



**LIFE INSURANCE CORPORATION OF INDIA
ENGINEERING DEPARTMENT
NORTH CENTRAL ZONAL OFFICE,
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**NAME OF WORK : PROPOSED CONSTRUCTION
OF SALES TRAINING CENTRE (STC) & HOSTEL
BUILDING ON PLOT NO 5&6 PANDEYPUR
VARANASI. (Main Building work including Civil,
Plumbing & Sanitary, Electrical, Lift, Fire Fighting System,
Air Conditioning System, Solar Water Heating System,
Interior work, H.T. work & other Ancillary works)**

PART-I

(TENDER DOCUMENT)

PART- I

TENDER FOR BUILDERS WORK, WATER SUPPLY, SANITARY INSTALLATION, ELECTRICAL INSTALLATION, LIFTS AND INTERIOR FURNISHING WORK & OTHER ANCILLARY WORKS FOR PROPOSED CONSTRUCTION OF SALES TRAINING CENTRE (STC) & HOSTEL BLDG ON PLOT NO 5&6, PANDEYPUR, VARANASI.

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CONDITIONS OF CONTRACT

1. INTERPRETATIONS:

- 1.1 In construing these Conditions, the Specifications, the Priced Schedule of Quantities, Tender and Agreement, the following words shall have the meanings herein assigned to them except where the subject or context otherwise requires:
- 1.2 “Employer” shall mean THE LIFE INSURANCE CORPORATION OF INDIA and his (their) heirs, legal representatives, assignees and successors.
- 1.3 “Chief Engineer” shall mean the person occupying the post of head of the Zonal Engineering Department of the Corporation.
- 1.4 “Corporation’s Engineers” shall mean such Deputy Chief Engineers, Superintending Engineers and/or Executive Engineers of the Corporation, who shall from time to time be appointed by the Chief Engineer for supervising the work carried out by the Contractor or for any purpose in connection therewith:
- 1.5 The term “Site Engineer” shall mean the person appointed and paid by the Employer, acting under the order of the Corporation’s Engineer to superintend the work.
- 1.6 The Contractor shall mean, the individual, firm or company whether incorporated or not, who is awarded the contract & shall include the legal representative of such individual or the persons composing such firm or company or the successors of such individual, firm or company & the permitted assignees of such individual, firm or company.
- 1.7 The “Site” shall mean the lands/buildings and/or other places on, in, into or through which work is to be executed under the contract or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the contract.
- 1.8 “This Contract” shall mean the Articles of Agreement, these Conditions, the General Instructions to Contractor, General Preambles to Schedule of Quantities, Special Conditions, the priced Schedule of Quantities, the Specifications, the Appendices, the Drawings and other related correspondence.

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- 1.9 “Act of Insolvency” shall mean any act of insolvency as defined by the Presidency Towns Insolvency Act, or the Provincial Insolvency Act or any amending Statute.
- 1.10 “Notice in Writing” or written notice shall mean a notice in written, typed or printed characters, sent (unless delivered personally or otherwise proved to have been received) by registered post to the last known private or business address or registered office of the addressee and shall be deemed to have been received when in the ordinary course of post it would have been delivered.
- 1.11 Words importing persons include Firms and Corporations, words importing the singular only also include the plural and vice versa where the context so requires.
- 1.12 The titles of the Clauses shall not affect or alter the meaning of Clauses and are solely for the purpose of facilitating reference.
- 1.13 The following abbreviations shall be followed for the designations of various LIC Officers:

DESIGNATIONS

ABBREVIATIONS

Executive Director (Engineering)	E.D.(E)
Zonal Manager	Z.M.
Chief Engineer	C.E.
Chief Architect	C.A.
Deputy Chief Architect	D.C.A.
Deputy Chief Engineer	Dy.C.E.
Superintending Engineer	S.E.
Senior Architect	S.A.
Executive Engineer	E.E.
Deputy Senior Architect	D.S.A.
Asstt. Secretary	A.S.

- 1.14 Wherever the words “approved”, “directed”, “as required”, “selected” or words of like effect are used, it is to be understood that the approval/direction, requirement or selection of the Corporation’s Engineer are intended unless otherwise specified.
- 1.15 The words “as described” shall mean the description in the Special Conditions, Specifications, General Instructions, Drawings etc. of this tender.

- 1.16 The words “allow” shall mean that the Contractor shall include in his rates for the particular matter referred to.
- 1.17 “Day Work” shall mean items of labour and/or materials which in the opinion of the Corporation’s Engineer are not capable of being evaluated by the accepted method of measurement and analysis.

2. SCOPE OF CONTRACT:

- 2.1 The Contractor shall carry out and complete the works in every respect in accordance with this Contract and in accordance with the directions and to the satisfaction of the Corporation’s Engineer. The Corporation’s Engineer may issue further drawings and/or written instructions, details, directions and explanation in regard to:

- a. The variation or modification of the Design, quality of works or the addition or omission or substitution of any work;
- b. Any discrepancy in the Drawings or between the Schedule of Quantities and/or Drawings and/or Specifications;
- c. The removal from the site of any materials brought thereon by the Contractor and the substitution of any other material thereof;
- d. The removal and/or re-execution of any work executed by the Contractor;
- e. The dismissal from the work of any persons employed thereupon;
- f. The opening up for inspection of any work covered thereupon;
- g. The amending and making good of any defects under relevant Clause giving details of defects after completion.

- 2.2 The Contractor shall forthwith comply with and duly execute all works comprised in such Instructions subject to the provisions of relevant specific conditions of the Contract. In the event of any dispute or difference of opinion the contractor shall refer the matter within 7 (seven) days of the issue of such instruction to the Chief Engineer whose decision shall be final & binding.

3. DISCREPANCIES:

- 3.1 If there are varying or conflicting provisions made in any one document forming part of Contract, the Chief Engineer shall be the deciding authority with regard to the intention of the document and his decision shall be final and binding on the contractor.

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- 3.2 The several documents forming the Contract are to be taken as mutually explanatory of one another, and the order of precedence shall be as follows;
- Special conditions
 - General preambles to schedule of quantities
 - General instructions
 - Conditions of contract
- 3.3 In case of discrepancies between the Schedule of Quantities, the specifications and/or drawings the following order of precedence shall be observed
- Description in Schedule of Quantities
 - Specifications of relevant Trade
 - Drawings; detailed drawings shall be followed in preference to small scale drawings and figured dimension in preference to scale.
 - Indian Standard Specifications of 'BIS'

4. DRAWINGS AND SCHEDULE OF QUANTITIES:

- 4.1 Two complete sets of the Drawings and Specifications and Schedule of Quantities shall be furnished by the employer to the contractor. Two copies of the additional Drawings, if any, shall be furnished within such time as the Chief Engineer may consider reasonable which may be necessary for execution of any part of the work. Such copies shall be kept on the work site and the CE and his representatives shall at all reasonable times have access to the same and they shall be returned to the EE by the Contractor on completion of the contract.
- This Contract and the signed Drawings, Specifications and Schedule of Quantities shall remain in the custody of the Employer.

5. CONTRACTOR TO PROVIDE EVERYTHING NECESSARY FOR EXECUTION OF WORK:

- 5.1 Contractor shall provide everything necessary for the proper execution of the work according to the intent & meaning of the Drawings, Priced Schedule of Quantities and Specifications taken together, whether the same may or may not be explicitly shown or described therein provided that the same can reasonably be inferred there from and if the Contractor finds any discrepancy therein he shall immediately and in writing refer the same to the CE whose decision shall be final and binding on the Contractor.

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- 5.2 The Contractor shall supply, fix and maintain at his cost during the execution of any work all the necessary Centering, Scaffolding, Staging, Planking, Timbering, Strutting, Shoring, Pumping, Fencing, Boarding, Watching and Lighting by night as well as by day, required not only for the proper execution and protection of the said work but also for the protection of the Public and the safety of any adjacent Roads, Streets, Cellars, Vaults, Ovens, Pavements, Walls, Houses, Buildings and all other erections, matters or things and the Contractors shall take down and remove any or all such Centering, Scaffolding, Staging, Planking, Timbering, Strutting, Shoring, etc., as occasion shall require or when ordered to do so, and shall fully reinstate and make good all matters and things disturbed during the execution of the work to the satisfaction of the Corporation's Engineer.

6. AUTHORITIES NOTICES AND PATENTS:

- 6.1 The Contractors shall conform to the provisions of any Acts of the Legislature relating to the work and to the Regulations and Bye-Laws of any Authority and or any Water, Lighting and other Companies and/or Authorities with whose system the structure is proposed to be connected and shall before making any variations from the Drawings or Specifications that may be necessitated by so conforming give to the CE written notice specifying the variations proposed to be made and the reasons for making them and apply for instructions thereon. In case the Contractor shall not within 7 (seven) days receive such instructions, he shall proceed with the work conforming with the Provisions, Regulations or Bye-Laws in question.
- 6.2 In particular, the Contractors shall be responsible to Register themselves under the Contract Labour (Regulation & Abolition) Act 1970 and Rules there under and any amendment thereto; they must comply with and carry out all the provisions and obligations under the said Act and Rules and furnish all information to Employer as may be required by it and shall indemnify the Employer against any penalties/claims arising from any default on their part.
- 6.3 The Contractor shall arrange to give all notices required by the said Acts, Regulations or Bye-Laws to be given to any Authority and to pay to such Authority or to any Public Office all fee that may be properly chargeable in respect of the work and lodge the receipts with the Employer.
- 6.4 The Contractors shall indemnify the Employer against all claims in respect of patent, rights, and shall defend all actions arising from such claims unless he has informed the

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Chief Engineer before any such infringement and received his permission to proceed and shall himself pay all royalties, licence fees, damages, costs and charges of all and every sort that may be legally incurred in respect thereof.

- 6.5 The Contractor should observe that his work shall not cause any nuisance to the Public in general and to the neighbouring occupants in particular.
- 6.6 Should the Contractor desire to work on Sundays, Holidays and during night hours, permission in writing from the Corporation's Engineer must be obtained in time. It shall be the responsibility of the Contractor to obtain permission from Civil Authorities, if necessary.

7. SETTING OUT WORK:

- 7.1 The Contractor shall set out the work and shall be responsible for the true and perfect setting out of the same and for the corrections of the positions, levels, dimensions and alignment of all parts thereof. If at any time any error shall appear during the progress of any part of the work, the Contractor shall at his own cost rectify such error, if called upon, to the satisfaction of the Corporation's Engineer. The Contractor must not commence work until the outlines of the building and Centre line layout have been pegged out and approved by the Corporation's Engineer.

8. CONTRACTOR IMMEDIATELY TO REMOVE OFFENSIVE MATTER:

- 8.1 All soil, filth or other matter of an offensive nature taken out of any trench, sewer, drain, cesspool or other place shall not be deposited on the surface, but shall be at once carted away by the Contractor to some pit or place provided by him.

9. MATERIALS AND SAMPLES:

- 9.1 All the materials stores and equipment required for the full performance of the Contract must be provided through normal trade channels and must include octroi, excise and import duties, sales tax payable to all authorities and other charges. They shall be of approved quality and the best of their kind available and the Contractor must be entirely responsible for the proper and efficient carrying out of the work. The Contractor shall order all materials required for the execution of the work from local/outside sources as early as necessary to the satisfaction of the Corporation's Engineer and to ensure that such materials are on site well ahead of requirement for use in the work.
- 9.2 Before ordering such materials, the Contractor shall get samples of the materials approved well in time. Preference shall be given to ISI marked products and approved

brands of requisite quality as mentioned in the tender. For materials, which are neither approved brands nor ISI marked, the same shall be got tested from approved laboratories at the Contractor's cost before approval. Approved brand and ISI marked product will also be tested if desired by the CE and if the test results are satisfactory, the cost of testing shall be borne by the Employer otherwise by the Contractor. No claim will be allowed for delay to the progress of work caused by test. If called upon by the Executive Engineer the Contractor shall produce proof for having arranged for the supply of materials well in time.

- 9.3 The Contractor shall furnish well in time before work commences at his own cost, any samples of workmanship that may be called for by the Corporation's Engineer for his approval and any further samples in case of rejection until such samples are approved. Such samples when approved shall be the minimum standard for the work to which they apply. In case of items like suspended ceiling, partitions, etc. typical sample panels or proto-types shall be erected in position for approval before undertaking work. Rates quoted shall cover for such preliminary work.

10. ACCESS:

- 10.1 Any of the Corporation's Engineers or any persons authorised by any one of them shall at all reasonable time have free access to the work and/or the workshops, factories or other places where materials are being prepared or constructed for the Contract and also to any place where the materials are lying or from which they are being obtained and the Contractor shall give every facility to all of them necessary for inspection and examination and test of the materials and workmanship. Except the representatives of the Public Authorities, no person shall be allowed on the work at any time without the written permission of the Corporation's Engineer.

If any work is to be done at a place other than the site of the work, the Contractor shall obtain the written permission of the Corporation's Engineer for doing so.

11. CONTRACTOR'S SUPERVISION & MINIMUM REQUIREMENT OF TECHNICAL STAFF:

- 11.1 The Contractor shall either himself supervise the execution of the contract or may appoint a Competent Agent approved by the CE to act in his stead.
- 11.2 Where the contractor is not a qualified Engineer or even if he is so qualified, he cannot in the opinion of C.E., give his full personal attention to the works, he shall at his own expense employ person(s) possessing the qualification and experience as described

hereunder as his accredited agent to supervise the works and to receive instructions from Corporation's Engineers. Any directions, instructions or notices given by the Corporation's Engineer to such supervisor(s) shall be deemed to be given to the contractors.

a. **FOR WORKS COSTING UPTO Rs. 100 LAKHS :**

A qualified resident Engineer having a Government recognised Diploma in Civil Engineering and minimum of 2 years experience on building construction site.

b. **FOR WORKS COSTING MORE THAN Rs. 100 LAKHS & UPTO Rs. 200 LAKHS :**

A qualified resident Engineer having a Recognised Degree in Civil Engineering or equivalent qualification and minimum of 2 years experience on building construction site/s or a recognised Diploma in Civil Engineering with minimum 5 years experience on such construction jobs.

c. **FOR WORKS COSTING MORE THAN Rs.200 LAKHS :**

- i) A qualified resident Engineer having a Recognised Degree in Civil Engineering and minimum of 3 years experience of such major construction site/s or a recognised diploma in Civil Engineering with 8 years experience.
- ii) In addition the contractor shall employ suitable number of supervisors with recognised degree / diploma in the relevant branches or recognised qualification & experience in the relevant trades for proper execution of the work as approved by the Chief Engineer.

d. The CE may vary any of the above qualification / experience at his discretion if so warranted by conditions prevailing and applicable to any particular work such as Air-conditioning, HT, Interiors etc.

e. If the contractor fails to employ suitable person(s) to supervise the work or fails to appoint replacement(s) when necessitated, amount as stipulated in the Appendix to the conditions of contract shall be recovered from the contractor for each Engineer and each supervisor for the period of non-employment.

12. DISMISSAL OF WORKMEN:

12.1 The Contractor shall, on the instruction of the Corporation's Engineer, immediately dismiss from the work any person employed thereon, who may, in the opinion of the

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Corporation's Engineer, be unsuitable or incompetent or who may misconduct himself and such person shall not be again employed or allowed on the work without the permission of the Corporation's Engineer.

13. DATES OF COMMENCEMENT AND COMPLETION:

13.1 The "Date of Commencement" shall be as stated in the Work Order and the Contractor shall thereupon and forthwith begin the work and shall regularly proceed with and complete the same on or before the "Date of Completion" stated in the Work Order, subject to the provisions for extension of time hereinafter contained.

14. ASSIGNMENT:

14.1 The whole of the work included in the Contract shall be executed by the Contractor and the Contractor shall not directly or indirectly transfer, assign or underlet the Contract or any part, share of interest therein nor shall he take a new partner without the written consent of the CE and no subletting shall relieve the Contractor from the full and entire responsibility of the Contract or from the active superintendence of the work during its progress.

15. DEVIATION, VARIATION, EXTRA/DEVIATED ITEMS AND PRICING:

15.1 The Contractor should note that unless otherwise stated, the tender is strictly on Item Rate basis and his attention is drawn to the fact that rates for each and every item should be correct, workable and self supporting. The quantities in the Schedule of Quantities approximately indicate the total extent of work and no variation i.e. additions, omissions or subtractions shall vitiate the Contract. No liability shall attach to the Employer for any error therein or variation there from.

15.2 The contractor may when authorized and shall when directed, in writing by the CE or the Corporation's Engineers, whom the CE may for that purpose appoint, add to, omit from, make alterations in, substitutions for, or vary the works shown upon the Drawings or described in Specifications or included in the priced Schedule of Quantities but the Contractor shall make no additions, omissions, alterations, substitutions or variations without such authorization or direction. A verbal authority or direction by the CE, if confirmed by the contractor in writing within 7 (seven) days, be deemed to have been given in writing.

15.3 The rates of such altered, additional or substituted works shall be determined in accordance with the following.

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- a. The net rates or prices in the original tender shall determine the valuation of the extra work where such extra work is of similar character and executed under similar conditions as the work priced therein.
- b. The net price of the items in the original tender shall determine the value of the items omitted. However, if omissions vary the conditions under which any remaining items of the work are carried out or if the amount of any omission relative to the amount of the whole of the Contract works or to any part thereof shall be such that in the opinion of the Chief Engineer, the net rate or price contained in the Priced Schedule of Quantities or Tender or for any item of work involves loss or expenses beyond that reasonably contemplated by the Contractor and is by reason of such omission rendered unreasonable or inapplicable, the Chief Engineer shall fix another rate or price as in the circumstance he shall think reasonable and proper.
- c. If the rate for any altered, additional, or substituted item of work is not specified in the schedule of quantities, the rate for that item shall be derived from the rate for the nearest similar item specified therein.
- d. If the rate for altered, additional or substituted item of work cannot be determined in the manner specified above, then such items of work shall be priced on the basis of coefficients of labour and materials as given in the latest CPWD rate analysis handbook and rates for labour and materials wherever applicable shall be the market rate prevailing at the time of execution.
- e. Where such co-efficient are not available in C.P.W.D. rate analysis, the actual Labour/Materials involved and recorded by the Executive Engineer in executing the items shall be considered.
- f. Where extra work cannot be properly measured or valued, the Contractor shall be allowed "Day Work" prices at the net rates stated in the Tender or the Priced Schedule of Quantities or, if not so stated, then in accordance with the local "Day Work" rates and wages for the district, provided that in either case vouchers specifying the date and time (and if required by the EE the names of workmen employed) and materials incorporated be delivered for verification to the EE or his representative at or before the end of the week following that in which the work has been executed. The EE is not bound to recognize the cost

of materials furnished in vouchers; the CE at his discretion, will fix the price of such materials based upon market value.

- g. While fixing rates of extra items 15% (Fifteen percent only) shall be allowed on the cost of material and labour to cover all supervision, overheads, statutory Taxes and Levies and profits. This shall not however apply if 100% advance is given by the employer for purchase of any material (such as cement, steel etc.). In such cases 3.75% of the cost of materials only shall be allowed as handling charges and 15% shall be allowed only on the labour cost.
- h. Where the quantities of any item in the schedule exceeds by 100% in foundation and in plinth, and 50% in super-structure (above plinth), these extra quantities over 100% & 50% respectively will be treated as extra items of work and priced accordingly as above. [Items such as roads, pavements etc. shall be considered as below plinth]. The decision of CE for terming items below or above plinth is final & binding on the contractor.
- i. For all extra items of work, the contractor should submit to the concerned Corporation's Engineer the necessary particulars along with his analysis and the rate he proposes to claim for consideration within a period of 4 (four) weeks from the time of cropping up of any authorized extra / deviated item. He shall also ensure that all the authorized claims are included in the final bill. If the contractor fails to submit his claim within the stipulated period or the period duly extended by the Corporation's Engineer, then the CE shall proceed to fix the rate for the item(s) and the same shall be final and binding on the contractor.
- j. The Contractor shall note that Extra/Deviated items claim and/or any other claim whatsoever if submitted after submission of his Final Bill, will not be entertained and considered by the Employer. The Contractor shall not be allowed to make any Additions/ Alterations/ Revisions / Changes/ Modifications/ Variations in the final bill, after the final bill is submitted by him.

16. SUB-CONTRACTORS:

- 16.1 All specialist Merchants, Tradesmen and others, executing any work or supplying, fixing any goods for which provisional sums are included in the Schedule of Quantities and/or Specifications, who may be nominated or selected by the CE, who shall be the final authority are hereby declared to be Sub-Contractors and are herein referred to as nominated Sub-Contractors.

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- 16.2 No nominated Sub-contractor shall be employed on or in connection with the work against whom the Contractors shall make reasonable objection or (save where the CE and the Contractor shall otherwise agree) who will not enter into a Contract providing:-
- a. That the nominated Sub-Contractor shall indemnify the Contractor against the same obligation in respect of the Sub-Contractor as the Contractor is under, in respect of this Contract;
 - b. That the nominated Sub-Contractor shall indemnify the Contractor against claims in respect of any negligence by the Sub-Contractor or his servants or agents or any misuse by him or them of any scaffolding or other plant or the property of the Contractor or under any Workmen's Compensation Act in force.

17. THIRD PARTY LIABILITY, DAMAGE TO NEIGHBOURING PROPERTY, LOSS OF MATERIAL AND WORKMEN'S COMPENSATION:

- 17.1 The Contractor shall be responsible for all injury to persons, animals or things, and for all damage to structural and/or decorative part of property which may arise from the operations or neglect of himself or of any Sub-contractor or any of his Sub-Contractor's employees, whether such injury or damage arise from carelessness, accident or any other cause whatsoever in any way connected with the carrying out of his Contract. This Clause shall be held to include inter-alias, any damage to Building, whether immediately adjacent or otherwise and any damage to roads, streets, footpaths, bridges, or ways as well as all damage caused to the building, and the works forming the subject of this Contract by frost, rain, wind or other inclemency of the weather. The Contractor shall fully indemnify the Employer and hold him harmless in respect of all and any expenses arising from any such injury or damage to persons or property as aforesaid and also in respect of all and any claim made in respect of injury or damage under any acts of Government or otherwise and also in respect of any award or compensation or damages consequent upon such claim.
- 17.2 The Contractor shall fully indemnify the employer against any loss, damage or deterioration for whatever reason, of all materials brought at site and especially material supplied by or paid for partly or wholly by the employer.
- 17.3 The Contractor shall reinstate all damage and loss of every sort mentioned in this Clause so as to deliver up the whole of the Contract works complete and perfect in every respect and so as to make good or otherwise satisfy all claims for damage to the property of the third parties.

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- 17.4 The Contractor shall fully indemnify the Employer against all claims which may be made against the Employer by any member of the Public or other third party in respect of anything which may arise in respect of the works or in consequence thereof.
- 17.5 The contractor shall at his own expense arrange to effect from the date of commencement & maintain till the date of virtual completion of contract, with any licensed general insurance company, a **POLICY OF INSURANCE(Contractor's All Risk Policy)** to cover all such risks detailed above viz. loss, damage & third party liability etc. The policy shall be of an amount as mentioned in Appendix to Conditions of contract and in the joint names of the employer & contractor and shall be deposited with the employer and renewed as required from time to time during the currency of the contract.
- 17.6 The Contractor shall also fully indemnify the Employer against all claims which may be made upon the Employer, whether under the **WORKMEN'S COMPENSATION ACT** or any other **STATUTE** in force during the currency of this Contract or at Common law in respect of any Employee of the Contractor or any Sub-Contractor and shall at his own expense effect and maintain until the Virtual completion of the work, with "licensed General Insurance Company" a **POLICY OF INSURANCE** of adequate amount in the joint names of the Employer and the Contractor against such risks and deposit such policy or policies with the employer & renew the same as required from time to time during the currency of the Contract.
- 17.7 The Contractor shall be responsible for anything, which may be excluded from the Insurance Policies above referred to, and also for all other damage to any property arising out of or incidental to the negligence or defective carrying out of the Contract.
- 17.8 The amount of insurance to be taken for the above policies will be jointly decided between the contractor and the employer before issue of acceptance letter based on the tendered cost, nature of work, location of site, local hazards etc.
- 17.9 In default of the Contractor insuring as provided above, or having insured failing to renew the same as required the Employer on his behalf may so insure/renew and may deduct the premiums paid from any monies due or which may become due to the Contractor together with penalty as the CE deems appropriate.

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17.10 The Contractor shall also fully indemnify the Employer in respect of any costs, charges or expenses arising out of any claim or proceedings at law and also in respect of any award of compensation of damages arising there from.

17.11 The Employer shall be at liberty and is hereby empowered to deduct fully the amount of any damages, compensation costs, charges and expenses arising or accruing any such claim of damage from any sum or sums due or to become due to the Contractor.

18. DELAY AND EXTENSION OF TIME:

18.1 If the works be delayed due to any of the following:

- (a) by force majeure ,
- (b) by reason of any exceptionally inclement weather,
- (c) by reason of proceedings taken or threatened by, or disputes with, adjoining or neighbouring owners, or public authorities,
- (d) by the work, or delays, of other Contractors or Tradesmen engaged by the Employer,
- (e) by reason of any additional work or instruction ordered by the employer,
- (f) by reason of Civil Commotion, local commotion of workmen or strike or lock-out affecting any of the building trades,
- (g) in consequence of the Contractor not having received in due time necessary instructions from the CE for which he shall have specifically applied in writing,
- (h) from other causes which the CE may certify as beyond the Control of the Contractor,
- (i) by reason of non-payment of interim certificate at specified time, then upon the happening of any such event causing delay the contractor shall immediately, give notice thereof in writing to the Corporation's Engineer, but shall nevertheless use constantly his best endeavours to make good this delay.

18.2 Request for extension of time shall be made by the contractor at the earliest but not later than 14 (fourteen) days of the event causing the delay.

18.3 In case of strike or lockout the Contractor shall give written notice thereof to the CE as soon as possible but he shall nevertheless constantly use his endeavours to prevent delay and shall do all that may reasonably be required to the satisfaction of the CE to proceed with the work.

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- 18.4 The CE shall make a fair and reasonable assessment of the delay and grant extension of time accordingly. Such extension shall be communicated to the contractor by the Corporation's Engineer within 3 (Three) months of the date of receipt of such request. Non-application by the contractor for extension shall however not be a bar for giving fair and reasonable extension which shall be as decided by the CE.
- 18.5 The decision of the CE as communicated by the Corporation's Engineer to the contractor on the extension of time shall be final & binding.
- 18.6 No claim in respect of compensation or otherwise, howsoever arising, as a result of extension granted under the above conditions shall be admissible.

19. DAMAGE FOR NON-COMPLETION:

- 19.1 If the Contractor fails to complete the work by the date of completion stated in the "Appendix to Condition of Contract" or within time properly extended under Clause (18) hereof and the CE certifies in writing that in his opinion the same ought, reasonably so, to have been completed, the Contractor shall pay or allow the Employer the sum named in the Appendix as "Liquidated Damages" for the period during which the said works shall so remain incomplete and the Employer may deduct such damages from any money due to the Contractor. In case liquidated damages in accordance with the above provision accrue to maximum limit as mentioned in the Appendix to the Conditions of the Contract, the Chief Engineer shall be at liberty to rescind the Contract and to get it completed entirely at the risk and cost of the Contractor through any other agency he decides to appoint. All extra expenses incurred shall be recoverable from the money due to Contractor or lying to his credit with the Employer against the present or any other Contract.

20. FAILURE BY CONTRACTOR TO COMPLY WITH CE'S INSTRUCTIONS :

- 20.1 If the Contractor after receipt of written notice from the CE, requiring compliance with such further Drawings and/or his instructions, fails within 7 (seven) days to comply with the same the CE may employ and pay other persons to execute any such work whatsoever as may be necessary to give effect thereto and all additional costs incurred in connection therewith shall be deducted from any money due or to become due to the Contractor.

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21. PAYMENT OF BILLS :**a. MEASUREMENT OF WORKS**

- 21.1 The EE may, from time to time, intimate the contractor that he requires the work to be measured and the contractor shall forthwith attend or send a qualified representative to assist the EE or his representative in taking such measurements and calculations and to furnish all particulars or to give all assistance required by either of them. All items having a financial value shall be entered in the Measurement Book . All measurements and levels shall be taken jointly by the Contractor or his authorised representative and Site Engineer or his authorised representative from time to time during the progress of the work and such measurements shall be signed and dated by both the parties in token of their acceptance. If any of the measurements recorded are objected by any one of the party, a note shall be made to that effect with reason, signed by both parties and referred to Corporation's Engineer whose decision in the matter shall be final and binding. Measurements can also be recorded through electronic medium where specifically approved by Chief Engineer.
- 21.2 Should the contractor not attend or neglect or omit to send such representative, then the measurements taken by the EE or representative shall be taken to be correct measurements of the work. Wherever not specified in the "Schedule of Quantities or elsewhere" the mode of measurements shall be in accordance with the latest brochure issued by the Indian Standards Institutions (now renamed as Bureau of Indian Standards) on "Method of measurement of Building works".
- 21.3 The Contractor or his representative may, at the time of measurement, take such notes and measurements as he may require.
- 21.4 All authorized extra work. Omissions and all variations made without the Chief Engineer's knowledge, if subsequently sanctioned by him in writing, shall be included in such measurement.
- 21.5 If the contractor or his authorised representative does not record the measurements periodically for the completed works, then the site Engineer shall take measurements after giving notice in writing of at least 3 (three) days. Measurements recorded in the absence of Contractor shall be intimated with a copy of such measurements to the contractor. If the contractor fails to countersign or record objections within a week from the date of measurement, then such measurement recorded in absence by the Site Engineer shall be deemed to be accepted by and binding on the Contractor.
- 21.6 The Contractor shall, without any extra charge provide all assistance with every appliance, labour and other things necessary for taking measurements (either by him

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or by site Engineer) and recording levels including test checking of such measurements by any person authorised by the Employer.

- 21.7 All work shall be measured net as fixed in its place. All measurements of 'cutting' shall be held to include for the consequent wastage on the materials used.
- 21.8 Except where any general or detail description of the works expressly shows to the contrary, measurements shall be taken in accordance with the procedure set forth in the specifications notwithstanding any provision in the relevant Standard Method of measurement or any general or local custom. In the case of items for which procedure is not covered in the specification, measurement shall be taken in accordance with the relevant Standard Method of measurement issued by BIS and if for any item no such standard is available then a mutually agreed method shall be followed.
- 21.9 Measurements of all hidden/concealed items of work including extra items if any, such as, work in foundations including excavations, plinth filling, masonry, concrete etc. steel in all R.C.C. work, pipe to be encased etc. shall be jointly recorded by the contractor and Site Engineer or his authorised representative before they are covered up. Immediately after the work is ready for measurements, Contractor will give specific notice to the Site Engineer for recording the measurements. If the Site Engineer or his authorised representative fails to record the measurements, the Contractor will refer the matter to the Corporation's Engineer for instructions, but in no case shall cover up work without the latter's permission.

22. PAYMENTS:

- 22.1 The contractor shall be paid by the Employer, from time to time, by instalment under Interim Certificate to be issued by the EE to the Contractor on account of the work executed, when in the opinion of the EE, work to the approximate value named in the Appendix to the conditions of Contract as "Value of work for Interim certificate" (or less at the reasonable discretion of the Executive Engineer) has been executed in accordance with this contract, subject however to a retention of the percentage of such value mentioned in Appendix to the Conditions of Contract hereto as "Retention percentage on account of Security Deposit". The Interim Certificate shall be based upon interim Bills of Running Account Bills to be prepared by the Contractor and supported by the detailed measurements. The EE may include in the Interim Certificate such amount as he may consider proper on account of materials delivered upon the site by the contractor for use in the work, after satisfying price of materials on basis of vouchers/bills submitted by the contractor.

In case any material have been supplied by the Employer to the contractor in connection with the work, necessary recovery for the same shall be effected from the bills of the

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contractor by the CE at the issue rates of such materials as stipulated while calling for tenders and in other cases at a stock rate or market rates of such materials, whichever is higher. The contractor will, however, not be entitled to modify his rates for items of work requiring use of such materials and when the work has been virtually completed and the CE shall have certified in writing that it has been so completed on the basis of detailed measurements and after obtaining written endorsement by the CE that the CE Deputy Chief Engineer has made a final Scrutiny and that there are no disputed items, rates of quantities, the contractor shall be paid by the Employer in accordance with certificate to be issued by the CE the sum of money named in the Appendix as "Instalment after Virtual Completion" and the contractor shall be entitled to the payment of the final bill in accordance with the final certificate to be issued in writing by the Deputy Chief Engineer with the approval of the CE with expiration of the period referred to as "Defects Liability Period", in the Appendix to Conditions of Contract hereto from the date of Virtual Completion or as soon after the expiration of such period as to work shall have been finally completed and all defects made good according to the true intent and meaning hereof, whichever shall last happen.

Provided always that the issue by the EE of any certificate during the progress of the works or at after their completion shall not relieve the contractor from his liability under Clause (2) in cases of fraud, dishonesty or fraudulent concealment relating to the work of materials or to nay matter dealt with in the certificate in case of all defects and insufficiencies in the work or materials which a reasonable examination would not have disclosed. No certificate of the Deputy Chief Engineer or Executive Engineer shall of itself be conclusive evidence that any work or materials to which it related are in accordance with the contract.

The Deputy Chief Engineer may be any certificate make any correction in previous certificate which shall have been issued by the Executive Engineer.

Payment upon the EE's certificate shall be made within the periods named in the Appendix "Period for honouring Interim Certificate" after such a certificate has been delivered to the Employer.

The CE shall have power to withhold any certificate if the work or any part thereof are not being carried out to his satisfaction.

- 22.2 Provided always that the issue by the Corporation's Engineer of any Certificate during the progress of the works or after their completion shall not relieve the Contractor from his liability in cases of fraud, dishonesty or fraudulent concealment relating to the work or materials or any matter dealt with in the Certificate in case of all defects and insufficiencies in the work or materials which a reasonable examination would not have

disclosed. No Certificate of the Corporation's Engineer shall of itself be conclusive evidence that any work or materials to which it related are in accordance with the Contract.

22.3 Payment upon the Corporation's Engineer's Certificate shall be made within the periods named in the Appendix "Period for honouring Interim Certificate" after such a Certificate has been delivered to the Employer;

22.4 The CE shall have power to withhold any Certificate if the work or any parts thereof are not being carried out to his satisfaction. However, if the final certificate is not issued within the period as mentioned under Clause No.22.5, 26 due to Audit para by CTE etc., the amount involved for such items of deficient work as decided by Chief Engineer would be with held. The same would be allowed as agreed upon by the CTE & the Chief Engineer and the final certificate would accordingly be issued and final bill passed. For such with held amount, a simple interest @ 6% per annum shall be paid to the contractor along with the said payment. Such interest will be calculated from the last date (as mentioned in Appendix to Conditions of Contract) for honoring final certificate till the date of payment.

22.5 The measurements and valuation in respect of the Contract shall be completed within the "period of Final Measurement" stated in the Appendix or if not so stated then within six months of the completion of the contract works as defined in Clause (26) hereof. No further claim shall be made by the contractor after submission of the final bill and these shall be deemed to have been waived and extinguished.

22.6 The final certificate shall be based on the submission of final measurements or overall measurements of the work (to be taken if so directed by Corporation's Engineer) with all relevant details similar to 22.1 above. The CE may direct the Contractor to resubmit details if the same are found incomplete to issue the final certificate and his decision to accept the details is final and binding on the Contractor. Final Certificate shall be issued by the CE after the conditions are met with as per 22.4, 22.5, 22.6 and 26 and contractor's submission of **No Claim certificate cum receipt** as per the Proforma given in Appendix to Conditions of Contract.

23. SECURED ADVANCE AGAINST MATERIALS

23.1 The Contractor shall be entitled to be paid advance along with interim bill against materials which are not perishable and which are in the opinion of Corporation's Engineer, required for the works and have been brought on site for incorporation in the work but have not been so incorporated and are safeguarded against loss due to any

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cause whatsoever, (refer clause no-17). The amount of such advance against materials shall be arrived at on the following basis:

- a) 80% of the market value of materials required for the work and brought on site.

OR

80% of the cost of such materials (brought on site) as derived from the relevant accepted tender rate for the particular item involving such materials, whichever is lower.

- b) Such advance payment made against materials shall be recovered from or adjusted from the interim bills as and when the materials are utilized in the work. Examples of certain perishable materials on which no advance shall be paid are Sand, Paint, Bitumen, Hard Boards/Soft Boards and other paper products, Petroleum Products, Coal Tar, Insulating Boards etc.

- 23.2 In case of dispute, the decision of the Chief Engineer on whether advance payment can be made against specific materials shall be final and binding.

24. UNFIXED MATERIALS AND EQUIPMENTS:

- 24.1 All tools, plants and materials brought to the site by the Contractor shall vest in the Employer and shall not be removed from the site of works except by permission of the Corporation's Engineer in writing. The Employer shall have a lien on these materials and plants.

25. REMOVAL OF IMPROPER WORK:

- 25.1 The Corporation's Engineer shall during the progress of the work have power to order in writing from time to time the removal from the work within such reasonable time or as may be specified in the order, of any materials, which in their opinion are not in accordance with the Specifications or instructions, the substitution of proper materials and the removal and proper re-execution of any work executed with materials or workmanship not in accordance with the Drawings and Specifications or Instructions and the Contractor shall forthwith carry out such an order at his own cost. In case of default on the part of the Contractor to carry out such an order, the CE shall have the power to employ other persons to carry out the same and all expenses consequent thereon or incidental thereto as certified by the EE shall be borne by the Contractor and may be deducted from any amounts due or that may become due to the Contractor.

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26. VIRTUAL COMPLETION:

26.1 The work shall be completed in accordance with the Contract and to the entire satisfaction of Chief Engineer. All unused materials, tools, plants, scaffoldings, temporary structures, hutments and things belonging to the Contractor shall be removed and the site of works cleared of rubbish and all waste materials by the contractor at his own expenses and delivered up tidy to the employer. After completion of the work, the contractor will serve a written notice to the CE to this effect. The Chief Engineer after satisfying himself shall thereupon approve the virtual completion. The Defect Liability Period shall commence from the date of such certification.

27. DEFECTS AFTER COMPLETION:

27.1 The defects, shrinkage, settlements or other faults, which may appear within "the Defects Liability Period, stated in the "Appendix to the Conditions of Contract" or if not stated then, within 12 (twelve) months after virtual completion of the work, arising on account of materials or workmanship not in accordance with the Contract shall, upon the directions in writing of the Corporation's Engineer and within such reasonable time specified therein, be amended and made good by the Contractor at his own cost unless the CE shall decide that he ought to be paid for such amendment and for making good, and in case of default, the CE may employ and pay other persons to amend and make good such defects, shrinkage, settlement or other faults, and all damages, loss and expenses consequent thereon or incidental thereto shall be recovered from any monies due or that may become due to the Contractor. The CE may in lieu of such amending and making good by the Contractors, deduct from any money due or that may become due to the Contractor, a sum to be determined by the CE equivalent to the cost of amending such work. Should any defective work have been done or materials supplied by any Sub-Contractor employed on the work, who has been nominated or approved by the CE as provided in Clause No.16 the Contractor shall be liable to make good in the same manner as if such work or material had been done or supplied by the Contractor and been subjected to the provisions of this Clause and Clause No.2 hereof. The Contractor shall remain liable under the provision of this Clause notwithstanding the payment of any Certificate or the passing of any accounts.

28. PROVISIONAL SUMS, APPLICATION OF:

28.1 For all the work listed under items for which provisional sums are provided in the tender, the CE reserves the right to invite separate tenders or select or order from any manufacturer or firms at his discretion and reserves to himself the right of paying direct to persons or firms for any such work. The Contractor will not have any claims over

these items, but if tenders are invited for such items, he will also be invited to quote along with others.

- 28.2 If ordered by the CE, Contractor shall be required to carry out provisional sum items at the same conditions and rates as applicable for this Contract.

29. OTHER PERSONS ENGAGED BY THE EMPLOYER:

- 29.1 CE reserves the right to execute any work not included in this Contract, which he may desire to have carried out, by other persons and the Contractor shall allow all reasonable facilities and the use of his scaffolding and plant for the execution of such work, but is not required to provide any special plant or materials for the execution of such work except by special arrangement with the Employer. Such work shall be carried out in such manner as not to impede the progress of the work included in the Contract and the Contractor shall not be responsible for any damage or delay which may happen to or be occasioned by such work.

30. SUSPENSION BY THE CONTRACTOR:

- 30.1 If the Contractor except on account of any legal restraint upon the Employer preventing the continuance of the work, shall suspend the work or in the opinion of the CE shall neglect or fail to proceed with due diligence in the performance of his part of the Contract or if he shall make default in respect of Clause No.2, the Employer shall have the power to give notice in writing to the Contractor requiring that the work be proceeded within a reasonable manner and with reasonable dispatch. Such Notice shall purport to be a notice under this clause. After such notice is given, the Contractor shall not be at liberty to remove from the site of the work or from any ground contiguous thereto any plant or materials belonging to him, which shall have been placed thereon for the work and the Employer shall have a lien upon all such plant and materials to subsist from the date of such notice being given until the notice shall have been complied with. If the Contractor shall fail for 7 (seven) days after such notice given to proceed with the work as therein prescribed, the CE may proceed as provided in Clause No.31.

31. DETERMINATION OF CONTRACT BY EMPLOYER:

- 31.1 If the Contractor (being an individual or a firm) commit any "Act of Insolvency" or shall be adjudged as Insolvent or shall make an assignment or composition of the greater part in number or amount of his creditors or shall enter into a deed of assignment with his creditors, or being an Incorporated Company shall have an order made against

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him or pass an effective resolution for winding up either compulsorily or subject to the supervision of the Court or Voluntarily or if the official Assignee of the Contractor shall repudiate the Contract or if the official Assignee or the Liquidator in any such winding up shall be liable within 7 (seven) days after notice to him requiring him to do so, to show to the reasonable satisfaction of CE that he is able to carry out and fulfill the Contract and if required by the CE to give security therefore or if the Contractor (whether an Individual Firm or Incorporated Company) shall suffer execution to be issued or if the Contractor shall suffer any payment under this Contract to be attached by or on behalf of any of the creditors of the Contractors or if the contractor shall assign or sublet the Contract without the consent in writing of the CE first obtained or if the Contractor shall charge or encumber this Contract or any payment due or which may become due to the Contractor there under, or if the CE shall certify in writing that in his opinion the Contractor,

- a. has abandoned the Contract, or
- b. has failed to commence the work, or has without any lawful excuse under these conditions suspended the progress of the work for 7 (seven) days after receiving from the CE written notice to proceed, or
- c. has failed to proceed with work with such due diligence and failed to make such due progress as would enable the work to be completed within the time agreed upon, or
- d. has failed to complete the work within the stipulated date including authorized extensions or
- e. has failed to remove the materials from the site or to pull down and replace the work within 7 (seven) days after receiving a written notice from the Corporation's Engineer that the said materials or work were condemned or rejected or
- f. has neglected or failed persistently to observe and perform all or any of the acts, matters, or things, by this Contract to be observed and performed by the Contractor for 7 (seven) days after written notice shall have been given to the Contractor requiring the Contractor to observe or perform the same, or
- g. has to the detriment of good workmanship or in defiance of the CE's instructions to the contrary sub-let any part of the Contract.

then and in any of the said causes, the CE notwithstanding any previous waiver, after giving 7 (seven) days notice in writing to the Contractors, determine the Contract, but without thereby affecting the powers of the CE or the obligations and liabilities of the Contractor, the whole of which shall continue to be in force as fully as if the contract

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has not been so determined and as if the work subsequently executed had been executed by or on behalf of the Contractor. And further, the Employer, his agents or servants, may enter upon and take possession of the work and all plant, tools, scaffolding, sheds, machinery, steam and other power, utensils and materials, lying upon the premises or the adjoining lands or road and use the same as his own property or may employ the same by means of his own servants and workmen in carrying on and completing the work or by employing any other Contractors or other person or persons to complete the work, and the Contractor shall not in any way interrupt or do any act, matter, or thing to prevent or hinder such other Contractor, other persons or person employed for completing and finishing or using the materials and plant for the work. When the work shall be completed or as soon thereafter as convenient, the CE shall give a notice in writing to the Contractor to remove his surplus materials and plant and should the Contractor fail to do so within a period of 14 (Fourteen) days after receipt thereof by him, the Employer may sell the same by public auction and shall give credit to the Contractor for the amount so realized. The CE shall thereafter ascertain and certify in writing under his hand what (if anything) shall be due or payable to or by the Employer for the value of the said plant and materials so taken possession of by the Employer and the expense or loss which the Employer shall have been put to in getting the work to be so completed, and the amount, if any, owing to the Contractor and the amount, which shall be so certified shall thereupon be paid by the Employer to the Contractor or by the Contractor to the Employer, as the case may be and the Certificate of the CE shall be final and conclusive between the parties.

32. TERMINATION OF CONTRACT BY CONTRACTOR:

- 32.1 If payment of the amount payable by the Employer under any Certificate of the EE shall be in arrears as unpaid for 60 (sixty) days after notice in writing requiring payment of the amount with interest of aforesaid shall have been given by the Contractor to the Employer, or if the work be stopped for six months under order of the CE or by any injunction or other order of any Court of Law, then and in any of the said cases, the Contractor shall be at liberty to determine the Contract by notice in writing to the Employer and he shall be entitled to recover from the Employer payment for all the work executed and for any loss, he may sustain upon any plant or material supplied or purchased or prepared for the purpose of the Contract.
- 32.2 In arriving at the amount of such payment, the net rates contained in the Contractor's original tender shall be followed or where the same may not apply, valuation shall be made in accordance with Clause No.15 hereof.

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33. DETERMINATION OF CONTRACT DUE TO ABANDONMENT OR REDUCTION IN SCOPE OF WORK:

33.1 If at any time after the acceptance of the tender, the Employer shall for any reasons whatsoever not require the whole or any part of the works to be carried out, the CE shall give notice in writing to the Contractor who shall have no claim to any payment of compensation or otherwise whatsoever on account of any profit or advantage which he might have derived from the Execution of the whole of the works.

The Contractor shall be paid at contract rates for the full amount of work executed and in addition:

- a. The cost at site of all surplus approved materials collected for incorporation in the work, which the Contractor does not wish to retain and which shall thereafter become the property of the Employer.
- b. Where the Contractor desires to retain the surplus of approved materials (excepting materials supplied by the Employer or obtained in Employer's name, which shall, in any case, be returned to the Employer) the cost of handling and cartage charges for removal from the site to a reasonable distance not exceeding 25 kms.
- c. If upon the determination of the Contract under this condition, the Contractor is of the opinion that he has suffered hardship by reason of the operation of these conditions, he may refer the circumstances with full details to the Chief Engineer, who on being satisfied that such hardship exists or has existed, shall make such allowance, if any as in his opinion is reasonable, and his decision shall be final, conclusive and binding.

34. DISPUTES TO BE FINALLY DETERMINED BY CHIEF ENGINEER:

34.1 The Instruction, Decision, Opinion, Direction, Certificate or Valuation of the CE with respect to all or any of the matters under Clause (2), (3), (5), (6), (9), (14), (15), (18), (23), (27), (30), (31) and (33) hereof (which matters are herein referred to as EXCEPTED MATTERS) shall be final and conclusive and binding on the parties hereto and shall be without appeal. Any other Decision, Opinion, Direction, Certificate or Valuation of the CE or any refusal of the CE to give any of the same shall be subject to the right of Arbitration and review as given under Clause No.36.

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35. SECURITY DEPOSIT AND PERFORMANCE GUARANTEE:

- 35.1 Amount towards Security deposit shall be calculated as per details given under Serial No.9 of “APPENDIX TO CONDITIONS OF CONTRACT” in Part-II of the tender. Security Deposit can be either in Cash or in the form of Bank Guarantee.

In case of cash option, the EMD shall be retained as part of Security Deposit and balance Security Deposit shall be accumulated through deductions from Running Account Bills at 7.5% (maximum) of gross amount of bill. In case of Bank Guarantee option, the Contractor shall furnish one Bank Guarantee for full amount of Security deposit valid till end of defects liability period OR, two Bank Guarantees of like amounts each equal to half the Security deposit; one valid till virtual completion and the other till end of defects liability period. If the EMD is submitted partly in the form of Bank Guarantee and if the contractor desires to avail cash option for Security Deposit, then the contractor has to deposit the amount equal to the amount of EMD in the form of Bank Guarantee, in the form of Demand Draft/Pay Order drawn in favour of Life Insurance Corporation of India, payable at Kanpur within 21 days of intimation to the contractor of acceptance of tender and balance Security Deposit shall be accumulated through deductions from Running Account Bills at 7.5% (maximum) of gross amount of bill.

- 35.2 Performance Guarantee under 9(b) of “Appendix to Conditions of Contract” shall be only in the form of Bank Guarantee valid up to scheduled date of completion.
- 35.3 The Bank Guarantee/s shall be from any Nationalised / Scheduled Bank approved by the Chief Engineer, which is located at the Zonal Office Headquarters of L.I.C within whose jurisdiction the work falls or at the place of work.
- 35.4 Bank Guarantee/s (BGs) against Security Deposit (SD) and Performance Guarantee (PG) shall be executed as per the specimen pro-forma at Annexure B and C. These guarantee/s shall be submitted within 21 (twenty one) days from the date of acceptance letter.
- 35.5 In case of failure by the contractor to furnish the Bank Guarantee against Performance Guarantee as per Cl.35.2 by the stipulated date or extended date if any, Employer shall without prejudice to any other right or remedy available in law, be at liberty to cancel the tender and forfeit the Earnest Money absolutely.

- 35.6 50% of the Security Deposit (cash option) shall be refunded after the certificate of virtual completion is issued to the contractor & provided that the employer has no claim for forfeiture of part or whole of the said deposit.
- 35.7 Balance 50% of Security deposit will be refunded to the contractor after the satisfactory completion of the defects liability period, subject to deductions for any appropriations thereof required to be made by the employer as per the conditions of contract.
- 35.8 If one Bank Guarantee in lieu of total Security Deposit is furnished, the same will be released only after the successful completion of Defects Liability period subject to any appropriations as aforesaid.
- 35.9 If two Bank Guarantees in lieu of Security deposit are furnished, the First Bank Guarantee will be released after the certificate of Virtual completion is issued to the contractor and second shall be released after the satisfactory completion of Defects Liability Period subject to any appropriations as aforesaid.
- 35.10 Bank Guarantees towards Performance Guarantees (where applicable) shall be released after the virtual completion is issued.
- 35.11 Contractor shall keep the Security Deposit and Performance Guarantee, where applicable, replenished to its full value whenever any recovery or appropriation there from occurs. The employer reserves the right to do so from any money(s) due to the contractor lying with them.
- 35.12 The Contractor should note that no interest will be allowed on any part of the Security deposit.
- 35.13 No deductions will be effected from the bills when the total security deposit is paid in the form of Bank Guarantee(s) and the EMD shall be refunded after acceptance of Bank Guarantee(s).
- 35.14 In the event of failure by the contractor to submit Bank Guarantee(s) by the specified / extended date, recovery of Security deposit shall be effected from the R.A Bills. However, where the contractor fails to furnish Bank Guarantee against Performance Guarantee the matter shall be dealt with as per Cl. 35.5 above.

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- 35.15 In all cases of Bank Guarantees, there shall be further provision of claim period of 6 months. If the contract period gets extended for any reason whatsoever, the contractor shall obtain the required extensions to the Bank Guarantee(s).

36. SETTLEMENT OF DISPUTES, ARBITRATION:

- 36.1 All disputes and differences of any kind whatsoever arising out of or in connection with the Contract or the carrying out of the work (whether during the progress of the work or after its completion and whether before or after determination, abandonment or breach of the Contract) shall be referred by the Contractor to the Chief Engineer within 15 (fifteen) days of any such matter arising. The CE shall upon receipt of such reference convey his written instructions or decision within 30 (Thirty) days to the contractor. If the contractor be dissatisfied with the decision of the CE on any matter, other than EXCEPTED MATTERS, then and in any such case, the Contractor shall within 30 (Thirty) days after receiving notice of such decision give a written notice to the Employer requiring that such matters in dispute (other than excepted matters) be arbitrated upon. Such written notice shall specify the matters which are in dispute or difference of which such written notice has been given and no other shall be and is hereby to be referred to the Arbitration. In case the Contractor fails to serve the written notice on any or all the issues in dispute within 30 (Thirty) days the decision conveyed by the CE shall be taken as final, binding and conclusive and shall not be open to arbitration.
- 36.2 Any disputes or differences that the employer may have with the contractor shall also be referred to Arbitration.
- 36.3 All disputes between the parties to the contract (other than those for which the decision of the CE or any other person is by the contract expressed to be final & binding) shall after written notice by either party to the contract to the other of them be referred to sole arbitration by an Arbitrator to be appointed by the Executive Director (Engineering), which shall be final and binding.
- 36.4 If the arbitrator so appointed resigns his appointment or vacates his office or is unable or unwilling to act due to any reason whatsoever, the appointing authority shall appoint a new arbitrator in his place.

36.5 Unless both the parties agree in writing, reference of such disputes to arbitration shall not take place until after the completion or alleged completion of the work or termination or determination of contract.

36.6 The Sole Arbitrator shall determine all matters in dispute other than EXCEPTED MATTERS (referred in Cl.No.34) which shall be referred to the Sole Arbitrator.

36.7 The Arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act 1996 or any statutory modifications thereof.

36.8 The Contractor hereby also agrees that Arbitration under this Clause shall be a condition precedent to any right of action under the Contract.

37. LUMP SUM ADVANCE (APPLICABLE TO CONTRACT COSTING Rs.25 LAKHS AND ABOVE)

37.1 Loan will be available if required by the Contractor, and may be given as under on submission of application by him subject to other conditions being fulfilled.

37.2 A lump sum amount not exceeding 5% of the Contract sum may be advanced against a Bank Guarantee and at the interest rate as specified in Appendix to the Conditions of Contract, repayable half-yearly-compounded. The advance shall be utilized by the Contractor for the purpose of this Contract only and for no other purpose.

37.3 The Bank Guarantee (Performa at Annexure 'C') shall be for the equivalent amount of loan 'plus' simple interest at specified rate plus 1% of loan amount to cover costs. The Bank Guarantee shall be from any Nationalized or approved scheduled Bank preferably located at Zonal Head Quarters of LIC or place of work and shall be valid till the date of completion as specified in Appendix to Conditions of Contract.

37.4 The amount of loan which may be given to the Contractor shall be at the sole discretion of the CE and may be in one or more installments.

37.5 Recovery of the sums advanced by way of loan as above and of interest, thereon shall be made by deduction from the Contractor's running account bills in suitable percentages in relation to the progress of work as fixed by the CE subject to the condition that entire amount of loan with interest thereon shall be fully recovered by the time the work amounting to 75% of the Contract sum is completed or completion period whichever is earlier. Provided that if at any time the Contractor fails to execute

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the Contract to the satisfaction of the Employer for any reason whatsoever, the Employer shall be entitled to recall forthwith the entire amount so advanced with interest, cost and legal expenses, etc. and/or recover the whole/balance amount as the case may be, from the bill if any, payable to the Contractor or by enforcing the Bank Guarantee.

- 37.6 Whenever extension of time is granted to the Contractors for the completion of the project and where the loan is not fully recovered, Contractor shall furnish fresh Bank Guarantee for extended period of Contract for the outstanding loan amount together with specified simple interest for the remaining period and 1% of outstanding loan amount towards costs.
- 37.7 Whenever the full amount of loan plus interest has been fully recovered, the Bank Guarantee shall be released.
- 37.8 If the situation so warrants a second loan will be available if required by the contractor subject to the following conditions :
- a) At least 50% of the first loan stands recovered
 - b) The amount of the loan shall not exceed 5% of the balance amount of work.
 - c) The sum of amount outstanding plus amount of second loan shall not exceed 5% of the total value of work.
- 37.9 All other conditions applicable to lump-sum advance shall apply for the Second loan also.

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GENERAL INSTRUCTIONS TO CONTRACTORS FOR BUILDERS (CIVIL & ELECTRICAL) WORK

1. DRAWINGS:

- 1.1 Drawings shall be kept open for inspection at places as mentioned in the letter to the contractor from the Chief Engineer. Drawings generally include the site plan, floor plans, elevations and sections of the proposed work.

2. INSPECTION OF SITE:

- 2.1 The Tenderer shall visit and examine the site of work and satisfy himself as to the nature of the existing roads or other means of communication, the character of the soil and of the excavations, the correct dimensions of the work and facilities for obtaining materials and shall obtain generally his own information on all matters affecting the execution of the work. No extra charge made, in consequence of any misunderstanding or incorrect information on any of these points or on the grounds of insufficient description will be allowed. All expenses incurred by the Tenderer in connection with obtaining information for submitting this tender including his visits to site and efforts in compiling the Tender shall be borne by the Tenderer and no claims for reimbursement thereof shall be entertained.

3. WHOLE WORK TO BE COMPLETED IN THE SPECIFIED COMPLETION PERIOD:

- 3.1 The whole work is to be completed within the completion period stated in the Appendix to Conditions of Contract or the extended date of completion, if any. The Contractor will be required if necessary, to work overtime to complete the work by the stipulated date. No extra will be allowed on the Contract sum for such overtime work.

4. TIME AND PROGRESS CHART:

- 4.1 A time and Progress Chart is attached to this Contract for guidance. The Contractor shall submit his version of time and progress chart fitted within the specified overall period of completion (as stated in Appendix to Conditions of Contract) within 15 (fifteen) days of the communication of acceptance of the tender, to the Corporation's Engineer. In case of contractor does not come forward for any change in the time and progress chart as provided in the General Instruction to the contractors, it shall be presumed that the Time & progress Chart is accepted in full in letter and script to maintain the pace of the progress of the work.

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- 4.2 Ancillary work should be so started that all such work is completed before the specified overall contractual period of completion.
- 4.3 The Contractor shall assume full responsibility for any delay in delivery of materials by Merchants or nominated Sub-Contractors not having completed the work in accordance with the Time and Progress Chart. Such excuses shall not form any criterion for extension of time, or any claims by the Contractor.
- 4.4 Any failure on the part of the contractor to adhere to the starting and completion date of individual items mentioned in the chart shall entail application of the liquidated clause on whole or part at the discretion of the Chief Engineer, notwithstanding the over all period of completion stated in the appendix to the conditions of contract.

5. BENCHES:

- 5.1 The Contractor is to construct and maintain proper benches to indicate the intersection of all main walls in order that the lines and levels may be accurately checked at all times. The Contractor shall provide suitable stones with flat tops and build the same in concrete for temporary or permanent benchmarks. All the pegs for setting out the work and fixing the necessary levels required for the execution thereof shall, if desired by the Corporation's Engineer likewise, be built in masonry at such places and in such a manner as the Corporation's Engineer may determine. Contractors' rates shall cover for these factors.

6. DRAWINGS ON SITE:

- 6.1 The Drawings maintained on the site are to be carefully mounted on boards of appropriate size and covered with a coat of approved transparent varnish or laminated at the cost of the Contractor. They are to be protected from the ravages of termites, ants, silver fish and other insects.

7. ORDER OF WORK:

- 7.1 The Chief Engineer reserves the right to fix the order in which the various items of work involved in this Contract is to be executed and Contractor shall comply with the same. There shall be no extra claims on account of this.

8. WORKMANSHIP:

- 8.1 The Work calls for a high standard of workmanship combined with speed.

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9. REJECTED WORKMANSHIP OR MATERIALS:

- 9.1** Any workmanship, or materials not complying with the specific requirements or approved samples, or which have been damaged, contaminated or deteriorated, must be removed immediately from the site and replaced at the Contractor's expense as directed.

10. QUOTED RATES:

- 10.1** The rate is percentage tender.

11. WATCHING AND LIGHTING:

- 11.1** The Contractor from the time of being placed in possession of the site must allow for watching, lighting and protecting the work, the site and surrounding, properly by day and night on all days including Sundays or other holidays, at his own cost.

12. WATER:

- 12.1** The rates quoted by the Contractors shall include for providing all water required for the work including that required by special tradesmen and Sub-Contractors and pay all charges required by Local Municipal or other Authorities. Water must be clean, fresh, pure and free from earth, vegetable or organic matters, acid or alkaline substance in solution or suspension. The Contractors shall make their own arrangements for water supply. If supply from the Municipality or other local bodies be inadequate, the Contractor should provide tube well or wells or open well at his own cost. The Contractors must execute any temporary plumbing and pay all fees and charges. All health regulations in force shall be strictly observed by the Contractor and pay all necessary charges.

13. ELECTRICITY:

- 13.1** The Contractor shall arrange with the concerned Electricity Supply Authorities for a temporary meter and supply to the site and shall provide all temporary wiring, power and lighting points for the whole of the works and clear away when no longer required. He shall pay all charges for the same and for electricity consumed, including that consumed by Sub-Contractors. The Contractor should submit disconnection & no dues certificate from the supplying authority along with his final bill.

14. OFFICE FOR CORPORATION'S ENGINEER ON SITE:

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- 14.1** The Contractor shall at his cost, provide a separate office (of suitable size) for the Corporation's Engineer/s on site with writing tables, chairs, electric lights and fans, drinking water arrangements, etc. as directed by the Executive Engineer and clear away at completion of work and make good all work disturbed and pay all charges. The Contractor shall also provide facilities for having the Corporation Engineer's office cleaned every day and kept in good and hygienic condition.

15. OFFICE ACCOMMODATION FOR CONTRACTOR'S STAFF :

- 15.1** The Contractor shall, at his cost, provide, fit-up and maintain in an approved position proper office accommodation for his representative and staff, which offices shall be open at all reasonable hours to receive instructions, notices or communications and clear away on completion and make good all work disturbed.

16. SECURITY AND PROTECTION:

- 16.1** The Contractor shall at his cost, provide any necessary temporary enclosures, gates, entrances, etc. for the protection of the work and materials and for altering and adapting same as may be required and removing at completion of the works and making good all works disturbed.
- 16.2** During inclement weather, the Contractor shall suspend concreting or plastering for such time as the Corporation's Engineer may direct and shall protect such work in course of execution from damage by approved measures.
- 16.3** Should the work be suspended by reason of rain, strike, lock-outs or any other cause, the Contractor shall at his cost take all precautions necessary for the protection of the work and shall make good any damage arising from any of these causes.
- 16.4** The Contractor shall at his expense cover-up and protect from injury from any cause, all new work and supply all temporary doors protection to windows, and any other requisite protection for the whole work executed, whether by himself or special tradesmen of Sub-Contractors and any damage caused must be made good by the Contractor at his own expense.
- 16.5** All fences, trees, shrubs, grasses, lawn and other surfaces around the buildings or approaches thereto, which are required to be maintained are to be kept free from damage due to operations in connection with the work, at Contractor's expense.

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16.6 The Contractor shall, at his expense, protect all projecting sills, jambs, copings, stone or concrete treads and mouldings and all concrete steps, wood work and joinery and the like from injury during the progress of the work.

16.7 The Contractor shall at his cost, protect joinery and make good all damages to the same from any cause whatsoever during the performance of the Contract and leave perfect to the satisfaction of the CE at completion. Before giving possession, the Contractor must see that all doors, windows and ventilation etc. work easily and shall make all necessary adjustments for such smooth working.

17. SANITATION:

17.1 The Contractor shall at his cost provide adequate latrine facilities and keep the same in a clean and hygienic condition to the satisfaction of the Public Health Authorities and shall cause such latrine and night soil to be cleared away whenever necessary and shall make good all works disturbed by these conveniences.

18. MINIMUM WAGES ACT:

18.1 The Contractor shall pay rates of wages and observe hours of work and conditions of employment to existing rules under Minimum Wages Act. Further, it shall be Contractor's responsibility to ensure that he pays his workmen wages, which are not lower than the minimum prescribed by the Union Government and State Government in which area this Contract, is being operated.

19. SHEDS FOR MATERIALS:

19.1 The Contractor shall at his cost provide and maintain proper approved sheds for the storage and protection of materials etc. and other work that may be executed on the site including the tools and materials of Sub-Contractors and remove on completion. Sheds for storage of Cement are to have floors raised from the ground.

