area and includes furnishing, placing, watering, compacting and shaping suitable material obtained from approved sources in accordance to lines, levels, grades, dimensions shown on the Drawings and or as required by the Engineer. Fill material used shall not exceed 150 mm and 75 mm within the 300 mm and 150 mm of formation level respectively. Fill material shall not have organic content value exceeding 5% and soaked CBR value less than 6% unless otherwise approved by the Engineer.

Activities involved shall be preparation of surface, scarifying, supply, and laying of suitable material in layers. Except where material is laid close to the formation level, each layer shall not exceed 300 mm in thickness before compaction. Each layer of material shall then be watered and compacted to 95% dry density at optimum moisture content. Testing shall be carried out by sand cone using relevant BS or ASTM Standards.

The top level of such fill executed shall be regarded as the formation level.

**3 common backfill in structures**

Common backfill includes stacked suitable material recovered from excavations or material transported from outside. This may include granular material passing through 75 mm sieve or sandy soil. The backfill material shall be spread uniformly in layers, leveled, watered and then compacted to 95% of its optimum density in layers not exceeding 200 mm for buildings works and 250 mm for others. Compaction may be done manually or with mechanical means. Manual compaction in each layer will be done using 2 to 5 kg rammers made of cast-iron or wood. Mechanical compaction shall be executed with either plate compactors, earth rammers, depending on site conditions.

Compaction tests shall be conducted with sand cones using relevant BS or ASTM standards.



**E6 TRANSPORTATION AND HANDLING OF EXCESS DISPOSABLE MATERIAL**

This work will be required in connection with transportation of materials from demolition works (unless otherwise specified) and excess suitable or unsuitable material from excavation. Transport will include all distance beyond the initial lead (30m unless otherwise specified) for safe disposal as specified by the Engineer.

Activities involved will be supply of necessary means of transport, loading, and transportation safely without damage/loss, unloading and leveling properly at disposal sites. The disposed materials shall be laid in layers mechanically or manually compacted to the satisfaction of the Engineer.

The excess material shall be disposed manually with or without equipment like wheelbarrows or by trucks depending on the location of disposal sites.

**E7 Measurement**

Measurement will be based first in m<sup>3</sup> of loose volume of accepted works with 35% deduction for voids for all leads indicated in the BOQ. The measurement will be made at the disposal site.

**E8 Payment**

Payment for work under this Clause will be made on the basis of contract unit price indicated in the BOQ. The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.



**F CONCRETE WORK****F1 SCOPE**

This Section covers the materials, design of mixes, mixing, transport, placing, compaction and curing of concrete (plain and reinforced), either cast-in- situ or pre-cast and mortar required in the civil engineering and building construction works. It also covers reinforcement for concrete.

**F2 DEFINITIONS**

Structural concrete is any class of concrete which is used in reinforced, pre-stressed or un-reinforced concrete construction which is subject to stress.

Non-structural concrete is composed of materials complying with the Specification but for which no strength requirements are specified and which is used only for filling voids, blinding foundations and similar purposes where it is not subjected to significant stress.

A pour refers to the operation of placing concrete into any mould, bay or formwork, etc. and also to the volume which has to be filled. Pours in vertical succession are referred to as lifts.

**F3 MATERIALS FOR CONCRETE****(1) General**

The Contractor shall submit to the Engineer full details of all materials which he proposes to use for making concrete. No concrete shall be placed in the works until the Engineer has approved the materials of which it is composed. In accordance with Clause C, approved materials shall not thereafter be altered or substituted by other materials without the consent of the Engineer.

**(2) Cement**

Cement shall comply with the requirements of Clause C13.

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed unbroken bags or in bulk. Bagged cement shall be transported in vehicles provided with effective means of ensuring that it is protected from the weather.

Bulk cement shall be transported in vehicles or in containers built and equipped for the purpose.

Cement in bags shall be stored in a suitable weatherproof structure of which the interior shall be dry and well ventilated at all times. The floor shall be raised above the surrounding ground level not less than 30cm and shall be so constructed that no moisture rises through it.

Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation with min gap of 500mm from outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. Stack of cement bags shall not exceed 8 bags in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks.

Cement from broken bags shall not be used in the works. Cement in bags shall be used in the order in which it is delivered.

Bulk cement shall be stored in weather proof silos which shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity on site to ensure that his anticipated program of work is not interrupted due to lack of cement.

Cement which has become hardened or lumpy or fails to comply with the Specification in any way shall be removed from the Site.

All cement for any one structure shall be from the same source as far as possible.

All cement used in the works shall be tested by the manufacturer. The manufacturer shall provide the results of tests as given in F32-1 & F32-2 for each supply and for the last six months of his production. The Contractor shall supply two copies of each certificate to the Engineer.

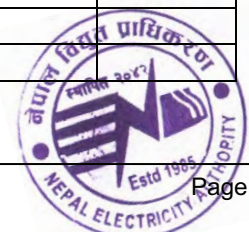
**TABLE F3.2-1: TEST RESULTS FOR CHEMICAL COMPOSITION OF CEMENT**

Compounds %	Mean	Min	Max	Standard deviation
Lime CaO				
Silica SiO2				
Alumina Al2O3				
Iron Oxide Fe2O3				
Magnesia MgO				
Sulphur Trioxide SO3				
Soda, Potash				

**TABLE F3.2-2: TEST RESULTS FOR PHYSICAL PROPERTIES OF CEMENT**

Characteristics	Requirements	Nominal	Mean	Min	Max	St. dev.
Fineness, M2/KG : (by Blaine's	225					
Air Permeability Method)						
Minimum Setting time (initial), minutes	45					
Maximum Setting time (final), minutes	600					
Soundness (by. Le Chatelie method) mm, maximum	10					
Minimum Average Compressive Strength of three mortar cubes, (N/mm2)						
3 days	16,27*					
7 days	22,37*					
28 days	33,53*					

\*denotes the requirements of High Strength Portland Cement.



Each set of tests carried out by the manufacturer on samples taken from cement which is subsequently delivered to site shall relate to no more than one day's output of each cement plant.

The Contractor shall constitute, from each delivery and each type of cement and not less than one samples for every 200 tons or part of it, representative samples to be tested when instructed by the Engineer in a laboratory acceptable to him, in case of the concrete mixes do not comply with the requirements of this Specification.

Cement which is stored on site for longer than one month shall be tested in such laboratory for every 200 tons or part thereof and at monthly intervals thereafter.

The Contractor shall keep full records of all data relevant to the manufacture, delivery; testing and the cement used in the works and shall provide the Engineer with two copies thereof.

### (3) Fine Aggregate

Fine aggregate shall be clean hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with IS 383. All the material shall pass through a 4.75 mm IS sieve and the grading shall be in accordance with IS 383. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source.

The deviation from the initial fineness modulus shall be no more than  $\pm 0.30$  for ordinary concrete and  $\pm 0.20$  for high quality concrete.

However, in respect of the presence of deleterious materials the fine aggregate shall not contain iron pyrites, iron oxides, mica, shale, coal or other laminar soft or porous materials or organic matter unless the Contractor can show by comparative tests on finished concrete as set out in Clause F17 and as per the direction of the Engineer, that the presence of such materials does not affect the properties of the concrete.

### (4) Coarse Aggregate

Coarse aggregate shall be clean hard and durable crushed rock, crushed gravel or natural gravel corresponding to the following classes:

Class A: Aggregate shall consist of crushed igneous or quartzite rock from an approved source.

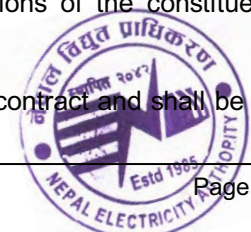
Class B: Aggregate shall consist of crushed quarry rock other than Class A from an approved source.

Class C: Aggregate shall consist of natural or partly crushed gravel, pebbles obtained from an approved gravel deposit. It may contain a quantity of material obtained from crushing the oversize stone in the deposit provided such material is uniformly mixed with the natural uncrushed particles.

Class D: Aggregate shall consist entirely of crushed gravel. The crushed gravel shall be produced from material retained on a standard sieve having an opening at least twice as large as the maximum size of aggregate particle specified.

Class E: Aggregate shall consist of an artificial mixture of any of the above classes of aggregate the. The use of Class E aggregate and the relative proportions of the constituent materials shall be approved by the Engineer.

Coarse aggregate shall be supplied in the nominal size called for in the contract and shall be of



the grading as single sized aggregate or graded aggregate of nominal size 40 mm, 20 mm, 12.5 mm and 10 mm in accordance with IS 383.

Other properties shall be as set out below:

**Flakiness Index.** When tested in accordance with IS 2386 Part 1, the Flakiness Index of the coarse aggregate shall be as set out hereunder:

For ordinary concrete : not more than 25

For high quality concrete : not more than 15

If the Flakiness Index of the coarse aggregate varies by more than five units from the average value of the aggregate used in the approved trial mix, then a new set of trial mixes shall be carried out if the workability of the mixes has been adversely affected by such variation.

**Water Absorption:** The aggregate shall not have a water absorption of more than 2 per cent when tested as set out in IS 2386 Part 3.

**Los Angeles Abrasion (LAA):** The aggregate shall have LAA not more than 45% for ordinary concrete, and not more than 35% for high quality concrete, when tested in accordance with IS 2386 Part 4.

**Aggregate Crushing Value (ACV):** The aggregate shall have ACV not more than 30% for pavement structure and not more than 45% for other structure when tested in accordance with IS 2386 Part 4.

**Alkali Aggregate Reactivity:** The aggregate shall comply with IS 383/3.2 notes when tested in accordance with IS 2386 Part 7.

## (5) Testing Aggregates

### (a) Acceptance Testing

The Contractor shall deliver to the Engineer samples containing not less than 50 kg of any aggregate which he proposed to use in the works and shall supply such further samples as the Engineer may require. Each sample shall be clearly labeled to show its origin and shall be accompanied by all information called for in IS 2386 Part 1 to 8. Tests to determine compliance of the aggregates with the requirements of Sub-clause F3 (3) and (4) shall be carried out by the Contractor in a laboratory acceptable to the Engineer. If the tested materials fail to comply with the Specification, further tests shall be made in the presence of the Contractor and the Engineer. Acceptance of the material shall be based on the results of such tests.

All the materials shall be accepted if the results of not less than three consecutive sets of test executed in accordance with IS 2386 (Part 1-8) show compliance with the Sub-clauses F3 (3) and (4).

### b) Compliance Testing/Process Control Testing

The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period that concrete is being produced for the works. The tests set out below shall be performed on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to site provided that the set of tests shall represent not more than 100 tons of fine aggregate and not more than 250 tons of coarse aggregate, and provided also that the aggregates are of uniform quality.



Grading : IS 2386 Part 1

Silt, Clay Contents and Organic Impurities: IS 2386 Part 2

If the aggregate from any source is variable, the frequency of testing shall be increased as instructed by the Engineer.

In addition to the above routine tests, the Contractor shall carry out the following tests at the stated frequencies:

Chloride Content: As frequently as may be required to ensure that the proportion of chlorides in the aggregates does not exceed the limit stated in the Specification. Sulphate Content and Alkali Aggregate Reactivity; as frequently as may be required according to the variability of sulphate content and alkali reactivity assessed from the laboratory tests carried out during the concrete mix design.

#### **(6) Delivery and Storage of Aggregates**

Aggregates shall be delivered to site in clean and suitable vehicles. Different type or sizes of aggregates shall not be delivered in one vehicle.

Each type or size of aggregate shall be stored in a separate bin or compartment having a base such that the contamination of aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

The storage of aggregates shall be arranged in such a way that drying out in hot weather is prevented in order to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged in such way that they can drain sufficiently before use in order to prevent fluctuations in water content of the concrete.

#### **(7) Water for Concrete and Mortar**

Water shall be clean and free from harmful matter and shall comply with the requirements of IS 456.

Brackish water containing more than 1000 ppm chloride ion or 2000 ppm sulphate ion shall not be used for mixing or curing concrete.

The Contractor shall carry out tests in compliance with IS 456 to establish compliance with Specifications.

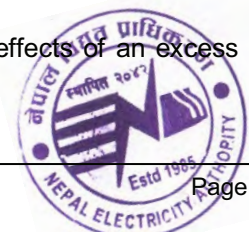
#### **(8) Admixtures**

##### **(a) General**

The use of admixtures in concrete may be required under the contract to promote special properties in the finished concrete or may be proposed by the Contractor to assist him in compliance with the Specification.

In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the manner in which he proposes to add it in the mix. The information provided shall include:

- (i) The typical dosage, the method of dosing, and the detrimental effects of an excess or deficiency in the dosage.



- (ii) The chemical names of the main active ingredients in the admixture.
- (iii) Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
- (iv) Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage, and if so the extent to which it does so.
- (v) Details of previous uses of the admixture in Nepal.

The chloride ion content of any admixture shall not exceed 1 per cent by weight of the admixture nor 0.02 per cent by weight of the cement in the mix.

Admixtures shall not be mixed together without the consent of the Engineer.

Calcium chloride or admixtures containing calcium chloride shall not be used in pre-stressed concrete.

Admixtures may be supplied as liquid or as powder. They shall be stored in sealed and undamaged containers in a dry, cool place. Admixtures shall be dispensed in liquid form and dispensers shall be of sufficient capacity to measure at one time the full quantity required for each batch.

- (b) Workability Agents

Workability agents shall comply with BS 5075 and shall not have any adverse effect on the properties of the concrete.

#### **F4 THE DESIGN OF CONCRETE MIXES**

##### **(1) Classes of Concrete**

The classes of structural concrete to be used in the works shall be as shown on the Drawing and designated in Table F4.1-1, in which the class designation includes two figures. The first figures indicates the characteristic strength  $f_{ck}$  at 28 days expressed in MPa ( $N/mm^2$ ) and the second figure is the maximal nominal size of aggregate in the mix expressed in millimeters. Letter M in the class designation stands for Mix, letters SM stand for Special Mix.

Consistence of the mix, assessed through the Slump Test where the slump is measured in millimeters, is designated as follows:

S: Stiff consistence, for slump < 40

P: Plastic consistence, for slump > 40 and < 90

VP: Very Plastic consistence, for slump >90 and < 150

F: Flowing consistence for slump > 150



**TABLE F4.1-1: CONCRETE CLASSES AND STRENGTH**

Classes of concrete	Consistence	Type of uses	Characteristic Strength (fck) MPa (N/mm <sup>2</sup> )	Maximum Nominal Size of Aggregate (mm)	Trial mixes Minimal Target Strength fd=1.1fck MPa (N/mm <sup>2</sup> ) Early works test cubes	Early works test cubes	
						Any one result (aver, of 3 cubes) MPa (N/mm <sup>2</sup> )	Average of 3 consecutive results MPa (N/mm <sup>2</sup> )
M 10/75	S	Ordinary	10	75	11	10	14
M 10/40	S	Ordinary	10	40	11	10	14
M 15/20	S	Ordinary	15	20	16.5	15	19
M 15/40	S	Ordinary	15	40	16.5	15	19
M 20/20	S	Ordinary	20	20	22	20	24
M 20/40	S	Ordinary	20	40	22	20	24
M 25/20	S	Ordinary	25	20	27.5	25	29
M 25/40	S	Ordinary	25	40	27.5	25	29

**(2) Design of Proposed Mixes**

Concrete mixes shall comply with Clause F17.

The Contractor shall design all the concrete mixes called for in the Drawing using the ingredients which have been approved by the Engineer in accordance with Clause F3 and in compliance with the following requirements:

- The aggregate portion shall be well graded from the nominal maximum size of stone down to the 150 micron size.
- The cement content shall be such to achieve the strength called for in Table F4.1-1 but in any case not less than the minimum necessary as shown in Table F4.2-1
- The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions.
- The water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater than 0.5 for classes of concrete from M20 to M50 taking due account of any water contained in the aggregates. The Contractor shall take into account that this requirement may in certain cases require the inclusion of a workability agent in the mix.

**TABLE F4.2-1 MINIMUM CEMENT CONTENT**

Classes of concrete	Minimum cement content in kg per m concrete of compacted		
	Moderate exposure	Intermediate exposure	Severe exposure
M15/40, M15/20	150	200	225
M20/40, M20/20	250	300	325
M25/20, M25/40	300	325	350

**Note:** The minimum cement contents shown in the above table are required in order to achieve impermeability and durability. In order to meet the strength requirements in the Specification higher contents may be required.

The categories applicable to the works are based on the factors listed hereunder:

Moderate exposure : Surface sheltered from severe rain, buried concrete.

Intermediate exposure : Surface exposed to severe rain; alternate wetting and drying; traffic; corrosive fumes; heavy condensation.

Severe exposure : Surface exposed to water having a pH of 4.5 or less, groundwater containing sulphate.

### (3) Laboratory Trial Mixes

For each mix of concrete for which the Contractor has proposed a design, he shall prepare the number of concrete batches specified hereunder:

Nominal composition : 3 separate batches

Modified compositions, the quantities of other constituents being unchanged:

Water : +10% 1 batch

Water : -10% 1 batch

Cement : +15% 1 batch

Cement : -15% 1 batch

Samples shall be taken from each batch and the following action taken, all in accordance with BS 1881:

- The slump of the concrete shall be determined.
- Six tests cubes shall be cast from each batch. In the case of concrete having a maximum aggregate size of 20 mm, 150 mm cubes shall be used. In the case of concrete containing larger aggregate, 200 mm cubes shall be used and in addition any pieces of aggregate retained on a 50 mm IS sieve shall be removed from the mixed concrete before casting the cubes.
- The density of all the cubes shall be determined before the strength tests are carried out.



- (d) All faces shall be perpendicular to each other.
- (e) Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.

For "Smaller Contracts works", the following composition are suggested as a starting basis for the Laboratory trials for one m<sup>3</sup> of concrete:

Concrete Class	Characteristic Strength N/mm <sub>2</sub>	Cement (kg)	Total aggregates (kg)	Fine aggr./ Total Aggr. (%)	Water (max) (lit.)	Workability
M 15/40-1 M 15/20	15	250	1900	35-45	160	Stiff
M 20/20	20	300	1875	35-45	165-170	Plastic Stiff

A "result" being the average strength of the three cubes from one batch, the average of the three results from tests at 28 days for the nominal composition shall not be less than the Minimal Target Strength.

One result from the modified compositions shall not be less than the nominal strength as shown on Table F4.1-1.

#### (4) Site Trials

At least six weeks before commencing placement of concrete in the permanent works, site trials shall be prepared for each class of concrete specified.

For each mix of concrete for which the Contractor has proposed a design and successfully tested in Laboratory, he shall prepare three separate batches specified hereunder using the materials which have been approved for use in the works and the mixing plant which he proposes to use for the works. The volume of each batch shall be the capacity of the concrete mixer proposed for full production.

Samples shall be taken from each batch and the action taken similar to the above Sub-clause F43 (a) to (e).

The average of the three results of tests at 28 days shall not be less than the Minimal Target Strength shown in Table F4.1-1.

The Contractor shall also carry out tests to determine the drying shrinkage of the concrete unless otherwise directed by the Engineer.

Based on the results of the tests on the Laboratory trial and site trial mixes, the Contractor shall submit full details of his proposals for mix design to the Engineer, including the type and source of each ingredient, and the results of the tests on the trial mixes.

If the Engineer does not agree to a proposed concrete mix for any reason, the Contractor shall amend his proposals and carry out further trial mixes. No mix shall be used in the works without the written consent of the Engineer.

#### (5) Quality Control of Concrete Production

- (a) Sampling

For each class of concrete in production at each plant for use in the works, samples of



concrete shall be taken at the point of mixing or of deposition as instructed by the Engineer, all in accordance with the sampling procedures described in BS 1881 and with the further requirements set out below.

Six 150 mm or 200 mm cubes as appropriate shall be made from each sample and shall be cured and tested in accordance with BS 1881 three at seven days and the other three at 28 days. Where information samples are required, such as for post-tensioning operations, three additional cubes shall be made.

The minimum frequency of sampling of concrete of each grade shall be as following:

For 1-5 m <sup>3</sup> quantity of work	-	1 no. of sample
For 5-20 m <sup>3</sup> quantity of work	-	2 no. of sample
For 20 m <sup>3</sup> and more quantity of work	-	3 no. of sample plus one additional for each 20m <sup>3</sup> or part thereof. At least one sample shall be taken from each shifts of work

Until compliance with the Specification has been established the frequency of sampling shall be three times that stated above and not less than 3 samples/day for each class of concrete in production at each plant or such lower frequency as may be instructed by the Engineer.

(2) Testing

- (i) The slump of the concrete shall be determined for each batch from which samples are taken and in addition for other batches at the point of production and deposition or at the frequency instructed by the Engineer.

The slump of concrete in any batch shall not differ from the value established by the trial mixes by more than 25 mm or one third of the value whichever is the less.

- (ii) The air content of air entrained concrete in any batch shall be within 1.5 times of the required value and the average value of four consecutive measurements shall be within the required value expressed as a percentage of the volume of freshly mixed concrete.
- (iii) Early Works: Until such time as sufficient test results are available to apply the method of control described in (iv) below, the compressive strength of the concrete at 28 days shall be such that no single result (average of 3 cubes) is less than the characteristic strength  $f_{ck}$  as shown in Table F4.1-1 under the heading "early works test cubes" and also that the average of three consecutive results is not less than  $f_{ck} + 4$  as shown in Table F41-1 under the same heading.

The 7-day cube result may be used as an early strength indicator, at the discretion of the Engineer.

- (iv) When at least 20 consecutive results on tested batches are available for any class of concrete mixed in any one plant, no single result shall be less than  $f_{ck} + 4$  (N/mm<sup>2</sup>) and also the average of any group of three consecutive results shall not be less than  $f_{ck} + 4$  (N/mm<sup>2</sup>).

In addition the Coefficient of Variation shall be less than the figure given below:

Number of batches	Maximum coefficient of variation	
	Ordinary concrete	High quality concrete
After 20 tested batches	18%	15%
After 50 tested batches	15%	12%

Where the Coefficient of Variation = (Standard Deviation of the results/Average value of the result)

(v) Failure to comply with Requirements:

If any one result in a group of three consecutive results is less than  $f_{ck}-4$  (N/mm<sup>2</sup>), but the other results of group satisfy the strength requirement, then only the batch from which the failed result was obtained shall be deemed not to comply with the Specification.

If the average strength of the group is less than the strength requirement then all the batches between those represented by the first and the last result shall be deemed not to comply with the Specification, and the Contractor shall immediately adjust the production procedure or the mix design subject to the agreement of the Engineer to restore compliance with the Specification. If adjustment of the mix design is agreed, the Contractor shall again be required to comply with F4 (3) and F4 (4).

The Contractor shall take necessary action to remedy concrete which does not comply with this Specification. Such action may include but not necessarily confined to the following :

- Increasing the frequency of sampling until control is again established.
- Carrying out non destructive testing such as ultrasonic measurements, load tests or other appropriate methods,
- Cutting test cores from the concrete and testing in accordance with BS 1881
  - Carrying out strengthening or other remedial work to the concrete where possible or appropriate.
  - Removing the concrete.
  - Accepting as sub standard

## F5 MIXING CONCRETE

Before any batching, mixing, transporting, placing, compacting and finishing and curing the concrete ordered or delivered to site, the Contractor shall submit to the Engineer full details including Drawing of all the plant which he proposes to use and the arrangements he proposes to make.

Concrete for the works shall be batched and mixed in one or more plants or concrete mixer unless the Engineer agrees to some other arrangement. If concrete mixers are used, there shall be sufficient number of mixtures including stand by mixers.

Batching and mixing plants shall be complying with the requirements of IS 1791 and capable of



producing a uniform distribution of the ingredients throughout the mass. Truck mixers shall comply with the requirements of IS 4925 and shall only be used with the prior approval of the Engineer. If the plant proposed by the Contractor does not fall within the scope of IS 1791 it shall have been tested in accordance with IS 4634 and shall have a mixing performance within the limits of IS 1791.

All mixing operations shall be under the control of an experienced supervisor.

The aggregate storage bins shall be provided with drainage facilities arranged so that the drainage water is not discharged to the weigh hoppers. Each bin shall be drawn down at least once per week and any accumulations of mud or silt shall be removed.

If bulk cement is used, the scale and weight hopper for cement shall be distinct from the scale and weight hopper for aggregates.

Cement and aggregates shall be batched by weight. Water may be measured by weight or volume.

The weighing and water dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerances described in IS 1791 and not more than plus or minus one percent, and checked against accurate weights and volumes when required by the Engineer.

The weights of cement and of each size of aggregate and the weight or volume of water as indicated by the mechanism employed shall be within a tolerance of plus or minus three per cent of the respective weight per batch agreed by the Engineer.

The Contractor shall provide standard test weights at least equivalent to the maximum working load used on the most heavily loaded scale and other auxiliary equipment required for checking the satisfactory operation of each scale or measuring device. Tests shall be made by the Contractor in the presence of the Engineer during the site trials described in Sub-clause F44 (4) and then at intervals to be determined by the Engineer but not less than once per three months. The Contractor shall furnish the Engineer with copies of the complete results of all check tests and shall make any adjustments, repairs or replacements necessary to ensure satisfactory performance.

The nominal drum or pan capacity of the mixer shall not be exceeded. The turning speed and the mixing time shall be as recommended by the manufacturer, but in addition, when water is the last ingredient to be added, mixing shall continue for at least one minute after all the water has been added to the drum or the pan.

The blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment.

Mixers shall be fitted with an automatic recorder registering the number of batches discharged.

The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer immediately before mixing begins each day and thereafter at least once per hour and for each delivery of aggregates during concreting. When the correct quantity of water, determined as set out in the Specification, has been added to the mix, no further water shall be added, either during mixing or subsequently.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Mixers shall be cleaned out before changing to another type of cement.



**F6 Ready mixed concrete**

Plant mixed ready-mixed concrete shall be transported to the place of use only in truck-mixers or in agitator trucks. In transit this concrete shall be kept in motion at the mixing speed. This is not necessary if the concrete is transported in the truck mixer and is, just before being unloaded, so mixed again that it is delivered uniformly mixed to the site.

Truck mixers and agitator trucks shall be completely discharged not later than 90 minutes after the water has been added. If accelerated stiffening of the concrete (e g as a result of climatic effects) is to be expected, the permitted periods of time up to unloading the concrete shall be appropriately reduced.

The concrete shall have the required consistency on delivery. All transport equipment shall be subjected to the approval by the engineer, who may demand reasonable alterations of the plant for equipment.

**F7 TRANSPORTATION OF CONCRETE**

The concrete shall be discharged from the mixer and transported to the works by means which shall prevent adulteration, segregation or loss of ingredients, and shall ensure that the concrete is of the required workability at the point and time of placing. The loss of slump between discharge from the mixer and placing shall be within the tolerances specified in Sub-clause F4 (5) (b) (i).

The capacity of the means of transport shall not be less than the full volume of a batch.

The time elapsing between mixing transporting placing and compaction altogether of a batch of concrete shall not be longer than the initial setting time of the concrete. If the placing of any batch of concrete is delayed beyond this period, the concrete shall not be placed in the works.

**a. Truck mixer**

Truck mixer consist of equipment mounted on trucks and capable of mixing concrete in conveying between the batching plant and the point of placing. There is often considerable slump loss in truck-mixed concrete especially in warm weather. Such loss shall be kept to a minimum reducing the revolution speed avoiding over mixing.

**F8 Conveying methods**

The structural concrete shall be supplied to each part of the structure being concreted without unnecessary unloading and reloading. Distributing it on the structure is performed by using chute, Light conveyor, pumps or buckets. The method of handling and conveying shall be so adjusted among the various operations as to obviate segregation and shall be subjected to the approval by the engineer.

**i. Buckets**

The capacity of the buckets shall conform to the size of the concrete batch, or a multiple there of, in order that there will be no splitting of batching in loading buckets. It shall be capable of prompt discharge of lo slump, Lean mix concrete. The dumping mechanism shall permit discharge of a relatively small portion of concrete in one place. Buckets shall be filled and discharged without noticeable separation of coarse aggregate.

**ii. Chutes**

Use of chutes is to be avoided as far as reasonably possible but the operation if any must be controlled in a way that segregation and loss of slump will be avoided



Concrete which have been transported in non-agitating equipment and consistency has suffered from transport vibration shall not be worked by adding water prior to placing and shall thus not be used unless explicitly approved by the engineer.

**iii. Belt Conveyer**

Slump loss, in use of conveyer, is largely preventable by protecting the belt from sun and wind. Segregation, which occur chiefly at transport points and at the end of the conveyer shall be avoided by use of suitable hopper and drop chutes.

When belt conveyer carries concrete, scrappers and devices for holding the concrete together at the throw off point shall be provided.

**iv. Pumping**

For conveying concrete by pumping, it shall be permitted to use light alloy pipes, pipelines for pumping shall be laid in such a way that no interruption can occur on the flow of concrete in the pipe. Pump lines shall be as short as possible.

The concrete pumping plant shall be provided with water pressure valve connecting pipe with needle valve cleaning rods, outlets for drainage of water and a high pressure (30-35 kg/cm<sup>2</sup>) centrifugal pump for flushing out the concrete pipe lines. Pipes for pumping concrete shall have minimum inner diameter of 15 cm. Pipe joints for concrete pumping shall permit a deviation in pipeline axis by at least 3 degrees. They shall be of quick connection type to permit easy disconnection and emptying if concrete gets stuck in the conveying pipeline and cannot be removed

At the end of pumping operation the conveying pipe shall be immediately emptied and cleaned (blow out)

**F9 PLACING OF CONCRETE****(1) Consent for Placing**

Concrete shall not be placed until the Engineer's consent has been given in writing. The Contractor shall give the Engineer at least two full working day notice of his intention to place concrete.

If concrete placing is not commenced within 24 hours of the Engineer's consent the Contractor shall again request consent as specified above.

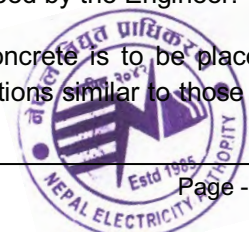
**(2) Preparation of Surface to Receive Concrete**

Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section E.

Existing concrete surfaces shall be prepared as set out in Clause F12. Before deposition of further concrete they shall be clean, hard and sound and shall be wet but without any free-standing water.

Any flow of water into an excavation shall be diverted through proper side drains to a sump or be removed by other suitable method which will prevent washing away the freshly deposited concrete or any of its constituents. Any under drain constructed for this purpose shall be completely grouted up when they are no longer required by a method agreed by the Engineer.

Unless otherwise instructed by the Engineer surfaces against which concrete is to be placed shall receive prior coating of cement slurry or mortar mixed in the proportions similar to those of



the fines portion in the concrete to be placed. The mortar shall be kept ahead of the concrete. The mortar shall be placed into all parts of the excavated surface and shall not be less than 5 mm thick.

If any fissures have been cleaned out they shall be filled with mortar or with concrete as instructed by the Engineer.

The amount of mortar placed at one time shall be limited so that it does not dry out or set before being covered with concrete.

### (3) **Placing Procedures**

The concrete shall be deposited as nearly as possible in its final position. It shall be placed so as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items or formwork. It shall be brought up in layers approximately parallel to the construction joint planes and not exceeding 300 mm in compacted thickness unless otherwise permitted or directed by the Engineer, but the layers shall not be thinner than four times the maximum nominal size of aggregate.

When placing on a nearly horizontal surface, placing shall start at the lower end of the surface to avoid de-compaction of concrete.

Layers shall not be placed so that they form feather edges nor shall they be placed on a previous layer which has taken its initial set. In order to comply with this requirement, another layer may be started before initial set of the preceding layer.

All the concrete in a single bay or pour shall be placed as a continuous operation. It shall be carefully worked round all obstructions, irregularities in the foundations and the like so that all parts are completely full of compacted concrete with no segregation or honey combing. It shall also be carefully worked round and between water stops, reinforcement, embedded steelwork and similar items which protrude above the surface of the completed pour. All work shall be completed on each batch of concrete before its initial set commences and thereafter

The concrete shall not be disturbed before it has set hard. No concrete that has partially hardened during transit shall be used in the works and the transport of concrete from the mixer to the point of placing shall be such that this requirement can be complied with.

Concrete shall not be placed during rain which is sufficiently heavy or prolonged to wash mortar from coarse aggregate on the exposed faces of fresh concrete. Means shall be provided to remove any water accumulating on the surface of the placed concrete. Concrete shall not be deposited into such accumulations of water.

In dry weather, covers shall be provided for all fresh concrete surfaces which are not being worked on. Water shall not be added to concrete for any reason.

When concrete is discharged from the place above its final deposition, segregation shall be prevented by the use of chutes, down pipes, trunking, baffles or other appropriate devices.

Forms for walls shall be provided with openings or other devices that will permit the concrete to be placed in a manner that will prevent segregation and accumulations of hardened concrete on the formwork or reinforcement above the level of the placed concrete.

When it is necessary to place concrete under water the Contractor shall submit to the Engineer his proposals for the method and equipment to be employed. The concrete shall be deposited either by bottom-discharging watertight containers or through funnel-shaped tremies which are

kept continuously full with concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation.

If the level of concrete in a tremie pipe is allowed to fall to such extent that the water enters the pipe, the latter shall be removed from the pour and filled with concrete before being again lowered into the placing position. During and after concreting under water, pumping or de-watering in the immediate vicinity shall be suspended if there is any danger that such work will disturb the freshly placed concrete.

#### **(4) Interruptions to Placing**

If the concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and shall thoroughly compact the concrete in accordance with Clause F8. All work on the concrete shall be completed before elapse of initial setting time and it shall not thereafter be disturbed until it is hard enough to resist damage. Plant and materials to comply with this requirement shall be readily available at all time during concrete placing.

Before concreting is resumed after such an interruption the Contractor shall cut out and remedy all damaged or un-compacted concrete, feather edges or any undesirable features and shall leave a clean sound surface against which the fresh concrete may be placed.

If it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, the new concrete shall be thoroughly worked in and compacted against the existing concrete so as to eliminate any cold joints.

In case of long interruption concrete shall be resumed as directed by Engineer.

#### **(5) Dimensions of Pours**

Unless otherwise agreed by the Engineer, pours shall not be more than two meters high and shall as far as possible have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in Sub-clause F7(a)

The Contractor shall plan the dimensions and sequence of pours in such a way that cracking of the concrete does not take place due to thermal or shrinkage stresses.

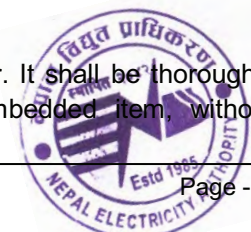
#### **(6) Placing Sequence**

The Contractor shall arrange that the intervals between successive lifts of concrete in one Section of the works are of equal duration. This duration shall not be less than three days or not more than seven days under temperate weather conditions unless otherwise agreed by the Engineer.

Where required by the Engineer to limit the opening of construction joints due to shrinkage, concrete shall not be placed against adjacent concrete which is less than 21 days old. Contraction gaps in concrete shall be of the widths and in the locations as shown on the Drawing and they shall not be filled until the full time interval shown on the Drawing has elapsed.

### **F10 COMPACTION OF CONCRETE**

Concrete shall be fully compacted throughout the full extent of the placed layer. It shall be thoroughly worked against the formwork and around any reinforcement and other embedded item, without



displacing them. Care shall be taken at arises or other confined spaces. Successive layers of the same pour shall be thoroughly worked together.

Concrete shall be compacted with the assistance of mechanical immersion vibrators, unless the Engineer agrees another method.

Immersion and surface vibrators shall operate at a frequency of between 70 and 200 hertz. The Contractor shall ensure that vibrators are operated at pressures and voltages not less than those recommended by the manufacturer in order that the compactive effort is not reduced.

A sufficient number of vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period and, in addition, stand-by vibrators shall be available for instant use at each place where concrete is being placed.

Vibration shall be continued at each point until the concrete ceases to contract, air bubbles have ceased to appear, and a thin layer of mortar has appeared on the surface. Vibrators shall not be used to move concrete laterally and shall be withdrawn slowly to prevent the formation of voids.

The vibrators shall be inserted vertically into the concrete to penetrate the layer underneath at regular spacing which shall not exceed the distance from the vibrator over which vibration is visibly effective and some extent of vibration is overlapped.

Vibration shall not be applied by way of reinforcement nor shall the vibrators be allowed to touch reinforcement, sheathing ducts or other embedded items.

## **F11 CURING OF CONCRETE**

### **(1) General**

Concrete shall be protected during the first stage of hardening from loss of moisture and from the development of temperatures differentials within the concrete sufficient to cause cracking. The methods used for curing shall not cause damage of any kind to the concrete.

Curing shall be continued for as long as may be necessary to achieve the above objectives but not less than seven days or until the concrete is covered by successive construction whichever is the shorter period.

The above objectives shall be dealt with in Sub-clauses F9(2) and F9(3) but nothing shall prevent both objectives being achieved by a single method where circumstances permit.

The curing process shall commence as soon as the concrete is hard enough to resist damage from the process. In the case of large areas or continuous pours, it shall commence on the completed Section of the pour before the rest of the pour is finished.

### **(2) Loss of Moisture**

Exposed concrete surfaces shall be closely covered with impermeable sheeting, properly secured to prevent its removal by wind and the development of air spaces beneath it. Joints in the sheeting shall be lapped by at least 300 mm.

If it is not possible to use impermeable sheeting, the Contractor shall keep the exposed surfaces continuously wet by means of water spray or by covering with a water absorbent material which shall be kept wet, unless this method conflicts with Sub-clause F9.3.

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



Formed surfaces may be cured by retaining the formwork in place for the required curing period.

If instructed by the Engineer, the Contractor shall, in addition to the curing provisions set out above provide a suitable form of shading to prevent the direct rays of the sun reaching the concrete surfaces for at least the first four days of the curing period.

### (3) Limitation of Temperature Differentials

The Contractor shall limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances including the following:

- (a) Limiting concrete temperatures;
- (b) Use of low heat cement for mass concreting, subject to the agreement of the Engineer;
- (c) Leaving formwork in place during the curing period. Steel forms shall be suitably insulated on the outside;
- (d) Preventing rapid dissipation of heat from surfaces by shielding from wind.

## F12 PROTECTION OF FRESH CONCRETE

Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from these causes.

Concrete placed in the works shall not be subjected to any loading including traffic until it has attained at least its characteristic strength as defined in Clause F4.

## F13 CONCRETING IN HOT WEATHER

### (1) General

The Contractor shall prevent damage to concrete arising from exposure to extreme temperatures, and shall maintain in good working order all plant and equipment required for this purpose.

In the event that conditions become such that even with the use of equipment the requirements cannot be met, concrete placing shall immediately cease until such time as the requirements can again be met.

### (2) Concrete Placing in Hot Weather

During hot weather the Contractor shall take all measures necessary to ensure that the temperature of concrete at the time of placing in the works does not exceed 30°C and that the concrete does not lose any moisture during transporting and placing.

Such measures may include but are not necessarily limited to the following:-

- (a) Shielding aggregates from direct sunshine.
- (b) Use of a mist water spray on aggregates.
- (c) Sun shields on mixing plants and transporting equipment.

Surfaces in which concrete is to be placed shall be shielded from direct sunshine and surfaces shall be thoroughly wetted to reduce absorption of water from the concrete placed on or against them.



After concrete has been placed, the selected curing process shall be commenced as soon as possible. If any interval occurs between completion of placing and start of curing, the concrete shall be closely covered during the interval with polythene sheet to prevent loss of moisture.

#### **F14 CONSTRUCTION JOINTS**

Whenever concrete is to be bonded to other concrete which has hardened, the surface of contact between the Sections shall be deemed a construction joint.

Where construction joints are shown in the Drawing, the Contractor shall form such joints in such positions. The location of joints which the Contractor requires to make for the purpose of construction shall be subject to the approval of the Engineer. Construction joints shall be in vertical or horizontal planes except in sloping slabs where they shall be normal to the exposed surface or elsewhere where the Drawing require a different arrangement.

Construction joints shall be arranged as to reduce to a minimum the effects of shrinkage in the concrete after placing, and shall be placed in the most advantageous positions with regard to stresses in the structures and the desirability of staggering joints.

Feather edges of concrete at joints shall be avoided. Any feather edges which may have formed where reinforcing bars project through a joint shall be cut back until sound concrete has been reached.

The intersections of horizontal and near horizontal joints and exposed faces of concrete shall appear as straight lines produced by use of a guide strip fixed to the formwork at the top of the concrete lift, or by other means acceptable to the Engineer.

Construction joints formed as free surfaces shall not exceed a slope of 20 per cent from the horizontal.

The surface of the fresh concrete in horizontal or near horizontal joints shall be thoroughly cleaned and roughened by means of high pressure water, and air jets or wire brush, when the concrete is hard enough to withstand the treatment without the leaching of cement. The surface of vertical or near vertical joints shall be similarly treated if circumstances permit the removal of formwork at a suitable time.

Where concrete has become too hard for the above treatment to be successful, the surface whether formed or free shall be thoroughly scabbled by mechanical means, manually or wet sand blasted and then washed with clean water. The indentations produced by scabbling shall not be less than 10 mm deep and shall be away from the finished face by 40mm.

If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar composed of one part of cement to two parts of sand by weight and complying with immediately prior to the deposition of fresh concrete. The mortar shall be kept just ahead of the fresh concrete being placed and the fresh layer of concrete shall be thoroughly and systematically vibrated to full depth to ensure complete bond with the adjacent layer. No mortar or concrete shall be placed until the joint has been inspected and approved by the Engineer.

#### **F15 RECORDS OF CONCRETE PLACING**

Records of the details of every pour of concrete placed in the works shall be kept by the Contractor in a form agreed by the Engineer. These records shall include class of concrete, location of pour, date and duration of pour, ambient temperature and concrete temperature at time of placing and all relevant meteorological information such as rain, wind etc., moisture contents of the aggregates, details of mixes, batch numbers, cement batch number, results of all tests undertaken, part of the structure and place where test cube samples are taken from.

The Contractor shall supply to the Engineer four copies of these records each week covering work



carried out the preceding week. In addition he shall supply to the Engineer monthly histograms of all 28 day cubes strength results together with cumulative and monthly standard deviations, Coefficient of Variation, and any other information which the Engineer may require concerning the concrete placed in the works.

**F16 REINFORCEMENT****(1) General**

Reinforcement as plain bars and deformed bars and steel fabric shall comply with the following Indian Standards.

IS 1786 for high strength deformed steel bars and wires. IS 1566 for steel mesh fabric.

IS 432 mild steel and medium tensile steel bars.

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit the ISI certification mark or other test certificate from the manufacturer acceptable to the Engineer. The Contractor shall furnish all information as manufacturer's certificate, invoice, and other relevant details to ensure the quality of steel.

The reinforcements shall have no crack, scale or rust or foreign particles that will destroy or reduce the bond. The bars shall be accurately bent and formed to the dimension indicated in the Drawings. The Contractor shall prepare bending schedules for each structure and calculate the weight of the reinforcement. The schedule of bars and the calculations shall be submitted to the Engineer for approval.

Binding wire used to bind reinforcements shall be annealed galvanized binding wire of 20 gauge.

The sampling and frequency of testing shall be as set out in the NS 84-2042 and NS 191-2045. All reinforcement not complying with the Specification shall be removed from site.

**(2) Storage of Reinforcement**

All reinforcement shall be delivered to site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths which have been transported bent over double.

Any reinforcement which is likely to remain in storage for a long period shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which, in the opinion of the Engineer, will affect its properties shall either be removed from site or may be tested for compliance with the appropriate Indian Standard in accordance with Sub-clause F14(1) at the Contractor expense.

Reinforcement shall be stored at least 150mm above the ground on a clean area free of mud and dirt and sorted out according to category, quality and diameter.

**(3) Bending Reinforcement**

Unless otherwise shown on the Drawing, bending and cutting shall comply with IS 2502.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the Drawing.

Bars shall be bent mechanically using appropriate bar benders. Bars shall be bent cold by the



application of slow steady pressure. At temperatures below 5°C the rate of bending shall be reduced if necessary to prevent fracture in the steel.

Bending reinforcement inside the forms shall not be permitted except for mild steel bars of diameter less or equal to 12 mm, when it is absolutely necessary.

After bending, bars shall be securely tied together in bundles or groups and legibly labeled as set out in IS 2502.

#### **(4) Fixing Reinforcement**

Reinforcement shall be thoroughly cleaned. All dirt, scale, loose rust, oil and other contaminants shall be removed before placing it in position. If the reinforcement is contaminated with concrete from previous operations, it shall be cleaned before concreting in that Section.

Reinforcement shall be securely placed and fixed in position as shown in the drawing or directed by the Engineer.

Unless otherwise agreed by the Engineer, all intersecting bars shall be either tied together with not less than 1.6 mm diameter soft annealed iron wire and the end of the wire turned into the body of the concrete, or shall be secured with a wire clip of a type agreed by the Engineer.

Spacer blocks shall be used for ensuring that the correct cover is maintained on the reinforcement. Blocks shall be as small as practicable and of a shape agreed by the Engineer. They shall be made of mortar mixed in the proportions of one part of cement to two parts of sand by weight. Wires cast into the block for tying in to the reinforcement shall have not less than 1.6 mm diameter and shall be soft annealed iron.

Alternatively another type of spacer block may be used subject to the Engineer's approval. All reinforcement shall be checked of shape, size, diameter and number where necessary.

Reinforcement shall be rigidly fixed so that it remain intact during placing of concrete. Any fixers made to the formwork shall not remain within the space to be occupied by the concrete being placed.

No splices shall be made in the reinforcement except where shown on the Drawing or agreed by the Engineer. Splice lengths shall be as shown on the Drawing or directed by the Engineer.

Reinforcement shall not be welded except where required by the contract or agreed by the Engineer. If welding is employed, all welded splices shall be full penetration butt welds complying with the procedures set out in IS 2751 or IS 9417 as applicable. Mechanical splices shall not be used unless the Engineer agrees otherwise. Acceptance for welded or mechanical splices of approved design shall be based on qualification tests to be carried out by the Contractor prior to start of the work. Construction control testing as instructed by the Engineer shall be also carried out.

The Contractor shall ensure that reinforcement left exposed in the works shall not suffer distortion, displacement or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars or six times the bar diameter for high yield bars. Such bends shall be carefully straightened without leaving residual kinks or damaging the concrete round them before concrete placing. In no circumstances heating and bending of high yield bars shall be permitted.

Bars complying with IS 1786 or other high tensile bars shall not be bent after placing in the works.



**F17 CONCRETE FOR SECONDARY PURPOSES****(1) Non-structural Concrete**

Non-structural concrete (NS concrete) shall be used only for non structural purposes where shown on the Drawing.

NS concrete shall be compound of ordinary Portland cement and aggregates complying with this Specification.

The weight of cement mixed with 0.3 cubic meters of combined aggregate shall not be less than 50 kg. The mix shall be proportioned by weight or by volume. The maximum aggregate size shall be 40 mm nominal.

The concrete shall be mixed by machine or by hand in accordance with Sub-clause F15(3) to a uniform color and consistency before placing. The quantity of water used shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

The concrete shall be compacted by hand towels or rammers or by mechanical vibration.

**(2) No Fines Concrete**

No Fines concrete (NF concrete) is intended for use where a porous concrete is required and shall only be used where shown on the Drawing or instructed by the Engineer.

The mix shall consist of Ordinary Portland cement and aggregate complying with this Specification. The aggregate size shall be 40 mm to 10 mm only. The weight of cement mixed with 0.3 cubic meters of aggregate shall not be less than 50 kg. The quantity of water shall not exceed that required to produce a smooth cement paste which will coat evenly the whole of the aggregate.

**(3) Hand Mixed Concrete**

Concrete for structural purposes shall not be mixed by hand. Where non structural concrete is required, hand mixing may be carried out subject to approval of the Engineer.

For making hand mixed concrete, cement, sand and aggregate shall be batched separately by volume or by weight as applicable. Then cement and sand shall be mixed dry to uniform color. The aggregate shall be stacked in a proper shape upon which cement sand mix shall be spread and whole mix shall be turned up and down to have uniform mix of all ingredients. Then water shall be added as specified and shall be mixed to uniform consistency.

For hand mixed concrete the specified quantities of cement shall be increased by 10% and not more than 0.25 cubic meter shall be mixed at one time. During windy weather precautions shall be taken to prevent cement from being blown away in the process of gauging and mixing.

**F18 EARLY LOADING**

No load shall be applied to any part of a structure until the specified curing period has expired, and thereafter loading shall be allowed after approval by the Engineer. The Engineer's decision shall be based on the type of load to be applied, the age of concrete, the magnitude of stress induced and the propping of the structure.

No structure shall be opened to traffic until test cubes have attained the specified minimum 28 days



strength as defined.