20. TEMPORARY ROADS:

20.1 The Contractor shall, at his expense, provide such temporary roads on the site as may be necessary for the proper performance of the Contract and for his own convenience but not otherwise. Upon completion, such roads shall be broken up and levelled where

so required by the Drawings at Contractor's expense unless the CE shall otherwise direct.

21. OBJECTS OF VALUE AND ANTIQUITY FOUND ON SITE:

21.1 All objects of value or antiquity found on the site shall remain the property of the Employer and such findings shall be immediately reported to the Chief Engineer.

22. WORKS AND SITE TO BE KEPT AND DELIVERED UP CLEAN:

22.1 All shavings, cuttings and other rubbish as it accumulates from time to time during the progress of the work and at completion, including that of Sub-Contractor and special tradesman to be cleared and carted away. All rejected materials shall be removed. Contractor's quoted rates shall allow for these factors.

23. USEFUL EXCAVATED MATERIALS:

23.1 Any sand, gravel, moorum or rock taken from excavation will remain the property of the Employer and in the event of it not being allowed to use in the work, the Employer reserves the right to dispose it off in any way he wishes or to direct the Contractor to cart it away as ordinary materials.

23.2 Should suitable sand or gravel or moorum or rock be found in the excavations and the Contractor be allowed to use the same in the work, in place of materials to be brought by him from outside he will be required to pay the Employer the full market value of the same.

24. SIGN BOARD AND HOARDINGS:

24.1 The Contractor shall not affix or place any placards or advertisement of any description or permit the same to be affixed or placed in or upon any hoarding, gantry, buildings or structure other than that approved by the Chief Engineer.

25. SCIENTIFIC AND MEASURING INSTRUMENTS:

25.1 Theodolite, levelling instruments, prismatic compass/chain, steel and metallic tapes and all other surveying instruments found necessary on the works, shall be provided by the Contractor at his expense for the due performance of this Contract as instructed by the Corporation's Engineer.

26. TOOLS FOR MASONS:

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26.1 Every bricklayer or plasterer on the work shall be provided with suitable level, battens, trowels, wooden floats and breaking hammers for cutting bricks and templates, to enable him to carry out the work in a neat and workman like manner and each gang of brick layers or plasterers not exceeding six in number shall be provided with a suitable measuring rule, a plumb bob, a spirit level and a square in addition to the above mentioned, all to be to the approval of the Site Engineer.

27. CONTRACTOR'S MISTERIES AND SUPERVISORS:

27.1 The Contractor's Masson and the Supervisors on the works shall carry with them a suitable measuring rule, a measuring tape, a spirit level, a plumb bob and a square and shall check the work of the bricklayer, plasterers, and carpenters and joiners to see that the work is being done according to the Drawings and Specifications. The Corporation's Engineer/Supervising Staff will use any and all measuring instruments or tools belonging to the Contractor as he chooses, while checking the work executed or being executed on the works.

28. NO OVERLOADING OF SLABS:

28.1 Floors of buildings under construction shall not be loaded by stacks of materials during construction without the prior approval of Corporation's Engineer. It is important that no load comes on the reinforced concrete floors until they are at least three weeks old and at no time must the load placed upon them exceed the load for which they are designed.

29. ALTERNATIVE ITEMS:

29.1 In regard to alternative items, if any, specified in the Schedule of Quantities, Contractor should note that the Employer reserves the right to order the Principal item or its alternatives at the CE's discretion.

30. ATTENDANCE ON SUB-CONTRACTORS:

30.1 Co-ordination: The Contractor shall be responsible for the co-ordination of all the work including that of Sub-Contractors, for arranging runs of all services and working to the requirements and layout of the specialist trades, in all matters necessary for the complete execution of the work.

30.2 Rates quoted by the Contractor shall be inclusive of all attendance on Sub-Contractors or other Contractors nominated by the Employer. Contractor must allow for provision of

the use of his scaffolding to Sub-Contractors and for its retention until such time all relevant Sub-Contract works are completed.

- 30.3** The Contractor shall accept liability for and bear the cost of the supply of all necessary water, electricity, lighting, watching etc. for the Sub-Contractors work.
- 30.4** The Contractor must allow in his rates for making good any holes and chases left by the Sub-Contractors or other Contractors nominated by the Employer before the Builder's Work is completed and handed over
- 30.5** The Contractors shall, at all times, give access to workmen employed by the local or other authorities or any men directly employed on the buildings and to provide such parties with proper, sufficient, and if required, special scaffolding, hoists and ladders and provide them with water and lighting, and leave or make any holes, grooves etc. in any work directed by the Chief Engineer, as may be required, to enable such workmen to lay or fix pipes, electric wiring, special fittings etc. Contractor's quoted rates shall allow for these factors.

31. OCCUPATION BY EMPLOYER:

- 31.1** The Employer reserves the right to occupy the works by sections as completed, as may be considered by the Chief Engineer both practicable and reasonable and without hindrance to the Contractor's progress.

32. TAXES, DUTIES, LEVIES AND DEDUCTION AT SOURCE:

- 32.1** The Contractors shall be responsible to pay all statutory levies imposed by the State and Central Government such as Income Tax/ Sales Tax/ Sales Tax on works contract, Value Added Tax (VAT), Service Tax , Excise Duty, Octroi, Building and other construction workers welfare cess tax , royalties payable to state Government on purchase of various materials like bricks, sand , aggregate etc. and the rates quoted in the tender shall allow for the same except service tax. In other words ,the quoted rates shall be exclusive of Service tax. **The service tax is reimbursable to the contractor or payable by LIC to the Government of India as per financial act amended from time-to-time.**
- 32.2** Deduction at source of Income/Sales Tax on works contract and any other tax as decided by government shall be made by LIC of India as per the provisions prevailing from time to time from the Running Account or Final Bills and remitted to the concerned Taxation Authorities/State Government on behalf of the contractor.

ANNEXURE –‘A’**PROFORMA FOR
ARTICLES OF AGREEMENT**

ARTICLES OF AGREEMENT made at.....this.....day of20....
between THE LIFE INSURANCE CORPORATION OF INDIA, a body corporate constituted
and established by the Life Insurance Corporation Act, 1956 (Act 31 of 1956) and having
its Central Office at "Yogakshema", Jeevan Bima Marg, Mumbai and its Zonal Office at
..... hereinafter called the Employer (which expression shall include its successors
and assignees wherever context or meaning shall so require or permit) of the one part and
M/s(hereinafter called "**The Contractor**") of the other part.

WHEREAS the Employer is desirous of constructing
the.....
and has prepared drawings and specifications and the Schedule of Quantities which have
been signed by or on behalf of the parties hereto.

AND WHEREAS the Contractor has agreed to execute upon and subject to the
conditions and instructions set forth herein (hereinafter referred to as "**the said
Conditions**") the works shown upon the said drawings and /or described in the said
Specifications and included in the said Abstract Schedule of Quantities at the item rates
therein set forth amounting to the contract sum of Rs..... hereinafter referred to as
"**the said contract Amount**".

NOW IT IS HEREBY AGREED AS FOLLOWS:

1. In consideration of the said Contract Amount to be paid at the times and in the
manner set forth in the said conditions, the contractor shall upon and subject to
the said Conditions execute and complete the works shown upon the said
Drawings and described in the Specifications and/or the priced Schedule of
Quantities.
2. The Employer shall pay the contractor the said Contract Amount or such other
sum as shall become payable for the items and in the manner hereinafter specified
in the said conditions.

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3. The said Conditions and Appendices thereto shall be read and construed as forming part of this Agreement, and the parties hereto shall respectively abide by and submit themselves to the conditions and perform the Agreement in their part respectively in such conditions contained.
4. All disputes arising out of or in any way concerned with this Agreement shall be deemed to have arisen in _____ and only the Courts in _____ shall have jurisdiction to determine the same.
5. The contract comprises :-
 - i) Tender Documents Serial Pages.....
 - ii) Subsequent Correspondence Serial Pages.....
 - iii) Architectural Drawings Serial Pages
6. Only () alterations have been made in these documents and as evidence that these alterations were made before the execution of Contract Agreement, they have been initialled by the contractor and.....
.....
_____Engineer, _____ Zone, Life Insurance Corporation of India _____. The said officer is hereby authorised to sign and initial on the Employer's behalf, the documents forming part of this contract.
7. IN WITNESS WHEREOF THE Official Seal of the LIFE INSURANCE CORPORATION OF INDIA, _____ ZONE, was thereto affixed and signed on its behalf by the Chief Engineer and by _____ on behalf of the Contractor/s on the dates respectively mentioned against their signatures in the presence of the witnesses whose signatures are also appended.

In the presence of

CHIEF ENGINEER

1. Signature :

FOR AND ON BEHALF OF THE
LIFE INSURANCE CORPORATION
OF INDIA

Name :

Address :
.....

Date :

2. Signature :

Name :

Address :
.....

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EMPLOYER

In the presence of

1. Signature :

Name :

Address :

.....

2. Signature :

Name :

Address :

.....

FOR AND ON BEHALF OF THE
CONTRACTOR

M/S

Date :

CONTRACTOR

EMPLOYER

ANNEXURE – 'B'**LIFE INSURANCE CORPORATION OF INDIA****(Refer Clause No. 35 of Conditions of Contract)****FORM OF BANK GUARANTEE IN LIEU OF SECURITY DEPOSIT****IN INDIVIDUAL CONTRACTS**

To

THE LIFE INSURANCE CORPORATION OF INDIA

In consideration of the Life Insurance Corporation of India having its _____ Zonal Office at _____ in the State of _____ (hereinafter called '**the Corporation**' which expression shall unless repugnant to the subject or context include its successors and assignees) having agreed under terms and conditions of contract (vide its acceptance letter No. _____ dated _____) made between _____ (hereinafter called the said Contractor) and the Corporation in connection with _____ (hereinafter called '**the said contract**') to accept a Deed of Guarantee and Indemnity as herein provided for Rs. _____ from the _____ in lieu of the Security Deposit to be made by the contractor and/or in lieu of the deduction to be made from the Contractor's bills, for the due fulfilment by the said contractor of the terms and conditions contained in the said contract, we the _____ (hereinafter referred to as '**the said Bank**') and having our office at _____ do hereby undertake and agree to indemnify and keep indemnified the Corporation from time to time to the extent of Rs. _____ (Rupees _____ only) against any loss or damage, costs, charges and expenses caused to or suffered by or that may be caused to or suffered by the Corporation by reason of any breach or breaches by the said contractor in respect of the said contract or of any of the terms and conditions contained in the said contract, or in respect of all its claims for money and / or material found due and recoverable from the said contractor and to unconditionally pay the amount claimed as such by the Corporation on demand and without demur to the extent aforesaid.

2. We, the said Bank further agree that the Corporation shall be the sole judge of and as to whether the said contractor has committed any breach or breaches of any of the terms and conditions of the said contract and the extent of loss, damage, costs, charges and expenses caused to or suffered by or that may be caused to or suffered by the Corporation from time to

CONTRACTOR**EMPLOYER**

time on account thereof and the decision of the Corporation in this respect shall be final and binding on us.

3. The Corporation shall have the fullest liberty without affecting in any way the liability of the Bank under this Guarantee or Indemnity from time to time to vary any of the terms and conditions of the said contract or to extend time of performance by the said contractor, or to postpone for any time and from time to time any of the powers exercisable by it against the said contractor and either to enforce or forbear from enforcing any of the terms and conditions governing the said Contract or securities available to the Corporation and the said Bank shall not be released from its liability under these presents by any exercise by the Corporation of the liberty with reference to the matters aforesaid or by reason of time being given to the said contractor or any other forbearance, act or omission on the part of the Corporation or any indulgence by the Corporation to the said contractor or of any other matter or thing whatsoever, which under the law relating to sureties would but for this provision have the effect of so releasing the Bank from its liability.

4. It shall not be necessary for the Corporation to proceed against the contractor before proceeding against the Bank and the Guarantee and Indemnity herein contained shall be enforceable against the said Bank, notwithstanding any security which the corporation may have obtained or obtain from the contractor shall at the time when proceedings are taken against the Bank hereunder be outstanding or unrealized.

5. Notwithstanding anything contained in any of the foregoing clauses the liability of the Bank under this Guarantee shall not exceed Rs. _____ (Rupees _____ only). The guarantee shall remain in force till _____. If any extension of time be granted to the contractor, we undertake to extend the guarantee with the consent of the contractor. Unless a claim or demand under this guarantee is made or presented to the Bank within six months from the expiry date, all the rights of the Corporation under this Guarantee shall cease and the Bank shall be released and discharged from all liability hereunder.

6. We, the said bank lastly undertake not to revoke this guarantee and indemnity during its currency except with the previous consent of the Corporation in writing and agree that any change in the constitution of the said contractor or the said Bank shall not discharge our liability hereunder.

For and on behalf of the Bank

(Name and Designation)

CONTRACTOR

EMPLOYER

The above Guarantee is accepted by the
LIFE INSURANCE CORPORATION OF INDIA.

For and on behalf of the LIC of India

(Name and Designation)

Dated:

Note No.1 * : FILL IN AS APPLICABLE

A) For Proprietary concerns:-

Shri _____ son of _____ resident of
_____ carrying on business under the name and style of
_____ at _____

(hereinafter called '**the said contractor**' which expression shall unless the context requires otherwise include his heirs, executors, administrators and legal representative).

OR

B) For Partnership concerns:-

1. Shri _____
son of _____
resident of _____
2. Shri _____
son of _____
resident of _____

_____ carrying on business in partnership under the name and style of
_____ of _____ at _____
_____ (hereinafter collectively called '**the contractor**' which expression shall unless the context requires otherwise include each of them and their respective heirs, executors, administrators and legal representatives)

OR

C) For companies :-

M/S / Shri _____ a company under the Companies Act 1956 and having its registered office at _____ in the state of _____ (hereinafter called '**the said contractor**' which expression shall unless the context requires otherwise include its successors and assignees).

Note No.2:

**** Please fill in the name and address of Bank.**

CONTRACTOR

EMPLOYER

ANNEXURE – ‘C’**LIFE INSURANCE CORPORATION OF INDIA****(Refer Clause No. 35 of Conditions of Contract)****FORM OF BANK GUARANTEE FOR PERFORMANCE GUARANTEE****IN INDIVIDUAL CONTRACTS**

To
THE LIFE INSURANCE CORPORATION OF INDIA

In consideration of the Life Insurance Corporation of India having its _____ Zonal Office at _____ in the State of _____ (hereinafter called **‘the Corporation’** which expression shall unless repugnant to the subject or context include its successors and assignees) having agreed under terms and conditions of contract (vide its acceptance letter No. _____ dated _____) made between _____ (hereinafter called the said Contractor) and the Corporation in connection with _____ (hereinafter called **‘the said contract’**) to accept a Deed of Guarantee and Indemnity as herein provided for Rs. _____ from the _____ for the due fulfillment by the said contractor of the terms and conditions contained in the said contract, we the _____ (hereinafter referred to as **‘the said Bank’**) and having our office at _____ do hereby undertake and agree to indemnify and keep indemnified the Corporation from time to time to the extent of Rs. _____ (Rupees _____ only) against any loss or damage, costs, charges and expenses caused to or suffered by or that may be caused to or suffered by the Corporation by reason of any breach or breaches by the said contractor in respect of the said contract or of any of the terms and conditions contained in the said contract, or in respect of all its claims for money and / or material found due and recoverable from the said contractor and to unconditionally pay the amount claimed as such by the Corporation on demand and without demur to the extent aforesaid.

2. We, the said Bank further agree that the Corporation shall be the sole judge of and as to whether the said contractor has committed any breach or breaches of any of the terms and conditions of the said contract and the extent of loss, damage, costs, charges and expenses caused to or suffered by or that may be caused to or suffered by the Corporation from time to time on account thereof and the decision of the Corporation in this respect shall be final and binding on us.

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3. The Corporation shall have the fullest liberty without affecting in any way the liability of the Bank under this Guarantee or Indemnity from time to time to vary any of the terms and conditions of the said contract or to extend time of performance by the said contractor, or to postpone for any time and from time to time any of the powers exercisable by it against the said contractor and either to enforce or forbear from enforcing any of the terms and conditions governing the said Contract or securities available to the Corporation and the said Bank shall not be released from its liability under these presents by any exercise by the Corporation of the liberty with reference to the matters aforesaid or by reason of time being given to the said contractor or any other forbearance, act or omission on the part of the Corporation or any indulgence by the Corporation to the said contractor or of any other matter or thing whatsoever, which under the law relating to sureties would but for this provision have the effect of so releasing the Bank from its liability.

4. It shall not be necessary for the Corporation to proceed against the contractor before proceeding against the Bank and the Guarantee and Indemnity herein contained shall be enforceable against the said Bank, notwithstanding any security which the corporation may have obtained or obtain from the contractor shall at the time when proceedings are taken against the Bank hereunder be outstanding or unrealized.

5. Notwithstanding anything contained in any of the foregoing clauses the liability of the Bank under this Guarantee shall not exceed Rs. _____ (Rupees _____ only). The guarantee shall remain in force till _____. If any extension of time be granted to the contractor, we undertake to extend the guarantee with the consent of the contractor. Unless a claim or demand under this guarantee is made or presented to the Bank within six months from the expiry date, all the rights of the Corporation under this Guarantee shall cease and the Bank shall be released and discharged from all liability hereunder.

6. We, the said bank lastly undertake not to revoke this guarantee and indemnity during its currency except with the previous consent of the Corporation in writing and agree that any change in the constitution of the said contractor or the said Bank shall not discharge our liability hereunder.

For and on behalf of the Bank

(Name and Designation)

The above Guarantee is accepted by the

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LIFE INSURANCE CORPORATION OF INDIA.

For and on behalf of the LIC of India

(Name and Designation)

Dated:

Note No.1 * : FILL IN AS APPLICABLE

A) For Proprietary concerns:-

Shri _____ son of _____ resident of _____
_____ carrying on business under the name and style of _____
_____ at _____

(hereinafter called '**the said contractor**' which expression shall unless the context requires otherwise include his heirs, executors, administrators and legal representative).

OR

B) For Partnership concerns:-

1. Shri _____
son of _____
resident of _____
2. Shri _____
son of _____
resident of _____

carrying on business in partnership under the name and style of _____
_____ of _____ at _____

_____ (hereinafter collectively called '**the contractor**' which expression shall unless the context requires otherwise include each of them and their respective heirs, executors, administrators and legal representatives)

OR

C) For companies :-

M/S / Shri _____ a company under the Companies Act 1956 and having its registered office at _____ in the state of _____
(hereinafter called '**the said contractor**' which expression shall unless the context requires otherwise include its successors and assignees).

Note No.2:

**** Please fill in the name and address of Bank.**

CONTRACTOR

EMPLOYER

ANNEXURE – 'D'**LIFE INSURANCE CORPORATION OF INDIA**

(Refer clause 37 of Conditions of Contract)

FORM OF BANK GUARANTEE TO SECURE A LUMP SUM ADVANCE

To

THE LIFE INSURANCE CORPORATION OF INDIA

In consideration of the Life Insurance Corporation of India having its _____
Zonal Office at _____ in the State of _____ (hereinafter called
'The Corporation' which expression shall unless repugnant to the subject or context include its
successors and assignees) having agreed under the terms and conditions of contract vide its
acceptance letter No. _____ dated _____ made
between _____ *

_____ hereinafter
called the said Contractor and the Corporation in connection
with _____ (hereinafter
called the said 'contract'), to make at the request of the contractor a lump sum advance of
Rs. _____ for utilizing it for the purpose of contract on his furnishing a
guarantee acceptable to the Corporation, we the _____ ** Bank (hereinafter
referred to as 'the said Bank') a company under the companies Act, 1956 and having our
registered office at _____ do hereby guarantee the due recovery by the Corporation
of the said advance together with interest and costs thereon according to the terms and
conditions of the said contract. If the said contractor fails to utilize the said advance for the
purpose of the contract and/or the said advance together with interest thereon as aforesaid is
not fully recovered by the Corporation, we the said Bank hereby unconditionally and
irrevocably undertake to pay to the Corporation on demand and without demur to the extent of
the sum of Rs. _____.

1. We, the said Bank further agree that the Corporation shall be the sole judge of and as to whether the said contractor has not utilized the said advance or any part thereof for the purpose of the said contract and the extent of loss or damage caused to or suffered by The Corporation on account of the said advance together with interest and costs thereon not being recovered in full and the decision of the Corporation in this respect, shall be final and binding on us.

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2. The Corporation shall have the fullest liberty without affecting in anyway the liability of the Bank under this Guarantee or Indemnity, from time to time to vary any of the terms and conditions of the said contract or the advance or to extend time of performance by the said contractor or to postpone for any time and from time to time any of the powers exercisable by it against the said contractor and either to enforce or forbear from enforcing any of the terms and conditions governing the said contract or the advance or securities available to the Corporation and the said Bank shall not be released from its liability under these presents by any exercise by the Corporation of the liberty with reference to the matters aforesaid or by reason of time being given to the said contractor or any other forbearance, act or omission on the part of the Corporation or any indulgence by the Corporation to the said contractor or of any other matter or thing whatsoever which under the law relating to sureties would but for this provision have the effect of so releasing the Bank from its such liability.
3. It shall not be necessary for the Corporation to proceed against the contractor before proceeding against the Bank and the Guarantee herein contained shall be enforceable against the Bank notwithstanding any security which the Corporation may have obtained or obtain from the contractor shall at the time when proceedings are taken against the Bank hereunder be outstanding or unrealized.
4. Notwithstanding anything to the contrary hereinbefore contained the Bank's liability hereunder shall not exceed Rs. _____ (Rupees _____) in the aggregate. This Guarantee shall remain in force till the _____ day of the year 20...and the Bank's liability hereunder will cease to be operative unless any claim is lodged with the Bank within 6 (six) months thereafter.
5. We, the said Bank lastly undertake not to revoke this Guarantee during its currency except with the previous consent of the Corporation in writing and agree that any change in the constitution of the said contractor or the said Bank shall not discharge our liability hereunder.

For and on behalf of the Bank.

(Name and Designation)

The above Guarantee is accepted by the Life Insurance Corporation of India.

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For and on behalf of the
LIFE INSURANCE CORPORATION OF INDIA

(Name and Designation)

Note No.1 * : FILL IN AS APPLICABLE

A) For Proprietary concerns:-

Shri _____ son of _____ resident of _____ carrying on business under the name and style of _____ at _____ (hereinafter called 'the said contractor' which expression shall unless the context requires otherwise include his heirs, executors, administrators and legal representative).

OR

B) For Partnership concerns:-

1. Shri _____
son of _____
resident of _____
2. Shri _____
son of _____
resident of _____

carrying on business in partnership under the name and style of _____ of _____ at _____ (hereinafter collectively called 'the contractor' which expression shall unless the context requires otherwise include each of them and their respective heirs, executors, administrators and legal representatives)

OR

C) For companies:-

M/S / Shri _____ a company under the Companies Act 1956 and having its registered office at _____ in the state of _____ (hereinafter called 'the said contractor' which expression shall unless the context requires otherwise include its successors and assignees).

Note No.2 ** : Please fill in the name and address of Bank.

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Annexure-X**FORM OF BANK GUARANTEE IN LIEU OF PART OF THE EARNEST MONEY DEPOSIT**

(On Non-judicial Stamp Paper to be stamped in accordance with stamp act, the stamp paper to be issued in the name of Executing Bank)

BID BOND

B.G. No. _____ dated _____.

This Deed of Guarantee ("Bid Bond") executed at _____ by _____ (Name of Bank) having its Head/Registered office at _____ (hereinafter referred to as "the Guarantor") which expression shall unless it be repugnant to the subject or context thereof include its executors, administrators, successors and assigns;

In favour of

the Life Insurance Corporation of India having its North Central Zonal Office at Kanpur in the State of Uttar Pradesh (hereinafter called "the Corporation" which expression shall unless repugnant to the subject or context include its successors and assignees)

Whereas M/s. _____, a **[Legal Entity] having its registered office** at _____ (hereinafter called "the Tenderer") which expression shall unless it be repugnant to the subject or context thereof include its executors, administrators, successors and assigns, has decided to bid for the Tender for invited by the Corporation vide NIT dated (hereinafter referred to as "the Tender").

Whereas in terms of the Tender as specified hereinabove issued by the Corporation, the Tenderer is required to furnish to the "the Corporation" an unconditional and irrevocable bank guarantee for an amount of Rs. Lakhs (Rupees only), as Bid Bond in lieu of the part of the Earnest Money Deposit (EMD) as per the Tender and the Guarantor has at the request of the Tenderer agreed to provide such Guarantee being these presents:

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Now this deed witnesseth that in consideration of the premises, We, _____
_____ the Guarantor hereby declare, undertake and agree as follows:

a) We as primary obligor shall unconditionally and irrevocably pay to the “the Corporation” without demur, an amount not exceeding Rs. lakhs (Rupees only), within 5 days of receipt of a written demand from the “the Corporation” stating that the Bid Bond has been invoked and forfeited upon the Tenderer being declared and notified by “the Corporation” as a Successful Bidder and the Tenderer not fulfilling the requirements as per terms of the tender Document. Any such demand made on us by the “the Corporation” shall be conclusive and absolute as regards to the invocation and the forfeiture of the Bid Bond and the amount due and payable under this Guarantee. We expressly acknowledge that this Guarantee may be invoked multiple times.

b) The above payment shall be made by us without any reference to the Tenderer or any other person and irrespective of whether the claim of the “the Corporation” is disputed by the Tenderer or not.

c) This Guarantee shall remain in full force for a period of **six** months from or for such extended period as may be mutually agreed between the “the Corporation” and the Tenderer and shall continue to be enforceable till all amounts under this Guarantee are paid.

d) In order to give full effect to this Guarantee, the “the Corporation” shall be entitled to treat the Guarantor as the principal debtor and the obligations of the Guarantor shall not be affected by any variations in the terms and conditions of the tender Document or other documents or by extension of time of performance of any obligations by the Tenderer or any postponement for any time of the powers exercisable by the “the Corporation” against the Tenderer or forebear or enforce any of the terms and conditions relating to non-compliance of the tender Document by the Tenderer and we shall not be relieved from our obligations by

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reason of any variation or extension being granted to the Tenderer or forbearance or omission on the part of the “the Corporation” or any indulgence by the “the Corporation” to the Tenderer to give such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

e) This Guarantee shall be irrevocable and shall remain in full force and effect until all our obligations under this Guarantee are duly discharged.

f) Any payment made hereunder shall be made free and clear of and without deduction for, or on account of, any present or future charges, fees, commissions, deductions or whatsoever and by whom ever imposed.

g) The Guarantor has power and authority to validly execute and issue this Guarantee and the undersigned is duly authorised to execute and deliver this Guarantee pursuant to the power granted under _____ and its obligations under this Guarantee will be legally valid and binding and enforceable against it.

h) **Notices.**

Any demand certificate, notice or any other communication under this Guarantee shall be (i) in writing and (ii) faxed or sent by person, or overnight courier or by electronic mode at the following addresses:

.....

[insert]

All such Demand Certificates, notices and communications shall be effective (i) if sent by fax, when sent (with the correct answerback), (ii) if sent by person, when delivered, (iii) if sent by courier one (1) Business Day after deposit with an overnight courier, and (iv) if sent by registered letter when the registered letter would, in the ordinary course of post, be delivered whether actually delivered or not.

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i) This Guarantee is subject to the laws of India. Any suit, action, or their proceedings arising out of this Guarantee or the subject matter hereof shall be subject to the exclusive jurisdiction of courts of Kanpur, India.

In Witness whereof the Guarantor has set its hands hereunto on the day, month and year first hereinabove written.

Signed and Delivered by _____

Bank by the hand of Shri _____

Its _____ and authorised official.

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SPECIFICATIONS FOR BUILDER'S WORK

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SPECIFICATIONS FOR BUILDER'S WORK

1. EXCAVATION AND EARTHWORK

1.01 GENERAL :

The excavation will generally refer to open excavation of foundation (including basement if necessary) wet or dry.

1.02 EXAMINE THE SITE :

The Contractor shall visit and ascertain the nature of the ground to be excavated and the work to be done and shall accept all responsibility of the cost of the work involved.

1.03 CLEARING THE SITE :

The site on which the structure is to be built shown on the drawing and the area required for setting out and other operations like roads, drains, sheds, etc. should be cleared and all obstructions, loose stones, materials and rubbish of all kinds, slumps, bush wood and trees removed as directed, roots being entirely grubbed up. The materials obtained will be the property of the LIC and materials considered useful by the Corporation's Engineers will be handed over to the LIC. Rejected materials will be removed by the Contractor to his own dump at his own cost.

1.04 GROUND LEVELS AND SITE LEVEL PLAN :

Before starting the excavations, the requisite block levels of the entire plot shall be taken by the Contractor in consultation with the Corporation's Engineer and a proper record of these levels kept, which shall be jointly signed by the Contractor and the Corporation's Engineer. A block level plan showing all the ground levels of the plot shall be prepared and shall be jointly signed by the Contractor and the Corporation's Engineer.

1.05 SETTING OUT :

After clearing the site, and preparing the site level plan, the Contractor will set out the centre lines of the building or other involved works and get the same approved from the Corporation's Engineer. It shall be the responsibility of the Contractor to install substantial reference marks, bench marks etc. and maintain them as long as required

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by the Corporation's Engineer . The Contractor will assume full responsibility for proper setting out, alignment, elevation and dimension of each and all parts of the work.

1.06 EXCAVATION AND PREPARATION OF FOUNDATION FOR CONCRETING

Excavation shall include removal of all materials of whatever nature at all depths and whether wet or dry necessary for the construction of foundation and sub-structure (including mass excavation for basements where applicable) exactly in accordance with lines, levels, grades and curves shown on the drawings or as shall be levelled both longitudinally and transversely or stepped as directed by the Corporation's Engineer.

Should the Contractor excavate to a greater depth or width than shown on the drawings or as directed by the Corporation's Engineer, he shall at his own expense fill the extra depth or width with cement concrete in proportion as directed by the Corporation's Engineer but in no case with concrete of mix leaner than 1:4:8 cement concrete.

The contractors shall report to the Corporation's Engineer when the excavations are ready to receive concrete. no concrete shall be placed in foundations until the Contractor has obtained the Corporation's Engineer's approval. In case, the excavation is done through different strata of soil and if the same is payable as per provision in the schedule of quantities, the Contractor shall get the dimensions of the strata payable decided from the Corporation's Engineer. if no specific provision is made in the schedule of quantities it will be presumed that excavation shall be in all types of soil and the Contractors rate shall cover for the same. After the excavation is passed by the Corporation's Engineer (and before laying the concrete) the Contractor shall get the depth and dimensions of the excavations and levels (and nature of strata if applicable as per schedule of quantities like hard rock, soft rock etc.) and measurements recorded from the Corporation's Engineer on site. Refer I.S. 1200(Part-1)-1969 for classification of excavated material. Chief Engineer's interpretation regarding classification shall be final and binding on the Contractor. Excavated rock/boulders could be used for soling if approved by S.E./Executive engineer. Recovery at the market rate shall be made based on stack measurement after deducting 30% for voids.

1.07 SHORING :

The sides of the excavations should be timbered and shored in such a way as is necessary to secure them from failing in and the shoring shall be maintained in position as long as necessary. The Contractor shall be responsible for the proper design of the

shoring to hold the sides of the excavation in position and ensure safety from slips and prevent damage to work and property and injury to persons. The shoring shall be removed as directed after the items for which it is required are completed.

1.08 PROTECTION :

All foundation pits, lift pits, well pits and similar excavations shall be strong fenced and marked with red lights at night to avoid accidents. Adequate protective measures shall be taken to see that the excavation does not affect or damage adjoining structures. All measures required for the safety of the excavation, the people working in and near the foundation trenches, property and the people in the vicinity shall be taken by the Contractor at his own cost, he being entirely responsible for any injury and damage to property caused by his negligence or accident due to his construction operations.

1.09 STACKING OF EXCAVATED MATERIALS :

All materials excavated will remain the property of the L.I.C. and rate for excavation includes sorting out of useful materials and stacking them on site as directed. Materials suitable and useful for backfilling, plinth filling or levelling of the plot or other use shall be stacked in convenient place but not such a way as to obstruct free movement of men, animals and vehicles or encroach on the area required for constructional purposes.

1.10 BACK FILLING :

All shoring and form work shall be removed after their necessity ceases and trash of any sort shall be cleaned out from the excavation. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface with approved excavated materials in layers 15 cm to 20 cm, in thickness, watered and rammed. The filling shall be done after concrete or masonry is fully set and done in such a way as not to cause undue thrust on any part of the structure. Where suitable excavated material is to be used for refilling, it shall be brought from the place where it was temporarily stacked and used in refilling. No excavations or foundations shall be filled in or covered up until all measurements of excavations, masonry concrete and other works below ground level are jointly recorded. Black cotton soil shall not be used for back filling or in plinth filling.

1.11 DEWATERING :

Rate for excavation shall include bailing or pumping out water which may accumulate in the excavation during the progress of work either from seepage, springs, rain or any other cause and diverting surface flow if any by bunds or other means. pumping out water shall be done in such approved manner as to preclude the possibility of any damage to the foundation trenches, concrete or masonry or any adjacent structure.

When water is met in foundation trenches or in basement excavations pumping out water shall be from an auxiliary pit of adequate size dug slightly outside the building excavations. The depth of the auxiliary pit shall be more than the working foundation trench levels . The auxiliary pit shall be refill with approved excavated materials after the dewatering is over.

The excavation shall be kept free from water (1) during inspection and measurement. (2) when concrete and/or masonry are in progress and till they come above the natural water level, and (3) till the Corporation's Engineer considers that the concrete/mortar is sufficiently set.

1.12 SURPLUS EXCAVATED MATERIAL :

All excavated materials certified as surplus and not useful shall be removed by the Contractor from the site in an approved manner to his own dump at his own cost.

1.13 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract; rates for the item of excavation shall also include for the following:

- i. Clearing site
- ii. Setting out works as required and setting up bench marks and other reference marks.
- iii. Providing shoring and strutting and subsequently removing the same.
- iv. Bailing and pumping out water as required and directed.
- v. Excavation at all depths (unless otherwise specified in the schedule of quantities) and removal of all materials of whatever nature wet or dry and necessary for the construction of foundation/basement etc. and preparing bed for laying concrete.
- vi. Sorting out useful excavated materials and conveying beyond the structure and stacking them neatly on the site for back filling or re-use as directed.

- vii. Back filling the trenches alongside masonry or concrete with approved excavated material up to the natural ground level including watering and ramming.
- viii. Necessary protection including labour materials and equipment to ensure safety and protection against risk or accident.
- ix. Removal of surplus excavated material as directed to Contractors own dump.
- x. Drilling of small holes as directed to explore the nature of substratum if necessary.

1.14 MEASUREMENTS FOR EXCAVATION :

Excavation for foundation of columns, beams, walls and the like shall be measured and paid net as per drawing dimensions of concrete (bed concrete where so specified) at the lowest levels in regard to length and breadth and depth shall be computed from the concerned excavation levels and ground level taken before excavation. Any additional excavation required for working space, form work, planking, dewatering and strutting etc. shall not be measured and paid for separately but rates quoted for excavation shall include for all these factors. No increase in bulk after excavation shall be made.

1.15 EARTH FILLING IN PLINTH :

If there is approved surplus earth after back filling the sides of excavations, the same will be used for plinth filling if required. Any additional approved earth if required for plinth filling the same shall be brought on to the site by the Contractor from outside. No borrow pits shall be opened on the site. Filling in plinth shall be done in layers of 15cm to 20cm thick, each layer being consolidated by ramming and watering. Black cotton soil shall not be used for plinth filling.

Filling in plinth shall be measured net as in position after consolidation height or depth of filling being measured from original ground level to top of earth filling after consolidation.

SPECIFICATION FOR CONCRETE

2. CONCRETE AND STEEL REINFORCEMENT CEMENT CONCRETE :

2.1 GENERAL :

P.C.C. shall mean plain cement concrete.

R.C.C. shall mean Reinforced cement concrete.

2.2 Constant and strict supervision of all items of the construction is necessary during the progress of work, including proportioning, mixing and placing of concrete. Supervision is also extremely important in checking the reinforcement and its placing, before being covered.

2.3 Contractor shall finalise the details in consultation with the Clerk-of works as per which from work is proposed to be carried out and also the details of planning of concreting operations including adequacy of acceptable materials, testing of mixer and vibrator for ascertaining that they are in working condition, availability of test cube moulds, slump test apparatus etc.

2.4 SAMPLES AND TESTS:

Every facility shall be provided to enable the Corporation's Engineers to obtain samples and carry out tests on the materials and construction. If these tests show that any of the materials or construction do not comply with the requirements of this specification, the Contractor will be responsible for the costs of the test and the replacement of the defective materials and/or construction.

2.5 REJECTED MATERIALS:

All materials which have been damaged contaminated or have deteriorated or do not comply in any way with the requirements of the specification shall be rejected and shall be removed immediately from the site at the Contractor's own expenses.

2.6 LOADING OF FLOOR SLABS:

Materials shall not be stored or stacked on suspended floors and roofs without the Corporation's Engineer's prior approval.

2.7 CO-ORDINATION :

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The Contractor shall be responsible for the co-ordination with sub-contractors or other contractors for incorporating any inserts or electrical conduit pipes, fixing blocks, chases, holes etc. in concrete members as required. The Contractor shall ensure that these requirements have been approved by the Corporation's engineer before concreting operation are put in hand. All fixing blocks, chases, inserts, holders, etc. to be left in the concrete shall be of sizes specified and be accurately set out and placed before pouring concrete. The Contractor's rates quoted for concrete items shall include for all these factors. Holes or chases shall not be out in concrete without prior approval of the Corporation's Engineer.

2.8 INSERTS IN CONCRETE :

Contractor should note that he shall provide necessary wooden lugs, sleeves, etc. for his own works to be made for which no extra payment will be made. He will have to provide if so directed, any inserts, wooden lugs, sleeves for other contractor's work such as Electrical Contractor, plumbing Contractor, A.C. Contractor, Contractor of lifts , etc. for which he will be entitled for payment but in case the other contractors provide such inserts, then he will have to take proper measures (at his expense) and take care not to disturb the work while laying concrete.

2.9 Contractor shall provide work-site-testing equipment for aggregate and concrete such as test sieves, balances, slump cones, test cube moulds etc.

2.10 MATERIALS : ALL MATERIALS SHALL BE OF APPROVED QUALITY.

2.11 CEMENT :

- a. Ordinary port land cement shall conform to the I.S. specification I.S:269/1976. Portland Pozzolana cement shall confirm to I.S. 1489-1976. Portland slag cement shall confirm to I.S. 456-1989.
- b. The cement shall be stored in such a manner as to permit of easy access for proper inspection, in a suitable weather-tight building to protect the cement from dampness and to minimise warehouse deterioration. The shed shall be built at the cost of the Contractor. Care shall be taken to see that (i)there is no leakage from side walls and (ii) windows are not provided. The plinth level of the shed shall be raised and the surrounding ground shall drain the surface water away from the shed. The floor of the shed shall consist of wooden planks

resting on a base prepared of dry bricks laid on edge. The bags should not be piled against the wall. A space of 30cm shall be left all around between exterior walls and piles. The bags shall be placed closed together in the pile to reduce circulation of air as much as possible. The bags should not be piled more than 10. the bags shall be arranged in header and stretcher fashion so as to lessen the danger of toppling.

When removing the bags for use, "First in, first out" rules shall be applied. For this purpose, consignment as it comes in for storage shall be stacked separately and a placard bearing date of arrival shall be pinned to the pile.

- c. Contractor shall be fully responsible for the quality of cement brought at the work site. The contractor shall satisfy himself that the cement brought to the work site conforms to the requirements of I.S. : 269/1976 or relevant Indian Standard and shall procure manufacturer's certificate to this effect. In his own interests. In case the Contractor has any doubt regarding the quality of cement brought on work site it is up to him to have it tested at his own expenses and make sure that cement is of right quality.
- d. In case Corporation's Engineer gets any doubt about quality of cements he can order the contractor to have cement tested or he can take sample in the presence of contractor from cement bags stored at work site and forward them to a government approved laboratory for testing. In respect of charges for testing in such a case, contractor will be paid the charges, provided the cement conforms to the specified I.S. Standards.
- e. Cement concerning which there is doubt, shall not be used pending testing and satisfactory results. All cement not conforming to specifications and rejected by Corporation's Engineer and cement that is stored at site for a period long than three months and deteriorated, damaged or set shall not be allowed to be used. All such cement shall be immediately removed from work site by the contractor. The cost of all such cement shall be borne by the contractor.

2.12 AGGREGATES:

Aggregates shall conform to IS:383/1970 and shall be from approved sources.

2.13 FINE AGGREGATE :

- a. The fine aggregate-sand shall be hard, strong, dense, durable, clean with uncoated grains. The maximum size of the particles shall be 4.75mm(3/16in.)

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and shall be graded down. The sand shall not contain any harmful material such as iron pyrites, coal mica, silt, clay, alkali, sea shells, organic impurities, loam etc. or in case of reinforced concrete work, any material which might attack the reinforcement or which might be detrimental to concrete. Aggregates which are chemically reactive with the alkalis of the cement, shall not be used, the maximum quantity of deleterious material shall not exceed the limits specified in the relevant I.S specification. Silt and dust present in natural sand shall be limited to 3% by weight. in case it is more than 3%, it shall be washed at site. Presence of mica in sand shall not be more than 1% by weight.

- b. Grading: The natural sand used for work shall have a grading conforming to one of the three grading zones given in following table (Table IA):-

TABLE 'IA'
GRADING OF FINE AGGREGATES

(In accordance with IS:2386/1963 Part-1) percentage passing for

Sieve	Zone-1	Zone-2	Zone-3
10 mm	100	100	100
4.75 mm	90 - 100	90 - 100	90 -100
2.36 mm	60 - 95	75 - 100	85 -100
1.18 mm	30 - 70	55 - 90	75 -100
600 micron	15 - 34	35 - 59	60 - 79
300 micron	5 - 20	8 - 30	12 - 40
150 micron	0 - 10	0 - 10	0 - 10

When grading falls outside the limits of any particular zone of sieves, (other than 600 micron IS Sieve) by a total amount not exceeding 5% it shall be regarded as falling within the grading zone.

2.14 COARSE AGGREGATES :

- a. Coarse aggregates shall consist of hard, dense, durable, uncoated crushed rock. Gravel aggregate shall be allowed to be used only if specially specified in the schedule of quantities. Otherwise, it shall be taken that only crushed rock from an approved quarry shall be permitted as coarse aggregates.

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- b. The aggregates shall be from soft, friable, thin or long laminated pieces. Aggregates shall be free from injurious amounts of alkali, organic matter and other deleterious materials. Flaky or weathered stones shall not be used. The maximum percentage of deleterious materials shall not exceed those specified in the relevant I.S. specifications.
- c. In selecting the aggregate, the contractor shall satisfy that the source is suitable for regular supply and a watch shall be maintained that the particle shape and grading remain reasonably uniform throughout the progress of work.
- d. Contractor shall arrange to supply coarse aggregates in single sizes, conforming in the case of each nominal size, to the grading given in the following table (Table 1B) under column "A", the single sizes shall be combined in suitable proportions to get desired overall grading of aggregates. The Corporation's Engineer, at his discretion may allow the use of "Graded Aggregates" of nominal size, to conform to the grading in the limits specified in the Table-1B under column "B".

TABLE 1- B COARSE AGGREGATES

COLUMN "A"

COLUMN "B"

**Percentage passing for single sized
aggregates**

**Percentage passing for graded
aggregates**

IS sieve Mm	63mm	40mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16mm	12.5mm
80	100	-	-	-	-	-	100	-	-	-
63	85-100	100	-	-	-	-	-	-	-	-
40	0-30	85-100	100	-	-	-	95- 100	100	-	-
20	0-5	0-20	85-100	100	-	-	30-70	95- 100	100	100
16	--	-	-	85- 100	100	-	-	-	90- 100	-
12.5	-	-	-	-	85-100	100	-	-	-	90-100

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10	0-5	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75	-	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36	-	-	-	-	-	0-5	-	-	-	-

e. Size of Aggregates:-

- (i) Nominal maximum size of aggregates in beams and columns should be restricted to 5mm less than the minimum clear distance between the main bars or 5mm less than the minimum cover to the reinforcement whichever is less.
- (ii) Where reinforcement is widely spaced as in slabs, nominal maximum size of aggregate of 20mm may be used.
- (iii) In no case the maximum size of aggregate to be greater than one quarter of the minimum thickness of the member so as to facilitate concrete to be placed without difficulty to surround all reinforcement.
- (iv) Generally on reinforced concrete work, nominal maximum size of 20 mm is considered suitable.

- f. Grading: It can be assumed as a rough guide that from 45percent to 75 percent of the total aggregate (fine plus coarse) shall pass through a sieve of aperture size equal to one half of the maximum size of coarse aggregate.
- g. Stock-piling of aggregate or storage of aggregates: Aggregates shall be stored at site on a hard and dry patch of ground preferably levelled and rolled. piles of sand and piles of different sizes coarse aggregate shall be stored in separate stock piles with height preferably not exceeding 1.25 to 1.5 metres. A bottom layer of aggregates of 10cm deep shall be left undisturbed while removing the material for use.
- h. If the aggregates are stored at site for a long time there is accumulation of dust. The contractor is required to sieve the aggregate before use, if advised by Corporation's engineers. Washing the aggregates by means of hose pipe is not

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permitted. Silt and find dust permitted in coarse aggregate is only upto 1% by weight.

2.15 WATER :

Water used for both mixing and curing shall be potable and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substance that may be deleterious materials which are likely to affect the strength or durability of concrete or steel. Water containing any sugar shall not be allowed for use. Also water which fails to satisfy the following requirements shall not be used:-

- To neutralise 100ml. sample of water, using mixed indicator, it should not require more than 25ml. of 0.02 normal H_2SO_4 .
- To neutralise of 100 ml. sample of water, using phenolphthalein as an indicator , it should not require more than 5ml. of 0.02 normal NaOH.
- Water should not contain solids in excess of the following:

Organic	200 mg/litre.
Inorganic	3000 mg/litre.
Sulphate(as SO_4)	400 mg/litre.
Chloride(as Cl)	2000 mg/litre for P.C.C. 500 mg/litre for R.C.C.
Suspended matter	2000 mg/litre.
The PH value of water shall be between	6 to 8.

2.16 MIXES OF CONCRETE :

Concrete used shall be in volumetric mix / Design mix / RMC such as 1:4:8, 1:3:6, 1:2:4, 1:1.5:3, 1:1:2 / M15, M20, M25 etc.

2.17 BATCHING :

The quantity of cement shall be determined by weight. Batching of cement and water shall be as specified in Paras 2.20 and 2.22 respectively.

2.18a. In proportioning concrete the quantity of cement shall be determined by weight. One bag of cement containing 50kgs. of cement shall be assumed to contain 35 litres (1;20Cft). The quantities of fine and coarse aggregates and water shall be determined

by volume. If fine aggregate is moist allowance shall be made for bulking in accordance with filled method of determining the necessary adjustment for the bulking of fine aggregates. Moisture causes loosely filled sand to occupy a larger volume than it would occupy if dry. It is therefore necessary to increase the volume of sand by the % of bulking. The correction shall be made on the following lines :-

In a 250 cu. cm. measuring cylinder pour the sample of the fine aggregate (Sand) to be used at site, consolidate it by shaking, until it reaches 200 cu. cm. mark. Then fill the cylinder with water and air the sand well. The water must be sufficient to completely submerge the sand. The sand surface will be seen below its original level. Suppose other surface is at mark 'X' Cu. cm. The % of bulking of sand due to moisture shall be calculated from the following formula

$$\text{Percentage of bulking 'K'} = \left(\frac{200 - X}{X} \right) \times 100$$

$$\text{Therefore true volume} = \frac{100 \times \text{Measured Volume}}{K + 100}$$

- b. The water cement ratios shall not be more than those specified in Table it below. in case mechanical, vibrators are used, water content shall be suitably reduced, without reducing cement content, to avoid aggregation. Water content specified in table II may be increased under exceptional circumstances where workability of concrete produced poses difficulties of placement and compaction. Prior permission of Corporation's Engineer shall be obtained for this purpose. When the water content is increased in the manner indicated above, the cement content also shall be increased proportionately so that water cement ratio given in Table II is maintained. Cost of extra cement shall be borne by the contractor.

TABLE II

Mix of concrete	Quantity of water 50kg Of cement. Max. litre
1:3:5	34
1:2:4	32
1:1½ :3	30
1:1:2	27

- c. Allowance shall be made for surface water present in the aggregate while computing the water content. Surface water shall be determined by one of the field methods

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described in IS:2386(Part II)/1963. In the absence of exact data, with the approval of the Corporation's Engineer the amount of surface water may be estimated from the values given in table III below:-

TABLE –III
SURFACE WATER CARRIED BY AVERAGE AGGREGATE.

Aggregate	Approximate quantity of surface water in litre/Cu.M.
Very wet sand	120
Moderately wet sand	80
Moist sand	40
Moist gravel or crushed rock	20 to40
Coarser the aggregate lesser water it will carry	

2.19 WORKABILITY :

Workability of concrete should be controlled by direct measurement of water content, making allowance for any surface water in the fine and coarse aggregates. The slump test or compacting factor test shall be carried out at intervals as directed by the Corporation's Engineer. The slump test is suitable for slump of 5cm to 15cm.

2.20 MIXING AND PLACING OF CONCRETE: MEASUREMENT OF MATERIALS:

Cement shall be batched by weight even though aggregates are batched by volume. Where the weight of the cement is determined by accepting the maker's weight per bag; a number of bags as directed by Corporation's Engineer shall be weighed separately to check the net weight.

2.21 AGGREGATES :

- a. The quantities of fine and coarse aggregates shall be determined by volume. The proportions of aggregates (i.e. ratio of fine aggregate to coarse aggregate) shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes, fine, and maximum size of coarse aggregates becomes larger.
- i). For an average grading fine aggregate i.e. Zone II of IS: 2386/1963 Part I the ratios of fine aggregate to coarse aggregates shall be:

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Maximum size of coarse aggregate	Maximum size of coarse aggregate
10mm	20 mm
1:1 ½	1:2

For fine aggregates within their grading zones the ratio shall be increased as the fine aggregate gets finer, that is , passes from zone I to III.

- ii) For maximum size of coarse aggregate 20 mm the ratios of fine aggregate to coarse aggregate shall be (Zones as per IS : 2386/1963 - Part I)

Zone I	Zone II	Zone III
1:1.1/2	1:2	1:3

- b. The measuring boxes prepared for measuring the aggregates shall be of correct size. The measuring boxes are required to be certified by Corporation's Engineer before they are used on site. Internal dimensions of the boxes shall be generally 35cm x 25cm x 40cm. Heaping of aggregates over the boxes is prohibited. Aggregates shall be filled in only up to the brim of the boxes and struck off horizontally with a timber or steel bar. Allowance for bulkage for sand shall be made as determined by Corporation's Engineer. Refer clause no- 2.18

2.22 WATER :

Water shall be measured by volume in calibrated tanks/vessels having a conical shape narrow at top. Water shall not be measured using ordinary uncalibrated buckets, which are wider at top and narrower at the base. The measurement of water to control and maintain a constant water cement ration is of utmost importance and adequate attention to this requirement by the Contractor to the satisfaction of Corporation's Engineer, shall be given.

2.23 MIXING OF CONCRETE :

- a. Machine mixing: Concrete shall be mixed in a mechanical mixer, having an optimum speed which yields good concrete that is neither inadequately mixed nor showing tendency of segregation. This avoids frequent washing. A small amount of water shall be fed first followed by all solid materials. Remainder of water shall be added after the solids. Mixing shall be continued until there is

uniform distribution of materials and the mass is uniform in colour and consistency. The mixing time shall be counted after all the materials are in drum and shall be in accordance with IS: 1791/1963 but in no case mixing shall be done for less than two minutes.

- b. Hand mixing: Hand mixing shall not be permitted except for unimportant structural members and purely at the discretion of the Corporation's Engineer. Hand mixing will not be permitted for concrete going into columns. When hand mixing is permitted, it shall be ensured that the mixing is continued until the mass is uniform in colour and consistency. the contractor shall use 10% extra cement for hand mixing for which no extra payment will be made. Hand mixing when permitted shall be done on platform.

2.24 TRANSPORTING :

Concrete shall be handled from the place of mixing to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of the ingredients. It shall be deposited as nearly as practicable in its final position to avoid rehandling or flowing. Wet concrete discharged from each batch of mixer shall be neatly collected and transported. Remnants from earlier batches shall be rejected and removed.

2.25 PLACING :

The concrete shall be placed in position and compacted before the initial setting time and shall not be disturbed subsequently. Concreting shall be carried out continuously upto construction joints; the position and arrangement of which shall be predetermined.

When the work has to be resumed on the surface which has hardened, it shall be thoroughly hacked, swept clean, wetted and covered with a layer of mortar composed of cement and sand in the same ratio as the cement and sand in the concrete mixture. This mortar shall be freshly mixed and placed immediately before placing of the concrete. Concrete shall be placed in shuttering by shovels or other approved implements and shall not be dropped from a height, say greater than 1 M or handled in a manner which will not cause segregation. Concrete which has already set shall not be allowed to be incorporated in the work even after adding cement and remixing.

2.26 DEBRIS ETC. REMOVED :

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All debris, saw dust, etc. shall be removed from the shuttering before any concrete is placed. Care shall be taken to see that the shuttering is watertight and has been properly treated with approved composition to prevent absorption of water.

Shuttering for concrete shall be rigidly constructed of approved material and shall be true to the shape and dimensions described on the working drawing. Faces in contact with concrete shall be free from adhering grout, projecting nails, splits and other defects. Joints shall be sufficiently tight to prevent the leakage of cement grout and to avoid the formation of fins and other blemishes. Shuttering shall be secured so as to be strong enough to retain the correct shape during consolidation of concrete. Shuttering shall be true to line and braced and strutted to prevent deformation under the weight and pressure of the wet concrete, constructional loads, wind and other forces. The shuttering of beams and slabs shall be erected in such a way that the shuttering on the sides of the beams and soffits of slabs can be removed without disturbing the beam bottoms. Re-propping of beams shall not be permitted. Immediately prior to placing of the concrete, the shuttering shall be well wetted.

2.27 PROTECTION AND PLACING IN LAYERS :

Concrete shall be placed in single operation to the full thickness of slabs, beams and similar members and shall be placed in horizontal layers not exceeding 1M deep in walls, columns and similar members. Concrete after placing shall be protected by use of covering to the approval of the Corporation's Engineer during first stages of hardening against high winds, hot sun and/or rain or surface water. No shock or vibrations shall be allowed to be imparted to forms supporting fresh concrete.

2.28 COMPACTION :

Concrete shall be thoroughly compacted during operation of placing and carefully worked around the reinforcement embedded fixtures and into corners of form work. The use of mechanical vibrators is strongly recommended. Sufficient number of vibrators (including stand by) of adequate capacities shall be used for compaction of concrete. Vibration shall be carried out by trained men and in the presence of a qualified supervisor trained in the use of vibrators and vibrated concrete. In certain portions where vibration is not effective, careful rodding and tamping shall be carried out and sufficient men employed to ensure that thorough consolidation takes place. Where manual compaction becomes necessary the workability of the mix should be controlled

to suit such mode of compaction subject, of course, to compliance of strength requirements specified.

2.29 CONTINUOUS CONCRETING :

Concreting shall be carried out continuously up to predetermined positions of construction joints. The position and arrangement for construction joints shall be approved by the Corporation's Engineer. Rest pauses for meals etc. shall be subject to the Corporation's Engineer's approval.

2.30 PACKING ROUND REINFORCEMENT :

In the case of reinforced concrete work, the concrete shall be carefully consolidated round the reinforcement and care shall be taken to ensure that reinforcement is not displaced during the placing and compaction of concrete. If reinforcement moves out of its place, it must be brought back to position immediately.

2.31 VIBRATION OF CONCRETE :

- a. Number and size of vibrations: Vibrators shall be of sturdy construction, adequately powered and capable of transmitting to the concrete not less than 3500 impulses per minute when operating under load. The vibration shall be sufficiently tense to cause the concrete to flow or settle readily into place and visibly effect the concrete over a radius of at least 450 mm(18") when used in concrete having slump of 25mm. A sufficient number of vibrators (at least one vibrator for a rate of concreting of 1.5 Cum.i.e 50 Cu. ft per hour) shall be employed so that vibration throughout the entire volume of each layer of concrete and complete compaction are secured.
- b. Manipulation of vibrators: Internal vibrators shall be keep constantly moving in the concrete and shall be applied at points uniformly placed not farther apart than the radius over which the vibrator is visibly effective. The vibrator shall not be held in one location long enough to draw out a pool of grout from surrounding concrete. The vibration shall be such that the concrete becomes uniformly plastic and there shall be at least 200 seconds of vibration per square metre (20 seconds of vibration per sq. ft.) of surface of each layer of concrete, computed on the basis of visibly effected radius and taking overlap into consideration, vibrations shall be stopped when air bubbles have practically cease coming to the surface.

2.32 CURING :

All concrete work shall be kept constantly wet for a minimum period of seven days after concreting Horizontal surfaces shall be kept covered with water ponded by means of bunds and vertical surfaces like those of columns, fins, etc. by burlaps kept constantly wet by water sprays. Mere sprinkling of water on vertical surfaces without sacks of burlaps will not be allowed. In respect of concrete made out of pozzalana cement curing shall be continued for another eight days, viz. fifteen days in all.

2.33 TRADING SUPERVISOR :

It is essential that the contractor's supervisor who is in charge of the construction an all concrete works, whether reinforced or not, shall be skilled in this class of work and shall superintend personally the whole construction and pay special attention to:-

- The quality, testing, proportioning and mixing of the materials and particularly control of water cement ratio.
- Laying of materials in place and thorough consolidation of the concrete to ensure solidity and freedom from voids.
- Sizes and positions of reinforcements.

2.34 STRENGTH REQUIREMENTS OF CONCRETE :

Where ordinary portland cement is used, the compressive strength requirements for various mixes of concrete shall be as given in Table IV. It shall be the contractor's responsibility to obtain specified strengths for the various mixes of concrete .

TABLE IV

STRENGTH REQUIREMENTS OF CONCRETE

(All values in kg/ sq. cm.)

All tests conducted in accordance with IS 516-1959.

Concrete Mix.	Minimum Compressive strength on 15cm cubes at 7 days (works Test only)	Minimum compressive strength of 15 cm cubes at 28 days. (works test only)
1:3:6	70	100
1:2:4	100	150
1:1 ½ :3	135	200
1:1:2	170	250

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Note : Works Test: A test conducted in an approved laboratory on the specimens made on the works, out of the concrete being used on the works.

2.35 CRITERION REGARDING STRENGTH :

Although the works test Cubes are specified to be conducted at the age of 7 and 28 days, in all cases 28 days compressive strength specified in Table IV shall alone be the criterion for acceptance or rejection of concrete.

2.36 CLASSIFICATION OF CONCRETE OF LOWER OR HIGHER STRENGTH THAN SPECIFIED :

If concrete made in accordance with the proportions given for a particular mix does not yield the specified average strength of three cubes at 28 days(refer table V for acceptance criteria) such concrete shall be dealt as stated in the criteria for acceptance of concrete.

2.37 TEST CUBES :

- a. Concrete used for preparing works test cubes shall represent quality of concrete incorporated in the work. The concrete for preparation of one set of six cubes shall be taken from one batch of mixed concrete discharged from mixer. The cubes shall be moulded in accordance with Indian standard code of practices.
- b. The cubes shall be cured as per IS Code of practices: The entire operation of casting, arranging and despatch of cubes to laboratory will be carried out by the Contractor under the joint supervision of the Corporation's Engineer and Contractor's Engineer. Out of six cubes, three cubes shall be tested at an age of seven days and the other three at the age for 28 days in a laboratory approved by the Chief Engineer.
- c. The cubes shall be initialled jointly by Contractor's representative and the Corporation's Engineer with a piece of wire on nail, so that an indentation of the initials is left on the cubes.
- d. The contractor shall arrange to transport the cubes to the laboratory and arrange to have the test results forwarded (in duplicate) directly from the laboratory to the Corporation's Engineer. The contractor shall bear all expenses in connection with the preparation of test cubes like cost of moulds, cost of concrete, labour and transportation charges to the approved laboratory etc. The charges for testing shall be paid initially by the Contractor to the laboratory.
- e. A register shall be maintained at site by the Corporation's Engineer with the following details entered and initialled by the contractor and the Corporation's Engineer:-

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- i. Date and time of casting.
 - ii. The mix of concrete.
 - iii. Reference to specific structural member receiving the batch of concrete from which the cubes were cast.
 - iv. Mark on cubes.
 - v. Water cement ratio by weight and slump.
 - vi. Crushing strengths as obtained at the end of seven days for three cubes out of a set of six and at the end of 28 days for the other three cubes.
 - vii. Laboratory in which tested and reference to test certificate.
 - viii. Any other information directed by the Chief Engineer.
- f. A record of the quantity of concrete incorporated in the work that is represented by the quality of concrete of the set of cubes along with the description of the structural members where such concrete has been deposited shall be maintained. For floor beams and slabs, such record shall be supported by a drawing on which the areas of concreting carried out and representing the set of cubes take out shall be properly demarcated with cube references entered in the drawing at the relevant portions. This record shall be initialled by the contractor and maintained by the Corporation's Engineer.
- g. Samples size and acceptance criteria: All tests shall be carried out in accordance with IS:516-1959. The number of test specimens required, the frequency of sampling and the criteria for acceptance of a concrete of a specified mix shall be in accordance with the Table V': Ordinary Concrete' .

2.38 STANDARD OF ACCEPTANCE :

Seven days tests: The average compressive strength of the three specimens tested at seven days shall satisfy the specified strengths given in Table IV, for the appropriate mix. As a guidance the difference between the maximum and the minimum strength of the three specimens shall not exceed 15% of the average strength. In case seven days test result is not satisfactory all further work structurally interlinked with the concrete represented by the samples shall be stopped unless otherwise decided by Chief Engineer.

Twenty eight days test: Acceptance criteria of twenty eight days shall be as follows :

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- a. If the average compressive strength of three cubes is more than the compressive strength indicated in Table IV, the concrete shall be accepted at full rates.
- b. If the average compressive strength of three cubes is less than the specified but not less than 85% of the specified strength, the concrete may be accepted at reduced rate at the discretion of the Chief Engineer.
- c. If the average compressive strength of three cubes is less than 85% of the specified strength, Chief Engineer shall reject and get dismantled the defective portion of the work represented by the sample along with the structurally connected work as considered necessary at the risk and cost of the Contractor. In case of (b) and (c) above, Chief Engineer, if he so decides may order the additional tests like core test, ultrasonic test, rebound hammer test, load test of structure or part of structure etc. to be carried out. All the charges in connection with these additional tests shall be borne by the contractor. If on the basis of these additional tests the Chief Engineer is satisfied about the structural adequacy of the concrete, he may accept the work at reduced rates.

2.39 CONCRETE ORDERED TO BE DISMANTLED :

Where the Chief Engineer does not accept the poor or defective concrete and orders the same to be dismantled then the contractor shall dismantle such concrete at his expense and reconstruct the same to the Chief Engineer's satisfaction. Concrete thus dismantled will not be measured and paid for. The additional work if any, required to be carried out for reconcreting, shall be to the contractor's account.

2.40 CONCRETE RETAINED WITH RECTIFICATION :

Where the Chief Engineer in order to save time and where he considers adequate, orders that defective concrete be strengthened as directed by him the contractor shall carry out all rectification measures to Chief Engineer's approval at his expense. The concrete thus strengthened and accepted shall however, be paid at reduced rate (for mixes of concrete refer table IV under para 2.34).

2.41 QUANTITY OF DEFECTIVE CONCRETE REPRESENTED BY CUBES:

In all cases of defective concrete as revealed by works test cubes strength failing below the specified strength, the quantity of concrete thus affected and represented by the

cubes shall be decided by the Chief Engineer whose decision shall be final and binding on the contractor.

In all cases of Design Mix Concrete the sampling, strength of designed concrete mix, acceptance criteria, inspection and testing of structures, clause no – 15, clause no – 16 and clause – 17 (along with all sub clauses under clause no – 15, clause – 16, clause – 17) of IS 456 : 2000 shall be applicable.