**F19 MEASUREMENT****(1) Concrete**

Concrete laid in place as specified in the Drawing or directed by the Engineer shall be measured in cubic meter separately for each class. No deduction shall be made in the measurement for:

- a) bolt holes, pockets, box outs and cast in components provided that the volume of each is less than 0.15 cubic meters;
- b) mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 100 mm total width or less;
- c) reinforcement

**(2) Blinding Concrete/Non Structural Concrete**

Blinding concrete laid in place shall be measured in cubic meter. No deduction shall be made for openings provided that the area of each is less than 0.5 square meters. Blinding concrete over hard material shall be measured as the volume used provided that the maximum thickness of 150 mm allowed for over break is not exceeded.

**(3) Admixtures, Workability and Hardening Agents**

Measurement of these items shall be carried out as specified in the contract.

**(4) Reinforcement**

All types of reinforcement shall be measured in metric ton

Only that reinforcement which is required and placed in work as per Drawing or as directed by the Engineer shall be measured. In addition, other reinforcement not shown on the Drawing but directed by the Engineer such as splices, chairs, hangers and the like shall also be measured.

Rolling margin or cutting waste shall not be measured. Length along centre line of the individual reinforcement of each type placed as described above shall be measured including their hooks, and bents, if any. An average weight of at least 5 samples each one meter length shall be determined by the laboratory approved by the Engineer. The weight of each type of the reinforcement shall be determined by multiplying average weight of the respective reinforcement by its length.

**(5) Fabric Reinforcement**

Fabric reinforcement laid as per Drawing or as directed by the Engineer shall be measured in square meter. No allowance shall be made for laps and wastage.

**F20 PAYMENT****(1) Concrete**

Every class of concrete shall be paid as per respective contract unit rate. In addition to those specified in Clause A15 the respective rate shall also include the cost of:

- a) admixtures and workability agents including submission of details unless specified.



- b) class of UF1,2 or 3 surface finish.
- c) laying to sloping surfaces not exceeding 15° from the horizontal and to falls.
- d) formwork to lean concrete.
- e) placing and compacting against excavated surfaces where required including any additional concrete to fill over break and working space.
- f) complying with the requirements of Clauses F1 to F13.

**(2) Admixtures, Workability and Hardening Agents**

Payment shall be made at contract unit rate which shall be the full and the final compensation to the Contractor as per Clause A15 and for all specified in the contract.

**(3) Reinforcement**

The reinforcement shall be paid at contract unit rate. In addition to those specified in Clause A15 the rate shall also include compensation for the cost of providing , cutting to length, splice lengths additional to those shown on the Drawing, laps, bending, hooking, waste incurred by cutting, cleaning, spacer blocks, provision and fixing of chairs or other types of supports, welding, fixing the reinforcement in position including the provision of wire or other material for supporting and tying the reinforcement in place, bending reinforcement aside temporarily, and straightening, placing and compacting concrete around reinforcement and for complying with Clause F19.

**(4) Fabric Reinforcement**

The fabric reinforcement shall be paid at contract unit rate which shall be also inclusive of compensation for wastage and laps.



**G BRICK MASONRY WORK****G1 SCOPE**

This Section covers the furnishing of materials and construction of brick works for structures in accordance with the detail shown on the Drawing and these Specifications or as directed by the Engineer.

**G2 MATERIALS****(1) Bricks**

Burnt clay bricks shall conform to the requirements of NS-1/2035 except that minimum compressive strength when tested flat shall not be less than  $8 \text{ N/mm}^2$  for individual bricks and  $10 \text{ N/mm}^2$  for average 5 specimens and that the size may be according to local practice with a tolerance of + 5 percent.

**(2) Mortar**

Mortar shall comply with IS 2250-1981; Code of Practice for preparation and use of masonry mortar. The mortar used in work shall have the strength not less than  $5 \text{ N/mm}^2$  or  $7.5 \text{ N/mm}^2$  at 28 days as specified.

However, if provided in the Contract, cement and sand may also be mixed in specified proportions. Cement shall be proportioned only by weight, by taking its unit weight as 1.44 ton per cubic meter and sand shall be proportioned by volume after making due allowance for bulking.

Sand shall comply with Clause C12. Cement shall comply with Clause C13.

The mixing shall be done in a mechanical mixer unless hand-mixing is permitted by the Engineer. If hand-mixing is allowed, the operation shall be carried out on a clear watertight platform. In the required proportion cement and sand shall be first mixed dry to obtain an uniform color. Then required quantity of water shall be added and the mortar shall be mixed to produce workable consistency. The mortar shall be mixed for at least three minutes after addition of water in the case of mechanical mixing. In the case of hand mixing, the mortar shall be hoed back and forth for about 10 minutes after addition of water in order to obtain uniform consistency.

Only that quantity of mortar shall be mixed at a time which can be used completely before it becomes unworkable. Any mortar that has become unworkable due to loss of water before elapsing the initial setting time of cement, shall be rewet to make it workable and shall be used in the works. On no account mortar shall be used after elapsing the initial setting time of cement.

**G3 SOAKING OF BRICKS**

Bricks shall be soaked in water for a minimum period of one hour before use. When bricks are soaked they shall be removed from the tank sufficiently in advance so that at the time of laying they are skin dry. Such soaked bricks shall be stacked on a clean place where they are not spoilt by dirt, earth, etc.

**G4 LAYING OF BRICKS**

All bricks work shall be laid in English bond, even and true to line, plumb, level and all joints accurately kept. Whole bricks used on the face shall be selected ones of uniform size and true rectangular face.

Bricks shall be laid with frogs up, if any, on a full bed of mortar. When laying, bricks shall be slightly pressed so that the mortar gets into all the surface pores of bricks to ensure proper adhesion. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left.

Before laying bricks in foundation, a layer of not less than 12 mm of mortar shall be spread to make the surface on which the brick work will be laid even. Immediately thereafter, the first course of bricks shall be laid.

The brick work shall be built in uniform layers. Corners and other advanced work shall be raked back. Brick work shall be done true to plumb or in specified batter. No part of it, during construction, shall rise more than one meter above the general construction level, to avoid unequal settlement and improper jointing.

Toothing may be done where future extension is contemplated but shall be used as an alternative to raking back.



**G5 JOINTS**

The thickness of joints shall not exceed 10 mm.

**706 JOINTING WITH EXISTING STRUCTURES**

When fresh masonry is to be placed against existing surface of structures, the surface shall be cleaned of all loose materials, roughened and wetted as directed by the Engineer so as to effect a good bond with the new work.

**G7 CURING**

Green work shall be protected from rain by suitable covering. Masonry work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water so as not to disturb or washout the green mortar.

During hot weather, all finished or partly completed work shall be covered or wetted in such a manner as to prevent rapid drying of the brick work.

**G8 SCAFFOLDING**

The scaffolding shall be sound and strong to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left in masonry under one meter in width or immediately near the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good.

**G9 CONDITION OF EQUIPMENT**

All equipment used for mixing or transporting mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.

**G10 FINISHING OF SURFACES****(1) General**

The surfaces can be finished by 'jointing', 'pointing' or 'plastering', as specified. For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted. The mortar for finishing shall be prepared as per Clause G2.

**(2) Walling Finish:**

Where walling is to be finished with a fair face of the workmanship and quality, the bricks are to be selected so that the exposed face is free from defects and the joints finished flush as the works proceed. The faced work shall be kept perfectly clean and no rubbing down of brickwork will be allowed.

Where bricks work is to be plastered the joints shall be raked out as the work proceeds.

**(3) Walling Building:**

Bricks shall be wetted before being laid and the top of walling where left off shall be wetted before re-commencing building. Walls to be kept wet three days after building.

Bricks shall be well buttered with mortar before being laid and the brickwork carried up evenly course so that no part is allowed to be carried up more than 90cm higher at any time than any other part.

**(4) Cavity Walling Building**

The two layer of half brick wall with half brick cavity is cavity walling of the building. Bricks shall be wetted before being laid and the top of walling where left off shall be wetted before re-commencing building. Each left brick wall shall be connected by 10G GI links made as per design at every five course vertically and at the 60cm spacing horizontally or as per drawing. The two courses below sill will be solid wall. One or both half brick wall will be laid in fair face in stretcher bond. The walls are to be kept wet three days after building.

Bricks shall be well buttered with mortar before being laid and the brickwork carried up evenly course-by-course so that no part is allowed to be carried up more than 90cm higher at any time than any other part.

**(5) Setting Out Walling**

The contractor shall provide proper setting- out rods and set out all work on it for corners, openings, heights, etc. And shall build the walls and piers etc. To the width, depth and height indicated on the drawings and as directed and approved by the Engineer in-charge.

**(6) Bonding Walls**

Load bearing brickwork generally shall be of Quota bond (nominal thickness 350mm) and reinforced as shown on the detailed drawings. One brick walls (nominal thickness 230mm) shall be in English bond and half brick walls (nominal thickness 115mm) in Stretcher bond. No broken bricks or bats shall be used unless required to from bond.

All propounds, quoins, reveals and other angles of walls shall be built strictly true and square. Cement & sand shall be as before specified.

Lime shall be freshly burnt lime slaked at least one month before being used by drenching with water, well broken up and mixed and the slurry passed through a 3mm mesh screen to remove all lumps and impurities.

**(7) Mortar**

Unless otherwise specified, all mortar shall consist of cement and sand in the proportion as described in the Bill of Quantities.

The ingredients of mortars shall be measured in proper gauge boxes on a boarded platform all bring mixed dry and again whilst adding water. In the case of cement/ lime mortar, the sand and lime shall be mixed dry and then the cement added. All mortars shall be thoroughly mixed to a uniform consistency with only sufficient water to obtain a plastic condition suitable for trawling. Mortar, which has commenced to set, shall not be used or knocked up again for use.

**(8) Filling for Brick work**

Where brickwork cavities are specified to contain reinforcing bars they shall be filled with concrete mix as previously described. The filling shall be placed and consolidated in section not exceeding 90cm in height. Cavities that are to be filled shall be kept free of all mortar dropping.

**(9) Brick Lintels**

Lintels over doors and under openings except where in concrete, shall be formed in brick work by reinforcing the three concrete immediately above the opening with steel wire reinforcement projecting 45cm at either end of the opening and the rates are to include for any necessary centering.

**(10) Putlog Holes**

All putlog holes shall be not less than one course deep and carefully filled with bricks cut to fit size of opening with beds and joints filled with mortar well tamped in after scaffolding is removed.

**(11) Keeping Clean**

The contractor shall allow in his rates for keeping the fair-faced brickwork free from mortar at all times and for cleaning the work at completion.

**(12) Construction Joints between Walls**

Where Construction joints indicated on the drawings should be filled by 25\*100m flexible jute carpet coated with bitumen and covered by 16G galvanized steel sheet in exposed faces. All the construction debris shall be removed before placing it.

**(13) Jointing**

In jointing, the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick-work. The faces of brick-work shall be cleaned to remove any splashes of mortar during the course of raising the brick-work.

**(14) Pointing**

For pointing, the mortar shall be filled and pressed into the raked out joints, before giving the required finish. The pointing shall then be finished to proper type given on the Drawing. If type of pointing is not mentioned on the Drawing the same shall be ruled pointing. For ruled pointing after the mortar has been filled and pressed into the joints and finished off level with the edges of the bricks, it shall while still green be ruled along the centre with a half round tool of such width as may be specified by the Engineer. The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned of all mortar.

**(15) Plastering**

Plastering shall be started from top and worked down. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. Wooden screeds 75 mm wide and of the thickness of the plaster shall be fixed vertically 2.5 to 4 meters apart to act as gauges and guides in applying the plaster. The mortar shall be laid on the wall between the screeds using the plaster's float and pressing the mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight edge reaching across the screeds. The straight edge shall be worked on the screeds with a small upward and sideways motion 50 mm or 75 mm at a time. Finally, the surface shall be finished off with a plaster's wooden float. Metal floats shall not be used.

When recommencing the plastering beyond the work suspended earlier the edges of the old plaster shall be scraped, cleaned and wetted before plaster is applied to the adjacent areas.

No portion of the surface shall be left out in a condition to be patched up later on.

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required by the Engineer.

The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness minus 3 mm.

Any cracks which appear in the surface and all portions, which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and re-done as directed by the Engineer.

**(16) Curing of Finishes**

Curing shall be started as soon as the mortar used for finishing has hardened sufficiently not to be damaged when watered. It shall be kept wet for a period of at least 7 days. During this period, it shall be suitable protected from all damages.

**G11 TEST AND STANDARD OF ACCEPTANCE**

Before laying any mortar, the Contractor shall make three sets of mortar test cubes from each source of sand to demonstrate the compliance of the mortar to the specified strength. Each set shall comprise two cubes, one to be tested at 7 days and the other to be tested at 28 days. Testing shall be in accordance with IS 2250. During construction the Contractor shall make and test mortar cubes at the rate of three for every 10m<sup>3</sup> or part of it of brick work to assess the strength of the mortar subject to a minimum of 3 sample cubes for a days work. The brick shall be tested for compressive strength and water absorption as per NS-1/2035 and shall meet the requirement of this Specification.

**G12 DRY BRICK WORKS****(1) Flat Brick Soling**

The flat brick soling shall be made in foundation and floor. The brick shall conform to clause G2(1). The brick soling shall be done over the 5cm sand filling in line and level. The bricks are then rammed with spreading sand and water.

**(2) Brick On Edge Soling**

The Brick on Edge brick soling shall be made in foundation and floor. The brick shall conform to clause G2(1). The brick soling shall be done over the 5cm sand filling in line and level. The bricks are then rammed with spreading sand and water.



**G13 MEASUREMENT**

All brick work shall be measured in cubic meters except soling and half brick thick wall.

The work of plastering and pointing shall be measured in square meters separately.

**G13 HALF BRICK WALL**

When half brick thick wall is built, it shall be constructed in structure bound. Each third layer shall be leveled and content 8mm reinforcement fixed & jointed into RCC columns. The reinforcement is measured saperately in kg. and half brick wall is measured in squire meters.

**G14 PAYMENT**

The brick works, plastering and pointing shall be paid at their respective contract unit rate which shall be the full and the final compensation to the Contractor as per Clause A15 to complete the work as per these Specifications.



**H FORM WORK****H1 SCOPE AND DEFINITIONS**

This Section covers the materials, design of mixes, mixing, transport, placing, compaction and curing of concrete (plain and reinforced), either cast-in- situ or pre-cast and mortar required in the civil engineering and building construction works. It also covers reinforcement for concrete.

**H2 GENERAL**

Form works shall include all temporary or permanent forms required for forming the concrete together with all temporary construction for their support.

Form works shall be designed and erected by the Contractor so that concrete can be properly placed and compacted in a manner that the hardened concrete conforms to the required shape, position, and level subject to the specified tolerances and standards of finish. It shall be assembled with adequate nails and /or nuts and bolts. It shall consist of wooden boards, sheet metals, and any other suitable material that prevent loss of grout when the concrete is vibrated.

Special care shall be taken to maintain the stability of the form works and the tightness of the joints particularly during concrete vibrating operations.

The formworks shall be as specified in the BOQ with adequate ribs for the beam, column and slabs. The Engineer shall approve the material and position of any ties passing through the concrete. The whole or part of the tie shall be capable of being removed such that any remaining part shall be embedded in the concrete by at least the specified thickness for reinforcement cover. Any holes formed by removal of ties shall be filled with concrete or mortar of approved composition.

Form works at top shall be provided where the slope of the formed surface exceeds one in four. Before each concrete operation commences, form works shall be cleaned of all rubbish and other foreign particles.

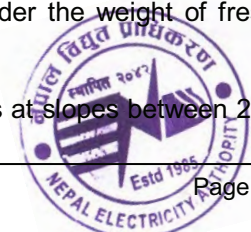
Concrete operations shall not commence until the erected form works has been inspected and approved. The Contractor shall give at least 48 hours notice for such inspection. On rejection for any reason, the Engineer shall require another 48 hours to inspect the rectified errors. The inside surface of forms shall be coated with an approved material to prevent the adhesion of concrete. Such material shall be applied strictly in accordance with the manufacturer's instructions and shall not come in contact with the reinforcement or anchors

**H3 FORMWORK FOR CONCRETE****(1) Construction of Formwork**

Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced and horizontal or vertical and shall be continuous in a regular pattern. All joints in formwork shall be water tight. Where reinforcement projects through formwork, the form shall fit closely round the bars.

Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete. It shall also incorporate provisions for making minor adjustments in position, if required, to ensure the correct location of concrete faces. Due allowance shall be made in the position of all formwork for movement and settlement under the weight of fresh concrete.

Surfaces at slopes less than 20° may be formed by screeding. Surfaces at slopes between 20°



and 30° shall generally be formed if the Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.

Horizontal or inclined formwork to the upper surface of concrete shall be adequately secured against uplift due to the pressure of fresh concrete. Formwork shall also be tied down or otherwise secured against floating within the body of the concrete.

The internal and external angles on concrete surfaces shall be formed with fillets and chamfers of the sizes shown on the Drawing unless otherwise instructed by the Engineer. Supports for formwork may be bolted to previously placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete are used in conjunction with bolts, the metal left in shall not be close to the face of the concrete by less than 50mm. Formwork shall not be re-used after it has suffered damage which is sufficient to impair the finished surfaces of the concrete.

Where circumstances prevent easy access within the form, temporary openings shall be provided through the formwork for cleaning and inspection. Shear keys of the size and shape as indicated on the Drawing shall be provided in all construction joints.

Where pre-cast concrete elements are specified for use as permanent formwork, or proposed by the Contractor and agreed by the Engineer, they shall comply with the requirements of formwork as specified in the Specifications in respect of surface finish, strength and rigidity. Such elements shall be set true to line and level within the tolerances prescribed for the appropriate class of finish and fixed so that they cannot move when concrete is placed against them.

## (2) Preparation of Formwork

Before any reinforcement is placed into position within formwork, the latter shall be thoroughly cleaned and then dressed with a release agent. The agent shall be either suitable oil incorporating a wetting agent, an emulsion of water suspended in oil or low viscosity oil containing chemical agents. The Contractor shall not use an emulsion of oil suspended in water nor any release agent which causes staining or discoloration of the concrete, air holes on the concrete surface, or retards the set of the concrete or affects the strength of concrete.

In order to avoid color differences on adjacent concrete surfaces, only one type of release agent shall be used in any one section of the works.

In cases where it is necessary to fix reinforcement before placing formwork, all surface preparation of formwork shall be carried out before it is placed into position. The Contractor shall not allow reinforcement or pre-stressing tendons to be contaminated with formwork release agent.

Before placing concrete all dirt, construction debris and other foreign matter shall be removed completely from within the placing area. Before concrete placing commences, all wedges and other adjusting devices shall be secured against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs. If any movement noticed, the formwork shall be set right immediately.

## (3) Removal of Formwork

The Contractor shall give 24 hours notice of his intentions to strike any form works. Forms shall be removed without shock vibrations or other damage to the concrete.



Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand any stresses safely to which it may thereby be subjected.

The minimum periods which shall elapse between completion of placing concrete and removal of forms are given in Table and apply to ambient temperatures higher than 10°C. At lower temperatures or if cement other than ordinary Portland are involved, the Engineer may instruct longer periods.

Alternatively, formwork may be removed when the concrete has attained the strength set out in Table provided that the attained strength is determined by making test cubes and curing them under the same conditions as the concrete to which they refer.

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until the removal can be completed without damage to the concrete.

If the Contractor wishes to strip formwork from the underside of arches, beams and slabs before the expiry of the period for supports set out above, it shall be designed so that it can be removed without disturbing the supports. The Contractor shall not remove supports temporarily for the purpose of stripping formwork and subsequently replace them.

As soon as the formwork has been removed, bolt holes in concrete faces other than construction joints which are not required for subsequent operations shall be completely filled with mortar sufficiently dry to prevent any slumping at the face. The mortar shall be mixed in the same proportions as the fine aggregate and cement in the surrounding concrete and with the same materials and shall be finished flush with the face of the concrete.

After removal of the formwork, the date of casting of concrete shall be marked on the surface of related concrete by water proof paint/marker for estimation of curing time. Minimum Time for Form works.

**TABLE H3-3.1: MINIMUM TIME FOR FORM WORKS**

Form work	Normal Weather (days)	Cold Weather (days)	Strength to be attained
1. Vertical or near vertical faces of mass concrete	24 hours		0.2 $f_{ck}$
2. Beam sides,walls and unloaded columns	48 hours	1.5	0.3 $f_{ck}$
3. Soffits of slabs and beams:			
a. Spans upto 3m	4 days	7 days	$f_{ck}$
b. pans over 3m to 6m	11 days	17 days	$f_{ck}$
c. Spans over 6m to 12m	14 days	24 days	$f_{ck}$
d. Spans over 12m	21 days	30 days	$f_{ck}$

#### H4 SURFACE FINISH ON FORMED SURFACE

##### Classes of Finish

The surface finish to be achieved on formed concrete surfaces shall be as shown on the Drawing and are defined here under:-



**(1) Class F1 Finish**

This finish is for surfaces against which backfill or further concrete will be placed. Formwork may be sawn boards, sheet metal or any other suitable material which will prevent the loss of laitance from the concrete being placed.

**(2) Class F2 Finish**

This finish is for surfaces which are permanently exposed to view but the highest standard of finish is not required. Forms to provide a class F2 finish shall be faced with wrought thickened tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them.

Joints between boards or panels shall be horizontal and vertical unless otherwise directed. In this type of finish pitting, fins, surface discoloration and other minor defects shall be remedied at the time and by methods agreed by the Engineer.

**(3) Class F3 Finish**

This finish is for surfaces which will be in contact with water flowing at high velocity and for surfaces prominently exposed to view where good appearance is of special importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood or equivalent material in large sheets. The sheets shall be arranged in an approved uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface.

All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to remain accurate alignment in the plane of the sheets. Unfaced wrought boarding or standard sheet panels will not be permitted for Class F3 finish. The contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.

**(4) Curved Surfaces**

For curved surfaces where F2 or F3 finishes are called for the formwork face shall be built up of splines cut to make a tight surface which shall be then be dressed to produce the required finish.

Alternatively single curvature surfaces may be faced with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush. Linings shall not bulge, wrinkle otherwise deform when subjected to temperatures and moisture changes.

**(5) Tolerances**

All parts of formed concrete surfaces shall be in the positions shown on the drawing within the tolerance set out in table H4-5.1.

In cases where the drawings call for tolerances other than those given in the Drawing shall rule.

Where pre-cast units have been set to a specified tolerance, further adjustments shall be made as necessary to produce a satisfactory straight or curved line. When the Engineer has approved the alignment, the contractor shall fix the units so that there is no possibility of

further movement.

**TABLE H4-5.1: TOLERANCES**

Class of finish	Tolerances in mm (See Note)		
	A	B	C
F1	10	10	+ 25 to -10
F2	5	10	+ - 15
F3	2	5	+ -10

**Note:** The tolerances A, B and C given in the table are defined as follows:

A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of formwork.

B is a gradual deviation from a plane surface as indicated by a straight edge 3 m long. In the case of curved surfaces the straight edge shall be replaced by a correctly shaped template.

C is the amount by which the whole or part of a concrete face is displaced from the correct positions shown in the drawing.

## H5 FINISHES ON UNFORMED SURFACES

Horizontal or nearly horizontal surfaces which are not cast against formwork shall be finished to the class shown on the drawing and defined here under:-

### (1) UF1 Finish

All surfaces on which no higher class of finish is called for on the drawing or instructed by the Engineer shall be given a UF1 finish.

The concrete shall be leveled and screeded to produce a uniform plain or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

### (2) UF2 Finish

This is a floated finish for roof or floor slabs and other surfaces where a hard-trowled surface is not required.

The surface shall first be treated as a class UF1 finish and after the concrete has hardened sufficiently, it shall be floated by hand or machine sufficient only to produce a uniform surface free from screed marks.

### (3) UF3 Finish

This is a hard-troweled surface for use where weather resistance or appearance is important, or which is subject to high velocity water flow.

The surface shall be floated as for a UF2 finish but to the tolerance stated below in Sub-clause H6. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, it shall be steel-trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel mark.

### (4) Tolerances

All parts of formed concrete surfaces shall be in the positions shown on the drawing within the



tolerance set out.

In cases where the drawings call for tolerances other than those given in the Drawing shall rule.

**TABLE H5-4.1: TOLERANCES**

Class of finish	Tolerances in mm (See Note)		
	A	B	C
UF1	Applicable	10	+ 20 to -10
UF2	Nil	10	+20 or -10
UF3	Nil	5	+12.5 or -7.5

**Note:** The tolerances A, B and C given in the table are defined as follows:

A is the maximum allowable value of any sudden change of level in the surface.

B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three-meter-long straight edge or correctly shaped template placed on the surface.

C is the maximum allowable value of the difference in level or position between a three-meter-long straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

## H6 REMEDIAL WORK TO DEFECTIVE SURFACES

If on removal of any formwork the concrete surface is found to be defective in any way, the contractor shall make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions which the Engineer may give.

Defective surfaces shall not be made good by plastering.

Areas of honey combing which the Engineer agrees, shall be repaired after cutting back to sound concrete when the concrete is no more than 3 days old. Care shall be taken that reinforcement and sheathing ducts are not damaged. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surface in the cavity. It shall then be filled immediately with the concrete of the same class as the main body. The concrete shall be prepared from the aggregate of maximum size 0.5 times the depth of the cavity or 20mm whichever is smaller. A form provided with a lip to enable concrete to be placed shall be used against the cavity. The form shall be filled above the top edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface shall be ground smooth.

When the concrete is more than three days old, areas of honey combing shall be repaired using an epoxy bonding agent with a method approved by the Engineer.

Surface irregularities which are outside the limits of tolerance set out in clause H5 shall be ground down in the manner and to the extent instructed by the Engineer.

Blowholes in vertical surfaces shall be filled with laitance or mortar using fine aggregate not larger than 0.3mm, rubbed over the affected area with a rubber face float and finished with polythene.

Defects other than those mentioned above shall be dealt with as instructed by the Engineer.



**H7 MEASUREMENT**

Except as stated below, formwork shall be measured in square meter of formwork in contact with the finished face of the concrete. No deduction shall be made in the measurement for openings, pipes, ducts and the like, provided that the area of each is less than 0.50 square meters. Unless otherwise stated, if the volume or area of concrete has not been deducted when measuring the concrete, formwork to form box or the void shall not be measured.

Formwork required for lean concrete, to form construction joints and shear keys for future concrete and other construction surfaces shall not be measured and the costs shall be included in the rates for other work.

Formwork to contraction and expansion joints shall be measured in square meter on one face only. The rates shall include for the costs stated below and for forming recesses for sealant and channels for grout.

The measurement of formwork is inclusive of the measurement for formwork finished surface, shoring, staging, scaffolding and other accessories required for erection and removal of the formwork.

**H8 PAYMENT**

The formwork shall be paid as per the contract unit rate. In addition to those specified in clause A15 the rates for formwork shall include the cost of submission of details, transportation and use of all materials for formwork, erection including provision of supports, fillets and chamfers 75 mm and less in width, bolts, ties, fixings, cutting to waste, drilling or notching the formwork for reinforcement where required, working around pipes, ducts, conduits and waterstops, temporary openings, cleaning, dressing, removal of formwork, filling bolt holes and any remedial work and for complying with Clauses F7, F9, F12 and Section H including all incidental works required to complete the work as per Specification.

The payment for unformed surfaces of concrete shall be deemed included in the contract unit rate of the relevant concrete.



**I WOOD WORK****I1 SCOPE**

This Section covers timber construction of permanent works at locations as shown in the Drawing. The work specified herein may not be relevant not for the temporary facilities and formwork (centering and shuttering).

**I2 MATERIAL****(1) Timber**

Timber for carpentry shall be straight and free from twist, sapwood, shakes, dead and loose knots, worm holes, other holes, signs of decay and other defects, and seasoned and shall comply with the requirements of IS 883-1994 The natural moisture content of any untreated timber delivered to site shall not exceed those as recommended by IS 287-1993.

All beams and scantling shall be sawed along grain and under no condition beams, rafters, wall plates, blocks etc. shall be sawed across grain. All timber and assembled woodwork shall be protected from weather for which temporary shed shall be built. All timber shall be stored at least 750mm above ground level or more, if deemed necessary, and individual members shall be separated by strips so that air may circulate around all four sides. All wood work except door/window frames or ceiling shall be painted with two coats of creosote conforming to IS 218 1952.

**(2) Hardware**

Hardware shall consist of bolts, with the necessary nuts and washers, timber connectors, drift pins, dowels, nails, screw nails, coach bolts, spikes and other metal fasteners. They shall be galvanized or un-galvanized as specified. Bolts, nuts and washers shall be mild steel and comply with IS 1363-1992. Drift Pins and dowels shall be mild steel. Nails shall comply with IS 723-1972. Screw nails and screws shall comply with IS 451-1972/IS 2585-1968. Coach bolts shall comply with IS 2609-1972. Spikes and other metal fastenings shall be of mild steel.

All panels except where specified in the drawing shall be fitted with frames having steel double breasted butt hinges. Window frames shall have three 7.5cm / 2.00 mm thick hinges on each panel whereas the size of hinges for door panels shall be as follows:

Width of panels (up to 75cm)	: 10cm double breasted butt hinge, 2.00mm thick, 3 nos.
Width of panels exceeding 75cm	: 12.5cm double breasts butt hinges, 2.25mm thick, 3 nos.

Following shall be the size of the screw:

For 7.5cm hinges	:	25mm long No. 8
For 10cm hinges	:	30mm long No. 9
For 12.5cm hinges	:	45mm long No. 10

Above No. refers to Nettlefolds or equivalent screws only.

Doors shall be fitted with double-action automatic hydraulic door closers wherever instructed.

**Tower Bolt**

All tower bolts shall be of aluminum with bolt casted monolithic with the handle. Following shall be size of the tower bolt.

Windows Panels 15cm top and bottom
Door 15cm top

15cm bottom (wherever necessary)

All screws shall be of Nettlefold or equivalent suitable lengths and diameter.

**Handles**

All door shall be provided with handle on both sides and all windows with handles on the inner side only. Door handle shall be minimum 15cm clear inside and window handle 10cm clear.



All door shall be fitted with mortise lock of heavy quality, preferably of aluminum.

Note

A sample of hardware (tower bolts, handles, hinges, catch and allotropic screws) will be displayed at the site at Project Engineer's office as the sample of desired quality and design. The Contractor shall submit samples of hardware in writing to Project Engineer for approval.

**(3) Timber Preservation**

When described in the contract or shown on the Drawing timber shall be treated with preservative in accordance with the Indian Standard Code of Practice for the preservation of timber IS 401-1982.

**Insect Damage**

All timber shall be free from live borer beetle or other insect attack when brought upon the Site. The Contractor shall be responsible to the end of the maintenance period for executing at his own cost all work necessary to eradicate insect attack of timber which becomes evident, including the replacement of timber attacked or suspected of being attacked, not with standing that the timber concerned may have already been inspected and passed as fit for use.

**Seasoning of Timber**

All timber shall be seasoned to a moisture content of not more than 22% for carpentry and 15% for joinery. The Contractor's price must include for any kiln drying that may be necessary to achieve these figures.

**Inspection and Testing**

The Project Engineer shall be given facilities for inspection of all works in progress whether in Workshop or on Site. All timber as it arrives on the Site and not approved by them must be removed forthwith, failing which the Employer, with the advise of the Project Engineer, may arrange for the removal of the rejects and impose of them as they may consider advisable at the Contractor's expenses.

Notwithstanding approval having been given as above, any timber incorporated in the Works found to be in any way defective before the expiry of the maintenance period shall be removed and renewed at the Contractor's expense. The Contractor is to allow for testing or prototypes of special construction units and the Project Engineer shall be at liberty to select any samples they may require for the purpose of testing i.e. for moisture content, or identification of species, strength, etc.

Where timbers need to be extended into a wall, they shall be thoroughly "Brush Treated" with a wood preservative approved by the Project Engineer, and as much clear air space maintained around the timber where it adjoins the wall as possible.

**Clearing Up**

The Contractor is to clear out and destroy or remove all cut and shavings and other wood waste from all parts of the building and the Site generally, as the work progress and at the conclusion of the work.

**(4) Galvanizing**

When described in the contract or shown on the Drawing, all hardware shall be galvanized in accordance with the Indian Standard Recommended Practice for Hot-Dip Galvanizing of Iron

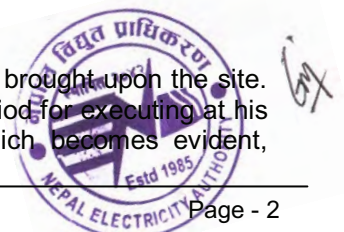
**I3 CARPENTRY AND JOINERY**

**(1) Timber**

Generally the timber for carpentry and joinery shall be Sal wood of the best quality obtained from an approved saw mill. The timber shall be reasonably straight grained. All timber shall be seasoned and are to be open stacked. All timber as it arrives on the site shall be inspected by the Engineer In-charge, and any unapproved timber at the must be removed forthwith. All timber of assembled woodwork shall be protected from the weather and stored in such a way as to prevent attack by termites, insects or decay fungi.

The minimum compressive strength of the timber shall be 70 kg/cm<sup>2</sup>.

All timber shall be free from live borer beetle or other insect attack when brought upon the site. The contractor shall be responsible up to the end of the maintenance period for executing at his own cost all work necessary to eradicate insect attack of timber which becomes evident,



including the replacement of timber attached or suspected of being attacked, notwithstanding that the timber concerned may have already been inspected and passed as fit to use before.

All timber shall be seasoned to moisture content of not more than 22% for frames and 15% for shutter. The contractor's price must include for any kiln drying that may be necessary to achieve these figures.

All timber and assembled wood work shall be protected from the weather and stored in such a way as to prevent attack by termites, insects or decay fungi.

**(2) Carpentry**

All carpentry shall be executed with workmanship of the best quality. Scantlings and boarding shall be accurately sawn and shall be of uniform width and thickness throughout. All carpenter's work shall be left with sawn surface except where particularly specified to be wrought.

All carpenter's work shall be accurately set out in strict accordance with the drawings and shall be framed together and securely fixed in best possible manner with properly made joints. All necessary brads, nails and screws, etc. shall be provided as directed and approved.

Actual dimensions of scantlings for carpentry shall not vary from the specified dimensions by more than 3mm in deficiency or excess but must be uniform throughout. Boards 25mm thick or less shall hold up to the specified sizes. All timbers shall be as long as possible and practicable, in order to eliminate joints.

**(3) Joinery**

Generally all joiner's work shall be accurately set out on boards to full size for the information and guidance of the artisans before commencing the respective works, with all joints, iron work and other works connected therewith fully delineated. Such setting out must be submitted to the Project Engineer and approved before such respective works are commenced.

All joiner's work shall be cut out and framed together as soon after the commencement of the building as is practicable, but is not to be wedged up or glued until the building is ready for fixing same. Any portions that warp, wind or develop shakes or other defects within twelve months after completion of the works shall be removed and new fixed in their place on Contractor's own expense.

All work shall be properly mortised, tenoned, housed, shouldered, dovetailed, notched, wedged, pinned, braided, etc., as directed and to the satisfaction of the Project Engineer and all properly glued up with the best quality approved glue.

Joints in joinery must be as specified or detailed, and so designed and secured as to resist or compensate for any stresses to which they may be subjected. All nails, springs, etc. are to be punched and puttied. Loose joints are to be made where provision must be made for shrinkage, glued joints where shrinkage need not be considered and where sealed joints are required. Glue for load-bearing joints or where there is damp conditions must be of the resin type. For non-load-bearing joints or where dry conditions may be guaranteed casein or organic glues may be used. All exposed surfaces of joinery Work shall be wrought and all arises "eased-off" by planing and sand papering to an approved finish suitable to the specified treatment.

**Dimensions**

Joinery shall hold up to the specified sizes and as measured.

**Fixing Joinery**

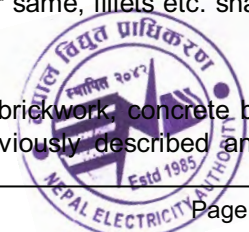
All beads, fillets and small members shall be fixed with round or oval brads on nails well punched in and stopped. All large members shall be fixed with screws, the heads let in and palliated to match the grain.

Unless otherwise specified, plugs of external work shall be of hardwood, plugs for internal work may be of softwood. Holes for plugging must be made with a proper drilling tool and the holes completely filled with the plugging material.

Unless otherwise specified all skirting, window, grounds and backings for same, fillets etc. shall be plugged at intervals not exceeding 60cm.

**Budding Joiner**

All door and window frames, sills, wooden bars etc., which are fixed to brickwork, concrete by means of grounds, lugs, etc., shall be bedded solid in mortar as previously described and



pointed with a recessed joint 6mm deep to the approval of the Project Engineer.

Plywood's, Blackboards, Chipboards etc., shall be of a standard quality. They shall be bonded with synthetic resin or "interior" type unless otherwise stated. Where stated to be "exterior" type, they shall be weatherproof. All exposed edges of blackboard and clipboard shall be lipped with hardwood as described below.

Samples of all such materials and their source of manufacture must be approved by the Project Engineer before used in the works.

#### **Plastic Sheeting**

Shall be approved laminated sheeting 1.5mm thick, securely fixed by means of Aerodux 185 adhesive, and in colors approved by the Project Engineer.

#### **(4) Ironmongery**

All locks and Ironmongery shall be fixed with screws, etc., to match. Before the woodwork is painted, handles shall be removed, carefully stored and re-fixed after completion of painting and locks oiled and left in perfect working order.

Prices for fixing locks must include for organizing master-keying systems if required and all keys shall be labeled with door references marked on approved labels before handing the Project Engineer on completion.

#### **I4 BEAMS LINTEL, RAFTERS, PURLINS, WALL PLATES, POST/COLUMN**

All wood work shall be planed neatly and truly finished to the exact dimensions. All joints shall be neat and tight, truly and accurately fitted. Wall plates, purlins and rafter shall be painted with 2 coats of creosote conforming IS 218 1952.

All beams shall be bedded on (1:2:4) RCC beds of 10cm x 7.5cm x 4.5cm dimension with a minimum of 15cm bearing or as specified in the drawing. All portion of timber in contact with masonry shall have 6mm gap sides. All beams shall rest on bearing.

Measurement of wood work shall be in volumes. for the finished work, including fixing, sawing, planning, joining, nails, screws etc. Wooden blocks/joints wherever specified may be measured in number.

#### **I5 DOORS AND WINDOWS FRAMES**

Timber for carpentry shall be of salwood of best quality, free from saps, fissures, and knots, sore and/or other defects. All beams and scantling shall be sawed along grain and under no condition beams, rafters, wall plates, blocks etc. shall be sawed across grain. All timber and assembled woodwork shall be protected from weather for which temporary shed shall be built. All timber shall be stored at least 750mm above ground level or more, if deemed necessary, and individual members shall be separated by strips so that air may circulate around all four sides. All wood work except door/window frames or ceiling shall be painted with two coats of creosote confirming to IS 218 1952.

#### **I6 WOODEN DOOR AND WINDOWS FRAME**

##### **(1) Material**

Generally the timber for carpentry and joinery shall be Sal wood of the best quality obtained from an approved saw mill. The timber shall be reasonably straight grained. All timber shall be seasoned and are to be open stacked. All timber as it arrives on the site shall be inspected by the Engineer In-charge, and any unapproved timber at the must be removed forthwith. All timber of assembled woodwork shall be protected from the weather and stored in such a way as to prevent attack by termites, insects or decay fungi.

The minimum compressive strength of the timber shall be 70 kg/cm<sup>2</sup>.

All timber shall be free from live barer beetle or other insect attack when brought upon the site. The contractor shall be responsible up to the end of the maintenance period for executing at his own cost all work necessary to eradicate insect attack of timber which becomes evident, including the replacement of timber attacked or suspected of being attacked, notwithstanding that the timber concerned may have already been inspected and passed as fit use before.

All timber shall be seasoned to moisture content of not more than 22% for frames and 15% for shutter. The contractor's price must include for any kiln drying that may be necessary to achieve these figures.



**(2) Construction Procedures**Clearing Up:

The contractor is to clear out and destroy or remove all cut and shavings and other wood waste from all parts of the building and the site generally, as the work progress and at the conclusion of the work.

Carpentry:

All carpentry shall be executed with workmanship of the best quality. Scantling and boarding shall be accurately sawn and shall be of uniform width and thickness throughout. All carpenter's work shall be left with sawn surface except where particularly specified to be wrought.

All carpenter's work shall be accurately set out in strict accordance with the drawings and shall be framed together and securely fixed in best possible manner with properly made joints. All necessary brads, sheet metal screws, etc. shall be provided as directed and approved.

Joinery:

All joints shall be accurately set out on boards to full size for the information and guidance of the artisans before commencing the respective works, with all joints, iron work and other works connected therewith fully delineated. Such setting out must be submitted to the Engineer In-charge and approved before such respective works are commenced.

All joiner's work shall be cut out and framed together as soon after the commencement of the building as is practicable, but is not to be wedged up or glued until the building is ready for fixing same. Any portions that warp, wind or develop shakes or other defects within six months after completion of the works shall be removed and new fixed in their place on contractor's own expense.

All work shall be properly mortises, tenons, house, shouldered, dovetailed, notched, wedged, pinned, braided, etc., as directed and to the satisfaction of the consultants and all properly glued up with the best quality approved glue.

Joints in joinery must be as specified or detailed, and so designed and secured as to resist or compensate for any stresses to which they may be subjected. All nails, springs, etc. are to be punched and puttied. Loose joints are to be made where provision must be made for shrinkage, glued joints where shrinkage need not be considered and where sealed joints are required. Glue for load-bearing joints or where conditions may be damp must be of the resin type. For non-load-bearing joints or conditions may be guaranteed casein or organic glues may be used. All exposed surfaces of joinery work shall be wrought and all arise "eased-off" by planing and sand papering to an approved finish suitable to the specified treatment.

Dimensions:

Joinery shall hold up to the specified sizes and as measure.

Fixing Joinery:

All beads, fillets and small members shall be fixed with round or oval brads on nails well punched in and stopped. All large members shall be fixed with brass screws, the heads let in and palette to match the grain.

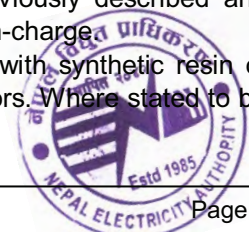
Unless otherwise specified, plugs of external work shall be of hardwood; plugs for internal work may be of softwood. Holes for plugging must be made with a proper drilling tool and the holes completely filled with the plugging material.

Unless otherwise specified all skirting, window, grounds and backings for same, fillets etc., shall be plugged at intervals not exceeding 600mm.

Bedding Joinery:

All door and window frames, sills, wooden bars etc., which are fixed to brickwork, concrete by means of grounds, lugs, etc., shall be bedded solid in mortar as previously described and pointed with a recessed joint 6mm deep to the approval of the Engineer In-charge.

Plywood, Block boards, Chipboards and MDF board, shall be bonded with synthetic resin of "interior" type and sheet metal screws unless otherwise stated for the doors. Where stated to be "exterior" type, they shall be weatherproof.



All exposed edges of block board and chipboard shall be lipped with hardwood as described below.

Samples of all such materials and their source of manufacture must be approved by the Engineer In-charge before used in the works.

**(3) Inspection and Testing**

The Engineer In-charge shall be given facilities for inspection of all works in progress whether in workshop or on site. All timber as it arrives on the site and not approved by them must be removed forthwith, failing which the Employer, with the advise of the Engineer In-charge, may arrange for the removal of the rejects and impose of them as they may consider advisable at the contractor's expenses.

Notwithstanding approval having been given as above, any timber incorporated in the works found to be in any way defective before the expiry of the maintenance period shall be removed and renewed at the contractor's expense. The contractor is to allow for testing or prototypes of special construction units and the Engineer In-charge shall be at liberty to select any samples they may require for the purpose of testing i.e. for moisture content, or identification of species, strength, etc.

Where timbers need to be extended into a wall, they shall be thoroughly "Brush Treated" with a wood preservative approved by the Engineer In-charge, and as much clear air space maintained around the timber where it adjoins the wall as possible.

**(4) Measurement**

Measurement of works will be made in m<sup>3</sup> of works as specified.

**(5) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**17 WOODEN WINDOW SHUTTERS**

**(1) Material**

The material shall conform as in Clause I7(1)

The window shutters shall have minimum of 100mm steel hinges with steel screws, one aluminum handle and 150mm two tower bolts of super brand or equivalent with steel screws.

**(2) Construction Procedure**

The window shutters may be fully paneled, fully glazed, partly glazed and partly paneled, battened or Venetian as specified. Styles and panels shall be neatly planed and truly finished to exact dimensions. Styles and rails shall be framed properly and accurately with mortise and tenon joints and fixed with bamboo pins as per drawing. Glue shall be applied at all joints before clamping and fixing with bamboo pins. Panels shall be of one piece without any joints and shall be housed with 12.5mm insertion into rails and styles.

Panels shall be of thickness as specified in the drawing. All rails above 100mm in width shall have double tenon. No tenon shall exceed 6mm the thickness of the member. In case of swing door, swing door hung in lace shall not be rebated together. It shall be fitted with vision panels.

The construction procedure shall conform as in Clause I7(2)

**(3) Testing and Inspection**

The Testing and Inspection shall conform as in Clause I7(3)

**(4) Measurement**

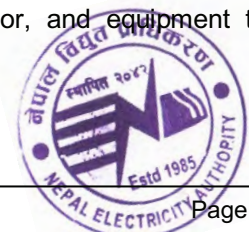
Measurement of works will be made in m<sup>2</sup> of works as specified.

**(5) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**18 GLAZED WINDOW SHUTTERS**



**(1) Material**

The material shall conform as in Clause I7(1)

All glass shall be IAG free from flaws like bubbles, specks, waves and other imperfections.

Glass panes shall be cut to sizes to fit the openings with not more than 1.5mm play all round and where puttied shall be sprigged to wood or clipped to metal frames.

Glass shall be of quality and type as follows:

Clear sheet glass	O.Q. quality
Cast and/ or obscured glass	pattern similar to sample approves by the Engineer In-charge.
Plate-glass	S.G. quality or "Float" Glass

Putty for glazing in wood frames shall be composed of pure linseed oil and whiting powder free from grittiness.

Rebates of metal frames receiving glass shall be prepared and treated with primer for putty prior to glazing and putty shall be primed ten days after glazing (See Painting).

Glass louvers shall have ground edges and be fixed in accordance with the instruction of the louver frame manufacturer.

Mirrors shall be 4mm S.G. silvered plate glass or Swan brand with polished edges, and shall be drilled for and fixed with four chromium plated screws with detachable dome heads.

On completion remove all broken, scratched or cracked panes and replace with new to the satisfaction of the Engineer In-charge. Clean inside and out with approved cleaner. On no account shall scraping with glass clean windows.

The thickness of the glass, if not specified in the detail drawing, shall be as follows:

- i. For a pane of more than 1160 sq. cm. but less than 2790 sq. cm. the thickness shall be 4mm or more as decided by the site In-charge.
- ii. For a pane of not more than 1160 sq. cm. area, thickness should not be less than 3mm.
- iii. For a pane more than 2790 sq. cm. thickness of glass shall be 5mm or more as decided by the Engineer In-charge.
- iv. For vision pane in swing window-thickness should be 4mm minimum.

All glass panes shall be fitted with wooden beads.

All wooden beads shall be from hard wood fitted against the glass. Wooden beads shall be bedded against the rebate and secured by 12.5mm glass nails fixed at 75mm apart. The rebate depth shall be 12.5mm Wooden beads shall not project beyond the rebate.

All glass panes shall have edge-clearance, when fitted of 1.5mm all round.

Beads shall be painted with approved paint before fixing glass pane.

The window shutters shall have minimum of two-piece 100mm steel hinges with steel screws, one aluminum handle and two pieces of 150mm tower bolts of super brand or equivalent with steel screws.

**(2) Construction Procedure**

The window shutters may be fully paneled, fully glazed, partly glazed and partly paneled, battened or Venetian as specified. Styles and panels shall be neatly planed and truly finished to exact dimensions. Styles and rails shall be framed properly and accurately with mortise and tenon joints and fixed with bamboo pins as per drawing. Glue shall be applied at all joints before clamping and fixing with bamboo pins. Panels shall be of one piece without any joints and shall be housed with 12.5mm insertion into rails and styles.

Panels shall be of thickness as specified in the drawing. All rails above 100mm in width shall have double tenon. No tenon shall exceed 6mm the thickness of the member. In case of swing door, swing door hung in lace shall not be rebated together. It shall be fitted with vision panels.

The construction procedure shall conform as in Clause I7(2)

**(3) Testing and Inspection**

The Testing and Inspection shall conform as in Clause I7(3)



**(4) Measurement**

Measurement of works will be made in m<sup>2</sup> of works as specified.

**(5) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**I9 WOODEN paneled DOOR SHUTTERS****(1) Material**

The material shall conform as in Clause I7(1)

The door shutters are polished with clear chapra polish and painted with two coats of touch wood polish.

The Door shutters shall have minimum of three pieces of 150mm brass hinges with brass screws, one IPSA Mortise lock of heavy duty or equivalent, two pieces of 150mm brass tower bolts of good quality with brass screws, 75 mm doorstopper.

**(2) Construction Procedure**

The door shutters may be fully paneled, fully glazed, partly glazed and partly paneled, battened or Venetian as specified. Styles and panels shall be neatly planed and truly finished to exact dimensions. Styles and rails shall be framed properly and accurately with mortise and tenon joints and fixed with bamboo pins as per drawing. Glue shall be applied at all joints before clamping and fixing with bamboo pins. Panels shall be of one piece without any joints and shall be housed with 12.5mm insertion into rails and styles.

Panels shall be of thickness as specified in the drawing. All rails above 100mm in width shall have double tenon. No tenon shall exceed 6mm the thickness of the member. In case of swing door, swing door hung in lace shall not be rebated together. It shall be fitted with vision panels.

The construction procedure shall conform as in Clause I7(2)

**(3) Testing and Inspection**

The Testing and Inspection shall conform as in Clause I7(3)

**(4) Measurement**

Measurement of works will be made in m<sup>2</sup> of works as specified.

**(5) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**I10 WOODEN SOLID CORE DOOR SHUTTERS****(1) Material**

Wooden solid core of lightwood with 4mm Teak plywood in both sides glued and lipped with mould salwood of sample approved by project engineer. The tolerances for the overall size are +3mm +-1mm in thickness.

Where described as "External Quality" flushes doors are to be finished with weatherproof plywood as before described and the Engineer In-charge must approve sample doors before the doors are completed. The door shutters are polished with clear chapra polish and painted with two coats of touch wood polish.

The doors shall be stucked with molding of approved design in the shape as shown in the drawing.

The Door shutters shall have minimum of three pieces of 150mm brass hinges with brass screws, one IPSA Mortise lock of heavy duty or equivalent, two pieces of 150mm brass tower bolts of good quality with brass screws, 75 mm doorstopper.

The material shall conform as in Clause I6(1)

**(2) Construction Procedure**

The window shutters may be fully paneled, fully glazed, partly glazed and partly paneled,



battened or Venetian as specified. Styles and panels shall be neatly planed and truly finished to exact dimensions. Styles and rails shall be framed properly and accurately with mortise and tenon joints and fixed with bamboo pins as per drawing. Glue shall be applied at all joints before clamping and fixing with bamboo pins. Panels shall be of one piece without any joints and shall be housed with 12.5mm insertion into rails and styles.

Panels shall be of thickness as specified in the drawing. All rails above 100mm in width shall have double tenon. No tenon shall exceed 6mm the thickness of the member. In case of swing door, swing door hung in lace shall not be rebated together. It shall be fitted with vision panels.

The construction procedure shall conform as in Clause I7(2)

**(3) Testing and Inspection**

The Testing and Inspection shall conform as in Clause I7(3)

**(4) Measurement**

Measurement of works will be made in m<sup>2</sup> of works as specified.

**(5) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**I11 WOODEN CARVING DOOR AND WINDOWS FRAME AND SHUTTERS**

**(1) Material**

The material shall conform as in Clause I7(1)

**(2) Construction Procedure**

The construction procedure shall conform as in Clause I6(2). The carving of the doors and windows should be refined aesthetically with reflection carving craftsmanship as approved by Architect

**(3) Testing and Inspection**

The Testing and Inspection shall conform as in Clause I7(3)

**(4) Measurement**

Measurement of works will be made in m<sup>2</sup> of works as specified.

**(5) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.



**J PLASTER AND POINTING WORK****J1 SCOPE**

This Section covers furnishing of materials and construction of different grades of plaster works in accordance with the BOQ, Drawing and this Specification or as directed by the Engineer.

Plastering shall be made up of mortar consisting of cement, sand in the different proportion as indicated in the BOQ as specified in the drawing.

**J2 MATERIAL**

Cement shall be fresh and free from impurities and as specified in clause C13, river bed sand shall be used. Sand for plastering shall be finer than the sand used for concreting or stone work. Following shall be proportion of different size of grains.

Grain		Percent
0 to 0.5 mm	=	30%
0.5 to 2 mm	=	50%
2 to 3 mm	=	20%

Water shall be clean and free from pollution by soil particles, humus, mud, dirt, natural or vegetable oil, soap and other impurities.

**J3 CONSTRUCTION PROCEDURES**

The surface to be plastered shall be brushed clean mortar joints of brick masonry or hollow concrete walls or any other surface to be plastered shall be raked to a depth of approximately 12mm, and the surface brushed down with a stiff brush and thoroughly wetted. The surface shall be free of all dust, loose materials, grease etc.

The mortar shall be first dry mixed, by measuring with boxes to required proportion, and then water added slowly and gradually and mixed thoroughly to uniform consistency.

The thickness of the plaster shall not be less than 12 mm not more than 20mm. In case of plaster thicker than 20mm, it shall be built by two or more coats each coat not exceeding 12mm in thickness.

Cement shall be as specified above.

Sand shall be as before specified but shall be graded to a suitable fineness in accordance with the nature of the plaster, etc., in order to obtain the finish required.

Lime for plastering shall be as before described in clause C14 and slaked and run at least four weeks before use.

All other mixes shall be constructed in a like manner.

Moist curing shall be accomplished by keeping the plaster uniformly damp by suitable means. Moist curing shall start during application and continue for not less than 7 days.

**Hacking**

Prices of all paving and plastering etc. shall include for hacking concrete ceilings, beams, floors etc., by approved means and for raking out joints of walls 12mm deep to form a proper key. Plastering on walls generally shall be taken to include flush faces of lintels etc., in same.

Surfaces to be paved or plastered must be brushed clean and well wetted before each coat is applied. All cement plaster shall be kept continually damp in the interval between application of coats and for seven days after application of the final coat.

Dubbing out where required shall be composed of similar material to that following.

Partially or wholly set material will not be allowed to be used or re-mixed.

**Samples**

The Contractor shall prepare sample square meter of the plastering and paving as directed until the quality, texture and finish required is obtained and approved by the Project Engineer after which all plastering or paving executed shall conform with the respective approved sample. No payment shall be accounted for such sampling.



**Finish**

Care shall be taken to insure that finished plaster surfaces shall be plumb, square, straight and true to line.

Generally all screeds and paving shall be finished smooth, even and truly level (unless specifically required to falls and currents, etc.), and paving shall be steel troweled or floated.

Rendering and plastering shall be finished plumb, square, smooth and even.

All surfaces to be plastered shall be thoroughly wetted before any plastering is commenced and the Contractor shall allow in his prices for dusting external angles with neat cement to give additional strength.

No plastering will be allowed to take place until all chases for service have been cut, services installed and chases made good. On no account may finished plaster surface be chased and made good.

All Work shall be to approval and any not complying with the above shall be hacked away and replaced, as directed, and at the Contractor's expense.

**Arises and Angles in Plastering**

All arises shall be clean and sharp or slightly rounded as directed including neatly forming miters.

All making good shall be cut out to a rectangular shape, the edges undercut to form dovetail key and finished flush with face of surrounding plaster. All cracks, blisters and other defects must be cut out made good and the whole of the paving and plastering Work left perfect on completion.

Screeds shall be in cement and sand (1:4) and rates shall include for thoroughly hacking, cleaning and soaking the receiving structure in water. No creed shall be laid on a dry structure in any circumstances.

Where changes of floor finish occur they shall be divided by strips as specified.

The Contractor's special attention is drawn to the fact that all screeds, immediately after the initial set has taken place, will be required to be continuously covered in water by the sand trap or other approved method for at least 10 days. Any screed panel that is found to be dry before the end of this period shall be removed at the discretion of the Project Engineer.

Waterproofed external rendering shall consist of minimum 12mm cement and sand (1:4) rendering at the rate of 2.05 liter to 41 kgs of cement all in accordance with the manufacturer's instructions and finished perfectly true and even with a wood float.

**External Plastering and Rendering:**

Waterproofed External Plaster or Rendering work shall consist of minimum 12.5mm to 16mm as detailed in the Bill of Quantity with cement/ sand ratio 1:3 or 4 at the rate of 1/2 gallon to 90 lbs of cement all in accordance with the manufacturer's instructions and finished perfectly true and even with a wood float.

**Internal Plastering and Rendering:**

Internal Plastering or Rendering shall consist of minimum 12.5mm to 16mm as detailed in the Bill of Quantities with cement/ sand ration 1:3, 4 finished perfectly true and even with a wood float.

**J4 PUNNING AND POINTING WORKS****(1) Materials**

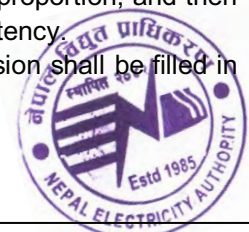
The materials required for punning and pointing works are cement, sand and water and shall be in accordance with the requirements of clause J2.

**(2) Construction Procedures**

Before applying the punning and pointing, the base surface shall be cleaned, any dust or loose particles removed and thoroughly wetted. The surface shall be free of all dust, loose materials, grease etc. The average thickness of the punning and pointing work shall not be less than 3 mm. The pattern shall be as per instruction of the Engineer or as shown in the drawings.

The mortar shall be first dry mixed, by measuring with boxes to required proportion, and then water added slowly and gradually and mixed thoroughly to uniform consistency.

The coat shall be finished by rubbing with a steel trowel and any depression shall be filled in and rubbed to shining surface.



Cement shall be as specified above.

Sand shall be as before specified but shall be graded to a suitable fineness in accordance with the nature of the plaster, etc., in order to obtain the finish required.

All other mixes shall be constructed in a like manner.

Moist curing shall be accomplished by keeping the plaster uniformly damp by suitable means.

Moist curing shall start during application and continue for not less than 7 days.

**J5 MEASUREMENT**

Measurement of works will be made in m<sup>2</sup> of works as specified.

**J6 PAYMENT**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.



**K PAINTING****K1 SCOPE**

This Section covers furnishing of materials and construction of different types of painting works in accordance with the BOQ, Drawing and this Specification or as directed by the Engineer.

**K2 DELIVERY AND APPLICATION OF PAINT:**

All materials shall be delivered on site intact in the original drums or tins and shall be mixed and applied strictly in accordance with the manufacturer's instructions and to the approval of the Engineer. All cement paints and washable distemper shall be applied by brush; emulsion paints shall be applied by means of a brush then rolled. All enamel paints are applied by brush or sprayed, and bitumen and bituminous base aluminum paints are applied by brush. Before application of any paint, adjoining surfaces shall be covered by cloth, or paper and wherever paints stains it shall be removed before leaving the work in same day.

The only addition, which will be allowed to be made locally will be liquid thinners supplied or recommended by the manufacturers and none shall be, thinned more than approved by the Engineer.

**K3 PREPARATION AND PRIMING OF SURFACES:**

Concrete and Cement rendered surfaces shall be smooth and free from defects and shall be allowed to dry out thoroughly. Surfaces shall be thoroughly brushed down and left free from all efflorescence, dirt and dust.

All such surfaces, which are to be finished with oil or enamel paint, shall be primed with two coats of alkali resisting primer.

Plaster surfaces shall be perfectly smooth and free from defect. All such surfaces shall be allowed to dry for a minimum period of four weeks. Surfaces shall be stopped with approved plaster compound, rubbed down flush, thoroughly brushed down and left free from all efflorescence, dirt and dust.

Fair-faced surfaces shall be dry, brushed down and free from dust or dirt and shall be treated with an approved alkali resisting primer (for plastic emulsion).

Metal work generally shall be thoroughly wire brushed to remove all scale, rust, and through sand papering shall be done before any painting is done. Where severe rust exists, the special anti-rust primer must be used. After painting it shall be stored in covered shed and 60cm above ground.

Shop primed surfaces shall have bare places touched up with an approved metal primer.

Un-primed surfaces shall be given one coat of primer as last.

Galvanized surfaces, which are thoroughly weathered, shall be, brushed down with white spirit, washed down and given one coat of zinc chromate primer.

Bituminous-coated surfaces shall be given as isolating coat of shellac knotting followed by an approved metal primer.

Woodwork generally shall be rubbed down, given one coat shellac knotting, one coat wood self knotting primer, and all cracks, nail holes, defects, and uneven surfaces, etc., stopped and faces up with hard stopping rubbed down flush.

Before oiling woodwork all stains must be removed and uniform color obtained and filled.

**K4 COLORS AND PRIMING:**

The priming undercoats and finishing coats shall each be of differing tints and the priming and undercoats shall be of the correct types and tints to suit the respective finishing coats in accordance with the following instructions. All finishing coats shall be of colors and tints selected by the Engineer. The paintwork shall have and uniform finish and all paint for external work shall be exterior quality only.

**(1) Rubbing Down:**

Each coat of paint shall be properly dried and shall be well rubbed down with fine glass paper before the next coat is applied. The paintwork shall be finished smooth and free from brush marks.

Samples Cards of all paints, etc., shall be submitted to and samples prepared for approval of the Engineer before laying on and such samples, when approved, shall become the standard for work



**(2) Program:**

The contractor shall so arrange his program of work that all other Trades are completed and away from the area to be painted when the painting begins.

**(3) Ironmongery, Protection and Cleaning Up:**

All ironmongery shall be removed from joinery before painting is commenced and shall be cleaned and renovated of necessary and re-fixed after completion painting.

Cover up all floors, etc., with non-resinous sawdust or other approved covering when executing and all painting decorating work.

Paint splashes, spots and stains shall be removed from floors, woodwork, etc., and damaged surface touched up and the whole of the work left clean upon completion.

**(4) Materials:**

All paint materials of specified brand shall be obtained the manufacturer or authorized dealer. All sealers, primers and undercoating are to be obtained from the makers of the finishing materials and are to be in accordance with their recommendation for the particular finish required.

**(5) Knot Sealer:**

For use on knots and resinous portions of woodwork.

Stopping and Filling composed of parts putty to one part of stiff white lead.

**(6) Lacquer:**

Approved polyurethane eggshell clear lacquer applied in accordance with the manufacturer's instructions.

- Polish shall be an approved brand of wax polish.
- Oil shall be best quality linseed oil.
- Filler for polished or oiled surfaces to be Beeswax filler.

**(7) Wood Preservative:**

All wood work, as specified or instructed shall, be treated after cutting and preparation but before assembly or fixing with three coats of solution consisting of one part of Atlas "A" wood preservative brown grade to three parts of water. The solution is to be brushed in all faces of all timbers unless exposed to view and painted. This is applicable in the wood frame contact with masonry and roof purling, batten and counter rafter.

The contractor shall note that this solution is HIGHLY POISONOUS and shall take all necessary precautions and instruct his workmen accordingly.

**(8) Paint Application:**

Painting Items as described hereafter shall comprise the following, and shall all include for preparing and priming surfaces as above described: -

Cement Paint	:Apply two coats.
Plastic Emulsion	:Apply a minimum of three coats, using a thinning medium or water only if and as recommended by the manufacturer. An approved plaster primer tinted to match may be substituted for the first coat.
Paint	:Apply two undercoats and one finishing coat of enamel gloss oil paint.
Flat oil paint	:Apply two coats of flat oil paint, using thinning medium in accordance with the manufacturer's instructions.
Oil	:Apply two coats of linseed oil.
Wax Polish	:Apply a minimum of two coats to approval.
Lacquer	:Apply three coats of Polythene lacquer as described, to approval.
Prime	:Prepare and prime only before fixing.



**K5 CEMENT PAINT**

Cement paint shall be of ready mixed type in sealed container of Approved brand. It shall be procured either in 50 kg. Container or 25 kg. Container. All such container shall have unbroken seal with manufacturer's name and trade marks as well as a description of contents all clearly marked. Such paint shall be mixed and applied strictly in accordance with the manufacturer's instructions and with the approval of site In-charge. All materials shall be stored in dry place.

Only fresh cement paint shall be used, hard or set paint shall not be used. The container shall be made loose by rolling and shaking the container before opening.

First a paste shall be prepared by mixing 2 parts of cement paint powder with one part of water by volume and immediately this shall be thinned by adding another part of water to have uniform solution of consistency of paints.

Before application of paint all dust and foreign materials shall be removed from the surface by use of wire brush. The surface shall be allowed to run off. The fresh mixed point shall be frequently stirred during application and no mixture (paint) shall be used after an hour of mixing. The first coat shall be kept wetted for at least 24 hours before the second coat is applied. The surface shall be thoroughly wetted before the second cost is applied.

The final painted surface shall exhibit uniform and good finished appearance. Measurement shall being square meter of actual covered area. No extra shall be allowed for scaffolding, curing and painting corners, plaster strips etc.

**K6 ENAMEL PAINT**

The enamel paint shall be of Approved Brand. All surfaces to be painted shall be planed and thoroughly sand papered, first by using No. 120 sandpaper. Ordinary putting shall fill up nail holes, cracks or other in equalities. Putting shall be made up of 2 parts of best quality whiting (absolutely dead stone lime) 1 part if white lead mixed together in linseed oil and kneaded (3 oz. of linseed oil to 1 lb. of whiting). A primer coat shall be locally applied in holes, cracks etc. before putty is applied.

After the surface is dry, it shall be sand paper by using No. 60 sandpaper.

Surface so prepared shall be painted with one coat of primer. The primed surface when dry shall be sand papered by using No. 100 sand paper.

The primed surface so prepared shall be painted with one coat of selected enamel using bristle brush and not horsehair ones. The paint shall be applied in thinnest possible layers with parallel strokes.

Care shall be taken to ensure the surface being free from dust or other foreign material before priming or enameling the surface. No paint shall splash on the floor, wall jambs, sill or other part of the building.

Primers and paints shall be of first class approved quality and of approved manufacturer as specified. These materials shall be ready mixed and in sealed tins with manufacturer's name, color and instruction clearly painted in the container.

**K7 WASHABLE DISTEMPER**

Washable distemper shall be of approved Brand. The Engineer shall examine the paints before seal is broken.

Only fresh distemper shall be used, hard or set shall not be used.

**K8 PLASTIC EMULSION PAINT**

Approved brand of plastic emulsion paint shall be used in the plaster of Paris or lime punned surfaces.

**K9 BITUMINOUS ALUMINUM PAINT**

Bituminous Aluminum paint shall be of approved Brand. The Engineer shall examine the paints before seal is broken.

**K10 RED LEAD PRIMER**

Red Lead primer paint shall be approved brand. The lead content in the paint shall be less than 60% by weight. The site in charge shall examine the paints before seal is broken.

**K11 CHAPRA POLISH**

Before application of Chapra polish, the timber surfaces shall be thoroughly sand papered to obtain



smooth surfaces and all the dust are removed from the surfaces. A coat of primer of chalk power mixed with resin is applied and sand papered to fill in the voids and joints.

The chapra polish is prepared from the chapra mixed with spirit. The chapra must completely dissolve in the spirit. Over the primed surfaces, two layers of resin is applied by the smooth cotton clothes and dried.

**K12 POLYURETHANE PAINT**

Approved polyurethane or equivalent eggshell clear lacquer applied in accordance with the manufacturer's instructions.

Polish shall be an approved brand of wax polish.

Oil shall be best quality linseed oil.

Filler for polished or oiled surfaces to be Beeswax filler.

**K13 WHITE WASHING**

Fresh white lime slaked at Site of Work shall be mixed with clean water to make thin cream. It shall be screened through a coarse cloth, and gum (glue) in the proportion of 100 grams to 16 liters of water shall be added.

The surface to be white washed must be dry and thoroughly cleared from dust and dirt. The wash shall be applied with "Babio" or brush, vertically and horizontally alternately, and the wash kept stirring in the container while using as per standard code of practice..

No paint should splash on floor or door/window frames and panels.

**K14 MEASUREMENT**

Prices of paints, etc., shall include for preparation of surfaces, rubbing down between each coat, stopping, knotting, etc., and all other Work in connection as described and as necessary to obtain a first class and proper finish. Should the description stated in the items of the bills be insufficient in the Contractor's opinion to obtain such a finish, the Contractor must allow in his prices for such extra coats, materials or Work necessary to obtain such a finish to the Engineer's approval. Price must include for the provision of all necessary scaffolding, plant and tools, and also for applying different colors and cutting into where and as necessary.

Painting Items as billed hereafter shall comprise the following, and shall all include for preparing and priming surfaces as above described:-

Cement Paint	-	Apply two coats.
Plastic Emulsion	-	Apply a minimum of three coats, using a thinning medium or water only if and as recommended by the manufacturer. An approved plaster primer tinted to match may be substituted for the first coat.
Paint	-	Apply two undercoats and one finishing coat of enamel gloss oil paint.
Flat oil paint	-	Apply two coats of flat oil paint, using thinning medium in accordance with the manufacturer's instructions.
Oil	-	Apply two coats of linseed oil.
Wax Polish	-	Apply a minimum of two coats to approval.
Lacquer	-	Apply three coats of Polyurethane lacquer as

described, to approval.

Prime - Prepare and prime only before fixing.

Measurement of all the painting works will be made in m<sup>2</sup> of works as specified except for the grills, handrails, railing and cornices.

**K15 PAYMENT**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified



**L FLOORING****L1 SCOPE**

This Section covers furnishing of materials and construction of different types of flooring works in accordance with the BOQ, Drawing and this Specification or as directed by the Engineer.

The flooring works shall include cement mortar or adhesives for laying the finished material.

**(1) Protection**

All finishing on completion are to be adequately protected against damage by following trades or any other clause to the satisfaction of the Engineer In-charge until the works are handed over to the owner.

**(2) Where Changes in Floor Finish Occur**

Where changes of floor finish occur they shall be divided by strips as specified.

The contractor's special attention is drawn to the fact that all screeds, immediately after the initial set has taken place, will be required to be continuously covered in water by the sand trap or other approved method for at least 10 days. Any screed panel that is found to be dry before the end of this period shall be removed at the discretion of the Engineer In-charge.

**(3) Earthwork in Filling**

Earth filling in floor shall be done with proper ramming in 23cm layers, after sprinkling with water and consolidating to 15cm. Earth shall be free from rubbish, organic or vegetable growth including roots, weeds etc. All clods shall be first broken.

Particular care shall be exercised not to dump earth clods in space between foundation trench and inside face of the masonry.

Measurement shall be in cu.m. of consolidated actual Work.

**(4) Brickbat Filling**

Brickbat boulders shall be hard, tough, sound and durable. No brickbat shall be more than 5cm. Boulders shall be laid in their natural bed. Smaller size boulders/pebbles shall be used to fill up gaps between boulder in order to form uniform well-knitted floor structure.

Measurement shall be in cubic meter of actual length, breadth and depth.

**L2 CONCRETE FLOORING**

Plain cement concrete in floors with cement, sand and stone aggregate including mixing, laying finishing to approved level, lines and dimensions, curing including centering, shuttering all complete shall be measured in sq. m. with thickness specified.

The concrete shall be either 1:2:4 mix or 1:4:8 mix or as specified in the drawing.

Cement used shall confine to IS and shall be free from lump or such defects.

Aggregate of 12mm nominal gauge shall be properly gauged. Sieving may be insisted upon in which case the contractor shall provide/ supply necessary sieves and labor at his own cost.

Sand shall be clean inner bed. Grain distribution shall be same as described under 'Plastering'.

All mix shall be by volume except cement, which shall be proportioned by weight and as specified. Mixing shall be done on a watertight platform. Material shall be dry mixed after accurately gauging different materials in wooden boxes. The dry mixture shall be turned over thrice (at least) till the color is uniform and then twice while wet. Water shall be added gradually and no more than necessary to sufficiently wet the materials. Only that much concrete shall be mixed which can be used within half an hour. Each stock of dry mix shall not be larger than consuming one bag of cement.

Before laying the concrete, the surface shall be covered with one layer of building paper running along the room length. Site lap of such paper shall be 150mm or more. Building paper shall be smoothly curved up to upper level of DPC along the floor edge.

Concrete shall be laid in horizontal layers and gently rammed.

After lying, the concrete shall be allowed to harden. Harden concrete shall be kept wet for 15 days

In case of machine mixing IS. code shall be strictly followed and the mixing done under the supervision of the site In-charge.



**L3 FLAG STONE FLOORING**

Floor stone shall be of uniform color free from cracks and other defects. Each of the four edges shall be trimmed to four straight lines with right angle to other edge. The size of the flagstone shall be of uniform in width of 45cm and the variable length not less than 30cm. Thickness of the slab shall not exceed more than 50mm nor be less than 30mm.

Sample of floor stone shall be produced before site In-charge for approval and the contractor shall procure only those stone slabs that clearly and definitely confirm with the approved sample. At any case, the procured slabs shall be exhibited before using as floor slab.

Stone slab shall be laid on 1:4 cement sand bed. Joints shall be kept as thin as possible and shall not exceed 6mm and all the joints are pointed with 1:1 Cement sand mortar.

Laying shall start from one side in the slope as indicated in drawing or instruction. Under no circumstances shall the contractor insert small stone chips underneath the slab to raise its level to desired level. After the slabs of stone are laid, the mortar in the joints shall be raked to a depth of 12.5mm to 20mm. Joints flush pointed with 1:1 cement sand mortar. Special care shall be taken to protect the floor from walking over it before it is completely dry or in any event not earlier than 3 days.

**L4 PLAIN AND COLORED CERAMIC TILES**

Ceramic tile shall be of approved quality and size mm size or as shown in the drawings. Ceramic vitreous tiles, colors as selected by the Engineer, and glazed tile shall conform to the IS 777.

Mortar shall comply with IS 2250-1981; Code of Practice for preparation and use of masonry mortar. The mortar used in work shall have the strength not less than 5 N/mm<sup>2</sup> or 7.5 N/mm<sup>2</sup> at 28 days as specified. However, if provided in the Contract, cement and sand may also be mixed in specified proportions. Cement shall be proportioned only by weight, by taking its unit weight as 1.44 ton per cubic meter and sand shall be proportioned by volume after making due allowance for bulking.

Sand shall comply with Clause C12. Cement shall comply with Clause C13.

The mixing shall be done in a mechanical mixer unless hand-mixing is permitted by the Engineer. If hand-mixing is allowed, the operation shall be carried out on a clear watertight platform. In the required proportion cement and sand shall be first mixed dry to obtain an uniform color. Then required quantity of water shall be added and the mortar shall be mixed to produce workable consistency. The mortar shall be mixed for at least three minutes after addition of water in the case of mechanical mixing. In the case of hand mixing, the mortar shall be hoed back and forth for about 10 minutes after addition of water in order to obtain uniform consistency.

Only that quantity of mortar shall be mixed at a time which can be used completely before it becomes unworkable. Any mortar that has become unworkable due to loss of water before elapsing the initial setting time of cement, shall be rewet to make it workable and shall be used in the works. On no account mortar shall be used after elapsing the initial setting time of cement.

**(1) Installation of Tiles on Walls**

Wall surfaces shall be brushed cleaned and wetted and approximately 12 mm thick level and plumb scratch coat of cement mortar 1:3 applied. The scratch coat shall be moist cured for at least 24 hours before application of floating coat. Before applying floating coat the scratch coat shall be thoroughly wetted. The floating coat, plastic mix of neat cement of approximately 3 mm thickness shall be applied even with screeds to true plane. Floating coat shall be applied over areas no larger than can be covered with tile while the mortar is still plastic (half set). Glazed tile shall be soaked, completely immersed in clean water at least 30 minutes and drained. Individual tile that exhibits drying along edges shall be allowed to remain on the backs of tile at the time of setting.

Tiles shall be installed by applying a skin coat of a plastic mix of neat cement to backs of tile and firmly pressing tile into the floating coat to true plane and position. White cement shall be used for the skin coat where white joints are required.

During the process of setting tiles, continuous horizontal and vertical cuts every 40cm to 60 cm shall be made through the floating coat while plastic, using the point of a trowel turned edge wise, Care shall be taken to prevent cutting into the scratch coat.

Where full size tile cannot be laid, it shall be cut (sawn) to required size and edges rubbed smooth to ensure a true and straight joint.



**(2) Joints in Tile Work**

Joints in tile work shall be accurately aligned with horizontal joints level and vertical joints plumb. Joints shall be maintained uniformly wide by aligning spacer lugs on tile edges if tiles are so manufactured or by use of wetted strings.

**(3) Tile Layout**

Layout tile work so that no tile less than half size occurs, where tile must be cut at edges or penetrations, the cut edges shall be carefully fitted and neatly ground. No chipped, cracked or broken tile shall be used and all defective work shall be replaced and repaired to the satisfaction of the Engineer and at the Contractor's expense.

All tile work finishing shall be adequately protected from damage during the progress of construction and any damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

**(4) Grouting the Tile Joints**

After tiles have been set firm and strings removed, the tiles shall be dampened and joints grouted full with a plastic mix of neat cement by trowel, brush or finger application. Unless otherwise directed, grout shall be white cement. During grouting all excess grout shall be cleaned off the tile surface with damp cloth sponges.

**L5 MARBLE FLOOR**

Marble from Quarries in Nepal or India, shall conform to IS. Marble shall be not less than 18 mm thick and dimensions shall be based on the Drawings with adjustments, depending upon availability of sizes as directed by the Engineer. Samples shall be selected based on color and texture approved by the Engineer.

**L6 TERRAZZO TILES FLOORING:**

The tiles shall conform to IS: 1237 having the color approved by the consultant and the rate shall include provision of border tiles and of different colors in pattern if directed. The mosaic or terrazzo tile shall be of 200\*200\*20mm from Sidecar Tile factory. The mosaic topping of lighter shade tiles shall be made of white cement with an approved shade pigment and neutral shade tiles shall be of gray cement with an approved shade pigment. The type of tiles shall be as specified in respective items of Work.

The sub-grade shall be thoroughly wetted after cleaning of all dirt, laitance and loose material. A bed of white cement mortar consisting of one part of cement and two parts of sand shall be laid and properly leveled to an average thickness of 25mm and the surface shall be kept slightly rough to form a satisfactory key for tiles, neat cement plaster or honey like consistency shall be spread over mortar bed, over such area at a time as would accommodate about 20 tiles. The tiles shall then be fixed with a thin coat of cement plaster on back of each tile and then each tile being gently tapped with a wooden mallet till it is properly bedded and in level with adjoining tiles. Joints shall be fine and as imperceptible as possible.

After tiles have been laid in a room or a day's a fixing work is completed, surplus cement grout that may have come out of the joints may be wiped off gently and joints cleaned. A cement slurry shall be spread over it and rubbed by rubbing machine so as to seal even a thinnest joint between the tiles and make it impervious and finished according to IS: 1443.

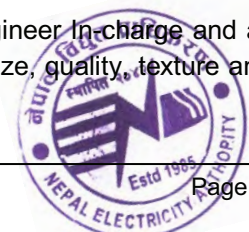
**L7 IN SKIRTING, RISERS ETC**

Stone slabs shall be laid on a backing plaster or cement mortar 1:4 of 15mm to 50mm thick on the plinths protection, stairs risers and tread.

**L8 GLAZED WALL TILING**

Glazed wall tiles shall be of Approved quality in cushion edged eggshell finish approved color tiles with spacer lugs, well soaked in water and bedded with straight joints in cement and sand (1:3) and pointed in white cement and cleaned down on completion to approval.

The contractor shall submit samples of tile for selection and approval by the Engineer In-charge and all tiles delivered to the site shall conform to the approved samples with regard to size, quality, texture and color.



Pressed Cement Wall tiling shall be of local manufacture of a minimum thickness of 20mm and applied as directed for glazed wall tiling including special fittings and cutting.

**L9 NON SLIPPERY TILES IN FLOORING**

Non-Slippery tile from Approved Manufacture conforming to IS: 777 shall be used. They shall be of specified size and thickness. All specials viz. coves, internal and external angles corners, beads etc. shall be used wherever directed. Under layer of specified thickness and mortar of stipulated proportion shall be laid as described in marble mosaic flooring. Tiles shall be washed clean and set in cement grout and each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to surplus cement grout shall be cleaned off.

The joints shall be cleaned off the gray grout with a wire brush or trowel to a depth of 5mm and all dust a loose mortar removed. Joints shall then be kept wet for seven days. After curing, the surfaces shall be washed with mild hydrochloric acid and clean water. The finished floor shall not sound hollow when tapped with a wooden mallet.

**L10 TIMBER FLOORING****(1) Eucalyptus Planks**

The seasoned and aldrin treated Timber Planks of finished size of 450mm x65mm x15mm of Eucalyptus semi hardwood or as directed by the consultant shall be used and laid in approved type of pattern over leveled cement punned surfaces and fixed to the floor with Dendrite glue or water repellent Glue and each tile is screwed to ground with two nos. sheet metal screws and grip. At the edges, of floor the plank should have minimum of 8mm gap for the expansion and contraction. The top surface shall be finished in perfect line and level.

The planks shall be painted with chapra paints as per the specifications and finished with 2 coats of Polyurethane paints as wearing coat. The texture of the floors shall be in mat or as instructed by the Project In-charge.

**(2) Nemo Parquets**

Nemo parquets shall be prepared from seasoned sissoo wood of different pattern made in the tile form. The minimum thickness of parquets is 10mm. These wooden tiles are laid over the dust and grease free cement surface floor. The floor is adequately spread with adhesive and tiles are laid. The joints of one tile to other tile should  $\pm 0.5$ mm. After laying is complete the wooden surfaces are cleaned and machine grinded to smooth surfaces and sand papered.

The chapra polish is carried to obtain natural color of wood. Over these surface two coats of transparent lacquer paints are applied.

**L11 TELIA TILE**

Locally manufactured leveled Telia tile shall be used for the flooring. The size of Telia tile shall be of 150\*150\*25mm laid over the 16mm thick 1:4 Cement sand mortar with 1:1 cement sand mortar and joints should be 2mm and pointed with 1:1 Cement sand mortar.

**L12 POLYTHENE SHEETING**

Underlay sheeting shall be "Visqueen" polythene building sheet 0.25mm thick and lay over sand in floors or as directed by the Engineer In-charge. The overlapping of sheet shall be not less than 25cm.

**L13 PAVING, SKIRTING ETC**

In-situ Granolithic Paving, Skirting, etc. shall be of a total thickness as measured in the Bills of Quantities with topping of one part of cement to two parts of hard stone chippings from as approved local quarry, graded from 10mm to 20mm gauge, free from dust and impurities and washed to give the approved color and finish. The topping shall be at least 10mm thick and on a cement and sand screed (1:4) or backing coat and ground with carborundum to expose the aggregate and polished to approval.



The terrazzo/ mosaic finish shall be laid on an under layer of thickness as specified in the respective items. In addition to the under layer, unless otherwise specified, a cushioning layer of lime mortar of lime concrete with brick bat aggregate of specified proportion shall also be provided to the specified thickness. The topping shall consist of a layer of marble chips of selected sizes, color and design approved by consultant, mixed with cement with desired shade of pigment

For lighter shade mosaic/ terrazzo white cement shall be used and for neutral shade, gray cement shall be used. The proportion of terrazzo mix shall be three parts of cement and one part of marble powder mix, the proportion of marble aggregate by volume shall be 1-1/2 parts unless otherwise specified.

The topping shall be mixed and laid in panels as described in IS: 2114 and as per decorative designs prepared by consultants. The dividing strips for panels shall be aluminum or as specified in the schedule of quantities. It shall be polished as specified in IS: 2114.

**MEASUREMENT**

Measurement of all the works will be made in m of works as specified.

**PAYMENT**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**L14 FLOOR HARDENER**

Approved non-rust abrasion resistant floor hardener/ topping to be laid over the "green" concrete (1:1.5:3) floor using 20mm down well graded coarse aggregate and concrete admixture (conforming to IS: 9103- 1979), after the bleed water has evaporated. The hardener shall be from a ready mix combination of hard aggregates on mineral non-metallic in origin and binder; sprinkled over the green concrete @ 6kg/m and allowed to stand over the green concrete for 10-15 minutes to absorb moisture of the concrete slab. Troweling operation on the surface will be done with hand/ mechanical trowel on the surface will be done to ensure that the hardener/ topping becomes monolithic with the concrete base and the appearance is reasonably smooth. Shrinkage joints on the floor will be maintained by using aluminum/glass strips in both directions as shown on the drawings. The cost of hardener/ topping application shall be included in the unit rate of concrete slab item as mentioned in the schedule of quantities.

**L15 POLYTHENE/ POLYTHENE SHEETS**

Polythene/ Polythene sheet used over the hardcore soling shall be used under the concrete floor base as a damp proof membrane (DPC) over a layer of sand blinding above the hardcore.

Material: Polythene sheet of 10.25mm (1000 gauge) supplied in rolls.

Application: After a blinding of sand had been spread over the hardcore surface, the polythene sheet will be laid over the blinding and lapped 150mm at joints and continued across surrounding walls under dip for full wall thickness. The overlap joint between the sheets shall be sealed with mastic or mastic tape and the joints completed with polythene joining tape.

All protection against damage during, subsequent building operations and in the spreading or laying of spread or concrete is the full responsibility of the contractor.

**L16 MEASUREMENT**

Measurement of all the works will be made in m<sup>2</sup> of works or as specified.

**L17 PAYMENT**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.



**M CEILING WORKS****M1 ACOUSTIC CEILING**

The acoustic ceilings are provided in the class rooms and meeting hall for the reduction of echo.

**(1) Material**

12.5 mm Gypsum board tiles of 610 x 610 mm size conforming to IS 2095: 1982 & 2542-1981. The tiles shall have full square holes in regular pattern. These are to be backed by non-woven lining to absorb unwanted sound.

The suspenders are galvanized mild steel straps of 28G and horizontal and transverse members are galvanized mild steel channel of 16 G. Construction Procedures

**(2) Construction Procedures**

The acoustic ceilings are suspended from the truss and purling by steel hangers to suspend the horizontal steel channels. The horizontal members are screwed with steel screws and grip in the wall. The suspenders are clamped to the truss and purling with steel screws. After the framing is completed the engineer in charge shall check the framing before allowing fixing the ceiling boards.

The ceiling boards free of damages are fixed to the framing in perfect line and level. The joints are sealed with plaster of Paris and non-woven paper tapes with out forming any bubble.

Once laying of ceiling is completed the dust and floors are cleaned for the painting works.

**(3) Measurement**

Measurement of all the works will be made in m<sup>2</sup> of works as specified.

**(4) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**M2 GYPSUM BOARD CEILING**

The Gypsum board ceilings are provided in the office rooms and meeting hall. These boards are in various design and texture.

**(1) Material**

9.5 mm Gypsum board tiles of 610 x 610 mm size conforming to IS 2095: 1982 & 2542-1981.

The tiles shall have texture and design pattern.

The suspenders are galvanized mild steel straps of 28G and horizontal and transverse members are galvanized mild steel channel of 16 G. Construction Procedures

**(2) Construction Procedures**

The board ceilings are suspended from the concrete ceilings, and or truss and purling by steel hangers to suspend the horizontal steel channels. The horizontal members are screwed with steel screws and grip in the wall. The suspenders are clamped to the truss and purling with steel screws. After the framing is completed the engineer in charge shall check the framing before allowing fixing the ceiling boards.

The ceiling boards free of damages are fixed to the framing in perfect line and level. The joints are sealed with plaster of Paris and non-woven paper tapes with out forming any bubble.

Once laying of ceiling is completed the dust and floors are cleaned for the painting works.

**(3) Measurement**

Measurement of all the works will be made in m<sup>2</sup> of works as specified.

**(4) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.



**M3 MARINE BOARD CEILING**

The marine boards of 16mm are laid over the purling of slope roof where no ceiling will be required.

**(1) Material**

The marine waterproof boards of 16mm thickness are used for the roof ceiling in slope. These boards can be of size 210x120cm or of any size available in market. It should conform to Indian standard.

**(2) Construction Procedures**

The board ceiling are laid over truss and purling with U-hooks. U-hooks are of 8mm Galvanized mild steel. All the nuts and bolts are tightened with limpet washers and bitumen washers. In order to achieve water tightness luster of silicon is placed over the nut and bolt. The board joints are sealed with silicon.

Once laying of ceiling is completed the dust and floors are cleaned for the painting works.

**(3) Measurement**

Measurement of all the works will be made in m<sup>2</sup> of works as specified.

**(4) Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ.

The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.

**(5) Testing**

The marine board samples shall be soaked in hot water for 24 hours. The sample should not bulge and separation of marine sheet shall not occur.



**N PLASTER OF PARIS/ BIRLA PUTTY WORK**

1. This section covers finishing of the ceiling wall surface ready for painting in general and applying two or more coats of Birla Putty or equivalent material in the cement plaster surface in particular.
2. Surface preparation: The Surface of the plaster to be racked/ made rough to receive such layer of finishing.
3. Preparation: Adequate water to be mixed with the powder to form a paste of workable consistency.
4. Application: The first layer is applied to hide all voids and uneven surface of the plaster area or corners are made sharp and true right angle of the entire ceiling and wall surface. The 2<sup>nd</sup> layer then applied over the first layer, to make the entire surface truly smooth and even from all direction. All loose material and scales shall be sanded properly.
5. The are shall be measured nett in surface area.
6. The rate shall cover all material, labour and scaffolding etc. complete.



**O STRUCTURAL STEEL WORK****O1 GENERAL****(1) Scope**

This Section covers fabrication, storage, handling and erection of steel structures excluding those covered by Sections O.

**(2) Codes of Practice**

The fabrication, storage, handling and erection of structural steelworks shall comply with the relevant Sections of the IS and IRC, if otherwise not specified in the contract.

Should there be any disagreement between IS and IRC, the provision in the IRC shall prevail to the extent of the disagreement.

**O2 MATERIALS**

(1) Materials for use in connection with the protection of the steel work against corrosion are specified. Other materials used in connection with steel structures such as concrete, bearing pads, etc., shall be governed by the appropriate Sections of these Specifications. Unless otherwise specified or described in the contract, structural steel materials shall comply with the appropriate standards listed below.

IRC 24-1967 : Standard Specifications and Code of Practice for Road Bridges.

IS 2062-1992 : Steel for General Structural Purposes

IS 9550-1980 : Specification for Bright bars.

IS 3757-1985 : Specification for High Strength Structural Bolts.

IS 6623-1985 : Specification for High Strength Structural Nuts.

IS 6649-1985 : Specification for Hardened and Tempered Washers for High Strength Structural Bolts and Nuts.

**O3 FABRICATION : GENERAL REQUIREMENTS****(1) General**

This Clause shall apply to all operations undertaken in the fabrication in the workshop or elsewhere whether on or off the site. The requirements contained herein shall not be waived, nor shall be modified to conform to any set of rules that any shop adopted as its standard unless so authorized in writing by the Engineer.

Substitution of structural Sections of different dimensions, weight or strength from those specified in the contract may be made only when approved in writing by the Engineer. No payment shall be made for increased weight or strength/properties resulting from approved substitution, but any decrease in weight shall be deducted from the final pay quantity.

The various components/elements of the steel structure shall be fabricated in accordance with the approved shop Drawing. Any errors or omissions in them shall be reported to the Engineer, and his decision for their correction shall be final.

**(2) Shop Detail Drawing**

The Contractor shall furnish shop detail Drawing for the complete fabrication of all components/elements required by the contract. When it is specified in the contract that the employer shall furnish prints of standard shop detail Drawing, the Contractor shall be required to make any additions or revisions to the detail Drawing as may be necessary to produce a finished structure in accordance with the contract. Shop detail Drawing shall consist of detailed Drawing showing the dimensions and sizes of the components/elements, bolt lists for field erection, a match marking diagram, complete field erection Drawing and such other details and information as may be necessary for fabrication.

Shop detail Drawing of widening or reconstruction work shall contain sufficient field dimensions, so that the shop Drawing may be checked. The Drawing shall also contain a note to the effect that these are field measurements which the Contractor has furnished and for which he is responsible. Such detail Drawing shall also show a portion of the existing work, using light dotted lines or colored ink for this purpose.

Shop detail Drawing shall be prepared in a neat and legible form, on the dull side of tracing cloth, with India ink, or by other methods approved by the Engineer. Each sheet shall have a title in the lower right hand corner giving the fabricator's name, the fabricator's contract number and brief description of the details shown on the sheet.

Bills of material and bolt lists may be furnished on the fabricator's own standard sheets.

The Contractor shall submit blueprints of shop Drawing to the Engineer for approval. No work shall be done in the shop until such Drawing has been finally approved. In general, 2 sets of preliminary prints shall be required, but the Contractor shall furnish additional prints free of charge upon request. Only checked Drawing in complete sets shall be submitted for approval. The details of anchorages, bearing plates, castings, etc., shall be submitted in advance, in order to avoid delay in construction.

When changes on the submitted Drawing are requested by the Engineer, or when the Contractor makes additional changes, other than those requested, attention shall be called to the changes on the blueprints submitted for approval by encircling or underscoring all change with contrasting colored ink or rayon.

After the Drawing has been finally approved, the Contractor shall, without direct compensation thereof, furnish to the Engineer 4 sets of prints of the corrected Drawing, and such additional prints as may be required. The shop Drawing as approved by the Engineer shall become a part of the contract.

The ordering of material or the performance of shop work prior to the Engineer's approval of shop Drawing shall be at the Contractor's risk and cost. No changes shall be made in any approved Drawing without the written authorization of the Engineer. The Engineer's approval of shop Drawing shall not relieve the Contractor of responsibility for the accurate assembly and fitting of all structural members. After the shop work has been completed, the Contractor shall deliver to the Engineer all of the original tracings of the shop details, or photo positives thereof, on cloth.

**(3) General Shop Practice**

**(a) Storage**

Before and after fabrication, all materials shall be so stored that they are not deformed or damaged, and shall be protected against the accumulation of water, dirt, oil or other foreign matter. Material that has become pitted from exposure or other causes shall not be acceptable for any use. Material that has been damaged during storage shall be replaced with equivalent or better material.

**(b) Identification**

Structural alloy steel shapes and Sections shall, in addition to standard mill practice identification, be further identified during all operations, from the mill to the completely fabricated structure, by the use of, and continued maintenance of, color coding in accordance with IS 2049.

Alloy steel and non-ferrous alloy bolts shall be identified by coded markings embossed or impressed on the head or tip during manufacture. Pieces on which identification has been lost shall be rejected.

**(c) Workmanship and finish**

All metals shall be neatly and accurately cut to required size with proper allowance as may be necessary or required for finishing operations.

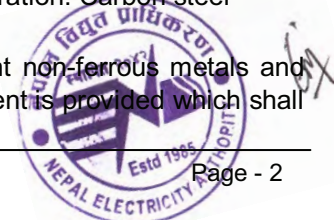
All fins, ragged or distorted edges resulting from shearing, speed sawing, or flame cutting shall be removed by milling, chipping, or grinding.

Shearing shall not be used for the purpose of cutting non-ferrous metals where the thickness is greater than 13mm.

**(d) Flame cutting**

The gas cutting torch may be employed in the operation of cutting metals or preparing joints provided that the metal is not carrying stress during the operation. Carbon steel

above 0.30 carbon alloy steels, heat treated steel or aluminum, wrought non-ferrous metals and plated metals shall not be flame cut unless subsequent corrective treatment is provided which shall



be subject to the approval of the Engineer.

When the cutting torch is used, the burned edges shall be trimmed smooth to exact lines by milling, chipping or grinding. Maximum deviation for "free hand" cutting shall be 1.5mm from true lines. A mechanical guide shall be used for the flame cutting torch on all work requiring precision cutting on which the maximum deviation permitted shall not be greater than 0.8mm. All "notch effects" shall be completely removed from the portions of members where the extreme fiber is subject to flexure, tension or perpendicular shear.

Where the ends of members which are to take bearing, are cut with a torch, a suitable allowance in their length shall be made to permit proper milling or planing.

Joints for welding may be prepared by "flame cutting" or "flame gouging" provided all slag and oxidized metal are removed.

**(e) Re-entrants**

Interior and re-entrant corners shall be filleted to a 25 mm radius unless a shorter radius is indicated in the plan. Fillets less than 25 mm in radius shall be formed by drilling.

**(f) Bending**

All bending or crimping shall be done at the bend lines shown, by a mechanical operated press, without unnecessary loss of Section in the metal being bent. The bends shall conform to wood or metal templates. All low carbon steel and other wrought metals shall be bent cold when the required bending will not produce cracks or fractures. When heating is necessary to accomplish bending of ferrous metals, the material shall be carefully heated to and bent at or above a temperature evidenced by a dark red color,

but in no case at a lower temperature. All material bent below such temperature shall be rejected and annealing shall not be considered a corrective measure. Heated material shall be slowly cooled after the bending operation. Heat treated metals shall be shaped before heat treatment. Material having fractures or other defects caused by bending shall be rejected.

Cold-bent load-carrying rolled steel plates shall conform the following:

(i) They shall be so taken from the stock plates that the bent-line is at right angles to the direction of rolling.

(ii) The radius of bends, measured to the concave face of the metal shall be more than specified below.