TABLE V :- ACCEPTANCE CRITERIA, TESTS ETC. FOR CONCRETE
(Ref. : Para 2.37 and 2.38)

AGGREGATE							CONCRETE					
Separation		Tests		Batching			Test					
Fine	Coarse	Grading	Moisture determination	Cement	Aggregates	Workability	Strength (Works Test Only)					Criteria for Acceptance
						Minimum number of Specimens (15 em cubes)		Minimum Frequency				
						7 days Compressive Strength Test	28 days Compressive Strength Test	Quantity In M³	No. of samples	In Terms of Period		
One Size	Single Sized aggregate in two sizes (20mm 10 mm) for maximum 20mm size aggregates or In three sizes (40mm, 20mm, 10mm) for max-40mm sized aggregates or if approved by EE graded aggregates conforming to Table under Para 2.14 (d)	After Standard Has been establised when variation is suspected	When Variation in moisture is suspected e.g. rain	By Weight	By Volume	As frequency as directed by the corpo-ration's Engineers.	3	3	1-5	1	As	Refer Para 2.38
									6-15	2	decided	
									16-30	3	by	
									31-50	4	E.E.	
									51 & above	4+1 additional sample for each 50 M³ or part thereof.		

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2.42 HONEY COMBING :

- a. Where honeycombed surfaces are noticed in the concrete, the contractor shall not patch up the same until examined by the Corporation's Engineer and decision given regarding the acceptance with rectification or rejection of the same. If contractor patches up such defects without the knowledge of the Corporation's Engineer, the corporation's Engineer will be at liberty to order demolition of the concerned concrete members to the extent he considers necessary. In such case, the contractor at his expense, shall reconstruct demolished work. Demolished work shall not be measured and paid for.
- b. If in the opinion of the Corporation's Engineer the honeycombing is harmful to the structure and where so directed by the Chief Engineer, the full structural members affected by honeycombing as decided by Chief Engineer shall be dismantled and reconstructed to Chief Engineer's approval at contractor's expense. The demolished concrete will not be measured and paid for.

Such honeycombed areas which are not severe in the opinion of Corporation's Engineering and can be retained rectification shall be dealt with as under:-

Patches are first treated with the coat of thin grout composed of 1 part of cement and 1 part of sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10 mm thick and each layer is given a scratch finish to secure bond with the succeeding layer.

- c. Such honeycombed areas which are not severe in the opinion of Corporation's Engineer and can be retained with rectification shall be dealt with as under :-

Patches are first treated with the coat of thin grout composed of 1 part of cement and 1 part of sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer.

2.43 OTHER DEFECTS :

Any other defects in concrete shall be made good as directed by the Chief Engineer at contractor's expense.

2.44 DEVALUATION OF RATES FOR CONCRETE NOT CONFORMING TO SPECIFIED STRENGTH :**CONTRACTOR****EMPLOYER**

In case of average compressive strength being less than the specified strength but up to 85% of the specified strength, the rate payable shall be in the same proportion as average compressive strength bears to the specified compressive strength.

In case average compressive strength of concrete is less than 85% of the specified strength (but the same is accepted to be retained in the structure), the rate payable shall be 85% of the quoted rate minus $1\frac{1}{2}$ times the further percentage reduction below 85% strength.

Note: While working out the devaluation only the concrete component of the rate excluding shuttering shall be taken into account for calculation.

2.45 CONSTRUCTION JOINTS :

a. Location:

The contractor shall submit sketches showing the locations where he proposes to provide construction joints and get them approved from the Corporation's Engineer prior to concreting.

b. Stop boards:

All vertical construction joints shall be formed with proper wooden stop board at the joint. Where directed the joint shall be rebated or joggled and be of approved shape.

c. Water bars:

Wherever water bars/stops are specified, the same shall be provided as per drawings or as directed. It is necessary to ensure that water bars form continuous diaphragms. When PVC water bars/stops are provided the joints shall be properly heated and fused as per manufacturers' specifications.

2.46 CONSTRUCTION JOINTS IN BASEMENT :

a. Location and formation:

Contractor shall prepare a drawing showing the proposed constructions joints and have it approved by the Corporation's Engineer. After it is necessary to place stop boards, well in advance, at predetermined positions and carry out the concreting right up to the stop boards.

b. Particular care is required to form and treat construction joints in basement in order to ensure water-tightness for which contractor shall be responsible.

- c. Joints in the base slab: Joints in the base slabs and beams of a basement shall be so located that the joint is parallel to the principal reinforcement. Where it is unavoidable and is at right angle to the principal reinforcement, the joint shall be in the middle of the span of the slab or beams.
- d. Formation vertical joints: Vertical construction joints in base slab and well of basement shall be formed by using vertical stop-boards in predetermined positions. P.V.C. water bars shall be provided for vertical joints in walls.
- e. Formation horizontal joints: Horizontal joints in walls shall be rebated and care shall be taken to establish a proper and good bond between the hardened concrete and freshly laid concrete to produce a watertight joint which shall be contractor's responsibility. P.V.C. water bars shall be provided for horizontal joints in walls.

Wall slab junctions: Each layer must be compacted before placing the next layer, concrete in the splays at the junction of the wall and the slab shall be placed without joint at the time of concreting the slab.

2.47 TREATMENT OF CONSTRUCTION JOINTS IN BASEMENTS :

- a. When work is resumed on the surface which has hardened such surface shall be roughened. It shall be thoroughly cleaned and wetted and covered with 12mm layer or mortar composed of cement and sand in the same ratio as cement and sand in the concrete mix. This 12mm layer of mortar shall be freshly mixed and placed immediately before the placing of the concrete.
- b. Where the surface has not fully hardened, the laitance shall be removed by scrubbing the wet surface with wire bristle brushes, care being taken to avoid dislodgement of aggregate particles. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with thin neat cement grout.
- c. Care shall be taken to obtain good bond between the hardened and freshly placed concrete. Careful ramming and moulding of concrete around the water bar is very important.

2.48 CONSTRUCTION JOINTS IN SUPERSTRUCTURE :

- a. **COLUMNS :**

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A joint shall be formed horizontally at the top of a foundation and 75mm below the lowest soffit of the beams meeting at the head of the column or 12mm below the top of anchor bar projected from the floor beam into the column whichever is lower. Concrete in the head of a column where one or more beams meet shall be placed without a joint i.e. concrete in the joint shall be poured along with floor concrete.

b. **BEAMS** :

Concrete in the beam shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c. **SLAB** :

A joint in the slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidable and at right angles to the principal reinforcement, the joint shall be vertical and at the middle of the span.

d. Treatment of construction joints:

same as for construction joints in basement i.e. 2.47 above.

2.49 EXPANSION JOINTS :

a. Expansion joints shall be provided as shown in the drawings.

b. Expansion joints are meant to provide discontinuity in the structure. Care shall be taken to ensure this discontinuity by having clear joints throughout the length and height of the expansion joints. There shall be no connection between two sides of an expansion joint except with the materials used to form the expansion joints like fillers, G.I. strips etc.

c. Filler material for expansion joints shall be Shalitek joint filler as manufactured by M/s Shalimar or other equal and approved make and of appropriate thickness. The filler material shall extend to the entire depth of a joint except for a distance of 25mm from the exposed faces.

d. Contractor shall ensure that expansion joints are made watertight and the no leakages occur through these joints for which he shall be responsible.

2.50 WATER TIGHT CONCRETE :

Concrete in all basement works such as basement base slab and beams, walls, etc. Water tanks and the like where concrete of 1: 1½ :3 mix or richer mix is

specified, will be considered as watertight concrete whether so specifically mentioned or not in the Schedule of Quantities. In respect of such concrete it shall be the contractor's responsibility to ensure that the resulting construction is watertight. If it is not, the contractor shall carry out at his own cost, all necessary remedial measures which the Chief Engineer directs.

2.51 FORM WORK : MATERIALS AND DESIGN :

- a. The form work shall be to timber or plywood or steel. if any particular material or materials be specified in the Schedule of quantities for form work such particularly specified material or materials shall be used in work. The form work shall be so constructed as to remain sufficiently rigid during placing of the concrete and shall be sufficiently tight to prevent, loss of liquid from the concrete. The forms shall have sufficient strength and rigidity to hold concrete and withstand the pressure of ramming and vibration without excessive deflection of the prescribed lines and more so when the concrete is vibrated. The surface of all forms in contact with concrete shall be clean, rigid, watertight and smooth. Suitable devices shall be used to hold corners, adjacent ends and edges of panels of other forms together in accurate alignment.
- b. The form work shall conform to the shape, lines and dimensions to suit the RCC members as shown on drawings and to be so constructed. Form work shall be adequately designed to support the full weight of workers, fresh placed concrete without yielding settlement or deflection and to ensure good and truly aligned concrete finished in accordance with the construction drawings. A camber in all directions of 6mm for every 5M span in all slab and beam centering shall be given to allow for a unavoidable sagging due to compression or other causes.
- c. The form work shall be so designed that the sides of the beams shall be first struck leaving the soffit of beams and the supporting props in position. Props shall be designed to allow accurate adjustment and to permit of their being struck without jarring the concrete.
- d. Temporary opening shall be provided at the base of column form and at other points where necessary to facilitate cleaning and observation immediately before concrete is deposited.
- e. Vertical shuttering: The vertical shuttering shall be carried down to such solid surface as is sufficiently strong to afford adequate support and shall remain in

position until the newly constructed work is able to support itself. Props shall be securely braced against lateral deflection. Where timber props are used like bullies, they shall be of a minimum diameter of 10cm. and shall be straight and adequately strong. The spacing of such struts shall be designed to carry loads imposed on it without undue deflection of the members supported by the props. The spacing of props shall be approved by the corporation's Engineer and any alterations suggested by him shall be carried out at contractor's expense. Bracing shall be provided as directed without extra cost. Contractor shall allow in his rates providing props and struts for any height shown in the working drawings issued to Contractor from time to time.

2.52 WATER TIGHTNESS :

It is the contractor's responsibility to ensure that the forms are checked for water tightness just before concreting operation starts and to make good any deficiencies.

2.53 CLEANING AND TREATMENT OF FORMS :

All rubbish, particularly chippings, shavings and sawdust, shall be removed from the interior of the forms before the concrete is placed and the form work in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved composition. Care shall be taken that such approved composition is kept out of contact with the reinforcement.

2.54 STRIPPING :

Forms shall be left in place until their removal is authorised by the Corporation's Engineer and shall then be removed with care so as to avoid injury to concrete. In no circumstances shall forms be struck until the concrete reaches a strength of at least twice the stress to which concrete may be subjected at the time of striking. The strength referred to shall be that of concrete using the same cement and aggregates with the same proportions, and cured under conditions of temperature and moisture similar to those existing on the work. Where possible, the form work shall be left longer, as it would assist the curing.

2.55 STRIPPING TIME :

Removal of form work (stripping time): In normal circumstance and where various types of cements are used, forms, may generally be removed after the expiry of the following periods:

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Type of form work	Minimum period before striking form work for OPC 33 grade	Minimum period before striking form work for OPC 43 grade	Minimum period before striking form work for PPC
(a) Vertical form work to column, walls, beams	16 – 24 hrs.	16 – 24 hrs.	24 – 36 hrs.
(b) Soffit form work to slabs (Props to be refixed immediately after removal of form work)	3 days	3 days	4 days
(c) Soffit form work to beams (Props to be refixed immediately after removal of form work)	7 days	7 days	10 days
(d) Props to slabs: (i) Spanning upto 4.5m (ii) Spanning over 4.5m	7 days 14 days	7 days 14 days	10 days 20 days
(e) Props to beams: (i) Spanning upto 6.0m (ii) Spanning over 6.0m	14 days 21 days	14 days 21 days	20 days 30 days

Note 1: For other type of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally if Portland Pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

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

Note 3: For rapid hardening cement, 3/7 of above period for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

Note 4: In case of cantilever slabs, beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

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Note 5: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

Note 6: Work damaged through premature or careless removal of forms shall be reconstructed with in 24 hours.

2.56 FORM WORK IN LIFTS FOR CONTINUOUS SURFACES :

Where forms for continuous surface are placed in successive units (as for example in columns or walls), the forms shall fit tightly over the completed surfaces so as to prevent leakage of mortar from the concrete and do maintain accurate alignment of the surface.

2.57 PROCEDURE FOR REMOVING THE FORM WORK :

All form work shall be removed without such shock or vibration as would damage the reinforced concrete. Before the soffit and struts are removed, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occurs with all cements in the cold weather. For cantilevers props shall be removed from the tip towards support. Special notes given in relevant structural drawings shall be strictly adhered to in order to avoid mishaps.

2.58 TOLERANCES :

The following shall be the maximum permissible tolerances:-

- a. On general setting out dimensions upto 4M in length, a tolerance upto 3mm will be allowed.
- b. On lengths of more than 4M tolerance of not more than 5mm will be allowed.
- c. On the cross sectional dimensions of columns, beams, slabs, facia, chhajjas, mullions, grilles, fins, louvers and such other members tolerance of more than 2mm will not be allowed
- d. The top surface of concrete floor slab shall be within 6mm of the level and line shown on the drawings.
- e. Column and walls and other vertical members shall not be more than 3mm out of plumb in their storey height and not more than 6mm out of plumb in their full height.
- f. If the work is not carried out within the tolerances set out above in (a) to (e) , the cost of all rectification measures or dismantling and reconstructing as decided by

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the Chief Engineer shall be borne by the contractor. In case work is dismantled, the same shall not be measured and paid for.

2.59 CONTRACTOR'S RATES FOR CONCRETE TO INCLUDE :

The rates of contractor for providing and laying cement concrete in various grades or proportions in the Schedule of quantities shall, apart from any other factors specified elsewhere in the tender documents, include for the following:

- a. For all factors and method of work described in these specifications:
- b. For all materials, labour tools and plants, scaffolding, etc. mixing conveying and placing concrete in position, ramming, vibrating, towelling, curing providing necessary scaffolding and removing the same after the work is complete.
- c. Unless otherwise specified in the Schedule of Quantities the cost of concrete items, shall include for providing and fixing from work as described inclusive of erecting, propping to required heights, bracing, providing slays, struts, bolts nuts and everything necessary to keep the forms rigid, smoothening the surface to receive concrete as per detailed drawings, striking and stripping form work after the concrete is cure, hacking the concrete surface required to receive plaster etc.
- d. The reinforcement in case of reinforced concrete work will be paid for separately unless otherwise stated in the particular items, but rate shall include for pouring concrete and packing around reinforcement.
- e. The measurement of concrete will be as per detailed drawings, shapes and size based on net structural sizes as per drawings i.e. exclusive of plaster;
- f. Rates for concrete items shall cover for any shape of structural members like columns, beams fascias, fins, louvers, etc. and of cantilevered beams, slabs etc. as per detailed final drawings including providing slopes to slabs, beams, chajjas, canopies etc. wherever required.
- g. Formation and treatment of construction and expansion joints (where water bars like P.V.C. water bars, strips or joints fillers like "shalitex" or other equal and approved make are specified, such materials shall be paid for separately);
- h. Fixing all inserts like pipes, plugs, forming holes, etc. as described.
- i) For volumetric batching
- j. For taking out dowel bars, fan hooks etc. through shuttering;
- k. In cases where at the junctions of beams, columns, slabs the composition of concrete mix or specified strength be different for columns, beams and slabs, then in such cases only the richer concrete among those specified for in all these members shall be used at the junctions and rate quoted for columns, beams and

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slabs or any members entering such junctions shall allow for the same. Rate shall also cover for spill over of richer concrete in beams to natural angle of repose of wet concrete required from practical considerations, while concreting the junctions

- l. For forming chambers, bands and drip moulds in columns, beams, slabs, chajjas, fascias, sills, coping etc. and where shown in the drawings or as directed;
- m) For work at all levels.

2.61 STEEL REINFORCEMENT AND IRON WORK : MILD STEEL BARS: Mild steel reinforcement bars shall conform to IS 226-1962 "Standard Quality" or I.S.432-1960 "Grade 1" Other qualities of steel shall not be acceptable.

HIGH STRENGTH DEFORMED BARS:

Wherever deformed high strength reinforcement bars are specified, the Contractor shall use one of the following, accompanied by a certificate from the Manufacturer.

- a. "Tistong-11" as manufactured by M/s TATA Iron & Steel Co. conforming to IS:1139-1966.
- b. "Tor steel" as manufactured by M/s Hindusthan Steel or other manufacturers under licence from M/s Istag Steel Corporation of Luxemburg, conforming to IS:1786-1966.
- c. Where "Tistrong -11" or "Torsteel" is specified, they shall be used as per the recommendations of the manufacturers.

2.61 CLEANING OF REINFORCEMENT :

Before steel reinforcement is placed in position, the surface of the reinforcement shall be cleaned of rust, dust, grease and other objectionable substances.

2.62 CUTTING OF REINFORCEMENT :

Before the reinforcement bars are cut the contractor shall study the lengths of bars required as per drawing and shall carry out cutting only to suit the sizes required as per drawings.

2.63 PLACING AND SECURING :

Reinforcement bars shall be accurately placed and secure in position and firmly supported or wedged by precast concrete blocks of suitable thickness, at sufficiently close intervals so that they will not sag between the supports or get displaced during the

placing of concrete or any other operation of the work. It is most important to maintain reinforcement in its correct position without displacement and to maintain the correct specified cover. Contractor shall be responsible for all costs for rectification required in case the bars are displaced out of their correct position.

2.64 BINDING WIRE :

The reinforcement shall be securely bound wherever bars cross or required with annealed steel binding wire of size not less than 0.9 mm and Conforming to IS 280-1962.

2.65 WELDING :

Welding of bars shall not be carried out unless specially authorised in writing by the Chief Engineer.

2.66 BENDS ETC :

Bends, cranks etc. on steel reinforcement shall be carefully formed, care being taken to keep bends out of winding. Otherwise all rods shall be truly straight. If any bend shows signs of brittleness or cracking, the rod shall be removed immediately from the site. Minimum radius of 9 times diameter of the bar shall be used unless otherwise specified in the drawings. However, in respect of standard hooks the radius of bend shall be 2 times of diameter of bar. Heating of reinforcement of bar to facilitate bending will not be permitted. The bars shall always be bent by heating with written permission of the Executive Engineer. Bars when bent hot shall not be heated beyond cherry red colour and after bending shall be allowed to cool slowly without quenching. The bars damaged or weakened in anyway in bending shall not be used on the work. High strength deformed bars shall in no case be heated to facilitate binding or cranking.

2.67 INSPECTION OF REINFORCEMENT :

No concreting shall be commenced until the Corporation's Engineer has inspected the reinforcement in position and until his approval has been obtained. A notice of at least 24 hours shall be given to the Corporation's Engineer by the Contractor for inspection of reinforcement. If in the opinion of the Corporation's Engineer any material is not in accordance with the specification or the reinforcement is incorrectly spaced, bent or otherwise defective, the Contractor shall immediately remove such materials from the site and replace with new and rectify any other defects in accordance with the instruction of the Corporation's Engineer and to his entire satisfaction.

2.68 NETT MEASUREMENTS :

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Reinforcement shall be placed as shown on the structural drawings and payment will be made on the net measurement from drawings. Only such laps, dowels, chairs and pins on reinforcement as approved by the Executive Engineer of shown on drawings shall be paid for. The Contractor shall allow in his quoted rate for all wastage which will not be paid for

2.69 COVER FOR REINFORCEMENT :

Cover shall be measured from the outer surface of main reinforcement. Cover shall be as follows:

- a. At each end of a reinforcement bar, 25mm or twice the diameter of such rod or bar, whichever is greater.
- b. For a longitudinal reinforcing bar in a beam, 25mm or the diameter of such rod or bar, whichever is greater.
- c. For tensile, compressive, shear or other reinforcement in a slab, 15 mm, or the diameter of such reinforcement, whichever is greater.
- d. For reinforcement in any other member such as a lintel, chhajja, Canopy or pardi, 13mm, or the diameters of such reinforcement, whichever is greater.
- e. For main reinforcement in isolated footings (side and bottom) clear cover be 50mm.
- f. For column bars clear cover shall be 40mm, unless otherwise specified in drawing.
- g. For bars in slabs of strip footings and mat foundations, the clear cover shall be 30mm. Beam bars shall be placed over slab bars in respect of beam and slab type foundations.

2.70 STOCK AND PILING OF STEEL :

Steel required shall be stockpiled well in advance of need in the work. Contractors shall stockpile 1/3 requirement within 15 days of commencement, 2/3 requirement at 1/4 contract time and full requirement at 1/2 contract time.

2.71 RATES QUOTED FOR REINFORCEMENT SHALL IN ADDITION TO ANY FACTORS MENTIONED ELSEWHERE SHALL ALSO INCLUDE FOR :

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- a. All cutting to lengths, labour in bending and cranking, forming hooked ends, handling, hoisting and everything necessary to fix reinforcement in work as per drawing.
- b. Cost of binding wire required as described. The weight of binding, wire will not be accounted for in the measurements.
- c. Cost of precast concrete cover blocks to maintain cover and holding reinforcement in position.
- d. For fabricating and fixing reinforcement in any structural member irrespective of its location, dimensions and level.
- e. Removal of rust and every other undesirable substances, using wire brush etc. as described.
- f. Stock piling of reinforcement as described.
- g. Work at all levels.

2.72 RATE FOR M.S. RAILING, GRILLS, ROLLING SHUTTER, GRILL DOOR, LADDER, RUNG LADDER, WELDMESH GRILLS, FAN HOOKS ETC., SHALL INCLUDE FOR THE FOLLOWING:-

- a. Fabrication, cutting and bending to required size and shape, drilling, punching, counter sinking, welding, fitting, etc. finishing erecting, fixing in position.
- b. Wherever the M.S. grills/railing/rolling shutter/M.S. Weld mesh grille are required to be fixed to brick/concrete jambs/floor, they shall be fixed by means of required size and number of M.S. lugs and embedded/grouted in cement concrete block 1:2:4 and/or fixed by means of suitable counter sunk screws with rawl plugs.
- c. Wherever the M.S. grills are required to be fixed to frames of steel windows and ventilators, they shall be fixed by welding.
- d. Grille door shall be fixed by means of M.S. holdfasts of required numbers, size and shape as approved, embedding/grouting the holdfasts in 1:2:4 cement concrete block and/or rag bolts and nuts of approved size.
- e. Both legs of both ends of M.S. ladders shall be fixed to concrete floor/slab by embedding/grouting in 1:2:4 cement concrete block/base of required size.
- f. M.S. rung ladders shall be fixed in brick/concrete work by embedding/grouting as required in 1:2:4 cement concrete.
- g. In case of M.S. grill doors the contractor shall provide and fix G.I. pipe pieces of suitable size wherever required, duly inserted in brick/concrete jambs to accommodate the sliding rod of aldrop.

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- h. The fixing accessories like M.S. holdfasts, lugs, screws, rawl plugs, concrete for embedding/grouting, bolts and nuts of any type, G.I. pipe pieces and such other accessories for fixing, shall not be considered in the measurement of the weight/quantity and shall not be paid separately.
- i. Rates quoted for M.S. guard bars/M.S. grills to windows and ventilators shall also include for making holes in frames of windows and ventilators/fan lights wherever required.

2.73 Except for bar reinforcement, all exposed steel, cast iron, wrought iron and mild steel work shall be painted with two coats of synthetic enamel paint (first quality) of approved colour and shade over a coat of red oxide primer, manufactured by M/s Alkali and Chemical corporation of India, M/s Garware paints, M/s Goodlass Nerolac, M/s Jenson & Nicholson, M/s British paints or other equal and approved. Rate quoted shall include for above. Although, three coats of paint are specified, Contractor will have to do additional coats of paint if well finished surface is not obtained to the satisfaction of the S.E./E.E. and there shall be no extra payment on account of this.

2.74 M/s rounds for M.S. guard bars to windows/ventilators and M.S. rounds for rung ladders shall be supplied by contractor.

2.75 MEASUREMENT :

Weight of the steel reinforcement bars (mild Steel and high strength deformed bars) used in the construction shall be on the basis of the length incorporated in concrete and shall be computed in accordance with the table given below:

Diameter	mm.	Weight per Metre length in kgs.
6		0.222
8		0.395
10		0.617
12		0.888
16		1.579
20		2.467
22		2.985
25		3.855
28		4.836
32		6.316

(The weight per metre of bars given in the table above are calculated on the basis that steel weights 7.85 g/cm³. In case of any error or omission in this table, the weight per

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metre length in kgs. shall be computed on the basis of actual area and taking the density of steel as 7.85 g/cm³).

- 2.76** For measurement of rolling shutter the area of the actual opening covered shall be considered.

3. UNCOURSED RUBBLE MASONRY

3.1 GENERAL :

Stones to be used in the masonry shall be hard, sound, free from cracks, flaws or defects and shall be from approved quarries.

3.2 QUALITY OF RUBBLE STONE :

Rubble stones for hearting shall be of approved quality, sound, hard, dense and durable, free from segregation, seams, cracks, weathered portions and other structural defects or imperfections tending to affect their soundness and strength. Stones shall generally be freshly quarried with sharp edges, and clean faces. They shall be free from rounded, worm or weathered surfaces, or skin or coating which prevents the adherence of mortar. Size and shape of stone shall be as per the requirement.

3.3 QUALITY OF OTHER STONES :

Stones to be used as headers, quoins, copings, etc., shall comply with the requirements of facing and hearting as may be relevant and shall further comply with the requirement of size and shape.

3.4 FACE STONES :

Face stones shall generally comply with specifications 3.2 above. The face stones shall be selected from the mass of quarry stones for their greater size, and good beds, close grain and uniform colour. 50% of the stones shall be more than 0.010 cum. or 10 litres, in walls up to 50 cm. in thickness and 0.015 cum. or 15 litres in thicker walls. The beds and joints shall have an average bearing of not less than 2 cm.

3.5 HEARTING AND BACKING STONES :

These stones shall comply with specification 3.4 above in walls of 50 cm. and less about 30 % of the stones shall not be less than 0.010 cum. or 10 litres and for thicker wall about 30 % of stones shall not be less than 0.015 cum., or 15 litres.

3.6 QUOINS :

The quoins shall be of selected stone and shall normally be 19 cm x 24 cm x 39 cm or as directed by the E.E. The faces of quoins shall be rough tooled with 40 mm chisel drafts at the corner edges

The beds and tops shall be dressed square to the face and rough tooled to 10cm. from the face and vertical joints similarly dressed to 40 cm from the face. In the embedded portion the length of the side shall not be less than that of the exposed side opposite by more than 8 cm. for the longer side and 5 cm. for the shorter side.

3.7 THROUGH STONES :

One through stone shall be provided per half square metre of facing evenly distributed in a staggered pattern. They shall be about 0.03 sqm. in face area and shall a tailing of the full width of the masonry when the width of the masonry is 60 cm. or less. If the wall or masonry be over 60 cm. thick a line of header over lapping each other by at least 15 cm shall be laid right through the wall from face to back. The length of the interior headers shall not be less than 45 cm and their average cross sectional area shall not be less than 0.025 sqm. face header shall be distinctly marked on its face.

3.8 SAMPLES :

Samples of stones including quoins and headers to be used in the work shall be got approved by the E.E. before the work is started and such samples shall be maintained in the Corporation's Engineer's Office at site.

3.9 MORTAR :

Unless otherwise mentioned the mortar for masonry work shall be composed of 1 part of cement : 5 parts of coarse approved sand. Sand for masonry mortar shall be as per I.S. 2116-1965 as applicable to unreinforced masonry work.

3.10 SCAFFOLDING :

Scaffolding will be double or single as is warranted for the particular work. Put log holes shall be made good by bricks to match the face work when put logs are removed after ensuring that the holes behind are solidly filled in with 1:4:8 cement concrete.

3.11 CONSTRUCTING DETAILS :

The masonry shall be laid to lines, levels, curve and shapes as shown on the drawings. Fixtures, plugs, frames, pipes, conduits, etc. if any shall be built in at places shown on the plan or as directed while laying the masonry and not later by removing the stones already laid.

- a. Stones in the hearting shall be laid on their broadest face which gives better opportunity to fill the space between stones.
- b. Stratified stones must be laid on their natural beds. All beds joints shall be normal to the pressure upon them.
- c. In battered walls, the beds of stone and the place of course should be at right angles to the batter.
- d. If masonry is to be laid directly on the excavated bed or on concrete footing the bed or footing shall be cleared of all loose materials, cleaned and wetted just before laying masonry. Buildings shall not project more than 40mm in faces where joints are to be pointed or struck and 12mm in faces proposed to be plastered. Quoins in the unexposed portions shall have uniform chisel drafts of 40mm in the exposed portions and up to 15 cm. below the finished ground level, quoins shall be rough tooled, with 40mm chisel drafts at the corner edges.
- e. The face stones shall be laid without any pinning on the exposed faces. In each course the headers or lines of headers as the case may be shall be kept in position as specified intervals and with specified laps where such laps are required before the masonry of the layer is commenced to ensure that they are being laid properly and in required numbers and intervals. They shall be embedded in mortar as masonry in that layer progresses. Quoins shall be laid stretcher and header wise as seen on each face and shall correspond to the arrangement of quoins in the same course.
- f. The stones shall be wetted before laying in mortar. Each mason shall be supplied by the Contractor with a vessel full of water and tumbler for wetting stones, care being taken not to spill any water on green masonry. The bed which is to receive the stone shall be cleaned, wetted and covered with a layer of fresh mortar. All stone shall be laid full in mortar both in bed and vertical joints and settled carefully in place with a wooden mallet immediately on placement and solidly bedded in mortar before it has set. Clean chips and spalls, carefully selected to fit in the spaces shall be wedged in to mortar joints and beds wherever necessary, to avoid thick beds or joints of mortar. When the foundation masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in the mortar bedding over the rock. No dry or hollow space shall have at the embedded faces completely covered with mortar. If a portion of masonry is dismantled every stone must be found with mortar adhering fast to all

its embedded surface and there shall be no hollows. This will be one of the tests in deciding if the masonry is good or bad if need arises. Where hollows or other defects are suspected a stone here or there may be removed for confirmation. If these are confirmed such portions shall be dismantled and rebuilt at the cost of the Contractor.

- g. Face work and hearting shall be brought up evenly but the top of each course shall not be levelled up by use of flat chips.
- h. No face joints shall exceed 16mm and the same shall be struck while mortar is fresh.
- i. The face joints should be properly struck while the mortar is fresh. When no pointing or plastering is to be done, but its plastering and pointing is required to be done, the joints shall be raked out when the mortar is fresh.
- j. Stones in corners of walls and angles which are to be plastered shall be rounded. The corners shall also be rounded in plaster while plastering. The frames of doors, windows, cupboards, etc., shall be housed into the masonry while laying the masonry only. Chisel dressing for the width of door and window frames shall be done to obtain good fit between the frame and the masonry. Jambs shall be made up of quoins only. Where shown to other than square than square the jambs shall be splayed to conform to the drawings or the instructions of E.E. and shall be true to the template. Quoins of the full thickness of the wall shall be provided at the rate of 3 of each side of the door opening and 2 for each side of the window opening when the wall is 40mm thick or less in thicker walls, two quoins may be used to make up the full thickness of the wall with break of joint of not less than 8cm with stones above and below.
- k. Holes of the required size and shape shall be left in the masonry during construction alone for fixing pipes, service lines, passage of water etc. after the service lines, pipes etc., are fixed the extra hollow left shall be filled with 1:3 cement mortar or 1:3:6 cement concrete and the face shall be finished with matching stones.
- l. The top of masonry, on which coping, R.C.C. slab or other flooring is to be laid, shall be finished level or to the required slope with stones and mortar to give an even bearing. Bed blocks of stone or R.C.C. shall be built up in the masonry under the beams, if separately provided in the tender.

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3.12 RATE OF RAISING MASONRY :

The rate of raising uncoursed rubble masonry brought up in uniform levels may be limited to a height of 69 cm per day in case of cement mortar and 45 cm in the case of lime mortar. But no fresh course shall be laid over masonry previously laid within 4 hours of its laying for cement mortar and 8 hours for lime mortar.

3.13 WATERING :

All masonry work shall be kept well watered for 14 days after laying. Where pozzolana cement is used for mortar, the curing shall be extended by one week at the Contractor's expense.

3.14 RATE TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rate for items to masonry work shall include for the following :-

- a. Constructing stone masonry work, including quoins, headers etc., in cement mortar to lines, levels, batters, piers, pillars curves and to any position or shape, to any heights or levels including raking out joints and housing frames fixtures, pipes, rawl plugs, making grooves, rebates, chamfers, making square or splayed jambs, and raking out joints for plastering/pointing and striking out joints wherever directed.
- b. All labour materials, use of tools, equipment and other items incidental to the satisfactory completion of stone masonry.
- c. Erecting and removing of all scaffolding, ladders and plant required for the execution of the work to the height and depths and shapes as shown on the plan or as ordered by the E.E.
- d. Curing the stone work.
- e. Removing of all stains and adhering mortar pumps on the stone work surfaces.

3.15 MODE OF MEASUREMENT :

- a. Stone masonry work shall be measured in cubic metre. When measuring walls, the thickness shall be measured to the nearest one centimetre, namely fractions including 0.5 cm and above shall be measured as one centimetre and fractions below 0.5 cm. shall be ignored.
- b. No deduction or addition shall be made on any account for :-

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- i. Ends of dissimilar materials (i.e., joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.) up to 500 cm² in section.
- ii. Openings up to 0.1 m² in sections.

NOTE :

In calculating the area of opening, any separate lintels or sills shall be included along with the size of the openings but the end portions of lintels shall be excluded (see (b)) (i) and the extra width of rebated reveals, if any, shall also be excluded.

Wall plates and bed plated, and bearing of slabs, CHAJJAS and the like, where the thickness does not exceed 10 cm. and the bearing does not extend over the full thickness of the wall.

4. BRICK WORK**4.1 BRICKS :**

- a. The bricks shall be table moulded first quality of regular and uniform size, shape and colour, uniformly well burnt through out but not over burnt. They shall have plane rectangular faces with parallel sides and sharp, straight and right angled edges. They shall be free from cracks or other flaws. They shall have a frog of 10 mm depth on one of their first faces.
- b. They shall give a clear metallic ringing sound when struck.
- c. They shall show a fine grained, uniform, homogeneous and dense texture on fracture and be free from lumps of lime, lamination, cracks, air holes, soluble salts causing efflorescence of other defects which may in any way impair their strength, durability, appearance or usefulness for the purpose intended. They shall not have any part under burnt. They shall not break when thrown on the ground on their flat face in a saturated condition from a height of 60 cm.
- d. Bricks of one standard size shall be used on one work unless specially permitted by the Executive Engineer. In part of North Central Zone (i.e., U.P. & U.K. etc.) bricks which are commonly of size 23 x 11.5 x 7.5 cm. shall be used. The following tolerances are permitted in the standard conventional size adopted on a particular work :-

Length	Plus or minus	3mm (about 1/8")
Breadth	Plus or minus	1.5mm (About 1/16")
Depth	Plus of minus	1.5mm (About 1/16")

- e. After immersion in water, absorption by weight shall not exceed 20 percent of the dry weight of the brick when tested according to I.S.S. No. 1077-1976.
- f. Unless otherwise specified, the load to crush the brick when tested according to I.S.S. No. 1077-1976 shall not be less than 50 Kg / Sq.cm.

4.2 **MORTAR :**

Unless otherwise specified, mortar for brick work shall be composed of 1 part of cement to 5 parts of coarse approved sand for walls of one brick thick (i.e., 23 cms.) and over and one part of cement to 4 parts of coarse approved sand for half thick wall. Other specifications for mortar in brick work shall be as per I.S.S. 2116-1965.

The particle size grading of sand in mortar for unreinforced masonry work shall be within the limits specified below :-

I.S. Sieve designation	Percentage by weight Passing I.S. Sieve.
4.75 mm	100
2.36 mm	90-100
1.18 mm	70-100
600 micron	40-100
300 micron	5-70
150 micron	0-15

4.3 **CONSTRUCTION DETAILS :**

a. **SOAKING :**

All bricks shall be immersed in water for two hours before being put into work so that they will be saturated and will not absorb water from the mortar.

b. **BATS:**

No bats or cut bricks shall be used in the work unless absolutely necessary around irregular openings or for adjusting the dimensions of different course and for

closers, in which case, full brick shall be laid at comers, the bats being placed in the middle of the coarse.

c. LAYING :

The bricks shall be laid in mortar to line level and shapes shown on the plans, slightly pressed and thoroughly bedded in mortar and all joints shall be properly flushed and packed with mortar and no hollows left anywhere. Bricks shall be handled carefully so as not to damage their edges. They should not also be thrown from any height to the ground but should be put down gently. All courses shall be laid truly horizontal and all vertical joints made truly vertical. Vertical joints in one course and the next below shall not come over one another and shall not normally be nearer than quarter of a brick length. For battered faces bedding shall be at right angles to the face. Fixtures, plugs, frames etc., if any, shall be built in at places shown in the plans while laying the courses only and not later by removal of brick already laid. Care shall be taken during construction to see that edges of bricks at quoins, walls, heads etc., are not damaged.

The verticality of the walls and horizontality of the courses shall be checked very often with plumb-bob and spirit level respectively.

d. BOND:

Unless otherwise specified, brick work shall be done in English bond.

e. JOINTS:

Joints shall not exceed 10mm (About 3/8") in thickness and this thickness shall be uniform throughout. The joints shall be raked out not less than 10mm (about 3/8") deep when the mortar is green where pointing is to be done. When the brick surfaces are to be plastered the joints shall be raked to a depth of 5mm when the mortar is green, so as to provide good key to plaster.

f. UNIFORM RAISING :

Brick work shall be carried up regularly in all cases where the nature of work will admit, not leaving any part 60 cm lower than another. But where building at different level is necessary, the breaks shall be stepped so as to give later a uniform level and effectual bond. Horizontal courses should be to line and level and even and face plumb or to batter as shown on the plan. The rate of laying masonry may be up to a height of 80 cm per day if cement mortar is used and 45 cm (about 18") if lime mortar is used.

4.4 SCAFFOLDING :

Scaffolding will be double or single as is warranted for the particular work. Put log holes shall be made good by bricks to match the face work when put logs are removed after ensuring that the holes behind are solidly filled in with 1:4:8 cement concrete.

4.5.1 CURING :

All brick work shall be kept well watered for 14 days after laying. Where pozzolana cement is used for mortar, the curing shall be extended by one week at the Contractor's expense.

4.6 EXPOSED WORK :

Where exposed brick work is prescribed, the usual specifications for the "Brick Work" as mentioned above will be applicable for "Exposed Brick Work" but in addition specially selected bricks shall be used for facing, ensuring regular and clean faces of uniform colour. No bricks which are broken, chipped, wrinkled or which have irregular edges or corners shall be used. Depending on the quality of bricks and if instructed by the Corporation's Engineers, the exposed face of every brick shall be rubbed before laying without extra charge. Wooden fillets 10 mm thick and 10mm wide shall be placed at the edge of joints so that no mortar comes on the surface of the bricks and a regular thickness of joints is maintained. The surface shall be rubbed down with brushes of bricks if necessary, and thoroughly washed. No mortar shall be allowed to stick to the surface, which shall be left clean to the Corporation's Engineer's satisfaction with all joints even and true to a straight line. Double scaffolding shall be used in exposed brick work.

4.7 REINFORCEMENT IN HALF BRICK THICK WALLS :

- a. Half brick thick and brick on edge walls shall be provided with reinforcement consisting of 2 nos, 6mm dia M.S. round bars of 500mm long (each) as dowels, embedded in mortar 15mm thick at every fourth course and securely anchored at their ends where the partitions bond with the cross walls. The cost of reinforcement in half brick thick and brick on edge walls shall be paid separately unless otherwise stated in the schedule of quantities.

4.8 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rate for items of brick work shall include for the following :

- a. All labour, materials, use of tools, equipment and other items incidental to the satisfactory completion of brick masonry at all heights and levels.

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- b. Erecting and removing of all scaffolding, ladders and plant required for the execution of the work to the height and depths and shapes as shown on the plan or ordered by the Engineer.
- c. Constructing brick work to lines, levels, batters, pillars, curves and to any position or shape, to any heights or levels including raking of joints and housing frames, fixtures etc.
- d. Curing the brick work.
- e. Removing of all stains and adhering mortar lumps on the brick work surfaces.

4.9 MEASUREMENTS :

- a. Half brick thick and brick on edge walls shall be measured in Sqm. unless otherwise mentioned.
- b. One brick thick wall and thicker walls shall be measured in Cum. Brick walls up to and including 3 bricks in thickness should be measured if multiples of half bricks which shall be deemed to be inclusive of mortar joints. Widths of more than three bricks in walls will be measured actually and limited to the width specified.
- c. No deductions or additions shall be made on any account for :-
 - i. Ends of dissimilar materials (i.e.,) joints, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.) up to 500 cm² in section and
 - ii. Openings up to 0.1 m² in section.

NOTE :

- i. In calculating the area of openings, any separate lintels or sills be included along with the size of the openings but the end portions of the lintels shall be excluded and the extra width of debated reveals, if any, shall be excluded.
- ii. Wall plates and bed plates, and beating of slabs, CHAJJAS and the like which the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

5. STEEL DOORS, WINDOWS AND VENTILATORS

5.1 I.S. SPECIFICATION :

Unless otherwise stated, the Indian Standard Specification applicable for steel doors, windows and ventilators shall be IS-1038-1957 - "Specification for Steel Doors, Windows and Ventilators"

5.2 OPENING :

All the window and ventilator shutters should open outside unless otherwise specified.

5.3 FLASH WELDING :

Both the fixed and opening frames of the doors, windows and ventilators shall be formed by cutting sections to required lengths, and mitred. The corners shall be electrically flash welded. Sash-bars of the units shall be tenoned and reveted into the frames. Slots shall be cut in the fixed frames and hinges shall be inserted inside and welded to frames.

5.4 HANDLES, PEGSTAYS :

Each side hung shutter shall be provided with suitable protruding hinges and pegstays arms 300 mm (12") long and shall have holes to keep the shutter open in three different positions up to 90 degree (The peg and the arm for the pegstay shall be riveted). The handle shall be mounted on a handle plate and the plate shall be welded to the opening frame. The handle shall have a two point nose which will engage with suitable tapered striking plate provided on the fixed frames to keep the shutter open in a slightly open position as well as in a last position.

5.5 TOP/BOTTOM HUNG VENTILATORS :

Top hung and bottom hung ventilators shall be provided with two plain hinges, with 300 mm (12") pegstay arms, which will keep the shutter open in three different positions and will act as a stopper too.

5.6 CENTRE HUNG VENTILATORS :

Centre hung ventilators shall be made with two outer frames with mastic waterproof compound embedded between these two other frames. They shall also be provided with a spring catch which when pulled by a cord, the upper half shall open inside and the lower half shall open out.

5.7 BEADING :

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Where wooden or metal beading is specified in the Drawing or elsewhere for the glazing, the Contractor should provide windows with threaded holes for fixing the beading with screws.

5.8 SAMPLE OF WINDOW :

A typical approved sample window for each building should be kept in the office of the Executive Engineer of the Corporation until the satisfactory completion of the building. All windows and ventilators supplied and fixed at site should be of the same quality as of the approved sample ; otherwise they shall be rejected. The decision of the Chief Engineer or his Authorised Representative whether a window or ventilator compares well with the approved sample shall be final and binding on the Contractor.

5.9 CHIEF ENGINEER'S APPROVAL :

All windows and ventilators are subject to the approval of the Chief Engineer or his authorised representatives and they shall be strictly in accordance with the specifications without any bends, dents etc.

5.10 AS PER DRAWINGS :

All windows and ventilators shall be manufactured as per drawings supplied to the Contractor.

5.11 FIXING TO BRICK WORK/CONCRETE :

Steel windows and ventilators shall be fixed to brick work by means of standard M.S. lugs of size 100x16x3 mm and to concrete work by means of 125mm long counter sunk screws with rawl plugs after drilling into concrete with a power drill. Steel windows/ventilators etc., shall be fixed as per manufacturer's recommendations or I.S. specifications. Holdfasts shall be grouted in concrete of 1:2:4 mix of dimensions as directed. Quoted rates to cover for all these factors.

5.12 IMPORT LICENCE :

No import licence shall be made available for obtaining any material not available in India.

5.13 STRUCTURAL SUFFICIENCY OF WINDOWS :

All windows, doors and ventilators shall be manufactured from standard extruded sections of approved, appropriate size suitable for the particular type and size of the window etc. Detailed shop drawings indicating the full design of every type of window and ventilators shall be furnished for approval before undertaking the work. Contractor shall assume full responsibility regarding soundness of the window, doors and ventilators and adequacy of the sections used for the particular sizes required to provide appropriate stiffness and strength. If, in the opinion of the Chief Engineer deficiencies in the sections used are

found the Contractor shall replace the windows, ventilators, etc. at his expense by windows and ventilators etc., made from approved sections.

5.14 ALL TYPES OF WINDOWS :

Rates quoted for steel windows and ventilators shall cover for all types of windows and ventilators whether of standard sizes or purpose made. Where composite or continuous windows over long lengths (In plan) are required, rates shall cover for mullions, transoms at vertical or horizontal junctions of approved design. Rates should also cover for partly open-able type of continuous windows, shutters of any type like side hung, centre hung, top hung etc., as per drawings.

5.15 PAINTING :

All steel windows, doors and ventilators etc. to have two coats of ready mixed oil paint of approved shade, colour and manufacture (M/s Jenson & Nicholson or other equivalent and approved) over a coat of red oxide primer. Contractors rates to be inclusive of such painting. If a proper and even surface is not obtained to the satisfaction of Chief Engineer in the number of coats specified, Contractor shall carry out additional coats of painting to approval at his expense.

5.16 RATES TO COVER :

Unless otherwise stated Contractor's rates for steel windows, ventilators shall, apart from any other factors mentioned elsewhere in this contract, include for providing and fixing the following.

- a. Windows/Ventilator frames and shutters with hinges as described,
- b. M.S. holdfasts or lugs as specified projecting 100mmx16mmx3mm in the positions and as per design in I.S. Specification or where fixed to concrete 125 mm long counter sunk screws with rawl plugs,
- c. Rolled Steel Mullions
- d. Transoms with projecting weather bars for side hung shutters and plain ones for fixed windows
- e. Aluminium beading with brass screws
- f. Bolts, nuts, screws
- g. Handles and peg stays
- h. Manganese brass spring catches
- i. Chords for centre hung windows
- j. Painting as described in these specifications
- k. Grouting of holdfasts in 1:2:4 concrete.

5.17 MEASUREMENT :

Measurement shall be in Sqm.

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6. WOOD WORK AND JOINERY

6.1 TIMBER

- i. Unless otherwise specified all timber for frames and shutters for doors, windows, ventilators, cupboards etc., shall be first class, sound, well seasoned, C.P. Balarshah or other equivalent and approved teak and shall be free from knots, shakes, fissures, flaws, sun cracks and other defects. The planned surface shall be smoothened free from blemishes and discolorations. Timber shall be wrought, framed and cut to shape as shown on drawings and/or as directed.
- ii. All timber for carpentry and joinery in touch with masonry or concrete shall be coal tarred or creosoted before fixing. All rough frame work in partitions, suspended ceilings and veneering to walls etc., shall be treated with approved wood preservative 'Bison' or other equivalent and approved as per manufacturer's instructions and specifications. The rates quoted shall provide for such treatments.
- iii. All fully fabricated timber shall be air seasoned on site of work for a period of not less than two months to allow for any shrinkage that may take place. The preparations of timber for joinery is to commence simultaneously with the beginning of the project work generally and should proceed continuously until all the wood work is prepared and fixed/stacked on or near the site as the case may be. Generally wood shall be free from knots, however, wood with knots may be permitted provided individual hard and sound knot shall not be more than 40 mm in diameter and aggregate area of all the knots shall not exceed one half percent of the area of the piece
Teak wood shall be approved incorporating in the work Contractor should ensure wood work does not warp or show other defects due to lack of proper seasoning.

6.2 HOLD FASTS :

Three hold-facts shall be fixed to each post of the door from and two to each post of the window frame. Unless otherwise mentioned in the item, the M.S. Hold-fasts shall be of the Size 300mm x 35 mm and 6 mm and shall be fixed to the frames by means of screws and not nails . The other. End of the hold fast shall be fixed into jambs within 1:2:4 P.C.C if dimensions as directed .

Whenever asked for, rawl plugs or bolts as directed shall be used for rough grounds framing hangers etc. The rates quoted for wood work and joinery shall allow for all types of hold fasts as directed (Horns in frames shall be cut and shall not be used as hold facts)

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6.3 **WORKMANSHIP AND CONSTRUCTION :**

- i. The workmanship shall be first class and to the approval of the E.E. Scantling and boarding shall be accurately sawn and shall be of required width and thickness. All carpenter's work shall be wrought except where otherwise described. The workmanship and joinery shall be accurately set out in strict accordance with the drawings and shall be framed together and securely fixed in approved manner and with properly made joints. All work is to be properly tenoned, shouldered, wedged, pinned, braded etc. and properly glued with approved quality glue to the satisfaction of the E.E.
- ii. **SCREWS** :All screws to be used in wood work and joinery shall be of brass and not iron.
- iii. **TOLERANCES** :

15mm (1/16") will be allowed for each wrought face of the sizes specified except where described as 'finished' in which case they shall hold to the full dimensions. For door/window frames tolerance shall be +/- 2/3 mm. in cross sectional dimensions and for shutters +/- mm in thickness +/- 2/3 mm in width of styles and rails. For flush door shutters tolerance in width/height shall be +/- 3 mm and on thickness +/- 1.2 mm.
- iv. **PROTECTION** :

All wood work and joinery edges of timber frames etc., shall be protected from being damaged during construction by the Contractor.
- v. If it is decided by the Employer to provide antitermite treatment, the Building Contractor shall coordinate his work suitably as directed by the Executive Engineer.
- vi. Door/Window frames shall have cut rebates. Planted rebates shall not be permitted.

6.4 **WOODEN FLUSH SHUTTERS (SOLID CORE TYPE)**

- a. Solid core flush shutters shall be of commercial or Teak veneered type as specified in the item manufactured by M/s Sita Board Mysore Commercial Union Ltd., or other equivalent and approved quality. An approved sample shall be deposited in the office of the Corporation's Engineer on site for reference. The

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shutters will be provided with lipping. Finished thickness of the shutter shall be as mentioned in the item.

- b. **PARTITION BOARD** : Shall be of waterproof quality 'NOVA TEAK SUPER' (Phenol bonded, 3 layers flat pressed), manufactured by M/s Plywood Manufacturing Ltd., Bombay or other equal and approved.

6.5 TEAK WOOD PANELLED SHUTTERS :

Solid wood panels for shutter shall be of pattern and size specified. Wherever possible each panel shall be in a single width piece. But where two pieces are used, width of each piece should not be less than 12.5 cm. In order to avoid warping, splitting and cracking, normally pieces not exceeding 20 cm. in width should be used. When made from more than one pieces. The pieces shall be jointed with a continuous tongued and grooved joint and glued together and reinforced the longer dimension of the panel. Planes shall be framed in to grooves to the full depth of the groove leaving an air space of 1.6 mm and the faces shall be closely fitted to the sides of the groove. Mouldings to the edges of panel openings shall be scribed at the joints.

6.6 FIXTURES AND FASTENINGS :

Unless otherwise specified in the Schedule of Quantities each shutter shall be hung with three iron butt/parliamentary hinges of approved quality size and make with iron screws the things and screws bolt should be copper Oxide coated and the Contractors rate shall cover for providing and fixing hinges to the shutters. Unless otherwise specified in the Schedule of Quantities other fittings, if ordered, shall be paid separately as prime cost items. Hardware for doors and windows shall be of M/s Bivon, M/s Manmatha Hari & Sons, M/s De's Lock Industries, M/s Godrej, M/s Garnishor other equivalent and approved make.

6.7 FINISHING :

The wood work shall be finished by 3coat of painting. French polishing or wax polishing as specified in the item.

6.8 RATE TO INCLUDE :

Apart from other factors mentioned elsewhere in this Contract, the rate for item of wood work and joinery shall include for the following :-

- i. All labour, materials and equipments for carrying out the work.

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- ii. Providing and fixing frames and shutters, fastening and fixtures including embedding in the floor about 40/50 mm deep and labour for fixing hardware fittings, supplied by L.I.C.I. or purchased under prime cost items.
- iii. Bison or other equivalent wood preservative treatment to rough frame work in partitions, suspended frame work in ceilings and timber veneering to walls etc.
- iv. Coal tarring / creosoting of embedded parts of woodwork in masonry and concrete.
- v. Unless otherwise specified, sheet glass (plain or frosted) for shutters of doors/windows/fanlight, as manufactured by M/s Hindustan Pilkington or other equal and approved.
- vi. T.W. beadings/T.W. planted beads for fixing panels of shutters of doors, wherever required to be provided.
- vii. Providing T.W. cover mould of approved size.
- viii. 3 coats of 1st quality synthetic Enamel paint of approved colour and shade including primer as manufactured by M/s The Alkalis & Chemical Corporation of India Ltd. (With I.S.I. trade mark), M/s Goodlace Nerolac, M/s Jenson & Nicholson or equal and approved, 3 coats of French or wax polishing to approval as specified in the item.

6.9 MODE OF MEASUREMENT :

Timber Doors/Windows shall be measured in Sqm. over door, window frames if the item specified is composite one otherwise only shutter shall be measured in Sqm. Length shall be measured nearest to centimetre.

7. RUBBLE SOLING

7.1 RUBBLE :

The rubble shall be trap, granite, or any other approved stone and shall be sound, hard, tough, durable, dense, clean, free from laminations, soft spots, cracks, decay, weathering and other defects. The stones shall be broken rubble with water absorption as low as possible but not more than 5%. The shape of the stones shall be regular as can be obtained by quarrying without attempt at shaping or dressing. They shall be sufficiently flat bedded. The stones shall be broken with the smallest dimensions equal to the specified, thickness of soling. The length and breadth shall not generally exceed twice its thickness. Each stone shall not be less than 0.04 Cum. in size and shall be in one piece for the full depth of soling.

7.2 PREPARATION OF SUB-GRADE :

All the fittings shall be watered and compacted to get maximum consolidation. All the necessary trimming of filling for the laying of the soling in line and required grade shall be done. The sub grade shall be marked by stakes and strings for the required depth for laying of the soling.

7.3 LAYING SOLING :

Unless otherwise specified the thickness of the rubble soling shall be 20/25 cm. The stones shall be closely hand packed on the prepared bed with the largest face downwards and in contact with each other. The stones shall break joints as far as possible. The full thickness of soling shall generally be made with one stone only. As the laying of rubble advances, the soling shall be hand packed by wedging and packing with stones of smaller size in the joints of the soling and driving them by crow bars and hammers etc., so as to fill the voids as completely as possible. Such filling of the interstices shall be carried out simultaneously with the placing in position of the large stones and shall in no case be permitted to lag behind. The soling shall be laid and hand packed true to grade and level. The soling thus laid shall be finished by knocking out projecting stones and filling depressions by chips to come up to the required level.

7.4 CONSOLIDATING :

The soling shall be watered and rammed with wooden rammers of approved weight. Hollows which appear during ramming shall be made good with smalls. Ramming and making good shall continue till a closely knit compacted surface conforming to the required levels is obtained. Earth on no account shall be used for making good or blinding

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purposes and it approved by Executive Engineer, sand or gravel as directed shall be used for blinding purposes. Water shall be lightly sprinkled if required and directed by the Executive Engineer.

7.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the Contractor's rate quoted shall include for the following :

- i. Preparing the sub-grade.
- ii. Providing and laying rubble soling including hand packing.
- iii. Consolidating, watering, ramming and blinding with approved sand or gravel as directed.
- iv. All labour, materials and use of equipments and tools required for carrying out the work satisfactorily.

7.6 MODE OF MEASUREMENT :

The measurement for rubble soling shall be in square metre as provided of specified thickness.

8. BRICK ON EDGE SOLING

- 8.1** The bricks, unless otherwise specified shall be locally available over burnt bricks, and shall be approved sound, hard, tough, durable, dense, clean, free from soft spots, cracks, decay and other defects. Brick bats shall not be used.

8.2 PREPARATION OF SUB-GRADE :

All the filling shall be watered and compacted to get maximum consolidation. All the necessary trimming of filling for the laying of the soling in line and required grade shall be done. The sub grade shall be marked by stakes and strings for the required depth for laying of the soling.

8.3 LAYING SOLING :

The bricks shall be laid on edge (unless otherwise specified) touching each other. Bricks shall be laid in parallel rows breaking bond or in Herring bone pattern as directed. All bricks shall be laid closely in position and firmly embedded, true to line and gradient as required, the joints shall be filled by sand as directed.

8.4 CONSOLIDATING :

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The soling shall be watered and rammed with wooden rammers of approved weight. The brick soling shall not be rammed with heavy rammers, as the bricks are likely to be crushed. Ramming shall continue till closely knit compacted surface conforming to the required levels is obtained. Earth on no account shall be used for making good or blinding purposes and if approved by Executive Engineer, sand shall be used for blinding purposes. Water shall be lightly sprinkled if required and directed by the Executive Engineer.

8.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the Contractor's rate quoted shall include for the following :

- i. Preparing the sub-grade.
- ii. Providing and laying the bricks, on edge as described above.
- iii. Consolidating, watering, ramming and blinding with approved sand as directed.
- iv. All labour, materials and use of equipments and tools required for carrying out the work satisfactorily.

8.6 MODE OF MEASUREMENT :

The measurement for brick on edge soling shall be in square metre as provided.

9. CEMENT CONCRETE FLOORING AND CEMENT SKIRTING OR DADO, PLAIN CEMENT CONCRETE FLOORING IN SINGLE LAYER.

9.1 CEMENT CONCRETE :

Unless otherwise specified, the proportion of cement concrete shall be 1:2.5:3.5 (Cement fine aggregate : coarse stone aggregate : coarse stone aggregate of size 12 mm and below by volume. Cement however, shall not be measured in volume but by weight. One bag of cement of 50 Kgs. shall be assumed to contain 35 litres of cement i.e., 1.20 cft.). The coarse aggregate shall be from approved source, carefully selected, sufficiently tough and hard stone pieces broken in a manner that will provide particles of approximate cubicle shapes affording good interlocking. Elongated or thin flake like fragments should be avoided. The maximum size of coarse aggregate shall be 12mm. The fine aggregate shall be sand from approved source and consist of properly graded particles. The coarse and fine aggregates shall be conforming to relevant I.S. 383-1970 and shall be washed clean if necessary.

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Unless otherwise mentioned in the item concrete in flooring shall be 40 mm thick. The least amount of mixing water that will produce a workable mix and will allow finishing without excessive trowelling shall be used. Generally a water cement ratio of 0.5 should suffice.

9.2 PREPARATION OF SUB-GRADE :

Before placing the concrete flooring the sub-grade shall be got approved by the Executive Engineer. The top surface of the sub-grade, shall be thoroughly cleaned of the dirt, loose particles, cake mortar droppings and laitance, if any, by scrubbing with coir or steel wire brush or by hacking if necessary. The top surface of sub-grade shall be slightly rough and shall have the required slope. The sub-grade shall be mentioned before laying the concrete flooring without forming any pools of water.

9.3 LAYING :

The concrete flooring shall be laid in alternate bays not exceeding 2x2 M each. The edge of each panel into which the floor is decided should be supported by flat iron or wood duly oiled to prevent sticking. Their depth shall be same as that proposed for the concrete flooring as mentioned in the item. The flat iron should be removed before filling in the adjoining panels. At least 48 hours shall elapse before the concreting in the adjoining bays is commenced. A.C. glass strips or approved separators shall be provided if specified in the item.

The concrete shall be laid immediately after mixing. While being place, the concrete shall be vigorously sliced and spaded with suitable tools to prevent formation of voids or honeycomb pockets. The concrete shall be brought to the specified levels by means of a heavy straight edge resting on the side forms and drawn ahead with a sawing motion in combination with a series of lift sand drops alternating with small lateral shifts. While concreting the adjacent bays, care shall be taken to ensure that the edges of previously laid bays are not broken by careless or hard tampering. Immediately after laying the concrete , the surface shall be inspected for high or low spots and any needed correction shall be done by adding or removing the concrete. After striking of the surface to the required grade, it shall be compacted with wooden float. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given to complete the ramming. The floating shall be followed by steel trowelling after the surface has hardened sufficiently to prevent excess of fine material from working to the surface. The finish shall be brought to a smoothened eve surface, free from defects and blemished and tested with straight edges and mason's spirit level to detect any inequalities in the surface which, if any , shall be made good immediately. No dry cement mixture of dry

cement and sand shall be sprinkled on the surface of concrete to absorb moisture or to stiffen the mix. The junctions of floor and walls shall be rounded off if so directed without extra payment.

No extra mortar shall be laid over the concrete to make the floor in level if broom finish is specifically mentioned in the item, the surface shall be obtained rough with parallel broom marks before the concrete sets. After the concrete in the bays has set, the joints of the panels shall be filled with cement paste as directed. The joints shall be straight both ways i.e., along the length and width. The vertical edge of the bays shall be neatly marked on the surface with a pointed trowel after filling the joints.

9.4 CURING :

The surface shall be protected from direct sun when it is green. As soon as the surface had hardened sufficiently to prevent damage to it, it shall be kept continuously moist for at least 14 days by means of wet gunny bags, 50mm thick layer damp sand spread over the surface or pooling water on the surface.

9.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rates shall include for the following :

- i. Cleaning and Preparing the sub-grade.
- ii. Providing and laying concrete of the specified mix, and finishing the surface as described above.
- iii. Providing and fixing A.C. or glass of approved separators to form panels when specified
- iv. Curing
- v. All labour, materials and use of equipments and tools required for carrying out the work satisfactorily.

9.6 MODE OF MEASUREMENT :

The measurements shall be in square metre of cast in situ of cement flooring as provided

9.7 CEMENT DADO AND SKIRTING :

- a. The walls to which skirting or dado is to be done shall have all joints raked out to a depth of 10mm, if not already done. R.C.C. surface shall be properly hacked to get good key to the mortar. All dust and oily matter, if any, shall be brushed and cleaned and the surface shall be kept wet for 6 hours before the dado or skirting work commences. The dado or skirting work shall not be commenced unless the preparatory work is passed by the Executive Engineer.

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b. CEMENT MORTAR :

Unless otherwise mentioned the proportion of mortar shall be 1:3 (1 cement : 3 sand). Sand in mortar shall be as per I.S. : 1542-1960 as applicable to internal wall plastering, and washed clean if necessary. The thickness of dado or skirting shall be 20mm thick unless otherwise specified.

c. APPLICATION :

The mortar shall be firmly applied with some what more than the required thickness and well pressed, rubbed and levelled with a flat wooden rule to give required thickness. Long straight edges shall be freely used to ensure perfectly plane and even surface. No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface to absorb moisture or to stiffen intimately when set and there should be no hollow sound when struck. All corners, angles and junctions shall be truly vertical and neatly horizontal as the case may be , carefully and neatly finished. Care shall be taken to see that the top edge of the skirting or dado shall be straight in line and square and jointed with plaster above as required. When neat cement finish is specified over the plaster surface, a coat of pure Portland cement slurry 1.5mm thick shall be applied and well rubbed to the plaster surface while the plaster surface is still fresh. When the finish is specified, the plastered surface shall be rubbed well to an even plane with a wooden float for external surface and finished smooth with a steel trowel for internal surface. If coloured dado or skirting is required, approved coloured cement or cement mixed with the required shade of approved pigment shall be used.

d. CURING :

The dado or skirting shall be kept wet for 14 days.

9.8 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rates for the items of dado or skirting shall include for the following :

- i. Preparing the surface.
- ii. Providing and applying cement mortar of specified mix, and finishing the edges with plaster as stated above.
- iii. Providing coloured cement and colouring pigment when coloured cement dado/skirting is specified.
- iv. Curing
- v. All labour, materials, tools and equipment for carrying out the items as specified above.

9.9 MODE OF MEASUREMENT :

- a. Dado shall be measured in square metre as provided .