Angle through which plate is bent	Radius
61° to 90°	1.0 T
91° to 120°	1.5 T
121° to 150°	2.0 T

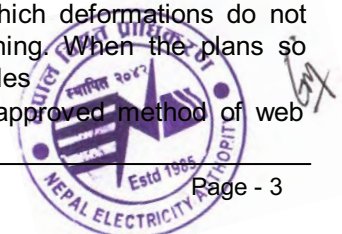
Where T is the thickness of the plate undergoing bend.

(iii) Before bending, the corners of the plate shall be rounded to a radius of 1.5 mm throughout that portion of the plate at which the bending is to occur. If a shorter radius is essential, the plates shall be bent hot.

**(g) Straightening Material**

All wrought and extruded Sections must be made straight or cambered as shown in the plan before being marked, punched or otherwise worked on in the shop. If straightening is necessary, it shall be done by methods which will not change the physical properties, reduce the Section, or otherwise damage the metal. Material which develops kinks, fractures or evidence of embrittlement shall be rejected. Materials that are warped by cutting, punching or welding shall be straightened to correct lines and dimensions before being assembled. Sections that are distorted during assembly and/or welding shall be straightened by methods that will not shear, fracture, or pre-stress the welds or connecting members. If, in the opinion of the Engineer, Sections can not be properly straightened after assembly, the bent material shall be taken out, straightened and reassembled in the unit. Any material damaged during such operations shall be replaced with equivalent or better material.

Unless otherwise specified in the contract, structural steel Sections which deformations do not exceed normal rolling tolerances will be acceptable without straightening. When the plans so indicate, beams shall have unwrapped webs with flanges at true right angles thereto. Such beams shall, if necessary, be straightened cold by an approved method of web



pressing.

**(h) Layouts and Templates**

Full scale layouts will be required for intricate portions of structures that present problems of fabrication or erection. When requested by the Engineer, such layouts shall be made available to him for checking purposes. Duplicate work shall be fabricated with the aid of templates or jigs. Wood or metal templates shall be used for all miter joints except when an approved jig is used. Reaming or drilling templates shall be made of metal, using hardened steel bushings 25 mm thick. Sweeps for laying out and checking curved surfaces shall be made of wood or metal and shall be of sufficient length to produce accurate results.

Working points and working lines shall be clearly marked on all templates and sweeps. All templates shall be made available for the Engineer's use.

**(i) Built-up Members**

A built-up member shall be true to detailed dimensions and it shall be free of twists, bends, open joints, or other defects resulting from faulty fabrication or workmanship. The assembly shall be such that all field joints will have the planned clearance. The joints shall be smooth, and free from all burrs or other obstructions.

Closed Sections or pockets which might harbor moisture or dust and which cannot be readily cleaned and painted shall be filled with plates or closed by caulking or welding. Filler plates shall be full size and fitted sufficiently tight to exclude all moisture and dust after being painted. Tack welding may be employed to hold fillers in place.

**(j) Incidental Items**

The following items shall be furnished by the Contractor without additional payment unless otherwise provided for in the contract:

**(i) Pilot Points and Driving Nuts:**

One new pilot point and one driving nut for each size of shouldered pin.

**(ii) Erection Pins, Bolts and Washers:**

All erection pins, bolts and washers necessary for field erection.

**(iii) Field Rivets:**

Extra rivets of each size and length, in the amount of 10 rivets plus 10 per cent of the number actually required for field erection, to compensate for losses due to misuse, improper driving or other contingencies.

**(iv) Field Shims:**

Shims 3 mm or more in thickness shall be made of structural steel and those thinner than 3 mm shall be made of sheet brass.

"Field shims" shall be constructed to mean all metal plates which are required, because of inequalities or inaccuracies in fabrication or erection or because of the substitution of Sections by the fabricator, to bring metal surfaces of members into contact or to bring the structure to the required grade and alignment. "Fillers" shall be constructed to mean metal plates which are required by the design to bring metal surfaces of members into contact or to bring the structure to the required grade and alignment, and shall be included in the quantities for which payment shall be made.

**(v) Sections:**

Increase of Sections over net size required in the contract, and other Sections, metals, parts, or equipment added for the purpose of erection only which may or may not subsequently remain a part of the finished structure.

**(4) Machining**

**(a) Definition of Terms**

**(i) Rough Finish:**

The surface shall be true but may show very slight grooves.

**(ii) Finish:**

The surface shall be true and smooth and shall show no visual evidence of grooves.



## (iii) Smooth Finish:

The surface shall be true and perfectly smooth to the touch.

## (iv) Polished Finish:

The surface shall be true, smooth and polished.

## (v) Milled Finish:

The surface shall be the same as the defined for rough finish.

## (vi) Bored Finish:

The surface shall be the same as that defined for smooth finish.

**(b) Machine Lubricant**

Soap water solution shall be used as a lubricant on all structural material requiring machine work. The use of oil or grease shall not be permitted for this purpose. Cutting oil shall be used on machinery parts and bolt stock.

**(c) Edge Planning**

Structural steel plates with sheared edges having a thickness of more than 16 mm and structural alloy plates having a thickness of 13mm or more, except web plates for built-up girders, sole or base plates, and fillers, shall be planed to correct size with square edges by removing not less than 6 mm of metal. The use of mechanically guided needle torch may be permitted in lieu of specified edge planning of expansion plates when used for the purpose of making bevel cuts.

**(d) Bearing Surfaces**

After a column has been otherwise completely welded and before the cap or base plates are attached, the bearing surfaces shall be milled true to the angle shown in the plan. End connection angles shall be welded to the main member before milling.

Cap and base plates of columns shall have full contact with the milled surface after assembly. Sole plates of beams and girders shall have full contact with the flanges. Warped or deformed plates shall be machine finished or otherwise straightened by an approved method to secure an accurate and uniform contact. Countersunk rivet heads or extruding weld metal shall be chipped smooth and flush with the surrounding surface.

Castings shall be machined as indicated in the plan. Bronze bearing plates shall have a "Polished Finish".

**(e) Abutting Joints**

The ends of members shall not be milled until such members have been completely welded. Members whose ends are improperly milled shall be rejected.

The ends of members forming a compression joint or splice shall be accurately milled to proper length, alignment and bearing, using a wood or steel template as a guide. Gusset plates connecting milled ends of members shall conform to the same wood or metal templates from which the milled ends were formed. The use of bevel square shall not be permitted.

Joints in main chord tension members shall be close and neat, and in no case shall the opening be more than 3 mm.

**(f) Boring Pin Holes**

Pin holes shall be accurately located as detailed, and bored true to exact dimensions. They shall be bored smooth, straight, and at right angles to the axis of member. A finishing cut, which shall be a complete and separate operation, will be required.

Unless otherwise indicated in the plans, the difference in diameters of the pins and the pin holes shall be 0.8 mm exact.

**(g) Pins and Rollers**

Pins and rollers shall be accurately turned to the detailed dimensions. The final surface shall be smooth, straight, and free from flaws. The final surface shall be machined to a smooth finish.

All bridge pins and rollers 150mm in diameter and smaller shall be made of Bright steel



bars complying with IS 9550.

All segmental rollers and all pins whose nominal diameter is to be greater than 150mm shall be made from annealed forging.

A hole 50mm in diameter shall be bored longitudinally through the centre of each pin or roller having a diameter greater than 230mm. Pins or rollers showing defective interiors shall be rejected.

Pins shall be held in place by recessed nuts. The nuts shall be hexagonal in shape and shall be made of malleable iron, pressed or cast steel. The grip face of the nut shall be machined square to the axis of the pin. Pins and nuts shall be accurately made so that the recessed face of the nut will bear uniformly against the end face of the pin when the nut is turned up tight. The threaded portion of the pin shall project at least 6mm through the nut after assembly. Where a recessed cut is made between the threads and the shoulder of the pin, it shall not be wider than 6 mm nor deeper than the base of the thread.

**(5) Marking and Dispatching**

All material shall be accurately and legibly marked according to the field erection plan, prior to dispatch. Such markings shall be made with contrasting paint on previously painted surfaces. The omission of marks on duplicate pieces shall not be permitted unless otherwise authorized by the Engineer.

When practicable, loose connection plates for a member shall be bolted in position thereon for shipment. All rivets, bolts, nuts and washers shall be parceled separately as to size. They shall be shipped in suitable containers, but the gross weight of any single container shall not exceed 100 kg. A list and description of the included material shall be plainly marked on the outside of each container.

Pins, roller nuts, name plates, sheet lead, and small parts shall be boxed or crated for shipment. Pins shall be shipped with the nuts in place.

When the Engineer directs, finished work shall be weighed in the presence of the Inspector. The fabricator shall supply satisfactory scales and shall do the handling and weighing. When requested by the Engineer, members weighing more than 300 kg shall be marked to show their scale weight.

The loading, unloading, handling, transportation and storing of structural material shall be carefully conducted so that the metal will be kept clean and free from damage. All girders, partly assembled trusses, and large I beams shall be transported in an upright position. Cambered members shall be securely blocked to prevent any loss of camber. All sheets and copper waterstops shall be crated for transport.

Anchor bolts, pier nose angles, and other anchorage or grillage materials shall be dispatched in advance of other material to suit the requirements of the construction work.

**(6) Shop Painting**

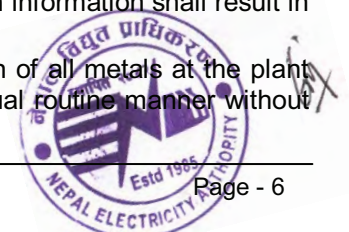
All ferrous metals which have not been plated, galvanized or enameled shall be given one shop coat of paint of the kind specified in the contract. Non-ferrous metals shall not be painted or otherwise surface treated unless so specified in the contract. All cleaning and painting shall conform to Clause O9.

**(7) Inspection and Testing**

**(a) General Requirements**

The Contractor shall advise the Engineer as to the actual date and place of preparation of materials so that sufficient time may be had, prior to such preparation, to arrange for inspection. This inspection will be dependent upon the character and importance of the work and may involve inspection in the mill, the foundry, the fabricating shop and the field, as may be considered necessary by the Engineer. Information relative to the time of beginning various operations, such as mill rolling, foundry casting, heat treating, shop layout, punching, riveting, welding, milling, assembling, painting and shipping, shall be furnished to the Engineer in sufficient time so that he may provide for the proper supervision and inspection of the work. In general 28 days shall be considered as the required time of advance notice. Failure to furnish such information shall result in the rejection of the material involved.

The Employer may depute structural-metals-inspectors for the inspection of all metals at the plant or in the field. When such inspection service can be furnished in the usual routine manner, without



any additional expenditures, no charge shall be made against the Contractor. When such inspection service entails additional costs, the Contractor shall be charged for the expense incurred but such charges shall not be greater than the amount specified in the contract per person per ton, based on the total metal tonnage of the contract.

As soon as the progress of the work permits, the Contractor shall furnish to the Engineer 2 copies, or more, if required, of each of the following:

Mill or purchase orders, certified reports of physical characteristics and chemical analysis of all materials involved, and the fabricator's shipping statements showing the net scale weight of each shipment. When requested, the scale weights of individual member or Sections shall be furnished.

All materials and workmanship shall be subject to inspection and Engineer's agreement. The inspection of materials and fabrication shall as far as possible be carried out at the place of manufacture.

Except as provided for above no fabricated steelwork shall be dispatched to the Site before it has been inspected and agreed. All inspected and agreed steelwork shall be marked in accordance with the agreed procedures.

**(b) Inspector's Authority**

The Inspector shall reject the materials and/or the workmanship which do not fulfill the requirements of the contract. However, in cases of dispute, the Contractor may appeal to the Engineer, whose decision shall be the final.

Inspection at the mill and shop is provided for the purpose of facilitating fabrication work and to avoid errors, but such inspection shall not relieve the Contractor of his responsibility for the correction of errors and faulty workmanship or for the replacement of imperfect materials.

**(c) Facilities for Inspection**

The Contractor shall furnish all facilities, tools, and such assistance as the Inspector may require for the inspection of material and workmanship in the mill, foundry or shop. The inspector shall be granted free access to the plant premises for the required inspection service. All fabricated parts shall be piled separately in such a manner as to facilitate inspection.

The Contractor shall furnish office space at the fabrication plant for the Inspector's use during the period of fabrication, assembly and paintings.

**(d) Testing**

Unless otherwise provided, the Contractor shall furnish test specimens as specified, and all labor, testing machines and tools necessary to prepare the specimens and to make the prescribed tests. Where check tests are required by the Engineer to determine the suitability of any materials, the Contractor shall furnish representative samples for further testing by the Engineer before such material is finally approved for use.

Where no specific tests are provided for in the contract, tests for metals shall be conducted in accordance with the Engineer's directions.

**(e) Rejection**

Rejected materials and workmanship shall be promptly replaced with satisfactory material and workmanship. Any shipment of materials that has been damaged in transit shall not be unloaded until an agreement as to its disposition has been reached with the Engineer.

**O4 FABRICATION OF BOLTED STRUCTURES**

**(1) End Connection Angles**

End connection angles of floor beams, stringers and diaphragms shall be accurately assembled to the dimensions shown in the plan, and the length, back to back of angles, shall be exact. Unless otherwise specified, the finishing of end connection angles shall not be required except as a correction to a faulty assembly. When finishing is necessary for such correction, the thickness of the angle shall not be reduced by more than 3mm but in no case shall the final thickness of the angle be less than 9 mm. Portions of members extending beyond the face of the connection angles shall be chipped or ground flush. No portion of a web or a connecting member shall be recessed

more than 9mm from the face of the connection angles.

**(2) Stringers**

Stringers shall be straight and their bearing surfaces shall be true, and free from all burrs and distorted edges.

The fixed ends of stringers supported on brackets or on the top flanges of floor beams shall be secured by means of bolts having hexagonal heads and nuts.

The maximum clearance between abutting ends of stringers shall be 13mm unless otherwise specified. Stringers supported on brackets shall have a maximum clearance of 13mm between the end of the stringer and the web of the floor beam.

**(3) Expansion Devices**

Expansion and deflection devices shall be fabricated to exact dimensions, and no tolerance in materials or dimensions shall be allowed. Unless otherwise indicated in the plan these devices shall be secured to stringers or floor beam by means of bolts having hexagonal heads, hexagonal nuts and lock washers.

**(4) Bolted Plate Girders**

The web plate of a finished girder shall in no case project beyond the face of the flange angles or end stiffener angles. In girders with full-length cover plates, the edges of the web shall not be more than 6 mm inside the face of the flange angles except that, in cases of cambered beams, the width of the web may be 13 mm less than the distance (back to back) between the flange angles provided the web is centered. In girders without cover plates, the edges of the web shall not be more than 3 mm below the face of the top flange angles. In girders with partial length cover plates, the above requirements shall apply together with the additional requirement that, unless the edges of the webs are flush with the faces of the flange angles at the ends of the cover plates, any space between them shall be plugged with a weld at least 13 mm long. In no case shall the ends of the webs be more than 9 mm inside the face of the end stiffener angles.

Holes in all girder web splices shall be subpunched or subdrilled. After assembly these holes shall be reamed to specified size.

Splicing of flange angles shall not be permitted, unless required by the contract, except when girders are to be constructed with curved ends, in which case the flange angles shall be spliced near the curved portion to facilitate bending and assembly. Curved and flange angles shall be bent in pairs. After bending, the curved angles shall be true to the plan radius and free of all wrinkles or waves. After assembly, these curved end angles shall be butt welded to the flange angles, and the weld shall then be ground smooth.

When splices in flange angles are required by the contract, the abutting ends of the angles shall be milled to a close fit. All holes in such splices shall be subpunched and reamed, or drilled from the solid. Smoothly ground butt welds will be acceptable for joints in flange angles in lieu of milling. Such welds shall not be considered as a substitute for the splice plates or angles as detailed.

Unless otherwise indicated in the plan, end stiffeners and intermediate stiffeners intended for supports for concentrated loads shall be milled or ground smooth to secure a uniform, even bearing against the top and bottom flange angles. When welding is indicated or permitted in lieu of milling or grinding, the welds shall be of sufficient size to develop fully the stiffener in bearing and they shall be so placed as to completely seal the stiffener ends against entrapment of moisture. Welding transversely across the tension flanges of beams or girders which have a flange stress of more than 75 per cent of their designed capacity, shall not be permitted. At locations of higher stress, wedge fillers shall be incorporated in conjunction with longitudinal welds.

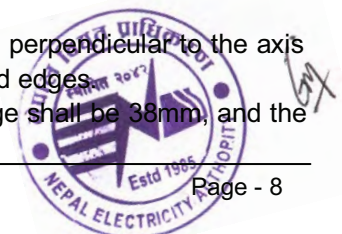
Intermediate stiffeners shall fit sufficiently tight to exclude moisture after being painted. Fillers under stiffeners shall fit within 1.5mm at each end. Crimped stiffeners angles or tees shall be properly bent to a steel template, and they shall have full contact bearing against the flange and the web plates.

**(5) Holes for Unfinished Bolts**

**(a) General**

All holes shall be true to the shape and size specified, clean-cut, perpendicular to the axis of the member and free from all burrs and distorted, torn or ragged edges.

The minimum distance from the centre of a hole to a sheared edge shall be 38mm, and the



minimum distance to a planed or rolled edge shall be 1.5 times the diameter of the bolt specified for such hole, except as hereinafter provided or otherwise indicated in the plan. The edge distance for lace bars shall be not less than 1.6 times the diameter of the rivet or bolt.

**(b) Type**

When reaming or drilling is not specified in the contract, full size punched holes in low carbon and low alloy steels may be acceptable, provided the thickness of the metal does not exceed the diameter of the hole to be punched, and provided no more than 5 thickness of metal are to be connected. When there are more than 5 thicknesses of metal or when any of the material is thicker than the diameter of the hole, all of the holes in the material composing such connections shall be formed by subpunching (or subdrilling) and reaming or by drilling from the solid, as hereinafter specified. Stress-carrying high-carbon steels, non-ferrous metals and alloys 13mm in thickness or less shall be subpunched (or subdrilled) and reamed. Where such metals are of greater thickness the holes shall be drilled from the solid with all parts assembled. Railing Sections may be jig drilled full size.

When general reaming is specified in the contract for low carbon and low alloy steels, all bolt holes, including connection holes to main members, shall be subpunched (or subdrilled) and reamed, or drilled from the solid; except for the following, which may be full punched:

Holes for unfinished bolts, or plug welds.

- Holes in expansion and deflection devices, stringer diaphragms and railings.
- Holes in laterals and lateral plates; away frames other than in towers or bents; brackets; sole, bearing or anchor plates; and grillages.

**(c) Punched Holes**

The diameter of full-sized punched holes shall be 1.5mm larger than the nominal diameter of the rivet or bolt. The diameter of the die shall not exceed the diameter of the punch by more than 1.5mm.

All holes shall be so accurately punched that, after the assembly of the component parts of a member, and before any reaming is done, a cylindrical pin whose diameter is 3mm less than the nominal diameter of the punched hole shall pass freely through at least 75 per cent of the holes in any group. Correspondingly, a pin whose diameter is 5mm less than the nominal diameter of the punched holes shall pass freely through all holes in any group. Material failing to meet either of the above requirements shall be rejected. Reaming shall not be permitted as a corrective measure.

**(6) Holes for Turned Bolts**

The diameter of holes for turned bolts shall be 0.4 mm larger than the diameter of the bolt. If the bolts are to be inserted in the shop, the holes may be either drilled from the solid, or subpunched and reamed. If the bolts are to be inserted in the field, the holes shall be subpunched or subdrilled in the shop and reamed in the field. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled and securely fastened together. No offsets shall be permitted in holes for turned bolts.

**(7) Slotted Holes**

Slotted holes shall be securely located, true to planned dimensions. Where full size slot punches are not used for this purpose, the holes shall be made under size and subsequently finished to true size and shape by chipping grinding or filing.

**(8) Bolts**

**(a) Unfinished Bolts**

Unless otherwise specified, all bolts for steel construction shall be unfinished and shall have hexagonal heads, hexagonal nuts and lock washers. The length of the bolt shall be such that, after placement, it will project through the nut not less than 3mm nor more than 9mm. The material for and the manufacture of bolts shall conform to the equipments of IS 1364 or IS 3757 as appropriate.

**(b) Turned Bolts**



The heads and the nuts shall be hexagonal. The bolt shall be machined from a hexagonal bar, the size of which shall be the same as the bolt head. The shank of the bolt shall be turned and given a smooth finish to exact diameter. The length of the unthreaded portion of the bolt under the head shall be 3mm greater than the thickness of material it is to pass through. The diameter of the unthreaded portion of the bolt shall have a diameter at least 2.4 mm less than the diameter of the unthreaded portion of the bolt, and it shall be the nearest standard bolt size. The threads shall extend from the end of the bolt to within 1 thread distance from the shoulder. Washers 6mm in thickness shall be used under all nuts, and the hole in the washer shall be the same size as the reamed or drilled hole.

(c) **Anchor Bolts**

Anchor bolts shall be of the swage type and shall have hexagonal nuts. Bolts for expansion joints shall be provided with 2 nuts. Those portions of bolts which extend above masonry or concrete shall be painted 1 shop coat of paint.

(d) **High Strength Friction Grip Bolts**

High Strength friction grip bolts shall comply with IS 3757.

All load indicators shall be suitably marked for identification purposes and shall be of standard black, lightly oiled, finish and shall be packed prior to dispatch, by the manufacturer, in waterproof containers and shall be stored in those containers under cover until required for use in the works.

Only general grade load indicators shall be used with general grade high strength friction grip bolts.

Each high strength friction grip bolt when installed in the works shall be complete with one washer placed under the nut and one load indicator placed under the bolt head and each bolt shall be tightened at all stages by rotating the nut only, the bolt head being completely restrained against rotational movement.

Alternatively, in joints where accessibility is limited to the extent that bolts must be tightened by rotating the bolt heads, then washers shall be laced under the bolt heads and both load indicators and nut face washer shall be placed under the nuts. In these cases each bolt shall be tightened at all stages by rotating the bolt head only, the nut being completely restrained against rotational movement.

All high strength friction grip bolts shall first be tightened sufficiently to secure the structural steelwork during its erection or assembly. Following the completion of the erection or assembly of each portion of the structural steelwork those bolts shall be finally tightened until the gaps between the load indicators and either the bolt heads or the nut face washers have been reduced to:

- (i) 0.400mm where load indicators are fitted under the bolt heads.
- (ii) 0.250 mm where load indicators are fitted under the nuts and beneath nut face washers.

The bolts may be tightened by a part-torque part-turn method. The part-torque tightening for bedding down shall be in accordance with BS 4604: Part 1 except that it shall be carried out by a calibrated tightening device such as a torque-controlled manual wrench or power operated wrench. The bedding torque to be applied to the bolts shall be as given in Table O-1.

**TABLE O-1: PRELIMINARY TIGHTENING OF NUTS**

Nominal dia of bolt mm	Bedding torque $\pm$ 10 percent Nm
16	80
20	160
22	210
24	270
27	340
30	460

After bedding down of the joints, each nut and the protruding threads of the bolt shall be permanently marked to record their relative positions. The nuts shall then be tightened to the approval of the Engineer by the part-turn of the nut method in accordance with BS 4604: Part 1.

**O5 CASTINGS AND HEAT TREATMENT****(1) Foundry Practice**

Patterns for casting shall be furnished by the Contractor. They shall be constructed to produce a finished casting in true conformity to the dimensions and details shown in the plan. All sharp angles shall be boldly filleted. Fillets shall be of such size that there is no reduction in planned clearances due to their addition. External corners on all castings, except ornamental type, shall be rounded to a 5 mm radius. Proper allowance for shrinkage shall be made in all patterns. Sufficient materials shall be provided on all surfaces which are to receive a finish so that, after finishing, the castings will be the planned size, and the finished surfaces will be true, free from pockets, sand intrusions, or other defects. Draft provided shall allow the plan dimensions and shall not reduce the thickness of metal specified. All patterns shall be painted, indicating in different colors, the metal, cores and finished surfaces.

Split cores shall not be permitted between unfinished surfaces of restricted clearance. The number and spacing of chaplets shall be such that the strength of the casting is not impaired by their use.

The casting shall be accomplished by a method that will ensure the complete filling of all corners, arises and edges. Castings requiring undercut surfaces shall be cast by the "lost wax process" or equivalent. Where practicable, castings having one machined surface shall be cast with the surface down. Metal from different melts shall not be permitted in the same casting.

Castings shall not be withdrawn from the mould until they have properly cooled. Quenching of casting to speed up the cooling shall not be permitted.

All castings shall be thoroughly cleaned of molding and core sand by sand blasting or by other approved methods. All high spots and rough edges resulting from pouring connections shall be ground smooth.

All castings shall ring true when suspended and struck with a hammer. When ordered by the Engineer, the soundness of the casting shall be further tested by drilling, planing, magnetic particle test or X-ray.

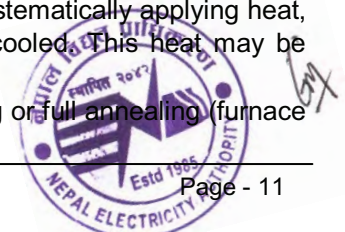
Any structural defect in a casting such as blow holes, pipes, sand holes, cracks, checks, slag inclusions, cold shuts, unfilled arises, warped surfaces, or deformation from core or flask movement shall be cause for rejection.

Castings with minor defects shall not be repaired until the Engineer has given his permission. The method employed in such repair work shall be approved by the Engineer.

**(2) Heat Treatment**

The term "heat treatment" shall mean any method of intentionally and systematically applying heat, at a temperature below the melting point, to any casting after it has cooled. This heat may be applied one or more times irrespective of cooling the procedure.

The term "annealing" shall mean either normalizing (air cooling) a casting or full annealing (furnace



cooling) a casting.

Full annealing shall consist of a heat treatment in which the casting is heated slowly to the proper temperature above the critical range, maintained in such temperature for the required time, and allowed to cool slowly in the furnace until the temperature has fallen to 260 degrees F or less. The casting may then be withdrawn from the furnace and air cooled. The furnace temperature shall be controlled by pyrometers.

All other castings shall be annealed when so specified in the contract.

All forgings, and such other steel Sections as may be required by the contract, shall be full annealed. Other steel members, except primed web stiffeners, that have been partially-heated shall be full annealed unless otherwise authorized by the Engineer.

## **O6 WELDED CONSTRUCTION**

### **(1) General**

Welding shall be generally in accordance with IS 1024 and relevant British Standards as further amplified in the following Sub-clauses.

### **(2) Materials**

Welding materials unless specified in the contract or agreed by the Engineer shall comply with the appropriate Indian Standard listed below:

- (a) IS 814 -1991 covered electrodes for manual metal arc welding of carbon and carbon manganese steel (fifth revision).
- (b) IS 1278-1972 filler rods and wires for gas welding (second revision) Classification and color coding of electrodes shall be in accordance with IS 814-1991.

### **(3) Welding Equipment**

Welding equipment shall comply with the appropriate Indian Standard listed below unless otherwise stipulated in the contract or agreed by the Engineer.

- IS 2635 -1975: DC electric welding generators (second revision).
- IS 4804 (Part 1) -1968: Single-phase transformers.
- IS 4804 (Part 2) -1968: Single-phase rocker arm spot welding machines.
- IS 4804 (Part 3) -1969: Single-phase spot and projection welding machines.
- IS 4559 -1993: Single operator rectifier type DC arc welding power source (second revision).
- IS 2641 -1989: Electrical welding accessories (first revision).

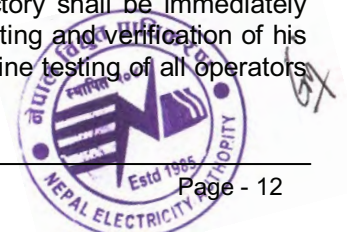
The welding plant and equipment employed on the works shall be of sufficient capacity to carry out the agreed procedures and suitable for the types of electrodes in use. All necessary staging and screens shall be provided for the welders, supervisors and inspectors and all plant and equipment shall be maintained in an efficient condition. Suitable tong test ammeters shall be provided for measuring the current, except only, when efficient means of so doing are incorporated as part of the welding plant. The strength of the welding current shall be within the range recommended by the manufacturer of the particular electrode being used and shall be towards the upper limit of the range rather than the lower.

Welding shall wherever possible be carried out in covered workshops and under the specified conditions of temperature, where continuous supervision is exercised. Machine welding may be allowed where approved machines are in use correctly controlled by qualified operators.

Site welding shall not be carried out unless prior written agreement from the Engineer has been obtained. All such welding shall be subject to 100% non-destructive testing.

### **(4) Qualification of Welders**

All welding operators shall be qualified persons in accordance with Clause 23 of BS 5135 and the names of all operators and details of their qualifications shall be submitted to the Engineer for agreement. Any operator whose standard of workmanship is unsatisfactory shall be immediately suspended. The operators shall be produced by the Contractor for re-testing and verification of his qualification once he has received further instruction in this respect. Routine testing of all operators shall be required in every six months.



**(5) Workmanship****(a) Assembly**

Material that is to be welded shall be free from loose mill scale, rust, or other foreign matter on the surface to be welded and for a distance of at least 50 mm on each side of the weld. The preparation of edges for welding may be made by milling, chipping or cutting with a torch. All traces of overheated metal caused by torch cutting shall be removed. For this chipping to expose clean metal may be required. Grinding shall not be permitted on any surface or edge which is to be welded, unless the surface is subsequently thoroughly cleaned of carborundum and metal particles.

Members or parts which have been painted shall have all of the paint removed from the area which will be affected by the heat of the arc. This shall be accomplished by burning with a blow torch or blow pipe and brushing with a wire brush.

**(b) Welding**

Welding shall not be done in rain, snow or wind, or when the temperature of the metal is below 4°C, unless satisfactory protection such as shelters, wind-breaks and heat is provided.

During moderately cold weather the use of small movable shelters and preheating the metal by means of blow torches will be in general satisfactory. When the temperature is below - 10°C, the span or portion of structure undergoing welding shall be entirely housed in and heated to a minimum of 5°C. The use of open salamanders for such heating shall not be permitted.

Welding procedures shall be such that distortion is reduced to the minimum practicable and local distortion is rendered negligible in the final structure.

All welding procedures including those items listed in Clause 20 of BS 5135 shall be submitted to the Engineer in advance for agreement. All welding procedures submitted for agreement shall have previously been approved by an Independent Inspector, from authentic documented experience gained with welding of joints similar to that for which the welding procedure applies. Where no such approval is available, then the welding procedure shall be subject to approval after testing in accordance with the requirement of BS4870.

All welds shall be of the specified size and shape, and they shall be placed at the locations designated. Welds which are not in conformity with those required or welds which are defective, shall be chipped out and redone in an approved manner. Weld protrusions which interfere with later work or which present an uneven or un-workmanlike appearance shall be finished smooth by chipping and grinding. Deposited weld metal must be completely fused to all metal with which it is in contact. The weld shall be free of all pits, porous Sections, cold shuts, or slag inclusions. All pits and craters shall be filled and all ends shall be boxed.

An electrode of the proper size shall be selected for the weld desired. The electric current shall be adjusted for the electrode so that full fusion will be obtained without undercutting. Undercut welds shall be chipped back to bright metal and re-welded. The arc shall be kept uniform and steady and shall be applied in a manner which will fuse the metal without boiling, running or unnecessary spatter.

The placement of welds shall be such as to minimize shrinkage or distortion of the members. Members in which there is distortion caused by welding must be straightened to the satisfaction of the Engineer without structural damage to the member or to the welds.

Peening for welds shall not be permitted.

**(c) Final Finish of Welds**

The final finished surface of the weld shall be smooth and regular and shall conform as closely as practicable to the design requirements. All slag shall be removed from the finished weld. All flux deposit which may cause paint to rot shall be entirely removed. The entire surface shall be thoroughly wire-brushed before painting. If required by the Engineer, the final surface shall be finished smooth by chipping and grinding the weld deposit.

**(d) Weld Inspection**

Inspection shall be made during the welding process and after the weld is completed and cooled in accordance with IS 3600. All defects shall be entirely removed or repaired to the satisfaction of the Engineer. The Engineer shall designate at least 25 mm of every 2500 mm of welding for removal, to determine the penetration, fusion and porosity of the weld.

Plug borings shall be furnished when requested with the use of "X-ray" or magnetic-particle examinations may be made where the proper testing equipment is available. In such cases the inspection practice shall be in accordance with IS 1182 or IS 5334 as appropriate.

**(6) Safety Precaution**

Suitable shoes, helmets, hand shields, glasses, gloves, aprons, screens, canvas, wind shields and all other equipment necessary for the protection of the work, the welders, the helpers and the Engineer's Inspector shall be provided by the Contractor at his own expense. The provisions of IS 818 -1968 Code of Practice of Safety and health requirements in electric and gas welding and cutting operations (first revision) shall be observed.

**(7) Procedure Trials**

When directed by the Engineer and before fabrication is commenced, welding and flame cutting procedure trials shall be carried out using representative samples of materials to be used in the work.

The samples of material shall be selected and marked by the Engineer when the materials for the work are inspected at the mills.

Trials on material 20mm thick shall be taken to include all material up to but not exceeding 20mm thick. Trials on material 38mm thick shall be taken to include material over 20mm and up to but not exceeding 38mm thick. Material over 38mm thick shall be tested for every thickness increment of 6mm.

The welding and flame cutting trials shall demonstrate to the satisfaction of the Engineer the procedures to be adopted in the fabrication of the work which shall include:

- a) Welding procedure in accordance with BS 5135-1984.
- b) The heat control techniques required to ensure that the flame cut surfaces of steel are free from cracks, local hardness, and any other defects which would be detrimental to the finished work.

The trials shall include specimen weld details representative of the actual construction which shall be welded in a manner simulating the most unfavorable conditions liable to occur in the particular fabrication. Where primers are to be applied to the work prior to fabrication, they shall be applied to the sample material before the procedure trials are made. After welding the specimens shall be held at a temperature not less than 10° for a period of not less than 72 hours and shall then be sectioned and examined for cracks and other defects.

The following groups of tests as per BS 709 shall be carried out in accordance with Clause 621.

**(i) Butt Welds**

- Transverse tensile test
- Transverse and longitudinal bend tests
- Separate tests shall be performed in each case with the root of the weld in tension and compression respectively.
- Charpy V-notch impact tests BS 4360
- Macro examination test

**(ii) Fillet Welds**

- Fillet weld fracture test
- Macro examination test

**(8) Use of Electrodes**

Electrodes and fluxes shall be used in accordance with the manufacturer's instructions.

**(9) Butt Welds**

Unless otherwise described in the contract, all butt welds shall be complete penetration welds made between prepared fusion faces.



In the fabrication of built-up assemblies, all butt welds in each component part shall be completed, whenever possible, before the final assembly.

The position of welds required for temporary attachments shall be agreed by the Engineer before the work commences.

Where automatic or semi-automatic process are used back gouging of deposited weld shall not be required where the Engineer is satisfied that the root run is free from imperfection.

Where butt welds are to be ground flush, there shall be no loss of parent metal. The final grinding shall be in the direction described in the contract.

Strud shear connector shall be welded in accordance with the manufacturer's instructions.

In butt joints the root edges or root faces shall not be out of alignment by more than 0.125 times the thickness of the thinner material for material up to 12mm thick or by more than 2mm for thicker material.

Requirements for "run-on" and run-off" plates shall be as follows:

- a) One pair of run-on plates and one pair of run-off plates all prepared to the same thickness and profile as the parent metal shall be attached by clamps to the start and finish respectively of all butt welds. Unless otherwise required by the Engineer, approximately 1 in 5 pairs of run-off plates, for butt welds in tension flanges and 1 in 10 pairs for other butt welds, shall be production test plates. The combined size of each pair of production test plates shall be either 225mm, 300mm or 375mm wide X 200mm long as shown in Table O.2 the length being measured in the rolling direction of the metal and at right angles to the weld.

**TABLE O.2: SIZES OF RUN-OFF PRODUCTION TEST PLATES**

Material	Combined size (per pair) of run-off production test plates		
	Plates up to 30mm thick	Plates from 30mm to 75mm thick	Plates over 75mm thick
IS-1915	300x200	375 x 200	Sizes to be agreed by the Engineer

- b) Butt welds shall run the full length of the joint and extend at full weld profile for a minimum distance of 25mm into the run-off plates, and for a minimum distances of 200mm, 275mm, 350mm respectively into the 225mm X 200mm X 200mm run-off production test plates.
- c) On completion of the welds the run-off production test plates shall not be removed until they have been marked in a manner agreed by the Engineer to identify them with the joints to which they are attached.
- d) When removing the run-on and run-off plates by flame cutting the cuts shall not be nearer than 5mm to the sides of the parent metal and the remaining metal shall be removed by grinding or other method agreed by the Engineer.
- e) Specimens for the following tests to be carried out in accordance with Clause 621 shall be selected from the run-off production test plates by the Engineer:
  - i. Transverse tensile test(s): The number of test shall be sufficient to cover the full thickness of plate,
  - ii. Transverse bend test

**(10) Camber**

Main girders shall be fabricated to the cambers shown on the Drawing. Plates shall be prepared to produce a profile which approximates to a parabolic curve, from the supports to the midspan point of the girder.

**O7 FIELD ERECTION REQUIREMENTS**

**(1) Handling and Storage of Materials**

Structural metals shall be carefully unloaded manually or by means of suitable equipment so as to avoid damage to the materials or their painted surfaces. Under no circumstances shall structural steel be dropped or skidded off cars or vehicles, nor shall it be dragged over the ground. Beams

and girders shall be transported and handled in upright position. Pin holes, or other field connection holes, shall not be used as places for "hook-on".

Material not to be placed directly in the structure shall be stored above probable high water, on skids or platforms in a manner that will prevent distortion in the members or the accumulation of water or dirt on such members. Beams and girders shall be stored in an upright position and securely stored. Provision shall be made to protect all metals against corrosion.

All damaged metals shall be rejected

**(2) Preparation for Bearing Area**

Before placing column bases, bed plates or shoes and the bearing shall be prepared to proper elevation.

**(3) Straightening Bent Metal**

Straightening of bends in main structural members shall not be permitted in the field. Such members shall be returned to the fabricator for proper repair or replacement.

Bent material shall be straightened, to the satisfaction of the Engineer and under his direct supervision, before such material is incorporated into the structure.

The straightening of bends shall be done by methods that will not produce embrittlement, fracture or damage. All material shall be straightened cold when practicable. No plated, galvanized, enameled, heat treated aluminum and similar metals shall be heated. When metals of these types can not be satisfactorily straightened cold, they shall be returned to the fabricator for repair or replacement.

Mild steel and structural grade steel may be heated when necessary to accomplish straightening. Other carbon steel and low alloy steels shall not be heated unless specific approval is granted by the Engineer. Heating and straightening shall conform to the requirements of Sub-clause O3

(3) (g).

**O8 ASSEMBLING AND BOLTING**

**(1) General**

All field contact surfaces, including shims, which have not been given a shop coat of paint, shall be thoroughly cleaned and given a coat of the specified "shop coat" paint, except when such surfaces are to be completely sealed by welding. Assembly of Sections shall be made while the contact paint is still plastic. All surfaces of metal which will be inaccessible after erection shall be thoroughly cleaned of all foreign matter, spot coated and field painted in accordance with the provisions of Clause O9. Immediately before assembly, all pins shall be thoroughly cleaned and given a coat of red lead. The pins shall be inserted into the holes before the red lead is dry and the pin nuts are drawn tight. The exposed threads shall be effectively burred or checked at the face of the nut.

Fabricated Sections which have been assembled, reamed, and match marked in the shop shall be erected in exact conformity with such match marks. The interchanging of parts shall not be permitted.

Steel structures shall be assembled to correct line and elevation before any welding is undertaken.

**(2) Trusses**

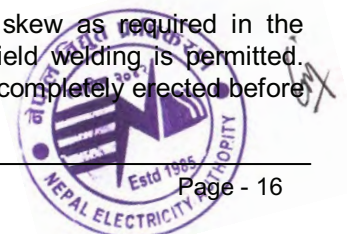
Truss spans, except those portions erected by the cantilever method, shall be erected on blocks so placed as to provide required camber. The camber shall be secured by adjusting all panel points to the elevations as shown in the plan or as directed by the Engineer.

Care shall be taken that trusses are in perfect alignment and that all milled ends of compression members are in full contact. The spans must be fully erected, including all portals, laterals, struts and sways, and all field connections, except connection for stringers, rails and expansion devices, shall be securely drift pinned and bolted before any of these is permitted. In case of cantilever spans, the Engineer may permit welding portions of the anchor spans before the cantilever arms are completely erected.

**(3) Simple Girders**

Simple girder and beam spans shall be accurately set to square or skew as required in the Drawing, with all diaphragms drift pinned and bolted in place before field welding is permitted.

Truss, girder or beam spans designed continuous over supports shall be completely erected before any welding is permitted.



Unless otherwise provided in the contract, suspended spans shall not be erected until the adjoining spans are completely erected. No welding shall be permitted until the erection is complete.

For continuous or cantilever spans, the number of fitting-up bolts and drift pins required shall be determined by the Engineer for the stresses developed in the various joints during erection. Drift pins and bolts shall be used in equal proportions and shall be located as to hold effectively the joint members in close contact and in correct position during all welding operations.

Erection washers not less than 5 mm in thickness and not less than 50 mm in diameter shall be used with all erection bolts.

**(4) Welding**

Connections to be welded shall be held in tight contact by means of bolts and clamps before welding and the welding shall conform to the requirements of Clause O6.

**(5) Bolted Connections**

Contact surfaces shall be thoroughly cleaned of rust, mill scale, dirt, grease, paint lacquer, or other foreign material before assembly. All bolts shall be installed with a hardened washer under nut or bolt head whichever is the element turned in tightening. Bolts may be tightened by any method to the required tension. The torque value needed to develop the required bolt tension shall be determined by the Engineer. Bolt tension shall be checked at locations determined by the Engineer in the presence of the Contractor and in such manner that the Engineer can read the torque gauge. Other methods of determining bolt tension may be used, provided the prior approval of the Engineer is obtained in writing. Nuts shall be positioned whenever practicable on the side of the member which will not be visible from the traveled way. Nuts for bolt which can be partially bedded in concrete shall be positioned on the side of the member that will be encased in concrete. Bolts up to 6mm larger in diameter of those shown in the Drawing may be used provided that the required clearance and edge distances are not reduced below those required for the larger bolt.

**O9 PROTECTION AGAINST CORROSION**

**(1) Preparation of Surfaces to Receive Paint**

Before paint is applied to any surface other than metal-coated surfaces the appropriate surface preparations as described in the contract shall be carried out in accordance with the following:

**(a) Bare Metal Surfaces**

Blast cleaning shall be carried out in accordance with BS4232 to the quality of surface finish as described in the contract. The maximum grade of abrasive permitted shall be as specified in Table 2 of BS4232. Non-metallic abrasives shall not be permitted. The abrasive used for blasting shall be free from contamination and any recovered material shall be cleaned to the satisfaction of the Engineer before re-use. The maximum amplitude (peak to trough) of the blast-cleaned surface shall not exceed 0.10 mm. Surfaces shall be protected within the following time of having been blast cleaned :

- 2 hours if humidity in air is < 85%
- 4 hours if humidity in air is < 75%
- 6 hours if humidity in air is < 60%

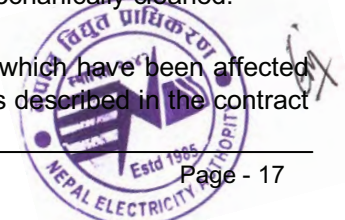
A sample blast-cleaned steel panel measuring not less than 150 mm x 150 mm x 6 mm adequately protected by sealed clean polythene wrapping shall be submitted to the Engineer for approval before any work is put in hand. The approved sample shall then be retained by the Engineer's inspectors for comparison with the prepared steelwork.

**(b) Mechanical Cleaning.**

Mechanical cleaning shall be carried out by power-driven tools, such as carborundum grinding discs, chipping hammers and needle guns, followed by steel-wire brushing and dusting to remove all loosened material. Excessive brushing of the metal through prolonged application of rotary wire brushes shall be avoided. Surfaces shall be protected within the time as specified above in Sub-clause O9 (1) (a) after they are mechanically cleaned.

**(c) Welds and Areas Affected by Welding**

Unless otherwise described in the contract, welds and surfaces which have been affected by welding shall be prepared for painting by the same process as described in the contract



for the adjoining metal.

(d) **Painted Surfaces**

Painted surfaces shall be cleaned of all dust immediately prior to the application of further paint. Any loose paint and rust shall be removed. Areas contaminated by oil and grease shall be cleaned with white spirit. Where required by the Engineer, the whole surface shall then be cleaned by washing down with a solution of an approved liquid detergent followed by rinsing with clean fresh water and allowed to dry thoroughly before paint is applied.

(2) **Treatment of Surfaces**

(a) **High Strength Friction Grip Bolt Interfaces**

The treatment of interfaces to be jointed by high strength friction grip bolts shall be as described in the contract. Paint work shall be stopped off at a distance of 75 mm from the joints and all interfaces shall be cleaned by wire brushing before assembly.

(b) **Untreated Surfaces**

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

(3) **Storage of Paint**

Paint shall be stored in sealed containers in a lock-up store in accordance with the manufacturer's instructions. Paint which has not been used within the "shelf life" period specified on the containers or within 12 months of the date of manufacture, whichever is the lesser, shall not be used.

Paint from painter's kettles shall be returned to store at the end of each working period where it shall be kept in a sealed container. Before it is re-issued for use it shall be thoroughly mixed and no fresh paint or thinners shall be added.

(4) **Application of paint**

All paint shall be supplied from the store to the painters ready for application. The addition of thinners or of any other material shall be thereafter prohibited. Any instructions given by the paint manufacturer shall be strictly followed.

All painting shall be carried out by skilled painters under competent supervision. Paint shall be applied to dry surfaces which have been prepared in accordance with Sub-clause O9 (1). The interval between preparation of the metal surface and the application of the first priming coat of paint shall be in accordance with the relevant requirements of Sub-clause O9(1).

Paint shall not be applied under the following conditions:

- a) When the ambient temperature falls below 4°C or the relative humidity rises above 90° except if otherwise stated in the manufacturer's instructions.
- b) During rain or mist.
- c) When condensation has occurred or is likely to occur on the steel.

Each coat of paint shall be applied by the method instructed by the manufacturer to produce a continuous film paint of uniform and even thickness. As soon as the first priming coat has dried, an extra stripe coat of paint shall be applied by brush to edges, corners, crevices, bolt heads and welds, using paint of similar composition to the subsequent undercoat, but in a contrasting shade. Successive coats shall have different shades for identification and each coat shall be thoroughly dry before the application of a further coat.

The total dry paint film thickness of the paint system on bare steel surfaces and on metal coated surfaces shall be as described in the contract. The dry paint film shall be measured by Elcometer or other instrument approved by the Engineer.

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

Wet film thickness gauges may be used for checking but shall not be permitted as a means of predicting the dry film thickness.

Unless otherwise agreed by the Engineer the paint system applied at the works shall be applied under cover, in controlled conditions, at the fabricator's works. One undercoat plus one finishing coat shall be applied at Site within the time limit stipulated by the paint manufacturer.

No paint shall be used after the expiration of the "pot-life" stipulated by the manufacturer. The paints of expired "pot life" shall not be mixed with fresh paint or have thinners added to them.

**(5) Storage of Painted Steelwork**

Painted steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surfaces. Suitable packing shall be laid between the layers of stacked materials. Where cover is provided, it shall be ventilated.

Prime painted steelwork which is to be stored out-doors or transported prior to fabrication shall not be exposed for periods longer than the following, before being overcoated:

Blast primers -1 coat Maximum 8 weeks, including 2 weeks of this time out-doors.

**(6) Repairs to damaged Surfaces.**

Areas of paint which have been damaged during handling, storing, loading and off-loading, transportation, erection and construction shall be cleaned to bare metal, and the edges of the undamaged paint leveled with sandpaper.

The full specified painting system shall then be re-applied and the new paint shall overlap the existing paint by at least 50 mm all round the affected area.

**(7) Painting of Joints**

As soon as possible after joints have been made and passed by the Engineer the parent and joint material, exposed parts of bolts, nuts and washers, weld and weld affected areas shall be prepared as stated in the contract and brought up to the same state of painting as the adjoining surfaces.

**(8) Painting Methods**

Coat of paint in a system of painting shall be applied each by one of the following methods:

- a) Brush
- b) Roller (for shop painting only), supplemented by brush where necessary
- c) Air pressure spraying
- d) Airless spraying

**(9) Protective systems**

The Contractor shall furnish the Engineer with duplicate copies of the manufacturer's data sheets for the paints he proposes to use. Following the Engineer's written instruction the requirements of the paint manufacturer's data sheets shall be adopted for the Works.

Where called for by the Engineer the Contractor shall carry out paint application procedure trials, either at the fabricator's works or at Site as appropriate, with the equipment and labor to be used in the works. The Contractor shall supply suitable blast cleaned steel and sufficient paint for the trials and must demonstrate his ability to apply each coat of paint of a designated paint system in accordance with the Specification and the paint manufacturer's data sheet. No painting of the contract steelwork shall be permitted until the procedure trials have been completed to the satisfaction of the Engineer. Any adjustment to the registered paint formulation shown to be required by the trials, other than an increase in the amount of thinners, must be agreed by the Engineer and made at the paint manufacturer's works before the final stage of a paint procedure trial and before delivery of the first batch of paint.

All requirements of the paint manufacturer's data sheets shall be complied with. Paint shall be supplied from the Contractor's paint store to the painters ready for application, the only adjustment of formulation being as provided in paragraph 2 above. Any addition of thinners must be made in the store under the supervision of the Engineer and only as allowed under the manufacturer data.

**(a) Superstructure Steelwork**

**(i) Steelwork Members**

Surface preparation at works : Blast clean to 1st quality (including joint areas) BS7079.

Painting: as shown on the following Table:



Painting at works	Coat	Paint	Method of application
	1 <sup>st</sup>	Zinc Chromate/Red Oxide Blast Primer	Airless Spray
Excluding joints	(Stripe to edges etc.) 2 <sup>nd</sup> 3 <sup>rd</sup> 4 <sup>th</sup>	Zinc Phosphate epoxy ester undercoat As Stripe Coat As Stripe Coat As Stripe Coat	Brush (Airless Spray grade paint) Airless Spray Airless Spray Airless Spray
At site	5 <sup>th</sup>	Micaceous Iron Oxide Phenolic/tung oil undercoat	Brush
	6 <sup>th</sup>	Micaceous Iron Oxide Phenolic/tung oil Finish Dark Grey	Brush

**(ii) High Strength Friction Grip Bolted Joints**

**a. Cover Plates**

Surfaces preparation at works: Blast clean to 1 st quality BS7079.

Painting at works (excluding contact surfaces) : One coat, Zinc Chromate/Red Oxide Blast primer applied by Airless Spray.

Surface Preparation at site : Before assembly, wire brush contact surfaces by hand.  
After assembly, wire brush works coat of blast primer.

Painting at site (after bolting) : Coats 1, Stripe and 2 to 6 as (i) above but all applied by brush and coat within 4 hours of wire brushing works blast primer.  
Minimum total dry film thickness at stripe coated areas: 250 micron.

**b. Contact Surfaces of Steelwork Members**

Surface preparation at site: Before assembly, mask around contact surface apply paint stripper and scrape off works coat of blast primer. Wash off stripper and wire brush by hand when dry.

**b. Bolts, Nuts and Washers**

At site: Remove oil than prepare surfaces and paint as for cover plates above.

**(iii) Painting System for Repairs to Damaged Surfaces**

Coats 1, Stripe (if relevant) and 2 to 6 as above but all applied by brush



**(b) Parapets and Guard-rails**

Surface Preparation: Pickling

Metal Coating : Hot-dip galvanizing Minimum weight of galvanizing 1610 g/m<sub>2</sub> or minimum thickness 85 micron.**(10) Metal Coatings**

Unless otherwise specified by the Engineer procedures for applying metal coatings shall be in accordance with the following :-

(a) BS729 Part 1: Hot-dip Galvanized Coatings

Part 2: Sherardised Coatings

Metal coatings to BS 729 shall only be applied to components of a tensile strength up to and including that of General Grade HSFG bolts unless specified by the Engineer.

(b) BS2569 Part 1 Sprayed metal Coatings (Zinc and Aluminum). The nominal thickness of coatings to be 100 micron.

(c) BS3382 : Part 1 and 2. Electroplated Coatings on Threaded Components( Cadmium and zinc). This British Standard shall be deemed to cover the electroplating of components up to and including 36mm diameter. The minimum thickness of coating to be 5 micron.

Where a metal coating is required only on part of an assembled Section it shall be applied before the rest of the Section receives its priming cot.

**(11) Etch Primers and Blast Primers**

Etch primers and blast primers shall be suitable for continuous spray application. They shall not be used on phosphated steel nor shall they be overcoated with zinc rich primers.

**O10 MEASUREMENT**

The structural steel shall be measured in ton and shall be based on the net weight of metal in the fabricated/erected structure computed on the basis of nominal weight of the elements. While computing the weight, the specific gravity of steel shall be adopted 7.85 ton per cubic meter. The weight shall be determined from the dimensions shown on the Drawing. The weight so measured shall be inclusive of weld fillets and weight of protective coatings, if any.

All operations like cutting, bending, straightening, heat and cold treatments, machining, temporary and permanent erections, connections, bolts, nuts and washers, welding, painting and protection against corrosion and other ancillary and incidental operations shall be deemed included in the weight of the steel structure as measured above.

**O11 PAYMENT**

The structural steel as measured shall be paid at the contract unit rate which shall be the full and the final compensation to the Contractor as per Clause A15 and also for the cost of all operations required for fabrication, connections, oiling, painting, temporary erection, inspection, tests and final erection including all other ancillary and incidental works needed to complete the work as per these Specifications and/or directed by the Engineer.



**P ALUMINUM COMPOSITE PANELS (ACP) WORK****P1 SCOPE**

This specification covers supply, fabrication & fitting of outer skin Aluminum composite panel (ACP) & inner skin calcium silicate board (CSB) in steel frame with 30 mm polyester insulation layer between ACP & CSB

**P2 MATERIALS**

Aluminum composite panel (ACPs) All ACPs shall be of two coil coated aluminum sheets, permanently bonded to a nontoxic & recyclable thermoplastic core, Bonding shall be achieved by both chemical & mechanical action giving extra bond integrity to the panels.

ACP shall be of two executive grades of Aluminum Panels for both external & internal application.

- PVDF coated panels for external application shall be well resistance from corrosion, chalking & fading humidity & self spray. Also it shall provide an unmatched, stable, easily workable & maintenance free finishing material.
- Polyester coated panels for interior application tested to ASTM shall enhanced appearance, sound barrier, fire resistance, easy installation & maintenance. It shall be easily used along with other finishing materials & shall provide uniform finish on larger spans.

**P3 INSTALLATION**

A trained fabricator shall work on-site for producing any dreamy form & plan as prescribed by designer.

**Drilling/ Punching** Drilling shall be with regular drills normally used for aluminum & plastic & shall be punched using conventional steel metal punching machines or manual notchers.

**Cutting** shall be with the help of vertical panel saw, CNC or copy routers are recommended

**Shearing** shall be done with peel off protective film. It is recommended using protective pads between down holders & ACP surface to prevent surface damage.

**Riveting/ clamping/ screwing**

Solid or blind riveting is possible with conventional riveting tool. Regular aluminum extruded sections can be used for clamping. For screwing, stainless steel screws are recommended to avoid corrosion.

**Routing & Folding** shall be done for giving flexibility in creating shapes as per designer.

Welding/ bonding, Hot air welding is recommended for water tight joints for non-structural application, basically for interiors, for load bearing criterion, adhesive sealing compounds or double sided VHB tapes shall be used for sealing.

- Fixing of MS square pipe/ Angle Section as per requirement for framing on external wall surface by using expanded bolt/plastic grip with S.S. screw. Size of this frame will be adopted according to given design or as per instruction.
- Cutting, bending & molding of ACP panel (tray) as per required frame size
- Fixing of prepared ACP panel on the frame with stainless steel self-tapping screw by using aluminium angle section piece of size 25 x 25 mm
- Filling of groove between two adjacent Acp panels with w/p sealant (silicon)

**P4 STANDARD**

Thickness, size & shades of panel shall be as per design, drawing & instruction of engineer

Available panel thickness : 2 mm, 3mm, 4 mm, 5 mm, 6 mm

Standard panel Size: panel width - 1220 mm upto 1550 mm  
panel length - 2440 mm upto 4880 mm

Shades : Metallic silver, Gold, Bronz , Copper etc.  
Blue, Green, Gray, Yellow, Red, White, Black etc.

Panel Tolerances : Width :  $\pm 2.0$  mm  
Length :  $\pm 4.0$  mm

Thickness :  $\pm 0.2$  mm

Bow : Max 0.5 % of length and / or width

Square ness : 5.0 mm (max)

#### P5 PHYSICAL PROPERTIES

Property	Standard	Unit	ACP	
			3mm/ 0.3	4mm/0.5
Sp. gr.	ASTM D 792		1.30	1.38
Panel weight	ASTM D 792	kg/m <sup>2</sup>	3.90	5.60
Apprent Thermal conductivity	ASTM C 363	kcal/m.h <sup>2</sup> .c	0.41	0.40
Deflection Temperature	ASTM D648	<sup>0</sup> c	105	115
Modulus of Elasticity ( Skin)	ASTM E8	N/mm <sup>2</sup>	70000	70000

#### P6 MECHANICAL PROPERTIES

Property	Standard	Unit	ACP	
			3mm/ 0.3	4mm/0.5
Tensile Strength	ASTM D 638	N/mm <sup>2</sup>	30	40
Elongation	ASTM D 638	C %	8	11
Flexural Rigidity	ASTM C 393	(x 10 <sup>6</sup> ) N/ mm <sup>2</sup>	16	35
Flexural Modulus of Elasticity	ASTM D 790	N/ mm <sup>2</sup>	25000	30000
Punching Shear Resistance	ASTM D 732	N/ mm <sup>2</sup>	18	22

#### P7 CHARACTERISTICS

Characteristics : It shall have following characteristics feature

Durability : Excellent resistant characteristics keeping the colour as against long outdoor exposure

Chemical resistance: Acid, base, salt resistance

Pollution resistance : with minimum maintenance requirement, high fluro content makes it pollution free, nice & clean looking.

Impact resistance: Highly impact resistant, stiff, bending will not damage the coating

Excellent flatness: Ideal for creating smooth, monolithic surfaces for an excellent finish compared to other building materials.

Resistant to breakage: Have high strength & rigidity. Deflection capacity & bending strength are outstanding. The rigidity of 4 mm panel will be equal to that of 4.5 mm solid aluminum or 3.2 mm steel.

Weather ability: superior finish resistant to fading, colour damage, weather damage, corrosion & chalking.

Acp panel shall have excellent properties of vibration proof, heat & sound insulation, easy formability & easy maintenance.

**P8 RATE**

The rate for item shall include all labor, materials, use of tools & scaffolding or ladder, supplying fabrication & installation all complete.

**P9 MEASUREMENT**

Measurement shall be per square meter of the net area covered with deduction of opening.

**Q GRANITE FLOORING****Q1 SCOPE**

This specification covers the pavement of different types of flooring such as Granite, Kota stone etc in the specified mortar in general & providing the necessary skirting edging of the same materials in particular.

**Q2 MATERIALS**

All materials shall be as specified in "STANDARD CONSTRUCTION MATERIALS" .

**Q3 SURFACE PREPARATION**

The flooring surfaces shall first be prepared as follows:

## i) Cleanliness

Any debris, contaminated layer, loose materials & dust or foreign particles shall be removed, brushed & cleared having neat concrete surface.

## ii) Roughness

Roughness of background or concrete surface shall be done by hacking, hammering, chiseling, wire brushing to obtain required degree of bonding of mortar as instructed by engineer.

## iii) Evenness:

The background shall be maintained even in order to avoid variations in thickness. Any unevenness must be leveled or maintain required slope with mortar before laying, granite or kota stone

**Q4 LAYING**

Granite/ Kota stone shall be laid on floor & corresponding edge wall skirting as per drawing & instruction

## a) Granite/ or Kota stone floor

Granite/ or Kota stone shall be clean, regular thickness, sizes & colour as specified. Neat cement grout of honey like consistency shall be spread over the bedding mortar just to cover so much area as can be laid within slurry & fixed in this grout one after the other, each piece being well pressed & gently tapped with a wooden mallet till it is properly bedded & in level with the adjoining granite/ or Kota stone. There shall be no hollows in bed or joints. The joint shall be kept as close as possible & in straight lines. Necessary slope shall be maintained wherever requires.

**Q5 SKIRTING**

Finishing of the skirting shall be in same material or different as specified in the drawing & as directed by the Engineer. All the top line shall be in perfect line & level (if sloped regular). The vertical joints shall be in the regular pattern corresponding to the joint of floor. Those part of wall where to be provided shall be chiseled, raked, brushed & cleaned properly, cement mortar of the specified proportion is then provided to such portion & laying shall be as described on flooring.

**Q6 SLOPES AND DRAINAGE**

The slopes & position of drains shall be as shown in the detailed drawing & as directed by the Engineer. Special care should be taken for draining out the water while laying in terrace, open varandah etc. Wherever the position of outlet is needed, it shall be cut properly to make the hole of the same size as that of outlet.

**Q7 CURING**

The surface shall be left dry for air-curing for a duration of 12 to 18 hrs. depending upon the atmospheric temperature condition.

**Q8 FINISHING**

The thickness & size shall be as specified in detailed drawing or as instructed by engineer.

The colour shall be of approved colour as instructed by engineer.



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Pattern & finishing shall be as specified drawing or as instructed by engineer. All the surface shall be cleaned properly so that there shall not remain any cement mortar above surface.

**Q9 RATE**

The rate includes the supply of material, labour, equipment required for the construction including cutting, laying, finishing all complete



**R RAILING WORKS****R1 SCOPE**

This specification covers supply, fabrication, and installation of railing works in stairs as well as verandah portion of different building complexes.

**R2 MATERIALS**

Mild steel pipes/ stainless steel pipe and fittings as specified shall comply with relevant IS code specification.

**R3 FABRICATION AND INSTALLATION**

Steel pipe railing are fixed with overall fittings as bends, Tees etc. which are welded as per drawing and instruction of Engineer. Welded joints shall be neatly made, filed smooth and left cleaned; and adequate means shall be employed for temporarily fastening the parts to be welded together until the joints are leveled.

**R4 PAINT**

The railing shall be finished with one coat of red lead followed by one coat of aluminum paint and fixed in position as per instruction of Engineer.

**R5 RATE**

The rate for the item shall include all labour, materials, use of tools and machinery inclusive.



**S EXTRUDED POLYSTYRENE FOAM INSULATION****S1 SCOPE**

This specification covers supply, fabrication & installation of extruded polystyrene foams for building in external & internal wall, cavity wall, roof & floors etc. It gives good thermal insulation, reduce air condition load along & decrease the electricity cost. It is easy to install, presents no risk to human health & will not shrink or sag thereby allowing heat to enter or escape from building.

**S2 MATERIALS**

Extruded polystyrene is a special high performance insulation materials widely used in insulation of wall, roof, floor etc. (in RCC/ metal/ stone surface) STYROFOAM TM developed by DOW or equivalent shall be used having characteristics features as,

- high insulation value long term,
- excellent mechanical strength,
- no capillarity, high moisture resistance,
- resistance to freeze thaw cycles,
- long term durability
- lightweight & easy to handle
- easy to cut with simple tools
- resistant to rot & exteriorization
- clean, odourless & non-irritant to skin

- ⇒ STYROFOAM SL/ROOFMATE™ SC - for insulation of flat roofs, floor & structures below ground
- ⇒ STYROFOAM TG - for insulation of cavity walls, pitched roofs & agricultural buildings
- ⇒ STYROFOAMIB - with rough surface, for insulation of interior & exterior walls, Sockles.

**S3 TECHNICAL DATA**

Properties	Standard	Unit	Roofmate SL Styrofoam SL	Styrofoam m IB	Styrofoam m TG
Density, min	DIN 53420	kg/m <sup>3</sup>	32	28	30
	ASTM D 1622	lb/ft <sup>3</sup>	2.0	1.75	1.9
Thermal conductivity at 10 <sup>0</sup> C	DIN 52612 DIN 52616	W/m.k	0.028	0.029	0.029
Mean temperature 23.9 <sup>0</sup> C	ASTM C 177-97	Btu. In/ft <sup>2</sup> .	0.2	0.21	0.21
	ASTM C 518-98	H.°F			
Compressive strength at 10% deflection	DIN 53421	kPa	300	210	250
	ASTM D 1621 - 95	psi	43	30	36
Capillarity			none	none	none
Linear coefficient of thermal expansion & contraction	DIN 52328	°C <sup>-1</sup>	70.10 <sup>-6</sup>	70.10 <sup>-6</sup>	70.10 <sup>-6</sup>
		°F <sup>-1</sup>	39.10 <sup>-6</sup>	39.10 <sup>-6</sup>	39.10 <sup>-6</sup>
Fire classification	DIN 4102	Building	B2	B2	B2

(Germany)	material class	normal fire behaviour		
Dimensions (mm)				
Width		600	600	600
Length		1250	2500	250
Thickness		20-100	20-100	30-80

**S4 General Application Information**

Styrofoam board – Contains a flame retardant additive to inhibit accidental ignition from a small fire source, but combustible to intensive fire.

- can be stored outside but should be protected against intense sunlight
- are resistant to construction materials as lime, cement, plaster, anhydrous gypsum as well as alcohols, acid & alkalis
- are not bio – degradable
- can be cut using knife, fine teeth saw, hot wire equipment etc.

**S5 INSTALLATION****Flat Roof Insulation**

The inverted roof concept over comes the problem by placing thermal insulation above the waterproof layer, maintaining it an even temperature close to that of the building interior & protecting it from the damaging effect of UV radiation & from mechanical damage. The insulation protects the waterproofing covering from;

- wide temperature variation +80 to -20°C
- degradation from weathering
- mechanical damage during construction, use & maintenance.

The waterproof layer acts as a total vapor control layer & being on the warm side of the insulation is maintained above dew point temperature so the risk of condensation is minimized.

The insulation can be;

- installed in any weather
- added to, without stripping the waterproof layer.
- Easily lifted & replaced / reused if the building is altered .

**Insulation of Pitched Roof**

The planned efficiency of thermal insulation in pitched roofs can be achieved when thermal bridges are prevented. There are several alternatives to create a properly functioning buildup with minimized thermal bridges, by placing the insulation;

- above the rafters or a timber / concrete deck
- below the rafters
- above & between the rafters
- between & below the rafters.

When the insulation is installed on the top of the rafters, a rigid insulation materials with high strength is demanded, being capable to resist to the loads; weight of roof covering, snow, wind load etc.

**Insulation of walls**

Insulation of Internal walls

In these cases where the external insulation of the façade wall is not possible, the insulation can be applied on to the internal walls. As possible, the insulation can be applied on the warm, inner side, the wall structures will be exposed to more severe temperature changes. Attention should be paid also to thermal bridges at the adjoining structures (walls, floor slabs, perpendicular to the façade wall). The condensation risk must be checked carefully, especially at rooms with high relative air humidity.

The internally insulated rooms require regular & efficient ventilation

### **Insulation of exterior walls**

Exterior insulation is the most effective way of thermally insulating buildings due to the fact that it is not interrupted at structural elements like columns, beams & slab which create thermal bridges if uninsulated

Exterior insulation can be installed in two ways:

- Behind mechanically fixed marble or granite panel, it shall be fixed to external face of walls using either plastic dowel with 50 mm dia.
- as a part of complete exterior insulation & finish system comprising:
  - a) Polymer modified base coat with fibreglass reinforcement.
  - b) acrylic or silicone base, completely crack free, stucco coat finish system

### **Cavity walls insulation**

A cavity wall is actually two walls separated by an air space.

Solution for this application is designed to give the maximum benefit in cavity wall construction

- tongue & groove edges, give continuity of insulation.
- board width suits with normal vertical spacing of wall ties
- a range of thicknesses allows thermal performance

### **S6 RATE**

The rate for item shall include all labor, materials, use of tools & scaffolding or ladder, supplying fabrication & installation all complete.

### **S7 MEASUREMENT**

Measurement shall be per square meter of the net area covered with deduction of opening.

**T TUBELER TRUSS / METAL TRUSS****T1 SCOPE**

This specification covers providing, fabricating, assembling, erecting in position tubeler truss / mild steel metal truss.

**T2 MATERIALS**

Structural steel section shall be as per IS specification and steel tubes used in the truss shall be hot finished tubes confirming to the requirements of specified in IS 1161-1968 and IS 807-1968. Tubes shall be of grade heavy or medium unless instructed.

**T3 FABRICATION**

The fabrication of truss using steel tubes shall be done in accordance with IS 800-1962. Welding shall be done with reference to the IS 820 and IS 816-1956.

The component parts of the structure shall be assembled in such a manner that they are neither twisted or damaged. The members of the truss shall be assembled and welding done according to the detailed drawing. All materials before assembly shall be straightened, if necessary, unless required to be of a curvilinear form and shall be free from twist.

**T4 BOLTING**

Washers shall be specially shaped where necessary or other means used, to give the nuts and the heads of bolts a satisfactory bearing.

In all cases where the full bearing of area of the bolt is to be developed, the treaded portion of the bolt shall be not within the thickness of the parts bolted together and washers of appropriate thickness shall be provided to allow the nut to be completely tightened.

Edges should be dressed to a neat and workman like finish and be free from distortion where parts are to be in a contact metal-to-metal.

**T5 SEALING OF TUBES**

Where the end of a tube is not automatically sealed by virtue of its connection by welding to another member, the end shall be properly and completely sealed. Before sealing, the inside of the tube should be dried and free from loose scale.

**T6 FLATTENED ENDS**

In tubeler construction, the ends of tubes may be flattened or otherwise formed to provide for welded, riveted or bolted connections provided that the methods adopted for such flattening do not injure the material. The change of section shall be gradual.

**T7 PANTING**

All tubes and part thereof shall unless specified otherwise, shall be painted with two coats of red oxide paint before erection at site.

**T8 ASSEMBLING**

After the members are cut into the required length, and welded to form a truss system by providing fish plate, anchor plates etc. fully but welded, the fabricated members shall be assembled in ground to form a full scale truss for inspection by architect. The truss then be lifted to the required level and position where pre-fixed holding down bolts are prepared to receive such truss in position and alignment. All the bolts and nuts including holding down bolts are well tightened using required washers.

**T9 SHOP DRAWING**

Before manufacturing / fabrication truss and its member the manufacturer / contractor shall produce shop drawing showing each components of member frame and joining detail. This drawing shall be backed by an

appropriated calculation for taking into consideration the wind forces, earthquake force and appropriate static loadings.

**T10 RATE**

Rate shall be inclusive of the following:

Complete material and laborers required for the following operation shall be included in the rate of the truss.

All truss members as per drawing.

All purlins coverage 3'0" to 3'6" c/c spacing

All horizontal wind ties average 6'0" to 7'0" c/c spacing.

All fish plates, bolts, nuts, and anchor bolts, etc.

All fabrication, cutting, welding and wastage etc.

Erection, scaffolding, and fixing of truss in position.

Painting with anti-corrossive red oxide, 2 to 3 coats.

All other works as per the item specification and drawing.



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**U WATERPROOFING****U1 SCOPE**

This specification covers furnishing of all labor, materials, services and equipment necessary for the supply and installation waterproofing to concrete substrate, above grade or below grade, on either dry or wet side of substrates as indicated on drawings and as specified

**U2 REFERENCES**

The followings standards are to be referred to complete the works:

- American Society for Testing and Materials (ASTM)
- Army Corps of Engineers (CRD)
- NSF International (NSF)
- German Standards (DIN) and
- Indian Standards (IS)

**U3 SUBMITTALS**

The following submittals are required prior to start of the works:

- Product Data: Submit product data, including manufacturer's specifications, installation instructions and general recommendations for waterproofing applications. Also include manufacturer's certification or other data substantiating that products comply with requirements of Contract.
- Test Reports: Submit for acceptance of Engineer complete test reports from approved independent testing laboratories certifying that waterproofing system confirms to performance characteristics and testing requirements specified herein.
- Manufacturer's Certification: Provide certificate signed by manufacturer or manufacturer's representative certifying that the materials to be installed comply in all respects with the requirements of the specification and that the applicator is qualified and approved to install the materials in accordance with manufacturer's product data.
- Manufacturer's Field Report: Provide copy of report from manufacturer's representative confirming that the surfaces to which waterproofing material is to be applied are in a condition suitable to receive same.

**U4 QUALITY ASSURANCE**

- Manufacturer: Provide products of manufacturer with no less than 10 years experience in manufacturing the cementitious crystalline waterproofing materials for the required work. Manufacturers that cannot provide the performance test data specified herein will not be considered for the project.
- Applicator: Waterproofing applicator shall be experienced in the installation of waterproofing materials as demonstrated by previous successful installations and shall be approved by the manufacturer in writing
- Pre-Installation Meeting: Prior to installation of waterproofing, conduct meeting with waterproofing applicator, installers of work adjacent to or which penetrates waterproofing, Engineer, owner's representative and waterproofing manufacturer's representative to verify and review the following:
  - Manufacturer's product data including application instructions.
  - Substrate conditions, and procedures for substrate preparation and waterproofing installation.

**U5 DELIVERY, STORAGE AND HANDLING**

- Deliver packaged waterproofing materials to project site in original undamaged containers, with manufacturer's labels and seals intact.

**U6 WARRANTY**

- Manufacturer's Warranty: Manufacturer shall provide standard product warranty executed by authorized company officials. Term of warranty shall be 10 years from Date of Substantial Completion.
- Applicator's Warranty: Applicator shall warrant the waterproofing installation against defects caused by faulty workmanship or materials for a period of 10 years from Date of Substantial Completion. The warranty shall cover the surfaces treated and will bind the applicator to repair, at his expense, any and all leaks through the treated surface which are not due to structural weakness or other causes beyond applicator's control.

**U7 EXECUTION**

## 1) Examination

- Site Visit: Prior to waterproofing installation, arrange visit to project site with waterproofing manufacturer's representative. Representative shall inspect and certify that concrete surfaces are in acceptable condition to receive waterproofing treatment.
- Verification of Substrate: Verify that concrete surfaces are sound and clean and that form release agents and materials used to cure the concrete are compatible with waterproofing treatment.
- Examination for Defects: Examine surfaces to be waterproofed for form tie holes and structural defects such as honeycombing, rock pockets, faulty construction joints and cracks. Such defects to be repaired in accordance to manufacturer's product data and specification.

## 2) Preparation

- Concrete Finish: Concrete surface to receive waterproofing treatment shall have an open capillary system to provide tooth and suction, and shall be free from scale, excess form oil, laitance, curing compounds and foreign matter. Horizontal surfaces shall have a rough wood float or broom finish. Where a smooth trowel finish is required on horizontal surface, crystalline waterproofing material shall be applied by dry shake method at time of concrete finishing in accordance with manufacturer's specifications.
- Surface Preparation: Smooth surface (e.g. where steel forms are used) or surfaces covered with excess form oil or other contaminants shall be washed, lightly sand-blasted, water-blasted or acid etched with muriatic (HCL) acid as necessary to provide a clean absorbent surface. Surfaces to be acid-etched shall be saturated with water prior to application of acid.
- Repair of Defects: Surface defects shall be repaired as per followings:
- Form Tie Holes, Construction Joints: Chip out defective areas in a "U" shaped slot one inch (25 mm) wide and a minimum of one inch (25 mm) deep. Clean slot of debris and dust. Soak area with water and remove excess surface water then fill the cavity with dry-pack as per manufacturer's specifications and Engineer's instructions. Compress tightly into cavity using pneumatic packer or block and hammer.
- Rock Pockets, Honeycombing or Other Defective Concrete: Root out defective areas to sound concrete. Remove loose materials and saturate with water. Remove excess water and apply a slurry coat of concentrate waterproofing materials. After slurry has set, but while still "green" fill cavity to surface level with non-shrink grout.
- Wetting Concrete: Prior to application of waterproofing treatment, thoroughly saturate concrete surface with clean water as required to ensure migration of crystalline chemicals into voids and capillary tracts of the concrete. Remove free surface water before application.

**U8 APPLICATION**

## 1) Roof Slab &amp; Horizontal Surface

Slab surface shall be clean, free from any debris, dust. Hacking or chipping shall be made for good bonding. Two or more coats of acrylic based two packed water proofing membrane like WATERGUARD A or equivalent shall be applied on the surface.

A layer of brick bats / brick ballests with average thickness of 11 cm shall be laid in cement sand mortar (1:4) to maintain a proper gradient. The joints between the brick bats shall be generally 15 to 25 mm wide filling with cement mortar (1:4) mixed with water proofing compound. The top surface shall be finished smooth with 25 mm thick IPS flooring (1:2:4) mixed with waterproofing compound marking with (300 x 300) mm false square. Curing shall be done for two weeks.

## 2) Side Walls/ Parapet Walls

The wall surface shall be clean, free from debris & surface shall be prepared upto the required height. Generally a height of 300 mm above the top of slab treatment is considered adequate.

The side wall shall be provided with water proof cement plaster (1:4) of 20 mm thick upto the specified height as per drawing or instruction. curing shall be done for two weeks.

## 3) Raft

Chemical injection in the form of pressure grouting to the raft at any depth, height & level shall be made by injecting cement slurry mixed with grout admixture MC special DM, xypex or equivalent in the required consistency through the prefixed GI nozzles in the 18 mm dia holes drilled in grid pattern at a spacing not exceeding 1 m c/c on the top of raft under pressure using grout hammer for fixing of GI nozzles to the required depth, grouting admixture & finally cutting the projected nozzles & sealing of the GI nozzles after injection operation is over with MC special DM, Dichtament DS, xypex or equivalent non shrink polymer grouting compound, finishing, curing etc as per manufacture's specification & instruction of site in-charge.

Rate shall include for preparation of surface by mechanical upgrading to remove all loose mortar, laitance, oil, grease etc & washing the surface with water to get neat surface, dewatering, finishing, curing, scaffolding, water proofing chemical, wastage, conveyance, tools & plants mixing device & gauge, shuttering, nozzles etc all complete as per manufacture's specification & as instructed by engineer.

## 4) Shear Wall

Following sequence of operation shall be done during treatment to shear wall, chemical injection treatment in the form of pressure grouting to shear wall by injecting cement slurry mixed with grout admixture MC special DM, non shrink polymer grouting compound or equivalent in the required consistency through the prefixed GI nozzles in the 18 mm dia. holes drilled on the surface of shear wall at every 1 m spacing in horizontal direction, after construction joints at every stage & junction of raft slab & shear wall under pressure using grout pump including preparation of surface dewatering, drilling holes using pneumatic Rammer, fixing of GI nozzles after the injection operation is over with MC special DM non shrink polymer grouting compound or approved equivalent chemical, finishing, curing etc as per manufacture's specification & instruction of engineer. Providing, supplying, mixing, applying two coats of ready acrylic polymer modified cement based flexible water proofing slurry like Emcefiex or approved equivalent conforming to IS to thickness of 2 mm on the surface of side wall after the chemical injection treatment shall be completed as specified under above paragraph.

Providing, supplying, mixing, laying cement plaster 12 mm thick with cement mortar 1:4 mixed with approved water proofing compound like MC special DM or equivalent confirming to IS as specified by the manufacture over the coated surface of operation specified in above paragraph

**U9 CURING**

- General: Begin curing as soon as waterproofing coating has hardened sufficiently so as not to be damaged by a fine spray. Cure waterproofing treatment with a mist fog spray of clean water three times a day for 2 to 3 days, or cover treated surface with damp burlap for the prescribed period. In warm climates, more than three sprayings per day may be necessary to prevent excessive drying of coating.
- Air Circulation: Do not lay plastic sheeting directly on the waterproofing coating as air contact is required for proper curing. If poor circulation exists in treated areas, it may be necessary to provide fans or blown air to aid in curing of waterproofing treatment.
- Holding Structures: For concrete holding structures such as swimming pools, reservoirs, water treatment tanks and wet wells, cure waterproofing treatment for three days and then allow treatment to set for 12 days before filling structure with liquid. For structure holding hot or corrosive liquids, cure waterproofing treatment for 3 days and allow to set for 18 days before filling.
- Protection: During the curing period, protect the treated surfaces from damage by wind, sun, rain and temperatures below 2°C. If plastic sheeting is used for protection, it must be raised off of waterproofing coating to allow sufficient air circulation.

**U10 FIELD QUALITY CONTROL**

- Observation: Do not conceal installed waterproofing system before Engineer, waterproofing manufacturer's representative and other designated entities has observed it.
- Flood testing:
- Perform flood test on completed waterproofing installation before placement of other construction.
- Plug or dam drains and fill area with water to a depth of 50 mm or to within 12.5 mm of top of waterproofing treatment.
- Let water stand for 24 hours.
- If leaks are discovered, make repairs and repeat test until no leaks are observed.

**U11 CLEANING AND PROTECTION**

- Cleaning: Clean spillage and soiling from adjacent surfaces using appropriate cleaning agents and procedures.
- Protection: Take measures to the completed waterproofing treatment from damage after application. Do not permit traffic on unprotected coating.

**U12 RATE**

The rate shall include all labor, materials and use of tools to carry out the following operation:

- a. Surface preparation and cleaning.
- b. Repairing structural defects, form tie holes, cavities and etc.
- c. Supplying and installation of waterproofing materials.
- d. Protection and curing the treated surfaces.
- e. Flood testing.
- f. And all other works required to complete the operations as per manufacturer's specification and product data.

**V ALUMINIUM WORKS****V1 SCOPE OF WORK****1. General**

- a) Work under this Division consists of the design, execution and completion of all Aluminium Works to all buildings for the Architectural Works all as indicated on the Drawings or as instructed by the Engineer.
- b) Aluminium Works shall include the design, manufacture, supply and installation with all associated frames, mullions, grounds, sub-frames, architraves, beads, cover strips, mouldings, glazing, glazing strips, insect screens, accessories and fixings of the following:
  - i) Aluminium doors (AD)
  - ii) Aluminium windows (AW)
  - iii) Aluminium screen with doors (AS)
  - iv) Aluminium louvers (AL)
  - v) Aluminium skylights (SKL)
- c) Aluminium louvers to external walls for connection of mechanical works shall include an approved type of insect proof screen with aluminium framing as specified in this Division.
- d) The materials for Aluminium Works shall be obtained from a manufacturer to the approval of the Engineer.
- e) The whole of the Aluminium Works shall be executed by the manufacturer or a specialist fabricator and installer approved by the manufacturer and the Engineer.
- f) Aluminium Works shall also include associated glazing and ironmongery which are specified under 40850 GLAZING and 40860 IRONMONGERY respectively.

**2. Submissions**

- a) Prior to commencement of Aluminium Works, the Contractor shall prepare a detailed Method Statement describing the labour, materials and Contractor's Equipment to be used and the method of work execution and obtain the Engineer's written approval. The Statement shall also describe the safety precautions to be adopted and all measures for compliance with environmental requirements.
- b) In addition and prior to commencement of the Aluminium Works, the Contractor shall prepare and submit the following for the Engineer's approval:
  - i) Details of the manufacturer and installer, including description of work experience, major equipment, labour, methods of quality control and safety control, etc.

- ii) Manufacturer's detailed technical data, specifications and installation instructions for all components and accessories within this Division
- iii) Shop drawings for all work required under this Division. Special attention shall be paid to the fabrication, assembly and erection requirements, material lists, joint and connection details and fixing details.
- iv) Shop drawings shall further indicate the location and installation details of all finish ironmongery.
- v) The Contractor shall prepare a full size finished mock up of one (1) complete section of the aluminium screen with door(s) (AS) with glazing, ironmongery and all associated works.
- vi) Samples and test certificates shall be provided of aluminium finishes and colours, together with cut lengths of full size aluminium section and profiles, as requested by the Engineer. Any materials delivered thereafter that the Engineer considers not equal to the approved samples, shall be rejected and removed from the Site.
- vii) Full size samples shall be provided for each corner connection and component detail, cut away as necessary to clearly indicate all door, window and frame construction and fabrication features, such as typical joints, connections, welding, seam treatments, finishings and other characteristics.
- viii) Samples of all finish ironmongery to be used in the work shall be submitted to the Engineer for approval, and no finish ironmongery shall be fitted until it has been approved.

### 3. Specific Standards

- a) Aluminium doors and windows shall comply with the requirements of JIS A4702 (for doors)/ A4706 (for sashes), IS1048/1049-1961 or other equivalent international standards.
- b) Required performance of steel doors shall be as follows, or equivalent:-
  - i) Wind-resistance performance: S-2 (JIS 4702) or equivalent

### 4. Manufacturers and Fabricators

- a) Manufacturers and fabricators shall have more than 5 years experience in similar works counted before the date of Bid opening.
- b) Items and components shall be the product of one (1) manufacturer, and units and parts thereof shall be readily interchangeable.
- c) Quality shall be of the highest international standard.

## V2 MATERIALS

### 1. Aluminium Frames

- a) Aluminium frames shall be extruded and conform to JIS H4100, equivalent standards.
- b) Thickness, unless otherwise specified, shall not be less than as follows:



- c) Load carrying members shall be per manufacturer's standards for profile sections required and as necessary to meet structural requirements. Minimum thickness shall be 1.8 mm or as indicated on the Drawings.
- i) Glass mouldings: 1.8 mm
  - ii) Exposed flashings: 1.6 mm
  - iii) Concealed flashings: 0.8 mm
- d) Finishing of aluminium materials shall be as follows:
- i) Anodised: conforming to JIS H8602, class B or equivalent
  - ii) Colour powder coating: conforming to relevant BS standards or equivalent, thickness not less than 60 micron.
  - iii) Colour: as directed by the Engineer from manufacturer's standard colour range
  - iv) Exposed surfaces to be mechanically polished, free from scratches, pits and any other imperfections or blemishes before anodising or powder coating

## 2. Louvers

- a) Louver and frame: aluminium blade with inverted "S"- section, opening area not less than 50 %

## 3. Melamine Plastic Panel

- a) Plywood: thickness not less than 8.0 mm
- b) Melamine plastic sheet: thickness not less than 1.5 mm

## 4. Glazing

As specified in the Drawings and 40850 GLAZING.

## 5. Fastenings

- a) Aluminium to steel shall be stainless steel only.
- b) Exposed and where permitted only, aluminium finished to match work with cross-slotted flat head types, countersunk flush.
- c) Exposed stainless steel to colour anodised work and where permitted only, heat treated to simulate anodising colour.

## 6a. Aluminum Composite Panel

Aluminum panel thickness	4 mm
Aluminum coil thickness	0.5 mm
Width	1220 mm
Length	2440, 3050, 3660 mm
Coating	PVDF
Protective Film	Dual shade
Weather Resistance	Maximum
Impact Resistance	No cracking at a maximum of 10N/m
Flatness	Total panel quality (Continuous stretching in accordance with the EN485-4neom)
Appearance	Completely evenness of finish and color

## 6b. Extruded polystyrene form for insulation

Physical Properties	Test method	Unit	Value
Density	ASTM D 1622	kg/m <sup>3</sup>	32
Compressive Strength at 10% deflection	ASTM D 1621	kPa N/mm <sup>2</sup>	≥300 0.300
Thermal conductive at 25°C	IS 3346	W/m-K Btu-in/ft <sup>2</sup> -h-°F	0.028 0.194
Thermal conductive at 10°C	IS 3346	W/m-K Btu-in/ft <sup>2</sup> -h-°F	0.014 0.097
Water Vapour Permeability	ASTM E 96	mg/hmPa	≥0.0037
Water absorption by Submersion (28 days)	ASTM D 2842	Volume%	≤1
Dimensional Stability	SPL test method	%	≤2
Flammability	DIN 4102,Part-1		B2
Width		mm	600
Length		mm	1250
Thickness		mm	30

**7. Others**

- a) Reinforcement, anchoring, etc. shall be stainless steel, hot dip galvanised carbon steel or aluminium alloy, to the approval of the Engineer.
- b) Air tightness components shall be made of polyamide.
- c) Hinges, arms, etc. shall be made of stainless steel or aluminium alloy.
- d) Insect screens shall be installed where indicated on the Drawings to the inside face of the windows. The frame of screen shall be made of aluminium alloy and screen of stainless steel mesh, 0.25 mm diameter or more; #16 to 18 mesh.
- e) Door thresholds: stainless steel sheet SUS 304, thickness 2 mm, hairline finish.
- f) Sealant shall be type SLT-2, polysulphide, with polyurethane back-up as specified in 30640 SEALANTS.
- g) Glazing recesses, glazing channels and gaskets shall be as shown on the Drawings.
- h) Wood adjusting blocks shall be of hardwood and shall be pre-treated in accordance with the requirements of Division 41000 WOODWORKS.

**8. Design Requirements**

- a) Aluminium Works shall be designed by the Contractor.
- b) The dimensions of aluminium profiles which are indicated on the Drawing for the aluminium work are in general minimum for reference only. The detail dimensions shall be finalised through the design by the Contractor.
- c) Each type shall be designed by the Contractor (or his specialist subcontractor) in order to achieve a completely coordinated integrated system of components complying in all respects to sizes, types, designs, performance, appearance and finishes specified or shown in the Specification or the Drawings.
- d) Members exceeding the specified dimension shall be provided with heavier wall thickness or internally reinforced as required and in lieu of increasing overall size differing from that shown or specified.
- e) The assemblies of doors, windows, grilles and skylights shall be designed and arranged to form and maintain an airtight and watertight assembly, free from leakage and rattling when subjected to maximum dimensional changes (expansion and/or contraction).
- f) Tempered glass doors for AS shall be frameless type.
- g) Size of aluminium grilles for mechanical works shall be coordinated with the respective specifications of mechanical equipment.
- h) All necessary weather drips, sealants, internal gutters, sleeves, weep holes and other work as necessary shall be provided.

- i) Stops, glazing recesses and neoprene glazing channels shall be provided, each sized to properly receive glass or panel thickness required, and with depths to meet or exceed minimum edge grips required by manufacturer of glass to be used.
- j) Allowance shall be made for expansion, contraction, building movement and settlement as required, with slip-joints or other special features as necessary.
- k) Anchors and connections to building structures shall be designed to safely resist all design loads; of types required and best suited for installation conditions likely to be encountered.
- l) Anchoring of jamb, water creasing and other main parts of doors/windows by bolting or screwing shall not be allowed.
- m) Mullions, back-mullions, transom bars and other intermediate or special items shall be provided as shown or approved.

### **V3 CONSTRUCTION METHOD**

#### **1. Fabrication Requirements**

- a) Aluminium welding shall be performed only by qualified welders, experienced in the type of work required.
- b) Welds shall be in concealed locations only; exposed surfaces shall be free from evidence of welding.
- c) Exposed intermediate joints in running members shall be permitted only if or where shown or approved.
- d) Joints shall be prepared for precision fit for neat, hairline appearance free from voids, burrs or other irregularities.
- e) Matching sleeves shall be provided for interior side of joints where spaced open for contraction-expansion.

#### **2. Protection**

- a) After fabrication, members and assemblies shall be suitably protected against weather or other damage, maintained in place and in good repair for as long as necessary.
- b) After erection, surfaces not otherwise shop protected shall be coated using clear, non-yellowing, high-gloss lacquer or equivalent proprietary protective coating applied and removed in accordance with manufacturer's instructions. Coatings which adversely affect colours or finishes or leave permanent residual deposits shall not be permitted.

#### **3. Assembly Requirements**

- a) Aluminium Works under this Division shall be factory assembled only, other than surface mounted or other finish ironmongery items projecting above finished surfaces.
- b) Other associated units, such as ironmongery, insect screens, and the like: optional factory or site assembly subject to approval of the Engineer.

**4. Installation Requirements**

- a) Frames:
- i) Shall be connected to building structures by anchors.
  - ii) Shall be installed in straight alignment parallel to building or column lines.
  - iii) Units set plumb, square and level, edges uniformly spaced and shimmed for sealant recesses.
  - iv) Members securely attached and free from movement, other than allowances for thermal variations as required.
- b) Doors
- i) Installed accurately aligned with frames; plumb in all positions of swing, adjacent leaves accurately aligned.
  - ii) Each unit square; faces true to plane and free from warps.
  - iii) Each unit plumbs in all positions of swing.
  - iv) Complete with vinyl or neoprene seals.
- c) Water Flashing/Sills
- i) Shall be installed accurately set to align with doors and frames, at positions required for operation of exit devices where required
  - ii) Shall be secured in place level, and grouted per requirements.
  - iii) Fastener heads shall be flushed countersunk.
- d) Windows, Louver, Skylights,
- i) Shall be installed in straight alignment, parallel to walls and building lines, adjacent units accurately aligned.
  - ii) Units shall be set plumb square and level, vents and blades level in all positions of swing, pivoted windows plumb in all positions of rotation.
  - iii) Each unit shall be well fitted and securely attached to supporting frames.
  - iv) Shall be complete with vinyl or neoprene seals and sealants.
- e) Voids behind thresholds shall be filled with mortar type M2 specified in 41110 IN SITU FINISHINGS. Thresholds shall be supported in position by galvanised or stainless steel rods by welding to reinforcement bars in the slab prior to mortar filling.

**5. Completion Requirements**

- a) Exposed surfaces shall be clean and free from scratches, dents, warping, waviness, buckling, broken parts or units, misaligned or improperly fitted joints, streaks, stains, discolouration or other defects or damage.
- b) Installations shall be free from exposed fastenings; unnecessary cuts, holes or blank plates; and exposed steel connections or reinforcing, other than as particularly shown, specified or approved.
- c) Installation shall be watertight throughout and free from leaks or entry of water into or through interior or concealed spaces of structure; other than via waterways or provisions for drainage as particularly provided for or approved.
- d) Each assembly shall be tightly and rigidly secured in place and free from unnecessary movement, squeaks or rattles.
- e) Movable or mechanical items or devices shall be serviced and adjusted to operate smoothly, quietly, easily and free from squeaking or binding.

**V4 QUALITY CONTROL/ TOLERANCES/ TESTING**

- a) Aluminium works with all frames, attachments and accessories shall satisfy the following requirements.-

**Table V4-1 - Aluminium Works – Tolerances**

Location/Position	Sizes (m)	Tolerances (mm)
Clearance Frame Opening	less than 2.0	± 1.5
	less than 3.5	± 2.0
	3.5 or more	± 2.5
Differences between Diagonal Clearances of Frame Opening	less than 2.0	=< 2.0
	less than 3.5	= < 3.0
	3.5 or more	=< 4.0
Height and Width of Leaf	-	± 1.5
Differences between Diagonals of Leaf	-	=< 3.0

**V5 GUARANTEE**

- a) Further to the requirements of Specification 10091 SCOPE OF CONTRACTOR'S DESIGN, the Contractor shall guarantee the water-tightness, colour fastness and durability of the Aluminium Works. The guarantee shall cover against warping and twisting of panels and frames and corrosion. The guarantee shall cover the colour fastness of aluminium components over the same period,

guaranteeing that if fading occurs then the colour shade of all components will stay the same and no noticeable differential colour shading shall occur.

- b) Refer to 40020 GUARANTEE:
  - i) Aluminium Works - Minimum two (2) years

## **V6 MEASUREMENT/ RATES**

### **1. Measurement**

- a) Aluminium Works shall be measured according to the item descriptions, classifications and units in the Bill of Quantities (BOQ) in the particular Division of the BOQ.
- b) Quantities shall be computed from dimensions on the Drawings.
- c) If measured separately in the particular Division of the BOQ, Aluminium Works shall be enumerated (no.) according to the item units and classifications in the Bill of Quantities.

### **2. Rates**

- a) The rates shall be full compensation for all plant, materials, transport, labour, equipment, temporary works, establishment charges, overheads, profit and taxes required to complete the Work described in this Division of the Specification and/or shown on the Drawings.
- b) Rates for Aluminium Works shall further include for:
  - i) Frames, jambs, heads and transoms.
  - ii) Sub-frames and grounds.
  - iii) Truss mullions, back-mullions and horizontal mullions.
  - iv) Flashings, drips, mouldings, cover beads, sills, trims, thresholds.
  - v) Termite treatment for all timber components.
  - vi) Colour anodising.
  - vii) Integral louvers and grilles.
  - viii) Galvanising all steel surfaces.
  - ix) Glass, glazing seals, glazing gaskets, glazing beads, anti-shatter film and personnel protection markings.
  - x) All ironmongery including, hinges, locking mechanisms, closing mechanisms, indicators, handles, etc.
  - xi) Automatic opening/closing devices to designated doors with all interface connections

- xii) Fixings, anchorages, anchor re-bars, welding, plugs, screws, nails and other proprietary fixings.
- xiii) Void filling mortar and insulation.
- xiv) Sealant and sealant back-up.
- xv) Protection.



## **W PILING FOR STRUCTURES**

### **W1 SCOPE**

This section covers the works connected with various types of piles required for structures.

### **W2 DEFINITIONS AND GENERAL REQUIREMENTS**

The requirements contained in this specification and in the Drawing are the minimum requirements. Strict compliance with these minimum requirements shall not relieve the Contractor of the responsibility of adopting whatever additional measures which may be necessary to ensure the completion of the work to the satisfaction of the Engineer. Unless contracted hereunder, the provision of IRC: 78-1983 shall be strictly followed.

The Contractor shall report immediately to the Engineer any circumstances which indicate that the ground conditions differ from those expected by the Contractor from his interpretation of the soil survey so as to materially affect the bearing capacity of the piles.