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- b. The height of skirting shall be specified in the item and shall be measured in R.M. (Skirting up to 30 cm. in height shall be measured in running metres.)

10. WHITE GLAZED TILES IN FLOORING AND DADO

10.01 TILES

White glazed tiles including specials shall be of approved make and quality and shall conform to IS-777-1961 in all respects. Samples of tiles shall be got approved by the Chief Engineer, who will keep them in his office for verification as to whether the materials brought for use conform to the approved samples. White glazed tiles shall be of the size 152x152x 5 mm.

10.02 MORTAR BEDDING :

Unless otherwise specified the tiles in Flooring shall be laid in the cement mortar 1:6 bedding . The amount of water added shall be minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the tiles. Before spreading mortar, sub-floor or base shall be cleaned of all dirt, scum, loose materials and laitance if any, by scrubbing with coir or steel wire brush or by hacking if necessary and then well wetted without forming any pools of water on the surface. Before laying, the mortar , the sub-grade shall be got approved by the Executive Engineer in case of R.C.C. floors, the top shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much area as will be covered with tiles before the setting of the mortar. The thickness of the mortar bed shall not be less than 20 mm.

10.03 LAYING, FINISHING, CURING AND CLEANING :

The tiles before laying shall be soaked in water for at least 2 hours. Tiles which are fixed in the floor adjoining the wall shall be so arranged that the surface of the round edge tiles shall correspond to the skirting or dado. Neat cement grout of honey like consistency shall be spread over the bedding mortar just to cover so much area as can be tiles within half an hour. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed of joints. The joints shall be kept as close as

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possible and in straight lines. The joints between the tiles shall not exceed 1.5mm wide. After fixing the tiles finally in an even plane, the flooring shall be covered with wet saw dust. The tile flooring shall be cured for 14 days.

After the tiles have been laid in a room or the day's fixing work is completed the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. Once the floor has set, the floor shall be covered with oil free dry saw dust which shall be removed only after completion of the construction work and just before the floor is occupied.

10.04 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the Contractor's rate quoted include for the following.

- i. Cleaning the base and providing and laying bedding mortar and levelling.
- ii. Providing and fixing the tiles including all specials like round edges corner cups, angles etc. in neat cement float over the bedding mortar.
- iii. Filling the joints of tiles with neat white cement slurry.
- iv. finishing, curing and cleaning.
- v. All labour, materials and use of tools for carrying out the items as specified above.

10.05 MODE OF MEASUREMENT :

Measurement for flooring tiles shall be in square metres as provided.

10.06 WHITE GLAZED TILES DADO :

a. TILES

White glazed tiles shall be same as described under white glazed tiles flooring.

b. MORTAR BACKING :

All joints in the face work shall be raked out to a depth equal to not less than the width of the joints or as directed by the Executive Engineer. Concrete surfaces shall be properly hacked. All dirt, soot oil, or any other material that might interfere with satisfactory bond shall be removed. The surface shall be cleared and scrubbed with fresh water and kept wet for 6 hours prior to applying backing mortar. The dado work shall not be commenced unless the preparatory work is passed by the Executive Engineer. The proportion of mortar bedding shall be 1:3 cement mortar. Sand in mortar bedding shall be from approved source, and shall conform to I.S.1542-1960 as applicable to internal wall and ceiling plastering and

external wall plastering. The thickness of mortar backing shall not be less than 12mm and not more than 20mm.

c. FIXING DADO TILES :

Dado work shall be done after fixing tiles on the floor. The white glazed tiles shall be soaked in water for atleast 2 hours before being used for dado work. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff. The back of tiles shall be covered with a thin layer of neat cement paste and the tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from bottom of wall upwards without any hollows in the bed or joints. Each tile shall be fixed as close as possible to the one adjoining. The tiles shall be jointed with white cement slurry. Any difference in the thickness of tiles shall be evened out in cushioning mortar so that all tiles faces are in one vertical place. The joints between the tiles shall not exceed 1.5mm in width and they shall be uniform. The tiles shall be fixed with straight joints. After fixing the dado, they shall be kept continuously wet for 14 days. If doors, windows or other openings are located within the dado area, the sills, jambs angles etc., shall be provided with white glazed tiles and appropriate specials according to the foregoing specification and such tiled area be measured net along with the dado.

d. CLEANING :

After the tiles have been fixed the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting work shall be washed thoroughly clean.

10.07 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rates for the item or dado or skirting shall include the following:-

- i. Backing mortar.
- ii. Providing and fixing tiles including all specials like round edges, angles, capping etc. in neat cement float over backing mortar.
- iii. Jointing of the tiles with white cement slurry.
- iv. Curing.
- v. Cleaning.

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- vi. All labour, material, use of tools and equipments for carrying out the items as specified above.

10.08 MODE OF MEASUREMENT :

Dado shall be measured in square metres as provided.

11. POLISHED KOTAH/SHAHABAD/TANDUR STONE FLOORING, DADO/LINING AND SKIRTING FLOORING

11.1 STONE SLABS :

The stone slabs shall be hard, sound, durable, resistant to wear. Unless otherwise specified, stone slabs shall be square in shape 30 x 30 cm size and 25mm thick. The stone slabs shall be without any soft veins, cracks or flaws and shall have a uniform colour. A tolerance of 3mm in thickness at any point shall be permitted. The exposed surface of stone slabs, shall be machine polished to a smooth even and true plan and the edges to be chiselled to half its depth, true and square to ensure uniform width of joint. The edges of stone slabs shall be machine cut square to the required shape, if necessary. The stone slabs shall be of approved colour and shades. A few approved samples of stone slabs to be used shall be deposited by the Contractor in the office of the Corporation's Engineer.

11.2 MORTAR BEDDING :

Lime mortar shall be prepared in mortar mill or pan. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the stone slabs. Before spreading the mortar the sub-floor or base shall be cleaned of all dirt, scum, loose materials and laitance if any by scrubbing with coir or steel wire brush or by hacking if necessary, and then well wetted without forming any pools of water on the surface. Before laying the mortar, the sub-grade shall be got approved by the Executive Engineer. In case of R.C.C. floors, the top shall be left a little rough. All points of level for the finished paying surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens, only over so much area as will be covered with slabs within half hour. The thickness of the mortar bedding shall not be less than 15mm and not more than 25mm. The required slope shall be given to the bed. Unless otherwise specified, the proportion of mortar bedding shall be 20 mm thick average cement mortar 1:6 and where lime bedding

is specified in the scheduled of the quantities proportion of Lime mortar shall be 1:3 1 lime : 3 sand).

11.3 LAYING, CURING, POLISHING, FINISHING AND CLEANING :

Before laying the stone slabs shall be thoroughly wetted with clean water. Neat cement grout of honey like consistency shall be spread on the mortar bed over as much area as could be covered with the slabs within half an hour. The stone slabs shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slope in the mortar bed. The stone slabs shall be laid in the approved pattern in single or two tone colour. Each stone slab shall be gently tapped with a wooden mallet till it is firmly and properly bedded. There shall be no hollows left. If there is a hollow sound on gently tapping of the stone slab, such stone slabs shall be removed and reset properly. The mason shall make the joint of uniform thickness and straight lines. The thickness of joints shall not exceed 1.5mm. The joints shall be grouted with neat cement slurry. No border stone slabs shall be less than 100mm in width, unless otherwise approved by the Executive Engineer.

When the bedding and joints of the flooring have been completely set, the surface shall be machine polished to give a smooth, even and true plane to the floor and thoroughly cleaned.

11.4 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the Contractors rate quoted shall include for the following :

- i. Cleaning the base of providing and laying bedding mortar and levelling.
- ii. Providing and fixing the stone slabs in neat cement float on the bedding mortar.
- iii. Filling joint of stone slabs with neat cement slurry of required colour to match the colour of the stone slabs.
- iv. Chiselling, polishing, finishing and cleaning.
- v. All labour, materials and use of tools for carrying out the item as specified above.

11.5 MODE OF MEASUREMENT :

Measurement for flooring, stone slabs shall be in square metre as provided.

11.6 DADO / LINING AND SKIRTING

The stone slabs shall be as specified above for flooring unless otherwise mentioned. The stone slabs shall be in approved lengths to match the flooring. The exposed edges of stone

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slabs such as in dado/lining and skirting, jams, soffits, sills etc, shall be machine cut and polished smooth.

a. MORTAR BACKING :

All joints in the face work shall be raked out to a depth equal to not less than the width of the joints or as directed by the Executive Engineer. Concrete surfaces shall be properly backed. All dirt, oil or any other materials that might interfere with satisfactory bond shall be removed. The surface shall be cleaned and scrubbed with fresh water and kept wet for 6 hours prior to applying backing mortar. The dado/lining or skirting work shall not be commenced unless the preparatory work is passed by the Executive Engineer. The proportion of mortar for backing shall be 1:3 cement mortar. Sand in mortar bedding shall be from approved sources and shall conform to I.S. 1542-1960 as applicable to internal wall and ceiling plastering and external wall plastering. The thickness of mortar backing shall not be less than 12mm and not more than 20mm.

b. FIXING DADO/LINING OR SKIRTING STONE SLABS :

Dado/lining or skirting shall be done only after fixing stone slabs on the floor. The stone slabs shall be thoroughly wetted in water before being used for Dado/lining or skirting work. The stone slabs shall be fixed when the backing mortar is still plastic and before it gets stiff. All the stone slabs shall be covered with an additional layer of neat cement paste and stones shall then be pressed in mortar and gently tapped against the wall with wooden mallet. The fixing shall be done from the bottom of wall upwards without any hollows in the beds or joints. Each stone slab shall be fixed as close as possible to the adjoining stone slab. The stone slab shall be jointed in neat cement slurry to match the colour of the stones. The joints shall not exceed 1.5mm in width and they shall be uniform. While fixing the stone slabs in dado/lining or skirting work, care shall be taken to see that the joints in the adjoining flooring below, matches with the joints in the dado/lining or in skirting, as the case may be, or shall be staggered as directed. When specified brass cramps and bins etc. of approved size shall also be used for fixing dado/lining.

c. POLISHING :

When stone slabs are completely set, polishing shall be done by hand with approved type of polishing stone. A smooth and even polished surface shall be obtained to match the finished surface of the flooring.

d. CURING :

The dado/lining or skirting shall be kept wet for 14 days.

11.7 RATES TO INCLUDE :

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Apart from other factors mentioned elsewhere in this contract the rate for the item of dado/lining or skirting shall include the following :-

- i. Backing mortar.
- ii. Providing and fixing stone slab with exposed edges machine cut including all special tiles and finishing the edges with plaster.
- iii. Providing and fixing brass cramps and pins etc., for dado/lining where specified.
- iv. Joints of the stone slabs filled with coloured cement slurry to match the stone slabs.
- v. Curing.
- vi. Chiselling, polishing, use of tools and equipments for carrying out the items as specified above.

11.7 MODE OF MEASUREMENT :

- a. Dado/lining shall be measured in Square Metres as provided.
- b. The height of skirting shall be specified in the item and shall be measured in R.M. (Skirting up to 30 cm. in height shall be measured in running metres)

12. CAST IN SITU MARBLE MOSAIC FLOORING, DADO AND SKIRTING.

12.1 CAST IN SITU MARBLE MOSAIC FLOORING :

- i. **PREPARATION OF SUB-GRADE** : The sub-grade shall be prepared as for the cement concrete flooring.
- ii. **FLOORING COMPOSITION** : This will compose of two layers, the bottom one called the 'Under coat' and the top one called the 'Top coat'. The bottom coat shall be 30mm thick and the top coat shall be 10mm thick. The total thickness shall be 40mm unless otherwise stated.

a. UNDER COAT :

The under coat will have the same proportion and consistency as for cement flooring and shall be mixed and placed in the same manner, except that no finishing shall be done to make the surface smooth ; the top surface of concrete in the under coat shall be kept sufficiently rough to form a key to the top coat.

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b. ALUMINIUM STRIPS :

While laying the under coat, aluminium strips of 10 gauge and 40mm wide as separators shall be provided to form approved panels. The area of each panel in the flooring shall not exceed 1.5 Sq. Metres the longest side of any panel not exceeding 2 metres. The cost of providing aluminium strips in the flooring shall be included in the rate quoted for mosaic flooring.

c. TOP COAT :

The grading, proportion and colour of the marble chips shall be got approved from the Executive Engineer after preparing a few samples of cast in situ mosaic flooring. The proportion of white cement, grey cement, coloured cement, pigments and marble chips in the top coat shall be got approved from the Executive Engineer to get light shades, medium shades and dark shades as required. The proportion of cement to marble chips shall be 1:2. The top coat shall be laid as per I.S.:2114-1962.

iii. POLISHING AND FINISHING :

After the top coat has hardened enough to prevent dislodgement of aggregate particles, the surface shall be machine polished and finally washed with 'TATRI' and then wax polished to give a smooth and shining surface.

iv. CURING :

The flooring shall be kept covered and damp till it is properly set and given final finish.

v. RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rates shall include for the following:

- a. Providing and laying 1:2:4 cement concrete for under coat in panels.
- b. Providing and fixing aluminium strips to form panels.
- c. Mixing the ingredients of terrazzo mix in white cement grey cement coloured cement/approved pigments and marble chips of approved quality, maximum size and graded down as required and laying it in the top coat.
- d. Curing
- e. Machine polishing and finishing as specified above.

vi. MODE OF MEASUREMENT :

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The measurement shall be in Square Metre of cast in situ mosaic flooring provided.

12.2 DADO AND SKIRTING :

- a. Dado and skirting shall be laid in two layers, the under coat being laid as plaster and the top coat with marble chips in white/grey/coloured cement as required.

b. **UNDER COAT :**

The under coat shall be in 1:3 cement mortar and shall be applied to the wall surface as per plaster. The thickness of the plaster shall be 12mm for brick and concrete faces, and 20mm for stone faces. The surfaces of the under coat shall be kept rough to form a key for the top coat of the marble chips in white/grey/coloured cement as required in different proportions.

c. **ALUMINIUM STRIPS :**

Aluminium strips shall be provided minimum 10 gauge and width to suit the thickness of the dado (Inclusive of top coat). The aluminium strips shall be fixed in plaster when it is green. Spacing of aluminium strip shall not exceed 2 metres.

d. **TOP COAT :**

This shall be similar to the top coat in cast-in-situ mosaic flooring.

e. **POLISHING :**

The finished surface shall be rubbed with Carborandum stone and finally washed with "Tatri" and then wax polished to get smooth and shining surface. The surface shall be kept damp till it is properly set.

12.3 RATES TO INCLUDE :

Apart from other mentioned elsewhere in this contract, the rates shall include for the following :-

- i. Applying under coat in 1:3 cement mortar and roughening the surface.
- ii. Providing and fixing aluminium strips.
- iii. Mixing the ingredients of terrazzo mix as required and laying it in top coat.
- v. Curing.
- v. Polishing and finishing the dado/skirting.

12.4 MODE OF MEASUREMENT :

- i. Dado shall be measured in Square Metre.
- ii. Skirting less than 30 cm. height shall be measured in Running metre.

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**13. PLAIN OR COLOURED CEMENT TILES OR TERRAZZO TILES FLOORING DADO
AND SKIRTING**

13.1 FLOORING :

13.2 TILES :

Plain or coloured cement tiles and terrazzo tiles shall be manufactured as per I.S.: 1237-1980 using grey or white cement and pigments and marble chips of sizes as required. Tiles shall be of the size 250x250x22 mm (10"x10"x7/8") or any other approved size. Tiles shall be of tiles to be used shall be deposited by the Contractor in the office of the Corporation's Engineer.

13.3 CONCRETE BASE AND MORTAR BEDDING :

The base of cement or lime concrete shall be laid and compacted to a reasonably true plain surface and to the required slopes and below the levels of the finished floor to the extent of the thickness of the tiles and mortar bedding. Cement concrete or lime concrete base shall be paid under a separate item. Lime surkhi-mortar for bedding shall be prepared in a mortar mill. The amount of water added shall be minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the tiles. Before spreading mortar, sub-floor or base shall be cleaned of all dirt, scum, laitance and all loose materials and then well wetted without forming any pools of water on the surface. In case of R.C.C. floors, the top shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much area as will be covered with tiles before the setting of the mortar. The thickness of the mortar bedding shall be 1:1:1 (1 lime putty : 1 surkhi : 1 sand). Sand for mortar bedding shall be as per I.S.S. No. 2116-1965 as applicable to unreinforced masonry work. Skirting, dado and raisers of steps/staircase shall be fixed on backing of cement mortar 1:3, 12mm thick with thick cement paste.

13.4 LAYING CURING, POLISHING, FINISHING AND CLEANING :

Before laying, the tiles shall be thoroughly wetted with clean water. Tiles shall be laid as per approved pattern on the mortar bed and floated in neat cement slurry. The joints of the tiles shall not be more than 1.5 mm wide and shall be filled with neat cement slurry of required colour to match the colour of the tiles if required , the border tiles shall be cut to

proper sizes and the rate quoted shall cover for the same. No border tile shall be less than 100 mm in width, unless otherwise approved by the Executive Engineer.

Flooring shall be kept wet for 14 days.

Polishing and cleaning of the whole floor shall be done according to I. S. 1443-1959

13.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the contractor's rate quoted shall include for the following :-

- i. Cleaning the base and providing and laying bedding mortar and levelling.
- ii. Providing and fixing the tiles in neat cement float on the bedding mortar.
- iii. Filling the joints of tiles with neat cement slurry of required colour to match the colour of the tiles.
- iv. Polishing finishing and cleaning. All labour, materials and use of tools for carrying out the item as specified above.

13.6 MODE OF MEASUREMENT :

Measurement for flooring tiles shall be in Square Metre as provided.

13.7 NOTE :

- a. Tiles with white cement shall be considered as light shade tiles.
Tiles approximately 50% white cement and 50% ordinary cement shall be considered as medium shade tiles.
- c. Tiles with ordinary cement shall be considered as dark shade tiles.
- d. Marble chips for terrazzo/marble mosaic tiles shall be varying from the smallest up to 20mm size.

13.8 DADO AND SKIRTING :

- a. Tiles shall be as specified above for flooring, except that in the case of skirting the height of tiles may be less than the height of 1 full tile.

b. MORTAR BACKING :

The proportion of mortar for backing shall be 1:3 cement mortar. Sand in mortar bedding shall be as per I.S. No.1546-1960 as applicable for under coat of internal plastering.

c. FIXING DADO OR SKIRTING TILES :

Dado or skirting shall be done only after fixing tiles on the floor. The tiles shall be soaked in water before being used for dado or skirting work. The tiles shall be fixed

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when the backing mortar is still plastic and before it gets stiff. All the tiles shall be covered with an additional layer of neat cement paste and tiles shall then be pressed in mortar and gently tapped against the wall with wooden mallet. The fixing shall be done from the bottom of wall upwards without any hollows in the beds or joints. Each tiles shall be fixed as close as possible to the adjoining tile. The tile shall be jointed in neat cement slurry to match the colour of the tiles. The joints shall not exceed 1.5mm in width and they shall be uniform. While fixing the tiles in skirting or in dado work care should be taken to see that the joints in the adjoining flooring tile below matches with the joints in the skirting or the dado tiles, as the case maybe, or shall be staggered as directed.

d. POLISHING :

Polishing may be done by hand with approved type of polishing stone. A smooth and even polished surface shall be obtained to match the finished surface of the flooring.

e. CURING : The dado or skirting shall be kept wet for 14 days.

13.9 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract the rate for the item of dado or skirting shall include the following :-

- i. Backing mortar.
- ii. Providing and fixing the tiles including all special tiles and finishing the edges with plaster.
- iii. Joints of the tiles filled with coloured cement slurry to match the tiles.
- iv. Curing.
- v. Polishing and cleaning the dado and skirting.
- vi. All labour, material, use of tools and equipments for carrying out the items as specified above.

13.10 MODE OF MEASUREMENT :

- a. Dado shall be measured in Square metre.
- b. The height of skirting shall be specified in the item and shall be measured in R.M.(Skirting up to 30 cm. in height shall be measured in running metres.)

14. MARBLE FLOORING

14.1 MARBLE SLABS :

The marble shall be of approved shade and sources as mentioned in the Schedule of Quantities and their size and the thickness shall be as shown on the drawings and as approved by the Executive Engineer. They shall be of selected quality, dense, uniform and homogeneous in texture and free from cracks or other structural defects. It shall have even and crystalline grains. The surface shall be machine polished to an even and perfectly plain surface and edges machine cut true and square. The rear face shall be rough enough to provide a key for the mortar. No slab shall be thinner than the specified thickness at its thinnest part. The dimension of slabs shall be as specified. A few approved samples of finished slabs to be used shall be deposited by the Contractor in the office of the Corporation's Engineer. Unless otherwise mentioned, the thickness of the marble shall be minimum 20 mm.

14.2 CONCRETE BASE AND MORTAR BEDDING :

The base of cement or lime concrete shall be laid and compacted to a reasonably true plain surface and to the required slopes and allow the level of the finished floor to the extent of the thickness of the slabs and mortar bedding. Cement concrete or lime concrete base shall be paid under a separate item. Cement concrete for bedding may be mixed manually or by a mechanical mixer as directed. Lime mortar shall be prepared in a mortar mill. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the stones. Before spreading the mortar, sub-floor or base shall be cleaned of all dirt, scum or laitance and of loose materials and then well wetted without forming any pools of water on the surface. In case of R.C.C. floors, the top shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much area as will be covered with slabs within half an hour. The thickness of the mortar bedding shall not be less than 12mm (about 1/2") not more than 25mm (about 1").

14.3 LAYING MARBLE SLABS :

Before laying, the marble shall be thoroughly wetted with clean water. Neat cement grout of honey like consistency shall be spread on the mortar bed cover as much area as could be covered with the slab within 1/2 an hour. The specified type of marble slabs shall be laid

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to pattern as directed on the neat cement float and shall be evenly and firmly bedded to the required level and slope in the mortar bed. Each slab shall be gently tapped with a wooden mallet till it is firmly and properly bedded. There shall be no hollows left. If there is a hollow sound on gentle tapping on the slabs such slabs shall be removed and reset properly. The joints as shall be hair fine width and in straight line grouted with neat coloured cement slurry to match the colour of the marble. The joints shall be struck smooth but there shall be no smearing over the mortar of the slabs. The edges of the adjoining slabs shall be in one plane.

- 14.4** The flooring shall be kept undisturbed at least seven days and wet for fourteen days. Marble flooring shall be given a final coat of wax polish of approved make. Polishing and cleaning of marble flooring shall be done according to I.S. No. 1443-1959.

14.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rate for item of marble flooring shall include for the following :-

- a. All labour, materials and equipments, cleaning the sub-base, laying mortar bed and cement grout and fixing marble slabs as specified above and making up the joints and wax polishing.
- b. Any cutting and waste if required.
- c. Curing.
- d. Cleaning the floor from all stains etc.

14.6 MODE OF MEASUREMENT :

The measurement shall be in Sq. metre for the actual marble flooring provided.

15. CEMENT POINTING RECESSED/FLUSH RECESSED POINTING :

15.1 PREPARATION OF SURFACE :

The joints in the masonry shall be raked out to a depth not less than the width of the joint as directed, when the mortar is green. The joints are to be brushed clean of dust and loose particles, with stiff brush. The Ares shall then be washed and the joints thoroughly wetted before pointing is commenced. All dust and oily matters if any, shall be removed.

15.2 PROPORTION OF MORTAR :

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The proportion of cement mortar shall be as described in item. The sand shall be from approved source free from foreign matter, washed clean if necessary and shall conform to I.S. 1542-1977. No more cement mortar shall be prepared than that can be used within half an hour. The mortar may be hand mixed or machine mixed. In hand mixed mortar, cement and sand in the specified proportion shall be thoroughly mixed dry on a clean impervious platform by turning over at least 3 times or more till a homogeneous mixture of uniform colour is obtained. Fresh and clean water shall be added gradually through a rose and thoroughly mixed so that mix becomes homogeneous and each particle of sand shall be completely covered with a film of wet cement. Mixing platform shall be so arranged that no deleterious extraneous material shall get mixed with mortar, not the mixing water of the mortar shall flow out.

15.3 APPLICATION :

Waterproofing compound of approved make, shall be added according to manufacturer's specifications to make the mortar waterproof. The raked out joints shall be filled with mortar of the specified mix and the required consistency and well pressed and rubbed smooth. A semi-circular depression 3 mm dia shall be made in the joint by pressing clean string with trowel keeping the string exactly horizontal and on the centre line of the joint. The vertical joints shall be similarly marked. These depressed lines will then be immediately rubbed with a nayla till they become uniformly 5 mm deep and 6mm wide and assumed fairly blackish colour intersections of the horizontal and vertical shall be finished neatly with the vertical line just touching the horizontal line but not crossing it. All superfluous mortar shall be removed with the trowel. The brick surface shall be cleaned and no stain shall be allowed to remain.

When joints are not horizontal or vertical as in the case of uncoursed rubble masonry, the pointing shall be made along the centre line of joints to uniform width and depth as directed and junctions of pointing made nearly. The pointing mortar shall not spread over the adjoining stones. Mortar pointing shall be restricted to the width of the joints and all superfluous mortar shall be removed with a trowel.

15.4 CURING :

All pointing work shall be kept damp, continuously for a period of 14 days.

15.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract rates for the item of pointing shall include for the following :-

- i. Erecting, dismantling and removing scaffolding.
- ii. Preparing the surface and watering.

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- iii. Providing and filling in the joints with cement mortar, including approved waterproofing compound.
- iv. Curing and cleaning the surface.
- v. All labour, materials, use of tools and equipments to complete the work as per specification.

15.6 MODE OF MEASUREMENT :

Pointing shall be measured in square metres as in the case of plaster.

15.7 FLUSH POINTING :

This item shall be carried out, when joints are not struck, while the masonry is being laid. All the specifications of recessed pointing shall apply to this as well except that instead of making the lines with string and forming groove etc., the joints shall be kept flush with face of joints in the masonry.

16. INTERNAL CEMENT PLASTER WITH / WITHOUT NEERU FINISH :

16.1 REPARATION OF SURFACE :

The walls to be plastered to have all joints raked out to a depth of 10 mm if not already done. R.C.C. surface shall be properly backed to get good key to the plaster. All dust and oily matter, if any, shall be brushed and cleaned and the surface to be plastered shall be kept wet for 6 hours before plastering is commenced.

16.2 PROPORTION OF MORTAR :

Unless otherwise mentioned, the proportion of internal cement plaster for walls and ceiling shall be 1:4 (1 cement : 4 sand). Sand shall be from approved source, free from foreign matter and shall be as per I.S. 1548-1960 as applicable to internal wall and ceiling plastering. No more cement mortar shall be prepared than that can be used within half an hour.

16.3 APPLICATION OF PLASTER :

The mortar shall be applied evenly with force on the surface to be plastered. The mortar surface shall be finished at once by being rubbed over with a trowel till the cement appears on the surface. All corners, angles and junctions shall be truly vertical and horizontal as the case may be, carefully and neatly finished. Rounding of corners and

junction where required shall be done without extra charge. The mortar shall adhere to the surface intimately when set and there should be no hollow sound when struck. The thickness of plaster shall be minimum 12mm over the proudest part of the surface of brick wall and R.C.C. surfaces and 20mm over stone walls. Plaster for ceiling shall not be more than 12mm.

16.4 NEERU FINISH :

If the plaster surface is to be given neeru finish, the surface shall be combed slightly with wire brushes or nails before it is completely set to form key for neeru. The under coat shall be only damped but not soaked before the application of neeru. The lime for preparing neeru shall be fat lime and shall be of approved quality and source. Lime shall be slaked and mixed with sufficient water to form a thick paste. It shall be reduced to a fine paste by grinding. It shall then be passed through a fine sieve (3 mm mesh) to remove all unslaked particles and foreign matter and allow to mellow under water for at least 10 days in large slaking tanks. The surplus water on the top shall be allowed to run off. The slaked lime paste thus formed shall be used for preparing neeru. The neeru shall be prepared by mixing together 4 parts of this lime paste and 1 part of approved fine sieved sand by volume. Jute fibres finely chopped shall be added to the above mortar at the rate of 4 Kg. of jute to every Cubic Metre of lime sand mixture. The mixture shall then be properly ground to a fine paste between two stones or a mill. The neeru thus prepared shall be kept moist until used and no more than what can be consumed in 15 days shall be prepared at time.

Neeru shall be applied to the prepared and partially set but somewhat plaster surface with steel trowel to a thickness slightly exceeding 1.5 mm (About 1/16") and rubbed down to 1.5 mm (1/16") thickness and polished to a perfectly smooth and even finish, working from top to bottom. While trowelling is going on soap stone powder contained in thin muslin bags shall be dusted over the surface and worked in.

Moisturing shall be commenced as soon as the plaster has hardened sufficiently and is not susceptible to injury. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used. The surface shall be kept sprinkled with water for 14 days.

16.5 NEAT CEMENT FINISH:

When neat cement finish is specified over the plaster surface, a coat of pure Portland cement slurry 1.5mm thick shall be applied and well rubbed to the plaster surface while the plaster surface itself fresh.

16.6 TROWEL FINISH :

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When no finish is specified, the plastered surface shall be rubbed well to an even plane with wooden flat for external surface and finished smooth with a steel trowel for internal surface.

16.7 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere to this contract, rates for the item of plaster shall include for the following :-

- i. Erecting, dismantling and removing the scaffolding.
- ii. Providing the surface to receive the plaster.
- iii. Providing cement plaster of specified average thickness.
- iv. All labour, materials, use of tools and equipment to complete the plastering as per specification.
- v. Curing for 14 days.
- vi. Any moulding work if shown on the drawings or as specified unless separately provided in the tender.
- vi. Plaster work in hands, arises, rounded angles, fair edges, narrow returns, quirks, 'V' joints, splays, drip mouldings, making good to metal frames, junctions with skirting or dados, narrow widths and small quantities making good around pipes, conduits, timbers, sills, brackets, railings etc., and making good after all the sub-contractors or nominated sub-contractors have done their work.
- viii. Neeru or cement finish when specified in the item.

16.8 MODE OF MEASUREMENT :

Plaster shall be measured in square metres.

a. WALLS :

- i. The measurements of wall plastering shall be taken between the walls or partitions (the dimensions before plastering shall be taken) for the length, and from the top of floor/skirting/dado (As the case may be) to the ceiling for the height.

ii. DEDUCTIONS :

- A. For jambs, soffits, sills, etc., for openings not exceeding 0.5 m² each in area and opening not exceeding 3 m² each , deductions and additions shall be made in the following manner :-

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- a. No deduction shall be made for ends of joists, beams, posts, etc., and openings not exceeding 0.5 m² each and no addition shall be made for reveals, jambs, soffits, sills etc., of these openings nor for finishing the plaster around ends of joists, beams, posts etc.
- b. Deductions for openings exceeding 0.5 m² but not exceeding 3 m² each shall be made as follows and no addition shall be made for reveals, jambs, soffits, sills etc., of these openings :-
 - 1. When both faces of wall are plastered with the same plaster, deduction shall be made for one face only.
 - 2. When two faces of wall are plastered with different plasters or if one face is plastered and the other pointed, deduction shall be made from the plaster or pointing out the side of frames for doors, windows, etc., on which the width of reveals, is less than that on the other side, but no deduction shall be made on the other side.
- B. In case of openings of area above 3 m² each, deductions shall be made for the openings but jambs, soffits and sills shall be measured.
- b. **CEILINGS :**
 - i. Ceilings shall be measured between the walls or partitions and the dimensions before plastering shall be taken.
 - ii. Ceilings with projected beams shall be measured over beams and the plastered sides of beams shall be measured and added to plastering on ceilings.

17. EXTERNAL CEMENT PLASTER WITH SAND FACED/COMBED /ROUGHCAST FINISH

17.1 PREPARATION OF SURFACE

The walls to be plastered to have all joints raked out to a depth of 10mm , if not already done, R.C.C. surface shall be properly hacked to get good key to the plaster. Any unevenness shall be levelled before the plastering is applied. All dust and oil matter if any, shall be brushed and cleaned with a stiff bristle or wire brush, and the surface to be

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plastered shall be kept wet for 6 hours before plastering is commenced. If the surface becomes dry in spots such areas shall be moistured again to restore uniform surface.

17.2 PROPORTION OF MORTAR :

Unless otherwise mentioned, the proportion of external cement plaster for brick or concrete surface shall be 1:4 (1 cement : 4 sand). Sand shall be from approved source free from foreign matter, washed clean if necessary and shall be as per I.S. 1542-1977. No more cement mortar shall be prepared than that can be used within half an hour. The mortar may be hand mixed or machine mixed. In hand mixed mortar, cement and sand in the specified proportion shall be thoroughly mixed dry on a clean impervious platform by turning over at least 3 times or more till a homogeneous and mixture of uniform colour is obtained. Fresh and clean water shall be added gradually through a rose and thoroughly mixed so that mix becomes homogeneous and each particle of sand shall be completely covered with a film of wet cement. Mixing platform shall be so arranged that no deleterious, extraneous material shall get mixed with mortar not the mixing water of the mortar shall flow out.

17.3 APPLICATION OF PLASTER :

The plastering shall be done in two coats namely under coat and finishing coat.

UNDER COAT :

The under coat shall be of cement mortar 1:4. Water proofing compound of approved make shall be added according to manufacturer's specifications to make the mortar waterproof. Patches of plaster 15 cm x 15 cm shall be put on about 3 m apart as gauges to ensure even plastering in one plane. The thickness of the under coat in any part shall not be less than 8 mm and more than 12mm. The mortar shall be firmly applied with somewhat more than the required thickness and well pressed into the joints and on the surface and rubbed and levelled with a flat wooden rules to give required thickness. Long straight edges shall be freely used to ensure perfectly plane and even surface. All corners must be finished to their true angles or rounded as directed. Plastering shall be done from top downward. Keys shall be formed on the surface by thoroughly combing it with wavy horizontal lines about 12mm apart and 3mm deep when the mortar is still plastic. Under coat shall be cured for not less than 2 days before finishing coat is applied.

FINISHING COAT :

Cement mortar for finishing coat shall have washed approved sand with slightly larger proportion of coarse material. The proportion of cement to sand shall be 1:4. The finishing coat shall be of such thickness as to make total average finish to thickness equal to the required plaster thickness as described. The finishing coat shall be not less than 4mm or not more than 8mm thick. The finished surface shall be true and even and shall be present

uniform texture throughout and all joining mark shall be eliminated. After application the surface should be finished with a wooden float lying with cork and tapped gently to retain coarse surface texture. A steel trowel shall not be used and overworking shall be avoided. Water shall not be applied to the surface of the finishing coat while working up, but patches showing signs of premature drying may be patted with a damp float. When the finishing coat has hardened, the surface shall be kept moist continuously for 14 days. In any continuously and day to day breaks made to coincide with Architectural breaks in order to avoid unsightly junctions. All mouldings shall be worked true to template and drawn neat clean and level. All exposed angles and junctions with door frames etc. shall be carefully finished as directed.

17.4 All plaster work shall be kept moist continuously for a period of 14 days. To prevent excessive evaporation on the sunny or windward side of the buildings in hot dry weather, matting or gunny bags may be hung over on the outside of the plaster in the beginning and kept moist.

17.5 **RATES TO INCLUDE** : Apart from other factors mentioned elsewhere in the contract, rates for the item of plaster shall include for the following :

- i. Erecting, dismantling and removing scaffolding.
- ii. Preparing the surface to receive the plaster.
- iii. Providing cement plaster of the specified average thickness, in two coats, including waterproofing compound.
- iv. All labour, materials, use of tools and equipment to complete the plastering as per specifications.
- v. Curing 14 days.
- vi. Any moulding work if shown on the drawings or as specified unless separately provided in the tender.
- vii. Plaster work in hands, arises, rounded angles, fair edges narrow returns, quirks, 'V' joints, splays, drip mouldings, making good to metal frames, junctions with skirting or dados, narrow widths and shall quantities, making good and pipes, conduits, timbers, sills, brackets railings, etc. and making good after all the subcontractors or nominated sub-contractors have done their work.

17.6. MODE OF MEASUREMENT :

All plastering work shall be measured in square metres. Dimensions shall be measured and quantity worked out correct upto two places of decimals in metre and square metre respectively. If the average thickness of plaster provided by the contractor is more than what is specified on any account, no extra payment will be made. For jambs, soffits, sills, etc. for openings not exceeding 0.5m² each in area ends of joists, beams posts, etc. not

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exceeding 0.5m² each in area and openings not exceeding 3m each deductions and additions shall be made in the following manner :

- a. No deduction shall be made for ends of joints, beams, posts, etc. and opening not exceeding 0.5m² each , and no addition shall be made for reveals, jambs, soffits, sills etc. of these openings nor for finishing the plaster around ends of joists, beams, posts etc.
- b. Deductions for openings exceeding 0.5m² but not exceeding 3m² each shall be made as followed and no addition shall made for reveal, jambs, soffits, sills, etc. of these openings :
 - i. When both faces of wall are plastered with the same plaster, deduction shall be made for one face only.
 - ii. When two faces of wall are plastered with different plasters or if one face is plastered and the other pointed, deduction shall be made from the plaster or pointing on the side of frames for doors, windows, etc. on which the width of reveals is less than that on the other side, but no deduction shall be made on the other side.

In case of openings of area above 3m² each, deductions shall be made for the openings but jambs, soffits and sills shall be measured.

17.7 COMBED FINISH :

All the specification given above for sand finish shall apply to this as well except that in the case of combed finish, the finishing coat will be treated to have combed texture of approved pattern.

17.8 ROUGH CAST FINISH :

- a. All the specifications given above for sand faced finish shall apply to this as well except for the application of plaster which is described below.
- b. **APPLICATION OF PLASTER :**
 The plastering shall be done in two coats namely under coat and finishing coat. The under coat shall be done same as in case of sand faced finish. The finishing coat shall contain a fairly coarse aggregate and shall be thrown on as wet mix and shall be left in rough condition. The mortar of the finishing coat shall consist of coarse aggregates of crushed stone or fine gravel of size generally 6 to 12 mm as approved by Executive Engineer and specially graded mixture, mixed with approved sand and cement. The proportion of cement to sand and

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aggregate/gravel shall be generally 1: 1½ : 3 The mortar shall be flung upon the under coat with large trowels to form an even protection coat,. The finishing coat must be applied while the under coat is still soft and plastic. The thickness of the finishing coat shall be about 12mm unless otherwise specified.

18. WHITE WASHING, COLOUR WASHING AND DISTEMPERING:

18.1 WHITE WASHING :

A. MATERIALS :

White wash shall be prepared from fresh burnt fat lime. The lime shall be dissolved in a tub with sufficient quantity of water (about 4/5 litres/kg. of lime) and the whole thoroughly mixed and stirred until it attains the consistency cream. The wash shall be taken out in small quantities and strained through a clean coarse cloth. Clean gum dissolved in hot water shall then be added in suitable proportion of two grams of gum arabic to a litre of lime to prevent the white wash coming off easily when rubbed. Rice seize may also be used instead of gum., gum Regd. Neel colour added for whiteness .

B. SCAFFOLDING :

This shall be double or single according to requirements and as directed. If ladders are used pieces of old gunny bags or cloth bags shall be tied on their tops to avoid damage or scratches to the plastered surfaces, etc. proper stage scaffolding shall be erected when white washing the ceiling

C. PREPARATION OF SURFACE :

The surface shall be prepared by removing all mortar droppings and foreign matter other means as may be ordered by the corporation's Engineers to produce an approved clean and an even surface. All loose pieces and scales shall be scraped off and holes, cracks etc. stopped with mortar to match with the surrounding finish. In case where the surfaces have been previously white washed or colour washed, the old white or colour wash shall be entirely removed and surfaces broomed down before the new white wash is applied. In case the old white wash cannot be removed by brooming, the surfaces shall be cleaned by scraping.

D. APPLICATION OF WHITE WASH :

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On the surface so prepared, the white wash shall be laid on with a brush. The first stroke of the brush shall be from top downwards, another from bottom upwards over the first stroke and similarly one stroke from the right and another from the left over the first brush before it dries. This will form one coat. each coat must be allowed dry and shall be subject to inspection and approval before the next coat is applied. When dry, the surface shall show no signs of cracking. It shall present a smooth and uniform finish free from brush marks and it should not come off easily when rubbed with a finger. Minimum 3 coats of white wash shall be applied.

No portions in the surface shall be left out initially to be patched up later on.

For old work, patches and repairs shall be white washed first. Thereafter, the whole surface shall be white washed with the required number of coats. For new work, the white washed surface shall present a smooth and uniform finish.

Doors, windows, floors and other articles of furniture, etc shall be protected from being splashed upon. Splashing, droppings, if any, shall be removed and the surfaces cleaned.

E. RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rates for white wash shall include for the following.

- i. All labour material, equipment required for white washing.
- ii. the surface for white wash including the scaffolding. Scaffolding including erection and removal.
- iii. Providing and preparing the white wash.
- iv. Preparing
- v. Applying the white wash in three coats minimum. If a proper even surface is not obtained to the satisfaction of the Executive Engineer in 3 coats, contractor shall carry out additional coats of white wash to approval at Contractor's expenses.

F. MODE OF MEASUREMENT :

The measurement shall be in sq. metre. The mode of measurement shall be as applicable to that for plaster.

18.2 COLOUR WASH :

MATERIAL :

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This shall be prepared by adding approved colouring matter to the white wash (prepared for white washing) according to that required. In all other respects the same conditions and specification as applicable to white wash shall also be applicable to colour wash.

18.3 DISTEMPERING :

POWDERED/DRY DISTEMPER :

a. MATERIAL :

The powdered/dry distemper shall be of approved colour and shade manufactured by M/s Blundell Eomite or other equivalent and approved.

b. SCAFFOLDING :

This shall be double or single as required and directed.

c. PREPARING THE SURFACE :

The surface to be distempered shall be cleaned and all cracks, holes and surfaces defects shall be repaired with gypsum and allowed to set hard. All irregularities shall be sand prepared smooth and wiped clean. The surface so prepared must be completely dry and free from dust before distempering is commenced. In the case for walls newly plastered, special care shall be taken to see that it is completely dry before any treatment is attempted. For the old surface which had earlier been distempered, the surface shall be cleaned of grease dust etc. the flaking of previous coatings, if any, shall be taken off. all cracks, holes, and surface defects shall be repaired with gypsum and allowed to set hard and then sand prepared smooth and wiped clean. But in case the surfaces are coloured or white washed, the wash must be removed thoroughly first.

d. PRIMING COAT:

The priming coat shall be applied over the completely dry surface in the manner recommended by the makers in the case of patent distempers. When no priming coat is specified by the manufacturer a finely powdered chalk mixed with a thin solution of glue shall be applied to prepare a good, hard background the coating when dry being sand prepared as clean and smooth as possible.

e. APPLICATION OF DISTEMPER :

The instructions of the makers shall be followed regarding the preparation of the surface and application of priming and finishing coats. Distemper shall not be mixed in a larger quantity than is actually required for a day's work. Hot water should be used to prepare the mixture. Distempers shall be applied in dry weather with a broad stiff brush in long parallel strokes. The treated surface shall be allowed to dry and harden. Second or succeeding coats shall not be applied until the proceeding coat has been passed by the Executive Engineer. Two more coats of distemper shall be given in exactly the same manner as the first one but only after the earlier coat laid has thoroughly dried.

f. RATED INCLUDES :

The rate shall include all labour, materials, equipment and tools for carrying out the following operations :

- i. Providing the primer and distemper and mixing the distemper.
- ii. Scaffolding.
- iii. Preparing the surface to receive the priming and finishing coats.
- iv. Applying the priming coat.
- v. Applying the distemper in 3 coats minimum. If a proper even surface is not obtained to the satisfaction of the Executive Engineer in 3 coats, Contractor shall carry out additional coats of distemper to approval at contractor's expense.

g. MODE OF MEASUREMENT :

Similar to that for white washing.

18.4 OIL BOUND DISTEMPER :

The specification and conditions for this shall be the same as that applicable for dry distemper above except that oil bound distemper or approved make, shade and colour shall be used after applying priming coat of petrifying liquid or other primer as may be recommended by the manufacturers of distemper or as directed.

19. PLASTIC EMULSION PAINT :

19.1 MATERIAL :

The emulsion paint and primers in general shall be of approved quality colour and shade as manufactured by M/s Goodlass Nerolac or other equal and approved.

19.2 SCAFFOLDING :

This shall be double or single as required and directed. If ladder are used, pieces of old gunny bags or cloth rags shall be tied on their tops to avoid damage of scratches to the plaster surfaces and flooring , etc. Proper stage scaffolding shall be erected when painting the ceiling.

19.3 PREPARATION OF THE SURFACE :

a. New surface :

The surface to be painted shall be cleaned and all cracks, holes and surface defects shall be repaired with plaster of Paris for spot filling and with filler prepared with whiting, water and little quantity of paint for filling and levelling the wider areas.

19.4 PRIMING COAT :

The priming coat of the approved shade shall be applied over the completely dry surface in the manner as recommended by the paint manufacturers. The emulsion paint, in the priming coat, may be thinned down with 20% water or as recommended by the paint manufacturer. Turpentine or any other solvent shall not be used for thinning the paint.

19.5 APPLICATION OF EMULSION PAINT :

The recommendation of approved paint manufacturers, whose product is used shall be followed regarding the preparation of the surface and the application of the priming and finishing coats. The contractor shall arrange for technical assistance and supervision from the paint manufacturer, during the execution of the painting work. After the priming coat has been applied and is perfectly dried all holes scratches if any, shall be repaired as mentioned in "preparation of surface" and then the second coat of approved shade and manufacture shall be evenly applied and allowed to dry. The third coat shall be carefully applied to achieve smooth and even surface after the previous coat has dried up. Minimum 3 coats of paint shall be applied inclusive of primer coat. If a proper and even surface is not obtained to the satisfaction of the Executive Engineer in 3 coats, contractor

shall carry out additional coats of painting to approval, at contractor's expense. care shall be taken that dust or other foreign materials do not settle or disfigure the various coats.

19.6 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rate for the item of plastic emulsion paint shall include for the following :

- i. All labour, materials and equipment necessary to carry out the work.
- ii. Supplying the approved emulsion paint for priming and finishing coats.
- iii. Preparing the surfaces for receiving the primer and finishing coats.
- iv. Scaffolding including its erection and dismantling.
- v. Application of one primer coat and minimum two coats of finishing. If a proper and even surface is not obtained to the satisfaction of the Executive Engineer, in 3 coats, contractor shall carry out additional coats of painting to approval at Contractor's expense.
- vi. Protection to painted surface till dried and handed over.
- vii. Expenses, if any, for supervision and technical assistance supplied by the approved paint manufacturer.

19.7 MODE OF MEASUREMENT :

The measurement shall be in square metre. The mode of measurement shall be as applicable to that for white washing.

20. PAINTING FRENCH POLISHING, WAX POLISHING :

20.1 POLISHING :

20.2 MATERIAL :

Ready mixed oil paints and primers, in general shall be of approved quality, colour and of approved manufacturer. These materials shall be in sealed tins and shall be opened in the presence of the Corporation's Engineer on site.

20.3 PREPARATION OF SURFACE :

- a. **IRON AND STEEL WORK** : Surface to be painted shall be thoroughly cleaned sand papered and/or rubbed with Emery cloth, if necessary, to remove grease,

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mortar or anything foreign material. In case of rusted surface, it shall be first cleaned with wire brush till the corroded rust is removed. The prepared surface shall be shiny and free from brush marks, patches, blisters and other irregularities. The surface thus finished shall be got approved for painting.

b. WOOD WORK :

All surfaces to be painted shall be thoroughly cleaned, sand papered and removed of all foreign materials. In case of surfaces having knot and nail holes, the same shall be filled with knotting and stopping materials. The knotting material shall consist of pure shellac dissolved in methylated spirit. Stopping materials, shall consist of putty. The surfaces thus treated shall be allowed to dry and then sand papered smooth.

20.4 APPLICATION :

After preparing the surface a primer coat shall be applied. The primer coat should be ready mixed of approved make and manufacturer. After the primer coat is applied and perfectly dried, all holes, cracks etc, if still remaining, shall be filled in with putty and the surfaces sand papered smooth. Then a second coat of paint of approved shade and manufacture shall be evenly applied and allowed to dry. The third coat shall be carefully applied to achieve smooth and even surface after the previous coat has dried up. Minimum 3 coats of paint shall be applied to inclusive of a primer coat. If a proper and even surface is not obtained to the satisfaction of the Executive Engineer in 3 coats, Contractor shall carry out additional coats of painting to approval, at Contractor's expense. Care shall be taken that dust or other foreign material do not settle or otherwise disfigure the various coats.

20.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rate for the item of painting shall include for the following :

- i. All labour, materials, and equipment necessary to carry out the work.
- ii. Supplying the approved paint for priming and finishing coats.
- iii. Preparing the surfaces including knotting and stopping for receiving the primer and finishing coats.
- iv. Scaffolding including its erection and dismantling.

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- v. Application of one primer, coat and two coats of finishing minimum. If a proper and even surface is not obtained to the satisfaction of the Executive Engineer in 3 coats. Contractor shall carry out additional coats of painting to approval at Contractor's expense.
- vi. Protection to painted surface till dried and handed over.

Mode of measurement :

Normally painting to wood work and steel shall be included in the concerned items of work and shall not be measured separately. If painting is to be measured separately the same will be as per I.S.:1200-1964. part –15

20.6 FRENCH POLISHING :

French polish to be used shall comply with I.S. 348-1952 in the requirements of quality and methods of test. Before French polish is applied, the surface of wood work shall be prepared in the same manner as for painting. The wood to be polished should be first painted with a filler composed of 1 part of whiting mixed with 0.53 part of methylated spirit. After drying, it should be finely sand papered. On the wood work thus treated a thin coat of French polish shall be applied and allowed to dry. After drying the surface shall be lightly rubbed with a lime sand paper prior to the second and third coat. The surface shall show an even polished surface and be approved by the Executive Engineer (Corporation's Engineer).

20.7 RATES TO INCLUDE : Similar to that of painting.

20.8 MODE OF MEASUREMENT : Similar to that of painting.

20.9 WAX POLISHING :

- a. The polish shall be of approved manufacture (e.g., Mansion Brand) or shall be prepared as under :
- b. A mixture of Bee's wax and turpentine in proportion of 2:1 by weight shall be used. The wax is melted and added to the turpentine, mixed well and allowed to cool.
- c. The surface of wood work shall be prepared as for oil painting before mixing. The wood work shall be measured with the mixture and allowed to remain overnight so that the mixture may soak into the pores of the wood. In the morning the superfluous wax shall be wiped off and the surface rubbed up with a soft flannel to a fine polish.

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20.10 RATES TO INCLUDE : Similar to that of painting.

20.11 MODE OF MEASUREMENT : Similar to that of painting.

21. CEMENT PAINTING :

21.1 MATERIAL :

External waterproof painting shall be of approved colour. Manufacture - Snowcem/ Durocem or other equivalent and approved quality.

21.2 PREPARATION OF SURFACE :

Before painting is commenced on surface, all dirt, oil, grease, efflorescence and organic material shall be completely removed. The surface shall be wetted by sprinkling of water with fine spray. The surface shall be sprayed several times with a few minutes intervals between each spraying to allow the moisture to soak into the surface.

21.3 APPLICATION :

Cement paint solution shall be applied to the surface with hair brushes in a number of coats to get uniform finish. After the first coat of paint is hardened, it shall be cured with water at least for 24 hours, before the application of the second coat. At least 24 hours should elapse between the two coats, similarly, 3rd coat shall be given to get uniform colour.

21.4 CURING :

Cement paint work shall be kept damp at least for 7 days.

21.5 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rate of providing cement paint shall include for the following :

- a. All labour , materials and equipment to provide cement paint.
- b. Scaffolding including erecting and removing.
- c. Preparing the surface as stated above.
- d. Applying 3 coats of approved Snowcem paint. If a proper and even surface is not obtained to the satisfaction of the Executive Engineer in the 3 coats applied, the Contractor shall provide additional coats painting to approval, at Contractor's expense.
- e. Curing as stated above.

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21.6 MODE OF MEASUREMENT :

Measurement shall be in Square Metre and as applicable to white wash. Nothing extra shall be allowed for painting the rough surface, for example, external sand faced plaster rough cast plaster etc.

22. LIME CONCRETE (BRICK BAT COBA) WATER PROOFING OF THE ROOF:**22.1 COARSE AGGREGATE :**

Coarse aggregate shall be broken from sound and thoroughly well burnt brick. These shall be strong, durable, clean and free from impurities and shall not contain any soft or powdery material. These aggregate shall be graded having a maximum size of 25mm generally conforming to I.S.3068 –1986 and approved by the Executive Engineer. Burnt brick aggregate shall be soaked thoroughly in water for a period not less than 6 hours before use in the concrete mix.

22.2 PREPARATION OF BASE :

The base shall be thoroughly rubbed, cleaned and slightly wetted and shall be got approved by the Executive Engineer before laying the concrete.

22.3 PREPARATION OF CONCRETE :

Lime and surkhi shall conform the relevant I.S. Specification. One part of Slaked Lime and two part of Surkhi by volume shall be mixed on a water tight platform. These shall be sprinkled with the required quantity of water and shall be well ground in a Mill or using mechanical grinders. The lime concrete shall be obtained by thoroughly mixing, the aggregate and lime surkhi mortar in the proportion of 2.5:1 part by volume. Concrete shall be mixed on a level impervious platform. The aggregate and mortar shall be and thoroughly incorporated by being turned over and over, backwards and forwards not less than 3 times, until every particle of the coarse aggregate is fully coated with mortar. No more concrete shall be mixed than can be laid in place and removed the same day. When it is necessary give greater fluidity to concrete, this shall be effected by adding where to mortar and remixing mortar and not to the mixed concrete.

22.4 LAYING :

Unless otherwise specified the average finished thickness of lime concrete shall not be less than 10 cms thick, after compaction, and minimum compacted thickness of the concrete layer shall no where be less than 7.5 cms. The top of concrete surface shall be given necessary slope as directed. After the lime concrete is laid, it shall be initially

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rammed with a rammer not more than 2 Kg. and finish brought to the required evenness and slope. The ramming shall be done rightly and rapidly to get the required compaction and to allow all the interstices to be filled with mortar. Further consolidation shall be done using wooden thapis by preferably female labour who will sit close together and beat the surface lightly and in rhythm and move forward gradually. Special care shall be taken to properly consolidate concrete at its junction with the parapet wall. The beating will normally have to be carried on for at least 7 days until the weight makes no impression on the surface and rebounds readily from it when struck. If the surface during the process of compaction becomes so uneven that water lodges in pools, the surface shall be pricked up and fresh lime concrete spread and consolidated as is necessary, so as to ensure proper slopes and levels. While the beating is in progress, the surface shall be sprinkled liberally with lime water and small proportion of sugar solution prepared by mixing about 3 Kgs. of jaggery and 1 1/2kg. 'Bael' fruit to 100 litres of water. On completion of beating, the mortar that comes on the top shall be smoothened with a towel or float, if necessary with the addition of sugar solution. Lime Concrete can be compacted with lime concrete tamping machine developed by CBRI, Roorkee. For the information of Contractors it may be informed that CBRI, Roorkee has developed the lime concrete tamping machine which gives the rapid, uniform and satisfactory compaction. This machine is being marketed by the following firms :

1. M/s M.S.S. Road, New Delhi - 5
2. M/s Roorkee Engineer and Co.,
16/67-68, Faiz Engineering Works,
Civil Lines, Roorkee (UP)

22.5 CURING :

The lime concrete after compaction shall be cured for six days until it hardens by covering with a thin layer of grass or straw which shall be kept wet continuously. Watering shall be done at frequent intervals, from a watering can through a perforated rose, in moderate quantity so as to ensure thorough setting of the concrete.

22.6 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the Contractor's rate quoted shall include for the following :

- i. Preparation of base.
- ii. Providing, laying and ramming lime concrete as directed above.
- iii. Compacting with lime, sugar and 'Bael' fruit solution as described above.
- v. Curing.

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- v. All labour, material and use of tools and equipments necessary for satisfactory completion of work.

22.7 MODE OF MEASUREMENT :

Lime concrete shall be measured in square metre as provided mentioning the average consolidated thickness.

23. CEMENT CONCRETE FLOORING IN TWO LAYERS:

23.1 PLAIN CEMENT CONCRETE FLOORING :

Unless otherwise mentioned in the item, concrete in flooring shall be 40mm thick overall and shall be laid in two layers. The concrete in under layer, unless otherwise specified, shall be in the proportion of 1:2:4 (Cement : Fin Aggregate : Coarse stone aggregate of size 12.5 mm and below) by volume and the proportion of the cement concrete for the top wearing layer shall be 1:2 (Cement : Combined stone aggregate 4.75 mm and below) by volume. Cement, however shall not be measured in volume but by weight. One bag of cement of 50 Kgs, shall be assumed to contain 35 litres of cement i.e., 1.20 cft. The coarse aggregate shall be from approved source, carefully selected, sufficiently tough and hard stone pieces broken in a manner that will provide particles of approx. cubical shapes affording good interlocking. Elongated or thin flake like fragments should be avoided. The fine aggregate shall be sand from approved source and consist of properly graded particles. The coarse and fine aggregates shall be conforming to relevant I.S. : 383-1963 and shall be washed clean if necessary.

Unless otherwise mentioned in the item, the cement concrete in under layer shall 25mm thick and the top wearing layer shall be 15mm thick. The concrete shall be as stiff as possible and the amount of water added shall be minimum necessary to give just sufficient plasticity for laying and compacting. For improving the workability of the mix thorough mixing for a longer period rather than addition of more water shall be resorted to generally a water cement ratio of 0.5 (By weight) should suffice. Mix shall be used within half an hour of the addition of water for its preparation.

23.2 PREPARATION OF SUB-GRADE :

Before placing the concrete flooring the sub-grade shall be got approved from the Corporation's Engineer. The top surface of the sub-grade, shall be thoroughly cleaned of the dirt, loose particles, cake mortar droppings and laitance if any, by scrubbing with coir

or steel wire brush or by hacking if necessary. The top surface of sub-grade shall be slightly tough and shall have the required slope. The sub-grade shall be moistured before laying the concrete flooring without forming any pools of water.

Before commencement of laying under layer of concrete on the prepared sub-grade, "Screeds" i.e., narrow strips of wood, bands of plaster or pieces of tiles laid on the sub-grade to act as guides for bringing the whole work to a true and even surface and imparting necessary slope to the under layer with average thickness of 25mm or as specified in the item shall be provided. The screed shall be removed after laying the concrete for under layer of all the floor area for which they have been applied as guides and filled up with concrete mix of under layer. No extra payment shall be made for these 'Screed'.

23.3 LAYING :

The concrete flooring shall be laid in alternate bays not exceeding 2x2M each. The edge of each panel into which the floor is divided should be supported by flat iron or wood duly oiled to prevent sticking. Their depth shall be same as that proposed for the concrete flooring as mentioned in the item. The flat iron should be removed before filling in the adjoining panels. At least 48 hours shall elapse before the concreting in the adjoining bays is commenced. A.C. glass aluminium strips or other approved separators (Depth to be same as that proposed for concrete flooring) shall be provided if specified in the item and shall be retained permanently in the concrete flooring. Care shall be taken to see that at no point the separators shall protrude above the finished floor level. Just before placing the concrete mix for under layer, neat cement slurry shall be thoroughly brushed into the prepared sub-grade.

The concrete for under layer shall be laid immediately after mixing. While being placed, the concrete shall be vigorously sliced and spaded with suitable tools to prevent formation of voids or honey-comb pockets. The concrete shall be brought to the specified levels by means of a heavy straight edge resting on the side forms and drawn ahead with a sawing motion in combination with a series of lifts and drops alternate bays, care shall be taken to ensure that the edges of previously laid bays are not broken by careless hard tamping. Immediately after laying the concrete, the

surface shall be inspected for high or low spots and any needed correction shall be done by adding or removing the concrete. After striking of the surface to the required grade, it shall be compacted with wooden float. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given to complete the ramming.

The surface of the concrete in under layer as laid above, shall not be finished smooth with a trowel but left rough after tamping it and levelling it with screed board.

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The top wearing layer of mix 1:2 cement concrete of consistency stiffer than that of under layer concrete shall then be immediately laid over the rough but green surface of under layer and thoroughly tamped, struck of level, and the surface floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any undulation in the surface which, if any, shall be made good immediately. The surface shall then be finished smooth as stated below.

23.4 FINISHING THE SURFACE :

After the concrete has been fully compacted it shall be finished by trowelling. Finishing operations shall start shortly after the compaction of concrete and shall be spread over the period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled at intervals so as to produce a uniform and hard surface. The satisfactory resistance of floor to wear depends largely upon the care with which trowelling is carried out. The object of trowelling is to produce as hard and close knit a surface as possible. The time interval allowed between successive trowelling is very important. Immediately after laying top wearing layer, only just sufficient trowelling shall be done to give a level surface. Excessive trowelling in the earliest stages shall be avoided as this tends to work a lay rich in cement to the surface. Sometime after the first trowelling the duration depending upon the temperature, atmospheric conditions and the rate of set of cement used, the surface

shall be retrowelled to close any pores in the surface, and to bring to surface and scrap off any excess water in concrete or laitance (It shall not be trowelled back into the topping). The final trowelling shall be done well before the concrete had become too hard but at such a time that considerable pressure is required to make any impression on the surface. The finished surface shall be smooth and even. Trowelling of a rich mix of dry cement and fine aggregate on to the surface shall not be permitted. The junctions of floor and walls shall be rounded off if so directed without extra payment.

Trowel marks, wherever visible shall be immediately removed by lightly brushing with 100 mm wide painter's brush which is made just moist, so as to have the surface of uniform appearance. Over brushing shall be avoided.

After the concrete in the bays has set, the joints (If permanent separators are not provided) of the panel shall be filled with cement paste as directed. The joints shall be straight both ways i.e., along with length and width. The vertical edge of the bays shall be neatly marked on the surface with a pointed trowel after filling the joints. No extra mortar shall be laid over the concrete to make the floor in level.

If broom finish is specifically mentioned in the item, the surface shall be obtained rough with parallel broom marks before the concrete sets.

- 23.5** If coloured cement flooring is specified in the item, the top wearing layer shall consist of concrete mix coloured with the addition of coloured cement and approved mineral pigment of required colour thoroughly mixed with cement when dry. Quantity of approved mineral pigment shall be such as to produce required shade but in no case will it exceed one third part of cement.

A few samples of coloured concrete flooring of required colour and shade (Light shade, medium or Dark shade as specified in the item) be got approved from the Executive Engineer before commencement of flooring work.

23.6 CURING :

Immediately after the flooring surface is finished, it shall be protected from rapid drying by erecting barriers against wind or draught and strong sunlight. As soon as the surface has hardened sufficiently to prevent damage to it, it shall be kept continuously moist for at least ten days by means of wet gunny bags, 50mm thick layer of damp sand spread over the surface or pooling water on the surface. During this period the flooring shall not be exposed to any traffic.

23.7 HAND GRINDING AND POLISHING :

Wherever specified in the item grinding shall be carried out as under, to make the surface smoother than trowel finish.

a. FIRST GRINDING WITH CARBORUNDUM STONE OF COARSE GRADE.

Grinding shall be commenced when the concrete surface is 3-4 days old and sufficiently hardened and cured. The first grinding should be done with Carborandum stone of coarse grade and fine sand sprinkled over the surface using water freely. After the first grinding, the surface shall be thoroughly washed to remove all grinding mud and covered with a grout of cement (Including colouring pigment in case of coloured concrete flooring) in order to fill the pores and pin holes that appear after grinding.

b. SECOND GRINDING WITH CARBORUNDUM STONE OF MEDIUM GRADE :

After the first grinding is over the surface shall be cured for 4 days and then the second grinding should be started with carborundum stone of medium grade. The flooring shall be washed and pores or holes if any shall be filled in the same manner as described in (a) above.

c. **FINAL GRINDING WITH CARBORUNDUM STONE OF FINE GRADE :**

After ten days from the completion of the second grinding. The final grinding shall be carried out with carborundum stone of fine grade.

d. **CLEANING AND POLISHING :**

After the completion of the grinding and above the floor shall be thoroughly washed with warm water and soft soap and when it is completely dry. Oxalic acid powder shall be dusted over the surface sufficiently, which must be sprinkled with water and rubbed hard with a piece of fell till the surface has acquired required gloss.

A hot mixture of turpentine and Bees Wax (4:1 by weight) shall then be applied to the surface and thoroughly rubbed with clean cotton waster. The rubbing must be continued until the flooring ceases to be sticky.

23.8 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in the contract, the rates shall include for the following :-

- i. Cleaning and preparing the sub-grade.
- ii. Providing and laying concrete of specified mixes and finishing the surface as described above.
- iii. Providing and fixing A.C. glass/Aluminium strips or the approved separators to form panels when specified.
- iv. Curing.
- v. Providing coloured cement and approved mineral colouring pigment when coloured concrete flooring is specified.
- vi. Grinding and hand polishing when specified.
- vii. All labour, materials, tools and equipment for carrying out the item as specified above.

23.9 MODE OF MEASUREMENT :

The measurement shall be in square metres of cast-in-situ cement concrete flooring as provided.

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24. THERMOLITHCRETE PARTITIONS:

24.1 THERMOLITHCRETE PARTITIONS :

Moisten the Thermolite Blocks (Do not soak in water) before use and back or roughen surface of the blocks so as to enable them to hold the plaster rigidly.

24.2 Use 1 to 4 ratio of cement sand mortar for jointing Thermolite Blocks. The joints between blocks should be staggered (Break joints) and should be not more than 12mm thick.

24.3 At every alternate layer of Thermolite Blocks, provide a hoop iron strip horizontally to give extra rigidity to the wall. At the time of erecting the wall not more than 3 layers of Thermolite Blocks should be laid at a time, otherwise the lower layer will go out of plumb. The same process may be repeated next day.

24.4 After the wall is erected, the joints should be sprinkled with water. Then allow the wall to dry for a minimum of 8 to 12 days or more. If possible, before commencing the plastering work. Electric conduits or plumbing pipe fittings should be embedded in the wall before the final plastering.

24.5 For plastering use 1 to 4 cement sand mortar. The plaster shall not be more than 12mm thickness. Finishing of the plaster can be done in any surface i.e., in Neeru or rough cast. After the plastering is done, it should be cured by spraying with water for at least four days. If the Thermolite Block Walls are in flush line with walls or beams, a chicken mesh over the joints should be provided over lapping 23 cm. on either sides.

24.6 For making a cavity wall, by using two layers of 75mm thick blocks of Thermolite on each side keeping about 100 mm hollow space in between two layers, a cross stay of a Thermolite Block piece to hold both walls together, should be provided at every alternative layers at a distance of every 1.2 M to 1.5 M.

24.7 Teak wood or steel frames of doors can be fixed in the same manner as the doors are fixed in brick walls. Hold-fasts can be fixed on the frames and embedded in the Thermolite Block walls.

24.8 When fixing teakwood door frames, first cut off the top 'horns' which project out of the frames and which are normally embedded in walls and covered by plaster. In this case the plaster generally cracks at the top corners but if the horns are cut off, and the top corners are square, the plaster will not crack at these corners.

25. RANDOM RUBBLE MASONRY SECOND SORT

All the specifications for random rubble masonry second sort shall be same as for 'UNCOURSED RUBBLE MASONRY' (Refer page nos. 104 to 110) except for the following :

25.1 FACE STONE :

Height shall not be greater than breadth of face and no stone shall have its length less than 1 1/2 times its height. All the sides of the stones on the face shall be dressed in straight lines and all the sides in the face shall be in one plane. Individual stones shall have generally a face area of not less than 0.05 sqm. They shall be as far as possible of equal size on the face.

Faces shall be only hammer dressed as explained below. The bed and the joint faces shall afford a square bearing of 2.5 cm. average from face by hammer dressing or chiselling. The sharp and irregular projections on the face shall be knocked off by the flat end of scabbing or spelling hammer. The surface shall be further dressed by lifting the hammer and then allowing the pointed end to drop on the surface freely. This process shall be continued till a fairly uniform and even stone surface is obtained. Chisel may be used to obtain straight edges for the sides and square surfaces for the beds and joints.

25.2 HEARTING AND BACKING STONES :

These stones shall not be less than 15 cm, in any direction for hearting. Backing stones shall conform to "Uncoursed Rubble Masonry" when it is to be plastered.

25.3 QUOINS :

The faces of quoins shall be rough tooled and side joints with masonry shall be vertical.

25.4 THROUGH STONES :

One through stone shall be provided per half square metre of facing evenly distributed in a staggered pattern. They shall be about 0.05 sqm. in face area.

25.5 CONSTRUCTION DETAILS :

The width of the joints shall not be more than 12mm.

25.6 RATE TO INCLUDE :

Rate shall include for construction of random rubble masonry second sort as per specification above.

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26. CRAZY MARBLE MOSAIC FLOORING/CRAZY MARBLE FLOORING :

GENERAL :

The item refers to the provision of crazy marble mosaic surface (Broken marble, mosaic tile pieces) set in cement mortar or lime mortar as specified , well compacted and finished and laid in the required positions with ordinary or coloured cement float.

MATERIALS :

26.1 BROKEN MARBLE MOSAIC TILE PIECES :

These shall be obtained from broken marble mosaic tiles (20mm thick) broken marble slabs of approved shade and manufacture and conforming to I.S.1257-1959. The sizes of pieces should be suitable to obtain the correct pattern of flooring as shown on the drawings or as directed by the Executive Engineer.

26.2 MORTAR BEDDING :

The base of lime concrete shall be laid and compacted to required slopes as shown on the drawings or as directed by Executive Engineer. Lime Concrete base shall be paid under separate item. Unless otherwise mentioned the proportion of mortar shall be 1:4 (1 cement : 4 sand) in case of cement mortar and 1:1:1 (1 lime putty : 1 surkhi : 1 sand) in case of lime surkhi mortar. Lime Surkhi mortar for bedding shall be prepared in a mortar mill. The amount of water added shall be minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the tiles. Before spreading mortar, sub floor or base shall be cleaned of all dirt, scum, laitance and all loose material and then well wetted without forming any pools of water on the surface. The sub grade or the base shall be got approved from the Executive Engineer. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much areas as will be covered with tiles before the setting of the mortar. The thickness of the mortar bed shall not be less than 25mm. Sand for mortar bedding shall be as per I.S.S. No. 2116-1965 as applicable to unreinforced masonry work.

26.3 LAYING, CURING, POLISHING, FINISHING AND CLEANING :

Mosaic tile/marble pieces shall be thoroughly wetted before fixing them. Ordinary coloured cement grout as required of honey-like consistency shall be spread over the mortar bedding when the mortar is still plastic. In this cement float, mosaic tile/marble pieces shall be fixed piece by piece to the required slope and pattern. The fixing shall be

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done by keeping the joints between the places as thin as possible. The flooring shall be laid to the correct level and slopes and compacted by striking the surface with hard weights and straight screed tamper. The grout shall cream up to the surface. The junctions of the flooring extended up the wall for 15 cm. After the flooring has been laid or the Day's fixing work is completed the surplus cement grout that may have come out of the joints on compacting shall be cleaned off.

The flooring laid shall be kept moist and allowed to mature undisturbed for 10 days to allow the bedding and flooring to set properly. After this, the surface shall be polished with a machine. Once the floor has set and is polished it shall be carefully washed clean and dried. When dry, the floor shall covered with oil free dry saw dust which shall be removed only after the construction work is completed.

26.4 RATES TO INCLUDE

Apart from other factors mentioned elsewhere in this contract, the Contractor's rate quoted shall include for the following :

- i. Providing and laying the mortar bedding to required slopes.
- ii. Providing and fixing mosaic tile pieces in masonry or coloured cement float on the bedding to the required pattern and compacting.
- iii. Approved waterproofing compound (If specified in the item).
- iv. Curing
- v. Polishing and cleaning the floor.

26.5 MODE OF MEASUREMENT :

The Contractor's rate shall be per square metre of the floor area covered. All work shall be measured net as provided including rounding at the junction of parapet walls and flooring.

**WATER SUPPLY, INTERNAL SANITARY INSTALLATIONS
AND DRAINAGE WORK - GENERAL SPECIFICATION**

1. GENERAL

- 1.1** All water supply, internal sanitary installations and drainage work shall be carried out by skilled and licensed plumbers manner complying in all respects with the requirements of the relevant by-laws of the Municipal or of the local bodies in whose jurisdiction the work is to be executed.
- 1.2** All fittings are to be accurately placed in the positions as directed by Executive Engineer, to be securely plugged to walls with hard wood or any other approved plugs or set in cement as required and are to be left in a clean, sound and perfect condition.
- 1.3 ALL SIZES AND LENGTHS TO BE VERIFIED AT SITE.**
- 1.4** The whole of the work is to be tested at Contractor's expense at such times and in such manner as Executive Engineer shall direct and to the latter's satisfaction. The Contractor shall also make arrangements for the disinfections of all mains and tanks intended for potable water to the satisfaction of the Executive Engineer and rates quote shall include for same. The mains and tanks should be thoroughly flushed with clean water after disinfections.
- 1.5** All damage done to floors, walls etc., during the process of fixing of water supply, internal sanitary installations and drainage work shall be restored to original condition to the satisfaction of the Executive Engineer at the Contractor's Expense.
- 1.6** All the materials shall be in accordance with the specifications and shall be approved by the Executive Engineer before bulk supplies are brought to site. The Contractor shall furnish well in time before work commences, at his own cost, any samples of materials or workmanship that may be called or by the Executive Engineer for his approval or rejection and any further samples in case of rejection until such samples are approved. Such samples when approved shall be the minimum standard for the work to which they apply. Where materials are specified to complete with an Indian Standard Specification, the Contractor shall, if required, furnish the Manufacturer's Certificate that the materials satisfy plumbing works, typical samples proto types shall be erected in position for approval before undertaking work. Rates quoted shall cover for such preliminary work. Materials rejected shall be removed forth with by the Contractor off the Premises.

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Sewers and drains shall be laid in proper alignment and gradient in accordance with the rules and regulations of statutory bodies whose approval are necessary on completion.

II. WATER SUPPLY :

2. CAST IRON PRESSURE PIPE AND SPECIALS.

2.1 Pipes and Specials : All pipes and specials shall be of cast or spun iron, straight with spigot and socket ends or with flanged ends as specified and shall conform to the latest edition of the Indian Standards Specification for class 'LA' pipes. Class A pipes may be used when the test water pressure exceeds 120 metre of head. The pipes and special shall be suitable for jointing with lead unless otherwise specified. As far as possible only standard specials shall be used.

2.1.1 All pipes shall be coated inside and outside while hot with an approved anti-corrosive paint having a tar or other suitable base.

2.1.2 Excavation of trenches for C.I. pipes and Specials :

2.2.1 EXCAVATION :

The trenches for the pipes shall be excavated to lines and levels as directed. The bed of the trenches shall have to be truly and evenly dressed throughout from one change of grade to the next.

2.2.2 The gradient is to be set out by means of boning rods and should the required depth be exceeded at any point the trench shall be refilled as directed by the Executive Engineer at the Contractor's expense.

2.2.1.3 The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and depressions thus formed shall be filled with sand or other soft materials as the Executive Engineer may direct.

2.2.1.4 If rock is met with, it shall be removed to 15 cm below the level of the pipe valves and fittings and the trench shall be refilled with sand or other suitable materials.

2.2.1.5 The excavated materials shall not be placed within 1 metre or half the depth of the trench, whichever is greater from the edge of the trench.

2.2.1.6 The trench shall be kept free from water. Shoring and timbering shall be provided wherever required.

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2.2.1.7 The width of trench at bottom between laces of sheeting shall be such as to provide not less than 20mm clearance on either side of pipe. Trench shall be of such extra width when required as will permit the convenient placing of timber support, strutting and planning and handling of specials.

2.2.2 Road Crossing : All road crossing will be excavated half at a time the second half being commenced, after the pipes have been laid in the first half and the trench refilled. The trench at existing road crossing shall be tiled with mud concrete for the full depth except for the top 15 cm layer, which will be filled with cement concrete 1:2:4. The rates quoted shall also cover the cost of breaking road surfaces of all types wherever met with including their foundations.

2.2.3 Protection of Existing Service : All pipes, water mains cables etc., met within the course of excavation shall be carefully protected and supported by the Contractors at their own cost to the satisfaction of the Executive Engineer. Such mains will be hung from timbers placed across the trench. Care shall be taken not to disturb the electrical and communication cables, removal of which if necessary shall be arranged by the Executive Engineer.

2.2.4 LIGHTING AND WATCH :

The open trenches shall be provided with fencing and watchmen to guard against accidents. Red flags during day and red lights during night shall be provided at the ends and at intervals along the sides of the trenches.

2.2.4.1 Sign boards with necessary wording such as "SLOW" , "ROAD CLOSED" etc., shall be provided at least 30 metres ahead of road crossings where the work is in progress. The precautions will be continued till the surface is restored. The Contractor shall be held responsible for compensation as a result of accident or injury to any person or property due to improper fencing or inadequate lighting arrangements.

2.2.4.2 Temporary bridges of planks shall be provided over the trenches for keeping open the access to private or public property.

2.3 LAY OF PIPES AND SPECIALS :

2.3.1 Stacking : The pipes and specials shall be lined up on one side of the trench, socket facing up hill or in the direction of flow of water.

2.3.2 Laying : Before being laid the pipes shall be examined to see that there are no cracks or defects subject to the approval of the Executive Engineer, the damaged portion of the cracked pipe may be cut a point not less than 15 cm beyond the visible extremity of the

crack with diamond pointed chisel. Before lowering the pipe in the trench, the pipes shall be thoroughly cleaned of all dust and dirt. Special care shall be taken to clean the inside of the sockets and the outside of the spigots. Holes to receive the sockets shall be excavated in the trench bed so as to firmly bed the full length of the pipe.

2.3.2.1 The pipes shall be lowered into the trench by means of suitable pulley blocks, shearings, chain, ropes etc., in no case the pipes shall be rolled and dropped into the trench. After lowering the pipes, the spigot of one pipe shall be carefully centered into the socket of the next pipe and driven to the full distance that it can go and the pipe line laid to levels required, being kept in position by earth filling well watered and rammed at two or more places in its length.

2.3.2.2 Specials shall also be laid in their proper position as stated above.

2.3.2.3 The pipes laid on level ground, will be laid with socket facing the direction of flow of water. In all other cases, the sockets will be laid facing up hill.

2.3.2.4 Any deviation either in plan or elevation of less than $11\frac{1}{4}$ (Degree) percent shall usually be effected by laying the straight pipes round a flat curve of such radius that minimum thickness of lead at the face of the socket shall not be reduced below 12 mm or the opening between spigot and socket increased beyond 12 mm at any joint. A deviation of about $2\frac{1}{2}$ degree can be effected at each joint in this way.

2.3.2.5 At the end of each day's work, the last pipe to be laid shall have its open end securely closed with a wooden plug to prevent access to dirt and animals.

2.4 Thrust blocks and Anchorage : Portland cement concrete thrust blocks of suitable design shall be provided at all bends of the pipes so as to withstand dynamic and static forces likely to be developed due to water running through the pipes. The thrust blocks shall be made after the joints have been chaulked with lead and these shall be paid for separately, unless otherwise specified.

2.5 LEAD CAULKED JOINT :

2.5.1 Lead for joints : It shall be bluish grey in colour very soft and malleable of uniform quality readily melted free from foreign material and shall conform to I.S.782.

2.5.2 Spun yard for joints : This shall be of best quality preferably white, it shall be free from oil, tar or greasy substances and shall be soaked in hot coaltar or bitumen and dried before use.

2.5.3 JOINTING :

The yarning materials shall be placed around the spigot of the pipe and shall be of proper dimensions to centre the spigot in the socket. When spigot is shoved home, the yarning material shall be driven tightly against the inside base or hub of the socket with suitable yarning tools. When a single strand of yarning material is used, it shall have an overlap at the top not more than 5 cm. When more than a single strand is required for a joint, each strand shall be cut to sufficient length so that the ends will meet without causing overlap. The ends of the strands shall meet on opposite sides of the pipe and not on the top or at the bottom. Successive strands of yarning material shall be driven home separately. The leading of the pipes etc., shall be done by means of ropes covered with clay or by using special leading rings. The lead shall be rendered thoroughly fluid and each joint shall be filled in one pouring.

2.5.4 Quantity of lead and yarn : Approximate weight of lead and yarn required for joint for various sizes of C.I. pipes and specials shall be as per I.S.3114 as under :-

Dia of Pipe	Lead/Joint	Spunyarn/Joint
80 mm	1.8 Kg.	0.10 Kg.
100 mm	2.2 Kg.	0.18 Kg.
125 mm	2.6 Kg.	0.20 Kg.
150 mm	3.4 Kg.	0.20 Kg.
200 mm	5.0 Kg.	0.30 Kg.
250 mm	6.1 Kg.	0.35 Kg.
300 mm	7.2 Kg.	0.48 Kg.
350 mm	8.4 Kg.	0.60 Kg.
400 mm	9.5 Kg.	0.75 Kg.

NOTE : The quantities of lead and spun yarn given in this table are provisional and a variation of 20 % is permissible.

2.5.5 CAULKING :

After the joints have been run they must be thoroughly caulked until they are perfectly water-tight. Caulking of joint will be done after a convenient length of pipe has been laid and leaded. The leading ring shall first be removed and any lead, outside the socket shall be removed and any lead, outside the socket shall be removed with a flat chisel and then

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the joint caulked round three times with caulking tools of increasing thickness and a hammer of 2 to 3 Kg. weight. Lead joints shall not be covered till the pipe line has been tested under pressure but the rest of the pipe line may be covered up to prevent expansion and contraction due to variation in temperature.

2.5.6 LEAD WOOL JOINT :

When it is impractical or dangerous to use woollen lead for joints they may be made with lead wool inserted in strings not less than 6mm thick and thoroughly caulked.

2.6 FLANGED JOINTS :

C.I. pipes may also be jointed by means of flanges cast on where specified. The jointing material between flanges of pipes shall be compressed fibre board or rubber of thickness between 1.5 mm to 3mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per Sqm. shall be not less than 112 gm/mm thickness.

- 2.6.1** Each bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable.

2.7 TESTING :

Before testing, the trench shall be partially back-filled except at the joints. Completed pipe line shall be subjected to the following tests :

- a. Pressure test at a pressure of at least double the maximum working pressure ; pipe and joints shall be absolutely water tight under the test.
- b. Leakage test (To be conducted after the satisfactory completion of the pressure test) for a duration of two hours.

- 2.7.1** Where any section of a main is provided with concrete thrust blocks or anchorage, the pressure test shall not be made until at least five days have elapsed after the concrete was cast.

2.7.2 PRESSURE TEST PROCEDURE :

Each valued section of the pipe shall be slowly filled with water and all air shall be expelled from the pipe through hydrants and blow offs. If these are not available at high places, necessary tapping may be made at points of highest elevation before the tests made and plugs inserted after the tests have been completed.

2.7.2.1 The specified pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Executive Engineer. The duration of the test shall not be less than 5 minutes.

2.7.2.2 All exposed fittings, valves, hydrants and joints should be carefully examined during the test. When the joints are made with lead, all such joints showing visible leaks shall be recaulked until tight. Any cracked or defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by sound materials and the test shall be repeated at Contractor's own expense until satisfactory results are obtained.

2.7.3 LEAKAGE TEST PROCEDURE :

Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

2.7.3.1 Should any test of pipe laid disclose leakage greater than that permitted by IS Code of Practice 3114, defective joints shall be repaired at Contractor's own expense until the leakage is within the specified allowance.

2.8 Refilling : Refilling in trenches for pipes shall be commenced as soon as the joints have been tested and passed. The filling on top and round the pipes, shall be done with great care and in such a manner so as to obtain the greatest amount of compactness and solidity possible. For this purpose each filling shall be done in regular layer of 15 cm (Watered and rammed at each layer). All surplus earth shall be disposed of as directed by the Executive Engineer.

3. G.I. PIPES AND FITTINGS :

3.1.1 Pipes and fittings : The pipes shall be of the class specified in the Schedule of quantities and shall be galvanised steel welded and seamless, screwed and socketed and shall conform to the latest Indian Standard

3.1.2 Specifications for such pipes. They shall be manufactured by a firm of repute. All fittings shall be of malleable iron galvanised fittings of approved make.

3.1.1 The details of screwed and socketed G.I. pipes regarding nominal bore thickness and weight shall be as per IS 1239 (Part I) as under :-

Nominal Bore	Light	Medium	Heavy
15 mm	0.96	1.23	1.46

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20 mm	1.42	1.59	1.91
25 mm	2.03	2.46	2.99
32 mm	2.61	3.17	3.87
40 mm	3.29	3.65	4.47
50 mm	4.18	5.17	6.24
65 mm	5.92	6.63	8.02
80 mm	6.98	8.64	10.30
100 mm	10.20	12.40	14.70

(The above weights are for black pipes and theoretical weights of galvanised pipes are of about 6% higher).

- 3.1.2** The pipes shall be tested to withstand a pressure of 50 Kg/Sqcm. without showing defects of any kind. These shall be supplied screwed with taper threads and the sockets with parallel threads.

3.2 LAYING IN TRENCHES FOR EXTERNAL WORK :

G.I. pipes and fittings shall be laid in trenches. The width of the trench shall be the minimum width required for the working. The pipes laid underground shall not be less than 60 cm from the ground level. They shall be surrounded on all sides by approved quality material. The work of excavation and refilling shall be done as specified earlier for Cast Iron Pressure Pipes. All pipes and fittings laid below ground shall be painted with anti-corrosive bitumastic paint and wrapped with hessian and again coated with anti-corrosive bitumastic paint of approved quality. The cost of the above shall be included in Contractor's rates.

- 3.2.1** Pipes embedded in masonry/concrete shall be treated similarly as described above.

- 3.3** Fixing of pipes for internal work : G.I. pipes and fittings on the walls shall be fixed by means of standard pattern holder bat clamps, keeping the pipe 12mm clear of the plastered surface of wall everywhere, or concealed (Inside chase) as directed. Where pipes are to be concealed in walls and floors by cutting chases, the pipes and fittings shall be coated with bitumen wrapped with hessian and again painted with one coat of anti-corrosive bitumen of approved quality and rates quoted shall include for same. Cutting long lengths of horizontal chases on the walls for concealing pipes shall be avoided.

- 3.3.1** All exposed G.I. pipes and fittings shall be painted with two coats of synthetic enamel paint of approved quality, manufacture, colour and shape, over a coat of red-oxide or other approved primer after cleaning thoroughly the surface of the pipes and fittings and allowed to dry. The cost of such painting shall be included in the rates quoted by the Contractor.

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- 3.3.2** All pipes and fittings shall be fixed truly vertical and horizontal or as directed by the Executive Engineer. Care shall be taken to ensure that concealed G.I. Pipes (Used for external or internal works) are not laid in lime mortar or lime concrete surroundings.
- 3.4** Jointing : Where pipes have to be cut or re-threaded ends shall be carefully filed out so that obstruction to bore is offered.
- 3.4.1** In jointing the pipes, the inside of the soaked and the screwed end of the pipe shall be rubbed over with white lead and few turns of home yarn wrapped round the screwed end of the pipe which shall then be screwed home in the socket with a pipe wrench. Care must be taken that all pipes and fittings are kept at all times free from dust and dirt during fixing.
- 3.5** All G.I. pipes and fittings may be tested to a pressure of 7 kg/Sqcm. to ensure that pipes have proper threads and that proper materials (Such as white lead and hemp) have been used in jointing. All leaky joints must be made leak proof by tightening or redoing at Contractor's expense.

4. WATER METERS, SLUICE VALVES AND OTHER APPLIANCES :

4.1 WATER METERS (DOMESTIC TYPE) :-

Water meters up to 50 mm nominal size shall conform to I.S. specifications for water meters (Domestic Type) I.S.779 of Type A unless otherwise specified. The meter body shall be of bronze gun metal or brass and marked to read in litres complete with registration box, cap and lid. The water meters shall be provided with strainers. Strainers shall be of a material which is not susceptible to electrolytic corrosion. They shall be laid easy to remove and clean and shall be possible to remove and clean the strainer in such a way as not to permit disturbing the registration box or tampering with it. Meters provided with internal stainer involving opening of the registration box for cleaning , shall be fitted with an additional strainer on the inlet side and rates quoted by Contractor shall include for such additional strainer, cost of testing and sealing by local municipal authorities.

4.1.1 CONNECTIONS :

The meter casing shall be lifted in the pipe line by two conical or cylindrical nipples or tail pipes with connecting nuts which shall be provided with each meter. The nipples of waters shall be made of the same materials as specified for body.

4.1.2 MAKINGS :

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Each meter shall be marked with the following information :

- a. Nominal Size.
- b. Direction of flow.
- c. ISI Certification mark
- d. Manufacturers name and trade mark.

4.2 WATER METERS (BULK TYPE) :

These shall conform I.S. : 2373 and shall be of size 50mm and above. They shall be of (Impeller) vane wheel type or helical type. The body of the meter shall be made from cast iron. The meter casing shall be fitted into the pipe line by means of a double flange, the internal diameter of which shall be equal to nominal size of meter. The meter shall be provided with registration box and cap of brass or cast Iron. Provision shall be made to lock the lid to registration box. Meters shall be supplied and fitted with an External Strainer (Dirt Box) for suitable materials not susceptible to electrolytic corrosion and rates quoted by Contractor shall include for the same. Meters shall be provided with makings as described in Clause 4.1.2 above.

4.3 FERRULES :

Brass ferrules shall conform to IS : 2962. Necessary saddle pieces of approved type shall be used for all take of the service connections and rates quoted shall include for the same.

4.4 SLUICE VALVES :

Sluice valves shall conform to IS:780 and shall be of Class I type unless otherwise specified with double flange and hand wheel for operation. The body, dome, cover, stuffing box, thrust plate, wedge, gland and cap may be of cast iron but the spindle shall be of brass or Aluminium bronze. Valve shall be fixed to spigot and socket cast iron and steel pipes by means of suitable flanged spigots or flanged socketed tail piece as directed and rates quoted by Contractor shall include for the same before the valves are actually fixed, they shall be cleaned and greased and it should be seen that all parts are in perfect working condition.

4.4.1 SURFACE BOXES FOR SLUICE VALVES :

This shall conform to I.S.3950 with a cast iron frame and mild steel hinge pin. The upper surface of the cover shall have non slip surface. The surface boxes shall be coated with a composite on having bitumen or tar base. The minimum weight of surface box shall be 33 kg. The internal size of surface box shall be 230 mm x 150 mm x 150 mm.

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4.5 **AIR VALVES :**

These are placed at every summit in the pipe line to permit the escape of air when the main is filled and if any air is carried into the main. Fixing of air valves may be done by means of fixing saddle pieces on pipes and drilling the same where necessary. Rates quoted shall include for the same.

- 4.6** Brick Masonry Chambers for housing meters, valves and appurtenances : These shall be constructed as per size as indicated. This shall be measured and paid for separately. The bricks used shall be of best quality locally available and from approved source and shall be laid in cement mortar 1:3. The walls shall be plastered both inside and outside with 20 mm thick cement plaster 1:3. The foundation concrete shall be of P.C.C. 1:4:8 and 75 mm thick. The top slab shall be of 100mm thick R.C.C. 1:2:4 unless otherwise specified.

INTERNAL SANITARY APPLIANCES

5. SQUATTING PATTERN W.C.PAN :

5.1. W.C. PAN :

The pan shall be of white vitreous china of specified size and pattern ("Orissa" or "Long pattern" as specified) with an integral flushing rim. It shall have the flushing horn in the front unless it is not possible to accommodate cistern to suit this design. The pan shall be approved quality conforming to I.S. specifications IS: 2556 (part iii). It shall have 100 mm C.I. or porcelain trap 'P' of 'S' type, with effective seal 50mm and 50mm vent arm.

5.1.1 FIXING :

The W. C. pan shall be sunk in floor sloped towards in a workman like manner, care being taken not to damage the pan in the process of fixing. If damaged in any way, it shall be replaced at Contractor's cost. it shall be fixed on a proper cement concrete base of 1:3:6 proportion taking care that the cushion is uniform and even without having any hollows between the concrete base and pan and finished just below level of run of pan to receive the specified thickness to the floor finishing. A pair of foot rests for long pattern pans shall be fixed at a convenient angle where specified.

- 5.1.2** The joint between the pan and the trap shall be made with cement mortar 1:1 and shall be leak proof.

- 5.2** Flushing Cistern : The flushing of the W. C. pan shall be done by pull and let go flushing cistern of the valve less siphonic type conforming to IS:774 unless otherwise specified.

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The cistern shall be of cast iron, mosquito proof, of 12.5 litres capacity or other specified together with cover lever, G.I. chain and pull of specified quality, ball valve with copper or plastic float as specified and necessary unions etc. for connection with inlet and outlet pipes and overflow.

5.2.1 Brackets : The cistern shall be fixed on cast iron or rolled steel cantilever brackets which shall be firmly embedded in the wall in CM 1:3 or fixed by using wooden plugs and screws, to the satisfaction of the Executive Engineer.

5.2.2 Overflow : The cistern shall be provided with 20mm G.I. overflow pipe with fittings which shall terminate into mosquito proof coupling secured in a manner which will permit it to be readily cleaned or renewed when necessary. The length of the overflow shall be as per Municipal requirements.

5.2.3 Flush pipe : The outlet of flush pipe from the high level cistern shall be of 32 mm galvanised wrought iron pipe not less than 1.00 mm thick or light quality G.I. pipe B class or lead pipe of minimum thickness 2.6mm as specified, which shall be connected to the WC pan by means of an approved type of joint. The flush pipe shall be fixed to wall by using holder bat clamps or embedded as required. Where lead pipe pieces are required to be used in conjunction with G.I. Flush pipes for ensuring proper connection, the contractor shall do so at his own cost and rates quoted shall include for the same.

5.2.3.1 If the connection between the cistern and the W.C. pan is made with G.I. pipe, the bends and off sets shall be made cold, and connection to the pan may be made means of an approved type of joint or while lead mixed with chopped hemp.

5.2.4 PAINING :

Inside of cistern and fittings shall be painted with approved bitumastic paint and outside of the cistern, brackets, overflow and flush pipe etc. shall be painted with a priming coat or red oxide, and finishing two or more coats of white zinc or any other colour and shade to match with the painting of surround-ing walls. The cost of such painting shall be included in the rate quoted for the flushing cistern.

Plastic Flushing Cistern (Low Level) :The low level plastic flushing Cistern shall be clock valve based on buoyancy principal and controlled by a water clock, designed for feather operation and shall conform to IS : 7231-1984 . The cistern tank shall have plastic body and shall be fixed in position along with all internal parts as per manufacture. The cistern shall have capacity of 10 litres. It shall be fixed in position along with all internal parts as

per manufactures manual. There shall be a provision of 15 mm dia overflow outlet from which 15 mm dia G.I. 'B' class (Medium quality) over flow pipe shall be provided to be terminated with a P.V.C mosquito proof coupling at 75 mm above W.C. floor level or as per municipal requirements if any. The out let or flush pipe from the cistern will be 32 mm P.V.C. Pipe which shall be connected to the W.C. pan with approved type of joint .

Rates Quoted for the low level flushing cistern should include for :-

- (1) Flushing cistern with all internal fittings and concealed brackets, flushing handle (Knob) etc.
- (2) P.V.C. inlet pipe connection piece 15 mm dia with brass nuts.
- (3) 15 mm dia C.P. brass stop cock weighing not less than 400 gms.
- (4) 32 mm dia P.V.C. flush pipe (15 mm dia G.I. medium quality 'B' class overflow pipe if required length shall be measured & paid extra under relevant item of the trade .)
- (5) Painting of G.I. overflow pipe with 3 coats of first quality synthetic enamel paint including a coat of primer.

6. PEDESTAL WASH DOWN WATER CLOSET :

6.1 W.C. PAN :

The W.C. pan shall be of white vitreous china of one piece construction of wash down type with integral 'P' or 'S' trap as required. it shall be of approved quality and pattern conforming to IS Specification IS 2556 (part - II).

6.2 SEAT & COVER :

The seat with lid shall be of well seasoned teakwood varnished or Mahogany polished or plastic seat as specified with rubber bullers and shall be fixed in position by using Chromium plated (CP) brass hinges and screws. The seat shall be non absorptive and free from cracks and crevices in the material. The plastic seat and cover where specified shall conform to I.S. Specifications and shall be black colour unless otherwise specified.

6.3 FLUSHING CISTERN :

The flushing of the W.C. pan shall be done by high level or low level valve less siphonic flushing cistern of ap-proved quality, as specified. In the former case the specifications will be same as those for flushing cisterns of squatting pattern W.C. pans. In the latter case there shall be white glazed vitreous china or porcelain enamelled or plastic as specified of 12.5 litre or of other capacity cistern as specified with all internal fittings, brackets and C.P. brass flushing handle, Which shall be fixed at low level and connected to the W.C. pan by

means of 40mm diameter white enamelled porcelain bend and rubber or 'Light' quality G.I. pipe or 2.6mm thick lead pipe connection or as other specified.

6.3.1 OVERFLOW :

There shall be 20mm overflow with mosquito proof coupling of approved design which shall conform to the specification as stated under squatting pattern W.C. pan.

7. BOWL URINAL :

7.1 BOWL URINAL :

The urinal shall be flat back or angular pattern lipped from basin or required dimensions of white vitreous China and one piece construction with integral flushing box rim or an approved make as specified. It shall be fixed in the position by using wooden plug embedded in the wall with screws of proper size. Each urinal shall be connected to a 40mm embedded in the wall with screws of proper size. Each urinal shall be connected to a 40mm diameter waste lead pipe unless otherwise specified, which shall discharge into a channel or a floor trap, or as specified. The connection between the urinal and flush or waste pipe shall be made by means of white lead mixed with chopped hemp. The flush pipe and waste pipe shall be concealed where directed.

7.2 FLUSHING :

The flushing of the urinals shall be done by automatic flushing cisterns conforming to I.S. specifications. Then cistern shall be of cast iron not less than 5mm body thickness or other specified having valveless siphon automatic flushing arrangement of specified capacity. It shall be supported on a pair of R.S. or C.I. cantilever brackets which shall be embedded or fixed to wall by means of wooden plugs and screws. The cistern shall be connected to the urinal basin by means of a G.I. Medium Quality or a lead or specified type of flush pipe with fittings. The pipe shall be fixed by using proper holder bat clamps or concealed by embedding as directed. The body thickness shall not be less than 6mm in the case of vitreous sanitary cistern and 1.60mm before coating in the case of pressed steel cistern. The latter should be porcelain enamelled against corrosion.

7.2.1 CAPACITY :

The capacity of the flushing cistern and the size of the flush pipe for the number of urinals in a range will be as follows :-

Number of	Capacity of	Main	Size of pipe
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Urinals in a range	flushing cistern		distribution.
1.	5.0 litres	-	15mm
2.	10.0 litres	20mm	15mm
3.	12.5 litres	25mm	15mm
4.	12.5 litres	25mm	15mm

7.2.2 The joint between the urinal basin and flush and waste pipe shall be made by means of putty or white lead mixed with chopped hemp or as specified in case of lead pipes.

7.2.3 Painting : The inside and the outside of the cast iron cistern the fittings and brackets shall be painted as given under flushing cistern for squatting pattern W.C. pan.

8. STALL URINALS :

8.1 URINAL STALLS :

The urinal stall and its screens shall be of white vitreous china of approved quality and manufacture. the stall shall be 114cm high and 46cm wide and 40cm deep. The stall shall be provided with 84cm x 36cm division plates. In case of range of two more urinals, there shall be further division plates similar to end screens. The range shall have 15cm deep tread plates of fire clay unless otherwise specified.

8.2 FLUSHING :

The stall be provided with white glazed vitreous china automatic flushing cistern or proper capacity with 6mm minimum body thickness unless otherwise specified. The cistern shall be complete with fittings and brackets which shall be fixed to the wall. The cistern shall be connected to the stall through standard size C.P. brass flush pipe with spreader arrangement and clamps unless otherwise specified. Capacity of flushing cistern and relevant sizes of flush pipe for stall urinals shall be the same as specified for bowl urinals.

8.2.1 OUTLET :

Each range of stalls shall be provided with C.I. urinal trap with vent arm having C.P. brass outlet grating of size 50mm for one or two stalls and 75mm for more stalls or as specified.

9. SQUATTING PLATES :

9.1 SQUATTING PLATES :

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The urinal plates shall be of white glazed vitreous china with integral flushing rim of size 600 mm x 350 mm as specified. There shall be white glazed vitreous channel with stop and outlet pieces in front. The plate and channel shall be of approved quality and conform to IS Specifications 2556 (Part VI).

9.2 FLUSHING :

Each set of plates shall be provided with automatic C.I. cistern complete with G.I. flush pipe with fittings and spreaders arrangements fixed with holder-bat clamps or embedded as specified. There shall not be more than four plates in a range fed by a single cistern.

9.2.1 CAPACITY :

The capacity of the flushing cistern and the size of the flush pipe for the number of squatting plate urinals in a range will be as follows :

Number of Urinals in a range	Capacity of flushing cistern	Main	Size of pipe distribution.
1.	5.0 litres	-	20mm
2.	10.0 litres	25mm	20mm
3.	12.5 litres	32mm	20mm
4.	12.5 litres	32mm	20mm

9.2.2 The cistern shall be fixed R.S. or C.I. cantilever brackets which shall be embedded or fixed to the wall by means of wooden plugs and screws.

9.2.3 The joint between the urinal plate and the flush pipe shall be made with putty or white lead mixed with chopped hemp.

9.2.4 Painting : The inside and outside of the cistern, the fittings and brackets shall be painted as described for flushing cistern for squatting pattern W.C. pan.

9.3 Outlet : The squatting plate or a range of squatting plates shall be provided with a 65mm diameter standard urinal C.I. trap with vent arm having 65mm C.P. brass outlet grating or as specified.

9.4 Walling : The squatting plate shall have 1.22M high wall in front and on either side, this shall be lined as specified.

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10. WASH BASINS :

- 10.1** Basins : The wash basins shall be of white vitreous china of approved quality, make and pattern conforming to I.S. Specifications. It shall be of one piece construction with an integral combined, overflow. The size of the basin shall be as specified.
- 10.2** Fittings : Each wash basin shall be provided with 15mm C.P. brass pillar taps as specified, 32mm C.P. waste with C.P. brass bottle trap or G.I. trap and plug as specified, C. P. chain and rubber plug, unions, joint etc. complete in all respects of approved quality.
- 10.3** Fixing : The basin shall be supported on a pair of R.S. or C.I. cantilever brackets embedded or fixed in position by means of wooden cleats and screws. These brackets shall be painted to the required shade as given under flushing cistern for squatting pattern W.C. The wall plaster shall be cut to rest over the top edge of the basin. After fixing the basin, plaster shall be made good and surface finished to match with the existing one.
- 10.4** Waste connection : The waste pipe shall discharge into a floor trap leading to a gully trap, on ground floor and on upper floors it may be connected to a waste pipe stack. The C.P. brass bottle trap and Union shall be connected to 32mm G.I. light class waste pipe or lead pipe as specified which shall be suitable bent towards the wall and/or concealed in the wall as directed.

11. SINKS :

- 11.1** Sinks : The sink shall be of white glazed fine clay with wire type overflow conforming to I.S. Specifications unless otherwise specified . The size of the sink shall be as specified. The sink shall be of approved quality and manufactured.
- 11.2** Fittings : Each sink shall be provided with 40mm C.P. brass waste coupling and union of standard pattern C.P. brass chain and 40mm rubber plug may be provided where specified.
- 11.3** Fixing : The sink shall be supported on C.I. cantilever brackets embedded, fixed into position. These brackets shall be painted to the required shade as given under flushing cistern for W.Cs. The wall plaster on the rear shall be cut to overhang the top edge of the sink.

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- 11.4** Waste connection : The waste pipe shall discharge into a floor trap leading to a gully trap on ground floor and may be connected to a waste pipe stack on upper floors. C.P. brass coupling and union shall be connected to 40mm G.I. light quality waste pipe provided with suitable tee and plug for cleaning purposes.

12. TOILET REQUISITES :

12.1 MIRROR :

The mirror shall be of approved make glass with bevelled edges. The size and shape of the mirror shall be as specified. It shall be mounted on an asbestos sheet and shall be fixed in position by means of C.P. brass screws and washers over rubber washers and wooden plugs firmly embedded in the wall. C.P. brass clamps with C.P. screws may be an alternative method for fixing.

12.2 GLASS SHELF :

The shelf shall be of glass of approved quality with edges rounded off. The size of the shelf shall be as specified. The shelf shall have C.P. brass guard rail with rubber washers on positions resting on glass plate and C.P. brass brackets which shall be fixed with C.P. brass screws to wooden plugs firmly embedded in the wall.

12.3 TOWEL RAIL :

The towel rail shall be of C.P. brass with two C.P. brass brackets. The size of the rail shall be as specified. The bracket shall be fixed by means of C.P. brass screws to wooden cleats firmly embedded in the wall.

12.4 TOILET PAPER HOLDER :

The paper holder shall be wooden or of C.P. brass or vitreous china as specified. The wooden paper holder shall be made of well seasoned teakwood finished with beeswax. These shall be fixed in position by means of C.P. brass screws and wooden cleats embedded in the wall.

12.5 LIQUID SOAP HOLDER :

This shall be of glass or C.P. brass as specified. It shall be fixed in position by means of C.P. brass screws and wooden cleats embedded in the wall. The liquid soap holder shall be of approved size and make.

12.6 SHOWER ROSE :

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The shower rose shall be of C.P. brass swivelling type approved size, make and design. Where specified, the same shall be provided with a C.P. brass shower arm with necessary C.P. brass wall flange and fitting.

12.7 WATER CONNECTORS :

Water connection to flushing cistern, wash basins etc. shall be by means of lead pipe or white polythene pipe connection pieces as specified with C.P. brass connectors on either ends and a stop cock. The size of the lead pipe or polythene pipe connection and stop cock will depend upon the size of water connection and shall be as specified. The length of the connecting pieces shall be at least 375 mm.

13. CAST IRON SOIL, WASTE, VENT AND RAINWATER PIPES AND FITTINGS

13.1 CAST IRON PIPE AND FITTINGS :

Cast iron soil, waste, vent and Rainwater pipes and fittings where specified shall conform to the latest Indian Standards Specifications for these pipes. The pipes shall have spigot and socket ends and shall be with or without ears as directed by the Executive Engineer.

13.2 WEIGHTS :

The standard weights and thickness of pipes are given below and a tolerance up to minus 10% may however be allowed against these standard weights.

SOIL WASTE AND VENT PIPE						
SAND CAST			SPUN IRON		RAIN WATER	
Nominal dia of pipe	Minimum Thickness	Nominal weight for 2 m long pipe exclusive of ears	Minimum thickness	Nominal weight for 2m long pipe	Minimum thickness	Nominal weight for 1.8 m long pipe exclusive of ears
Mm	mm	kg	mm	kg	mm	kg
50	5	12.65	3.5	9.2	3	7.5
75	5	18.36	3.5	13.8	3	11.0
100	5	24.15	4.0	21.0	3	14.0
150	5	35.66	5.0	38.5	4	26.0

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13.2.1 These shall be free from cracks and other flaws. the interior of pipes and fittings shall be clean and smooth. These pipes shall be coated internally and externally with suitable coating material having a tar or other approved base, in accordance with relevant I.S. Specification for these pipes.

13.2.2 The access door fitting shall be of proper design so as not to form any cavities in which filth may accumulate. Doors shall be provided with 3mm rubber insertion packing and when closed and bolted they shall be watertight and airtight.

13.3 FIXING :

The pipes and fittings shall be fixed to walls at least 5cm clear of the finished surface of wall by using proper holder bat clamps. The pipes shall be fixed perfectly vertical or in a line as directed. The spigot end shall about the shoulder of the socket and leave no annular space in between. The pipes shall be strongly supported at the foot by a bed of cement concrete 1:3:6, 150 mm thick and rates quoted shall include for provision of the same. All soil pipes shall be carried up above the roof and shall have a suitable cowl. The bends in the bottom most soil or waste stack shall necessarily be of long radius and preferably made of two 135 degree C.I. bends.

13.3.1 Connections between main pipe and the branch pipes shall be made by using proper branches and bends invariably with access doors for cleaning.

13.4 CEMENT MORTAR JOINTS :

Where specified, the pipes jointed with cement mortar joints shall be as under :

Closely twisted spun yarn gasket of such diameter as required to support the spigot of pipe at the proper grade and make truly concentric joints, and in one piece of sufficient length to pass around the pipe and lap at the top, shall be thoroughly saturated in cement paste. This gasket shall be laid in the socket for the lower third of the circumference of the joint and covered with cement mortar 1:1. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted and carefully driven home after which a small amount of mortar shall be inserted in the annular space around the entire circumference of the pipe and solidly rammed into the joint with a caulking tool the mortar previously placed being driven ahead of the gasket. The remainder of the joint shall then be completely filled with cement mortar 1:1 and bevelled off at an angle of 45 degrees with the outside of the pipe.

13.4.1 Where any water closet pan or earthen ware pan connected to such pan is to be jointed with C.I. soil pipe, the joint between the pan/trap and the socket of the C.I. pipe shall

always be of a flexible nature and such joint shall be made with a mixture of bitumen and chopped asbestos fibre (not dust).

13.5 LEAD CAULKED JOINTS :

Where the pipes are to be jointed with lead caulked joints, the same shall be done as follows :

The annular space between the socket and spigot will be first well packed in with spun yarn leaving 25mm from the tip of the socket for lead. The joint may be leaded by using proper leading rings or if they are not available by wrapping a ring of hemp rope covered with clay round the pipe at the end of the socket, leaving a hole through which lead shall be poured in (for pipes with sockets facing upwards 12mm high clay bound on the socket edge may be used).

13.5.1 The lead shall be rendered thoroughly fluid and each joint filed in one pouring. Before caulking, the projecting lead shall be removed by flat chisels and then the joint caulked round with proper caulking tools and a hammer of 1 to 1 ½ kg. in weight in such a manner as to make the joint quite sound. After being well set up the joint is to be let flush, neat and even with the socket.

13.6 TESTING :

All cast iron pipes and fittings including joints will be tested for gas tightness by a smoke test and hydraulic performance by a water test and left in working order after completion.

13.6.1 SMOKE TEST :

Smoke shall be pumped into the drains at the lowest end from a smoke machine which consists of a blow and burner. The materials usually burnt are greasy cotton waste which form clear pungent smoke which is easily detectable by sight as well as by smell if leaking at any point of the drain.

13.6.2 WATER TEST :

The water test may be applied before the appliances are connected and may be carried out in sections so as to limit the static head to 4.5 metres.

13.6.3 The contractor will have to rectify all defects traced in such tests at his own expense to the satisfaction of the Executive Engineer.

13.7. PAINTING :

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All the exposed C.I. pipes and fittings shall be painted with two coats of oil paint of approved quality, manufacture, colour and shade to match the surroundings. The cost of such painting should be included in the contractor's rates.

13.7.1 The surface of the pipes and fittings to be painted shall be cleaned thoroughly. Red oxide or other approved primer shall be painted and allowed to dry. The finishing shall be done by painting 2 or more coats with paints in an approved colour and shade.

13.8 On no account shall lime mortar or lime concrete come in direct contact with C.I. pipes.

14. ASBESTOS CEMENT RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS

:

14.1 PIPES AND FITTINGS :

Asbestos Cement Rainwater, soil, waste and vent pipes and fittings shall conform to the latest Indian Standard Specifications for these types of pipes. The pipes shall have spigot and socket ends. The access door fittings shall be of proper design so as not to form any cavities in which filth may accumulate. Doors shall be provided with 3mm rubber insertion packing and when closed and bolted they shall be water, light and airtight.

14.2 THICKNESS AND SIZES :

The standard thickness and sizes with permissible tolerance of the dimension for pipe and fittings shall be as given below.

Nominal diameter of pipe or Fitting	Thickness of pipe or Fitting	Permissible variation in thickness	Permissible Variation in External Diameter.
mm	mm	mm	mm
50	6.5	+/- 1.0	+/- 1.5
60	6.5	+/- 1.0	+/- 1.5
80	8.0	+/- 1.0	+/- 1.5
90	8.0	+/- 1.0	+/- 1.5
100	8.0	+/- 1.0	+/- 1.5
125	9.5	+/- 1.0	+/- 2.5
150	9.5	+/- 1.0	+/- 2.5

14.3 FIXING :

The pipes and fittings shall be fixed to walls at least 5 cm clear by using proper holder bats weighing 1 to 1½ Kgs each. The spigot end shall be abut the shoulder of the socket and leave no annular space in between. All soil pipes shall be carried up above the roof

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and shall have an A.C. Cowl . The bends in the bottommost soil or waste stack shall necessarily be of C.I. long radius and preferably made of two 135 Degree C.I bends

14.3.1 Connections between main pipe and the branch pipes shall be made by using proper branches and bends invariable with access doors for cleaning .

14.4 Jointing: A.C. pipes shall be jointed with cement Mortar Joints 1:1 as described for Cast iron pipes.

14.5 Testing : The joints of Pipes shall be tested by smoke test and water test as described for Cast iron pipes.

14.6 Painting : A.V. Pipes shall be painted to match the surroundings and rates quoted shall included to cover the same.

15. LEAD PIPES :

15.1 Lead Pipes : All lead pipes shall be hydraulic drawn and of equal substance throughout and shall conform to the relevant I.S. Specifications. When not supported on bearers, all lead pipes shall be supported by strong lead tracks at least 40 mm wide soldered on to the pipes at suitable intervals .The Size and weights of these pipes for flushing and soil, waste and ventilating pipes shall be given.

15.2 WIPED SOLDER JOINTS :

All joints of lead pipes shall be wiped solder joints as described below :

The pipe ends to be jointed shall be cleaned with a wire brush and freed from oxide if any. Chalk shall then be rubbed to kill the greasy nature of the lead. After this, plumbers black shall be applied. The length of the joint as given below shall then be marked on the pipe. a fine shaving of lead shall be removed from this length with a shave hook. Tallow shall then be smeared over the prepared surface. The molten solder, an alloy composed of 3 parts of tin and 7 parts of lead, shall be poured in a thin stream from a ladle moved in an elliptical direction over the joint position including a portion of the coiled pipe at each end beyond the mark. When sufficient solder has been poured the joint shall be wiped with a pad of wiping cloth with long continuous movements in one direction only so as to leave a neatly formed elliptical shaped joints. Surplus solder remaining on the joint shall be removed with a tool called "draw of".

15.2.1 The minimum and maximum length of the wiped solder joint shall be 8 cm & 9cm respectively.

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- 15.2.2** The joints shall be watertight, airtight and shall be free from tears, burrs, strings, rebinds or droppings.

15.3 CLEANING ACCESS :

Brass screw cleaning access shall be provided on lead pipe wherever necessary and directed Rates quoted shall include for the above.

15.4 LEAD PIPE CONNECTION :

The joints between lead pipe and C.I. or stoneware pipe shall be made as under:

Where any stoneware or C.I. pipe or trap is connected with a lead soil, waste, or vent pipe or trap, there shall be inserted between the two, a 4.5 mm thick brass ferrule or thimble 150 mm long which shall be slipped into or over the lead pipe and jointed to it by means of a wiped solder joint. The other end of the ferrule shall then be inserted into the socket of the cast iron or stoneware pipe. In the case of former, the joint shall be made with molten lead 9 lead caulked) and in case of the latter with cement mortar 1:1 as in stoneware pipe drains.

- 15.4.1** The joints between outgo of a W.C. pan and a lead pipe shall be made as under :

The lead pipe shall be slipped into a brass thimble or socket and jointed to it by a wiped solder joint. The outgo of a W.C. pan shall then be inserted into the socket and jointed by using cement mortar as in stoneware pipe drains.

15.5. PAINTING :

All exposed lead pipes shall be painted as in cast iron pipes and fittings. The cost of such painting should be covered in the contractor's rates.

16. PLUMBERS BRASS WORK AND WATER AND WASTE FITTINGS :

- 16.1** General : Generally, the whole of plumbers brass work or gunmetal fittings shall be of heavy quality and approved manufacture and pattern. They shall in all respects comply with the latest Indian Standard specifications. Brass castings for valves, unions, thimbles, ferrules, taps, traps, waste etc., shall be in all respects sound and good, free from laps, blow holes fittings, plugs, burns stops or patches. The fittings shall be fixed in the pipe line in a workman like manner. Care shall be taken to see that joints between fittings and pipes are made leak proof. The fittings and joints shall be tested to a pressure of 20 kg. per sq. Cm. unless otherwise specified. The defective fittings and the joints shall be required, redone or replaced Brass work requiring connection to lead pipes shall have tinned ends.

- 16.2** Screws down bib and stop taps : These shall be of cast brass of bronze, or 'polished bright' or 'chromium plated' finished and of size as specified and shall conform to I.S. 781.

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16.2.1 Unless otherwise indicated, the minimum finished weights of bib taps and stop taps shall be as given below :

Minimum finished weight in kg.

Size in mm	Bib taps	Stop taps
15	0.40	0.40
20	0.75	0.75
25	1.25	1.30
32	-	1.80
40	-	2.25
50	-	3.85

16.2.2 Washers for cold water taps shall be of selected leather, rubber asbestos composition or of plastics as directed. Washers for hot water taps shall be of good quality fibre or rubber asbestos composition as directed.

16.3 Pillar Taps : Pillar Taps shall be of cast brass or chromium plated finished and of size as indicated and shall conform to I.S. 1795. Washers shall be of materials as for bib taps and stop taps.

16.3.1 Unless otherwise indicated the minimum finished weights of pillar taps shall be as given below :

Size in mm	Minimum finished weight in kg.
15	0.60
20	1.00
25	1.50

16.3.2 Ball valves : Ball valves shall be of high pressure type, made of (excluding the float or ball) brass of size indicated and shall conform to IS : 1703. The float shall be of copper sheet or polythene as indicated. unless otherwise indicated, the minimum finished weights of ball valves exclusive of the float) and those of copper floats shall be as below :

Nominal size in mm	Weight in kg.		Diameter of float in mm
	Ball valve exclusive of float	Copper	
15	0.30	0.22	127
20	0.47	0.32	152

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25	0.87	0.68	203
32	1.20	0.92	229
40	1.65	1.05	254
50	1.92	1.53	305

16.4.1 The minimum thickness of the copper sheet used for making floats shall be 0.55 mm.

16.5 Siphon traps (Galvanised malleable iron or brass) : Traps for lavatory basins, sinks and baths shall be of C.P. brass unless otherwise specified or G.I. of approved manufactures. Traps for lavatory basins and sinks shall have one inspection eye, fitted with screw plug and washer, while for baths the traps shall have 2 branches screwed externally, one of which shall be fitted with washered cap and other with a vent tail pipe and union nut for overflow connection. A loose coupling nut shall be fitted to the inlet for coupling to the waste and the outlet shall be either plain tails for lead pipe or screwed with pipe thread and provided with union tail and pipe.

16.6 Waste fittings : Waste fittings shall be brass chromium plated conforming to I.S. 2963. Sink waste shall be of 40 mm bore and wash basin waste shall be 32 mm bore, unless otherwise specified.

16.7 Waste plug and accessories : Waste plug shall be of hard rubber or other equally suitable material and shall conform to IS : 3311. The depth and thickness of the plug shall be such as to provide the required rigidity and water tightness. Each waste plug shall have a loose shackle. The shackle and other metal components shall be of corrosion resistant material.

16.7.1 Plug chains shall be made of brass or bronze wire, of diameter not less than 1.80 mm, with brazed oval links approximately 13mm in length.

16.7.2 Chain stays shall be of brass or bronze and shall be of bolt or screw type as indicated.

16.8 LEAD TRAPS :

These shall be of size and pattern as indicated. The weights of lead sheets used in manufacture of traps shall be not less than 30 kg/sq.m.

16.8.1 The traps shall be supplied with brass screw caps, the screw of which shall be lead burnt or soldered to the trap with a well reinforced joint. Neither the screwed end of the cap, when screwed home, nor the sleeve shall produce beyond the inner surface of the trap. A washer to render the cap water-tight shall be supplied with every cap.

16.9 GATE VALVE :

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The Valves used for cold water services shall be of gunmetal and conform to Class - 1 type of IS 778. For hot water installations Class - II valves shall be used. The gate valves shall be the full way opening type with a metallic hand wheel fixed on the head of the spindle. The valves shall have screwed or flanged ends as approved by the Executive Engineer.

16.10 Globe valves (screw down stop valves) : These shall be of gunmetal Class - I type for cold water services conforming to I.S. 778 unless otherwise specified. The valves shall have screwed or flanged ends as directed. The valves shall be provided with metallic hand wheel fixed on the head of the spindle.

16.11 Check (non return) valves : These shall be of gun metal Class – I type for cold water services conforming to I.S. : 778, unless otherwise specified. The valves shall have screwed or flanged ends as directed. They shall be suitable for horizontal or vertical use as directed.

16.12 FOOT VALVES :

Foot valves shall be of swing or lift type and provided with brass strainer and conform to the requirements of I.S. : 4038. The ends shall be screwed or flanged as directed.

16.13 FLOOR TRAPS :

The traps shall be of Cast Iron and self cleaning design. The traps shall be of specified size and fitted with a hinged C.P. or Cast iron grating as specified.

16.13.1 The grating shall be fixed flush with the floor while the trap shall rest on a 1:6 cement mortar bed.

16.13.2 When one pipe or single stack system of plumbing is employed it shall be essential to provide deep seal Cast iron floor traps of effective water seal 50mm complying with the requirements of Indian Standard specification.

17. WATER TANKS :

17.1 Water Tanks : Hoisting of ready made mild steel galvanised iron, RCC or Asbestos Cement water tanks into position shall be carried out with proper tackle, care being taken that no part of the tank or of the structure is damaged with operation. The tanks shall be

installed truly level. Steel tanks of capacity up to 1800 litres (Mild steel or Galvanised iron or specified) shall be of 3.2 mm thick sheet reverted to 32mm x 32mm x 6mm angle iron frame complete with MS cover and frame weighing 15 kg. with locking arrangement including providing pads of size as required for inlet and outlet pipes G.I. overflow pipe piece with mosquito proof couplings and scour pipe with backing nut of required size shall be also provided. Supports for tanks shall be provides as specified shall be measured and paid for separately.

- 17.1.1 Moulded P.V.C. Water Tanks : Polyethylene water storage tanks shall be one piece moulded in single wall construction without any seams, welds or joints from F.D.A approved grades of High Density polyethylene (HDPE) and of approved manufacture . The tank should satisfy the tests of safe storage of drinking water (Portability) and necessary test certificates from approved test laboratory should be produced for test of potability of water stored in tanks. The water tanks shall be of specified capacity and cylindrical vertical /Horizontal type with closed tops as specified in schedule of quantities The tanks should be provided with double seal mosquito proof light duty manhole cover with locking arrangements of diameter not less than 400 mm and shall be provided with G.I. fittings like inlet outlet for water connections wash out overflow with mosquito proof P.V.C. coupling brass ball cock with P.V.C coupling brass ball cock with PV.C. floats all of specified sizes . The tanks shall be hoisted and installed in position as per manufactures instructions manual and shall comply with the local municipal regulations . No leaks whatsoever shall be around the insert of water connection like inlet/ outlet pipe wash out etc. or any part of the body of the tank after the tank is filled with water to its full capacity.

The rates quoted shall include for :

- (1) Hoisting and installation in position
- (2) providing and fixing all fixture and fittings like G.I. inlet ,outlet overflow with mosquito proof P.V.C. coupling, wash out brass ball cock with polyethylene float, all of specified sizes.
- (3) Manhole cover double seal mosquito proof of specified sizes.
- (4) Leakage test for the tank by filling water to full capacity after installation and completing all water supply connections.

17.2 **PIPE INSERTS** :

GI pipe inserts to be kept in position for outlets, washouts and inter connection of tanks while casting RCC water tanks shall be of the specified size and diameter and shall be threaded throughout its length. A 150mm x 150mm MS plate 6mm thick shall be welded

centrally on to the threaded body of pipe as directed. Rates quoted shall include for the same.

17.3 OVERFLOW PIPES :

Overflow pipe inserts for tanks shall be of the specified size and diameter with an approved mosquito proof coupling and rates quoted shall include for the same.

IV DRAINAGE

18. SALT GLAZED STONEWARE PIPE DRAINAGE

18.1 PIPES :

All pipes and fitting must be new and perfectly sound, free from fire cracks and imperfections of glazing, cylindrical and of standard nominal diameter, length and depth of socket. They shall be made of hard burnt stoneware of dark grey colour and thoroughly salt glazed inside and outside. These pipes and fittings shall conform to grade 'A' of the relevant latest IS. specifications for these pipes and fittings, unless otherwise specified.

18.2 EXCAVATION OF TRENCHES FOR SALT GLAZED STONEWARE PIPES :

Excavation of trenches connected works such as road crossing, protection of existing service lighting and water etc., shall generally be carried out in accordance with the procedure describe earlier in respect of Cast iron pressure pipes and fittings. Trenches for drainage work shall be carried out to the required levels. Use of sight rail and boning rods shall be adopted during the whole process of excavation and laying of pipes. Any excavation more than required shall be made good in 1:3:6 PCC at contractor's cost.

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18.3(a) CONCRETE SUPPORT OR PROTECTION :

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Where it is desired to support or surround pipe sewers or drain, it shall be done in concrete 1:4:8 by adapting one of the following methods as specified.

18.3.1 BEDDING :

Bedding shall be rectangular in section and shall extend laterally at least 15 cm. beyond on both sides of the projection of the barrel of the pipe. The thickness of the concrete, below the barrel of the pipe shall not be less than 10 cm. for the pipes under 15 cm. and over in diameter. Where bedding is used alone, the concrete shall be brought up at least to the invert level of the pipe to form a cradle and to avoid the line contact between the pipe and the bed.

18.3.2 HAUNCHING :

Concrete hunching shall consist of a concrete bed as described for bedding with the full width of the bed carried up to the level of the horizontal diameter of the pipe and splays from this level carried upon both sides of the pipe from the full width of the bed to meet the pipe barrel tangentially.

18.3.3 SURROUNDING OR ENCASING :

The surrounding or encasing shall be similar to hunching up to the horizontal diameter of the pipe and the top portion over this shall be finished in a semi-circular form to give a uniform encasing for the top half of the pipe. Encasement may be provided when the maximum subsoil water-table levels is likely to rise above the top of barrel or where there is insufficient earth cover over the top of the barrel.

18.4 LAYING OF PIPES :

Pipes shall be carefully laid to the levels and gradients shown on the plans. Great care shall be taken to prevent sand etc., from entering the pipes. The pipes between the man-holes shall be laid truly in straight line without vertical or horizontal undulations. The pipes shall be laid with the socket leading up hill. The body for the pipe shall for its entire length rest on an even bed of concrete and places shall be excavated in the concrete to receive the socket of the pipe.

18.5 JOINTING :

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In each joint, tarred gaskin or spun yarn soaked in neat cement slurry shall be passed round the joint and inserted in it by means of a caulking tool. More skeins of yarn shall be added and well rammed home.

18.5.1 The object of the yarn is to centre the spigot of one pipe within the socket of the other and to prevent the cement mortar of the joint penetrating into the pipes.

18.5.2 Cement Mortar 1:1 shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall then be punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degree.

18.5.3 Any surplus mortar projecting inside the joint shall be removed and to guard against any such projections, sack or gunny bag shall be drawn past each after completion.

18.6 CURING :

The cement mortar joint shall be cured at least for seven days, before testing.

18.7 Quantity of Cement and Span yarn : The approximate quantity of cement and span yarn required for each joint for certain common sizes of pipes are given below for guidance :

Nominal Dia of pipe mm	Cement Kg.	Span yarn Kg.
100	1	0.25
150	1.5	0.35
200	2	0.70
250	2.5	0.80
300	3.25	1.10
350	4.5	1.25
400	5.5	1.50

18.8 Jointing S.W. pipes with C.I. pipes : Where any C.I. soil, waste or ventilating pipe or trap is connected with stoneware pipe communicating with a sewer, the bedded spigot end of such C.I. pipe or trap shall be inserted into a socket of such S.W. pipe drain and the joint made with cement mortar 1:1.