### **W3 BORED AND CAST IN-SITU PILES**

#### **(1) Steel Casing**

When permanent steel casing is shown on the Drawing, the minimum thickness shall be 10 mm. The minimum length shall be from 100 mm above the bottom of the pile cap to 5 meter under the river bed or into the firm strata. Joints between casing shall be approved by the Engineer. The casing shall be handled and stored in a manner that shall prevent bucking and other deformation as well as accumulation of dirt, oil and paint.

#### **(2) Concrete**

The concrete shall conform to the requirements specified in Section F.

Concrete placed under water or drilling mud by tremie shall have a cement content of not less than 350 kg/m<sup>3</sup>. The density and consistency of the concrete shall conform to the tremie casting method. Sufficient workability (slump) of all the concrete during the casting and handling of casing including reasonably calculated delays, shall be secured by a design mix. Necessary retarders and plasticizers shall be tested by trial mixes prior to the pile construction.

All relevant concrete properties such as slump, time of setting, temperature and strength shall be measured on the trial mixes.

#### **(3) Reinforcement**

The reinforcement shall conform to Section O.



**(4) Drilling Fluid**

The following requirements shall be complied with, if bentonite mud is used to stabilize the boreholes:

**(a) Supply**

A certificate shall be obtained by the Contractor showing the properties of the consignment delivered to the site. This certificate shall be made available to the Engineer for his approval.

The Contractor shall get approval of the Engineer for any other material proposed by him for the drilling fluid.

**(b) Mixing**

Bentonite and any other material shall be mixed thoroughly with clean water to make a suspension which shall maintain the stability of the pile excavation for the period necessary to place concrete and complete the construction.

**(c) Tests**

The frequency of testing drilling fluid along with method and procedure of sampling shall be proposed by the Contractor for approved by the Engineer prior to the commencement of the work. The frequency may subsequently be varied as required, depending on the consistency of the result obtained.

The Contractor shall supply all equipments and experienced operators required to carry out tests on the drilling mud. No additional payment shall be made for these tests which shall be considered as an essential part of the drilling operations.

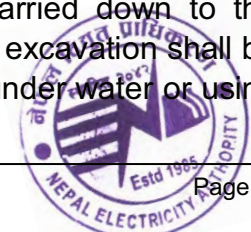
**(5) Construction Methods**

The Contractors shall demonstrate to the satisfaction of the Engineer that his proposed construction method for the pile do not weaken the pile shaft by contamination of the concrete by sectional reduction, by washing out of cement, by breaking during pulling of temporary casing or in any other way including the construction of neighboring piles.

**(a) Procedure**

The following construction procedure shall be followed:

- i. If permanent steel casings is not specified, a sufficient length of temporary steel casing shall be used to stabilize the upper part of the borehole.
- ii. Boring and excavation inside the steel casing shall be carried down to the casing toe level or to a level approved by the Engineer. The excavation shall be continue to final pile tip level using either temporary casing under water or using



- drilling mud. The fluid level inside casing shall at all times be at least 2 meters higher than outside the casings.
- iii. All mud or sedimentation from the bottom of borehole shall be cleaned up.
  - iv. Reinforcement cage, inspection pipes etc. shall be placed shown on the drawing or instructed by the Engineer.
  - v. Concreting underwater or drilling fluid shall be carried out continuously using tremie method.
  - vi. Withdrawing of the temporary boring casing to the instructed level shall be carried out concurrently with concreting.
  - vii. After hardening, the top Section of the concrete pile shall be broken to reach sound concrete in the pile.

**(b) Approval of Construction Method**

The Contractor shall describe the construction method he proposes, including name of proposed Sub-contractor (if any), information on boring equipment, materials, method of boring and quality control.

After the contract has been awarded the Contractor shall prepare a detailed programme and establish for the pile construction. The detailed programme shall contain all required information on materials, equipment, methods of work etc., and be approved in writing by the Engineer. Such approval shall not however relieve the Contractor of his responsibilities for pile construction. The import of any boring equipment or materials by the Contractor, before he has received the Engineer's approval of proposed construction methods, shall be at the Contractor's risk.

The Contractor shall check the casing position for each pile during and immediately after placing the casing, and agree it with the Engineer.

**(c) Tolerances**

The Centre of the complete pile at cut off level shall not deviate more than 100 mm from the theoretically correct position shown on the drawing. The inclination of the pile shall not deviate more than 1:100 from vertical. The Contractor shall provide suitable equipment such as inverted pendulum, to check the verticality of the boreholes at intervals during drilling and prior to concreting.

**(6) Boring****(a) Methods**

Methods of excavation shall be proposed by the Contractor for approval of the Engineer. Water or air jetting for boring of the piles shall not be allowed.



**(b) Boring near recently cast Piles**

Piles shall not be bored so close to other piles which are cast and contain workable or unset concrete likely to flow.

Boring and excavation for a pile shall not commence until 24 hours after completion of any pile within a radius of 6 metres center to center.

**(7) Temporary Casing**

Temporary casing of approved quality or an approved alternative method shall be used to maintain stability of pile excavation which might otherwise collapse.

**(8) Stability of Pile Excavation using Drilling Fluid**

Pile through water and/or soft upper soil layers shall be provided with permanent steel casing if shown in the Drawing.

The pile boring shall be carried out using temporary steel casing bored in pile toe, to the level of side fall or to a level approved by the Engineer. Before concreting the temporary casing shall be gradually withdrawn. Under certain circumstances the Contractor may be permitted to bore all part or the pile without casing under water or using drilling fluid to stabilize the borehole.

Where borehole is formed without casing under water or using drilling fluid for maintaining the stability of a boring, the level of the water or fluid in the excavation shall be maintained so that the water or fluid pressure always exceeds the pressure exerted by the soils and external ground water. The water or fluid level shall be maintained at a level not less than 2 meters above the level of the ground water level or any artesian pressure level.

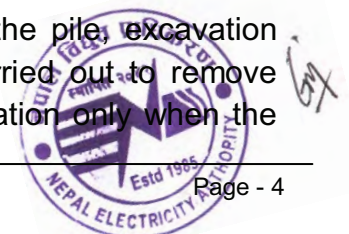
In the event of a rapid loss of water or bentonite suspension from the pile excavation, the excavation shall be backfilled without delay and the instruction of the Engineer shall be obtained before excavation at that location is resumed.

**(9) Pumping**

Pumping from the borehole shall not be permitted unless a casing has been placed into a stable stratum which prevents the flow of water from other strata in significant quantities into the boring, or unless it can be shown that pumping shall not have a detrimental effect on the surrounding soil or property.

**(10) Removal of Obstruction**

Where boulder or other obstruction render it impossible to bore the pile, excavation operation inside pile casing as directed by Engineer shall be carried out to remove obstructions. The Contractor shall be reimbursed from such operation only when the



largest dimension of the obstruction exceeds 200 mm and the obstruction is found more than 2 meters below the ground level.

Disturbed and/or undisturbed samples of the soils from boreholes shall be submitted to the Engineer. The contractor shall allow for carrying out sampling and tests to check soil strength including field tests like SPT tests as required by the Engineer.

### **(11) Final Toe Level of Piles**

The final toe level shall be as indicated on the drawing or as instructed by Engineer after due consideration of the Contractor's proposals, boring logs and test results.

The final toe level of other piles may subsequently be altered according to the results of the tests loading detail in the Section.

### **(12) Inspection and Cleaning bottom of Excavation**

The time between final excavation including bottom cleaning and the start of concreting shall be reduced as much as possible and in any case shall not exceed 6 hours.

The cleaning shall be done by an approved method. Before cleaning bottom of every excavation, notice shall be given to the Engineer. The Contractor shall show, to the satisfaction of the Engineer, that the bottom of the excavation is clean.

If boring without casing, the diameter of the borehole for a representative number of piles shall be measured by caliper to the placing of concrete.

These measurements shall be done by the Contractor using approved equipment and no reimbursement shall be made for this.

### **(13) Placing Reinforcement**

The reinforcement shall be placed as indicated on the Drawing. Reinforcement in the form of a cage shall be assembled with additional support, such as spreaders forks and lacings necessary to form a rigid cage. Hoops, links or helical reinforcement shall fit closely around the main longitudinal bars and be bound to them by approved wire, the ends of which shall be turned into the interior of the pile or pour. Reinforcement shall be placed and maintained in position. The cover to all reinforcement shall be not less than 75 mm.

Joints in longitudinal bars in piles with tension (for instance for test loading) shall be carried out by welding unless another method has been approved by the Engineer.



**(14) PLACING CONCRETE****(a) Approval from the Engineer**

No concreting shall take place before the bottom of excavation has been cleaned. The Contractor shall get borehole inspected and obtain approval in writing from the Engineer.

**(b) General Requirements**

While placing concrete, these requirements shall be complied with

- i. The method of placing and workability of the concrete shall be such that a continuous monolithic concrete shaft of the full cross Section is formed.
- ii. The concrete shall be placed continuously and without such interruption as would allow the previously placed batch to have hardened. In this respect the Contractor shall submit details of his contingency plans, standby plants etc. to be utilized in the event of an equipment failure.
- iii. The use of pumped concrete and the methods in its use shall be approved.
- iv. The Contractor shall take precautions in the design of the mix and placing of the concrete to avoid arching of the concrete in a casing. No spoil, liquid or other foreign matter shall be allowed to contaminate the concrete.
- v. Concrete to be placed under water or chilly fluid shall be placed by tremie and shall not be discharged freely into the water or drilling fluid.
- vi. Before concrete, measures shall be taken to ensure that there is no accumulation of silt or other material at the base of the boring. The Contractor shall ensure that heavily contaminated bentonite suspension, which could impair the free flow of concrete from the pipe of the tremie, has not accumulated in the bottom of the hole.
- vii. A sample of the bentonite suspension shall be taken from the base of the boring using an approved sampling device. If the specific gravity of the suspension exceeds 1.25, the placing of concrete shall not proceed. In this event the Contractor shall modify the mud quality. The concrete shall be a rich and coherent mix of high workability in accordance with the requirement.
- viii. The concrete shall be placed in such a manner that segregation does not occur.
- ix. During and after concreting damage to the concrete from pumping and dewatering operations shall be avoided.
- x. The hopper and pipe of the tremie shall be clean and watering throughout. The pipe shall extend to the base of the boring. A sliding plug or barrier shall be placed in the pipe to prevent direct contact between the first charge of concrete in the pipe of the tremie and the water of drilling fluid. At all times the pipe shall penetrate the concrete placed and shall not be withdrawn from the concrete until completion of concreting. The bottom of the tremie pipe shall be kept at least 1.5 metres under the surface of concrete. At all times a sufficient quantity of concrete shall be maintained within the pipe to ensure that the pressure from it exceeds that from the water or drilling fluid. The internal diameter of the pipe

tremie shall not be less than 150 mm for concrete made with 20 mm aggregate and not less than 200 mm for concrete made with 40 mm aggregate. It shall be so designed that external projections are minimized, allowing the tremie to pass through reinforcing cages without causing damage. The internal face to the pipe of the tremie shall be free from projections.

- xi. The Contractor shall maintain a continuous record of the volume of concrete used and the level of the concrete in the pipe. Any deviations from the theoretical, or expected, volume/level relationship shall be immediately reported to the Engineer.

### (c) Workability of Concrete

Slump measured at the time of discharge into the pile shall be in accordance with that given in the Table W.1.

Table W.1: Slump of Concrete for Pile Boring

Pilling mix workability	Slump		Typical conditions of use
	Minimum mm	Range mm	
A	75	75-150	Placed into water free unlined or permanently lined bore of 600 mm diameter or over where casting level lies below temporary casing: reinforcement widely spaced bearing ample room for free movement of concrete between bars.
B	100	100-200	Where reinforcement is not spaced widely where cut off level of concrete is within temporary casing where pile bore is water free and the diameter is less than 600 mm.
C	150	150	Where concrete is to be placed by tremie under water or chilly mud or by pumping.

## (15) Extraction of Temporary Casing

### (a) Workability of Concrete

Temporary casing shall be extracted while the concrete within remains sufficient workable to ensure that the concrete is no lifted.

### (b) Concrete Level

When the casing is being extracted a sufficient quantity of concrete shall be maintained in it to ensure that pressure from external water, drilling fluid or soil is exceeded and that the pile is neither reduced in Section nor contaminated. The toe of the temporary casing shall be kept at a minimum of 2 metres under the outlet of the tremie.

Adequate precautions shall be taken in all cases where excess head of water or drilling fluid exists.

The pile shall be concreted with certain over height to allow for chiseling off the top concrete down to sound hard concrete.

### **(c) Vibrating Extractors**

The use of vibrating casing extractors shall be permitted for the extraction of the casing.

### **(d) Reinforcement Cage**

During concreting and pulling casing, the reinforcement cage shall be secured against uplift the top shall be kept under close monitoring.

### **(e) Supervision**

The execution of the pile concreting shall be supervised by a qualified and experienced person of the Contractor, who shall keep records on the relation between quantity of concrete used, level of concrete and withdrawal of casing.

### **(16) Measures In case of Rejected Piles.**

If any pile is found unsatisfactory in the opinion of the Engineer for utilization in the structure, it shall be cut off below the pile cap, if so ordered by the Engineer. The piles shall be replaced as directed by the Engineer. All extra expenses shall be borne by the Contractor and the payment shall be made for original piles only considering that no replacement piles are bored.

When by test, the safe allowable bearing value of any pile is found to be less than the design load, longer piles or additional piles shall be installed as ordered in writing by the Engineer.

## **W4 MICROPILING**

### **(1) Description**

Furnish and place micropiling consisting of small diameter steel casing, grouted in place, and conforming to the details shown in the plans and this special specification.

### **(2) Materials**

The Contractor shall use materials that meet requirements of the following Items:

- a) The pipe for Micro pile must be approved brand medium quality Mild steel black pipe.
- b) The grout shall be cement sand slurry mixed with grouting chemical of approved brand core grout IG1 or equivalent (dosing – according to manufacturer)

specification). The grout shall be non-shrink cement grout. The grout mix design such as the water cement ratio, the minimum cement and grout strength at 7 and 28 days shall not be less than M20. Grout shall be tested in accordance with BS 1881 and BS 4550. If Grout cube as tested failed to satisfy the criteria as prescribed in specification and the drawings, the piles constructed using this batch of grout shall be rejected. The contractor shall undertake all necessary additional and consequential remedial/ compensatory work to the approval of the Engineer.

### (3) Working Drawings

The Contractor shall submit complete project specific working drawings for the micropile system, to the Engineer.

The Contractor shall include all information required for the construction and quality control of the piling, including the following:

- A. Information on headroom and space requirements for installation equipment that verify that the proposed equipment can perform at the site.
- B. Step-by-step procedure describing all aspects of pile installation including personnel, testing and equipment to assure quality control. Indicate the step-by-step procedures on the working drawings in sufficient detail so that the Engineer can monitor the construction and quality of the micropiles.
- C. Details for drilling a plumb hole.
- D. Details of centralizers.
- E. Grout mix designs.
- F. Details and procedures involved in testing components, including grout.
- G. Pipe
- H. Details of equipment and operation for grouting. Include provisions for monitoring grout quality, volume installed, and pressure during installation.
- I. Information on the minimum cure time and strength requirements of the pile system for test piles.
- J. Drawing showing micro pile location, number, design load, type and size.
- K. Post construction, Within 30 calendar days after completion of work, submit the following: As-built drawing showing locations of the micro piles and length; detailed drilling records; grouting records indicating the cement type and quantity injected; micro pile test results and graphs.

The Contractor should provide the Engineer sufficient time to review the working drawing submittal after a complete set has been received. The Contractor should not install micropiling until the Engineer has approved, in writing, the working drawing submittal.



**(4) Construction.**

- a) The Contractor shall dispose of cuttings and micropile installation and spilled or wasted grout in accordance with the Plans and federal, state and local laws. Core drilling, rotary drilling, percussion drilling, auger drilling, driven casing or other acceptable means unless otherwise directed shall be used. The Micropile can be installed in the drill hole after drilling or it can be advanced by the drill.
- b) Drilling mud or chemical stabilizers shall not be used. Foreign material dislodged or drawn into the hole during construction of the micropiles shall be removed. Remove loose material existing at the bottom of the hole after drilling operations are complete before placing grout.
- c) Centralizers when installing steel casing should be used. Provide a positive means of support for maintaining the position of the casing and reinforcement until the grout has set. Use a neat cement grout or a sand-cement grout with a minimum 28 day unconfined compressive strength of 4,000 psi. Mix the grout to produce a uniform mixture free of lumps and undispersed cement. Equip the pump with a pressure gauge to monitor grout pressures. Provide a pressure gauge capable of measuring pressure of at least 150 psi or twice the actual grout pressures used by the contractor, whichever is greater.
- d) Grouting equipment capable of pumping the grout in one continuous operation should be used. The mixed grout during pumping operations should be continuously agitated. Grout must be injected from the lowest point of the drilled hole. The grout may be pumped through grout tubes, casing, hollow-stem-augers or drill rods. Record the quantity of the grout and the grout pressures. Control the grout pressures and grout takes to prevent excessive heave. Fill the entire Micropile with grout. The grout tube may remain in the hole provided it is filled with grout.

The Micropile should not be loaded until three days after grouting.

**W5 PILE TESTS****(1) Test Piles**

The Contractor shall furnish test piles of the type, number and length specified in the contract. Generally the test piles shall be located so as to permit their use in the finished structure and they shall be installed at the positions shown on the Drawing or specified in the contract.

In order to obtain the best possible data from the test piling the Engineer shall have the right to change test piles from their planned location to any other location in that group or any other group of the structure without any adjustment in the Contract Prices.

The installation shall be done using the same equipment as is to be used for installing the other piles in the works. The Contractor shall co-operate with and assist the Engineer in obtaining data for bearing for the full length of the installation.



**(2) Loading Tests**

Loading tests shall be made on those piles shown in the Drawing or ordered by the Engineer. All labour, material, equipment and attendance required to complete the tests shall be furnished by the Contractor.

The piles shall be tested as follows:

- a) The test load shall generally be 200% shown of the bearing required in the contract and be applied by a method approved by the Engineer. It shall be measured within an accuracy of plus or minus 2%. Settlements shall be measured within an accuracy of plus or minus 0.25 mm.
- b) The test load shall be applied in the increments as specified or approved by the Engineer. These shall generally be those recommended in IS 2911.
- c) The load after each increment shall be kept constant until the rate of settlement does not exceed 0.25 mm per hour.
- d) The value of settlement shall be recorded before the next increase of load.
- e) The full test load shall be maintained for 48 hours and the total settlement shall be recorded.
- f) The load shall be reduced in decrements equal to the increments with which it was applied.
- g) The load after each reduction shall be kept constant until the rate of recovery does not exceed 0.25 mm per hour.
- h) The amount of recovery shall be recorded before the next decrease of the load.
- i) The Contractor shall, with 24 hours of the completion of the test, submit to the Engineer for each pile tested, graphs showing;
  - i. Load plotted against settlement and time
  - ii. Settlement and recovery plotted against load.
- j) The settlement of the pile under the test load and recovery of the pile after the removal of the load shall be within the limits required in the contract or ordered by the Engineer.

**(3) Other Requirements of Loading Tests**

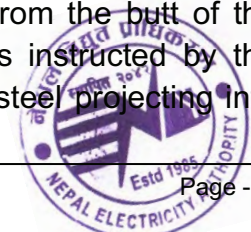
- a) A load test shall consist of the application of a load equal to twice the specified bearing capacity or as otherwise provided for herein or as directed by the Engineer. Unless otherwise permitted by the Engineer the load tests shall be completed before the remaining piles in the same structure are driven or cast.
- b) Load tests shall be performed on the day indicated by the Engineer. The Engineer may order load tests to be performed on piles other than test piles and may also specify different increments of load, more frequent loadings of gauges and different period of loadings than specified herein or in Sub-clause W5(2). Such changes shall not constitute any claim by the Contractor for any additional payment or compensation other than payment for test pile and load test in accordance with the contract unit price quoted by the Contractor in the Bill of Quantities.



- c) Load tests shall be made by method approved by the Engineer. The Contractor shall submit to the Engineer detailed plans of loading system and apparatus he intends to use at least 3 weeks in advance. The apparatus shall be so constructed so as to allow the various increments of the load to be placed gradually without causing vibration to the test piles. Tension anchor piles, if used, shall be of a design and driven to a depth satisfactory to the Engineer. Steel shells or piles whose walls are not of adequate strength to withstand the test loading when empty, shall have the required reinforcement and concrete placed before loading.
- d) The load test shall not be started until the concrete has attained a minimum compressive strength of 95% of specified strength. If the Contractor so selects, he may use high early strength cement (but not high alumina cement) in the concrete of the load test pile and the tension piles in order to decrease the time for load testing.
- e) Suitable approved apparatus for determining accurately the load on the pile and the settlement of the pile under each increment of load shall be supplied by the Contractor. The apparatus shall have a working capacity of three times the design load for the pile being tested. Reference points for measuring pile settlement shall be sufficiently removed from the pile to preclude all possibility of disturbance.
- f) All pile load settlements shall be measured by adequate devices, such as gauges, and shall be checked by means of an Engineer's level. Increments of deflection shall be recorded just after application of each load increment and at 15 minutes intervals thereafter. The safe allowable load shall be considered as 50 percent of the load which, after 48 hours of continuous application, has caused not more than 6 mm of permanent settlement, measured at the top of this pile.
- g) The first load to be applied to the test pile shall be 50% of the pile design load and the first increment shall be up to the pile design load. The load on the pile shall be increased to twice the design load by applying additional loads in three equal increments. A minimum periods of 2 hours shall intervene the application of each increment. If there is a question as to whether the test pile shall support the test load, the load increments shall be reduced by 50 percent, at the direction of the Engineer, in order that a more closely controlled failure curve may be plotted.
- h) When directed by the Engineer load tests shall be continued beyond twice the design load in 10-ton increments to failure or to a maximum of 3 times the design load.

## **W6 MEASUREMET**

The piles shall be measured in line metres of pile as completed and accepted in the structure. Pay lengths of the accepted piles shall be measured from the butt of the shoe to the cut-off level of the pile shown on the Drawing or as instructed by the Engineer. No allowance shall be made for cut-offs or reinforcing steel projecting into



the concrete structure as called for in the Drawing. Any additional pile lengths that may be necessary to suit the Contractor's method of operation or for any other reasons shall not be included in the measurements.

Test piles shall be measured per number of load test carried out including the complete installation of the pile. Piles driven by the Contractor for his own information or for calibrating diesel hammers shall not be measured as test piles.

Micropiles will be measured in line metres of pile as completed and accepted by the Engineer.

## **W7 PAYMENT**

The quantities of piling left in place in the accepted structure, measured as provided above, shall be paid at the contract unit rate. The contract unit rate shall be the full and the final compensation to the Contractor for all expenditures incurred by the Contractor for incidentals and for doing all the works involved in driving, placing filling materials for cast-in-situ or driven piles, cutting off piles as specified in this specification.

Additional quantities of concrete, reinforcement and form work, caused by incorrect location of piles or additional piles necessary to replace defective piles shall be at the Contractor's expense.

Test piles shall be paid at contract unit rate which shall be full and final compensation for the cost of all operations and incidental costs associated with supply of piles in place and testing.

The contract unit price paid for micropile includes full compensation for designing and furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing micropiles, including casings, grout, cutting tips, drill bits, pile anchorage, and disposing of materials resulting from pile installation, complete in place, as shown on the plans, as specified in the Standard Specifications and this special specification, and as directed by the Engineer.

No payment will be made for micropiles that are damaged either during installation or after the micropiles are complete in place. No payment will be made for additional excavation, backfill, concrete, reinforcement, nor other costs incurred from footing enlargement resulting from replacing rejected micropiles.



**X ANTI-TERMITE TREATMENT****X1 SCOPE**

This section covers the works connected with the anti-termite treatment.

**X2 DEFINITIONS**

The prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

**a) Materials**

Chemicals: Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used:

- (i) Chlorphosphos emulsifiable concentrate of 20%
- (ii) Lindane emulsifiable concentrate of 20%

To achieve the specified percentage of concentration, Chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. .

**b) Safety Precautions**

Chemical used for antitermite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed. The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons carrying out chemical soil treatments should familiarize themselves and exercise due care when handling the chemicals whether in concentrated or in diluted form. After handling the concentrates or dilute emulsion, worker shall wash themselves with soap and water and wear clean clothing especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought. The use of chemical shall be avoided where there is any risk of wells or other water supplies becoming contaminated.

**c) Treatment**

- (i) **Treatment along outside of foundations:** The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 litres per square metre of vertical surface of the sub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 litres per running metre of the channel. Rodding with 12 mm diameter mild steel rods at 150 mm apart shall be done in the channel. If necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 litre per running metre shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm

diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linear metre. In soils which do not allow percolation of chemicals to desired depth, the uniform disposal of the chemical to a depth of 300 mm shall be obtained by suitably modifying the mode of treatment depending on site condition.

In case of RCC foundations the soil (backfill) in contact with the column sides and plinth beams along with external perimeter of the building shall be treated with chemical emulsion at the rate of 7.5 litres/sqm. of the vertical surface of the structure. To facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams upto a depth of 300 mm or upto the bottom of the plinth beams, if this level is less than 300 mm.

The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

(ii) **Treatment of Soil under Floors** : The points where the termites are likely to seek entry through the floor are the cracks at the following locations:

- (a) At the junction of the floor and walls as result of shrinkage of the concrete
- (b) On the floor surface owing to construction defects
- (c) At construction joints in a concrete floor, cracks in sections
- (d) Expansion joints in the floor.

Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever such cracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or upto a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-charge.

d) **Treatment of Voids in Masonry** : The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at 300 mm intervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

### **X3 Measurement**

Measurement shall be in square meter of applied surface both horizontal and vertical.

### **X4 Payment**

Payment for work will be made on the basis of contract unit price indicated in the BOQ. The payment will be full and final compensation for all material, labor, and equipment to complete the works as specified.



**SPACIFICATION OF PLUMBING AND SANITARY WORK**

**SECTION 1. SANITARY FIXTURES**

- 1.1 SCOPE OF WORK
- 1.2 GENERAL REQUIREMENTS
- 1.3 INDIAN WC
- 1.4 EUROPEAN WC SET
- 1.5 URINALS
- 1.6 HAND WASH BASIN
- 1.7 SINKS
- 1.8 MIRRORS
- 1.9 SHOWER SET
- 1.10 BATHTUB
- 1.11 SCRUB SINK
- 1.12 SHOWER CURTAIN WITH ROD
- 1.13 COMPACT HAND DRYER
- 1.14 WALL HUNG ELECTRIC STORAGE WATER HEATER
- 1.15 ACCESSORIES
- 1.16 MEASUREMENT

**SECTION 2. WATER SUPPLY SYSTEM (INTERNAL & EXTERNAL)**

- 2.1 SCOPE OF WORK
- 2.2 GENERAL REQUIREMENTS
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- 2.4 CLAMPS
- 2.5 UNIONS



- 2.6 FLANGES
- 2.7 TRENCHES
- 2.8 GM GATE / GLOBE VALVES
- 2.9 BUTTERFLY VALVE
- 2.10 NON RETURN VALVE
- 2.11 AIR VALVES
- 2.12 SCOUR VALVES
- 2.13 STORAGE TANKS AND OVERHEAD TANKS
- 2.14 TESTING
- 2.15 MEASUREMENT

**SECTION 3. DRAINAGE (SEWERS AND STORM WATER)**

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- 3.2 GENERAL REQUIREMENTS
- 3.3 ALIGNMENT AND GRADE
- 3.4 EXCAVATION
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- 3.6 GULLY TRAPS
- 3.7 UPVC PIPES FOR DRAINAGE
- 3.8 FITTINGS
- 3.9 JOINTS
- 3.10 CLEANOUT PLUGS
- 3.11 CEMENT CONCRETE & MASONRY WORKS (FOR MANHOLES AND CHAMBERS ETC).
- 3.12 MEASUREMENTS

**SECTION 4. SOIL, WASTE & VENT PIPES & RAIN WATER PIPES**

- 4.1 SCOPE OF WORK



- 4.2 GENERAL REQUIREMENTS
- 4.3 UPVC PIPES AND FITTINGS
- 4.4 FITTINGS
- 4.5 FIXING
- 4.6 JOINTING
- 4.7 TESTING
- 4.8 TRAPS
- 4.9 CLEANOUT PLUGS
- 4.10 WASTE PIPE FROM APPLIANCES
- 4.11 RAINWATER PIPES AND FITTINGS
- 4.12 MEASUREMENT

**SECTION 5. WATER TREATMENT PLANT**

- 5.1 WATER TREATMENT SCHEME
- 5.2 COMPACT AND MODULAR TYPE REVERSE OSMOSIS SYSTEM

**SECTION 6. LIST OF APPROVED MAKES OF MATERIALS**



**SECTION 1. SANITARY FIXTURES****1.1 SCOPE OF WORK**

- 1.1.1 Work under this section shall consist of furnishing all labour materials necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories required by the drawings, specified hereinafter or given in the schedule of quantities and approval of the Consultant.
- 1.1.2 Without restricting to the generality of the foregoing the sanitary fixtures shall include all sanitary fixtures, chromium plated fittings and accessories etc, necessary and required for the buildings.
- 1.1.3 Whether specifically mentioned or not all fixtures, appliances and accessories shall be provided with all fixing devices, nuts, bolts, screws, hangers as required and said by the Consultant.

**1.2 GENERAL REQUIREMENTS**

- 1.2.1 Sanitary fixtures shall be of the best quality approved by the Consultant. Wherever particular makes are mentioned, the choice of selection shall remain with the Consultant.
- 1.2.2 All fixtures and fittings shall be provided with all such accessories and fixing devices as will be required to complete the item in working condition whether specifically mentioned in the schedule of quantities, specifications or drawings or not.
- 1.2.3 All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Consultant's/interior designer's requirements. Wherever necessary, the fittings shall be centered to dimensions and pattern desired.
- 1.2.4 Fixing screws shall be half round head brass/stainless steel screws with CP washers wherever required as per directions of Consultant.
- 1.2.5 Chromium plated fittings shall be cast brass chromium plated of the best quality approved by the Consultant.
- 1.2.6 All fittings and fixtures shall be fixed in a neat workmanlike manner true to level at heights shown on drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor.
- 1.2.7 Contractor shall provide poly-sulphide or any non-bio-degradable sealant appropriate for its use for all fixtures fixed on walls, marble and edges.

**1.3 EUROPEAN WATER CLOSET**

- 1.3.1 Vitreous China European pattern floor mounted water closet shall be of a white glazed and model as specified in the Bill of Quantities and approved by Consultant. It shall be fitted with a low down cistern as per the manufacturer's specifications.
- 1.3.2 The Cistern shall be provided with best quality internal fittings and ball cock to be a complete working cistern.
- 1.3.3 Each white glazed WC seat & cover set shall be so fixed that it remains absolutely stationery in vertical position without falling down on the WC.
- 1.3.4 The edge between the fixture and the wall shall be sealed with approved type of poly-sulphide or any non-bio-degradable sealant.
- 1.3.5 Each Cistern connection shall be provided with CP angle valves with CP wall flange, PVC connecting pipe of required length and bib cock.

**1.4 URINALS**

- 1.4.1 Vitreous China urinals shall be of white glazed model as specified in the Bill of Quantities, as compliance to the manufacturer's specifications and approved by the Consultant.
- 1.4.2 Half stall urinals shall be provided with 15mm dia. spreader, 32 mm dia. PVC bottle trap with wall flange, and shall be fixed to wall with adequate means of support. Where screw fixing holes are provided, each urinal shall have not less than two fixing holes one each having a minimum diameter of 6.5mm or complete as recommended by manufacturer's directives.
- 1.4.3 Half stall urinals shall be fixed at height specified in drawing with CP brass/stainless steel screws.
- 1.4.4 Urinals shall be flushed with push type flush valves as given in the schedule of quantities and as model described in the item.
- 1.4.5 Waste pipes for urinals shall be of uPVC. Waste pipes shall be concealed by chasing into the walls as directed by the Consultant.

**1.5 HAND WASH BASINS**

- 1.5.1 Vitreous China Wash Basin shape and type specified in the schedule of quantities, as compliance to the manufacturer's specifications and as shall be approved by the Consultant.
- 1.5.2 Each basin shall be supported Where screw fixing holes are provided, each basin shall have not less than two fixing holes one each having a minimum diameter of 6.5mm or complete as recommended by manufacturer's directives. The basin securely fixed to wall with tap hole 25mm round. For counter top basin shall be provided & fixed in place early so that the built up vanity may be installed in sufficient time to comply with completion dates.
- 1.5.3 Each basin shall be provided with 32mm dia CP waste with 32mm dia. PVC bottle trap with flange and PVC connecting pipe to stop cock and CP flange as given in the schedule of quantities.
- 1.5.4 Each basin shall be provided with prismatic pillar tap as specified in the schedule of Quantities and as approved by the Consultant.
- 1.5.5 Basins shall be fixed at proper heights as shown on drawings. If heights is not specified, the rim level shall be 79cms.
- 1.5.6 The edge between the fixture and the wall or the counter shall be sealed with approved type of poly-sulphide or any non-bio-degradable sealant.
- 1.5.7 Each wash basin faucet connection to cold shall be provided with CP angle valves with CP wall flange and PVC connecting pipe of required length.

**1.6 MIRRORS**

- 1.6.1 Mirrors shall be of superior sheet glass with edge rounded off. It shall be free from flaws, specks or bubbles and its thickness shall be 5.5mm of guaranteed quality of float glass and reputed make Asahai, size shall be as specified in the schedule of quantities & the drawings. The image shall be clear and without waviness at all angles of vision. It shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint.
- 1.6.2 Mirrors shall be provided with backing of enamel painted over all surfaces of 12mm thick waterproof marine plywood and fixed with CP brass semi-round headed concealed

screws and cup washers or CP brass clamps as specified or instructed by the Consultant.

**1.7 ACCESSORIES**

- 1.7.1 The Contractor shall install all chromium plated and porcelain accessories as shown on the drawings in compliance to the manufacturer's specifications directed by the Consultant, given in the Bill of Quantities and shown in the drawings.
- 1.7.2 All CP accessories shall be fixed with CP brass half round head screws and cut washer in wall with raw plugs and shall include cutting and making good as directed by the Consultant.
- 1.7.3 Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement 2 fine sand) and fixed in relation to the tiling work.

**1.8 MEASUREMENT**

- 1.8.1 Rate for providing and fixing of sanitary fixtures, accessories, urinal partitions shall include all items, and operations stated in the respective specifications and Bill of Quantities, nothing extra is payable and shall be measured by numbers.
- 1.8.2 Rate for providing and fixing of mirror shall be measured by square meters.
- 1.8.3 Rates for all items under specifications per above shall be inclusive of cutting holes and chases and making good the same, CP screws, nuts, bolts and any fixing arrangement required and recommended by manufacturers, testing and commissioning.

**SECTION 2. WATER SUPPLY SYSTEM****2.1 SCOPE OF WORK**

- 2.1.1 Work under this section consists of furnishing all labour, materials, equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the schedule of quantities.
- 2.1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:
- Connecting the mains supply to the designed tanks as per the drawings.
  - Control valve, masonry chambers and other appurtenances.
  - Connections to all plumbing fixtures and overhead tanks.
  - Excavation and refilling of pipe trenches.
  - Pipe protection and painting.

**2.2 GENERAL REQUIREMENTS**

- 2.2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Consultant.
- 2.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.
- 2.2.3 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.
- 2.2.4 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.2.6 Pipes shall be securely leveled to the required slopes & fixed to walls and ceilings by suitable clamps at intervals specified.

2.2.7 Valves and other appurtenances shall be located to provide easy accessibility for operation, maintenance and repairs.

### **2.3 CPVC (Chlorinated Poly Vinyl Chloride) PIPES, FITTINGS AND VALVES**

2.3.1 All pipes inside the building and where specified, outside the building shall be of CPVC SDR 11 class as specified schedule of quantities, as compliance to the manufacturer's specifications and as shall be approved by the Consultant

2.3.2 Fittings shall be CPVC fittings of specified make. All fittings shall have manufacturer's trade mark stamped on it. Fittings of CPVC pipes shall include reducer bushing, transition bushing, coupling, transition coupling, reducer coupling, brass coupling, tee, reducer tee, brass FPT tee, elbow 90 deg., reducer 90 deg., brass FPT 90 deg. Elbow, elbow 45 deg., male adapter CPVC / brass threads, female adapter CPVC / brass threads, union, cross, step over bend, plastic strap, elbow holder, tee holder.

2.3.3 Pipes and fittings shall be done with following procedure:

Cutting pipe with measure length and line shall be mark around the pipe with marker, beveling, fitting preparation using clean dry rag, wiping dirt and moisture from the fitting sockets and pipe end, applying a heavy and even coat of CPVC Solvent Cement of Flowguard 1-step adhesive solution (Yellow) ASTM F493 for sizes 15mm to 50mm and CPVC 724 or Primer P70 for 65mm to above the end of pipe and fitting, assembling immediately by inserting the pipe into the fitting socket and rotate the pipe  $\frac{1}{4}$  to  $\frac{1}{2}$  turn while inserting and hold for approximately 10 seconds to allow the joint to set up, it required 10 to 20 minutes for perfect joint. Care shall be taken to remove butt from the end of the pipe after cutting by a round file and tools shall use only design for plastic pipe and fittings. Teflon tapes shall be use for threaded fittings. Care shall be taken to avoid air pockets. CPVC pipes inside toilets and rooms shall be fixed in wall chases well with marble cutter above the floor. No pipes shall be run inside a sunken floor unless specifically instructed. Pipes shall be run under the ceilings, wall at skirting level and other areas as shown on drawings. Provide vertical and horizontal supports using Plastic Straps only. Pressure testing shall be done before plastering and imbedding works take place. At the end where angle valves and taps were be install should be with brass elbow or brass tee.

### **2.4 CLAMPS**

2.4.1 CPVC pipes in shafts and other locations shall be supported by MS clamps and hanger of design approved by the Consultant. Pipes at ceiling level shall be supported on structural clamps fabricated on MS structural brackets in spacing of 3m center to center and instructed by the Consultant.

Pipes in typical shafts shall be supported on slotted angles/channels as specified elsewhere.

### **2.5 UNIONS**

2.5.1 The Contractor shall provide adequate numbers of unions/flanges on all pipes to enable dismantling later. Unions shall be provided near each gunmetal valve, stop cocks or check valves and on straight runs as necessary at appropriate locations and required and/or directed by the Consultant.

### **2.6 FLANGES**

- 2.6.1 Flanged connections shall also be provided on all equipment connections as necessary and required or as directed by the Consultant. Connections shall be made by the correct number and size of bolts and made with 3mm thick insertion rubber washers. Where hot water or steam connections are made insertion gasket shall be of 1.5mm thick compressed fiber gaskets approved by the Consultant. Bolt hole dia for flange shall conform to match the specification for CI sluice valve to IS 780 and CI butterfly valve to IS 13095.

**2.7 TRENCHES**

- 2.7.1 All CPVC pipes below ground level shall be laid in trenches shall have a minimum cover of 60cms. Excavation for trenches shall be done as specified in subsequent pages of this tender but the width and depth of the trenches shall be as follows:

Dia of pipes	Width of trenches	Depth of trenches
15mm to 50mm	30cms	75cms
65mm to 100mm	45cms	100cms

Where specified all CPVC pipes in trenches shall be protected with fine sand 15cms all-round before filling in the trenches.

**2.8 GATE / GLOBE VALVES**

- 2.8.1 Valves 50mm dia and below shall be heavy gunmetal fullway screw type gate valves or globe valves conforming to IS 778-1971 class I. Valves shall be tested at the manufacturer's with test results and their name stamped on it.
- 2.8.2 All valves shall be approved by the Consultant before they are allowed to be used in the works.

**2.9 NON RETURN VALVES**

- 2.9.1 Where specified non return valves shall be provided through which flow can occur in one direction only.

**2.10 STORAGE TANKS AND OVERHEAD TANKS****2.10.1 Concrete tanks**

Tank shall be provided with adequate number of lockable type manhole frames and covers fabricated from MS sheet or standard cast iron tank covers as specified in Bill of Quantities. Manhole covers shall be of sizes shown on drawings and shall be approved by the Consultant.

- a) The Contractor shall provide puddle flanges fabricated from MS/GI heavy class pipes of required sizes and lengths and welded to 5mm MS plates. All puddle flanges must be fixed in true alignment and level and shall be back welded to the reinforcement to prevent movement during concreting.
- b) The Contractor shall make connection of pipe lines laid and fixed by him to concrete, masonry as required at site. No additional payment shall be allowed for making connections.

**2.10.2 Overhead Polyethelyne storage tanks**

Tanks of the size and capacity described in the Bill of Quantities shall be of the best quality schedule of quantities, as compliance to the manufacturer's specifications and as shall be approved by the Consultant shall be manufactured or by Hilltake Pvt. Ltd. Nepal.

They shall be free of all defects and numbers shall be written at each of the tank. Each tank covers shall be lockable with adequate number of locks approved by the Consultant.

- a) The outlet pipe shall be fixed 50 to 75mm above the bottom of the tank and fitted with a strainer. Tank shall be clean and water tight.
- b) Tanks shall be placed in a position as to enable thorough inspection and cleaning to be carried out.
- c) Tanks base shall be raised 300mm above the floor level, as specified detailed in drawings.

## 2.11 TESTING

- 2.11.1 All pipes, fittings and valves, after fixing at site, shall be tested by hydrastatic pressure of 10 kg/sqcm whichever is more. The open end of pipe line shall be temporarily closed with watertight CPVC end plug threads.

Pressure shall be maintained for a period of at least four hour without any measurable drop for at least half an hour.

The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of large diameter, by a power driven test pump, provided that the pump is not left unattended.

Pressure gauges shall be accurate and shall preferably have been recalibrated before test.

Testing shall do by area or location of sanitary fixtures wise.

A test register shall be maintained and all entries shall be signed and dated by contractor(s) and the Consultant.

- 2.11.2 In main shall be tested in sectional as the work of laying proceeds, the contractor shall test the entire installation after connections to the overhead tanks or pumping system or the mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good during the defects liability period without any extra cost.

- 2.11.3 After commissioning of the water supply system, the contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

- 2.11.4 When the service line is complete, it shall be slowly and carefully charged with water, allowing all air to escape and avoiding all shock or water hammer by drawing off all taps and fixtures simultaneously during initial charging of water. The service shall then be inspected under working conditions of pressure and flow. When all draw off taps are closed, the service pipes and fixtures shall be absolutely watertight. All piping fittings and appliances shall be checked over for satisfactory support and protection from damage, corrosion and frost.

## 2.12 MEASUREMENT

- 2.12.1 **Pipes**

Pipes above ground / below ground shall be measured per linear feet (to the nearest inch) and shall be inclusive of all fittings eg reducer bushing, transition bushing, coupling, transition coupling, reducer coupling, brass coupling, tee, reducer tee, brass FPT tee, elbow 90 deg., reducer 90 deg., brass FPT 90 deg. Elbow, elbow 45 deg., male adapter CPVC / brass threads, female adapter CPVC / brass threads, union, cross, step over

bend, plastic strap, elbow holder, tee holder and flanges, deduction for valves shall be made. Rate quoted shall be inclusive of all fittings, excavation, backfilling and disposal of surplus earth, cutting holes, chases with marble cutter and making good and all items mentioned in the specifications and schedule of Quantities.

2.12.2 Gunmetal, cast iron butterfly and non return valves, level indicators and meters shall be measured by numbers.

2.12.5 Cement plaster for brick pillars etc, shall be measured by area of the finished surface.

### **2.13 Painting**

Separate payment shall not be admissible for enamel painting over MS clamps and supports.

## **SECTION 3. DRAINAGE (SEWERS & STORM WATER)**

### **3.1 SCOPE OF WORK**

3.1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary as required to completely install the drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

3.1.2 Without restricting to the generality of the foregoing, the drainage system shall include: Sewer lines including excavations, pipe lines, manholes, drop connections, underground storm water drains, including pipes, manholes, catch basins, open drains and culverts.

### **3.2 GENERAL REQUIREMENTS**

3.2.1 All materials shall be new and of the best quality conforming to specifications and subject to the approval of the Consultant.

3.2.2 Drainage lines shall be laid to the required gradients and profiles.

3.2.3 All drainage connections work shall conform to the local municipal bye-laws. All slopes and run off shall conform to the best standard of the IS Hydraulic engineering practices.

3.2.4 The Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority as shall be required by local ordinances.

3.2.5 Location of all manholes, catch basins, etc, shall be confirmed by the Consultant before the actual execution of the work at site.

3.2.6 All works shall be executed as directed by the Consultant and subject to the final approval of the Consultant.

### **3.3 ALIGNMENT AND GRADE**

3.3.1 The sewers and storm water lines shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Consultant from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except at the express direction in writing of the Consultant.

### **3.4 EXCAVATION**

3.4.1 The excavation for sewers and storm water drains shall be laid in open cut trenches unless the permission of the Consultant for the ground to be tunneled is obtained in writing. Where sewers have to be constructed along narrow passages, the Consultant may order the excavation to be made partly in tunnel forms and in such cases the

excavated soil shall be brought back to refill the trenches or tunnel as shall be approved by the Consultant.

#### 3.4.2 **Opening out trenches**

In excavating the trenches etc, the soiling roads, metalling, pavement, kerbing, etc, and turf shall be placed on one side and preserved for reinforcement when the trenches or other excavation have been made good. The surface of all trenches and holes shall be restored as original and maintained to the satisfaction of the Consultant and of the owners of the roads or other property traversed and the contractor shall not cut out or break down any live fence or trees in the line of the proposed works but shall tunnel under them, unless the Consultant shall order to the contrary.

#### 3.4.3 **Obstruction of roads**

The contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and insufficient space shall then be left for public and private transit. He shall remove the materials excavated to a place where there is no objection or contest of the transiting public and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Consultant in writing before closing any road to vehicular traffic. Foot works and promenades shall be clear at all times. The contractor shall have written approval in the case where the work is to be on public property from all the related authorities to the satisfaction of the Consultant prior to commencing the work. The contractor shall indemnify the employer against any claims for nuisance or damage from any person or authority in this matter.

#### 3.4.4 **Removal of filth**

All night soil, filth or any other offensive matter if met with during the execution of works, shall immediately be completely removed from any trench, pit, sewer or cess pool. The waste matter shall not be deposited on any street or drain or where it will become a nuisance to the neighborhood or passed into any sewer or drain, where blockage can occur. This waste matter shall be at once put into leak-spill proof carts and removed to a suitable place to be provided by the contractor that shall be approved by the Consultant so long as the location is not contested by any person or local authority and is not likely to create a nuisance to any person or place in any manner what-so-ever.

#### 3.4.5 **Refilling**

Only after the sewers and other related work has been laid, installed and proven after testing to be water tight, the trench and other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent works. The filling in the trenches up to 75cms above the crown of the sewer and other lines shall consists of the finest selected sand and related materials placed carefully in 15cms layers and flooded to consolidation. After this layer has been laid the trench and other excavation shall be refilled carefully in 15cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Consultant shall otherwise direct.

#### 3.4.6 **Contractor to restore settlement and damages**

The contractor shall, at his own costs and charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc, whether public or private caused by his trenches or by other excavations of his and he shall be liable for any accidents caused thereby. He shall also, at his own expenses and charges repair and make good any damage done to buildings and other property. If in the opinion of the Consultant he fails to make good such works with all practicable despatch, the Consultant shall be at liberty

to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.

**3.4.7 Disposal of surplus soil**

The contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and road ways and sides left clear. The points where he disposes of his materials shall not be contestable by any person or organization and shall not create a nuisance to any person or place or the employer in no way shall be held responsible for any such negligence on the part of the contractor.

**3.4.8 Timbering of sewer and trenches**

- a) The Contractor shall at all times support efficiently and effectively the sides of the sewer and excavation trenches and other excavations of his with suitable timbering, piling and sheeting etc. Timbered supports shall be provided in loose or sandy strata and below the surface of the sub-soil water level.
- b) All timbering sheeting and piling with their walling and supports shall be of adequate dimensions and strength and shall be fully braced and strutted so that there shall be no risk of collapse or subsidence of the walls of the trench under any circumstances.
- c) The Contractor shall be held responsible for any negligence and shall be accountable for the sufficiency of all timbering, bracing, sheeting and piling used as also for all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

**3.4.9 Shoring of buildings**

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

**3.4.10 Removal of water from sewer, trench etc**

- a) The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed of by him in a manner as will neither cause injury to the public health nor nuisance or damage to the public or private property or to the work completed or in progress or to the surface of any pavements roads or streets, or cause any interference with the use and amenity of the same by the public.
- b) If any excavation is carried out at any point or points to a greater width than the specified cross section of the sewer with its envelope, the full width of the trench shall be filled with concrete by the contractor at his own expenses and charges to the requirements of the Consultant.