18.9 Testing : All joint shall be tested to a head of 60 cms of water above top of the highest pipe between two man-holes.

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18.9.1 The lowest end of the pipe shall be plugged watertight. Water shall then be filled in manhole at the upper end of the line. The depth of water in the manhole shall be 60 cm plus the diameter of the pipe. The joints shall then be examined. Any joint found leaking or sweating shall be remade or embedded into 15 cm layer of cement concrete 1:2:4. 30 cms. in length and the section re-tested, at the Contractor's expense until satisfactory results are obtained.

18.10 REFILLING :

Refilling in trenches for pipes shall be commenced as soon as the joint and concrete have been passed. The refilling on the top and around the drain shall be done with great care and in a manner as will obtain the greatest amount of compactness and solidity possible. For this purpose the earth shall be laid in regular layers of 15 cm. watered and rammed at earth layer. All surplus earth shall be disposed of as directed by the Executive Engineer.

19. STONEWARE STORM WATER DRAINS :

19.1 Storm Water Drains : When S.W. pipes are used for Storm water drainage, no concreting will be necessary. The cement mortar for jointing will be 1:3 or as specified. To avoid clogging of drains, both ends shall be kept plugged until the construction of manholes is completed in every respect. On compaction care shall be taken that each plug is removed and the face of the drain made smooth.

20 STONEWARE GULLY TRAPS :

20.1 Gully Trap : This must be new, perfectly sound free from fire cracks and other imperfections of glazing, of standard nominal diameter and other dimensions. It shall be made of hard burnt stoneware of dark grey colour and thoroughly salt glazed inside and outside.

20.1.1 Each gully trap shall have one C.I. grating 15 cm x 15 cm and one watertight C.I. cover with frame 30cm x 30cm (Inside dimensions) with machined seating faces.

20.2 EXCAVATION :

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Executive Engineer.

20.3 FIXING :

The gully trap shall be fixed on cement concrete foundation 70 cms squared and not less than 10 cm. thick. The mix for the concrete will be 1 : 4 : 8 (1 cement : 4 sand and 8 stone ballast 40mm). The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes.

20.4 MASONRY CHAMBER :

After fixing and testing the gully and branch drain, a brick masonry chamber 30 x 30 cm (Inside as specified in first class brick in cement mortar 1:4 shall be built with 11 cm thick wall round the gully trap from the top of the bed concrete up to ground level, the space between the chamber walls and the trap being filled in with cement concrete of the specifications of bed concrete. The chamber shall be plastered internally and externally with cement mortar 1:3 (1 cement : 3 sand) finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

20.5 C.I. COVER :

C.I. cover with frame 30x30 cm (Finished) or as specified with machined seating faces shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 and rendered smooth. The finished top of covers shall be left 5 cm. above the adjoining ground level so as to exclude the surface water from entering the gully trap.

21. REINFORCED CEMENT CONCRETE PIPE DRAINAGE :

21.1 R.C.C. PIPES :

All pipes and fittings must be new and perfectly sound, free from cracks, cylindrically straight and of standard nominal diameter and length. They shall be made of reinforced cement concrete, manufactured by centrifugal or spun process and shall have an even texture. Each pipe shall have one collar with it. The pipes shall conform to latest Indian Standard Specifications and shall be of 'NP2' class, unless otherwise specified.

21.2 EXCAVATION OF TRENCHES :

Excavation of trenches and connected works such as road crossings, protection of existing services, lighting and watch etc., shall generally be carried out in accordance with procedure described earlier of Cast Iron Pressure pipes and Stoneware pipes.

21.3 CONCRETE SUPPORT :

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Chairs made of cement concrete shall be used unless otherwise specified for supporting pipes. These shall be provided at suitable intervals which shall not exceed the length of pipe. In cases where the soil is made up or is very soft, other form of concrete supports may be resorted to form the bed of the trench below the pipe as directed by the Executive Engineer.

21.4 LAYING :

The pipes shall be carefully laid to levels and gradients shown in the plans and sections. Great care shall be taken to prevent sand etc., from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations.

21.4.1 The body of the pipe shall for its entire length rest on an even bed in the trench and places shall be excavated to receive the collar for the purpose of jointing.

21.5 JOINTING : A few skeins of span yarn soaked in neat cement wash shall be inserted in the groove at the end of the pipe and the two adjoining pipes butted against each other. The collar shall then be slipped over the joint covering equally both the pipes. Spun yarn soaked in neat cement wash shall be passed round the pipes and inserted in the joint by means of caulking tools from both ends of the collar. More skeins of yarn shall be added and well rammed home.

21.5.1 The object of the yarn is to centre the two ends of the pipes within the collar, and to prevent the cement mortar of the joint penetrating into the pipes.

21.5.2 Cement mortar 1:1 (1 cement : 1 sand) shall be slightly moistened, and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall then be punched and chaulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall be finished off neatly outside the collar on both sides at an angle 45 degree.

21.5.3 Any surplus mortar projecting inside the joint is to be removed and to guard against any such projection sack or gunny bag shall be drawn past each joint after completion.

21.6 CURING : The cement mortar joints shall be cured at least for ten days.

21.7 TESTING AND REFILLING : This shall be the same as described for S.W. pipe drains except that in the case of testing, the head of water for testing shall be 2 Meters above the top of the highest pipe between two manholes.

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22. STORM WATER DRAINS : When concrete pipes are used for storm water drainage, the cement for the jointing shall be 1:3 (1 cement : 3 sand), or as specified. To avoid clogging of drains, both ends shall be kept plugged until the construction of manholes is completed in every respect. On completion care shall be taken that each plug is removed and the face of the drain made smooth.

23. CAST IRON PIPE DRAINAGE :

23.1 APPLICATION : C.I. pipe drainage may be adopted in the cases mentioned below where specified.

- a. In bad or unstable ground where soil movement is expected.
- b. In made-up or tripped ground.
- c. To provide for increased strength where a sewer is laid at insignificant depth, where it is exposed or where it has to be carried on piers or above ground, and
- d. Under buildings and where pipes are suspended in basements and like situations.

23.2 PIPE : The pipes used shall conform to the latest Indian Standard specifications IS : 6163 for C.I. spigot and socket pipes unless otherwise specified.

23.2.1 All pipes shall be coated inside and outside while hot with an approved anticorrosive paint having a tar or other suitable base.

23.2.2 The nominal weights of the pipe shall be as per details below

Nominal dia of pipe MM	Nominal weight of pipes including socket length for pipes of over- all length 3.66 M. Kg.
80	44
100	52
150	85
200	

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23.3 EXCAVATION IN TRENCHES : LAYING AND JOINTING, REFILLING ETC. :

Specifications for trenches and connected works for laying and jointing, refilling cast iron pressure pipes & stoneware pipes shall apply in this case.

23.4 CONCRETE SUPPORTS : In normal ground no concrete support or protection to C.I. pipes need be provided. Where supporting pipes are specified, these shall not be less than 30 cm in length (parallel to the axis of pipe) and at least equal in section to that described for hunching under concrete supports for S.W. pipes. Piers shall be built just behind the pipe sockets intermediate piers being provided where necessary.

24. BRICK MASONRY OPEN SURFACE DRAINS.

24.1 SURFACE DRAINS : The top of the drain shall always be kept 50 to 75mm above adjoining ground level so as not to admit water form surrounding area into it.

The overall depths of various sizes of drains shall be as follows:

Drain size	Depth
10cm	15cm
15cm	23cm
23cm	30cm

24.1.1 The earth excavation shall be done true to levels and lines. The drains shall be build in 1st class brick in cement mortar 1:5 over a 10cm bed of cement concrete 1:5:10. The inside bottom concerns of the drain shall be rounded of by means of fine cement concrete 1:2:4. Inside of the drain, top and sides of the brick work shall be plastered with 12 mm cement mortar 1:3 finished with a floating coat of neat cement. The drain may be given as far as possible a uniform slope from the starting point to the discharging point.

24.2 BRICK MASONRY DRAINS WITH STONEWARE GLAZED CHANNELS :

The work shall be carried out as per specifications of open surface of drains except that the cement plaster of the inside of the drain shall be omitted and stoneware glazed channel of proper size shall be fixed in drain with cement mortar 1:1.

25. MANHOLES AND INSPECTION CHAMBERS :

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- 25.1 Chambers** : At every change of alignment, gradient or diameter of a drain there shall be a manhole or inspection chamber. The maximum distance between manholes shall not exceed 30 meters.
- 25.2 SIZE** : The size of the manhole or inspection Chamber specified shall be the internal size of the manhole (between brick faces). The work shall be done strictly as per drawings and specifications.
- 25.3 EXCAVATION** : The manhole shall be excavated true to dimensions and levels, shown on the plan or as directed by the Executive Engineer.
- 25.4 BRICK WORK** : The bricks shall be of first quality, best locally available and from approved surface. The brick work shall be laid in cement mortar 1:3. The joints shall be made thoroughly leak proof.
- 25.5. PLASTER** : The walls shall be plastered both inside and outside with 20mm thick cement plaster 1:3. Where subsoil water condition exists, the outside surface of the walls shall be plastered with the addition of approved water proofing compound.
- 25.6 FOUNDATION CONCRETE** : The manhole/inspection chambers shall be built on a base of cement concrete of mix 1:4:8 of thickness of atleast 15cm for chambers upto 1m. depth, at least 20cm for chambers from 1m. to 1.5m depth and atleast 30cm for inspection chamber of greater depth.
- 25.7 POINTING** : Pointing shall be done with cement mortar 1:2 whenever required.
- 25.8. CHANNELS AND BENCHING** : The channels and benching shall be done in cement concrete 1:2:4 and rendered smooth to the grade with cement mortar 1:2. The channel shall be semicircular in the bottom half and of diameter equal to the sewer. Above the horizontal diameter, the sides shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off.
- 25.9 R.C.C. COVER SLAB** : Cover slab shall be of RCC 1:2:4 of 100mm thickness or other specified with steel reinforcement as per details.
- 25.10 FOOT RESTS** : Foot rests shall be provided in all inspection chambers and manholes over 0.8m in depth and shall be of C.I. square flats 25mm weighing at least 4.50 kg or as specified and shall be painted with coal tar. These shall be embedded in masonry in cement mortar at least 25cm, while the brickworks is in progress. They shall be set staggered into two vertical runs which may be 38 cms apart horizontally and 30.5 cms apart

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vertically. The top foot rest shall be 45 cms below the manhole cover and the lowest not more than 30 cms above the benching.

25.11 LEVELS OF INVERT : Sewers of unequal sectional area should not join with level inverts in a manhole, but the crown of the sewers shall be kept at the same level and necessary slope given in the invert of the manhole chamber. The branch sewer should deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in the main is not impeded.

25.12 HOUSE CONNECTIONS : No drain from house fittings e.g. gully trap or soil pipe, etc. to manhole shall exceed a length of 6m unless it is unavoidable.

25.13 MEASUREMENTS : The depth of manhole shall be reckoned from the invert level of the channel to the top of the C.I. cover. The depth shall be measured correct to the nearest cm.

25.14 MANHOLE UPTO 1 METER : This shall be of 0.80 x 0.80 M unless otherwise specified and is generally constructed within compounds for house drainage only, The thickness of brick walls shall not be less than 23 cms.

25.15 MANHOLES OF DEPTHS BETWEEN 1.00 M AND 1.50 M : This shall be of 1.2 M x 0.9M unless otherwise specified. The thickness of brick walls shall not be less than 23 cms.

25.16 MANHOLE OF DEPTHS MORE THAN 1.5 METERS : Circular chambers with a minimum diameter of 1.4 meters or rectangular chambers with minimum internal dimensions of 1.2 M x 0.9 Meter shall normally be provided unless otherwise specified. The brick work for the portion exceeding 1.5 Meters and upto 2.20 Meters shall normally be of 34.5 cms thickness, unless otherwise specified.

25.17 DROP MANHOLES : Where it is impractical to arrange the connection of the branch pipe sewer within 60 cm of the invert of the outgoing sewer in the manhole, a drop connection shall be provided, if the difference in level between the in-coming drain and the sewer does not exceed 60cm the connecting pipe may be directly brought through the chamber wall and the fall accommodated by constructing a ramp in the benching of chamber.

25.17.1 The connection shall be made by constructing a vertical shaft outside the manhole chamber as shown in drawings or directed by the Executive Engineer. The rates quoted shall include for providing the requisite length of SW or RCC pipe embedded in the masonry or PCC at the upper and lower ends of the drop arrangement, providing and

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fixing SW or RCC right angled bend and double tee junction of the requisite size including cutting ends if required and jointing, providing 11cm thick brick masonry in 1:2 cement mortar or PCC encasement around including finishing with cement plaster 1:1, 20 mm thick and excavation and plugging the open mouths of the double tee junctions and house connection pipes wherever directed.

26. C.I. MANHOLE COVERS :

26.1. COVERS : The C.I. manhole covers and frame shall be cleanly cast and shall be free from air and sand holes, cold shuts and warping which are likely to impair utility of castings. They shall be of tough homogeneous cast iron, or heavy, medium or light duty type as specified. The sizes specified are the clear internal dimensions.

The minimum weights of the various types of manhole covers with frames and their internal sizes will be as given below.

weight	SL.	Description	Clear	Minimum	Minimum	Total
	No.		opening	weight of	weight of	
		mm	cover kg.	frame. kg.		kg.
	1.	Heavy Duty Circular	500 dia.	118	111	229
	2.	Medium Duty Rectangular	455x610	80	64	144
	3.	Medium Duty Circular	500 dia.	58	58	116
	4.	Light Duty Rectangular Double seal	455x610	29	23	52

26.2 Manhole covers with double seal shall be used near buildings and within compounds. When the inspection Chamber is built in domestic premises where they are not subjected to wheeled traffic head light duty. C.I. covers may be used. When it is build within the metalled width of the road under heavy vehicular traffic, it shall be provided with heavy duty C.I. cover. Medium duty covers shall be used in light traffic conditions such as internal approach roads and cycle tracks.

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26.2.1 The covers used in manholes on sewer lines shall invariably bear the work "SEWER" on the top, and those used for storm water drains shall bear work S.W.D. These makings shall be done during casting of the covers.

26.2.2 The frame of manholes cover shall be embedded firmly in the RCC slab or plain concrete as the case may be on the top of the masonry.

26.2.3 After the completion of the work manhole covers shall be seated by means of thick motor grease. All exposed surfaces of the frames and cover shall be painted with coat tar. The cost of such work should be included in the Contractor's rates.

ADDENDUMS TO
SPECIFICATION FOR BUILDERS WORK

27.9 READY MIXED CONCRETE (as per IS 4926)

27.9.1 Materials

27.9.1.1 Selection and Approval of Materials : Materials used should satisfy the requirements for the safety, structural performance durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between IS 4926 and materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

27.9.1.2 Cement : Cement used for concrete shall be in accordance with the requirements of IS 456.

27.9.1.3 Mineral Admixtures : Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

27.9.1.4 Aggregates : Aggregates used for concrete shall be in accordance with the requirement of IS 456. Unless otherwise agreed testing frequencies for aggregates in plant shall be as given IS 4926.

27.9.1.5 Chemical Admixtures

(i) Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.

(ii) It shall be the responsibility of the RMC Manufacturer to establish compatibility and suitability of any admixture with the other ingredients of the mix and the determine the dosage required to give the desired effect.

(iii) Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the RMC Manufacturer shall be clearly marked as to its content.

(iv) When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

(v) The amount of admixture added to mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the RMC Manufacturer and the purchaser.

27.9.1.6 Water : Water used shall be in accordance with the requirement of IS 456. Unless otherwise agreed, the testing frequencies for water shall be as given in Annex A.

The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The RMC Manufacturer's production staff and truck-mixer, drivers shall be made aware of the appropriate responses to variations in concrete

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consistency of a particular mix caused by normal variations in aggregate moisture content or grading.

27.9.2 General Requirements

27.9.2.1 Basis of Supply : Ready-mixed concrete shall be supplied having the quality and the quantity in accordance with the requirement agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with requirements of IS 456.

All concrete will be supplied and invoiced in terms of cubic meters (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

27.9.2.2 Transport of Concrete : Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re-handling or moving the concrete horizontally by vibration. If required by the purchaser the RMC Manufacturer can utilize admixtures to slow down the rate of workability loss,

27.9.2.3 Time in Transport : The general requirement is that concrete shall be discharged from the truck-mixer within 2 hrs of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced. The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable. Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

27.9.3 Sampling and Testing of Ready-Mixed Concrete

27.9.3.1 Point and Time of Sampling : For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the RMC Manufacturer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (see Annex A).

The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying in concrete as per the requirement given in this standard or otherwise agreed to where so permitted in the standard.

27.9.3.2 Workability : The test for acceptance is to be performed upon the RMC Manufacturer's delivery vehicle discharge on site. The workability shall be within the following limits on the specified value as appropriate:

Slump ± 25 mm or $1/3$ of the specified value, whichever is less.

Compacting factor : ± 0.03 , where the specified value is 0.90 or greater,

± 0.04 , where the specified value is less than 0.90 but more than 0.80,

± 0.05 , where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (see IS 9103) Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

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27.9.3.3 Specified Strength

(i) Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied should be one sample for every 50 m³ of production or every 50 batches, whichever is the greater frequency.

Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456) and three samples for compressive strength test at 7 days. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.

27.9.3.4 Additional Compliance Criteria : Any additional compliance criteria shall be declared to the RMC Manufacturer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance frequency of assessment, method of test and significance result.

27.9.3.5 Non-Compliance : The action to be taken in case of non-compliance shall be declared and mutually agreed upon.

27.9.4 Information to be Supplied by the Purchaser

27.9.4.1 The purchaser shall provide to the RMC Manufacturer the details of the concrete mix or mixes required by him and all pertinent information on the use of the concrete and the specified requirements.

5.9.4.2 Designed Mixes : Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information is conveyed to the RMC Manufacturer. In order to assist in this, the format given in Annex B may be completed and forwarded to the RMC Manufacturer at the time of enquiry.

27.9.4.3 Prescribed Mixes : The concrete mix shall be specified by its constituent materials and the properties or quantities of those constituents to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the RMC Manufacturer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format given in Annex B may be followed with suitable modifications as applicable to prescribed mixes.

27.9.5 Information to be Supplied by the RMC Manufacturer

When requested, the RMC Manufacturer shall provide the purchaser with the following information before any concretes is supplied:

- (a) Nature and source of each constituent material,
- (b) Source of supply of cement,
- (c) Proposed proportions or quantity of each constituent/M³ of fresh concrete.
- (d) Generic type(s) of the main active constituent(s) in the admixture;
- (e) Whether or not the admixture contains chlorides and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture;
- (f) Where more than one admixture is used, confirmation of their compatibility and
- (g) Initial and final setting time of concrete when admixture is used at adopted dosage (tested as per IS 8142).

27.9.6 Production and Delivery

27.9.6.2 Batching Plants and Batching Equipment : Hoppers for weighing cement, mineral admixtures, aggregates and water and chemical admixture (if measured by mass) shall consist of suitable container freely suspended from a scale or other suitable load-measuring device and

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equipped with a suitable discharging mechanism. The method of control of the loading mechanism shall be such that, as the quantity required in the weighing hopper is approached the material may be added at controllable rate and shut off precisely within the weighing tolerances specified in Annex C. The weighing hoppers for cement, mineral admixtures aggregate shall be capable of receiving their rated load, without the weighed material coming into contact with the loading mechanism. Where the rated capacity of a batching plant mixing cycle is less than 2.0 m³, additional precautions shall be taken to ensure that the correct number of batches are loaded into the truck mixer. The weighing hoppers shall be constructed so as to discharge efficiently and prevent the build up of materials. A tare adjustment, up to 10 percent of the nominal capacity of the weigh scale, shall be provided on the weighing mechanism so that the scale can be adjusted to zero at least once each day. Dust seals shall be provided on cement hoppers between the loading mechanism and the weigh hopper, and shall be fitted so as to prevent the emission of cement dust and not affect weighing accuracy. The hopper shall be vented to permit escape of air without emission of cement dust. Vibrator or other attachment, where fitted, shall not affect the accuracy of weighing. There shall be sufficient protection to cement and aggregate weigh hoppers and weighing mechanisms to prevent interference with weighing accuracy by weather conditions or external build-up of materials. Where chemical admixture dispensers are used, they shall be capable of measurement within the tolerance in annex C and calibrated container or weigh scales shall be provided to check the accuracy of measurement at least once a month. Where a continuous mixer with ribbon loading is used the batching procedure specified by the manufacture of the plant shall be followed. Each control on the batching console and weigh-dial or display shall be clearly labeled with its function and where concerned with the batching of materials, the materials type. When more than one type or grade of cement is being used, the weighing device and discharge screw or other parts of the transfer system shall be empty before changing from one type of cement to another. When more than one type or grade of cement is being used, the weighing device and discharge screw or other parts of the transfer system shall be empty before changing from one type of cement to another. When pulverized fuel ash and other mineral admixtures are batched through the cement weigh system, the weighing device and discharge screw or other parts of the transfer system shall be empty when the weighing system has returned to zero reading or completed the batch. Where a back weigh system is utilized to weigh materials a system shall be in place so as to prevent materials being loaded during the process of weighing.

27.9.6.3 Measurement of Materials : Cement and mineral admixture materials shall be measured by mass in a hopper or compartment separate from those used for other materials and on a scale of appropriate sensitivity, measurement being taken from a zero reading. Aggregates shall be measured by mass, allowance being made for the free moisture content of the aggregates. The added water shall be measured by volume or by mass. Any liquid chemical admixture (or paste) shall be measured by volume or by mass and any solid admixture by mass. When weighing materials any build up in the hopper during the day must be tared out or allowed for in the batch weights. After measurement all materials shall be discharged into the mixer without loss. The accuracy of the measuring equipment shall be within + 2 percent of the quantity of cement and mineral admixtures being measured and within + 3 percent of the quantity of aggregate, chemical admixture and water being measured. The plant operator shall be provided with a clear display of the quantities of materials to be batched for each mix and batch size with information identifying the display

to be selected for each designed and prescribed mix to be produced. Analogue scale displays for the weighing of cement, mineral admixtures, aggregates and water shall be readily discernable from the operating position. For digital readouts the numerals shall be readily discernable from the operating position. Fully automatic production systems shall be fitted with control equipment to allow the correct operation of the plant to be monitored during weighing and batching. Automatic control systems on batching plants shall not commence batching until all hoppers have been emptied and /or tared and the scales zeroed unless such systems are designed to take account of build up in their programming. All scales shall be tested and calibrated as per Annex C.

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27.9.6.4 Mixing

(i) *Washing Out Water* : Before loading concrete materials or mixed concrete into either a stationary mixer or truck mixer any water retained in the mixing drum for washing out purposes shall be completely discharged.

(ii) *Stationary or Central Mixers* : Stationary mixers shall not be loaded in excess of the manufacturer's

rated capacity. The mixing time shall be measured from the time all the materials required for the batch, including water, are in the drum of the mixer. The mixing time shall not be less than that recommended by the manufacturer. Where a continuous mixing plant is used, the complete mixing time shall be sufficient to ensure that the concrete is of the required uniformity.

(iii) *Truck Mixers* : When a truck mixer is used for the partial or complete mixing of concrete, mixing shall be considered to commence from the moment when all the materials required for the batch, including water, are in the rotating drum of the mixer. Truck or agitators shall not be loaded in excess of the manufacturer's rated capacity. In order to produce a satisfactory mix, and where there is no data available to establish different period and speed of revolutions, mixing shall continue for not less than 60 revolutions of the truck mixer drum at a rate of not less than 7 revolutions/min. All completely truck mixed concrete shall be visually inspected for uniformity prior to leaving the plant. When a truck mixer or agitator is used for transporting concrete which has been mixed before leaving the plant, the concrete shall be agitated during transit and remixed at the site for at least 2 minutes so that the concrete is of the required uniformity.

Where water is added to the concrete in the truck mixer through the truck mixer water meter and when such water is being accounted for in the total water within the mix, it shall be ensured that the truck mixer water meter is in operational condition and properly calibrated. Where a water meter is not available, water must be measured in a suitable container before being added to the truck mixer.

(iv) *Condition of Mixers* : Stationary and truck mixers shall be maintained in an efficient and clean condition with no appreciable build up of hardened concrete or cement in the mixing drum, on the mixing blades, or on the loading hopper or discharge chutes.

27.9.6.5 Delivery Ticket : Immediately before discharging the concrete at the point of delivery, the RMC Manufacturer or his representative shall provide the purchaser with a preprinted delivery ticket for each delivery of concrete on which is printed, stamped or written the minimum information detailed invoicing as per following:

The following information shall be included in the delivery ticket to accompany the load to the purchaser :

- (a) Name or number of the ready-mixed concrete depot
- (b) Serial number of the ticket
- (c) Date
- (d) Truck number
- (e) Name of the Purchaser
- (f) Name and location of site
- (g) Grade or mix description of the concrete
- (h) Specified target workability
- (i) Minimum cement content (if specified)
- (j) Type of cement and grade (if specified)
- (k) Maximum free water-cement ratio (if specified)
- (l) Nominal maximum size of aggregate
- (m) Generic Type or name of any chemical and mineral admixtures included.
- (n) Quantity of concrete in m³
- (o) Time of loading
- (p) Signature of the plant operator
- (q) A statement warning the purchaser of the precautions needed to be taken when working with

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cement and wet concrete.

D-2 On site the following information will be added. :

- (a) Time of arrival on site.
- (b) Time when discharge was completed.
- (c) Any water/admixture added by the supplier to meet the specified workability.
- (d) Any extra water /admixture added at the request of the purchaser of the concrete, or his representative, and his signature.
- (e) Pouring location.
- (f) Signature of the purchaser or his representative conforming discharge of the load.

27.9.7 Quality Control

(i) *Production Control* : The production of concrete at each plant shall be systematically controlled. This is to ensure that all the concrete supplied shall be in accordance with these requirements and with the specifications that has formed the basis of the agreement between the RMC Manufacturer and purchaser. li) Each load of mixed concrete shall be inspected before dispatch and prior to discharge.

iii) The workability of the concrete shall be controlled on a continuous basis during production and any corrective action necessary taken.

iii) For each load, written, printed or graphical records shall be made of the mass of the materials batched, the estimated slump, the total amount of water added to the load, the delivery ticket number for that load, and the time the concrete was loaded into the truck.

iv) *Product Control* : Concrete mixes shall be randomly sampled and tested for workability and where appropriate, plastic density, temperature and air content. Where significant variations from target values are detected, corrective action shall be taken.

v) It is important to maintain the water cement ratio constant at its correct value. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in the aggregates. Suitable adjustments should also be made in masses of the aggregates due to this variation (see IS 456). Any change in water content due to change in aggregate grading shall be taken care of by forward control by suitable modifications to mix design.

27.9.7.4 Mix Performance : The RMC Manufacturer shall be responsible for ensuring that suitable control

procedures are in place ensure the following.

(i) *Design Mixes* : A quality control system shall be operated to control the strength of design mixes to the levels required as per IS 456 and shall be based on random tests of mixes which form the major proportion of production. The system shall include continuous analysis of results from cube tests to compare actual with target values together with procedures for modifying mix proportions to correct for observed differences. Compressive strength testing shall be carried out using a machine that meets the requirements of IS 14858.

(ii) *Prescribed Mixes* : Periodic and systematic checks shall be made to ensure that the cementitious material contents of prescribed mixes comply with their mix descriptions.

27.9.9 Records

Records shall be maintained by the RMC Manufacturer to provide confirmation of the quality and quantity and

quantity of concrete produced. The records shall be retained for the purposes of these requirements for

a period of at least one year. They shall cover the following aspect:

(a) Production and delivery:

- (i) Batching instruction
- (ii) Batching Records,
- (iii) Delivery tickets, and
- (iv) Equipment calibration and plant maintenance.

(b) Materials and production control:

- (i) Concrete production and materials purchase, usage and stocks, and

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- (ii) Certificates or test results for materials.
- (c) Production quality Control: Control test results.

27.10 PLACING CONCRETE BY PUMPING

27.10.1 General

Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged directly

into the desired area is termed as pumped concrete.

Method of applying pressure to concrete is by pumps. Pumps to be used shall be either of the two types as mentioned below:-

(A) Piston type pumps

(B) Squeeze pressure type pumps.

Compressed air pressure pumps shall not be used in the works.

27.10.2.7 Lubricating of Pipe Line

Before pumping concrete into the pipeline, the line shall be lubricated with a properly designed mortar/grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. The quantity of mortar required as lubricant is dependent on the smoothness and cleanliness of the pipelines. As a guide line, for a 100 mm diameter pipe line of 100 metre length, 0.08 cum to 0.10 cum of mortar should normally be adequate, but this shall not be taken as specified, and the contractor shall establish his requirements.

The quantity of mortar that comes out of the delivery end of the pipeline shall not be used in place of the concrete work. However, with the approval of Engineer-in-Charge, this mortar may be used as bedding mortar against construction joints. The rest of the mortar shall be wasted.

Lubrication shall be maintained as long as the pumping of concrete continues.

27.11 GUIDELINES FOR FIELD PRACTICE

27.11.1 General Precautions

(i) The pump shall be placed as near the placement area as practicable. The surrounding area of the pump shall be free of obstructions to allow for movement of concrete delivery trucks. The surface must be strong enough to withstand the loaded trucks operating on it. If the surface is a suspended slab, the truck route shall be adequately supported in consultation with the Engineer in-Charge.

(iii) Pipe lines from the pump to the placing area shall be laid with minimum number of bend. For large placement areas, alternate lines shall be installed for rapid connection when required. A flexible pipe at the discharge end will permit placing over a large area directly without re-handling of pipelines. The pipeline shall be firmly supported.

(v) When pumping downwards, an air release valve shall be provided at the middle of the top bend to prevent vacuum or air buildup. Similarly, while pumping upwards, a no-return valve shall be provided near the pump to prevent the reverse flow of concrete.

(ix) When a delay occurs because of concrete delivery or some form repair works or for any other reason, the pump shall be slowed down to maintain some movement of concrete in the pipe line. For longer delays, concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with intermittent strokes of the pump. It is sometimes essential to run a return line back to the pump so that concrete can be re-circulated during long delays.

(x) If after a long delay, concrete cannot be moved in the line, it may be necessary to clean out the entire line. However, quite often only a small section of pipe line may be plugged and requires cleaning. The pump operator who know such details as the length of line, age of concrete in the line etc., should be depended upon to aid in deciding the appropriate section to be cleaned.

27.11.3 Sampling and Testing (Materials)

27.11.3.1 Aggregates

(i) The following information shall be furnished before the material is delivered to site:-

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

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- Trade group of principal rock type as per table 5.7 below :
- Presence or reactive minerals

TABLE 5.7

Trade group name of	Granite, Gabbro,
Aggregates to be used for concrete	Dolerite, Rhyolite, Basalt, Quartzite, Gneiss

Aggregates to be used for concrete : Dolerite, Rhyolite, Basalt, Quartzite, Gneiss.

(ii) The RMC manufacturer shall furnish reports on test results giving the following information for approval

to Engineer-in-Charge before delivery of material at site:-

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

27.11.3.2 Cement : Supplier of cement shall furnish the following documents before the cement is delivered to site:-

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

(ii) Certificate confirming that the chloride content in the cement is not in excess of 0.05 percent of mass of cement.

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

(vii) Following tests shall be conducted at site on each lot of cement delivered:-

Mandatory tests Number of test per lot

1. Consistency of standard cement paste 5

2. Initial and final setting time 5 each

3. Compressive strength test 10

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

All such tests shall be done on representative samples taken from each lot and testing and computation of test results shall be done as per IS 4031.

27.11.3.3 Water

(i) Water to be used in manufacturing and curing of concrete shall be tested before use. All such test results shall be submitted to the Engineer-in-Charge for his approval before water is used.

All testing procedure and computation of test results shall conform to IS 3025.

27.11.3.4 Admixtures

(i) Suppliers of Admixtures for concrete shall supply the following before any admixtures is approved by the Engineer-in-Charge for their used:-

Certificate confirming that the use of a particular brand of admixture shall not be harmful to concrete in any way.

Certificate confirming the exact dosage of admixture of a particular brand.

Certificate stating the specific purpose for which the admixture is to be used.

Special precautionary measures to be taken in the manufacturer of concrete when using the particular brand of admixture.

Certificate confirming that the admixture conforms to specifications of IS 9103 or to ASTM-C260, ASTM – C10, ASTM – C 595 or to ASTM- C 618.

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

(v) Expenses for all materials used for testing, sampling procedures and testing including preparing reports shall be borne by the concrete Manufacturer/ Contractor.

(vi) Rate of concrete is inclusive of cost of admixtures. The contractor shall not be paid anything extra for admixtures required for achieving direct workability without any change in specified water cement ratio for RCC/CC work.

27.11.4 Sampling and Testing for Quality Control of Fresh Concrete

Fresh concrete shall be tested for

- (a) Slump
- (b) Compacting Factor/ Workability
- (c) Consistency
- (d) Weight per cubic meter, cement factor and air content

27.11.4.1 Slump

(i) For concrete totally mixed in a central plant, slump shall be checked at:-

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

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

- (a) Point of discharge from delivery trucks
- (b) Final placement location

In this case also, the slump measured at the final placement location shall conform to the design slump. The placement contractor shall be responsible for transporting concrete from delivery truck discharge point to final placement location within 10 minutes. However, in this case, the truck shall discharge the concrete within 1 hour and 30 minutes from the time cement is added in the mixer and slump measured at point of discharge immediately on delivery. Manufacturer of concrete shall ensure that the final slump measurement corresponds to the ordered slump.

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

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

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

27.11.4.2 Compacting Factor

(i) For concrete whose ordered slump is 50 mm or less, compacting factor test shall be conducted at both field and central batch plant in addition to slump tests mentioned above.

(ii) Compacting factor check shall be done in field only at placement location, and shall also be conducted at central batch plant if concrete is totally mixed in plant.

(iii) For this test, sampling shall be done as for slump measurements in field and within the same frame as for slump test.

(iv) Only one compaction factor test shall be conducted for every 20 cum of concrete or part thereof

placed at location for each type of concrete. Since the test is sensitive, every care shall be taken to conduct this test totally in compliance with procedure mentioned in IS 1199.

(v) Laboratory tests for determining compacting factor of concrete shall be done as per

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manufacturer's requirements for establishing and controlling the design mix of concrete.

(vi) Compacting factor test shall not be taken as an acceptance criteria and shall be treated only as a guideline to workability of concrete.

27.11.4.3 Consistency of Concrete : This test shall be performed only at the batching plant laboratory using a Vee-Bee Consist meter, for determining and predicting the slump of concrete. Number and frequency of these tests shall be based on requirements of the manufacturer of concrete. Care shall be taken in producing mix design of required characteristic strengths of concrete within limits of Vee-Bee-Degrees between 1.6 and 4.5 for concrete transported and placed by normal method and between 0.8 and 3.5 for concrete transported and placed by pumping methods.

27.11.4.4 Weight, Cement Factor and Air contents Test : Freshly mixed concrete for every type shall be tested in the batch plant laboratory for each batch of concrete produced to determine weight per cubic metre of freshly mixed concrete, cement factor in concrete and the air content of the concrete. Frequency and number of test shall be finalized by the manufacturer of concrete in consultation with the Engineer-in-Charge for his requirement of the mode of measurement of concrete produced. The Engineer-in-Charge may at his discretion require further tests over and above those specified above in para 27.11.4.1 to be conducted on fresh concrete. The manufacturer and the placement contractor shall have to comply with all such requirements.

27.11.5 Sampling and Testing for Quality Control of Hardened Concrete

(i) Test on cube crushing strength of concrete in accordance and compliance with IS 456 and IS 516 shall done as under:-

(a) Sample of fresh concrete shall be taken from concrete at central batch plant mixer while loading delivery trucks or other transport and also from concrete transported to placement location.

(b) Test on specimens made from samples collected at placement location shall be considered as field test specimens and results there from shall be the criterion of concrete strength. Test in specimens made from samples at the batch plant shall only be taken as guidelines test.

Only in the case of doubtful result, the Engineer-in-Charge may refer to such guideline results for deciding on the quality of concrete.

(c) For truck mix concrete and shrink mix concrete guideline test specimens shall be made from samples collected at discharge location from mixing trucks. For this purpose first and last 15% of the load shall be omitted while collecting samples.

(e) All test specimens shall be made compacted cured and tested in compliance with IS 516 and test result interpreted in accordance with IS 456 for acceptance of concrete strength, field specimens test results shall not be less than values given in Table 5.6.

TABLE NO-5.6

<i>Specified Grade</i>	<i>Mean of the Group of 4 Non- Overlapping Consecutive Test Results</i>	<i>Individual Test Results in N/mm³</i>
(1)	(2)	(3)
M15	$\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest 0.5 N/mm}^2\text{)}$ or $f_{ck} + 3 \text{ N/mm}^2$ Whichever is greater	$\geq f_{ck} - 3 \text{ N/mm}^2$
M20 or above	$\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest 0.5 N/mm}^2\text{)}$ or $f_{ck} + 4 \text{ N/mm}^2$, Whichever is greater	$\geq f_{ck} - 4 \text{ N/mm}^2$

NOTE – In the absence of established value of standard deviation, the values given in Table No 8

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- **Assumed Standard Deviation** of IS: 456 may be taken, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

(f) In addition to 28 day crushing strength test on specimens made at frequencies specified in para 4 above, early strength tests at 7 days shall also be conducted on field specimens as well as guideline test specimens. Frequency of sampling for this set of test shall also be same as those specified in Table 5.8 above. 7 day strength shall conform to values given in Table 5.5. But these test results even if conforming to specified values shall only be taken a guideline values for projecting concrete strength and shall not be construed as conforming to specifications.

Table No- 5.5

Concrete Mix (Nominal Mix on Volume basis)	Compressive Strength in (Kg/ sq cm)	
	7 days'	28 days'
1:1:2	210	315
1:1.5:3	175	265
1:2:4	140	210

(g) For each grade of concrete and for all workability conditions with different water – cement ratios and compositions of admixtures, preliminary test shall be conducted for crushing strength on finalization to design mix for each type of concrete. Such test shall be conducted both at 7 days and 28 days under laboratory conditions. Six test specimens shall be made for 7 days test and six test specimens shall be made for 28 days test. Average of the six test results of different periods shall not be less than those specified in Table 5.5.

(h) Crushing strengths on cubes shall also be conducted during the process of finalization of concrete design mix. Frequency and number of such tests shall be as per Mix of requirements of concrete manufacturer.

(i) All test specimens for conducting crushing strength shall be properly labeled for identification indicating:-

- (i) Date of making specimen
- (ii) Grade of concrete
- (iii) Placement location exact
- (iv) Purchasers order number

(j) In addition to crushing strength test on concrete, the Engineer-in-Charge may call for other tests on hardened concrete. The placement contractor and the manufacturer of concrete shall comply with all such instructions.

(ii) Non-destructive Tests

(a) When the 28 days crushing values on field specimens and/ or specimens and/or specimens made for guideline test fall short of specified values, or in case of doubtful placement of concrete, the Engineer-in-Charge shall call for non-destruction tests on the structure. Such tests may be any one or a combination of the following:-

- ☐ Rebound hammer test
- ☐ Windsor Penetration Probe test
- ☐ Pulse velocity (sonic or Ultrasonic) test
- ☐ Core test
- ☐ Load test

(b) Interpretation of rebound hammer, Windsor Probe and Pulse velocity test results shall rest with the Engineer-in-Charge.

(c) Core test, if ordered by the Engineer-in-Charge, shall be done in accordance with IS 516. Samples for such test shall be taken from locations to be identified by the Engineer-in-Charge and such samples shall be collected in compliance with IS:1199.

(d) If felt necessary, the Engineer-in-Charge may instruct load testing for any part of the structure based on doubtful concrete strengths. Such test shall be carried out as per details to be provided by the Engineer-in-Charge in consultation with the structural consultants.

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(e) The concrete manufacturer/ concrete placement contractor shall arrange for all test to be conducted in accordance with these specifications, including all necessary tools, plants, equipment and material, and shall be responsible for conducting all test at his cost.

(f) All test conducted at the filed laboratory shall be carried out by qualified technicians employed by the concrete manufacturer/ concrete placement contractor, in presence of authorized representative of the Engineer-in-Charge. All test reports and observation reports shall be jointly signed by the Engineer-in-Charge authorized representative and the technician conducting such test.

(g) Engineer-in-Charge shall alone decide where such tests are to be conducted. He may instruct tests to be conducted at laboratories other than the field laboratory and such instructions shall be followed without claiming extra charges on this account.

(h) The Concrete Manufacturer/ Placement contractor shall set up a laboratory at this own expense which shall have facilities, for conducting all necessary field test on materials and field and laboratory test on concrete. The laboratory shall be staffed by the concrete Manufacturer/ Placement Contractor with qualified and experienced scientists and technicians.

28 AUTOCLAVED AERATED CONCRETE (AAC) BLOCK MASONRY

28.1 AAC BLOCKS:

28.1.1 The precast AAC blocks shall be confirming to BIS 2185 part-III 1984 of approved size shall be procured from approved manufactures only.

28.1.2 The material received at site shall be fully cured and shall have attained the required strength before delivery to the site. The material shall be free of cracks. The AAC blocks shall be dried for a period of minimum 4 weeks before supplying a site.

28.1.3 The AAC blocks shall have sizes as per requirement at site as approved by Engineer in charge. If different sized of AAC blocks are available, the sizes suitable for the work shall be procured by contractor.

The sizes of AAC Blocs to be used shall be 600 x 200 x 200 mm and 600x100x200 mm.

28.1.4 The maximum variation in the length of the Blocks shall not be more than +/- 5 mm and the maximum variation on the height and width of block not more than +/- 3 mm.

28.1.5 The samples of AAC blocks (each sample consisting of 6 specimen) shall be collected randomly from the lot procured and tested for various parameters specified below. One samples shall be tested for every 100 cum or part thereof. However, minimum one sample shall be tested from each lot received at site if the quantity procured in the lot is less than 100 cum. If required, Engineer-in-Charge or his authorized representative shall inspect the factory during production of the material for this work and also collect samples (of materials used for making AAC blocks and precast AAC blocks) from the factory itself. The contractor shall consider this contingency also while placing the order with one of the approved firms. Nothing extra shall be paid on this account.

28.1.6 AAC blocks shall be got tested for following parameters from any accredited laboratory as per provision of BIS 6441 (part I- IX) :

- A. Compressive strength.
- B. Thermal Conductivity (K Value)
- C. Dry Density

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D. Dimensional Tolerances.

The AAC blocks shall meet following parameters:

- a. Compressive strength shall not be less than 3 N/MM²
- b. Thermal Conductivity (K Value) – 0.24 W/m.k.
- c. Normal Dry Density shall be not be less than 550-650 kg/cum.

28.2 MORTAR :

Shall be as given in Clause no 4.2 of 'Brick Work'

28.3 CONSTRUCTION DETAILS :

AAC masonry work shall be executed as per specifications laid down in BIS-6041 - 1985

28.3 SCAFFOLDING :

Scaffolding will be double or single as is warranted for the particular work. Put log holes shall be made good by bricks to match the face work when put logs are removed after ensuring that the holes behind are solidly filled in with 1:4:8 cement concrete.

28.4 CURING: All brick work shall be kept well watered for 14 days after laying. Where pozzolana cement is used for mortar, the curing shall be extended by one week at the Contractor's expense

28.5 R.C.C. BAND IN 100 MM THICK WALL:

100 MM thick walls shall be provided with R.C.C. (M15 Grade) band of size 100 x 100 mm at very height of 1.05 Mtr with reinforcement consisting of 2 nos, 8 mm dia M.S. round bars and links of 8 mm dia bras at 300 mm c/c, including formwork . The cost of reinforcement shall be paid separately under respective item unless otherwise stated in the schedule of quantities

28.6 RATES TO INCLUDE :

Apart from other factors mentioned elsewhere in this contract, the rate for items of brick work shall include for the following :

- a. All labour, materials, use of tools, equipment and other items incidental to the satisfactory completion of brick masonry at all heights and levels.
- b. Erecting and removing of all scaffolding, ladders and plant required for the execution of the work to the height and depths and shapes as shown on the plan or ordered by the Engineer.
- c. Constructing Masonry work to lines, levels, batters, pillars, curves and to any position or shape, to any heights or levels including raking of joints and housing frames, fixtures etc.
- d. Curing the work.
- e. Removing of all stains and adhering mortar lumps on the brick work surfaces.

28.7 MEASUREMENTS: Shall be as given in Clause no 4.9 of 'Brick Work'

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29 FIRE RESISTANT DOOR (FRD) SHUTTERS:**55 mm thick 2 hour Fire Rated Shutters:**

- 29.1.1 The fire resistant flush doors along with the frames shall be procured as a set from one of the approved manufacturer and shall be as per the specifications, as per description of the item and the approval of the Engineer-in-Charge. The door shutters shall be entirely symmetrical on both faces. The door shutters shall have minimum two hour fire rating and shall satisfy performance required for integrity & insulation as per BS 476: Part 20 & 22. Besides, it shall conform to all the requirements for Flush door shutters as per the relevant IS 1141, 1708, 2191, 2202, 4020 etc.
- 29.1.2 The frame should be of second class teak wood of size 150mm x 75 mm of approved quality fixed to wall with hold fasts or metallic fastener (3 nos on each side)
- 29.1.3 The gap between the shutter and frame, between shutters in case of double leaf shutter should not be more than 1mm. Similar care shall be taken for making rebates for fixing hinges and other hard wares. The workmanship required is of superior class for achieving the desired results.
- 29.1.4 Graphite based Intumescent strip seal of size 10x4 mm shall be provided and fixed in the grooves on the door shutters all around the periphery except on the bottom to prevent penetration of smoke and fire. The shutters shall not be worked upon at site to prevent damage to the intumescent strip. In case of double leaf shutters, Intumescent strips, of size 10 mm x 4mm shall be fixed in the rebate portion of meeting styles of each leaf of the shutter.
- 29.1.5 All the FRD shutters shall be made from asbestos free frame work of 100x30mm treated hard wood for styles and rails and the core made of 30mm thick ceramic fiber blankets infill of density 96 kg per cum and face panel of 9mm thick calcim silicate boards, well matched commercial 3 ply veneering with vertical grains or cross bands on both faces of shutters and provided with 12mm thick 2nd class teak wood external lipping all around the shutter and 1mm thick decorative laminates as approved. The grooves of required size and shape shall be made in the external wooden lipping for fixing intumescent seal.
- 29.1.6 The hinges to be used for fixing the door shutters shall be stainless steel ball bearing hinges of grade 304 fixed with stain steel screws of grade 304. While testing for fire resistance, the whole assembly shall be tested along with the door shutter, doorframe, glass, beadings, hinges, glass panel in the opening etc.
- 29.1.7 All the shutters shall be treated for anti-termite treatment, against woodborer, fungus, pests etc. Therefore, it shall be provided with the preservative treatment based on Boron & Fluoride. Nothing extra shall be payable on this account.
- 29.1.8 The calcium silicate boards to be used for manufacturing fire rated door shutters shall be from one of the approved brand. It shall be noncombustible and shall conform to BS 476 part 4 and to class 1 of BS476 part 7 for surface spread of flame.
- 29.1.9 The contractor shall submit manufacturer's test certificate for specified fire rating for integrity and insulation criteria, required as per the item nomenclature and the specifications. The Contractor shall also co-ordinate and facilitate with the office of the Chief Fire Officer for obtaining clearance for the FRD shutters along with frames including getting the required site visits conducted by such authorities with a view to obtain Fire NOC. The Contractor shall also be responsible for liaising work required, if any, in this regard. Statutory charges, fees etc. required to be paid to the concerned authorities in this

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connection shall only be paid by the department or shall be reimbursable to the Contractor on production of proof of actual payment by him.

29.1.10 Destructive Testing for insulation and integrity criteria of the FRD shutters along with frames shall be done in an accredited laboratory approved by Engineer-in-Charge. The shutters shall be able to resist thermal stresses and should not fail on account of shrinkage, cracking or distortion or any other reason, during testing for the duration for which it is fire rated. The cost of samples of door shutters along with frame (including cost of laminates and / or wooden Veneering, fire rated glass for glazed / vision panels, wooden and G.I beadings, intumescent strips, hinges, screws), packaging, sealing and transportation of samples to the approved laboratory etc., shall be borne by the Contractor. At least one sample from each category of fire rating shall be tested. The shutters along with the doorframes shall, therefore, be procured from one of the approved manufacturer and in one lot only. The samples for testing shall have the finish of wood veneer and / or laminate etc. as specified and shall be representative of the actual door shutters along with the frames to be used in the work, as per the architectural drawings. The glazing / vision panel opening of required size and shape shall also be made in the test shutters as per specifications.

29.1.11 Measurement

Width shall be measured from outer to outer of frame. Height shall be measured from outer of top frame to floor finish. Area shall be worked out up to two places of decimal. No deduction shall be made for making vision panel.

29.1.12 Rate

The rate shall include cost of providing and fixing frame, shutters, lamination, hold fast or metallic fastener and SS hinges. Cost of making vision panel & providing fire resistant glass panelling will be paid for separately under respective item. Payment will be made separately under respective item.

29.2. 45 mm thick 1 hour Fire Rated Shutters:

29.2.1 The fire resistant flush doors along with the frames shall be procured as a set from one of the approved manufacturer and shall be as per the specifications, as per description of the item and the approval of the Engineer-in-Charge. The door shutters shall be entirely symmetrical on both faces. The door shutters shall have minimum two hour fire rating and shall satisfy performance required for integrity & insulation as per BS 476: Part 20 & 22. Besides, it shall conform to all the requirements for Flush door shutters as per the relevant IS 1141, 1708, 2191, 2202, 4020 etc.

29.2.2 The frame should be of second class teak wood of size 120mm x 70 mm of approved quality fixed to wall with hold fasts or metallic fastener (3 nos on each side)

29.2.3 The gap between the shutter and frame, between shutters in case of double leaf shutter should not be more than 1mm. Similar care shall be taken for making rebates for fixing hinges and other hardware. The workmanship required is of superior class for achieving the desired results.

29.2.4 Graphite based Intumescent strip seal of size 10x4 mm shall be provided and fixed in the grooves on the door shutters all around the periphery except on the bottom to prevent penetration of smoke and fire. The shutters shall not be worked upon at site to prevent damage to the intumescent strip. In case of double leaf shutters, Intumescent strips, of

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size 10 mm x 4mm shall be fixed in the rebate portion of meeting styles of each leaf of the shutter.

- 29.2.5 FRD shutters shall be asbestos free, comprising of one 15mm thick calcium silicate board with 19mm thick ceramic wool reinforced Fire retardant compound and faced with 4mm thick commercial 3 ply veneering with vertical grains or cross bands and 1mm thick decorative lamination on both faces of shutters and provided with 12mm thick 2nd class teak wood external lipping all around the shutter as approved. The grooves of required size and shape shall be made in the external wooden lipping for fixing intumescent seal.
- 29.2.6 The hinges to be used for fixing the door shutters shall be stainless steel ball bearing hinges of grade 304 fixed with stain steel screws of grade 304. While testing for fire resistance, the whole assembly shall be tested along with the door shutter, doorframe, glass, beadings, hinges, glass panel in the opening etc.
- 29.2.7 All the shutters shall be treated for anti-termite treatment, against woodborer, fungus, pests etc. Therefore, it shall be provided with the preservative treatment based on Boron & Fluoride. Nothing extra shall be payable on this account.
- 29.2.8 The calcium silicate boards to be used for manufacturing fire rated door shutters shall be from one of the approved brand. It shall be noncombustible and shall conform to BS 476 part 4 and to class 1 of BS476 part 7 for surface spread of flame.
- 29.2.9 The contractor shall submit manufacturer's test certificate for specified fire rating for integrity and insulation criteria, required as per the item nomenclature and the specifications. The Contractor shall also co-ordinate and facilitate with the office of the Chief Fire Officer for obtaining clearance for the FRD shutters along with frames including getting the required site visits conducted by such authorities with a view to obtain Fire NOC. The Contractor shall also be responsible for liaising work required, if any, in this regard. Statutory charges, fees etc. required to be paid to the concerned authorities in this connection shall only be paid by the department or shall be reimbursable to the Contractor on production of proof of actual payment by him.
- 29.2.10 Destructive Testing for insulation and integrity criteria of the FRD shutters along with frames shall be done in an accredited laboratory approved by Engineer-in-Charge. The shutters shall be able to resist thermal stresses and should not fail on account of shrinkage, cracking or distortion or any other reason, during testing for the duration for which it is fire rated. The cost of samples of door shutters along with frame (including cost of laminates and / or wooden Veneering, fire rated glass for glazed / vision panels, wooden and G.I beadings, intumescent strips, hinges, screws), packaging, sealing and transportation of samples to the approved laboratory etc., shall be borne by the Contractor. At least one sample from each category of fire rating shall be tested. The shutters along with the doorframes shall, therefore, be procured from one of the approved manufacturer and in one lot only. The samples for testing shall have the finish of wood veneer and / or laminate etc. as specified and shall be representative of the actual door shutters along with the frames to be used in the work, as per the architectural drawings. The glazing / vision panel opening of required size and shape shall also be made in the test shutters as per specifications.
- 29.2.11 Measurement
- Width shall be measured from outer to outer of frame. Height shall be measured from outer of top frame to floor finish. Area shall be worked out up to two places of decimal. No deduction shall be made for making vision panel.
- 29.2.12 Rate
- The rate shall include cost of providing and fixing frame, shutters, lamination, hold fast or metallic fastener and SS hinges. Cost of making vision panel & providing fire resistant

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glass panelling will be paid for separately under respective item. Payment will be made separately under respective item.

30. CEMENT CONCRETE FLOORING AND CEMENT SKIRTING OR DADO, PLAIN
CEMENT CONCRETE FLOORING IN SINGLE LAYER.

30.1 CEMENT CONCRETE :

Unless otherwise specified, the proportion of cement concrete shall be 1:2.5:3.5 (Cement : fine aggregate : coarse stone aggregate of size 12 mm and below by volume. Cement however, shall not be measured in volume but by weight. One bag of cement of 50 Kgs. shall be assumed to contain 35 litres of cement i.e., 1.20 cft.). The coarse aggregate shall be from approved source, carefully selected, sufficiently tough and hard stone pieces broken in a manner that will provide particles of approximate cubicle shapes affording good interlocking. Elongated or thin flake like fragments should be avoided. The maximum size of coarse aggregate shall be 12mm. The fine aggregate shall be sand from approved source and consist of properly graded particles. The coarse and fine aggregates shall be conforming to relevant I.S. 383-1970 and shall be washed clean if necessary.

Unless otherwise mentioned in the item concrete in flooring shall be 40 mm thick. The least amount of mixing water that will produce a workable mix and will allow finishing without excessive trowelling shall be used. Generally a water cement ratio of 0.5 should suffice.

31. PLAIN OR COLOURED CEMENT TILES OR TERRAZZO TILES FLOORING DADO
AND SKIRTING

31.1 CONCRETE BASE AND MORTAR BEDDING :

The base of cement or lime concrete shall be laid and compacted to a reasonably true plain surface and to the required slopes and below the levels of the finished floor to the extent of the thickness of the tiles and mortar bedding. Cement concrete or lime concrete base shall be paid under a separate item. Lime surkhi-mortar for bedding shall be prepared in a mortar mill. The amount of water added shall be minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the tiles. Before spreading mortar, sub-floor or base shall be cleaned of

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all dirt, scum, laitance and all loose materials and then well wetted without forming any pools of water on the surface. In case of R.C.C. floors, the top shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much area as will be covered with tiles before the setting of the mortar. The thickness of the mortar bedding shall be 1:1:1 (1 lime putty : 1 surkhi : 1 Graded crushed stone (GCS). GCS for mortar bedding shall be as per I.S.S. No. 2116-1965 as applicable to unreinforced masonry work. Skirting, dado and raisers of steps/staircase shall be fixed on backing of cement mortar 1:3, 12mm thick with thick cement paste.

32. CURTAIN WALL, ALUMINIUM CLADDING & LOUVRES

32.1.0 SCOPE OF WORKS

- i. The scope of works under this section includes design, supply, installation, protection, guarantees, testing and maintenance during the defects liability period of Curtain Wall and Aluminium Cladding, as well as structurally glazed windows.
- ii. The work under this section includes all labour, materials, equipment and services as required for the complete design, Corporation's Engineering, testing, fabrication, assembly, delivery, anchorage, installation, protection and waterproofing of the aluminium curtain wall system and cladding aluminium all in accordance with the true intent and meaning of the specifications and drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings or described in the specification provided that the same can be reasonably inferred therefrom. Anchorage includes all anchor assemblies and supportive brackets as required to secure aluminium structural glazing system, cladding and louvres to the R.C.C. building structure or structural steel framing.
- iii. The aluminium curtain wall system and aluminium cladding described hereafter shall include but will not necessarily be limited to the following :-
 - a. Frames, vision panels, spandrels and openable panels for curtain wall as indicated, inclusive of all accessories and fittings.
 - b. Fire-stops, caulking, flashing and sealing of all interfaces with buildings at roof, soffits, sills, heads internal partitions, doorways etc.
 - c. Aluminium louvres wherever indicated with framework accessories and fittings.
 - d. Sealant within and around the perimeter of all work under this section.
 - e. Separators, EPDM and silicon gaskets, trims etc.

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- f. All stainless steel bracket supports, anchor fasteners, inserts and attachments as required to secure curtain wall and aluminium cladding to R.C.C. or steel structure to structural Corporation's Engineers approval.
- g. All accessories and fasteners and other items implied in drawings and specifications though not specifically indicated.
- h. Isolation of all dissimilar metal surfaces as well as moving surfaces.
- i. Protection during storage and construction until handing over.
- j. Corporation's Engineering proposals, drawings and data.
- k. Shop drawings, Corporation's Engineering data and structural calculations of all systems including framing, fasteners and cladding.
- l. Scheduling and monitoring of the work.
- m. All samples, mock-ups and test units.
- n. Coordination with work of other agencies / contractors employed on site.
- o. All final exterior and interior cleaning of the aluminium structural glazing system, cladding, glazing, and louvres before handing over.
- p. Hoisting, staging, scaffolding and temporary services.
- q. Specified tests, inclusive of necessary reports.
- r. Maintenance manuals.
- s. Design and Performance guarantees.
- t. Periodic inspection, supervision and advice by tenderer's Principal as well as a back-up guarantee in an acceptable format by the Principal for the quality and performance of the system / installation.
- u. Construction monitoring for regular quality control and technical inspection to ensure the work conforms to the shop drawings and details (including any modification made during testing) and acceptable standards of quality.

32.2.0 STANDARDS

32.2.1 Materials and workmanship shall comply with the latest editions of the following standards as a minimum.

ANSI	Z97.1-84	Safety Glazing materials used in Buildings
ASTM	C 1036-90	Specification for float glass
ASTM	C 1048-90	Specification for Heat treated Float Glass
ASTM	E 774-88	Specification for sealed Insulating Glass Units
ASTM	C 1172-91	Specification for Laminated Architectural Glass
ASTM	C 864-90	Specification for compression Seal Gaskets

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ASTM	C 1115-89	Specification for Silicon Rubber Gaskets
ASTM	C 920-87	Specification for Sealants
ASTM	C 509-90	Specification for sealing material
CPSC	16 CFR 1201	Specification for Safety Glass
GTA Specification		Specification for environment durability for
No. 89-1-6		Heat strengthened Spandrel Glass with Applied opacifiers.
BSCP	118	Structural use of Aluminium
AS	1664-79	- Do -

In general the Contractor may follow any International Standards subject to his satisfying the Architect that these specifications are equivalent to latest specifications issued by ASTM, AAMA, BS

32.2.2 International Standards

In general the Contractor may follow International Standards issued by ASTM, SAA, AAMA, BSS, ISO & SSIR depending on their Principal's familiarity with particular codes.

32.2.3 Submittal of Codes

Copies of all codes proposed to be followed for design, materials, installation and testing shall be submitted to the Corporation's Engineer.

32.2.4 Building Regulations

Design of the aluminium structural glazing system shall comply with all Government codes and regulations. For wind design, all calculations shall comply with the requirements of the relevant National Building Code and Indian Standard Code, unless specified otherwise.

32.3.0 PERFORMANCE GUARANTEE

- i. The Contractor shall be responsible for and shall guarantee in an approved format proper design and performance of the installed systems for a period of 10 years from completion of Defects – Liability.
- ii. The design, fabrication and installation shall be to the best international standards and shall be guaranteed to take account of wind and seismic loads, storms, air pollution, thermal stresses, building movements and the like.
- iii. In addition specific 10 year guarantees in approved formats shall be given for performance of glass, double – glazed units, anodising, PVDF coating, sealants and EPDM gaskets.

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- iv. The installations shall be guaranteed against defective materials, products, workmanship, watertightness, design, performance, and against glass and seal breakage and other requirements given in the specifications.

32.4.0 CONTRACTOR'S RESPONSIBILITY FOR DESIGN

- i. Architectural drawings and specifications indicate the required basic dimensions, profiles and performance criteria.
- ii. The Contractor shall have the option of modification and addition of details and profiles subject to Corporation's Engineer's approval, provided the visual concept and performance requirements are fulfilled.
- iii. The acceptance of any modification suggested by the Contractor will not relieve the Contractor from sole responsibility for performance of the curtain wall system and cladding.
- iv. The Contractor shall be solely and fully responsible for proper design, installation and satisfactory performance. This shall include the design and sizing of all sections and anchor assemblies to meet the performance and design requirements, furnishing and installation of all inserts, fasteners, clips, bracing and framework as required for the proper anchorage of the structural glazing system elements to the structure, unless otherwise noted or specified to be furnished/installed by others.
- v. Approval by the Architect/Corporation's Engineer shall in no way relieve the Contractor of his design responsibility.

32.5.0 SHOP DRAWINGS

32.5.1 Preliminary Submittals

The following details are required to be submitted along with tender:

- a) Detailed specifications and typical drawings and full details of bidder's proposed systems for curtain wall, cladding and glazing systems (including aluminium sections, transoms, mullions, head/sill sections, openable panels, brackets, sealants, gaskets, glazing, fire stops, flashings, drainage, cladding grooves, interfaces etc.).
- b) Technical catalogues for all materials and systems with relevant offered items highlighted.
- c) List of manufacturers/suppliers for all materials including aluminium sections, glass, sealants, gaskets, cladding etc. including proof of equivalence for any supplier / manufacturer's product which is not listed in the Approved List of Suppliers.
- d) Business and technical profile of the system Principal and details of the specialist Sub-Contractor's tie-up with the Principal.
- e) A statement that the Principal will give a back-up guarantee for design / installation / performance of his system specifically for the works tendered for as stipulated under Principals' Responsibility.

32.5.2 Shop drawings

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- i. The Contractor shall prepare detailed shop drawings by necessary modifications to the preliminary drawings and two (2) copies of all shop drawings shall be submitted to the Corporation's Engineer for review and approval within one month of approval of preliminary design.
- ii. The Corporation's Engineer's review of all shop drawings will be limited to their conformity to the design concept & specifications. Corporation's Engineer's approval of the shop drawings will not relieve the contractor from any of the responsibilities and requirements as stated in Contract Documents.
- iii. No work shall be fabricated until the shop drawings and all other related submittals, documentation, certification, samples and the mock-up for that work have been reviewed and approved by the Corporation's Engineer.
- iv. On approval the Contractor shall submit 4 copies of approved drawings to the Corporation's Engineer for release to site. On completion of works two copies plus one CD each of final approved shop drawings incorporating all approved site changes shall be submitted to the Employer through the Corporation's Engineer.

32.5.3 Scope of Shop Drawings

- i. Shop drawings shall incorporate scaled and dimensioned plans, elevations, sections and full size details for all work in this section.
- ii. Shop drawings shall indicate the desired dimensional profiles and modules, function, design and performance standards and in general cover all dimensions and details required to fabricate and install all contract works.
- iii. The contractor shall verify and co-ordinate the shop drawings with all applicable and related trades, drawings and specifications.
- iv. All dimensions/modules, etc., shall be field checked as required.
- v. Details shall show and specify all metal sections, types of finishes, areas to be sealed and sealant materials, gaskets, applicable construction materials including fasteners and welds, all anchorage assemblies and components, fabrication and erection tolerances for the work.
- vi. All details shall be subject to the Corporation's Engineer's approval.

32.5.4 Section Profiles

Profile adjustments in the interest of fabrication, erection, weatherability or ability to satisfy the performance requirements may be made only with the written approval of the Corporation's Engineer provided that the general design and intent of the drawings and specifications are maintained.

32.6.0 STRUCTURAL DESIGN

- i. The Contractor shall employ an approved competent design Corporation's Engineer / agency to design his systems and components.

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- ii. During the design stage, the Contractor shall interact actively with the Corporation's Engineer concerning all aspects of design and shall obtain all the information from him concerning the structure, probable deflections and other building movements etc.
- iii. The Contractor shall take full account of all possible building movements as well as the movements of his curtain wall and cladding systems in his design.
- iv. The Contractor shall submit to the Corporation's Engineer his detailed structural calculations for the systems and each of their typical and non-typical components and shall guarantee that his design will ensure the structural safety and integrity of the curtain wall, cladding and glass panels against all natural forces, superimposed loads, environment and structural movements.
- v. The Contractor shall modify his design as required by the Corporation's Engineer to meet structural requirements.
- vi. The Contractor shall ensure that all the movements envisaged between the structure and the curtain wall are fully taken care of.
- vii. The Grade of R.C.C. in the building structure is as specified in **Clause 32.27.0 - DESIGN DATA** . The Contractor shall design anchorages for this grade of concrete with adequate safety factor.
- viii. Submittals

The Contractor shall submit 2 sets of design calculations to the Corporation's Engineer after certification by an independent Inspection Agency.

32.7.0 DOCUMENTATION AND CERTIFICATION

32.7.1 Glass and Glazing Documentation

- i. The glass manufacturer(s) shall submit written certification for the Corporation's Engineer's review and approval stating that all glass and glazing requirements as detailed and specified on the shop drawings have been reviewed and approved for use relative to their specific application and design parameters, compatibility to adjacent materials, bite, and in conformity with specifications.
- ii. Test Certificate from approved laboratories for U-Values and shading factor claimed by the Manufacturer shall be submitted.

32.7.2 Sealant Documentation

- i. All sealant applications must be clearly designated on shop drawings and details and referenced to a master sealant schedule specifying materials, special instructions and application procedures.
- ii. The sealant manufacturer shall certify that all sealant requirements as detailed and specified on the shop drawings have been reviewed and approved for use relative to their specific application and/or design intent, compatibility to adjacent materials and in conformity with specification.
- iii. The sealant manufacturer shall certify that the Contractor has followed all procedures recommended by him for fabrication and installation of curtain wall panels including cleaning, curing of 2-part sealant, storage, application at temperature below 30°C,

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butterfly and snap-time tests on pump start-ups, adhesion tests by deglazing, quality control and quality assurance.

- iv. The deglazing tests for sealant adhesion shall be performed in the presence of the sealant manufacturer.

32.7.3 Quality Control Documentation

- i. In-plant and job site quality control procedures shall be documented in writing for the Corporation's Engineer's review and approval to ensure the design integrity and performance of the as-built product.
- ii. Documentation shall include schedules, details, isometric and/or schematic explanatory sketches cross-referenced to the shop drawings, data sheets, etc., all as required to intelligently witness and assess methods and materials; and to ensure that both the fabrication and installation are in accord with the contract documents.
- iii. The Corporation's Engineer shall, if required, be given free access to the plant to inspect fabrication procedures.
 - a) The in-plant quality control procedures shall include but not be limited to the following items:
 - Materials : Visual inspection, field tests.
 - Fabrication : Tolerances, Joinery, Sleeves
 - Finish Match : Approved finish and controls required for matching the exposed surfaces.
 - Assembly : Welds, fasteners, sealants, gaskets, separators, glazing, bite
 - Protection : Handling, protection, shipping
 - b) The job site quality control procedures shall include, but not necessarily be limited to the following items:
 - Anchorage : Lines, grades and related building tolerances.
 - Installation : Setting-out, tolerances, finish match, connections, sleeves, flashing, welds, fasteners, sealants, bolt tension.
 - Sealing : As recommended by the sealant manufacturer(s).
 - Storage : As recommended by manufacturers.
 - Protection & Cleaning : As recommended by the material manufacturers.

32.8.0 SAMPLES AND MOCK-UP

32.8.1 Submittals

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The following samples of actual job site materials together with detailed technical data / catalogues shall be submitted in duplicate for the Corporation's Engineer's review and approval. Any omission of an item, or items which require the Contractor's compliance with these documents does not relieve him from such responsibility.

- (a) Aluminium sheet panel: Each type and thickness; 600 x 600mm
- (b) Aluminum extrusions: One of each section; 300mm long.
- (c) Glass: each type 300 x 300mm.
- (d) Glazing gaskets, tapes, separators, glass setting blocks, etc: Each section or unit, 300mm long or unit.
- (e) Fasteners and connecting devices: Each type and size.
- (f) Finish samples 100 x 200 : After approval of the final finish coating the Corporation's Engineer is to be provided with three (3) approved samples.
- (g) Window and door ironmongery and accessories, as applicable.
- (h) Flashings and finish samples 300 mm.
- (i) Samples submitted should also include assembly of various components forming a typical fixing detail complete with corners, glazing, extrusions, fasteners, sealants etc.
- (j) Cladding assembly 600 x 600
- (k) Louvre assembly 600 x 600

32.8.2 Mock-up

Before the fabrication and site installation is taken up, the Contractor shall put up a mock-up of his proposed curtain wall system 3 modules wide incorporating all types of in-fill panels, fire-stop, flashing, shadowbox, bracketry, hardware and fixtures. A mock-up of 4 panels of cladding shall also be put up. The mock-ups are essential for final approval of all materials and installation details.

32.8.3 Maintenance Manual

Two (2) copies each of detailed procedures for the periodic inspection, maintenance and cleaning of all the structural glazing and cladding, finishes etc shall be submitted to the Employer through the Corporation's Engineer.

32.9.0 WORK SCHEDULE

Within one month of issue of Work Order a detailed work schedule for works under this section co-ordinated with building works shall be submitted for architect's approval.

32.10.0 STORAGE AND PROTECTION

- i. The contractor shall submit a schedule of procedure for inspection during installation so as to control and assure quality on the job site.

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- ii. The Contractor shall submit a detailed method statement for the protection of the surface of the aluminium structural glazing & cladding members during delivery and erection, with description as to when the protection can be removed
- iii. The Contractor shall submit weekly reports on the inspection of erection and installation as directed by the Corporation's Engineer.
- iv. Delivery and Storage and Materials: All materials delivered to site shall be stored in allocated spaces where the stored materials will not be exposed to rainwater, moisture or damage, and shall permit easy access to and handling of the materials. Materials shall be stored neatly and properly stacked.
 - a) Aluminium wall cladding/Factory made structural glazing units and/or their components shall be transported, handled and stored in a manner to preclude damage of any nature.
 - b) Accessory materials, required for erection at the site shall be delivered to the site in labeled containers by the manufacturer.
 - c) All units or components which are cracked, bent, chipped, scratched or otherwise unsuitable for installation shall be removed and replaced.

32.11.0 PERFORMANCE REQUIREMENTS

- All components, assemblies and completed work shall conform to or exceed the following performance standards and all applicable and governing building codes and regulations.
-

32.11.1 Design Data

The works under this Section shall be designed as per DESIGN DATA given in Clause 32.27.0.

32.11.2 Thermal Movement

- i. Provide for noiseless contraction and expansion of component materials for an ambient temperature range of +10°C to 70°C and a material temperature range of 100°C without buckling, loss of seal, loss of integrity, glass breakage, undue stress on fasteners, or other detrimental effects.
- ii. Make allowance for vertical and horizontal expansion.
- iii. For fabrication, assembly and erection, procedures shall take into account the ambient temperature range at the time of the respective operations.

32.11.3 Building Movement and Related Building tolerance

The design and installation of the structural glazing system shall accommodate all inherent building movements and deflections and the fabrication and installation tolerances of all related work not involved in this section without the loss of, or any detrimental effect to, the performance requirements herein specified. The contractor shall verify and coordinate all such movements and tolerances with the Corporation's Engineer before designing the components of structural glazing and aluminium cladding so that movements and deflections

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in the structure do not at any time affect the integrity and safety of curtain wall and aluminium cladding and vice versa.

32.11.4 Thermal property

All insulation materials, fire-stops and smoke seals shall comply with local fire regulations

32.11.5 Structural Properties

- i. The design parameters of aluminium curtain wall system and cladding and all related components shall comply with the requirements of all relevant codes.
- ii. The curtain wall and cladding systems and components shall be designed for a wind load of 1.80 kN/m² (pressure or suction) uplift where applicable, rain storms, impact and all other forces likely to be imposed during the lifetime of the building.

Partial or full shading of glass and the possibility of air-conditioning the building fully or partially during office hours shall be considered when Corporation's Engineering the system.

- iii. No curtain wall and cladding elements including sealants and sealed joints shall sustain permanent deformation or failure under loading equivalent to 1.5 times the design wind pressure herein specified.

Failure means breakage, component disengagement or permanent distortion.

- iv. Deflections: The specified deflections must be reduced if they are in any way detrimental to the aluminium structural glazing and cladding elements and sealants.
 - The maximum horizontal deflection on design wind pressure shall not exceed 1/240 of height or 14mm whichever is lesser for mullions.
 -
 - No vertical deflection shall exceed 1/300 of span of transom/sill/head members
 -
 - Under 1.5 times design wind pressure there should be no permanent deflection of framing members.
 -
 - Maximum deflection of glass under design wind pressure at centre of any panel shall not exceed 15 mm. or as calculated by the manufacturer whichever is less.
 -
 - Reduction in glass bite under full load shall not exceed 2mm.
- v. The curtain wall shall be anchored to the R.C.C floor through stainless steel brackets. The surface of the bracket in contact with R.C.C. floor slab shall not be polished. The contractor shall adjust anchor bolt locations to avoid cutting through any reinforcement bar with the help of re-bar position detectors.
- vi. Transom/railing (where not backed by an R.C.C. parapet) shall be designed for an additional horizontal UDL of 1.00 kN/m run, UDL supplied to the infill of 1.0 kN/m² and a point load applied to any part of the infill at 0.5 kN.
- vii. No holes shall be burned, filed or drilled in any structural steel members unless expressly approved by the Structural Consultant in writing.

- viii. Member shapes and/or profiles if schematically shown on the Corporation's Engineer's drawings are not necessarily the exact shapes required or best suited for the particular condition. Final shapes and locations shall be as designed by the contractor and are subject to the Corporation's Engineer's review and approval.
- ix. No field forming, cutting and alterations of primary wall elements will be allowed. All framing members shall be shop fabricated and finish coated. No unfinished surfaces will be permitted on exposed surfaces.

32.11.6 Concrete Tolerances

The Contractor shall take into account tolerances in concrete and masonry surfaces to which the structural and glazing framework is fixed.

32.11.7 Lightning protection

The whole of the curtain wall when having insufficient clearance from the lightning protection system shall be bonded as directly as possible to the lightning protection system. At each end of each continuous length of curtain wall or cladding provision shall be made at top and bottom for bonding by the electrical Sub-contractor.

32.11.8 Fire-stop and Interface with building

- i. **Joints in the curtain wall / structural glazing system between successive floors shall have the required fire resistance of at least 2 hours and shall comply with requirements of Local Authorities. Additionally all cavities between glazing & blockwork or partitions shall be fire-stopped to 1 hour fire resistance.**
- ii. A fire-stop-cum-smoke seal shall be provided at each window-head level. In addition the Contractor shall provide an aluminium flashing to approved design at the window sill level.
- iii. Fire-stops and smoke seals shall be designed to accommodate relative deflections of Curtain Wall and building structure.
- iv. All interfaces with building structure, and other elements shall be sealed/flashed /provided with expandable gaskets to Corporation's Engineer's approval and shall allow for relative deflections of curtain wall and building structure.

32.11.9 Accoustics

- i. **Provisions shall be made (e.g. capping of all ends of hollow mullions) to prevent sound transmission through the system.**
- ii. Provisions shall also be made to prevent metal to metal rubbing noise due to thermal changes and wind pressure and also to prevent noise due to air whistles.

32.11.10 Visual Appearance

The Contractor shall ensure that the Corporation's Engineer's elevation drawings are strictly followed and the intent of the architectural design is fully respected. Visual appearance shall be a key consideration for acceptance of work.

32.11.11 Maintenance

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- i. The curtain wall and cladding systems shall be maintenance-friendly.
- ii. Glass units shall be so installed that any unit can be removed and replaced without disturbing adjacent units.

MATERIALS

32.12.0 MATERIALS GENERALLY

- i. Materials and components used shall be of the best quality and suitable for the purpose to the Corporation's Engineer's approval and shall have been tried and tested in environments similar to that of to that of place of worksite
- ii. All materials shall be free from any defect that may impair the strength, functioning or appearance of the glazing and cladding system or adjacent construction.
- iii. Testing by independent testing laboratories or review of data by the Corporation's Engineer shall not relieve the Contractor's responsibility to verify for himself that the work conforms to the intent of the contract documents.

32.13.0 METALS

32.13.1 In general, metals shall comply with relevant local and International Standards

32.13.2 Aluminium Wall Cladding

Aluminium cladding shall conform to specifications given under Clause 32.18.8 ALUMINIUM COMPOSITE CLADDING.

32.13.3 Fasteners

The type, size, alloy, quantity and spacing of all fasteners and/or anchorage devices shall be as required for the specified performance standards.

- i. Bolts, anchors and other fastening devices shall be of approved types as required for the strength of the connections, shall be self-locking, unless otherwise noted, shall be stainless steel grade 316 and shall be torque tightened, where required, to achieve the maximum torque tension relationship in the fasteners. PVC sleeves shall not be permitted with anchor fasteners. Washers, nuts and all accessory items shall be of the same material as fasteners.
- ii. Fastening devices between aluminium and aluminium shall be AISC Type 304 stainless steel unless otherwise approved.
- iii. Fastening devices between aluminium and dissimilar materials shall be 304 series austenitic stainless steel unless otherwise approved.
- iv. Exposed fasteners are subject to Corporation's Engineer's approval and shall be stainless steel grade 316.
- v. Self-locking fasteners shall be stainless steel with nylon inserts or patches.

32.13.4 Extrusions

- i. All aluminium extrusions shall conform to the system principal's specification for tolerances which shall, in any case, equal or be better than DIN standards. Any section not conforming to the tolerances shall be rejected.
- ii. In general aluminium alloy for extrusions shall be 6063 T5 or T6 as per B.S.1474. However, the grade and tempering specifications shall be as recommended by the supplier for each application and shall be approved by the system principal.
- iii. All aluminium sections shall be either anodised in approved colour to a thickness of 60 microns or coated with PVDF as described in drawings /Specifications/Schedule of quantities. The colour and gloss of the finish shall be uniform and free of streaks.
- iv. All surfaces abutting the parent sections and designed to receive sealants shall have adequate sealant contact and adhesion. They shall be finished to match parent sections.
- v. Sill sheets, plates and extrusions shall be visually flat under all lighting conditions.
- vi. Certification and tests shall comply with Clause 24.
- vii. All members of frames, sub-frames and panels shall be in one piece. No splices shall be permitted.

32.13.5 Aluminium Flashing

Flashings concealed from view shall be made from natural anodised aluminium sheets 1.2 mm thick. Visible flashings (e.g. on periphery of vision panels) shall be 2 mm thick aluminium sheets anodised in approved colour.

32.13.6 Capping

Top capping shall be made from 3 mm stretch-levelled aluminium sheets coated with PVDF in approved colour, or 4 mm A.C.P. as shown on drawings

32.13.7 Soffits and Suspended Ceiling System

Soffits and suspended ceiling system if required for cladding shall be of similar metal of the aluminium wall cladding with the same finish.

32.13.8 Fire stops – cum – smoke seals

- i. Fire stops – cum – smoke seals shall be provided at successive floor levels, and shall be two hour fire resistant. Insulation shall be 100mm thick fibre-glass of 64kg/m3 density or approved equivalent fixed to G.I. backing sheet with fasteners.
- ii. Metal sections shall be in galvanised steel sections minimum 1.2 mm thick. All details shall be to the Corporation's Engineers approval.

32.13.9 Protection

Materials used as permanent or temporary protection for metals shall conform with relevant International Standards.

32.13.10 Brackets

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Brackets shall be made from stainless steel sections 316 grade. Slots in brackets shall be pre-drilled / punched and not flame-cut. The surface shall be serrated for additional grip, serrations being parallel to the slot direction.

32.13.11 Fittings

- i. All hardware and fittings such as patch fittings, handles, locks, stay-arms, floor springs etc. for doors windows and openable panels shall be to the best International standards.
- ii. Hinges for openable panels shall be stainless steel friction hinges / stays selected for specified wind load and dead loads or specifically extruded in-built hinges.
- iii. All fittings and locks shall be approved by the Corporation's Engineer.
- iv. Each openable panel of the Curtain Wall shall be provided with:
 - a) 1 No GIESSE or approved equivalent 4- point cremone locking set with die-cast handle turning 90° painted in approved RAL colour and stainless steel fixing plate and screws,
 - b) 2 nos. COTSWOLD or equivalent heavy-duty top hung stainless steel friction stays openable upto 15°, with stainless steel screws,
 - c) 1 no. 70 mm sided triangular 3 M film or equivalent sign on glass surface # 1, with 5 years performance guarantee and with 40 % perforations.

32.14.0 SEALANTS & GASKETS

32.14.1 Documentation

All sealant applications must be clearly designated on the applicable shop drawings with reference to a master sealant schedule specifying materials, special instructions and application procedures. Provide documentation as per clause 7.

32.14.2 Selection of Sealants

- i. The compatibility and sequence of installation for all sealants must be carefully considered in all proposals in order to ensure the required cure and optimum performance.
- ii. Sealants must not degrade and/or fail under all design conditions including thermal and seismic movements, water, ultraviolet exposure and/or other adverse environmental conditions.
- iii. The designation of sealant types noted on the drawings is intended for general design guidance.
- iv. Final selection by the contractor for the sealant types shall be based on their conformity with the Performance Requirements herein specified and as recommended by sealant manufacturer.
- v. Maximum precautions shall be taken to prevent failure of sealant.
- vi. Sealants and gaskets shall not leach, discolour, stain or dry.

32.14.3 Structural sealant

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- i. Structural sealant shall be Dow Corning Silicone sealant DC 983, or approved equivalent recommended by manufacturer.
- ii. All exposed and concealed metal to metal (including tight or butt type metal to metal assembly prior to assembly), perimeter metal to concrete joints shall be 2-part silicone sealant, in approved colour, conforming to the manufacturer's recommendations for the specific uses and performance criteria.
- iii. The manufacturer shall conduct laboratory tests as required for adhesion for each lot of aluminium sections and glass. Laboratory reports shall be submitted to the Corporation's Engineer.
- iv. In special and isolated cases, 1-part silicon sealant (Dow corning DC 995 or approved equivalent) may be used with prior approval from the Corporation's Engineer.

32.14.4 Weather Sealant

The grades of sealants for concealed metal to metal and metal to concrete joints such as embedment and lappings of flashings where elements are to be installed or embedded in a full bed sealant shall be the best recommended by the manufacturer for the application. (Dow Corning, GE or equivalent.)

The weather sealant shall be generally DC 795 or equivalent, DC 991 HP or equivalent one-part non-streak high performance sealant for filling grooves in ACP cladding and DC 799 clear or equivalent transparent one-part sealant for butt joints in glass.

32.14.5 Back-up Materials

Back-up materials shall be non-gaseous polyethylene foam or non-gaseous polyolefin foam as per the written recommendations from the applicable sealant manufacturer for each specific application. Shape, size, hardness, compatibility and bond breaking requirements shall be considered in the selection.

Where the joint is too shallow to receive foam rods, polyethylene tape, as recommended by the manufacturer for the particular application, may be used.

32.14.6 Compatibility

All sealants must be non-staining and compatible with adjoining sealants, backup materials, substrate materials and their respective finishes and/or applied colour coatings.

32.14.7 Guarantee

- i. The Contractor shall give 10 years' Guarantee for materials, workmanship and performance of sealants from the date of completion of Contract.
- ii. The sealant manufacturer shall confirm in writing that
 - a) Sealants selected are the best suitable for the purpose intended and are compatible with materials in contact with sealants.
 - b) Sealant shall not deteriorate with uV radiation.
 - c) The joints and bites are correctly designed.
 - d) Sealants are suitable for ambient conditions at the time of application.

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32.14.8 Certification and Tests

Certification and tests shall comply with Clause 32.

32.14.9 Caulking compound

Dow Corning 795 or approved equivalent, one part gun grade consistency, colour to match adjacent material or approved by the Corporation's Engineer for use around frame or between frame and floor slab.

32.14.10 Gaskets

- i. Gaskets and seals shall be extruded steamcured or micro-wave cured EPDM of approved quality compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be uV resistant silicon gaskets.
- ii. Extruded EPDM sections shall have the following properties:

Shore Hardness	70 ± 5A
Tensile strength	Min. 70kg/cm ²
Elongation	300%
Ozone Resistance	No crack at 50 ± 5 pphm, test temp. of 40± 2°C, test Duration of 96 hours and 20% strain.
- iii. EPDM spacer block shall have a Shore hardness of 80, or as recommended by supplier/system Principal.
- iv. Gaskets for any lite shall be in one piece with injection moulded corners free of flashing and burrs.
- v. Test Certificate shall be submitted as specified in Clause 32.

32.14.11 Setting Blocks

Setting blocks used to support the dead load of the glass shall be extruded in a neoprene/EPDM compound or silicone material conforming to the design criteria, all as recommended by the glass manufactures.

32.14.12 Jamb Shims

Jamb shims used to centre and station the glass shall be extruded in a neoprene/EPDM compound or a silicone material conforming to the design criteria, all as recommended by the glass manufacturer.

32.14.13 Glazing Compounds

- i. Provide documentation as per Cl. 32.7.2.
- ii. All EPDM/neoprene materials shall be extruded high quality ozone resistant, cured, elastomeric, virgin EPDM / neoprene compounds with durometer hardness, profiles and design parameters, lengths and locations all as required and recommended in writing by the applicable glass manufacturer(s).

- iii. All EPDM/neoprene glazing materials shall have smooth neat exposed surfaces, all flashings and burrs removed and in profiles, including integral locking projections to engage into the parent drawings.
- iv. Furnish certified test reports to establish conformity with the specified standards.

32.15.0 SEPARATORS

- i. Separators between steel and aluminium members and wherever required shall be of rigid type, high impact, PTFE (Teflon) with a minimum thickness of 0.8mm or other non-conducting material smooth both sides as approved by the Corporation's Engineer.
- ii. Test Certificates shall be submitted as specified in Clause 28.

32.16.0 GLASS

32.16.1 General

- i. All glass and glazing materials shall be verified and coordinated with the applicable performance requirements .
- ii. Vision and spandrel glass shall have characteristics close to those specified in Clause 32.28.0 - **PERFORMANCE CHARACTERISTICS OF GLASS PANELS**, subject to aesthetic requirements and specified maximum relative heat gain, all to Corporation's Engineer's approval.
- iii. Samples of glass are available in the Corporation's Engineer's office. The contractor shall offer glass which is nearest to the sample in colour, tint and properties subject to the Corporation's Engineer's approval.

32.16.2 Installation

- i. The Contractor shall provide and install glass and glazing work as indicated on the drawings and as specified herein.
- ii. All glass panels shall be cut to required sizes and ready for glazing.
- iii. All glass panels shall be of accurate sizes with clear undamaged edges and surfaces which are not disfigured.
- iv. Any panel which does not fit any section of the curtain wall and glazing will be rejected and a replacement made at the Contractor's expense.
- v. Glass shall not be in direct contact with metal.

32.16.3 Heat Strengthened Glass

Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm within 260mm of leading or trailing edge, or 0.076mm in centre. Direction of ripples shall be consistent and their extent shall be acceptable to the Corporation's Engineer. Distortion of glass shall be controlled as much as possible during heat strengthening. Sag distortion shall be uni-directional at Corporation's Engineer's option. Surface compression shall be in the range of 27-48 N/mm²

32.16.4 Identification

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Permanent identification marking on glass shall be accomplished by a technique selected by the manufacturer. The location of the marking shall be proposed by the Manufacturer and approved by the Corporation's Engineer. All glass shall be delivered to site with the manufacturer's label of identification attached.

32.16.5 Submittals

- i. The contractor shall submit for the Corporation's Engineer's approval a complete list of materials to be used, including the sealants proposed and such samples as the Corporation's Engineer may require.
- ii. All glass and glazing methods and materials including the design and profile dimensions of glazing pockets shall be as approved and recommended in writing by the applicable glass and sealant manufacturers.
- iii. A sealant-substrate test report shall be submitted for each type of sealant for adhesion and compatibility.
- iv. The Contractor shall submit manufacturer's product data and specific instructions for maintenance, handling and installation of glass.

32.16.6 Curing of Sealants

Sealants in factory-glazed panels shall be fully cured prior to shipment to project site and installation.

32.16.7 Breakage

All glass breakage and damage to edges or surface caused by the Contractor because of negligence or caused by the installation of faulty work by him shall be replaced by the Contractor at his own expense without delay in the project completion.

32.16.8 Loads

Glass system shall be designed to withstand specified lateral imposed loads and other specified loads and comply with requirements of local building codes.

32.16.9 Thickness of Glass

The Contractor shall verify the thickness of glass in accordance with AS 1288 – 1989 "Glass in Buildings Selection and Installation" to satisfy design performance requirements and local design codes.

32.16.10 Selection of Glass

- i. Glass shall be free from defects or impurities detrimental to its performance. Defects such as bubbles, waves, spots, scratches, spalls, discolouration, visibly imperfect coating, chipping, and bubbles or delamination of opacifier film shall be limited in accordance with the Manufacturer's / trade guidelines. The glass is to be produced in such a way that the rollers will be parallel to what will be the horizontal position of the glass. Glass shall be consistent in colour.
- ii. Glass panels shall be selected / rejected on the basis of product quality standards specified by the manufacturer concerning scratches, pinholes, clusters, distortion, colour variations, flaws in coating and other defects.

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- iii. Each type of glass shall be obtained from only one manufacturer and in one lot. Adequate spare quantity shall be ordered to cover for breakage and for replacement during maintenance period.

32.16.11 Glazing

Manufacturers' glazing instructions regarding installation, dimensional tolerance, bite and edge clearance etc. shall be followed.

32.16.12 Protection

All glass panels shall be stored with particular care as recommended by the glass manufacturer and protected against abrasion, sun and moisture prior to installation. Protective film shall be changed every 45 days or as recommended.

32.16.13 Thermal Stress

- i. Precautions specified by glass manufacturers to minimise thermal stress must be followed.
- ii. A thermal stress analysis shall be obtained from glass manufacturer prior to fabrication and their recommendations shall be followed.
- iii. Allowance shall be made for thermal movements due to an air temperature range of 60°C and a material temperature range of 100°C.
- iv. The statistical probability of glass breakage shall not exceed 8 per 1000 at 60 seconds load during the lifetime of the building. The curtain wall system must be Corporation's Engineered accordingly.

32.16.14 Float Glass

- ❑ Quality and finishes: q3 unless otherwise indicated. ASTM C 1036 Type I. Thickness 6 mm $\pm$ 0.15 mm max.
- ❑ Heat strengthening : ASTM 1048 HS type I;
 Surface compression 27-48 N/ mm²,
- ❑ Heat treatment shall be adequate to provide strength to resist specified loads and induced stresses within safety glazing standards.
 No tong marks permitted.
- ❑ Light transmission over 88%

32.16.15 Insulating Units

- ❑ Insulating units shall be obtained only from approved manufacturers.
- ❑ Factory assembled multiple panes separated by and sealed to spacers forming airtight dehydrated airspace as per ASTM E 774 Class
- ❑ Space : 12 mm dehydrated air.

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- ❑ Spacer : Black aluminium 12 x 12 mm perforated tube.
- ❑ Spacer seal : Dual seal
- ❑ Primary seal : Polyisobutylene sealant on spacer bearing surfaces.
Secondary seal : Silicone sealant DC983 or equivalent structurally bonding the 2 glass lites to the spacer.
- ❑ The soft coating shall be edge deleted to the exact depth of the sealant.
- ❑ If the sealed insulating units are air freighted or are fabricated at an elevation significantly different from that of the project site provide temporary venting of internal airspace and subsequent sealing of vents.

32.16.16 Laminating units

- ❑ Laminate lites with interlayer in autoclave with heat plus pressure
- ❑ Lites shall comply with ASTM C 1172
- ❑ Interlayer material to be clear or as specified with no tendency to bubble, discolour or lose physical and mechanical properties after laminating glass lites.
- ❑ Laminated panels should be free of foreign substances, air or glass pockets

32.16.17 Quality assurance

- ❑ Certified Safety Glazing from Safety Glazing Certification Council (SGCC) or approval equivalent
- ❑ Comply with test requirements of 16 CFR1201 and ANSI Z97.1-1984-Safety Glazing Materials for Buildings.
- ❑ Insulating units to comply with ASTM E773& E 774 CLASS A with compliance certified by independent Certification program, **Insulating Glass Certification Council (IGCC) Level CBA** or approved equivalent.
- ❑ Certify laminated glass to comply with ASTM C 1172, float glass with ASTM1036, heat treated glass with ASTM C1048.
- ❑ Comply with inspection and acceptance standards of ASTM – C 1376

32.16.18 Material Procurement

- i. Glass shall be only from one manufacturer for each type of glass panels and where match between vision and spandrel panels is required.
- ii. Each unit shall be labeled on spacer or pane as directed.

32.16.19 Glass analysis

Glass analysis report showing the wind pressure, manufacturer's thermal analysis, specified maximum deflections and specified probabilities of breakage shall be submitted for approval.

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32.16.20 Glass certifications

- i. The Manufacturer shall certify that glass thickness and heat treatment have been selected to provide required strength and thermal performance
- ii. Sealant substrate test report shall be submitted for each sealant.
- iii. Insulating unit Warranty by the manufacturer shall be submitted

32.16.21 Guarantee

- i. The Contractor shall guarantee the integrity and coating of glass, insulation of I.G.U.'s and lamination of laminated glass for ten year's after the completion of Defects-liability.
- ii. The Contractor shall undertake to replace at his cost any broken panes (not attributable to vandalism or accident), defective insulated glazed units (evident due to condensation or dirt between the lites, failure of seal and damage to internal glass panes) for a period of 10 years after Virtual Completion of works.

32.16.22 Tests

Tests shall be conducted as specified Clause 32.28.

32.16.23 Edge Finish

- i. All structurally glazed panes shall have their edges matt finished-and not highly polished – to avoid internal reflection of light around the edges.
- ii. Glass edges shall be protected against damage at all stages from manufacture to handing over of works. Panes with damaged edges shall be rejected.

32.17.0 METAL COATINGS**32.17.1 Anodising**

Aluminium shall be satin anodised to minimum 60 microns as per approved colour.

32.17.2 PVDF Coating

- i. Metallic colour coatings to aluminium sections and cladding where specified shall be PVDF/fluoropolymer formulated and will consist of a conversion coat and a 3 coat system comprising an inhibitive primer, colour coat and clear anti abrasion top coat.
- ii. The coating system shall meet or exceed all the requirements of AAMA 2605-98. The total dry film thickness shall be minimum 35 microns.
- iii. For solid colour coatings a 2 coat system minimum 25 micron shall be used

32.17.3 Samples

After selection of colour by the Corporation's Engineer, the Contractor shall prepare two (2) sets of two (2) samples of each which shall define the colour and gloss range and submit them for approval.

32.17.4 Manufacturer's Recommendations

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The coating system, including materials and application shall conform to the requirements and recommendations of the paint manufacturer.

32.17.5 Matching of Finish

Wherever the same colour finish is specified for solid and composite aluminium sheets, the Contractor shall ensure that the colour of both is matched as closely as possible to the Corporation's Engineer's satisfaction.

32.17.6 Testing and Sampling Procedures

- i. In-process testing shall be performed on test specimens of equal metal thickness pretreated and finished along with the production metal.
- ii. Specimen shall exhibit a test of at least 75 mm x 300mm to permit instrument readings.
- iii. In addition to running in-process tests to assure high quality production, additional finished extrusions or panels are to be submitted to the coating manufacturer's laboratory for extended exposure testing.
- iv. All test samples shall be properly identified with date, batch number and shift indicated.

32.17.7 Performance Tests for PVDF Coating

Test Certificates shall be submitted as described in Clause 32.

32.17.8 Field Touch-up and Repair

The contractor shall supply materials for air dry touch up for spray or brush application per instruction of manufacturer. Touch up shall be held to an absolute minimum to the Corporation's Engineer's approval.

32.17.9 Galvanising

Hot dip galvanizing shall have a min. zinc coating of 600 g / sqm.

32.17.10 Guarantee

- i. The Manufacturer and the Contractor shall give a written guarantee for all work in connection with organic coating system to be free from defects in materials and workmanship for a period of Ten (10) years from completion of Defects liability and to correct promptly any defect free of cost.
- ii. The following are considered as defects without being limited thereto:
 - a. Peeling
 - b. Cracking
 - c. Checking
 - d. Blistering
 - e. Uniform Chalking in excess of #8 Chalk rating when measured in accordance with ASTM D659-44 (1965).

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- f. Uniform Fading or colour change in excess of 5 NBS unit when calculated from measurement on a spectrophotometer or colour meter capable of colour measurement by reflectance reading in accordance with ASTM D244-68.
- g. Uniform gloss reduction in excess of 50%

32.18.0 STRUCTURAL GLAZING/ SUSPENDED GLAZING WITH SPIDER FITTINGS AND CLADDING SYSTEMS

32.18.1 General

- i. The method of assembly, reinforcing and anchorage of the aluminium structural glazing/Suspended Glazing with Spider Fitting and cladding System, where indicated, is schematic. Locations and method of providing same shall be the Contractor's responsibility, who shall design the assembly, reinforcing and anchorage to suit each specified condition in an acceptable manner complying with the requirements specified hereinafter.
- ii. Visible joints shall be as shown on Corporation's Engineer's drawings/instructions.
- iii. All parts shall be secured by concealed means wherever possible. Where exposed to view, screw positions are to be indicated on the preliminary drawings. Exposed screws shall be of the countersunk type coloured in same finish as of aluminium, shall be of non magnetic stainless steel and shall be evenly and neatly located in the approved manner.
- iv. All components shall be assembled, secured anchored, reinforced, sealed and made weathertight in a manner not restricting thermal or wind movements of the structural glazing. Where possible, sealants shall be concealed.
- v. All fastening into or through aluminium shall be non-magnetic stainless steel.
- vi. Free and noiseless movement of all the components of the Curtain Walling System due to thermal effect, structural effect, wind pressure, seismic forces, erection or dead loads, shall be achieved without strain to the glass, without buckling of any components and without excessive stress to any members or assemblies.
- vii. Aluminium surfaces in contact with mortar, concrete, plaster, masonry, wet application of fireproofing and absorptive materials shall be coated with an anti galvanic, moisture barrier material.
- viii. The curtain wall system shall accommodate
 - a. Movement within its components.
 - b. Movement of building components to which the Curtain Wall is attached including long term and short term movements due to creep, column shortening, deflection, torsion and vibrations.

32.18.2 Waterproofing

- i. A drainage system must be incorporated into the structural glazing system. Water leakage and condensation shall be drained or discharged to exterior face of the wall and all internal spaces vented by acceptable means to ensure air pressure equalization.
- ii. Drainage system shall be sealed at every floor to prevent infiltrated water from leaking to lower floors.

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- iii. Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungus growth as a result of standing or trapped water.
- iv. Adequate weep-holes, slopes, splice plates at joints of mullions with horizontal sections, weather silicon sealants, EPDM gaskets and flashing shall be used to achieve waterproofing of the structural glazing system.

32.18.3 Anchorage System and Building Frame

Each glazed unit shall be fixed to the structural slab at each floor level. All steel fasteners shall be stainless steel of approved grade. The contractor shall also make necessary modifications to the positions of anchor fasteners to suit existing site conditions of steel reinforcement without additional charge. Re-bar location detectors shall be used to locate the existing reinforcement.

32.18.4 Mullions and Transoms

- a) The sections of mullions and transoms shall be designed to restrict deflection under wind pressure as specified and shall be rigid enough to support and retain the glass spandrel under all conditions. The mullions and transoms shall be designed for horizontal loads from cleaning equipment and process.
- b) Reinforcing members, where used, and if specifically approved in rare cases shall be completely enclosed.

32.18.5 Spandrel Units

- i. Spandrel shall be of glass having equal colour matching with vision areas after using a shadow box or as specified.
- ii. Structural spandrel wall or beam, structural glazing fasteners and other construction shall not be seen through the glass from the exterior and shall be fully concealed behind the shadow box.
- iii. A shadow box shall be provided a distance behind the spandrel glass panel. It shall consist of an approved black fibre-glass non-woven tissue stuck on surface #1, 50 mm fiberglass insulation of density 48 kg/cum., and 0.8 mm galvanised sheet steel tray natural finished on surface #2. The periphery shall be properly sealed. Surface #1 shall be adequately protected against damage until spandrel glazing is done.
- iv. Two hour rated fire stop – cum – smoke seal shall be installed continuously at bottom of the spandrel unit. The top of the spandrel unit at window sill level shall be closed with 1.2 mm thick anodised aluminium flashing, properly sealed with weather silicon sealant.

32.18.6 Ventilators, Openable Windows and Doors

- i. Ventilators, windows and doors shall be provided at positions as shown on the drawings. The openable panels when in closed position shall remain watertight under all weather conditions and pass the water tightness tests as specified.
- ii All hardware and accessories shall be supplied by the contractor and when exposed shall be of stainless steel or other approved materials.

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32.18.7 Coping and Soffit Trimmer

- i. All coping and soffit panels shall receive frame reinforcement and be fixed rigidly to the structure.
- ii. All joints between coping/soffit panels and between coping/soffit panels to structural glazing frame and other sections of the work shall be sealed up with 1.2 mm thick anodised aluminium flashing.
- iii. Effective drainage system shall be provided to drain out the water that may penetrate through the joints.
- iv. Coping and soffits shall be visibly flat in all lighting conditions.

32.18.8 ALUMINIUM COMPOSITE CLADDING

- i. Cladding shall be non-toxic composite aluminium panels 4 mm thick of adequate strength with approved details. The skins shall be min. 0.5 mm thick and shall sandwich a core of 3mm non toxic non combustible LDPE.
- ii. The panels shall be 4mm thick composite units finished with PVDF / fluoropolymer coating overall 35 micron thick of approved metallic colour or 25 micron thick of solid colour.
- iii. The coating system shall meet the requirements of AAMA 2605 – 98. The resin content of the PVDF / fluoropolymer coating shall be minimum 70%. Gloss shall be $30\% \pm 5\%$ as per ASTM D 253.
- iv. The back of the panel shall be chromatised, compatible with adhesives for stiffeners if any and/or given a polymer coating (total protection 3-7 micron thick).
- v. The cladding panels shall have uniform colour and gloss over the entire installation.
- vi. The fabrication and installation of the cladding systems shall be carried out as per manufacturer's instructions with invisible/concealed fastenings, aluminium sub-structure, silicon sealants (if shown on drawings) properly tooled etc.
- vii. All cladding panels of one kind shall be obtained in one lot from the manufacturers.
- viii. Each panel shall be guaranteed for a flatness of ± 0.8 mm from the true face after installation under no-wind conditions.
- ix. Deviations from the true alignment of adjoining panels shall not be cumulative.
- x. Full load deflections shall be kept to the minimum possible. Each panel shall be capable of withstanding 3 KN/Sqm. wind pressure without any permanent deformation.
- xi. The cladding system shall be adequately ventilated. The air-gap between the cladding panels and the concrete/block wall shall be at least 50 mm to allow proper ventilation of the rainscreen system. The cavity shall be closed by a perforated bird/vermin-proof closer at bottom and by a flashing at top with a bird/vermin proof air outlet built-in.
- xii. The fabrication processes including cutting, grooving, benching, folding, joining, rout-in as well as installation shall be performed as per manufacturer's instructions. The

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panels shall be backed by approved aluminium support framework, fixed to walls with aluminium/galvanised steel brackets.

- xiii. The Contractor shall give a 10 years' guarantee for the organic coating system to be free from the following defects :
 - (a) Peeling
 - (b) Cracking
 - (c) Checking
 - (d) Blistering
 - (e) Uniform chalking in excess of # 8 chalk rating as per ASTM D 4214 for non-metallic colours and # 6 rating for non-metallic whites.
 - (f) Uniform fading or colour change in excess of 5 Hunter Colour Difference units as per –ASTM D 2244.
 - (g) Uniform gloss reduction exceeding 50%.
- xiv. The composite Aluminium panels shall satisfy the following fire codes requirements:
 - BS476 Part6 Class 0
 - ASTM E-84 Part 7 Class 1
 - Flame Spread Index < 5
 - Smoke developed Index < 15

32.18.9 STRUCTURALLY GLAZED WINDOWS AND STRUCTURAL GLAZING

Specifications pertaining to curtain wall shall also apply to structurally glazed windows as well as to structural glazing in the Atrium wherever relevant.

32.19.0 FABRICATION

32.19.1 General

All assemblies shall be fabricated and assembled in accordance with the drawings and the requirements of these specifications. Deviations of any nature, without approval of the Corporation's Engineer shall not be permitted.

32.19.2 Tolerances

The Contractor shall furnish a schedule of fabrication tolerances for all major wall cladding components. In addition to the fabrication tolerances, provide for and schedule thermal movement including assembly and installation tolerances for all major and/or applicable wall cladding components and/or assemblies.

32.19.3 Workmanship

- i. All work shall be performed by skilled workmen, specially trained and experienced in the applicable trades and in full conformity with the specifications and approved shop drawings.
- ii. All work shall be carefully fabricated and assembled with proper and approved provisions for thermal expansion and contraction, fabrication and installation tolerances and design criteria.
- iii. All forming and welding operations shall be done prior to finishing, unless otherwise noted.

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- iv. All work shall be true to detail with sharp, clean profiles, straight and free from defects, dents, marks, waves or flaws of any nature impairing strength or appearance; fitted with proper joints and intersections and with specified finishes.
- v. All work shall be erected true to plumb, level, square to line, securely anchored, in proper alignment and relationship to work of other trades and free from waves, sags or other defects.

32.19.4 Joints in Metal Work

- i. All exposed work shall be carefully matched to produce continuity of line, design and finish. Joints in exposed work, unless otherwise shown or required for thermal movement, shall be accurately fitted, rigidly secured with hairline contacts and sealed watertight.
- ii. Where two or more sections are used in building up members, the surface in contact shall be brought to a smooth, true and even surface and secured together so that the joints shall be absolutely tight without the use of any pointing materials. Extrusions shall be tolerated to eliminate any edge projection or misalignment at joints.
- iii. The Contractor shall furnish physical samples of all joinery elements as for comparative appraisal and approval of the production materials. Physical samples of all typical wall intersection assemblies shall be colour coded on surfaces and/or areas to receive sealants.

32.19.5 Shop Assembly

- i. As far as practicable, all fitting and assembly of the work shall be done in the shop.
- ii. Work that cannot be permanently shop assembled shall be temporarily assembled in the shop and marked, before disassembly to ensure proper assembly later in the building.
- iii. All glazing shall be done in the shop. Gaskets shall be pre-positioned and welded in the shop as far as possible.
- iv. Site work shall be kept to a minimum.

32.19.6 Sleeves

Unless otherwise noted, all aluminium sleeves shall be extruded sections designed to accurately interlock with adjacent sections and incorporate serrated surfaces for the secure bedding of sealant between the parent metal and the sleeve.

32.19.7 Fasteners

- i. All fasteners shall be of stainless steel with self locking devices, unless otherwise noted, and of sufficient size and strength to withstand the applicable design wind load and dead load forces with safety allowance factors as required for the specific materials. The spacing and quantities of fasteners shall be as required to develop the maximum strength of the member they secure or support. Washers and/or other accessory items shall be of the same material as the fastener. All assembly fasteners shall be torque tightened to achieve the maximum torque tension relationship in the fastener.

- ii. All fasteners shall be concealed unless otherwise shown or approved. The head style for all exposed fasteners shall be countersunk oval head unless otherwise noted on the drawings. Exposed fasteners shall be finished to match surrounding metal finish.
- iii. All fasteners including washers and accessory items shall be scheduled and designated on the shop drawings so that anyone can witness and assess the assembled units to ensure that all fasteners conform to the designated and approved type, size, material, spacing, etc. When certain items are not readily apparent, such as material and alloy or torque tightening requirements, special instructions for the identification and appraisal of such items shall be issued.

32.19.8 Protection of Metals

- i. Protection against bimetallic corrosion shall be provided wherever dissimilar metals are in contact.
- ii. Aluminium which is to be in contact with cured concrete, mortar or plaster shall have the contact surfaces protected wherever crevices between the contact surfaces may entrap moisture and corrosive elements. All metals, except stainless steel, which are to be in contact with fresh concrete, mortar or plaster, shall have the contact surfaces protected with epoxy paint.
- iii. The Contractor shall furnish a schedule of all protective coatings and related items including the designation of area and/or specific locations, materials used, special instruction, specification data sheets, etc.

32.19.9 Welding

- i. All welding in aluminium work shall be done by the inert gas shielded arc or fluxless resistant techniques and with electrodes and/or by methods recommended by the suppliers of the metals being welded. Type, size and spacing of welds, shall be as shown on approved shop drawings.
- ii. Welds behind finished aluminium surfaces shall be so done as to eliminate distortion and/or discoloration on the finished side. Weld spatter and welding oxides on finished surfaces shall be removed by descaling and/or grinding. Low heat filled welds using chill bar on finished side shall be used to eliminate dimpling, distortion and/or discoloration on the finished or exposed surface. Plug, puddle or spot welding shall not be permitted. If weld beads are shown on exposed finished surfaces, the surfaces shall be ground and polished to match and blend with finish on adjacent parent metal.
- iii. Structural welds shall be made by certified welders and shall conform to the general recommendations and regulations of AWS Specification D1.0-46.
 - a) Dirt grease, lubricant, or other organic material shall be removed by vapour degreasing or suitable solvent.
 - b) Joints rejected because of welding defects may be repaired only by rewelding. Defective welds shall be removed by chipping or machining. Flame cutting shall not be used.
- iv. Where ever welding is done in proximity to glass or finished surfaces, such surfaces shall be protected from damage due to weld sparks, spatter or tramp metal.

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- v. All welds shall be scheduled and designated on the shop drawings so that one can witness and assess the assembled units to ensure that all welds conform to the designated and approved type, size, spacing etc.

32.19.10 Soldering

All soldering and/or brazing shall be done as recommended by the suppliers of the metals involved.

32.20.0 EXECUTION

32.20.1 General

- i. The drawings supplied by the Corporation's Engineer shall be considered essentially schematic, except for profiles of exposed surfaces which shall be as indicated. If, in the opinion of the contractor, a change of profiles is required in order to meet the specifications, he shall consult the Corporation's Engineer for a review.
- ii. The method of assembling, reinforcing and anchorage of the aluminium structural cladding system, where indicated is schematic. Location and method of providing same shall be the Contractor's responsibility, who shall design, assemble, reinforce and anchor to suit each specified condition in an acceptable manner, suiting main building structure.
- iii. Visible joints shall be as shown on the Corporation's Engineer's drawings.
- iv. All parts shall be secured by concealed means. Screws exposed to view shall not be allowed.
- v. All components shall be assembled, secured, anchored, reinforced, sealed and made weathertight in manner not restricting thermal or wind movement of the metal wall cladding/curtain walling system. Where possible, sealants shall be concealed.
- vi. Free and noiseless movement of all components of the aluminium structural glazing and cladding System due to thermal, structural, wind pressure, or dead loads, shall be achieved without strain to glass, without buckling of any components and without excessive stress to any members or assemblies.
- vii. The entire aluminium structural glazing and cladding system shall be assembled and installed so that all leakage and condensation shall be drained and discharged to the exterior face of the wall.
- viii. Movement of water behind and on exposed surfaces shall be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimise the potential for algae and fungus growth as a result of standing or trapping water.

32.20.2 Dimensions

The dimensions given on Corporation's Engineer's drawings shall not be used by the Contractor for preparing his shop drawings and for executing the work. All dimensions shall be actually measured on site and in case of any discrepancy between measurements on site and in drawings, modules shall be decided in consultation with the Corporation's Engineer.

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32.21.0 INSTALLATION**32.21.1 Quality Control**

As per Clause 32.7.3

32.21.2 Qualification of Workmen

All work shall be performed by skilled workmen, especially trained and experienced in the applicable trades employed and in full conformity with specifications and approved shop drawings.

32.21.3 Setting out

Bench marks for elevations and building line offset marks for alignment shall be established on each floor level by the contractor. Should any error be found in their location, the Contractor shall notify the Corporation's Engineer in writing and installation work shall not proceed in the affected area until the errors have been corrected.

The Contractor shall submit the structural glazing anchorage plan for endorsement by the Corporation's Engineer. The Contractor shall co-ordinate his system of anchorage with the Corporation's Engineer according to site conditions.

32.21.4 Prior Inspection of the Structure

After the setting out has been established and before beginning installation in any area, the Contractor shall examine all parts of the structure on which the curtain walling system/metal wall cladding are to be placed in that area. Should any conditions be found which, in his opinion, will prevent the proper execution of his work or endanger its permanency, he shall report such conditions in writing to the Corporation's Engineer. Installation work shall not proceed in that area until such conditions are corrected or adjusted to the satisfaction of the Corporation's Engineer.

32.21.5 Workmanship

All parts of the aluminium structural glazing and cladding system shall be erected true to plumb and in proper alignment and relation to established setting out, as shown on approved shop drawings.

32.21.6 Erection Tolerances

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The installed curtain walling / wall cladding system components shall conform to the following erection tolerances under no-wind condition:

- a) Amount of total deviation and/or misalignment in any direction for vertical members: 2mm maximum in a height of 4m(non-cumulative) and maximum 6mm in full-height of cladding/curtain walling.
- b) Amount of total deviation and/or misalignment in any direction for horizontal members: 2 mm max. in a length of 7m.
6 mm in full length
- c) Maximum offset from true alignment between two abutting members shall be 1mm. No edge projection or misalignment will be permitted.
- d) Maximum joints, gaps or openings between removable glazing stop and adjacent member shall be 1mm and/or a maximum 1mm cumulative opening at both ends of removable members (0.5mm each end)
- e) Deviation in spacing of brackets: $\pm 3\text{mm}$
- f) Allowances for the cumulative effect of all tolerances (fabrication, assembly, thermal and erection) must be made to ensure a workmanlike installation. The documentation and distribution of this information to all applicable installation and inspection personnel is essential in order to ensure the standard of quality and workmanship required.

32.21.7 Installation within and/or adjacent to concrete

Where work is to be installed within and/or adjacent to concrete, no aluminium structural glazing and cladding system components other than built in anchor devices shall be put in place until the concrete work is completed and finished.

32.21.8 Anchorage

- i. **Anchorage of the aluminium structural glazing and cladding system to the structure shall be by approved methods and in strict accordance with approved shop drawings. After the aluminium structural glazing and cladding system are properly positioned, all connections so designated on approved shop drawings shall be rigidly fixed by welding or other positive means.**
- ii. All anchorage assemblies and their related components shall be thoroughly scheduled and described on the shop drawings so that anyone can evaluate an installation and ensure its compliance with the contract documents. Designate trades responsible for furnishing and/or installing materials if other than the Contractor. Descriptive items shall include the access, removal, movement and tolerances of related building and the aluminium structural glazing and cladding system, direction and magnitude of thermal

expansion, materials, sizes, quantities and any special instruction as may be required. All primary aluminium structural glazing and cladding, anchorage assemblies inclusive of skylight space frame/structural mullion shall receive a 100% inspection.

32.21.9 Welding

All welding shall be done by skilled mechanics qualified or licensed in accordance with local building regulations. Welds and adjoining burnt areas in prime coated surfaces shall be thoroughly cleaned and painted with one coat of primer. Welds in galvanised steel shall be coated with two coats of zinc rich paint. Special care shall be taken to protect glass and other furnished surfaces from flame and welding spatter and to prevent fires.

32.21.10 Use of sealing materials

- i. Sealing materials shall be used in strict accordance with the Manufacturer's printed instructions and shall be applied only by workmen specially trained or experienced in their use. Before applying sealant, all mortar, dirt, dust, moisture and other foreign matter shall be completely removed from surfaces it will contact. Adjoining surfaces shall be masked when required to maintain a clean and neat appearance. Sealing compounds shall be tooled to fill the joint and provide a smooth finished surface.
- i. The manufacturer(s) of the applicable materials shall, when required, render, technical assistance prior to the application of any sealant and witness the first applications as well as periodic site inspections thereafter. The Contractor shall witness and document all inspections performed by the sealant manufacturer and provide close supervision of all workmen used to apply the sealant.

32.21.11 Tensioning of Bolts

All bolts shall be correctly tensioned. The tension shall be specified on shop drawings. At least 10% of bolts shall be mechanically checked for correct tension.

32.21.12 Sequence of Installation

If so directed by the Corporation's Engineer, installation of the aluminium structural glazing and cladding shall be postponed in areas as designated by the Corporation's Engineer for a specified period of time so as to facilitate moving materials/equipment into and out of the building and installation of mechanical & electrical fittings during construction. The Contractor's work is to proceed along guidelines and schedule directed by the Corporation's Engineer.

32.21.13 Protection and Cleaning

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- i. The Contractor shall adequately protect all aluminium sections, glazing, cladding sheets, components and accessories from damage during shipment, storage, erection and after completion of the work by use of protective film/foil of approved non-staining quality.
- ii. At such time as may be directed by the Corporation's Engineer, the Contractor shall remove all protective coverings and/or coatings and clean surfaces free of all soil and discoloration. All cleaning agents shall be acceptable to the applicable aluminium, glass and coating manufacturers; and where doubt exists, spot tests shall be made to satisfy the Corporation's Engineer.

32.22.0 LOUVRES

32.22.1 General

- i. Free area of louvres shall not be less than shown on drawings.
- ii. The Contractor shall submit shop drawings and samples according to clauses 5 and 8 respectively.

32.22.2 Louvres

- i. Louvres shall be provided at positions shown in the drawings.
- ii. Louvres frames and blades shall be manufactured from 6063 – T52 aluminium alloy extruded aluminium sections anodised to min. 22 microns in approved colour.
- iii. The louvre assembly including supports shall be designed to carry a wind load of 1.80 kN / m². Heavy duty sections shall be used to avoid deflection and flutter of blades in high winds.
- iv. Blades shall be supported and lined with gauge extruded aluminium blade braces, positively interlocked to each blade and mechanically secured to structural angles by an aluminium and stainless steel fastening.

Where horizontal louvres extend around corners, the blades shall be mitred and continuously welded.

- v. Allowance shall be made for expansion at jambs and at 6000 mm on centres.
- vi. All louvres shall be free of scratches.

32.22.4 Bird Screens

- i. Internal bird screens shall be provided behind all open areas of louvres.
- ii. 12.7 mm mesh with 1.6 mm aluminium inter crimp wire shall be fitted into extruded aluminium frames independent of louvres mitred at corners and secured with corner locks.
- iii. Screening shall be replaceable within extruded frames.

32.22.5 Fabrication

- i. Fabrication shall be done in strict accordance with the reviewed shop drawings. The assemblies shall be square, plumb straight and true.
- ii. Fabrication shall be done in the shop, ready for installation on site.
- iii. Unless otherwise indicated shop connections shall be welded. If riveted or bolted connections are approved, concealed fasteners shall be used.
- iv. Joints and intersections shall be tight fit and securely fastened.
- v. All necessary rebates, lugs, brackets and the like shall be provided in order to achieve neat and substantial assembly of work.
- vi. Aluminium surfaces coming in contact with other materials shall be protected by providing a dielectric separator such as lacquer, paint, tape, etc in order to avoid electromechanical corrosion.

32.22.6 Erection

- i. Stainless steel supports shall be provided if required, in addition to those shown on the structural drawings. All screws, bolts, washers, nuts and other fastening devices shall be of 316 austenitic grade stainless steel.
- ii. Louvres, screens and sills shall be installed in strict accordance with the approved shop drawings, straight, plumb, and level.
- iii. Tolerance shall be 2mm vertical or horizontal in line, level and plumb.
- iv. After the erection and installation are complete all finished coats damaged during transportation and erection shall be touched up using same coating specified for finished surfaces.
- v. Joint surfaces of louvres and adjacent work shall be cleaned up and a full bead of sealant shall be applied. The exposed face of sealant shall be tooled neatly to a slight concave profile and shall be free of ridges, wrinkles, sags, etc.

32.23.0 PERFORMANCE TESTING**32.23.1 General**

- i. Specifications 23.1 to 23.11 apply for pre-construction performance tests in laboratory conditions. These tests shall be required to be performed only if the Contractor is not able to submit reports on similar tests performed earlier on prototypes of the curtain wall system offered by him.
- ii. Specification 23.12 applies for site tests.
- iii. The Contractor shall supply copies of shop drawings and calculations to the Test Laboratory approved by the Corporation's Engineer prior to installation of the test units. These drawings shall include:
 - test elevation and sections;

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- full scale typical details of unitised panels including intersections of members;
 - typical support details;
 - extent of sealants;
 - size and number of pressure equalisation/drainage slots or holes;
 - blanking off details; and,
 - method of installation
- iv. Any deviations from the drawings shall be recorded and noted in the final report. After approval of structural calculations and shop drawings for the structural glazing test units for performance testing of the curtain wall shall be constructed by the Contractor at the testing laboratory.

32.23.2 Test Units

- i. The test units shall comprise components representative both in size and shape of the facade of the building under examination. The width of the test sample shall be not less than of three typical adjoining wall panels/units. The height of the test sample shall be not less than 2 storeys high and must contain full height modules of the aluminium structural glazing system. Vertical and horizontal movement joints shall be included in the test sample.
- ii. Where details of the building façade differ from those in the representative test sample, such as at corners, overhangs and the like, supplementary tests shall be performed on either composite or part sample of the facade.
- iii. The materials of the test sample (glass, aluminum, reinforced concrete, sealant, gaskets etc.) shall be of the sample, type and size and have the same details, methods of construction, flashing and anchorage as the building façade.
- iv. If not an actual on site representative sample of the wall of the building, the test sample shall be mounted and sealed into a simulated building frame in the same manner and by the same fixings which are intended to attach the façade to the building structure. The support frame shall be of equivalent stiffness to that supporting the building to prevent unrealistic deflection of the prototype sample.
- v. Simulated floor slabs and spandrel shall be to actual depth if, for example in curtain walls the air seal is connected to the slab. The internal finishes and linings shall be installed where they contribute to the air seal of the façade. The air seal of the test sample shall be continued to the air seal of the test chamber.
- vi. All unitised panels and other interconnected joints in the façade shall be sealed at the sample boundaries. This is to minimise the effects that the surrounding construction will have on the test performance of the sample. All pressure equalisation and drainage slots or holes in the test sample shall be left open.
- vii. Transparent viewing panels (or other means of observation such as an optical fiber probe) shall be provided so that the performance of the façade in areas that are not readily seen can be determined.

32.23.3 Inspection of test units

- i. The Contractor shall allow the Corporation's Engineer to inspect the test sample regularly during erection. At this stage the adequacy and stiffness of the support structure shall be assessed. When the installation of the test sample is complete, the Corporation's Engineer shall inspect the test sample before shipment to testing facility.

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- ii. Full time attendance by approved representatives of the contractor shall be provided for the erection of the test unit and all testing of the test units.

32.23.4 Test programme

- i. The Proposed testing procedure and related method shall be conducted in accordance with test specifications, or to other approved codes and parameters of equal or greater severity.
- ii. The following standards shall apply to the tests:

Air infiltration test	:	ASTME 283-91
Water penetration test	:	ASTME 331-86
Structural performance test	:	ASTME 330-90
Seismic test	:	AS/NZS 4284:1995

- iii. The test programme will be conducted in the following sequence:

- a) Preliminary loadings
- b) Air infiltration test
- c) Water penetration test (static pressure)
- d) Water penetration test (dynamic pressure)
- e) Structural performance test (design pressure)
- f) Seismic test (serviceability limit state)
- g) Water penetration test (dynamic pressure)
- h) Structural proof load test
- i) Seismic test (ultimate limit state)

32.23.5 Preliminary loading

The test unit shall be subjected to static pressures of +100 kg/m² and – 100 kg/m² for a period of 30 seconds each.

32.23.6 Air infiltration test-ASTM E 283-91

- i. This test shall be performed by attaching the test specimen on one side of the pressure chamber and sealing it. Air Pressure shall then be supplied from the chamber simulating pressure applied to the outer face of the specimen at a pressure difference of 10kg/m² in accordance to ASTM E 283-91. At the maintained specified test pressure difference across the specimen, measurement for the resultant air flow through the specimen shall be recorded. The results of the infiltration shall not exceed 1 liter/min per 300mm run of sash perimeter, and for the fixed glass panels air leakage shall not exceed 1 liter/min/m².
- ii. A stabilised pressure difference of 10kg/m² shall be maintained across the test specimen with its opening being sealed for the first result and then with the seal taken off for the second result. Measurement of air flow shall be recorded via the air flow meters at the supply source and near the specimen. The difference of the two measured air flows shall give the resultant air flow which is converted into units of litres per minute per unit length or area to be compared with the acceptance criteria.

32.23.7 Water penetration test- ASTM E 331-86

- i. **Static pressure**

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This test shall be performed by attaching the test specimen on one side of the pressure chamber and sealing it with the same type of sealant as would be used on site. Uniform pressure difference of 60kg/m^2 shall be introduced into the chamber in one step for ten minutes. The test shall then be repeated with a pressure difference of 120kg/m^2 (60% of positive wind pressure) for 5 minutes.

Water jet sprays shall be introduced onto the specimen at a rate of 3.40 liter per square meter per minute .

ii. Dynamic pressure

The procedure for the dynamic pressure test shall be similar to that for the static pressure, the only difference being that for the dynamic pressure test, pulsating pressure difference instead of uniform pressure difference will be used. The pulsating pressure shall fluctuate from 0 to 30 kg/cm^2 for fifteen minutes. The above test shall be repeated for pulsation between 60 kg/m^2 and 120 kg/m^2 for 15 minutes. The pulsating pressure shall be in cycles of between 3 to 5 seconds.

iii. For both the static and cyclic water penetration tests, no leaks shall be acceptable. A leak shall be considered to occur if

- a) Uncontrolled water appears on any inside surface of the façade
- b) Water appears on inside surface of the façade and is visible from the occupied building space.
- c) Water appears that is likely to wet insulation, fixtures and finishes.
- d) Water appears in other locations specified as unacceptable.

32.23.8 Structural performance test – ASTM E 330-90

23.8.1 General

i. The test specimen shall be installed on one side of the pressure chamber and sealed. Air pressure shall then be supplied to (positive pressure) and exhausted from (negative pressure) the chamber. At specified maintained pressure difference across the specimen, observation, measurement and record of deflection shall be carried out. The design wind pressure used for the test shall be $+200\text{ kg/m}^2$ and -200 kg/m^2 . Displacement transducers accurate to $\pm 0.25\text{mm}$. shall be fixed to the test unit at selected locations to be approved by the Corporation's Engineer.

ii. Transducers shall be attached to

- a) 2 mullions at 9 locations each including at brackets, joints with horizontal members and mid spans
- b) 2 transoms at mid- spans and joints with vertical members
- c) 2 sill / gutters at mid - spans and joints with vertical members

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- d) Centres of fixed vision panel, openable vision panel and 2 spandrel panels.
- e) 2 transoms and 2 sill/gutters at mid - spans for vertical displacement .
- f) Any other critical points if required by the Corporation's Engineer.

32.23.8.2 Static Pressure Test – Design Pressure

The proposed testing method shall be in accordance with procedure B of ASTM E 300-90. There will be four incremental loadings at 50 kg/m², 100 kg/m², 150 kg/m² and 200 kg/m² for positive pressures and at -50 kg/m², -100 kg/m², -150 kg/m², -200 kg/m² for negative pressures.