**3.5 Testing**

- a) All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from man hole to man hole. All pipes shall be subjected to a test pressure of at least, 1.5 meter head of water at the highest point. Pressure shall, however, not exceed 6 meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and to achieve the required head.

- b) A test register shall be maintained which shall be signed and dated by contractor(s) Engineer-in-charge and the Consultant.

**3.6 GULLY TRAPS**

- 3.6.2 Gully traps shall be fixed in cement concrete 1:2:4 (1 cement 2 coarse sand 4 stone aggregate 40mm nominal size) mix and a brick masonry chamber 30 x 30cms CI sealed cover and frame medium weighing to be constructed as per standard drawings.

**3.7 UPVC PIPES FOR DRAINAGE**

All drainage lines passing under buildings, floors and roads, in exposed position above ground shall be uPVC pipes. Position of such pipes shall generally be shown on the drawings, specified hereinafter and given in the schedule of quantities.

**3.8 Fittings**

Fittings used for uPVC drainage pipe shall conform to specified hereinafter and given in the schedule of quantities. Wherever possible junction from branch pipes shall be made by a Y tee.

**3.9 Joints**

Joints between pipes shall be made with fixing rubber ring into the groove and applying jointing lubricant and solvent cement to the chamfer end of the pipe right upto the mark made or to the socket end of the fitting and shall be water tight.

**3.10 Cleanout plugs**

Cleanout plugs shall be provided on starting points of each drain and in between at locations indicated on plans or directed by the Consultant. UPVC Cleanout plugs shall be of size matching the full bore of the pipe.

**3.11 CEMENT CONCRETE AND MASONRY WORKS (FOR ANAEROBIC BAFFLE REACTOR, MANHOLES AND CHAMBERS, ETC)****3.11.1 a) Water:**

Water used for all the constructional purposes shall be clear and free from oil, acid, alkali, organic and other harmful matter that can deteriorate the strength and/or durability of the structure. In general, only the water suitable for drinking purposes shall be considered good enough for constructional purposes.

**b) Aggregate for concrete:**

The aggregate for concrete shall be in accordance with IS 383 and IS 515. In general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of the Consultant. The size of the coarse aggregate shall be as given in the schedule of quantities.

**c) Sand:**

Sand for various construction purposes shall comply in all respect to IS 2116. It shall be clean, coarse, hard and strong, shape durable, uncoated, free from any mixture of clay, dust, vegetable matter, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Consultant as harmful for the construction.

**d) Cement:**

The cement used for all the constructional purposes shall be ordinary portland cement or rapid hardening portland cement conforming to IS 269.

**e) Mild Steel Reinforcement:**

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of IS 432 Grade I.

**f) Bricks:**

Bricks shall have a uniform colour, shall be thoroughly fired but shall not be over burnt. They shall have plain rectangular faces with parallel sides and sharp right angled edges.

They should give a ringing sound when struck. Bricks shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Consultant.

**g) Other Materials:**

Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest ISS. All such materials shall be approved by the Consultant before use.

**3.11.2 Cement concrete (Plain or Reinforced)**

- a) RCC for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Consultant. Rate for cement concrete shall be inclusive of all shuttering and centering at all depths and heights.
- b) Concrete work shall be of such thickness and mix as given in the Schedule of Quantities.
- c) All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipe trenches and foundations shall be kept free of water logging or flooding during the curing period.

**3.11.3 Masonry work**

Masonry work for manholes, chambers, septic tanks and other such works as required shall be constructed from 1st or 2nd class bricks as specified in the schedule of quantities in cement mortar 1:4 mix (1 cement 4 coarse sand). All joints shall be properly raked to receive plaster.

**3.11.4 MANHOLE AND CHAMBERS**

3.11.4.1 All manholes, chambers, septic tanks and other such works as specified shall be constructed in brick masonry in cement mortar 1:4 (1 cement 4 coarse sand) or as specified in the schedule of quantities.

3.11.4.2 All manholes, chambers, septic tanks, etc, shall be supported on base of cement concrete of such thickness and mix as given in the schedule of quantities or shown on the drawings.

3.11.4.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement 2 coarse sand 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be the full diameter of the pipe. Benching shall be finished with a floating coat of neat cement.

- 3.11.4.4 All manholes shall be plastered with 12/15mm thick cement mortar 1:3 mix (1 cement 3 coarse sand) and finished with a floating coat of neat cement inside. Manholes shall be plastered outside as above but with rough plaster.
- 3.11.4.5 All manholes with depths greater than 1m shall be provided with 20mm square or 25mm round rods catch rings set in cement concrete blocks 25 x 110cms in 1:2:4 mix 30cms vertically and staggered. Foot rest shall be coated with coal tar before embedding.
- 3.11.4.6 All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab. Weight of the cover and frame shall be as specified in the schedule of quantities.

**3.11.5 DROP CONNECTIONS**

- 3.11.5.1 Drop connections shall be provided between branch sewer and main sewer or in the main sewer itself in steep ground when the difference in invert level of the two exceeds 45 cms of the required sizes.
- 3.11.5.2 Drop connections from gully traps to main sewers in rectangular manholes shall be made inside the manholes and shall have HCI special type door bend on top and heel rest bend at bottom connected by a HCI pipe. This pipe shall be supported by holder bat clamps at 180cms intervals with at least one clamp for each drop connection. All joints shall be load caulked 25mm deep.
- 3.11.5.3 Drop connections from branch sewer to main sewer shall be made outside the manhole wall with cast iron LA pipe tee connections, vertical pipe and bend at the bottoms. The top of the tee shall be finished upto the surface level and provided with a CI hinged type frame and cover 30 x 30cms. The connection shall be embedded in cement concrete 1:2:4 mix 15cms all round the pipe and tee upto the surface chamber of the tee.
- 3.11.5.4 Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections. They shall be paid for under the relevant soil and waste pipes.

**3.12 MEASUREMENTS****3.12.1 Saturated soil**

No extra payment for pumping and bailing out water shall be made for excavation with an average depth of 1.5m in saturated soil, or where surface water from rain falls or where broken pipelines or sieves and other similar sources produced water logging. An extra rate as quoted in the Schedule of Quantities shall be paid for excavation in saturated soil for pipe trenches above an average depth of 1.5m. No payment is admissible for water collected from surface source and broken pipe lines or sewers.

**3.12.2 Refilling, consolidation and disposal of surplus earth**

Rate quoted for uPVC pipe laying shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 50m.

**3.12.3 UPVC and HDP pipes**

UPVC & HDP pipes shall be measured for the finished length of the pipe line per meter.

- a) Lengths between manholes shall be recorded from inside of one manhole to inside of other manhole inclusive of excavation, refilling and cement concrete or brick supports.
- b) Lengths between gully traps and manholes shall be recorded between the socket of the pipe near the gully trap and the inside of manholes.

Rates shall include all items given in the Schedule of Quantities and Specifications.

**3.12.4 Gully traps**

Gully traps shall be measured by the number and rate which shall include all excavation, foundation concrete, brick masonry, cement plaster inside and outside, CI grating and sealed cover and frame.

**3.12.5 Manholes**

- a) All manholes shall be measured by numbers and shall include all items specified in the preceding paras and Schedule of Quantities.
- b) Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest inch. Depth of the manholes, shall be measured from the top of the manhole cover to the bottom of the channel.

**SECTION 4. SOIL, WASTE & VENT PIPES AND RAIN WATER PIPES****4.1 SCOPE OF WORK**

- 4.1.1 Work under this section shall consist of furnishing all labour, materials, equipment and applications, necessary and required to completely install all soil, waste, vent and rain water pipes as required by the drawings, specified hereinafter and given in the Schedule of Quantities.
- 4.1.2 Without being restricted to the generality of the foregoing, the soil, waste, vent and rain water pipes system shall include:
  - a) Vertical and horizontal soil, waste, vent, rain water pipes and fittings, joints, clamps and connections to fixtures.
  - b) Connection of all pipes to sewer and storm water lines as shown on the drawings at ground floor levels.
  - c) Floor and urinal traps, cleanout plugs, inlet fittings and rain water heads.
  - d) Waste pipe connection from all fixtures eg. wash basins, sinks, urinals, kitchen, equipment and plant room equipment.

**4.2 GENERAL REQUIREMENTS**

- 4.2.1 All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultant.
- 4.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.
- 4.2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages, etc. Fitting positions shall in all cases line up with & conform to access panels for ease of maintenance.
- 4.2.4 Pipes shall be securely fixed at least 5cm clear from the walls and ceiling by suitable clamps at intervals specified.
- 4.2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.
- 4.2.6 All work shall be executed as directed by the Consultant.

**4.3 uPVC PIPES AND FITTINGS**

- 4.3.1 Soil, waste, vent and anti-siphonage pipes shall be uPVC pipes.
- 4.3.2 UPVC pipes shall be straight and smooth and inside free from manufacturing defects.

**4.4 Fittings**

- 4.4.1 Fittings shall conform to the Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.
- 4.4.2 Fittings shall be of the required degree of curvature with or without access door as requirement and as the approval of the Consultant.
- 4.5 Fixing**
- 4.5.1 All vertical pipes shall be fixed by MS clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).
- 4.5.2 Horizontal pipes laid to the correct slopes running along ceilings shall be fixed on structurally adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- 4.5.3 The Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provision in the structure as necessary and as required.
- 4.6 Jointing**
- Joints between pipes shall be made with fixing rubber ring into the groove and applying jointing lubricant and solvent cement to the chamfer end of the pipe right upto the mark made or to the socket end of the fitting and shall be water tight.
- 4.7 Testing**
- 4.7.1 Before use at site, all soil and waste pipes shall be tested by filling up with water for at least 10 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor seating shall be accepted at the discretion of the Consultant.
- 4.7.2 Pipes shall be tested after installation, by filling up the stack with water. All opening and connections shall be suitably plugged. The total head in the stack shall however not exceed 5m.
- 4.7.3 Alternately the contractor may test all soil and waste stacks with a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections. The top end shall however be left open. The stack shall then be observed for leakage and all defective pipes and fittings removed or repaired as directed by the Consultant.
- 4.7.4 A test register shall be maintained and all entries shall be signed and dated by the contractor's engineer-in-charge.
- 4.8 TRAPS**
- 4.8.1 Floor traps**
- Floor traps shall be stainless steel with "P" trap proprietary fixtures deep seal with an effective seal of 50mm. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement 2 coarse sand 4 stone aggregate 20mm nominal size) and extended to 40mm below finished floor level. The Contractor shall provide all necessary shuttering and centering for the blocks.
- 4.8.1.1 Floor trap inlets**
- Bath room traps and connections shall ensure free and silent flow of discharging water. Joint between waste and hopper inlet sockets shall be solvent cement joints. Floor trap inlets, hoppers and the traps shall be set in cement concrete blocks without extra charge.

**4.8.2 CP/Stainless steel gratings**

Floor and urinal traps shall be provided with 100-150mm square or round CP/Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 6 mm or as specified in the schedule of quantities.

**4.9 CLEANOUT PLUGS**

Clean out plug for soil, waste and rain water pipes laid under floors shall be provided near pipe junctions bend, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening.

The Contractor shall provide uPVC proprietary cleanout plugs as required. Cleanout plugs shall be threaded and provided with key holes for openings. Cleanout plugs shall be fixed to the pipe with a screw fixed collar internally splayed & fitted with neoprene gaskets.

**4.10 WASTE PIPE FROM APPLIANCES**

4.10.1 Waste pipe from appliances eg wash basins, sinks, urinals, water coolers shall be uPVC as given in the schedule of drawings.

4.10.2 All pipes shall be fixed in gradient towards the outfalls of drain. Pipes inside a toilet shall be chased unless otherwise shown in the drawings. Where required pipes may be run at ceiling level at a suitable gradient and supported from structural clamps. Spacing for clamps for such pipes shall be as follows:

	Vertical	Horizontal
uPVC Pipes	180 cms	120 cms

**4.11 RAINWATER PIPES AND FITTINGS**

4.11.1 All terraces and such areas that may be prone to the effects of rain shall be drained by providing down-takes uPVC rainwater pipes.

4.11.2 Rainwater pipes are separate and independent and connected to the storm water drainages system as shown on the drawings.

4.11.3 Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.

**4.11.4 Fittings**

Fittings shall be of compatible material and type and free from manufacturing defects of any kind.

**4.11.5 CLAMPS**

4.11.5.1 MS clamps, shall be of standard design and fabricated from MS flat 40 x 3mm thick. They shall be painted with two coats of black bitumen paint before fixing.

4.11.5.2 Where MS clamps are to be fixed on RCC column or slotted angles, walls or beam they shall be fixed with 40 x 3mm flat iron 'U' type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.

- 4.11.5.3 Structural clamps shall be fabricated from MS structural members eg rods, angles, channels, flats as per detailed drawings or as directed. The Contractor shall provide all nuts, bolts, welding and paint the clamps with one coat of red-oxide. Wooden saddles shall be provided free of cost but structural clamps shall be paid separately by weight.
- 4.11.5.4 Slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes as approved by the Consultant. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable expansion bolts or fasteners using electrical drilling for making holes. The spacing of support bolts horizontally shall not exceed 1m.
- 4.11.5.5 Wherever MS clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangements for making good with cement concrete 1:2:4 mix as directed by the Consultant.

**4.11.5.6 CUTTING AND MAKING GOOD**

Pipes shall be fixed and tested as building proceeds.

Contractor shall provided all necessary holes cut outs and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 course sand: 4 stone aggregate 20mm nominal size) or cement mortar 1:2 (1 cement: 2 course sand) and the surface restored as in original condition.

**4.12 MEASUREMENT****4.12.1 General**

4.12.1.1 Rates for all items quoted shall be inclusive of all work and items given in the above mentioned specifications and Schedule of Quantities and applicable for the work under floor, in shafts or at ceiling level at all heights and depths.

4.12.1.2 All rates are inclusive of preparing timber block-outs in RCC and chasing with masonry work and making good the same and even embedded wall.

4.12.1.3 All rates are inclusive of pre-testing and on site testing of all the installations and materials prior to commissioning to the satisfaction of the Consultant.

4.12.2 Pipes (Unit of measurement: feet to the nearest centimeter)

4.12.3 Slotted MS support and clamp shall be measured per kg of finished length and shall include support bolts and nuts embedded in masonry walls with cement concrete block and nothing extra will be paid for making good the same.

**4.12.4 Fittings**

Unit of measurement shall be the number of pieces. Floor and urinal traps, trap gratings, hoppers, cleanouts, plugs and fittings shall be measured by numbers and shall include all items described in the relevant specifications and Schedule of Quantities.

**4.12.5 Painting**

No extra payment shall be admissible with respect to Painting pipes with all fittings and clamps.

**4.12.6 Structural clamps**

Structural clamps and U clamps shall be paid for by weight per kg. Rate shall be inclusive of all nuts, bolts, drilling, cutting, welding. Weight of clamps shall be calculated from the actual length used in structural members multiplied by its theoretical weight given in manufacturer's catalogues. Weight of nuts, bolts, shall not be taken into account.

**4.12.7 Excavation for pipes**

No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for soil and waste pipes.

**SECTION 5. LIST OF APPROVED MAKES OF MATERIALS**

<b>SI No</b>	<b>Description</b>	<b>Brand Name</b>
5.1	Water Closet and Urinal	Parryware, Hindware, Jaquar
5.2	Basin	Parryware, Hindware, Jaquar
5.3	Bib Cock, Piller Cock, Angle Valve, Grab bar etc.	Parryware, Jaquar
5.4	PVC Connecting Pipe and Urinal Flush Valve	Parryware, Jaquar
5.5	Urinal Partition, Soap Holder, Paper Holder and Towel rod	Parryware, Hindware, Jaquar
5.6	UPVC Pipe, UPVC Fittings and PVC Floor Trap	Panchakanya, Nepatop, Astral
5.7	PVC Tank	Hilltake, Nepatop
5.8	CPVC Pipe and Valves	Astral, Asirbad
5.9	Non Return Valve and Y Strainer	Leader, Zoloto
5.10	Water Purification System	Euroguard
5.11	Insulation Tube	Aeroflex
5.12	Fire Extinguishers	Eversafe, Minimax, Naffco
5.13	MS Pipe	Hipco, Jindal
5.14	Manhole Cover	Swastika
5.15	Landing Valve	Minimax, Eversafe, Naffco
5.16	Ball Valve	Astral

**SPACIFICATION OF ELECTRICAL WORKS**



**SPECIFICATION OF ELECTRICAL WORKS****1. GENERAL**

All electrical works related to Nepal Electricity Authority, Corporate Office building shall be carried out to the highest degree of technical quality and workmanship accepted for this category of work. Special attention shall be given to rigorous application of safety codes and accepted practices so that with the completed works, operation of electrical services may add to the overall efficiency of functions to be performed within the building without in any way detracting from the safety aspects required within the premises.

This subsection covers supply, delivery to the site, installation and testing of interior electrical wiring and substation equipment.

**2. INTERIOR ELECTRIFICATION**

Installation of electrical services shall be undertaken in a safe, simple, systematic and orderly fashion giving attention to labeling of circuits, colour codes and numbering of cables so that the completed installation can be effectively maintained by personnel with nominal understanding of electrical engineering.

**3. SYSTEM**

Electrical power within the premises will be available at 400/230 VAC, three phase, four wire, 50Hz directly from the power utility or from an outdoor sub-station where conversion of utility voltage will take place. Hence all systems within the premises, except where specifically specified as High Tension (HT) works, shall be rated for this degree of incoming supply.

All erection set-up, tools, appliances and safety precautions to be used by the Contractor for electrical services within the building shall also be suitable for work under this Low Tension (LT) class of electrical work.

**4. STANDARDS**

Where not specified within this specification, all materials and workmanship used in the installation works shall be in accordance to the latest edition of the related Indian Standard Specification (IS:732-Code of Practice for Electrical Wiring Installation-System Voltage not exceeding 650 V ) or equivalent.

Notwithstanding the stipulation of above standards, local electrical codes for electrical services in buildings, where such exist, shall also be followed. Adequate consideration shall also be given to compliance of the equipment and works with local environmental conditions such as temperature, altitude, humidity, dust, vermin, attitude of personnel who will occupy the premises etc.

**5. SCOPE OF WORK**

The scope of works generally requires



- a. the supply and delivery of all required materials, fixtures, electrical equipment, and appliances;
- b. Preparation of shop drawings, setting, wiring, fixing and electrical installation of all required materials, fixtures, electrical equipment and appliances;
- c. testing and commissioning of the entire electrical installation; and
- d. any other required works.

The works undertaken shall be fully coordinated with the civil works so that all electrical works are set and finished in conformity with the building structural and architectural works. The work schedule shall also be coordinated so that no component of work schedules are interrupted owing to defective programming.

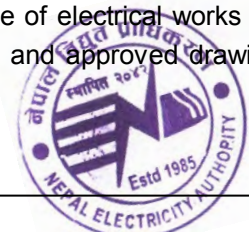
Works to be undertaken are categorized under the following major sections:

- a. laying of electrical conduit, outlet boxes, pull boxes and conduit accessories required for the electrical wiring of the system;
- b. laying of concealed conduit, junction boxes, pull boxes and conduit accessories required for the telephone and computer net works wiring of the system;
- c. wiring in concealed conduit or directly buried cables outdoor to achieve desired electrical sub - circuits for the given electrical layout;
- d. installation of and termination of wiring to light fixtures, outdoor lights, signage, power outlets, controlling switches, switch panels, telephone outlets, computer outlet, PA system, exhaust fans etc.
- e. installation of mains and sub-mains cable from the sub-station to the main panel board and from the main panel board to distribution panels;
- f. installation of the main panel board and distribution boards;
- g. installation of the 11kV/0.4 kV transformer inclusive of 11 kV lines
- h. installation of station earth; and
- i. Installation of 12kV VCB and accessories.
- j. all other works required supply, installation including testing, commissioning etc.

Works indicated shall include all civil and electrical works required to achieve a satisfactory electrical installation, whether or not such are specifically outlined in these specifications. The entire installation shall be suitable for a three phase, four wire, 400/230V AC, 50 Hz system.

## 6. SHOP DRAWINGS

Prior to commencing the electrical works, the contractor shall prepare shop drawings considering the drawings provided by the owner/consultant and propose the schedule of electrical works and submitted to the Owner/Consultant for approval. A set of the up-dated and approved drawings



shall be available at the site at all times for inspection by the Engineer. If any changes are made during installation, such changes shall be immediately marked in the drawings.

Prior to commencing procurement, the Contractor shall submit for approval, shop drawings showing layout, dimensions, materials used, standards specified for the fabrication or procurement of items such as the main panel board, distribution panels and other items for which custom design is necessary.

## 7. SAMPLES

Prior to commencing procurement, the Contractor shall submit for approval technical description, related catalog/brochures and a recommended brands of sample item each of all cable, conduit accessories, switchgears, switches, power outlets, lamps, fluorescent tubes, fixtures etc. which are to be procured and installed.

## 8. LOCATION OF FIXTURES

Location of conduit, fixtures, switches, outlets, distribution boards and other electrical equipment and appliances shall generally be in accordance with the updated construction drawings; and in accordance with the specifications and mounting heights and location details mentioned herein. Notwithstanding the guidelines given in the drawings and specifications, the location of all electrical items, equipment and appliances in the buildings shall be approved by the Engineer prior to commencement of electrical installation works.

## 9. CONDUIT

Electrical conduit used in the final sub-circuits of the electrical services shall be rigid, non-metallic HDP pipe of an approved manufacturer conforming to IS : 2509 - 1973 and shall be used only with corresponding approved accessories.

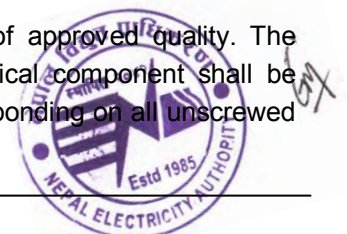
The size of the conduit shall be in accordance with the number and size of electrical cables to be drawn into the conduit. The number of cables that may be drawn in a conduit shall be as specified in the table below or as stipulated in the appropriate of the IS Code or equivalent.

Cable size (sq.mm.)	No. of cables in conduit size (mm)					
	16	19	25	32	38	51
1.5	4	6	10	14	-	-
2.5	3	5	10	14	-	-
4.0	2	3	6	10	14	-
6.0		2	5	8	11	-

HDP pipes shall be embedded in building structural works and conduit runs shall follow shortest route between points or as shown in electrical drawings.

Wherever necessary, bends or diversions may be achieved by bending the conduit or by employing approved bends, inspection bends, inspection boxes, elbows or similar fitting.

Conduit accessories such as ceiling outlets, junction boxes shall be of approved quality. The physical integrity of the conduit and accessories as an integral electrical component shall be ensured by approved means such as the use of water-resistant cement bonding on all unscrewed



conduit joints and terminations, and use of rubber gaskets in entry points to junction boxes or outlets or other approved means.

If required, 18 SWG galvanized 'fish' wire shall be inserted during the time of conduit laying to facilitate drawing in of cables at a later stage.

## 10. CABLES

Electrical cable used in the installation shall generally be of the following types:

- a. flexible cable for connection to fixtures, appliances and equipment from terminal points in outlet boxes, junction boxes etc.;
- b. final sub-circuit cable used for wiring from the distribution board to the terminal outlet box, junction box etc.;
- c. sub-mains cable used for electrical distribution from the main panel board to several power distribution boards within the buildings;
- d. mains cable used to interconnect the main switchboard (Main Panel Board) in the building to the transformer low voltage side connection.

## 11. FLEXIBLE CABLE

Flexible cables used for the purpose mentioned shall not be less than twin core, 48/0.2 mm size, with copper conductor and thermoplastic insulation.

Where a light fitting is supported by one or more flexible cord, the maximum weight to which the twin flexible cords may be subjected shall be as follows :

Cross-sectional Area of Twin Flex (Sq.m.)	No/Dia. of Wires (No./mm)	Max. Permissible Weight (Kg.)
1.5	48 / 0.20	3.5
2.5	80 / 0.20	8.8
4.0	128 / 0.20	14.0

## 12. FINAL SUB-CIRCUIT CABLE

Cables used for wiring in final sub-circuits shall feature high conductivity, stranded copper conductors with PVC insulation rated at 650 VAC.

Colour coding of cables shall be maintained in the cables used in the final sub-circuits in accordance with the following plan:

- a. Phase I - Red;
- b. Phase II - Yellow;
- c. Phase III - Blue;
- d. Neutral - Black;
- e. Earth - Green.



Cables sizes used in the final sub-circuits shall be standardized as follows unless indicated in the drawings or specified elsewhere:

- a. single core, stranded, 2.5 sq mm cu cable for indoor power circuits; and
- b. single core, stranded, 1.5 sq mm cu cable for indoor lighting and low power circuits.

Phase and neutral conductors in these cables shall be of the same cross-sectional area. A separate conductor of the size specified herein or indicated in the drawings shall be used in both types of sub-circuits for earth continuity.

### 13. MAINS AND SUB-MAINS CABLE

Cables sizes used in the mains and sub mains shall be as indicated in relevant drawings. These cables shall be multi-core cables with stranded copper/aluminium conductors cables, PVC insulated, PVC sheathed and rated for 660/1100 VAC.

### 14. POWER OUTLETS

Power outlets conforming to IS : 1293-1977 shall be three pin switch sockets rated at 15 A and 13 A, single phase. The outlets shall have an earth connection. Safety features shall be incorporated to ensure that when any appliance is plugged in, its earth continuity is first maintained prior to mating of the phase and neutral pins. Additional safety features shall include shutters, illuminated indicators and shrouded terminals. High grade brass sheet metal contact tubes shall ensure tight, spark-free contacts with mating plugs.

Controlling switches shall have high current capacity silver and silver cadmium oxide contacts, bounce free snap action, wiping action and making and breaking mechanism with minimum arcing.

All electrical parts shall be enclosed in a sturdy porcelain or thermoplastic housing. The power outlets shall preferably be screwed onto the junction box through a metal mounting plate. The cover plate over the switch socket assembly shall be of brass screwed onto the metal frame.

The outlets shall be flush mounted by means of recessed junction boxes, which have been fabricated precisely for the fixture dimensions. Such boxes shall be constructed of sturdy galvanized sheet steel and shall feature conduit knockouts on all sides. Rubber gaskets shall be provided along the knockouts through which conduit will enter so that a watertight continuity of electrical installation is maintained. Where the outlet is not fixed such junction boxes shall be covered with insulated plates.

Light socket for exhaust fans shall be three pin switched socket rated at 5A single phase. The outlet shall have an earth connection. Safety features shall be incorporated to ensure that when an AC plug in, its earth continuity is first maintained to mating of phase and neutral pins. Additional safety features shall include shutters, illuminated indicators and shrouded terminals.



**15. SWITCHES AND SWITCH PANELS**

Switches used in the electrical services for the control of lights and low power appliances shall be single pole, tumbler or rocker type switches rated at not less than 10 A or as indicated in the drawings. One way or two way switches shall be used as indicated in drawings. Switches used in the installation shall generally conform to IS 3854.1966 or equivalent and shall have high current capacity silver and silver cadmium oxide contacts, bounce free snap action, wiping action and making and breaking mechanism with minimum arcing.

All electrical parts shall be enclosed in a sturdy porcelain or thermoplastic housing. The switches shall preferably be screwed onto the junction box through a metal mounting plate. The cover plate over the switch socket assembly shall be of brass screwed on to the metal frame.

The switches shall be flush mounted by means of recessed junction boxes, which have been fabricated precisely for the fixture dimensions. Such boxes shall be constructed of sturdy galvanized sheet steel and shall feature conduit knockouts on all sides. Rubber gaskets shall be provided along the knockouts through which conduit will enter so that a watertight continuity of electrical installation is maintained.

At specific locations indicated in drawing, switches shall be fitted into a recessed switch panel to discourage tampering with the control of these appliances. Such switch panels shall be constructed of sheet steel and shall house the light switches and other accessories in a flushed arrangement. Dimensions of the panel shall be maintained to the minimum required. The panels shall feature a robust hinged lockable cover flush with the finished surface of the room wall. The exterior shall be painted to conform with interior decor.

**16. CEILING AND WALL FANS**

Ceiling and wall fans of an approved manufacture shall be of the type and sweep diameter as shown in drawings. Fan regulators shall be remote controlled wired unit featuring 5 speed for ceiling fan and 3 speed for wall fan, push button type selectors or continuous speed selection with dimmer type electronic circuitry. Ceiling fans shall be suspended from the ceiling on U- hooks which are bonded to reinforcement rods of ceiling structural works.

**17. EXHAUST FANS**

Heavy duty exhaust fans of an approved manufacture shall be of approximately 225 mm sweep integral metal units suitable for installation in walls or single or double panel windows. The fans shall be capable of delivery rate of not less than 800 m<sup>3</sup>/min at 1300 rpm. A louvered shutter shall be provided to close off the fan opening.

**18. 11/0.4 kV TRANSFORMER****18.1 GENERAL**

This specification covers the supply, delivery, installation works and field test of the 11/0.4 kV transformer complete with all accessories, fittings and auxiliary equipment for efficient and trouble-free operation as specified herein under.

**18.2 EQUIPMENT TO BE FURNISHED**

a) Two (2) unit of 11 kV/400V, three phase 630 kVA oil immersed, self cooled, outdoor use type distribution transformer.

**18.3 STANDARDS**

The equipment specified in this Section of the Contract shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particulars:

IEC 76	Power transformers
IEC 137	Bushings for alternating voltages above 1 kV
IEC 156	Method of determination of electric strength of insulating oils
IEC 296	Specification for unused mineral insulating oils for transformers and switchgear
IEC 551	Measurement of transformer and reactor sound levels
IEC 616	Terminal and tapping markings for power transformer
IEC 722	Guide to lightning and switching impulse testing of power transformers
IEC 733	Determination of water in insulating oils.
IEC 5493	Protective coating of iron and steel structures against corrosion.

**18.4 CONSTRUCTION FEATURES****18.4.1. Tank**

The transformer shall be provided with a case of rigid construction, which shall be oil-tight and gas-tight complete with oil preservation system. The tank shall be capable of withstanding, without leakage or permanent distortion, a pressure 25% greater than the maximum operating pressure resulting from the system of oil preservation used. The tank cover shall be bolted and provided with suitable hand holes. Two grounding pads complete with clamp type terminal connector shall be provided on the tank wall near the base.

**18.4.2 Core**

Cores shall be constructed of high quality, non-aging, high permeability silicon steel. The steel shall be in thin laminations. Both sides of each sheet shall be insulated, with durable, rigidly clamped with positive locking devices to insure adequate mechanical strength to support the windings and reduce vibrations to a minimum during operation. Cut type cores shall not be accepted.

**18.4.3 Winding**

The design, construction and treatment of winding shall give proper consideration to all service factors. The completed assembly of core and coils shall be dried in a vacuum sufficient to ensure elimination of air and moisture within the insulating structure. After the drying process, the assembly shall be immediately impregnated with dry oil. The windings of the transformer shall be fabricated of copper materials. Aluminum winding materials will not be accepted.

**18.4.4 Oil Preservation**

The transformer shall be provided with an oil conservator complete with oil filter flange or cap at the top.

**18.5 SHORT CIRCUIT CAPACITY**

The transformer shall be designed and constructed to withstand without injury the mechanical and thermal stress produced by short-circuit current limited by the impedance of the transformer only.

**18.6 TAP CHANGER**

An externally - operated tap changer shall be furnished with each transformer, to be operated only when the transformer is de-energized. The tap changer shall include an operating handle, visible indication of tap position and means for locking the tap changer in any desired position. The locking device shall be arranged to prevent locking the tap changer in an off position. Mechanical means shall be provided for limiting the maximum and minimum traveling of the extreme tap positions to be at the maximum and minimum position of the tap changer.

**18.7 INSULATING OIL**

The insulating oil shall be refined mineral oil. Necessary quantity of oil for the transformer shall be furnished by the contractor.

**18.8 BUSHINGS**

The bushings shall be made of homogeneous and well vitrified porcelain. The colour of the insulator shall be brown and the surface shall have polished glaze.

The high voltage bushings and the low voltage bushings shall have bolted terminal lugs of suitable size for terminating conductor and cables.

The low voltage neutral bushings shall include a lug for terminating a 25 mm sq. copper earth wire in addition to the 100-250 mm sq. copper circuit neutral.

The bushing shall be suitable for cable terminating kit.

**18.9 TEMPERATURE RISE**

Average winding temperature rise above maximum ambient temperature (45 Deg C) when carrying maximum continuous rated KVA shall not exceed 60 C. The temperature rise of the insulating oil shall not exceed 55 Deg C when measured near the top of the main tank.

**18.10 ACCESSORIES**

The following accessories shall be provided with the transformer.

- Upper oil filter valve
- Lower oil filter and drain valve
- Liquid level gauge
- Lifting Lug
- Name plate
- Hand Hole
- Buchholz Relay



Tank grounding terminal connector suitable for grounding cable #6 SWG solid or stranded copper.

*Any other spares recommended by the manufacturer.*

**18.11 TESTS**

Tests shall be performed in accordance with the relevant IEC standards supplemented by the specific requirements indicated below. In the absence of IEC recommendations the tests must be equivalent at least to the conditions, provisions and definitions of the above-mentioned standards.

- (a) Routine tests
- Applied voltage test
  - Induced voltage test
  - No load loss and excitation current test
  - Impedance voltage and load loss tests
  - Resistance measurement
  - Ratio tests
  - Polarity and phase relation tests
  - Leakage tests
  - Insulation resistance tests

**RATINGS AND FEATURE FOR 11/0.4 TRANSFORMER**

Rated power	630 kVA
Rated voltage	
- Primary	11 kV
- Secondary	400/230 V
Max. system voltage	
- Primary	12 kV
- Secondary	440 V
Rated Frequency	50 Hz
Connection:	
- Primary	Delta
- Secondary	Gnd. Wye
Cooling System	ONAN
Voltage vector group	DYn11
Rated impedance voltage	$\leq 6\%$
BIL for windings and bushings for primary side	75 kV
Withstand voltage, 50 Hz, 60 Sec.:	
- Primary	28 kV
- Secondary	3 kV
No load tap changer voltage taps on HV side	$\pm 2.5\%, \pm 5\%$



Mounting	Pad
Accessories	Includes supporting steel post, Lighting arrestor, Cut out fuses and other required accessories
Insulation levels	(IEC) 76 LI 170 AC28/AC3
Insulation temperature class	A (IEC 76)
Applicable standard	IEC

**19. LIGHT FIXTURES**

Fluorescent, LED, CFL and incandescent light fixtures shall be supplied and installed as shown in the drawings. Major types of fixtures are as briefly described below. All fixtures described shall be of an approved manufacture indicated in the article N-52 Brand of manufacturers. If fixtures of an alternate manufacture are offered, sufficient testimony must be provided to substantiate its equality with the product recommended.

- a. Fluorescent fixtures shall generally be surface mounted with, 1x36 W, or 2x36 W energy efficient fluorescent tubes with good colour rendering qualities with sturdy, corrosion free metal body and mounting channel with required type of reflectors, diffusers or optical assemblies. High quality, low loss, high accuracy current ballast and chokes shall of electronic type.
- b. Ceiling CFL/LED luminaries in single or multi-configuration shall generally be 200 mm dia. opal/frosted glass or clear glass spheres with even light diffusion characteristics housed in a non-corrosive sturdy spun metal body. A 11/9 W CFL/LED lamp shall be used with such fixtures.
- e. CFL/LED wall fixtures shall generally be decorative light fixtures compatible with interior decor. The fixtures shall be 200 mm dia. frosted sphere and shall have one 9/11 W CFL/LED lamps with electronic ballast as shown in the drawings. The lamps shall be consoled in a high quality of decorative glass fixture. The housing shall be of sturdy non-corrosive spun metal (brass).
- f. Light fixtures used for outdoor application either as post-top lanterns, street lights, recessed fixtures or wall brackets shall be integrally weatherproof with rubber gaskets or other approved means to exclude entry of water.

**20. MINIATURE CIRCUIT BREAKERS (MCBS)**

Miniature circuit breakers shall be used to protect final sub-circuits from the distribution board. Circuit breakers shall be in accordance with IEC : 898-1995 or IS : 8828-1996 and shall be of an approved manufacturer and shall incorporate the following safety features and ratings:

- a. thermal overload protection;
- b. magnetic short circuit protection;
- c. at least 9 kA breaking capacity at 415 VAC, 50 Hz.
- d. number of operating cycle :20000



- e. impulse withstand voltage: 6 kV

Individual MCBs shall be grouped in multi-pole configurations as specified in the drawings. Assembly of MCBs in a distribution board shall be done on DIN type rails that will allow front mounting of the MCBs with brass screws.

The body of the MCBs shall preferably be of thermo-setting glass filled polyester to provide maximum safety against terminal burn-outs and fire hazards.

## 21. MOULDED CASE CIRCUIT BREAKERS (MCCBs)

MCCBs used shall be dead-front, compact units, suitable for use in panel board. The operating mechanism shall feature quick-make and quick-break contacts in roto-active breaking principle with a trip-free handle. De-ion arc chutes are preferred to minimize arcing between breaker contacts. Tripping on fault is clearly indicated by the operating handle which comes to a position between the ON and OFF when tripping occurs.

Protective features shall include

- a. thermal elements of the indirectly heated bimetallic for delayed overload protection;
- b. magnetic trip for instantaneous responds to short circuit

Clear indication shall be given to indicate the breaker having tripped automatically on fault.

## 22. AIR CIRCUIT BREAKERS (ACB)

- 22.1 The ACB shall conform to the requirements of IEC 60947-2/IS 13947-2 and shall be type tested & certified for compliance to standards from – CPRI, ERDA/any accredited international lab. The circuit breakers shall be suitable for 400 V +/- 10%, 50 Hz supply system. Air circuit breakers shall be with moulded housing flush front, draw out type and shall be provided with trip free manual operating mechanism with mechanical “ON” “OFF” “TRIP” indications.

The ACB shall be  $\frac{3}{4}$  pole with modular construction, draw out, electrically operated version as specified. The circuit breaker shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified in the single line diagram and should be equal to the Ultimate breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

Circuit breakers shall be designed to ‘close and ‘trip’ without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhance safety and in accessibility to live parts. Electrical operated breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.



**22.2 Cradle**

The Cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

THERE SHALL BE 4 DISTINCT AND SEPARATE POSITION OF THE CIRCUIT BREAKER ON THE CRADLE.

Racking Interlock in connected/Test/Disconnected position

Service Position: Main Isolating contacts and control contacts of the breaker are engaged.

Test Position: Main Isolating contacts are isolated but control contacts are still engaged.

Isolated position: Both main isolating and control contacts are isolated.

The following safety features shall be incorporated:

- a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
- b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.
- c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.
- d. All Switchgear module front covers shall have provision of locking.
- e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

**22.3 Protections**

The breaker shall be equipped with microprocessor based protection having following salient features.

- Incorporate 8 bit microprocessor
- True RMS measurement
- True hot and cold characteristic
- Thermal memory takes care of residual heats in case of repeat overload. Thermal memory can be bypassed, if required.
- Comprehensive protection function: long time, short time, instantaneous and ground fault.
- Reliable tripping by direct operation on tripping mechanism of the breaker.
- No external power supply.
- Zone selective interlocking on short circuit and ground fault.
- Self diagnostic and self correcting watch dog provision.
- Suitable for 50/60Hz system.



**23. DISTRIBUTION BOARDS (DBS)**

Electrical distribution boards used in the electrical installation shall be manufactured from at least 16 SWG sheet steel, shall be suitable for flush/surface mounting, and shall be painted with a coat of enamel over two coats of primer & the painted colour conforming with surrounding decor. The Boards shall be integral units with appropriate conduit knockouts from the top and bottom. The construction shall be sturdy shall feature dust-proof and vermin-proof design. The interior shall have ample space for incoming and outgoing cables. Distribution boards shall be complete with

- a. appropriately rated copper bus bars with heat shrinkable phase identifications;
- b. neutral link and earth terminal;
- c. labeling of circuit breakers;
- d. clearly printed schedule of circuits; and
- e. hinged front cover with locking device;

The number and configuration of moulded case circuit breaker or miniature circuit breakers and their rating shall as shown in the appropriate drawings (BOQ). The back of miniature circuit breakers shall be mounted on a metal brackets which can be detached from the distribution board frame.

**24. MAIN PANEL BOARD**

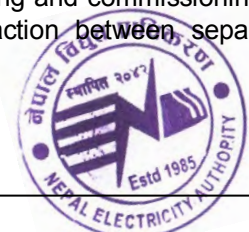
The main panel board used in the installation shall be a modular, free standing, dead front, unit fabricated from sheet steel not less than 2mm MS sheet and painted with two coats of primer and finished in navy grey enamel or as requirement of the owner/engineer. The switch board shall be completed with copper bus bars of suitable rating. The main Panel Board shall also consists of the followings:

- a. lifting lugs and cable entry knockouts;
- b. earth terminals and neutral links;
- c. clearly labelled incoming and outgoing MCCBs;
- d. indication lamps
- e. 0-500V, flush mounted voltmeters with phase selector switch;
- f. Multi function meters
- g. other accessories as specified in drawings

The switchboard design shall feature dust, moisture and vermin proof characteristics.

**25. RISING MAINS/BUSDUCTS****25.1 Sandwiched Construction****Scope**

The specification covers design, manufacturing, supply, installation, testing and commissioning of Sandwich type busbar trunking for use as feeder busbars for interaction between separate electrical equipment/load centers, and for use as plug in busbar risers.



**System details**

The busbar shall be suitable for operation in 600/1000V system, with frequency of 50Hz having 100% neutral and internal earth.

**Standards**

The busbar shall be designed and manufactured in accordance with the following international standards for busbar trunking:

- BS 5486 Part 2 : Particular requirement of busbar trunking system
- IEC 60439 – 2 : Particular requirement of busbar trunking system
- IEC 60529 : Degree of protection

The bus duct shall confirm to IEE/NEMA/BUI/JIS for seismic protection certification.

**Testing**

The busbars shall be type tested at a reputed international test laboratory (ASTA or CPRI) for short circuit withstand. The test shall be for a minimum duration of 1 second. Tests shall be performed over a range of current ratings, covering the different frame sizes of the manufacture.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP54 for indoor application and IP65 for out door application for sandwiched busbars.

**Manufacturer**

The manufacturer must have an established track record in design and manufacture of sandwich and cast resin busbar trunking, and must have supplied busbar system for at least 5 – 10 years.

The manufacture must have ISO 9001 certification for design, manufacture and testing of busbar systems.

**Design & Construction requirements – Sandwich busbars:****General**

The busbars shall be of sandwich construction, non – ventilated design. It shall be possible to mount the busbar system in any orientation, without affecting the current rating.

The bus duct shall consist of three phases and neutral busbar permanently positioned dust and vermin proof and the degree of enclosure protection shall be IP 52 for indoor installation and shall be IP-65 for outdoor installation as per schedule of quantities.

**Busbars**

The busbars shall of high conductivity Copper, or Aluminum, as specified in the Bill of quantities.

The maximum hotspot temperature rise at any point in the bus duct at continuous load shall not exceed 35 deg. C above a maximum ambient temperature of 45 deg. C in any position.



Where an earth conductor is required, it shall be a separate, integral earth conductor, of the same high conductivity material as the phase conductors.

### **Insulation**

The busbars shall be insulated throughout their length by epoxy coating/Mylar. The insulation material used shall be of minimum Class F (155 deg. C). The insulation must comply to UL 94 V – O. It shall be Halogen free.

### **Housing**

The housing shall be made of extruded Aluminum case duly enameled/electro – galvanized sheet steel, with and epoxy power coated paint finish. The housing shall be profiled, to provide higher strength and efficient heat dissipation. The width of the housing preferably be the same for all rating of busbars, in order to provide interchangeability of tap off boxes..

### **Joints**

The joints between sections shall be made so as to provide flexibility during installation and expansion/contraction of busbar during operation. The joint shall be of the single bolt type.

The joint construction must have following features.

- Heat expansion of at least 3mm per joint.
- The joint insulation must be of one piece molded design and not have any cut edges which can absorb moisture.
- The joint construction must allow a +/- 14 mm adjustment at the time of installation, for ease of adjusting to site measurement variations.
- The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of molded one piece.
- The joint system must be designed in a way that the installer can not insert the bus duct length too far and damage the bolt insulator.
- The busbar ends shall not have holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.
- It shall be possible to install and remove the joints with out disturbing the busbar run.

### **Tap off Units**

Where specified, tap off locations shall be provided for inspection of plug in tap off units. The tap off locations shall be covered by hinged plates.

### **Tap off units safety features**

- When the door is open, it should not be possible to turn the MCCB on. This should be by means of mechanical safety locking system and not by the rotary handle of the MCCB.
- The door shall be provided with lock and key.



- When the lever is in ON position, even with the key unlocked, the operator should not be able to remove the box or open the tap off location cover.
- During instertion, the earth conductor shall make contact first before the phases conductors. This should follow the sequences of first in last out concept.
- When the box is open the live conductors shall be safe guarded by a transparent insulator plate which allows for visible inspection but does not allow touching of the live conductors.
- The tap off boxes will be suitable for accommodating MCCBs or other accessories, as required. The tap off units should allow the flexibility of accommodating different, reputed MCCB makes, to be mutually agreed depending on the tender requirement.
- A full range of accessories like bends, end flanges, end feed units and support brackets shall be available.

**Installation**

- Bus ducts running along the wall shall be supported at intervals not exceeding 1.5 m. In case of branching, there shall be support on all branches at a distance of 300 mm from the point of branching. Support shall not be less than 40 x 40 x 6 mm MS angle secured in an approved manner. Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall. In case of ceiling suspended bus ducts, supports made out of 40 x 40 x 6 mm MS angle iron shall be provided. The horizontal distance between two such supports shall not be more than 1200 mm. The ducts supports shall be suspended from suitable approved suspension devices provided in the ceiling. Fire barrier shall be provided at each floor/wall crossing as per relevant IS code.

**Test at site**

The following test shall be carried out at site and test result to be recorded.

- a) Insulation resistance shall be tested with 1000V megger and shall be not less than 100 mega ohms.
- b) Earth continuity test

**26. 12 kV SWITCHGEAR****26.1 GENERAL**

This specification covers the supply, delivery field test and installation of 12 kV, metal clad, indoor switchgear, complete in all respects with all equipment fittings and accessories for efficient and trouble-free operation as specified herein under.

The scope of works shall include the supply and connection of power cables from 11kV utility supply to the incomer, and also for outgoing feeders. The cables shall be supplied with necessary terminations and accessories for two connecting ends.



The equipment specified in this Section shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60056	High-voltage alternating switchgear
IEC 62271	High-voltage alternating switchgear and controlgear
IEC 60298	Metal enclosed switchgear and controlgear for rated voltage up to 38 kV
IEC 60529	Degree of protection provided by enclosures
IEC 60694	Common specifications for high-voltage switchgear and controlgear standards

Manufacturer of 12 kV switchgears shall hold valid ISO 9001(including design) quality certificate.

## 26.2 EQUIPMENT TO BE FURNISHED

Complete 11 kV metal clad, cubicle type indoor switchgears shall be furnished for:

- Incoming feeder circuits
- Outgoing feeder circuits

The complete switchgear system shall consist of, but not limited to, the following:

- Vacuum Circuit Breakers
- Protective Relays
- Busbar system
- Measuring, control and indicating equipment

The switchgear shall be provided with controls and interlocks as required for the safe operation and maintenance of the switchgear. All supporting structures and installation materials including steel foundation frame, anchor bolts, holding down bolts, etc. shall be supplied. The interlocking, as a minimum, shall be provided:

- The VCB must be in open position before it can be lowered in its position
- The VCB cannot be closed before raising it to final plug-in position,
- etc.

Special tools and tackle required for erection, operation and maintenance of equipment shall be supplied.

Drawing, technical details, installation and maintenance manual for the switchgear and auxiliary equipment shall be supplied.

## 26.3 DESIGN REQUIREMENTS

The switchgear will be used for 11 kV, 3 phases, 50 Hz system.

Technical particulars of 12 kV indoor switchgear shall be as per Appendix 3.1 enclosed.

The equipment shall be installed indoor in a hot and humid climate. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

The maximum temperature rise in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in relevant standards.

The rated peak short circuit current or the rated short time current carried by the equipment shall not cause:



- a) mechanical damage to any part of the switchgear
- b) separation of contacts
- c) insulation damage of "Current Carrying Part"

All controls shall be suitable for 110V DC.

## 26.4 CONSTRUCTION FEATURES

### GENERAL

The switchgear shall be indoor metal-clad (cubical type), floor mounted, draw-out truck type design.

- a) The high voltage portion comprising of housing for bus bars, current transformers, voltage transformers (for incomer), cable pot heads and other accessories
- b) The movable portion comprising of circuit breaker
- c) Relays, meters, controls and indications shall be on front hinged door or properly isolated low voltage compartment

The switchgear shall have structural steel framework, enclosed on all sides and top by sheet steel of minimum 2 mm thick. Appropriate heat dissipating arrangements out of the bus-bar chamber shall be provided with pressure relief features.

The movable portion of the switchgear shall consist of circuit breaker mounted on a suitable carriage. The operating mechanism of the circuit breaker shall be located at the front of the carriage. Panels shall be dust, moisture and vermin proof. The degree of protection of enclosure shall be IP 43.

The moving carriage shall be complete with self-aligning primary and secondary disconnecting devices.

The moving carriage shall have three positions

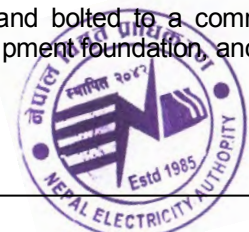
- (a) service (On position)
- (b) test and
- (c) withdrawn.

The switchgear shall be required to operate in the following manner.

- a) In "service" position all the power contacts and control contacts shall be maintained in normal operation, and the circuit breaker can be closed or tripped in normal way.
- b) In "test" position, the power contacts shall be disconnected and control contacts shall be maintained. In this position, the circuit breaker can only be closed and tripped from local panel only.
- c) In "withdrawn" position, both the power and control contacts shall be disconnected and the carriage shall be ready for removal out of the compartment.

The switchgear shall be designed in such a way that power contacts of the fixed portion shall be covered by an insulated shutter when the moving carriage is withdrawn from the switchgear.

Each switchgear assembly consisting of all the units shall be mounted and bolted to a common channel. The channel in turn shall be bolted to the foundation at site. All equipment foundation, anchor bolts, etc. shall be furnished.



The platform for circuit breaker carriage shall be equipped with appropriate rails and guide pin for drawing the CB into or out of the compartment.

The standard phase arrangement when facing the front of the switchgear shall be R-Y-B from left to right, from top to bottom and front to back. All relays, instruments, other devices, buses and equipment involving three-phase circuit shall be arranged and connected in accordance with the standard phase arrangement.

PT with fuses, lightning arresters etc. shall preferably be mounted appropriately inside the incomer cubicle.

The switchgear system shall be provided with a mimic diagram of the main circuit which shall clearly show the bus-bar configuration.

## 26.5 BUS BARS

The switchgear buses shall be rated for continuous current of magnitude as shown in Appendix. Maximum temperature rise of bus and connection shall be limited to 50 degree C over an ambient temperature of 40 degree C.

The bus bars of the switchgear section shall be of high quality electrolytic copper, liberally sized with high safety factor for required current rating.

The busbars, connections and their insulated supports shall be mechanically strong, and shall withstand all the stresses which shall be imposed upon them in ordinary working due to fixing, vibration, fluctuation in temperature, short-circuit or other causes.

Provision shall be made for expansion and contraction of the bus-bars and connections with variation of temperature. The Contractor shall also provide necessary arrangements to interconnect the busbar of new switchgears with the existing switchgears.

## 26.6 CIRCUIT BREAKERS

The circuit breakers shall be vacuum type mounted on the moving carriage. The features of the circuit breaker shall be as specified in the appendix.

Vacuum Interrupter: Vacuum interrupter, which makes use of the excellent dielectric properties, should confirm to obtain a highly reliable extinguishing device such as to quench the arc as soon as possible without causing the visible formation of the arc. There should not be any deterioration of the quenching medium. The design and manufacturing technology of the interrupter should ensure the vacuum integrity. The recovery should be faster and hence the arc quenching should be accomplished within the adequate contact gap to support the required rating. The contact surface should be free of impurities and pollution layers. Materials of high conductivity should be used such that the contact resistance will be very low. During switching, the Breaker should be **re-strikes free**.

The circuit breaker shall have motor-operated spring charging mechanism with mechanical couplings between three poles for three-phase opening and closing. The motor and the control coil shall be rated for 110V DC. The CB "On" or "Off" position indications shall be made by DC lamps: red for "On" position and green for "Off" position.

## 26.7 INSTRUMENT TRANSFORMERS

### a) Current transformer



The current transformers shall be of epoxy encapsulated/cast-in resin type, mounted on stationary portion of the switchgear and shall be easily accessible for maintenance and testing purposes.

The current transformers shall be capable of withstanding the short circuit stress corresponding to a fault level of the system.

The ratio and ratings of the current transformers shall be as specified in the appendix.

The current transformers shall conform to the latest edition of IEC. Unless specified otherwise, insulation, temperature rise and all other requirements of manufacture and testing shall conform to that given in the standards.

Facilities for shorting and grounding the terminals shall be provided at the terminal block.

Technical particulars of the CT shall be as specified in the appendix.

#### b) Potential transformers

The potential transformers shall be epoxy encapsulated/cast-in resin design, mounted in the incoming cubicle.

A manually operated disconnecting device shall be mounted on the primary side of potential transformer. This device shall be designed to operate externally without access into the line portion of the switchgear.

The connections from main circuit to potential transformers shall be capable of withstanding short circuit stress of the system.

Current limiting fuses shall protect the high voltage winding of the potential transformer. Low voltage fuses, sized to prevent harmful overload, shall be installed.

The technical particulars of the potential transformer shall be as specified in the appendix.

## **26.8 PROTECTION**

Numerical over current relay with built in earth fault protection shall be provided. The characteristics of the offered relay shall be as follows:

#### Over Current Relay

Setting range 20% - 250% (for over current element)

Setting range 200% - 2500% (for high set element)

Time Multiplier setting range 0.05 to 1.00 (programmable).

Characteristic Selection: IDMT,

#### Earth Fault

Setting range 10 % to 100% (for earth fault)

Setting range 50% to 500% (For high set element)

Time Multiplier setting range 0.05 to 1.00 (programmable).

Characteristic Selection: IDMT

The indication of relay operation shall be provided. A centralized alarm annunciator (with buzzer) for each circuit breaker shall be provided.

The control system shall be designed to permit the following:

- Automatic start/stop operation refers to spring charged motor for operating mechanism of 12 kV VCB.
- Automatic tripping of 12 kV VCB LV MCB if faults occur in protected lines equipments or circuits.



- The control system shall be arranged in such way that it is possible to change between local manual and remote automatic control of any time.
- The design shall be in general conformity with the single line diagrams and layout drawings accompanying this specification.
- Under manual control the individual operations shall full fill safe interlocks.
- The control scheme shall be operationally simple, safe, easy to maintain and functionally consistent.
- Each module shall have sufficient test points to facilitate faultfinding. Control circuits shall be brought out of isolating terminals to permit efficient trouble shooting.
- Each cubicle shall be provided with a sufficient point Annunciation Block to identify an alarm condition, including audible alarm, test, acknowledge and reset push button.
- Control switches for circuit breakers shall be of the discrepancy type. Two independent movements shall be required to initiate an operation.

**26.9 REQUIRED SIGNALS / ALARM SYSTEMS:**

The switchgear shall have following signalling and alarm system:

- CB Off/On position by green/red lamp
- White lamp for spring charged
- Flag or lamp indication of faults for:  
Over Current Protection, E/F Protection, DC Supply Failure, CB Failure, MCB tripped, AC supply failure.  
All signal lamps shall be LED type

The design shall avoid nuisance alarms and shall block those devices, which assume alarm conditions when the equipment is under shutdown. Annunciation Block windows shall be engraved with identification of the alarm condition.

**Annunciators shall have the following sequences:**

Condition	Lamp	Alarm
Normal	Off	Off
Alarm Flashing	On	On
Acknowledge	On	Off
<b>Reset After return:</b>		
Normal	Off	Off
Lamp test	On	Off

**26.10 AUXILIARY AND CONTROL POWER SUPPLY**a) AC power supply for space heater and cubical illumination lamps.

Each carriage control panel including the breaker operating mechanism shall be provided with thermostatically controlled space heater. The thermostat shall have adjustable range of 25 °C - 55 °C. The space heaters shall be rated for 230 volts, 1 phase, 50 Hz.

For cubical illumination, receptacle arrangement at suitable location of each control panel shall be provided with compact fluorescent lamps for the inspection and maintenance works. The lamps shall be controlled by a door switch. The receptacle shall be suitable for 230 volts, 1 phase, and 50 Hz supply. Wiring for space heaters and panel receptacles shall be suitably grouped so as to form a more or less balanced condition of 400V, 3 phase, 4 wire, 50 Hz supply.

Each space heater and hand lamp circuit shall be provided with ON/OFF switch and suitable protection.

b) DC power supply

- 1) The power for breaker control and indication shall be taken from 110 V DC power supplies from the DC distribution board of the substation. Bidder shall be required to distribute the DC power supply to the switchgear cubicles.
- 2) In addition, each cubicle shall be provided with one double pole, single-throw switch for its control circuit power supply.
- c) MCB

All protection for control and power circuits shall be MCCB/MCB for DC and AC. Plug fuses (screw-in type) shall not be accepted.

#### **26.11 SECONDARY WIRING**

All wiring for the equipment and devices located on or within the switchgear shall be furnished.

The wiring shall be complete in all respects so as to ensure proper functioning of control, indication, measurement, protection and interlocking scheme.

#### **26.12 CABLE TERMINATION**

##### a) HV Power cable

- 1) All power cable entry shall be from the bottom and provision for support of the cable termination shall be provided. The cable termination kit required also has to be provided by the contractor.
- 2) Where more than one cable is used per phase, the Contractor shall be required to arrange the cable in such way that detachment of any one shall not disturb another unit.

##### b) Control / LV power cable

All control/ LV power cables shall enter the switchgear from bottom. Removable plates at the bottom of the panel shall be furnished with compression type cable glands to make entry dust-tight and no weight is transferred on the terminal. The glands shall be suitable for terminating cable armour.

- c) All connectors and accessories required to complete the whole installation shall be supplied by the Contractor.

#### **26.13 TERMINAL BLOCKS**

Special design disconnecting type terminals shall be provided for CT/PT secondary connections.

#### **26.14 ACCESSORIES**

Following accessories shall be provided for each-switchgear.

- a) Channel base and foundation bolts
- b) Circuit Breaker Lifter, if applicable with operating winch handles, locking devices etc.
- c) Manual charging handle for circuit breakers
- d) Draw-out handle for circuit breaker.
- e) Test plug

#### **26.15 NAME PLATE**



Nameplates of approved design shall be furnished at the front of each compartment of the cubicles. Rating plates for each circuit breaker, relay and auxiliary switches and for each equipment mounted on the face or inside of the cubicles shall also be furnished.

Instruments and devices mounted on the cubicle doors of the switchgear shall be identified on the rear also with the respective numbers on or adjacent to the instrument or device case.

**26.16 GROUND BUS**

A ground bus of 25 mm x 6 mm copper shall be furnished along with the full length of the switchgear. Each stationary unit shall be connected directly to this ground bus.

Grounding terminals at two end of the ground bus shall be provided for connection to station ground grid.

The frame of each draw-out carriage containing circuit breaker shall be grounded through heavy multiple finger contacts at all times except when the unit primary disconnecting devices are separated by a safe distance.

**26.17 TESTS**

The switchgear unit shall be completely assembled, wired, adjusted and tested for operation under similar conditions to ensure accuracy of wiring, correctness of control schemes and proper functioning of all equipment.

**a) Routine test**

Each of the following equipment shall be subjected to standard routine tests as per applicable clauses of relevant IEC Specifications:

- Circuit breaker
- Bus bar assembly
- Instrument transformers
- Auxiliary relays
- Control switches and indication lamps, etc.

**b) Design tests**

The design tests shall consist of following:

- Impulse test
- One-minute power frequency voltage withstand test
- Temperature rise test
- Short circuit test, etc. (certificate to be submitted for same model)

The Bidder shall submit copy of design test report from accredited testing laboratory for the 12 kV switchgear of the offered model along with the bid.

The routine and type test certificates of the miscellaneous components shall also be furnished to the Employer for approval. The report shall furnish complete identification of data including serial number of each-equipment.

**26.18 FIELD TESTS**

After installation at Site, the switchgear shall be subjected to the following tests:



- a) Construction inspection
- b) Measurement of insulation resistance
- c) Calibration test for meters
- d) Characteristic test for relays
- e) Electrical control, interlock and sequential operation tests, etc.
- f) High voltage test

**26.19 DRAWINGS, DATA AND MANUALS**

The following drawings and details shall be furnished along with the Bid.

- a) Bidder's proposed typical general arrangement drawing showing constructional features.
- b) Technical leaflets of the switchgear offered.

After award of Contract, the successful Bidder shall submit the required number of copies of the following drawings for approval of the Employer.

- a) Confirmed outline dimensional drawing of the various switchgears showing the General Arrangement and indicating the following:
  - Space required in the front for breaker withdrawal.
  - Control cable entry points and termination arrangement.
  - Power cable entry points and termination arrangement.
  - Bus bar clearance phase to phase and phase to ground.
  - Configuration of bus bar.
  - Technical detail of supporting insulator and their spacing.
  - Location of instrument transformers.
  - Control panel details with equipment layout.
  - Terminal block details.
- b) Single and three line diagrams of all switchgears showing instrument transformers control switches, instruments and indication, etc.
- c) Control schematic diagram of each breaker showing all safety and operation interlocks, annunciation, etc.
- d) Typical design test and routine test results on identical switchgear offered.
- e) Foundation and anchor bolt details including dead load and impact load.
- f) Cross-section with parts list.
- g) Cubicle wiring diagram with terminal board disposition.
- h) Transport/shipping dimensions with weights.

The responsibility of correctness of wiring diagram shall be with the Contractor. The Employer will check the final schematic drawing after submission. If any modification, addition, or alternation is considered necessary to comply with the approved schematic drawing as stated herein above, the Contractor shall carry out the said modification, addition, or alternation. This shall either be done in their works if it is before delivery or at Site after delivery at no cost to the Employer.

Before starting manufacture of the equipment, the Contractor shall have to take approval of these design drawings from the Employer in writing. The Contractor at his own cost shall rectify any manufacturing done prior to approval of drawings in accordance with the approved drawing and the equipment shall be supplied within the stipulated period.



**APPENDIX 3.1: RATING AND FEATURES OF EACH 12 KV SWITCHGEAR PANEL**

S.No	Description	
1.	Type	Metal enclosed, cubical indoor type
2.	Voltage rating : a) Nominal system voltage b) Rated maximum system voltage	11 kV 12 kV
3.	Insulation level a) Impulse withstand voltage (crest) b) Power-frequency withstand voltage (1 min.)	75 kV 28 kV
4.	Frequency	50 Hz
5.	Minimum continuous bus-bar rating	1000 A
6.	Current rating a) Rated continuous current at 45 °C ambient b) Short circuit breaking current	630 A 25 kA
7.	Current transformer a) Current ratio b) Number of cores c) Burden per cores d) Accuracy class	50-100/5 3 15 VA 5P20 /PS/ 0.5
8.	Potential transformer a) Voltage ratio b) Number per set c) Rated Burden d) Accuracy class e) No. of core	11000/√3 / 110/√3 V 3 50 VA 3P/0.5 2
9.	Lightning Arrestor	9 kV
10.	Metering-digital a) Ammeter scale with selector switch b) Voltmeter scale with selector switch c) Other	0-200/100A 0 – 15 kV MW MVAR MWh
11.	Auxiliary supply a) Control circuit b) Space heater and auxiliary equipment.	110V DC AC, 230/400 V, 50 Hz
12.	Number of possible operations of Circuit Breaker without maintenance under: For contacts - Rated short circuit breaking current (25 kA) - Rated normal current For mechanism	100 Operations 10,000 Operations 2000 Operation
13.	Reclosing duty cycle of Circuit Breaker	0-15 sec-CO
14.	Total maximum break time	60 ms
15.	Maximum make time	120 ms
17.	Applicable standard	IEC



6/4

**APPENDIX 3-2: BILL OF MATERIAL**

The bill of materials shall cover only the major equipment, as will be required by the Bidder for general information. It is to be understood that, all other associated auxiliary equipment and accessories—although not listed in the bill of materials, but necessary for the complete and sound functioning of the entire 12 kV switchgears, as described in this specification—shall be furnished by the Contractor.

One lot of complete metal clad switchgear panels with necessary cables for incomer and outgoing feeders up to the point of overhead connection shall be supplied.

The following equipment of appropriate ratings shall be mounted inside the cubicles:

**1. For incoming circuits**

- (a) One (1) no. Vacuum Circuit breaker
- (b) One (1) set Current transformers
- (c) One (1) no. Ammeter with selector switch
- (d) One (1) no. Watt-hour meter
- (e) One (1) no. Voltmeter with selector switch
- (f) One (1) set. Over-current and Earth fault relay (numeric)
- (g) One (1) set. Control switch with position indicating lamps for circuit breaker.
- (h) Two (2) sets Potential transformer
- (i) One (1) no. MVAR meter
- (j) One (1) no. Watt-meter
- (l) Three (3) nos. Lightning arrester
- (m) Other accessories as required

**2. For outgoing circuits**

- (a) One (1) no. Vacuum Circuit breaker (C.B.)
- (b) One (1) set Current transformers
- (c) One (1) no. Ammeter with selector switch
- (d) One (1) no. Watt-hour meter
- (e) One (1) set. Over-current and Earth fault relay (numeric)
- (f) One (1) set. Control switch with position indicating lamps for C.B
- (g) One (1) no. Power factor meter
- (h) One (1) no. Watt meter
- (i) Other accessories as required

Ammeter, Voltmeter, MVAR meter, Watt meter, Watt-hour meter and power factor meters for above incoming and outgoing circuits

**27. 11 KV POWER CABLES AND TERMINATION****a) General**

The rated voltage of the power cables shall be 12 kV. The power cable shall be cross-linked polyethylene insulated, screened and steel tape armoured.

The scope shall include the supply, laying and connection of power cables from NEA tap off point to 11 kV incomer, and also for outgoing feeders (Transformers). The cables shall be supplied with necessary terminations and accessories for both connecting ends.

**b) Conductor**

Conductor for power cable shall consist of stranded aluminum wires for incoming and outgoing feeders. They shall comply with IEC Publication.

c) Cable Rating

The minimum current rating for the cable and conditions of installation shall be as follows:

i) For connecting incoming and outgoing feeders the cables shall be of 3 core 95 sq. mm.

d) Anti-Termite Covering

Anti-termite protection shall be applied to the cable and shall be black PVC suitable for the operating temperature of cable and shall meet the requirements of IEC standard.

e) Outer Covering

The outer covering of the cable shall be extruded, continuous black PVC suitable for the operating temperature of cable and shall meet the requirements of IEC standard.

f) Cable Drum

Cable drum shall be non- returnable and made of steel suitably protected against corrosion.

g) Outdoor and Indoor Termination

11 kV cable terminations shall be of the heat-shrinkable type / pre-moulded push on type. Terminations for cable shall be provided in sufficient quantities for complete installations of all feeders of the substations.

h) Jointing Accessories

Cables shall be installed in maximum possible lengths and straight-through jointing shall not be permitted without the prior written approval of the Employer.

i) Voltage Identification

The plastic covering shall be embossed with the name of the manufacturer, number of conductors, the cross sections, type of insulation followed by:

Electric cable - (Corresponding) volts

j) Phase Identification

Phase identification for either triplex or multi-core conductor cable shall be in accordance with the following:

Phase A ( R ) : Red  
Phase B ( Y ) : Yellow  
Phase C ( B ) : Blue

### **Installation requirements**

11 kV incoming cable shall be laid in the cable trench or buried in the ground; the outgoing feeder cables can be laid in ready made trenches.



For interconnection cable a depth of 1.5 m shall be considered as safe depth of burial. Before laying the cable a layer of sand shall be placed. After laying the cable and above the second layer of sand, brick soiling shall be provided and place a colour tape printed "**11000V Power Cable Line**" to protect the cable and then refill the remainder of the cable trench space by using the excavated earth and gravel.

For the road crossing NP 3 grade hume-pipe shall be used. Steel protection pipe shall be provided at each termination pole for feeder cables.

### TESTS FOR 11 KV POWER CABLE

#### Routine and Design Tests

Power cable shall be subjected to following routine tests. As far as practical, the procedure of IEC shall be followed:

- a) Measurement of the electrical resistance of conductor
- b) Partial discharge test
- c) Voltage test

The power cable design tests shall include following:

- a) Partial discharge test
- b) Bending test, followed by a partial discharge test
- c) Tan delta measurement
- d) Heating cycle test, followed by a partial discharge test
- e) Impulse test, followed by voltage test
- f) Voltage test for 4 hours.

The Bidder shall submit copy of design test report from recognized testing laboratory for the offered power cable along with the bid.

#### Field Tests

After installation at Site, cables shall be subjected but not limited to the following tests:

- a) Measurement of insulation resistance
- b) *DC dielectric test*

## 28. BATTERY AND BATTERY CHARGER

### General

The Battery Charger shall be float cum boost type IGBT controlled. The charger shall have selector switch for Auto Float-Boost/ Manual Float/Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost Mode and Vice – Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost Charge to trickle charge.

### Construction Feature

The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032.



**Performance**

The D.C output voltage of Float/Boost charger shall be stabilized within +/- 2% for AC input variation of 230 +/- 15%, frequency variation of 50Hz +/- 5% and DC load variation of 0 – 100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response IGBT control. The ripple content within 3% of DC output nominal voltage.

There shall be provision to select Auto Float/ Boost Manual Float/ Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float/Boost modes it shall be possible to set the output volts by separate potentiometers.

**Components**

The battery charge shall have double pole MCB at input side and some SP MCB at out put side. LED indications shall be provided to indicate status of charger e.g AC supply ON, Boost/Float Mode, Manual Mode, Fault indications etc.

The charger shall be built using double wounded naturally air cooled isolation transformer. Winding shall be of copper. IGBT with electronic control circuit shall be used to control and protection of the charger

Necessary Volt meters, Ammeters shall be installed in the input and out put circuits. A Rotary switch shall be provided to select auto float/boost and Manual float and Manual Boost mode. During Auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.

The battery charger shall have automatic output current limiting feature.

**Rating**

AC input : 230V +/- 15% 50 Hz Single phase  
DC output : To float/boost charge batteries and also supply a continuous load

Current Rating : 25 Amps  
Float Mode : 120.6 V (adjustable 108 – 128V)  
Boost Mode : 127.8 V (adjustable 104 – 144V)  
Voltage Regulation : +/- 2% for AC input variation of 230V +/- 15%. Frequency Variation of 50 Hz +/- 5% and DC load variation 0 – 100%

**BATTERIES**

9 Nos of standard type 12V Maintenance free Lead acid Battery (VRLA) shall be provided.

Battery Voltage : 12V  
Quantity : 9 nos  
Current Capacity : 60 – 70 A/H

**29. WIRING**

Wiring in the final sub-circuits shall be looped with cable terminations in the distribution box and the related outlet box of the fixture or appliance. Use of intermediate junction boxes shall be discouraged. Joints in cable within the conduit shall be prohibited.

Cable shall be pulled into the conduit only after civil structural works are complete and outlet boxes etc. have been fixed satisfactorily.



Where it becomes necessary to terminate or join final sub-circuit cables in outlet boxes, such terminations and joints shall be made in an approved manner.

### **30. POINT WIRING FOR LIGHT, FAN AND FIRE**

The point wiring of light and fans shall be carried in the manner each of which will confirm to the standard specification. All accessories such as switches and sockets shall be flush type. The point will commenced from distribution board including circuits each having independent phase and neutral wires up to the outlet and switch box. The conduit pipe will be completed including wires and accessories, necessary junction box outlets and switch box, connector, ceiling rose switch, switch plate, low power socket and flush plate, necessary earth, connections, etc.

### **31. POINT WIRING FOR POWER PLUG AND AIR CONDITION POWER UNIT**

Point wiring for power plugs shall be as mentioned in the schedule of quantities. Generally each circuit have only two - three power plugs which shall be wired with 3 x 2.5 sq mm insulated copper cable from the nominated distribution board. The wiring shall be completed with a suitable deep metal boxes at nominated point for power plugs and termination in distribution board with all necessary accessories as per instructions.

Point wiring for wall Air conditioner power unit shall be as mentioned in the schedule of quantities. Generally each circuit have only one power plugs unit which shall be wired with 4 sq mm PVC insulated copper cable and earthed with 2.5 sq mm PVC insulated copper cable. The wiring shall be completed with a suitable deep metal boxes at nominated point for power plugs and termination in distribution board with all necessary accessories as per instructions.

### **32. POINT WIRING FOR TELEPHONE AND COMPUTER NETWORK**

The point wiring of telephone line shall be wired with 2 pair telephone cables, carried in the manner each of which shall confirm to the standard specification. The wiring with all accessories for flush mounted outlet hair pin jacks type shall be completed with a suitable deep metal boxes at nominated point for telephone outlets and termination in telephone distribution board with all necessary junction box, connector and other accessories as per instructions. The point shall commenced from distribution board including circuits each having 2 pair telephone cables up to the outlet box.

The point wiring of computer networking shall be wired with four pair networking cable category CAT6 for the data transmission up to 10000 Mbps. The layout of the networking cable shall be carried in the manner each of which will confirm to the BICSI standard. The wiring shall be completed with a suitable deep metal boxes with cover at nominated point for outlet. The point will commenced from patch panel board including circuits each having independent four pair computer networking cable up to the outlet box.

### **33. EARTHING**

This specification covers supply, delivery, installation and testing of the complete grounding system as described below.

Station earth points shall be constructed to provide grounding points for all earth continuity conductors used in this installation. Station earths shall be as specified in the appropriate Indian Standards or equivalent.



All lap, cross and tee connections between two grounding conductors shall be made by thermo-welding process or compression type connector. The various joints shall have adequate mechanical strength as well as necessary electrical conductivity not less than that of the parent conductors of the joints. All accessories for grounding installation shall be of quality and design approved by the Engineer.

Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300 mm below the bottom elevation of such trenches/pipes.

Complete installation of the ground, test link chamber, grounding of all but not limited to the equipment located in the building and substation as specified herein. The supply of grounding conductors, jointing materials and all accessories to complete this grounding installation so as to obtain the specified value of earth resistance shall be covered under this specification.

The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class neat workman like manner. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during laying and installation. All exposed ground conductors runs shall be taken in a neat manner, horizontal, vertical and parallel to building walls or columns and shall not be laid haphazardly.

For all connections made to equipment or to the structures, the grounding conductor, connectors and equipment enclosures shall have good clean contact surfaces. Grounding conductor connection to all electrical equipment, switchgear, transformers, motors, panels, conduit system, equipment enclosures, cable trays, distribution boards, equipment frames, bases, steel structure, etc. shall be by pressure type or bolting type connectors.

Horizontal copper earth wire of 95 sq mm shall be laid as earth electrode along perimeter of building and transformer house (Substation). The earth resistance shall not exceed 1 ohm. On completion of the installation, either wholly or in sections, it shall be tested in compliance with relevant Code by the Contractor in presence of the Engineer. If the earth resistance can not be obtained as per specified value, then additional earth electrode shall be installed and treated soil to obtain the required low ground resistance without any additional cost.

The contractor shall calculate step potential and touch potential, these values shall be as specified in IEEE – 80. If step potential and touch potential are higher than permissible, the contractor shall do required treatment in earthing system without additional cost.

During construction of main building, the electrical contractor shall laid 25 x 3 mm GI stripe on or under the beam at the lower basement before casting of the beams. Tap off points from GI earth shall be brought out as shown in the drawings for connection to the main earth grid.

Earth electrodes size of 600X600X3.15 mm electrolytically pure copper plate, at least 2.5 meter below ground level surrounded by alternate layers of 150 mm with hydrosopic material such as 25 kg of coal and 50 kg of salt shall be used in some specific areas. Bonding of the station earth to the main earth terminal inside the building shall be with an earth conductor or strip not less than 50 sq.mm in cross-sectional area. A HDP pipe shall be used for earth conductor as protection from erosion. Earth continuity conductor running from earth terminal to each floor distribution board shall not be less than 10 sq.mm of copper conductor.



**34. CABLING**

Laying of cables between two points shall follow the following methods.

- a. laying of cables directly in the ground in outdoor applications; and
- b. laying or supporting of cables in cable trays, trenches and ducts, or clipped on to the walls or structural members of the building.

Where cables are to be laid direct in ground these shall be laid in cable trenches at least 0.8 m below ground surface. The cable laid shall be covered with 100 mm finely sifted sand and protected on the top with transverse bricks across the trench cross-section. The trench shall then be backfilled and compacted.

Where cable routes run under hard surfaces, or where cables have to be run inside masonry or structural components inside buildings, such cables shall be run in cable trays or cable ladder.

During laying of cables, special precautions shall be taken at bending areas. Bending radius shall be not less than 10 times of cable diameter.

**35. LIGHTNING PROTECTION**

For protection of the building from lightning, lightning protection system shall be provided. General layout of lightning protection system is shown in the drawings. The contractor shall submit working drawings before execution of the works for approval from the Engineer/Owner. Lightning protection of the building shall be considered as stated in IS 2309-1969. Lightning protective system shall be installed with a view to offering least to the passage of lightning current between air termination unit and earth. This is done by connecting the conductors to form a cage enclosing the building.

The principal components of a lightning protective system are:

air terminations,

down conductors,

joints and bends

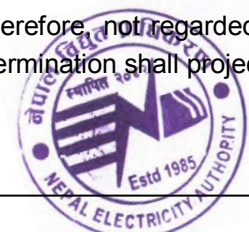
testing points

earth terminations

earth electrode and

fasteners

- 35.1** Air Termination- For the purpose of lightning protection, the vertical and horizontal considered equivalent and the use of pointed air terminations or vertical finals is therefore not regarded as essential except when dictated by practical considerations. A vertical air termination shall project at least 30 cm above the object, salient point or network on which it is fixed.



Horizontal air terminations should be so interconnected that no part of the roof is not more than 9 m away from the nearest horizontal conductor. For a flat roof, horizontal air terminations along the outer perimeter of the roof are used. Salient points even if less than 9 m apart should each be provided with air termination.

All air terminals shall be effectively secured against overturning either by attachment to the object to be protected or by means of substantial braces and fixing which shall be permanently and rigidly attached to the building.

## **35.2 Joints and Bonds**

**35.2.1 Joints-** The lightning protective system shall have as few joints in it as necessary. In the down conductors below ground level these shall be mechanically and electrically effective and shall be so made as to exclude moisture completely. The joints may be clamped, screwed, bolted, crimped or welded. With overlapping joints the length of the overlap should not be less than 20mm for all types of the conductors. Contact surfaces should first be cleaned and then inhibited from oxidation with suitable non-corrosive compound. Joints of dissimilar metal should be suitably protected against bimetallic action and corrosion.

**35.2.2 Bonds-** External metal on or forming part of a structure may have to discharge the full lightning current. Therefore, the bond to the lightning protective system shall have a cross sectional area not less than that employed for the main conductors. All the bonds shall be suitably protected against corrosion. Bonds shall be as short as possible.

**35.3 Testing Points-** Each down conductor shall be provided with testing point in a position convenient for testing but inaccessible for interference. No connection, other than one direct to an earth electrode, shall be made below a testing point.

**35.4 Earth Terminations-** Each down conductor shall have an independent earth termination. It should be capable of isolation for testing purpose. Suitable location for the earth termination shall be near to the damp area.

**35.5 Earth Electrodes -** Earth electrodes shall consist of rods. These rods shall be driven in to the ground as practicable but outside the circumference of the structure. Distance between two parallel rods shall be not less than twice the length of the rods.

**34.6 Earth Resistance -** The whole of the lightning protective system should have a combined resistance to earth not exceeding 10 ohms before any bonding has been effected to the metal in or on the structure or surface below ground.

**35.7 Testing-** On completion of the installation or of any modification, the resistance of each earth termination or section thereof, shall, if possible be measured and the continuity of all conductors and the efficiency of all bonds and joints shall be verified.

The ohmic resistance of the lightning protective system complete with air termination, but without the earth connection should be measured and this should be a fraction of an ohm. If it exceeds 1



ohm, then there shall be some fault either electrical or mechanical, which shall be inspected and the defect rectified.

### 35.8 Conductor sizes

Minimum sizes of conductors for use above ground

1. Copper Strip 25 mm x 3 mm
2. Galvanized iron strip 25 mm x 3 mm

Minimum sizes of conductors for use below ground

1. Copper Strip 32 mm x 6 mm
2. Galvanized iron strip 32 mm x 6 mm

**35.9** Corrosion- Where corrosion due to atmospheric, chemical electrolytic or other causes is likely to impair any part of the lightning protective system, suitable precaution should be taken prevent its occurrence.

## 36. POWER FACTOR CORRECTION SYSTEM

### Scope

Design, manufacture, supply, erection, testing and commissioning of indoor type power correction capacitor banks for power factor improvement as per specification given below:

### Standard

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments) : IS 13340 – 1993, IS 13341 – 1992, IEC 60831-1+2

### Rating

25 kVAR or less as specified in the BOQ shall be used to form of capacitor of desired capacity.

### Enclosure

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with power coating in the approved colour to match the colour of the other panels.

The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non live parts, providing necessary working clearance.

### APFC Relay/Controller

Microprocessor based APFC relay (intelligent Var controller) shall be used to ON/ OFF desired capacitors or stage to achieve the pre stage power factor. The controller shall have the following features:

- Controller shall provide output 16 stage.
- Digital setting of PF, Switching time delay, Step limit etc.



- Digital display of PF/V/KVAr etc.
- Indication of PF, preset parameter, contactor switching operation etc.

**Capacitors**

- Capacitors shall be 3 phase delta connected, 50 Hz.
- Capacitor shall be ISI marked.
- Capacitor shall be designed for minimum **520V** and shall have with stand system over voltage.
- Capacitor shall be of super heavy duty with double side metallised capacitor tissue paper. Oil impregnated and self – healing type with bi – axially oriented polypropylene film shall be fitted with pressure sensitive disconnecter in each individual capacitor cell.
- Capacitors shall operate at -25 deg. C to 70 deg. C

**Switching system**

Individual capacitor duty magnetic contactor suitable for three phase 400V system along with MCCB as a protection against short circuit and over load shall be used to switching the capacitors. A auto manual switch shall also be provided for auto and manual mode selection, push button switches shall also be considered for manual switching of the capacitors.

ON/OFF status of individual capacitor shall be indicated using indication lamps.

**37. FIRE DETECTION SYSTEM****General**

The purpose of the fire alarm system is to guarantee a reliable and fault-free early-warning system in the event of fire, so that orders for extinguishing the fire can be issued from a central point. The fire alarm system shall comply with the NFPA standards. All equipment is subject to approved standards.

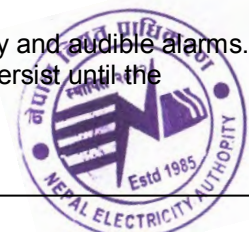
**Fire alarm central station**

The function of the fire alarm central station is to receive fire warnings from the automatic and manual fire alarms connected to the dedicated protection systems and to alarm a fire automatically in the central control room. The fire alarm central station is to be implemented with all electronic techniques using plug-in modules and groups on the modular construction principle.

The fire alarm central station shall be designed for a possible final extension. Therefore the internal wiring and layout of the panels shall be designed so, that any necessary extensions can be effected easily without involving a lot of alteration to the wiring.

The arrangement and functioning of the fire alarm central station shall be such as to permit the following at least:

- The fire alarm and fault annunciation system shall be designed with optically and audible alarms. Whereas the audible alarm must be resettable, the optical indication shall persist until the annunciation is finally extinguished or the fault cleared.



If a fault warning is followed by a fire alarm annunciation, the fault indication must be stored and suppressed until the fire alarm condition has been cancelled.

Provision shall be made for clear audible identification of the alarm/fault signal. Furthermore, fire alarm signals and fault signals shall be built up in a strictly separated manner.

- An automatic fire alarm signal (common fire alarm) shall be wired to terminals for later use. The alarm line shall be continuously monitored.
- The individual fire alarm lines and important functional groups of the fire alarm central station shall be continuously monitored for faults and breakdowns e.g. for
  - wire breakage of each alarm line
  - short-circuit of each alarm line
  - earth fault of the fire alarm system
  - power supply system faulty
  - main supply failure
  - alarm modules disconnected from plug-in frame.All fault signals shall be optically and audibly indicated.
- For checking out the functioning of the complete fire alarm system including the fire alarm lines and fire alarm devices, testing facilities shall be provided. When testing a circuit, it shall be prevented to initiate fire alarm warnings in external facilities. After testing, the tested circuit shall automatically reset to normal operation.

### **Detection systems**

The fire detector system elements and the associated pedestals are to be provided with sturdy, corrosion-proofed plastic housings and are to remain fully effective at 100 % relative humidity, 50 °C ambient temperature and severe dust conditions.

The fire alarm detectors installed in close rooms are to be provided with optical means for signaling their activation (e.g. light-emitting diode), and are to be suitable for the connection of an additional optical external alarm indication.

The following automatic fire alarms as a minimum shall be used for fulfilling the requirements for NEA Building:

#### **Optical smoke detector**

For early identification of visible smoke generation, consisting of photo-electric unit, alarm electronics, optical alarm indication, detector socket and connection possibility of a parallel optical alarm indication.

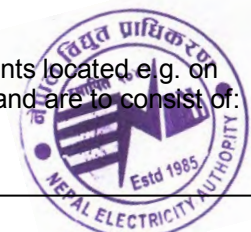
#### **Heat Detectors**

For early identification of initiation fires with rapid temperature rise and little smoke generation, consisting of temperature sensor, alarm electronics, detector socket and connecting possibility of a parallel optical alarm indication.

### **Manual operated alarms**

Push-button fire alarms are used for the manual initiation of an alarm and are to be connected to the fire alarm central station.

They are to be installed in the necessary number at readily accessible points located e.g. on escape routes, corridors and stairwells, exit doors, generator house, etc. and are to consist of:



- pushbutton, only operable after smashing the replaceable glass window fitted in the housing
- interlocking mechanism, which holds the pushbutton in the operated position and cannot be released until the glass window has been replaced or reset by key
- plastics or aluminium housing, painted red, type of enclosure IP 54, in areas where there is an explosion hazard, cast-iron housings with suitable locking mechanisms are to be used
- instructions for use in English are to be provided on the operating side as follows:
  - "Fire alarm"
  - "Break window"
  - "Pushbutton".

### Sirens/bells

The protection degree of the sirens/bells for indoor and outdoor installation must be at least IP 54. The arrangement of the sirens/bells must be according to the requirements at site for satisfactory warning of the operation personnel. The control of the sirens shall be performed automatically by the fire alarm system, but manual operation from the central control room must also be possible.

### Cabling

The cable of all detectors and alarm lines throughout the fire alarm system has to be self-extinguished highly flame resistant, neoprene insulated cable. The minimum cross section of the copper conductors of the control cables should be 1 mm<sup>2</sup>. The cables have to be laid with suitable spacing from power cables and other control cables.

All materials and equipment supplied and all works carried out shall comply in every respect with the technical NFPA standards.

### 38. Diesel Generator

Two unit of 500kVA and one unit of 125 kVA diesel generators have been considered for back up supply during city supply failures. In case of power loss in city supply at the initial, one unit of 500kVA diesel generator shall start and if the connected load is more than 450 kVA another 500kVA shall auto start and synchronised. 125kVA generator is considered for off hours and weekend/holidays. During weekend/holidays and off hours load of the building will be below 100 - 125kVA. So, 125 kVA generator is sufficient to cater the load. Both 500kVA generator shall start, stop and synchronize automatically. The contractor shall supply the generator and other accessories such as synchronizing panels PLC based automatic controller etc to fulfill above requirements. Main breakers for the generators have been considered in the Main Panel Board.

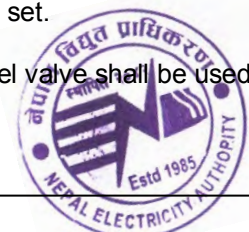
The diesel engine shall be designed for instantaneous starting and loading in cold condition by means of an electric starter motor. The loadability of the set after cold start shall be:

- immediately 75%
- after 30 s 90%
- after 5 min 100%.

The overload capacity shall be according to ISO 3046 (110% of ISO standard power for 1 hour in any period of 12 hours consecutive running).

The speed controlling device preferably be electronic and automatic with a setting range of  $\pm 10\%$  of rated speed. It shall be located in the control cabinet of the diesel generator set.

For stop of the engine a normally closed magnetic fuel valve and manual fuel valve shall be used.



The engine-generator shall be flanged together and mounted by means of vibration dampers on a stiff base-frame, which shall be designed in a way that it can be placed directly on the floor of the diesel room, no special foundation work being necessary.

Alternatively, the engine-generator can be rigidly mounted on the base-frame, which is placed on the floor by vibration dampers.

The base-frame system shall be strong enough to withstand the forces caused by a short-circuit.

The diesel engine shall be protected against over crank:

- vibration for the crank itself
- connecting roots.

The fuel system shall include:

A day fuel oil tank with a filling pipe with level valve, fuel supply and a return pipe with valve, drain valve, inspection opening and level indicator. The capacity shall be for at least 12 hours operation of the engine at rated load.

The diesel engine shall have a complete lubrication system with low lube oil pressure trip device. The combustion air intake shall have an oil-wetted air filter designed with regard to local ambient conditions.

The exhaust system shall include the silencer, the necessary piping, heat insulation and a flexible joint to absorb vibration. The cabinet of the generator shall be such that sound level of the generator shall not exceeds 70 dbm at one meter distance. The generator shall be soundproof type.

The engine shall be closed-loop circuit water-cooled with a radiator attached to it and a mechanically driven fan. The radiator shall be mounted to the same frame with the engine.

The diesel generator set shall be installed in a way that proper cooling airflow through the radiator is ensured. Cooling air inlet shall be so located that loop effect with exhaust system is prevented.

The starting system shall include:

- an electric starter motor
- a starter battery 12/24V DC
- a battery charger
- a low voltage alarm relay for battery voltage.

### **Generator**

The generator shall be in accordance with IEC standards.

The generator shall be Y-connected synchronous machine for three-phase, 400 V, 50 Hz, equipped with amply dimensioned terminal box for termination and connection of cables. The neutral point shall be brought to the outside and can be loaded continuously with the rated current. The generator shall be self ventilated, protection class IP 34.

### **Exciter and voltage regulator**

The generator shall have a rotating brushless exciter and a static voltage regulator.

The output voltage shall not deviate more than  $\pm 2.5\%$  from nominal value in any loading conditions. The voltage setting range shall be  $\pm 10\%$  from nominal value in any loading conditions.

### **Control panel**

The diesel generator set shall have complete equipment for automatic start and stop sequences in case of mains supply break and return. The automatic starting should make three consecutive

starting attempts and alarm after the third unsuccessful attempt. The control panel shall be micro processor based and all protection and measurement signals shall be brought to it. The automatic switching over from mains and back to mains shall be made by Air Circuit Breakers (ACB) installed in Main Panel Board. The switchover back to mains shall be made after 1 min after the mains have recovered.

After the switchover back to mains, the set shall run on no-load long enough to prevent due to post heat (e.g. 3 min)

Manual start/stop equipment and a OFF/MANUAL/AUTO switch shall be included. The automatic operation shall be blocked when the switch is on MANUAL, and all operation when the switch is OFF.

An emergency stop push-button with latching contact shall be included in the control cabinet.

Necessary document of generator including micro processor control panel shall be provided for maintenance purpose.

Protection and alarms:

- generator overload
- generator overcurrent
- over/underspeed
- over/undervoltage
- low lube oil pressure
- high cooling water temperature
- neutral current (thermal relay)
- low fuel-oil in day tank.

Measurements:

- Output voltage
- Output current
- kW meter
- KWhr Meter
- Frequency
- operation hour meter
- Battery Voltage
- Cooling water temp
- Oil pressure
- And other as recommended from manufactures

Technical Data

Alternator stand by power	500kVA Two unit ; 125 kVA One unit
Out put voltage	400 V 3 phase four wire
Out put frequency	50 Hz
Power Factor	0.8 lagging
RPM	1500 rev/Min
Excitation	Brushless type
Battery voltage	24 V
Charger	Individual fully automatic additional battery charger shall be provided in each generator
Governor	Electronic governor



Cooling System

Water cooled with forced air

**39. RENEWABLE ENERGY**

SOLAR POWER SYSTEM as a main and city supply as a back up supply has been considered for some indoor, out door lights and electrical vehicle charging system. The contractor shall supply good quality equipment to assure 99.9 % reliability of the hybrid system

Technical specifications of different equipment are as follows

**a. SOLAR PANELS**

Rated Power:	200W
Voltage at P Max:	36.9 V (Approx.)
Open Circuit Voltage:	45.4 V(Approx.)
Current at P Max:	5.44 A (Approx.)
Short Circuit Current (Isc):	5.8 A (Approx.)
Standard:	IEC 61215
Warranty:	20 Yrs

**b. SOLAR CHARGE CONTROLLER**

Nominal Battery Voltage:	192 V
Maximum PV array Voltage operating:	320 V
Maximum PV array open circuit Voltage:	500V
Charging Regulation:	Boost and float
Cut Out Voltage	: 240 V (The voltage shall be suitable for supplied battery)
Nominal Current:	75A

**c. INVERTER**

Nominal Output power	10kVA (8 kW)
Out put voltage	230V +/- 1% 1 phase
Output wave	pure sine wave
Out put frequency	50 Hz +/- 0.1 Hz
Efficiency	>90% for 20% - 100 % load
In put voltage AC	230+/- 15% V 1 phase
DC Voltage	192 V DC
Charging current	10A Adjustable
Alarms	Battery low, over load
Indications	Charging, Main supply, INV ON etc

**d. BATTERY**

Type	2V Tubular type
Voltage	2V per cell (unit)
Quantity	96 nos



Current capacity 400A/h

**40. TESTS**

The Contractor shall submit for approval, a technical description of the method which will be applied to test the electrical integrity of the entire installation including the measurement of obtained station earthing resistance and the insulation resistance of the installation. Tests shall be conducted on the completed installation to check the following:

- a. polarity : to verify that all terminals are correctly connected with regard to line, neutral and earth;
- b. insulation test between live and neutral conductors: to verify the Meager reading between line and neutral conductors is not below 1 Megohm with all switches and fuses on but fixtures and lamps out.
- c. insulation test between all non-earthed conductors and the earth on a live system is not below 1 Megohm from Meager reading.
- d. earth resistance test including the earth-loop test; and
- e. other tests to verify safety and integrity of the installation.

**41 AS-INSTALLED DRAWINGS**

After all tests on the completed installation have been approved, the Contractor shall submit two copies along with the original set of as-installed Electrical Drawings in hard-bound covers and one digital copy for subsequent maintenance and operation. These shall clearly indicate

- a. conduit runs and sizes with the number and size of cables enclosed in the conduit and the location of intermediate conduit accessories such as pull boxes, outlets etc;
- b. distribution patterns and circuits in main and sub-distribution and the controlling switchgear;
- c. location of earth stations and conductors;

location of all electrical appliances, equipment and components; underground and overground cable routes, sizes, cable trays and ducts provided.

**42. MANUFACTURE LIST OF MATERIALS**

Listed below are the make/brands of major materials to be used in the scope of works under the bill of quantities.

**Approved makes/brands or equivalent:**

1. Main panel board (MPB) - Hyonjan Engineering, M.K Metal,



2	Moulded Case Circuit Breaker (MCCB)	- Merlin Gerin/ Siemens/ ABB
3.	Floor Distribution Boards (DB)	- Hyonjan Engineering, M.K Metal, Corana Engineering
4.	Air Circuit Breaker	L&T, Merlin Gerin, Schneider
5.	Vertical Riser Busbar	L&T, ZETA India, Legrand
6.	Minature Circuit Breaker (MCB)	- Merlin Gerin/ Siemens/ ABB
7.	Cables/Wires	- Janta/ Prakash/ Lumbini/ Trishakti
6.	Switches	- North West/ Clipsal/ Legrand/ABB
8.	Power Sockets	- North West/ Clipsal/Siemens
9.	Telephone /Computer sockets	-North West/ Clipsal/D link/Siemens
10.	Fluorescent/LED Light Fixtures	- Philips/ Wipro/ GE or Equivalent
11.	Spherical ceiling and wall fixture	- Decon or Equivalent
12.	Outdoor fixture	- Decon or Equivalent
13.	Ceiling /Wall/ Exhaust fans	- Bajaj/ Usha/ Almonard
14.	11/0.4 kV Transformer	- Nepal Ekarat
15.	11kV VCB	- ABB, Crompton Greaves, SIEMENS or equivalent
16.	Capacitor Bank	-L&T, Epcos or equivalent
17	Generator	-Cummins/Green kriloskar/ Perkins or equivalent
18	Fire Alarm Control Panel	- Bentel/ Ademko/ Siemens or equivalent
19	PABX System	-Alcatel/Siemens/Panasonic/NEC or equivalent
20	11KV Cable Head	-Raychem
21	FRLS Cables	-Havells, Polycab or equivalent
22	Low Voltage Energy Meter	-L&T, Mitsubishi, Havells.
23	Multifunctional Meter	-Schneider, ABB or equivalent