32.23.8.3 Acceptance Criteria for Static Test

At 100% of design pressure and load :

- i. Net deflection perpendicular to enclosure surface for framing members shall not exceed span/240 or 15 mm whichever is less and shall not exceed span/300 for glass supporting members.
- ii. In the plane of the wall, deflection of horizontal rails shall not reduce the glass bite below 75% of the dimensions, and shall not reduce the glass edge clearance below 25% of the design dimensions or 3 mm whichever is greater.
- iii. At connection points of framing members anchors, anchor deflection shall not exceed 1mm.
- iv. Glass panel centre deflection shall not exceed span/90, or 15 mm. whichever is less.

32.23.8.4 Proof Load Test

The maximum pressure for the proof load test shall be 300 kg/m². The method of testing shall be as follows:-

- | | | |
|-------------------------|---|-----------------|
| + 150 kg/m ² | - | To remove slack |
| + 300 kg/m ² | - | At proof load |
| | | |
| - 150 kg/m ² | - | To remove slack |
| - 300 kg/m ² | - | At proof load |

32.23.8.5 Acceptance Criteria for Proof Load Test

Under proof load test there shall not be :

- i. Dislodgement of any glass.
- ii. Dislodgement of any frame, panel or any part thereof.

- iii. Failure of any fixings that connect the façade to the building structure.
- iv. Failure of any accessory, locking device, hinge, etc. which would allow an opening light to come open.
- v. Any permanent distortion of a panel shall be documented. The residual deflection of any member shall be nil. The slippage at support shall not exceed 1 mm.

32.23.9 Seismic Test – AS/NZS 4284:1995

32.23.9.1 *Serviceability Limit State*

The test unit shall be displaced by subjecting it to cyclic movement at the rate of 1 cycle/sec. for a period of 30 seconds (One cycle is movement from original setting to one extreme, then to the other extreme and back to original setting). The max. displacement shall be ± 12 mm. from the original setting at the seismic loading floor.

32.23.9.2 **Ultimate Limit State**

The procedure (a) above will be repeated with max. displacement of ± 18 mm.

The test unit shall not collapse during or after the seismic test at serviceability and ultimate limit state displacements. Any damage to seals, members or panels shall be recorded. Collapse shall mean any one or more of the conditions (a) to(d) described under Proof Load Test in 32.23.8.4 above.

The test unit shall be subjected to and shall pass the criteria set for dynamic water penetration test (Specification 32.23.7.ii after the seismic test at serviceability limit state displacements.

32.23.10 Form of Report

- i. Details of the test sample (including an outline of the simulated building frame) and the test apparatus, instrumentation and method shall be clearly given in a report in triplicate.
- ii. The report shall include the following:
 - a) An identification and general description of the facade and Certificate of Identity from the contractor.
 - b) Drawings of the actual test sample showing modifications, if any.
 - c) Test sequence and procedure with pressures used in all tests.
 - d) Location of all transducers for the structural performance test and moving support beam for seismic test.
 - e) Displacements, span/deflection ratios, air infiltration rates and water leakage details, permanent distortion or collapse, and damage to seals, members or panels.
 - f) Other pertinent observations.
- iii. The testing laboratory shall keep a copy of approved test unit, shop drawings and calculations at testing laboratory accurately and neatly record on the above mentioned

shop drawings all changes, revisions, modifications, etc. made to test unit, which shall become the record drawings.

- iv. At completion of testing and after approval of test reports, the testing laboratory shall submit the final record drawings to the Corporation's Engineer.

32.23.11 Cost of Performance Testing

The Contractor shall allow for the cost of fabrication, shipping, testing erection, modifications to and the demolition of the test unit. If the test unit fails to pass the initial testing, the Contractor shall make the necessary modifications to the test unit and shall have the Test unit retested by the Testing laboratory until it passes the test. Cost of modifications to the test unit and cost of retesting shall be borne by the Contractor.

32.23.12 Site Tests

- i. The Contractor shall carry out site tests at his own cost to determine resistance to water leakage as per recommendations given in AAMA 501.2-94 for "Field Check of Metal Storefronts, Curtain Walls and Sloped Glazing Systems for Water Leakage."
- ii. The test areas shall be selected by the Corporation's Engineer, at random in typical and non-typical locations, one for every 500 sq.m. or part thereof installed curtain wall system. In case of any test failing, the Corporation's Engineer shall order more tests to be conducted at the Contractor's cost.
- iii. Each test area shall be
 - (a) 10 sqm. minimum or
 - (b) 25 m. run of perimeter of vision and spandrel units.
 - (c) 4 entire panels of standard types, whichever is the least.

32.24.0 SCHEDULE OF TESTS AND CERTIFICATION

The contractor shall carry out the following tests in approved independent laboratories/ in manufacturer's test facilities/ in his fabrication shop /on site as applicable and shall submit test reports to the Corporation's Engineer. The cost of the tests shall be borne by the contractor. The extent of tests shall not be limited to the list given hereunder. The manufacturers shall carry out all other tests on materials during and after processing as required by codes/ trade practice and shall produce test certificates if so demanded by the Corporation's Engineer.

32.24.1 Curtain Wall System

i. Performance Tests

The tests as specified in Specification 21.1 To 21.11 shall be performed in an approved laboratory to prove the performance of the contractor's design and details prior to construction.

The Contractor shall provide attendance for the full duration of the test including installation in laboratory and modifications to the test unit. The test shall be performed in the presence of the Corporation's Engineer if so requested.

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ii Site Tests for water penetration

Site tests shall be performed as specified in Specification 21.12.

Tests shall be performed on curtain wall in locations selected by the Corporation's Engineer.

32.24.2 Glass

i. Tests in Approved independent laboratory

3 samples of each type of vision and spandrel panels (except for glass with ceramic frit) shall be tested for :

- (a) American summer U- Value in $W/m^2.K$ (ASHRAE standard)
- (b) Shading coefficient (ASHRAE standard)

ii. Certification by Manufacturer

For each lot of glass supplied, the Manufacturer shall certify the following:

- a. Characteristics
 - Light transmittance (380 to 780 nm.) : %
 - Light reflectance (external) : %
 - Light reflectance (internal) : %
 - UV transmittance (280 to 380 nm): %
 - Direct energy transmittance (300 to 2150 nm) %
 - Energy reflectance : %
 - Energy absorption : %
 - Shading coefficient %
 - = $\frac{\text{Total solar energy flux entering thru glass.}}{0.87 \times \text{incident solar energy}}$
 - U- value (American summer): $W/m^2.K$
ASHRAE conditions
- b. Compliance with Codes
 - ASTM C 1036-91 for vision glass
 - ASTM C 1048-92 for spandrel glass
 - CBA rating with IGCC in accordance with ASTM E 773 and E 774 for insulating glass
 - ASTM C 1048 – 92 for heat-processing
 - ANSI Z 97.1 and CPSC 16 CFR 1201 for safety glazing.
- c. Sealant – Substrate test report
- d. Surface compression in heat strengthened glass
- e. Manufacture's certification of cyclic thermal stress test as per ASTM C 1048-92 on heat processed glass.
- f. Manufacturer's report on heat- soaking program for each lot of glass supplied.
- g. Visual Inspection Reports.

❖ Thickness and dimension tolerances

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- ❖ Pinholes
- ❖ Uniformity of colour and opacity
- ❖ Distortion
- ❖ Scratches

32.24.3 Structural Sealant

32.24.3.1 Tests on 1 – component sealants

- i. **Skin –over Time /Elastomeric Test :**
Perform test in fabrication shop on each new lot and once a week to check on shelf life of one-part sealant as recommended by the manufacturer.
- ii. **Standard field adhesion Test :**

Perform 10 tests for the first 300 m. of sealant application and 1 test for every 300m. thereafter in fabrication shop as recommended by sealant manufacturer.

32.24.3.2 Tests on 2-component sealants

- i. Perform test every time mixing pump is started up to check on adequate mix of base and curing agent components.
- ii. **Snap – Time Test**

Perform test daily to relate the mix proportion to the curing rate of sealant as recommended by the manufacturer.

32.24.3.3 Deglazing

Deglaze complete panels from frame to confirm proper adhesion and joint fill.

Inspection of at least 3% of first 100 glazed panels and at least 1% of panels thereafter shall be carried out after deglazing in presence of the sealant manufacturer.

The following documentation shall be certified jointly by the sealant manufacturer and the contractor:

- (a) Size of structural bite - design and actual.
- (b) Size of structural glue-line.
- (c) Adhesion of sealant with panel and frame
- (d) Joint type /condition/ penetration of sealant applied.

32.24.3.4 Laboratory Tests by Manufacturer

- (a) Peel adhesion test as per ASTM C 794-93.
- (b) Compatibility test for sub-strates as per ASTM C 1248-93.
- (c) Indentation Hardness durometer test as per ASTM C 661-93.
- (d) Adhesion & Cohesion test under cyclic movement as per ASTM C 719-93.

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- (e) Tensile adhesion test as per ASTM C 1135-90
- (f) Ultimate elongation & tensile strength as per ASTM D 412.

1 set of Test certificates shall be submitted for each lot supplied.

32.24.3.5 The sealant incenufacturer shall submit laboratory test results for adhesion and compatibility for each lot of aluminium extrusions and glass.

32.24.4 Weather sealant

24.4.1 Laboratory Tests by Manufacturer

- i. Durometer Shore hardness as per ASTM D-2240
- ii. Tensile strength @ 150% elongation as per ASTM D-412.
- iii. Staining test as per ASTM D –510

1 set of test certificates shall be submitted for each lot supplied

32.24.5 Aluminium Extrusions

24.5.1 Each lot and type of aluminium extrusions shall be accompanied with :

- i. Certificate of mechanical properties and chemical composition.
- ii. Certificate of dimensional tolerances to DIN standard.
- iii. Certificate of temper.

24.5.2 The contractor shall certify minimum anodising thickness for each lot and type of aluminium extrusions.

24.5.3 Anodising thickness shall be checked on site on 10% of extrusions.

24.5.4 PVDF coating thickness shall be checked on site on 10% of extrusions.

32.24.6 Composite Aluminium Panels

24.6.1 The manufacturer shall submit one test certificate for each lot and type of composite aluminium panels for :

- (a) Tensile strength and yield strength of composite panels as per ASTM E-8
- (b) Tensile and yield strength of aluminium skin.
- (c) Elongation as per ASTM E 8
- (d) Punching shear resistance as per ASTM D 732
- (e) Impact test for denting (DUPONT) (0.5 kg and 1 kg steel balls at 500 mm height)

24.6.2 The following test result from approved fire test laboratory shall be submitted:

Flame spread and smoke developed indices as per ASTM E 84.

24.6.3 The following test certificates shall be submitted for PVDF/ fluoropolymer coating satisfying AA 2605 – 98.

- (a) Corrosion resistance.
- (b) Salt spray resistance
- (c) Weathering
- (d) Colour retention.
- (e) Chalking resistance
- (f) Glass retention
- (g) Resistance to erosion.

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- 24.6.4 The coating agency shall certify performance requirements of all tests as per AAMA 2605-98 – voluntary specification, Performance Requirements and Test procedures for superior performing organic coating on Aluminium Extensions & Panels.
- 24.6.5 The coating agency shall certify the minimum thickness of PVDF / fluoropolymer coating .
- 24.6.6 The Manufacturer shall certify conformance with BS 476, Part 6, Class 0 and Part 7, Class 1 6.5. The manufacturer shall certify the percentage of resin in PVDF / fluoropolymer coating.

32.24.7 E. P. D. M.

For each lot of EPDM, test certificates shall be submitted for

- (a) Shore hardness.
- (b) Tensile strength.
- (c) Elongation
- (d) Ozone resistance.

32.24.8 PTFE (TEFLON)

For each lot of polytetrafluoroethylene (TEFLON) separators, a set of manufacturer's test certificates shall be supplied for :

- (a) Tensile strength & elongation as per ASTM D-1457.
- (b) Compressive strength as per ASTM D-695.
- (c) Shore D hardness as per ASTM D-2240.
- (d) Flexural strength as per ASTM D-790.
- (e) Impact strength as per ASTM D-256.
- (f) Deformation as per ASTM D-621.
- (g) Coefficient of friction.

32.24.9 Foam spacers and Mounting Tapes

For each lot, manufacturer's test certificates shall be submitted for

- (a) Weathering
- (b) Tensile strength.
- (c) Compression .
- (d) Elongation.

32.25.0 APPROVED LIST OF BRANDS/MAKES

1. Glass

Monolithic heat-strengthened glass.
Insulated glass.
Laminated glass.
Tempered glass.

} Asahi India Glass Ltd.
St. Gobain India

2. Aluminium Extrusions

Jindal, Hindalco, Indal or approved equivalent subject to specified tolerance standards.

3. Aluminium Composite Cladding Panels

Alcobond, Aluma, Durabuild & Euro

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- | | | |
|-----|--|---|
| 4. | <u>Expansion anchors</u>
SS 316 Screw, Bolts & Nuts | HILTI, FISCHER or approved equivalent (with stainless steel 316 bolts nuts & washers)
ARROW, KUNDAN. |
| 5. | <u>Chemical anchors</u> | HILTI or approved equivalent. |
| 6. | <u>Door & Window furniture</u> | |
| a) | 4 Point lockset | GIESSE or approved equivalent |
| b) | S.S friction hinges | COTSWOLD or approved equivalent |
| c) | Patch fittings / SPIDER Fittings | DORMA, WINDOR, KITCH |
| d) | Floor springs, handles etc. | DORMA, |
| e) | Adhesive film | 3M, BIRLA or approved equivalent |
| 7. | <u>Structural Sealant</u> | Dow Corning, GE – Two Part |
| 8. | <u>Weather Sealant</u> | Dow Corning ,GE |
| 9. | <u>Foam Spacers and Mounting Tapes</u> | NORTON |
| 10. | <u>EPDM</u> | AMEE Rubber Industries or approved equivalent |
| 11 | <u>Insulation</u> | U.P. Twiga, Lloyds Insulation or approved equivalent |

32.26.0 DESIGN DATA

- Temperature Range : 60°C Ambient
100°C for Materials
- Wind Load : 1.80 kN/sqm.
- Seismic load : As per Bye-laws – Seismic Zone III
- Deflections :
- Mullions : Max. L/240 or 14 mm whichever is less.
- Transomes, sills, heads, gutters. : Max. L/300

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- Permanent deflection : NIL at 3 kN/Sqm. wind pressure.
in Mullions.
- Permanent deflection : Nil at 2 times dead load
in transomes, sills, Nil at 3 kN/Sqm. wind pressure
heads, gutters.
- Permanent deflection : Nil at 3 kN/sqm. wind pressure.
in cladding frame
members.
- Glass Panels : Max. 14 mm or as calculated by glass manufacturer for ea
typical panel, whichever is less.
- R.C.C. Grade : M 300
- Anticipated Building Movements :

The following building movements are anticipated by the Structural Consultants after the building structure is completed. The Contractor shall adequately allow for these movements in his design

- | | | |
|-----|---|------|
| (a) | Differential horizontal displacement of building face between consecutive floors due to wind or earthquake. | 4 mm |
| (b) | Differential vertical displacement of building face at any floor. | 1 mm |
| (c) | Max. axial compression in columns per floor height. | 2 mm |
| (d) | Expansion / Contraction of R.C.C. fascia per 10 m. length per 10°C temperature difference. | 1 mm |

32.27.0 GLASS CHARACTERISTICS:

(a) INSULATED GLASS

Type	:	Reflective Ultra Marine KS 738II of St. Gobain
Size (mm)	:	6 -12 - 6
Inner Pane	:	Clear Float
Outer Pane	:	Platinum (exact shade and radiance to Architect's approval)
Coating	:	# 2 Face

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Light Transmittance	:	23% & over
Light Reflectance	:	
Out		19% & under
In		19% & under
Shading Coefficient	:	0.12 & under
Summer day-time	:	
U Value (W/Sqm/K)		1.60 & under
Relative heat gain (W/Sqm)		96 & under
UV	:	3% & under

(b) MONOLITHIC GLASS

Identical to outer pane of insulated glass.

- (c)** The bidder may offer glass from any other manufacturer mentioned in the APPROVED LIST OF SUPPLIERS if all the characteristics of glass offered meet the specifications above and further if a sample of glass offered is approved **for colour effect prior to bidding**.

32.28.0 ALUMINIUM COMPOSITE PANEL COLOUR:

As approved by Corporation's Engineer.

5.8 DESIGN MIX

5.8.0 Definition

Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. The minimum mix of M25 shall be used in all structural elements in both load bearing & RCC framed construction.

5.8.1 Mix Design and Proportioning

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

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

5.8.1.3 As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23. Reference may also be made to ACI 211.1-77 for guidance.

5.8.1.4 Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer-in-Charge.

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

5.8.1.6 Before using an admixture in concrete, its performance shall be evaluated by comparing the properties of concrete with the admixture and concrete without any admixture. Chloride

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content of admixture should be declared by the manufacturer of admixture and shall be within limits stipulated by IS:9103.

5.8.2 Standard Deviation

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

5.8.3 Acceptance Criteria

5.8.3.1 Compressive Strength : The concrete shall be deemed to comply with the strength requirements when both the following condition are met:

(a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 5.6.

(b) Any individual test result complies with the appropriate limits in col. 3 of Table 5.6.

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

(a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm²

(b) The strength determined from any test result is not less than the specified characteristic strength/
0.3 N/mm².

5.8.3.3 Quantity of Concrete Represented by Strength Test Results : The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in col 3 of Table 5.6 or in item (b) of 5.8.3.2. Only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m³.

5.8.3.4 If the concrete is deemed not to comply pursuant to 5.8.3 the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

5.8.3.5 Concrete of each grade shall be assessed separately.

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

5.8.4 Cement Content of Concrete

5.8.4.1 For all grades of concrete manufactured/produced, minimum cement content in the concrete shall be 330 kg per cubic metre of concrete. Also, irrespective of the grade of concrete the maximum cement content shall not be more than 500 kg per cubic metre of concrete. These limitations shall apply for all types of cements of all strengths.

5.8.4.2 Actual cement content in each grade of concrete for various conditions of variable shall be established by design mixes within the limits specified in para 5.8.4.1 above.

5.8.5 Water Cement Ratio and Slump

5.8.5.1 In proportioning a particular mix, the manufacturer/ producer/ contractor shall give due consideration to the moisture content in the aggregates, and the mix shall be so designed as to restrict the maximum free water cement ratio to less than 0.5.

5.8.5.2 Due consideration shall be given to the workability of the concrete thus produced. Slump shall be controlled on the basis of placement in different situations. For normal methods of placing concrete, maximum slump shall be restricted to 100 mm when measured in accordance with IS 1199.

TABLE 5.6

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**Characteristic Compressive Strength Compliance Requirement
(Clause 5.8.3.1 and 5.8.3.3)**

Specified Grade	Mean of the Group of 4 Non-Overlapping Consecutive Test Results in N/mm ³	Individual Test Results in N/mm ³
(1)	(2)	(3)
M15	$\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest 0.5 N/mm}^2)$ or $f_{ck} + 3 \text{ N/mm}^2$ Whichever is greater	$\geq f_{ck} - 3 \text{ N/mm}^2$
M20 or above	$\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest 0.5 N/mm}^2)$ or $f_{ck} + 4 \text{ N/mm}^2$, Whichever is greater	$\geq f_{ck} - 4 \text{ N/mm}^2$
NOTE – In the absence of established value of standard deviation, the values given in Table may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.		

5.8.6 Approval of Design Mix

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

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

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ANNEXURE - "Q"

**STATEMENT SHOWING QUANTITIES OF THEORETICAL CONSUMPTION OF CEMENT
FOR MAJOR ITEMS OF WORKS**

Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
1.	PLAIN CEMENT CONCRETE WORK		
	A) Cement concrete (1:2:4)	Cu.M.	3.20
	B) Cement concrete (1:3:6)	Cu.M.	2.20
	C) Cement concrete (1:4:8)	Cu.M.	1.70
	D) Cement concrete (1:5:10)	Cu.M.	1.30
2.	DAMP PROOF COURSE		
	A) 25mm thick in C.C. (1:2:4)	100 Sq.M	8.0
	B) 38 mm thick in C.C. (1:2:4)	100 Sq.M	12.16
	C) 50 mm thick in C.C. (1:2:4)	100 Sq.M	16.0
3.	REINFORCED CEMENT CONCRETE WORK		
	A) R.C.C work in C.C. (1:2:4)	Cu.M.	3.20
	B) R.C.C. work in C.C. (1:1½:3)	Cu.M.	4.00
	C) R.C.C. work in C.C. (1:1:2)	Cu.M.	6.10
	D) Providing and fixing precast R.C.C. (1:2:4) set in partition in CM 1:2 including finishing with cement plaster 1:3 of thickness not exceeding 6mm	Cu.M.	3.80
	i) Kerb, step and the like	Cu.M.	3.80
	ii) Copings, bed plates, Anchor blocks, window sills and the like	Cu.M.	3.80
	iii) Small lintels not exceeding 1.5m clear, coping, shelves and the like	Cu.M.	3.77
4.	A) Brickwork (all classes) In cement mortar 1:3		
	i) with modular thick	Cu.M	1.12
	ii) with F.P.S. brick	Cu.M	1.28

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	B) Brick work (all classes) in mortar 1:4		
	i) with modular thick	Cu.M	0.84
	ii) with F.P.S. brick	Cu.M	0.95
	C) Brick work (all classes) In mortar 1:5		
	i) with modular thick	Cu.M	0.68
	ii) with F.P.S. brick	Cu.M	0.78
	D) Brick work (all classes) In mortar 1:6		
	i) with F.P.S. brick	Cu.M	0.62
	E) Half Brick work (all classes) In mortar 1:3		
	i) with modular thick	100 Sq.M	12.75
	ii) with F.P.S. brick	100 Sq.M	14.28
	F) Half Brick work (all classes) In mortar 1:4		
	i) with modular thick	100 Sq.M	9.50
	ii) with F.P.S. brick	100 Sq.M	10.64
	G) Brick work 3" thick in cement mortar 1:3 with F.P.S. brick	100 Sq.M.	9.23
	H) Honey comb brick work half brick thick in C.M. (1:4)		
	i) with modular brick	100 Sq.M	5.54
	ii) with F.P.S. brick	100 Sq.M.	6.56
	I) Brick drip course at junction of roofs and walls in C.M. (1:4)		
	i) 10 cm thick with modular brick	100 M	0.84
	ii) 7.6 cm thick with F.P.S. brick	100 M	0.83
	J) Brick drip course at junction of rooms and walls in C.M. (1:6)		
	i) 10 cm thick with Modular brick	100 M	0.55
	ii) 7.6 cm thick with F.P.S. Brick	100 M	0.54

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	K) Providing brick band 5cm projected from wall face in C.M. (1:4)		
	i) 10cm thick 5 cm Projected with modular brick	100 M	0.42
	ii) 7.6 cm thick 5.7 cm projected with F.P.S. brick	100 M	0.41
5.	STONE WORK		
	A) Random Rubble masonry within foundations or superstructure in cement mortar 1:6 including leveling up with cement concrete 1:6:12 at plinth or sill or ceiling level	Cu.M.	0.85
	B) coarse rubble masonry in foundation and super structure in cement mortar 1:6	Cu.M.	0.75
	C) Stone work plain ashlar cyclopean, sunk or moulded and ashlar punched in cement mortar 1:6 including pointing with cement mortar 1:2 with an admixture of pigment matching the stone shade.	Cu.M.	0.54
	D) Stone work plain ashlar cyclopean sunk or moulded arch, dome or circular moulded and curved columns in cement mortar 1:3 including pointing with cement mortar 1:2 with an admixture of pigment matching the stone shade.	Cu.M.	1.07
	E) Stone work plain in coping cronies; string courses and plinth course in cement mortar 1:6 including pointing with cement mortar 1:2 with an admixture of pigment matching the stone shade.	Cu.M.	0.54
	F) Stone work for wall lining etc. average thickness 40mm to 70mm in cement mortar 1:3 including pointing with cement mortar 1:2 with an admixture of pigment matching the stone shade	100 Sq.M	8.75

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	G) 30mm thick sand stone shelves, fixed in walls in cement mortar 1:3 including finishing complete	100 Sq.M.	1.64
6.	FLOORING		
	A) Brick flooring in cement mortar 1:4	100 Sq.M.	11.02
	B) Brick flooring in cement mortar 1:6		7.25
	C) 25mm thick cement concrete flooring 1:2:4 finished with a floating coat of neat cement		12.20
	D) 40mm thick cement concrete flooring 1:2:4 finished with a floating coat of neat cement		17.00
	E) 50mm thick cement concrete flooring 1:2:4 finished with a floating coat of neat cement		20.20
	F) 75mm thick cement concrete flooring 1:2:4 finished with a floating coat of neat cement		28.20
	G) Cement concrete pavement (25mm to 50mm thick) with 1:2:4 including finished complete	Cu.M.	3.20
	H) 50mm thick cement concrete flooring with metallic concrete hardener topping, under layer of 40 mm thick cement concrete 1:2:4 and top layer 10mm thick metallic cement, hardener consisting of mix 1:2 by volume with metallic hardening compound of approved quality is mixed in the ratio of 4:1.	100 Sq.M	21.10
	I) 40mm thick cast - in situ m.m. flooring (28mm thick under layer and 12mm thick top layer)		
	i) Neutral shade with Grey cement	100 Sq.M	19.07
	ii) Light shade with white cement Grey Cement	100 Sq.M	8.10
	iii) Medium shades 50% Grey White cement	100 Sq.M	10.97 15.02 4.05
	J) Pre-cast terrazzo tiles 22mm thick with marble chips of sized upto 6mm, laid in 20mm thick bed of cement mortar 1:6, cement slurry, jointing with gray cement		

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	i) Light shade using White cement Grey cement	100 Sq.M	4.40 10.00
	ii) Dark shades (with Grey cement)	100 Sq.M	14.40
	K) Pre-cast terrazzo tiles 22mm thick with marble chips of sizes upto 6mm. In skirting on walls, laid on 12mm thick cement plaster (1:3) jointed with neat cement slurry.		
	i) Light shade using white cement Grey cement	100 Sq.M	2.20 13.94
	ii) Medium shade using 50% white cement & 50% grey cement. White cement Grey cement	100 Sq.M	1.10 12.84
	iii) Dark shades (with Grey cement)	100 Sq.M	16.14
	L) checkered terrazzo tiles 22mm thick with marble chip of sizes upto 6mm on 25mm thick bed of lime mortar jointed with neat cement slurry		
	i) Light shade using white cement Grey cement	100 Sq.M	4.40 12.90
	ii) Medium shade using 50% white cement & 50% grey cement. White cement Grey cement	100 Sq.M	2.20 15.10
	iii) Neutral shades (with Grey cement)	100 Sq.M	17.30
	M) White glazed tiles 5.5 mm thick in flooring, treads and risers of steps, skirting and dado on 12mm thick cement plaster 1:3 in base and jointed with white cement slurry etc. White cement Grey cement	100 Sq.M 100 Sq.M	2.50 9.42
	N) Marble stone slab flooring over 20mm thick base lime mortar and jointed with grey cement slurry etc.		
	i) 20mm thick	100 Sq.M	5.0
	ii) 30mm thick	100 Sq.M	5.12
	iii) 40mm thick	100 Sq.M	5.36

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	O) Marble stone slab flooring over 20mm thick base of cement mortar (1:4 and jointed with Grey cement slurry)		
	i) 25mm thick	100 Sq.M	13.51
	ii) 30mm thick	100 Sq.M	13.63
	iii) 40mm thick	100 Sq.M	13.87
	P) Extra if white cement slurry used instead of Grey cement slurry in joints of stone flooring. (White cement)	100 Sq.M	0.76
	Q) Marble tiles 25mm thick in riser of steps, skirting and pillars, laid on 12mm thick cement mortar (1:3) and jointed with grey cement slurry	100 Sq.M	12.34
	R) Kotah stone slab flooring over 20mm thick base of lime mortar and jointed with cement slurry etc.		
	i) 25mm thick	100 Sq.M	6.40
	ii) 30mm thick	100 Sq.M	6.80
	lii) 40mm thick	100 Sq.M	7.60
	S) Kotah stone slab flooring over 20mm thick base of cement mortar (1:4) and jointed with neat cement slurry etc.		
	i) 25mm thick	100 Sq.M	14.91
	ii) 30mm thick	100 Sq.M	15.31
	iii) 40mm thick	100 Sq.M	16.11
	T) Kotah stone slab 25mm thick in riser in steps, skirting dado and pillars laid on 12mm thick cement mortar 1:3 and jointed with neat cement slurry etc.	100 Sq.M	13.74
	U) 40mm thick sand stone flooring over 30mm thick base of cement mortar 1:5 with joints finished flush.	100 Sq.M	7.75
	V) 40mm thick sand stone flooring over 20mm thick base of cement mortar 1:5 including pointing with cement mortar 1:2 (1cement 2 stone dust)	100 Sq.M	9.31
	W) 40mm thick sand stone flooring over 20mm thick lime mortar including pointing with cement mortar 1:2	100 Sq.M	1.56

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	X) 40mm thick fine dressed and rubbed stone flooring over 20mm thick base of cement mortar 1:5 (1cement 5 sand) with joints 5mm thick finished flush.	100 sq.M	8.28
	Y) 40mm thick fine dressed and rubbed stone, flooring, over 20mm thick base of cement mortar 1:5 with joints 5mm thick including pointing with cement mortar 1:2 (1cement 2 stone dust)	100 Sq.M	9.84
7.	FINISHING		
	A) 12mm cement plaster 1:3	100 Sq.M	7.34
	B) 12mm cement plaster 1:4	100 Sq.M	5.47
	C) 12mm cement plaster 1:5	100 Sq.M	4.46
	D) 12mm cement plaster 1:6	100 Sq.M	3.60
	E) 15mm cement plaster 1:3	100 Sq.M	8.77
	F) 15mm cement plaster 1:4	100 Sq.M	6.54
	G) 15mm cement plaster 1:5	100 Sq.M	5.33
	H) 15mm cement plaster 1:6	100 Sq.M	4.30
	I) 20mm cement plaster 1:3	100 Sq.M	11.42
	J) 20mm cement plaster 1:4	100 Sq.M	8.51
	K) 6mm cement plaster 1:3 to ceiling	100 Sq.M	3.67
	L) 6mm cement plaster 1:4	100 Sq.M	2.74
	M) Neat cement punning	100 Sq.M	2.20
	N) 18mm cement plaster in two coats underlay 12mm cement plaster 1:5 finished with a top layer 6mm thick cement plaster 1:6	100 Sq.M	6.26
	O) 18mm cement plaster in two coats under layer 12mm cement plaster 1:5 finished with a top layer 6mm thick cement plaster 1:3	100 Sq.M	8.13

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	P) 12mm cement plaster 1:2 (1 cement 2 stone dust)	100 Sq.M	9.79
	Q) 18mm thick or artificial red stone plaster of 12mm thick under layer of cement plaster 1:4 with 6mm thick finishing coat of cement mortar 1:1:3 mixed with red oxide (1cement:1marble dust:3stone dust)	100 Sq.M	9.47
8.	POINTING A) Flush or ruled or cut or Weather pointing on brick work with cement mortar 1:3 B) Raised and cut pointed on brick work with cement mortar 1:3 C) Flush or ruled pointing on stone work with cement mortar 1:3 D) Raised and cut pointing on stone work with cement mortar 1:3	100 Sq.M 100 Sq.M 100 Sq.M 100 Sq.M	 1.53 2.04 1.17 2.35
9.	MORTAR A) Cement mortar 1:1 B) Cement mortar 1:2 C) Cement mortar 1:3 D) Cement mortar 1:4 E) Cement mortar 1:5 F) Cement mortar 1:6	Cu.M Cu.M. Cu.M. Cu.M. Cu.M Cu.M	10.20 6.80 5.10 3.80 3.10 2.50
10.	SANITARY INSTALLATIONS: A) Fixing long pan or Orissa Pattern, squatting or pedestal type W.C pan B) Fixing Flat back or wall corner type lipped front urinal basin	Each Each	0.025 0.01

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	C) Fixing sink or wash basin	Each	0.015
	D) Fixing Holder bat clamps for 100 / 75 / 50 mm dia sand cast iron pipes	Each	0.005
	E) Fixing sand cast iron trap	Each	0.025
	F) Providing and fixing G.I fittings and clamps including cutting and making good the walls etc. (Internal work)		
	Exposed Walls	100 RM	0.05
	15mm dia	100 RM	0.06
	20mm dia	100RM	0.07
	25mm dia	100 RM	0.075
	32mm dia	100 RM	0.08
	40mm dia	100 RM	0.08
	50mm dia		
	G) Concealed pipe including ceiling chases and making good the walls 15/20 mm normal bore	100 R.M	0.88
	H) 100 mm dia SWG pipes	100 RM	22.91
	I) 150mm dia SWG pipes	100 RM	26.01
	J) Fixing square mouth S.W Gully trap	Each	0.40
	K) Inspection chambers Inside size 0.75 x 0.75 x 1.00 m depth	Each	2.13
	L) Inspection chamber Inside size 1.20 x 0.90 x 1.00 m to 2.00 depth	Each	3.70
11.	MISCELLANEOUS		
	A) Lime concrete terracing average 10cm thick with 25mm brick ballast and 50% lime concrete 1:2 (1 Lime putty: 2 surkhi) rammed and finished with gur and belgri finished with gur and belgri treatment and covered with flat brick tiles grouted with cement mortar 1:3 over 12mm layer of cement mortar 1:3	100 Sq.M	6.63

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Sl.No.	Description	Units	Quantity of cement per unit / Quantity of work in quintal
	B) Providing and laying average, 10cm thick cement based water proofing treatment with brick bat coba as per manufactures specification	100 Sq.M	(*)
	C) Providing and filling with waterproof brickbat cement concrete	100 Sq.M	(*)
	D) Rough cast or pebble dash plaster in two layers under layer 12mm cement plaster 1:4 and top layer 10mm cement plaster 1:3	100 Sq.M	11.59
	E) Plinth protection 50mm thick in cement concrete 1:3:6 over 75mm bed of dry brick ballast	100 Sq.M	11.0
	F) Brick edging 10cm wide 10cm deep to plinth protection including grouting with cement mortar 1:4	100 Sq.M	1.14
	G) Fixing of precast cement concrete jalli 1:2:4 in cement mortar 1:3	100 Sq.M	1.64
	i) 50mm thick		
	ii) 40mm thick		
	iii) 25mm thick		
	H) CC blocks for hold fasts	100 Nos.	1.10
	i) CC blocks for hold fasts for windows	100 Sqm.	1.30

(*) As specified by the specialist firm at the time of tendering

NOTE: For any other item of work, Site Engineer shall refer to the CPWD specification and norms. In case no coefficient is available for a specific item, the decision of Chief Engineer, shall be final and binding on the contractor.

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TECHNICAL SPECIFICATION FOR ELECTRICAL WORKS
SPECIFICATION FOR ELECTRICAL INSTALLATION WORKS IN L.I.C.I. BLDGS.
SUBJECT TO THE GENERAL CONDITION OF CONTRACT IN FORCE

(A) GENERAL

1. The installations shall generally be carried out in conformity with the Code of Practice for electrical wiring and installation (system voltage not exceeding 650 V. viz I.S. 732. 1989 or the latest revision thereof.
2. **Definition:**
As given in I.S. Code of Practice shall apply.
3. **Pressure and frequency of supply** :
All current consuming devices shall be suitable for 230 /415 V, 50cycle A.C. supply.
4. **System of wiring:**
 - i) The wiring shall be carried out as per schedule. Power wiring must be in separate PVC conduit and shall be kept separate and distinct from lighting wiring. All wiring must be done on the distribution system with main and branch distribution board at convenient centers. All conductors shall run as far as possible along the walls and ceilings so as to be easily accessible and capable of being thoroughly inspected. The contractor shall arrange beforehand the balancing of circuits in consultation with Electrical Engineer of L.I.C.I.
 - ii) Within one month of taking over the installation, the contractor shall submit three sets of completion drawings of the Electrical Installation incorporating all modifications made from time to time including cable & conduit lay-outs to the satisfaction of the Electrical Engineer of L.I.C.I. & the wiring plans shall be deemed to be "Drawings" within the meaning of the term as used in the general conditions of contract.
5. **Conductor:**
The conductors shall be of copper or otherwise stated in tender schedule of quantities and shall be either PVC insulated or PVC insulated PVC sheathed. The minimum sections of conductors used for wiring of light and plug points shall be 1.5 sq mm. single core wires shall only be used.
6. **Cables:**
All cables including flexible cables used shall be of ISI mark and confirming the ISI specifications.

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- i) Twin flexible cable shall be of minimum section area of 14/0.0076 and PVC insulated.
- ii) Wires as per specification of materials.

7. **Fall of Potential:**

The cross sectional area of all conductors inside buildings shall be so proportioned to their lengths that the drop in pressure between the main circuit breaker and their furthest point shall not exceed two percent, with all the consuming devices in use.

8. **Rating of Lamps and Fans:**

In estimating the current to be carried by any conductors the rating of all lamps and fans are to be considered as per actual value as specified.

9. **Test:**

The installation with fittings complete shall before current is switched on satisfactorily pass the following tests:

The whole of the lamps and appliance having been connected to the conductors and all switches and fuses / C.B being 'on', a pressure not less than twice the intended working pressure subject to a limit of 500 volts shall be applied. The insulation resistance in Mega ohms of the whole or any part of the installation to earth must not be less than 25 divided by the number of points as defined above. With all lamps and appliance removed from the circuits a similar test between poles may be demanded, provided that during the rainy season half the above test value will be accepted. Where any appliance referred to is a motor larger than one-half B.H.P. the insulation resistance of that particular circuit must be greater than one Mega ohm.

10. **Joints and Looping Back:**

No joints shall be allowed in conductors. Neutral and earth shall be looped from point to point whereas the live wires shall be looped in the switch board only from switch to switch.

11. **Switches and Sockets:**

All switches and sockets shall be of Modular type.

12. **Control at point of entry of Supply:**

There shall be one circuit breaker on each pole of each main circuit (other than the neutral conductor of a 3-wire circuit) at the point of entry of the supply.

1. **Distribution Boards:**

- i) Branch distribution board shall be provided with one fuse/ MCB for each circuit and one common neutral bar. Maximum number of points to be wired on each circuit shall be 8.
- ii) In wiring a branch distribution board the total number of points shall be divided as far as possible evenly between the numbers of ways of the board. A spare circuit shall be left for future extensions.
- iii) MCB shall be of approved materials and each circuit shall be clearly numbered from left to right in conspicuous figures to correspond with the wiring plans.

14. Passing through the walls / masonry work

All the conduits used shall have ISI mark. Wherever wires/ cables are taken through masonry works, roads crossing etc. they shall be protected by running them through rigid PVC conduits / GI pipes. After installation, walls, floorings, etc. shall be restored to the original condition by proper plastering free of cost. The size of the conduit shall be selected based on the overall diameter of the Cables / Wires / Earthing conductors and after leaving a free area of 40% of the overall cross section of the conduit. The total number of conduits crossing a particular point in the roof shall be limited so that the strength of the roofing concrete and the structure is maintained. Rigid PVC or metal conduits of suitable sizes may be used for Electrical conduits as conforming to IS 2509, 1653 or 3837. The conduits and accessories should conform to the IS specifications as applicable.

15. Ceiling Rose and Wall Sockets – Three pins Ceiling roses, and wall sockets shall not contain fuse terminals. Wall sockets shall comply with the requirements of the Bureau of Indian Standards.

16. Fittings. Where conductors are required to be threaded through tubes or channels formed in the metal work of fittings, these must be free from sharp angles or projecting edges and of such a size as will enable them to be wired with the conductors used for the final sub-circuits without removing the braiding taping or outer covering. As far as possible all tubes or channels should be for sufficient size to permit of 'looking back'. Where with approval of the Electrical Engineer of L.I.C. 'Electrolytic copper' wire is used for wiring fittings. The sub-circuit leads must terminate in a ceiling rose or connector from which this wire will be carried into the fittings. Flexible wire must not be used for wiring fittings, except portable fittings.

17. Lamp holders-Lamp holders for use on brackets, etc. shall have not less than a half inch female nipple and all those for use with flexible pendants shall be provided with cord grips. All cases must be solid and substantial thin case export type not being admissible. Edison screw holders will not be accepted for lamps below 100 watts.

18. External and Road lamps ; External and Road Lamps shall have weather proof fittings of approved design as per IP 65 so as to effectually prevent the admission of moisture. Flexible cord conductors and cord grip lamp holders must not be used where exposed to the weather.

19. Fans and Regulators

- (I) (a) All ceiling fans shall be suspended from a hook or shackle and insulated from the same. All joints in the suspension rod shall be screwed and all joints or bolts in connection therewith shall be additionally secured by means of split pins.
- (b) The canopy and wood block at the top of the suspension rod shall effectually hide the suspension.
- (c) The leading in wire shall be not smaller than 3/22 S.W. G. and shall be protected from being cut.
- (d) All fans shall be free from sparking, noise oil throwing and excessive heating.
- (ii) (a) All fans shall be hung nine and half feet above the floor or as directed by the Engineer Incharge..
- (b) All fans shall be capable of running at full speed for one month without additional oiling and shall not overheat after eight hours continuous run at full speed.
- (c) Each fan shall have a speed regulator of Electronic type.

20. Attachment of Fittings and Accessories :

In other than conduit wiring all ceiling roses, wall sockets, switches, regulators, brackets, pendants and accessories attached to walls or ceiling shall be mounted on suitable PVC Base plate.

21. Statutory approvals

It shall be the responsibility of the contractor to ensure that complete installation supplied and/or erected by him fully meets with the relevant standards, Acts, Rules, Regulations, etc. applicable.

It is responsibility of the contractor to get Initial and Final Approvals / NOC from the concerned Govt. Departments and Statutory Authority like EB, State Electrical Inspectorate, Public Roads Authority, etc. before commencing the work at site. All relevant documents and drawings as required by the Authority shall be prepared and submitted Engineer Incharge. If any change suggested by the Engineer Incharge, it shall also be incorporated accordingly. The contractor shall also do all liaison

works with the departments for getting the approvals. All the incidental expenses in connection with the above shall be borne by the contractor with no extra cost to LICl.

Any modification/rectification required by the Electrical inspectorate or any other statutory authority resulting from the improper installation by the contractor or to make the same in full conformity with the relevant standards, Acts, Rules, regulations, etc. applicable for the installation, shall be carried out by the contractor without any extra cost to LICl.

All testing/calibration etc., are to be carried out as per the requirements of Electrical Inspectorate and Electricity Board/Licensee.

If the current rating of any of the switchgears including circuit breaking mentioned in the "Schedule of Items of Work" is not available or is not in conformation to the Inspectorate standards, then it shall be rated to the nearest higher rating available with the current/fuse rating as specified.

It is the responsibility of the contractor to liaison with Electricity Board/Licensee for obtaining power supply to the installation executed by them. Necessary drawings, test reports, equipment details shall be submitted wherever needed.

For all approvals / NOC, statutory fees shall be paid by the contractor initially, however, it shall be reimbursed on submission of documentary evidences.

B. CONDUIT SYSTEM

- 1) **Conduit to be continuous** – Conduit shall be of approved pattern and manufacture and in accordance with the specification of the Bureau of Indian Standards & relevant IE rules.
- 2) **Bunching of Wires** – The wires of a circuit may be bunched together in a conduit, and if the supply is alternating current, they must be bunched.
- 3) **Junction in Conduit** – The lengths of conduit shall be joined by means of push fit joints or other approved joints. The greatest care shall be taken in preparing the conduit that no sharp edges or burrs are left which could damage the Insulation. The Electrical Engineer with a view to ensuring that the above provision has been carried out, may require (if he should consider if necessary) that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

Fixing of Conduit – The conduits laid through brick walls should be installed inside and flush with the surface of the brickwork. The brick masonry work may be chased using electrical cutter only to enable concealed installation of the conduits. Thickness of the conduits through the wall should be always maintained to run vertically between mounting boxes and wiring points and horizontal laying shall be avoided as far as possible. Horizontal laying should be done over the ceiling prior to roof casting or through the floor prior to flooring. The horizontal conduits if unavoidable should run either at a clearance of 50mm from the ceiling or at a clearance of 600mm from the finished floor level so that inadvertent access to the

conduits and Electrical lines are minimized. In case, the conduits required to be fixed to the surface of walls the same shall be done by saddles and round-headed screws. Before concealing the conduits, the marking of the same shall be done and same shall be got approved by the Electrical Engineer of L.I.C.

- 4) **Bends of Conduit** – The conduits shall be brought round the angles of walls by means of bends or elbows as may be directed.
- 5) **Outlets-** All outlets for fittings, switches, etc. shall be equipped with an approved outlet box.
- 6) **Conductors** – All conductors used in conduit wiring shall be stranded.
- 7) **Erection and Earthing of conduit** – The whole system of conduit shall be erected and completed before the conductors are drawn in. In conduit system, the pipe must be continuous when passing through walls or floors, and no other form of insulating or protecting tube is required.

Specifications for the Concealed Conduits in slab /wall columns etc. for electrical main / sub main / point wiring will be as under :

- i. Rigid PVC conduit of Medium class ISI marked and corresponding PVC conduit accessories.
- ii. Special deep junction boxes – 75 mm deep to be laid in the slab / ceiling.
- iii. The rectangular junction boxes wherever provide shall be made out of 16 gauge M.S. Sheets and painted with two coats of ready mixed oil paint of approved shade over a coat of red oxide primer.
- iv. Make of conduits to be used should be of ISI marked and as per list of Electrical Materials.
- v. **The electrical installation work shall be carried out through a Licensed Electrical Contractor. The name of licensed electrical contractor shall be get approved from the competent authority well in advance before commencement of the work.**
- vi. **INSTALLATION OF CONDUIT:**

All conduits including bends, unions, junction boxes, etc. shall be cleaned before they are fixed in position. Conduits which are to be taken in the ceiling slab shall be laid on the prepared shuttering work of the ceiling slab before concrete is poured. The conduits shall be properly fixed into the sockets, bends, junction boxes, outlet boxes and shall be made watertight by using proper sealant recommended by the manufacturer. The conduits in ceiling slab shall be straight as far as possible, to facilitate easy drawing of wires through them. Before the conduits are laid in the ceiling, the positions of outlet points, point control junction boxes shall be set out clearly so as to minimize offsets and bends.

Conduits recessed in walls shall be secured rigidly by means of steel hooks/staples at not more than 0.6 meter intervals before conduit is concealed in the walls. All chases, grooves shall be neatly made to proper dimensions to accommodate the required number and size of conduits. The outlet boxes, point control boxes, inspection and draw boxes shall be fixed as and when conduit is being laid. The recessing of conduits in walls shall be so arranged as to allow at least 12 mm plaster to cover the same. All grooves, chases, etc. shall be refilled with cement mortar and finished up to the wall surface before plastering of walls is taken up by the Contractor. Where conduits pass through expansion joints in the buildings, adequate expansion fittings or other approved devices shall be used to take care of any relative movement. Wherever conduits terminate into points control boxes, distribution boards, etc, conduits shall be rigidly connected to boxes, boards, etc. Running joints in conduits wherever necessary shall be rigidly held in aligned position. After conduits, junction boxes outlet boxes, etc. are fixed in position their outlets shall be properly plugged with PVC.

Stoppers or with any other suitable materials so that water, mortar, vermin or any other foreign material do not enter into the conduits system.

Draw box junction box, point control boxes, etc, shall be provided with bushes of PVC or rubber, after the conduit ends are properly filed to remove the burrs and sharp edges. Concealed conduit laying above false ceiling shall be executed in a similar manner described above. Wherever called for, surface conduit system shall be adopted with PVC conduits being fixed on to the wall surfaces, ceilings, etc., with saddles, clamps and screws.

Conduit shall be run in square and symmetrical lines with proper drawing and ventilation. Before surface conduits are installed, the exact route shall be marked at site and the approval of the Employer's Engineer shall be obtained.

Conduit shall be concealed wherever specified in ceiling, walls, etc. as required. The conduits shall be laid in ceiling slab before pouring of Concrete. Care shall be taken to ensure that conduits are not displaced during the process of pouring and consolidating the Concrete.

The following precautions shall be observed while installing the conduits:-

- a. As far as possible bending shall be done at site in a proper manner.
- b. Where a number of conduits converge, a large M.S. box shall be used to avoid crossing of conduits. Where conduits are installed in straight runs, draw boxes will be provided at centers not greater than 15 meters on straight runs and at every change in direction. No boxes will be provided in voids where access cannot be readily obtained.

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The rate for rigid P.V.C. conduit sleeves shall include for recesses and holes, etc. in brick work for electrical conduits as shown on drawings and as directed on site and making good the same.

SECTION-I

Specifications for LT (1.1 KV Grade) Cables

1 Scope:

This specification covers supply, testing at works, supply at site, installation, termination, jointing, connection, testing at site, commissioning and handing over of 1.1 KV grade Cables.

2 System :

The 1.1 KV grade cables are to be used in under ground distribution system with normal system voltage of 415 V, 50 Hz, 3 phases, 4 wire systems.

3 Applicable standards:

Cables to be supplied under this specifications shall be with Copper or Aluminum conductor as specified, in drawings or Bill of Quantities, PVC insulated and PVC sheathed, armored and with an outer PVC protective sheath, heavy duty type and shall confirm to, IS 1554 (Part I) 1976: PVC insulated electric cables.

IS 1753: Aluminum conductors for insulated cables.

IS 3961: Recommended current ratings for cables.

4.0 General requirements:

4.1 All cables shall be new without any kinks or visible damage. The manufacturers name, insulating material, conductor size and voltage class shall be marked on surface of the cable at distance not exceeding 1 M.

4.2 Procurement of cables shall be on the basis of the actual site measurements and the quantities given shall be regarded as a guide. Before procurement of the cables, the contractor shall submit the detailed measurement sheet, based on site measurement showing the various cable lengths and after approval of the same place orders for the cables.

4.3 Cables shall be tested at factory as per IS requirement. The tests shall incorporate routine tests, type tests and acceptance test. The Contractor shall produce the certificate for type test.

4.4 The cables shall be of one of the makes mentioned in the list of approved materials and with ISI mark.

4.5 The cables shall be supplied and delivered at site in original cable drums with manufacturer's name, cable size, type and length all clearly indicated on each drum.

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- 4.6 The unit rate shall include loading, unloading, transport, storage, handling, unwinding the cable from cable drums and laying in the cable trench or erected on cable trays etc.
- 4.7 The cables shall be laid by skilled and experienced labour.
- 4.8 Where the cable route intersects roads, streets or pathways, RCC spun pipes shall be laid in the trenches to serve as cable ducts. The pipes shall be joined by RCC spun collars. The RCC pipes shall project at least 150 mm on either side of road crossing.
- 4.9 The cable loops shall be kept at both ends of the cable length. Minimum 3 meters long loop shall be provided.
- 4.10 The contractor shall take care to see that the cables received at site are apportioned to various locations to ensure maximum utilization and cable joints are avoided. This apportioning shall be got approved before the cables are cut to lengths. Straight joints are permitted only under exceptional circumstances.

5 Storage and loading, unloading of cables. :

- 5.1 Cable drums shall not be stored one above the other. Sufficient space between cable drums shall be left for air circulation and the drums shall stand on battens placed directly under the flanges.
- 5.2 Cable drums shall be stored preferably on a plain ground without having any hard stones or any other sharp materials projecting above the ground surface. The drums shall be stored preferably in the shed or otherwise they shall be covered by tarpaulin.
- 5.3 Drums shall be stored and kept in such a way that bottom cable end does not get damaged.
- 5.4 Drums shall be rotated only in the direction marked on the drum.
- 5.5 Loading and unloading shall be done with material handling equipments only.

Erection and laying of cables:

6.1 General:

- 6.1.1 All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service.
- 6.1.2 When cables pass through holes in metal work, precautions shall be taken to prevent abrasion of the cables on any sharp edge. Cables passing through walls, ceiling or floor shall run through sleeves of Hume pipes of adequate dia. & after pulling of the cables both ends of the sleeve shall be sealed with fire resistance material to prevent spread of fire.
- 6.1.3 In every vertical channel, duct, trucking or cable trench, containing cables and exceeding three meters in length, internal barriers shall be provided so as to avoid heating of the air at the top of the unit.

6.1.4 In every vertical cable shaft, cable trench or any passage of cable through wall, ceiling, floor etc. Barriers against spread of fire and smoke shall be provided.

6.1.5 In fire hazard areas extra care shall be taken to prevent spreading of fire in case of cable failure. Cables in these areas shall be covered by glass wool or embedded in sand in appropriate trenches. The cabling in such areas shall be done as per FIA approval and IEE regulations.

6.1.6 Communication cables should be laid away from the power cables to avoid electromagnetic interference. Minimum clearance of 300 mm shall be maintained.

6.1.7 Control and power cables shall be laid on separate trays.

6.1.8 The maximum number of power cables on a tray should be limited to six.

6.1.9 Every cable shall be installed where it will not be exposed to direct sunlight, rain, dripping water, oil or any corrosive substance.

6.1.10 The cables shall be erected and laid by either of the following methods and as specified in Bill of Quantities or specifications or drawings.

6.2 Cables laid in excavated trenches:

6.2.1 The cables for external electrification work shall be laid in specially prepared cable trenches as specified under the section for cable trenches.

6.2.2 While laying cable in the trench the cable end shall be pulled with pulling eye only after mounting the drum on the jacks.

6.2.3 Care shall be taken in laying cables to avoid forming kinks. The drums shall be unrolled and cables run over wooden rollers, placed at intervals not exceeding 2 Mts.

6.2.4 High voltage cables are to be laid separately from other cables. HV, MV cables shall not be laid in the same trench and /or alongside of water main.

6.2.5 The cables shall not be laid directly in such soil, which is corrosive, and having components, which react with the insulating layer or armour of the cable. In such case it should be laid in pipes or concrete trenches.

6.3 Cables laid in built-up trenches:

6.3.1 For the cable route passing through the area which is proposed to be covered with concrete/tiles etc. the cables shall be laid in the R.C.C./brick masonry cable trenches as specified in the items. This arrangement shall be generally inside the building.

6.3.2 For the area outside the building but covered with concrete /tiles etc. the cables shall be laid through R.C.C. pipes laid in ground with brick chambers at both ends. The chambers shall be covered with C.I. heavy-duty covers if the area is prone for vehicular traffic otherwise medium duty C.I. covers should be provided.

6.3.3 Cables laid in the built-up cable trenches within the building shall be raised so as not to lay at the trench bottom. Cables shall be either secured to the wall by saddles or laid on hot dip galvanized angle iron brackets or cable trays, ladder, rack, trough etc.

6.3.4 Where cables are clamped to the wall a minimum clearance of 100 mm shall be maintained between wall and cable and minimum 150 mm vertical clearance shall be maintained between two cables. Where cables are laid on cable brackets, the brackets shall not be fixed more than 500 mm apart to avoid sag in the cables. Where cables are laid on cable tray /ladder /troughs /racks, minimum 300 mm distance shall be observed

between adjacent tier of tray/ladder /troughs /racks, and cable shall be fixed minimum 25 mm away from wall and minimum 150 mm distance shall be observed between two adjacent cables. Cable shall be properly fixed with the tray /ladder /troughs /racks with cable tie or saddles.

6.3.5 The dimensions of the trenches shall be determined depending upon the maximum number of cables that is expected to be accommodated. Wherever specified, trenches shall be filled with fine sand and covered with RCC or steel chequered trench covers.

6.3.6 Where cables are to be installed under floors or above suspended ceilings or below ceiling, they shall be laid on a cable tray and shall be run in such positions that they are not liable to be damaged by contact with the floor or the ceiling or their fixture. The cable tray shall be properly fixed with tie rod to the ceiling. The concrete inserts for fixing the tie rod shall be put in place while casting the slab. The cable tray route shall be co-coordinated with other services. While laying the cables on the tray minimum 150 mm distance shall be observed between two adjacent cables. At least 25 % space shall be kept spare for any future installation.

6.3.7 The cable reaching for the motors in the mechanical room or plant room or machine room or service area shall be laid on cable tray. The cable reaching to motors shall be protected by rigid galvanized conduits up to a height of 300 mm above the floor. Above that height, the cable shall be protected by means of oil tight flexible metallic conduits fixed to the terminal box of the motor. The connection between the rigid conduit and the flexible conduit shall be done by a screwed coupling of an approved type. The flexible conduit shall be properly fixed with the terminal box of the motor by means of double hexagonal check nut.

6.4 Duct System:

Wherever specified cables shall be laid in underground ducts. The duct system shall consist of a required number of reinforced Hume pipes with simplex joints. Wherever asbestos cement pipes are used, the pipes shall be encased in concrete of 75 mm thick. The ducts shall be properly anchored to prevent any movement. The top surface of the cable ducts shall not be less than 60 cm below the ground level. The duct shall be at a gradient of at least 1:300.

The ducts shall be provided with inspection manholes at all direction changes and at required regular intervals for drawing the cables. The manholes shall be of reinforced concrete either cast-in-situ or precast. The manhole covers shall be cast iron and machine finished to ensure a perfect joint. The manhole covers shall be installed flush with the ground or paved surface. The ducts shall be properly plugged at the ends to prevent entry of water, rodents etc. Suitable duct markers shall be placed along the run of the cable

ducts. The duct markers shall at least be 15 cm square embedded in concrete, indicating the voltage, number of ducts and the direction of run of the cable duct. Suitable cable supports made of angle iron shall be provided in the manholes for supporting the cables. Proper identification tags shall be provided for each cable in the manholes.

6.5 Cables on Trays / Racks:

6.5.1 Cable shall be laid on cable trays/racks wherever specified. Cable racks/trays shall be of ladder, trough or channel design suitable for the purpose. The nominal depth of the trays/racks shall be 150 mm. The width of the trays shall be as per the design shown on drawing.

The cable trays shall be made of steel or Aluminum as specified. The trays/racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware. Steel trays shall be hot dip galvanized. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of Aluminum strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with the following requirements.

- a. The tray shall have suitable strength and rigidity to provide adequate support for all contained cables.
- b. It shall not present sharp edges, burrs or projections injurious to the insulation of the wiring/cables.
- c. If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion resistant material.
- d. It shall have side rails or equivalent structural members.
- e. It shall include fittings or other suitable means for changes in direction and elevation of runs.

6.5.2 Installation of cable trays/racks:

- a. Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.
- b. Each run of the cable tray shall be completed before the installation of cables.
- c. In portions where additional protection is required, non-combustible enclosures to be used.
- d. Cable trays shall be exposed and accessible.
- e. Where cables of different system are installed on the same cable tray, non-combustible, solid barriers shall be used for segregating the cables.

- f. Cable trays shall be grounded by two nos. earth continuity wires. Cable trays shall not be used as equipment grounding conductors.

7 Cable trenches (excavated):

- 7.1 The cable trenches shall be excavated 60 cms below the finished ground level and shall have a minimum width of 300 mm for laying of single cable. When more than one cable are laid in the same trench, the width of the trench shall be increased such that the spacing between the cables is 200 mm and the end cables are at minimum 100 mm from the side of the trench. At the turning of the cable route the trench shall be dug with radius equal to 15 times the cable diameter.
- 7.2 The trenches shall be cut square with vertical sidewalls and with uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed and leveled. The bottom of the cable trench shall be prepared with 100 mm sand bed for laying the cables.
- 7.3 The cables shall be laid in trenches over the rollers. After the cable is laid and straightened it shall be covered with sand, and bricks shall be placed on top and at the side of the cable.
- 7.4 Wherever specified, half round RCC pipes shall be placed above the cables.
- 7.5 The cable trench then shall be refilled with excavated materials after removing the stones and other sharp materials and the refilled materials shall be compacted with light ramming.
- 7.6 Approved Cable markers made of Aluminum or CI with 15 cms crown shall be provided along the route of cables at a spacing of 25 - 30 meters and also at both ends of crossings or at the cable turning point. The class, type, No. of cables shall be indicated on markers.
- 7.7 Cable shall be laid in Hume pipes at all road crossings and in GI pipes at the wall entries or at the crossing of the drains/gutters.

8. Cable jointing:

- 8.1 The straight joint in cable shall be avoided as far as possible by correctly apportioning the cable lengths. If unavoidable following precautions shall be taken while jointing.
- 8.2 Cable jointing shall be done as per the recommendations of the cable manufacturer. Jointing shall be done by qualified cable jointer. The location of the cable joint shall not be where the cable takes a bend also where the soil is loose and shows signs of subsidence.
- 8.3 Cable jointing boxes shall be of appropriate size suitable for PVC insulated cables of particular voltage ratings and shall be of approved make.

8.4 Jointing of cables in the joint boxes and the filling of the compound shall be done in accordance with the manufacturer instructions and in an approved manner. All straight or T joints shall be done in epoxy mould boxes. All terminal leads of conductors shall be heavily soldered up to at least 50 mm length.

8.5 All cables shall be joined colour-to-colour and tested for insulation resistance and continuity before commencing the jointing. The seals of cables shall not be removed until preparations for jointing are completed. Joints shall be finished on the same day, as commenced and sufficient protection from the weather shall be arranged.

8.6 Joints shall be made by means of suitable solder for conductor, the conductors being firmly bolted into the connections or ferrule and the whole end soldered with proper solder and flux or resin. Conductors shall be properly insulated with high voltage insulating tape and by using separators of approved size and pattern. The joints shall be completely filled with epoxy compound (with necessary tapping) to ensure proper filling of the box.

8.7 Epoxy compound shall be prepared as per manufacturer instructions. Oil, water or any other liquid shall not be added to the mixture and which shall be used within 30 minutes of mixing. The surface on which epoxy is to be used shall be free from dust, rust, oil, grease and shall be dry. Joint shall not be moved or disturbed until the epoxy has completely hardened.

9 Cable Termination:

9.1 All cable terminations for conductors' upto 4 sq.mm may be insertion type and all higher sizes shall have tinned copper compression lugs.

9.2 Cable termination shall be done in cable end box or in terminal box or in pillars etc. The end terminations shall be insulated with a minimum of six half lapped layers of PVC tape.

9.3 Cable terminations are to be made with flange type brass cable glands so as to grip inner and outer PVC sheaths and also the cable armour. Cable gland shall be bonded to earth.

9.4 The cable conductor ends are to be connected by crimping tinned heavy-duty copper lugs. Hydraulic crimping tool shall be used.

9.5 Every connection at a cable termination shall be mechanically and electrically sound and protected against mechanical damage and any vibration liable to occur shall not impose any harmful mechanical damage to the cable conductor.

10 Testing of cable before laying and commissioning:

All tests shall be carried out in accordance with relevant IS codes of practice, IE rules and specifications.

10.1 100% cable drums shall be checked for continuity and cross continuity tests to ensure that there is no internal damage to the cable during transportation.

10.2 Prior to burying of cables, insulation resistance shall be measured with 500 V megger between the cores and all the cores to earth (armour) and results shall be recorded.

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10.3 On completion of cable laying work, all the tests such as insulation resistance test, continuity test, sheathing continuity test, earth test etc. shall be conducted in the presence of the Architects.

10.4 After the cables are installed, before commissioning it shall be tested for high DC voltage test. The recommended volts and duration of the test between each core and metallic armour (earth) at 3 KV DC is for 5 minutes. During high voltage test all electrical equipments related to the cable installation must be earthed and adequate clearance shall be maintained from the other equipments and from work to prevent flash over.

SECTION – II

Specifications for Earthing and Lightning Protection

1 Scope:

This specification covers supply of necessary materials, and erection at site, of complete earthing system including earth pits at the locations indicated, earth conductors from earth pit to the respective equipments, switchgears, pillars etc. and making connections, testing at site, commissioning and handing over.

2 Applicable standards:

The entire work of earthing system, shall conform to IS 3043, Indian Electricity Act and Rules and relevant regulations. The work of Lightning protection shall conform to IS 2309.

3 General requirements:

- 3.1 The earthing shall generally be carried out in accordance with the requirements of Indian Electricity Rules 1956 as amended from time to time and relevant regulations. Following IE rules are particularly applicable. IE Rule Nos. 32, 51, 61, 62, 67, 69, 88(2) & 90.
- 3.2 All earth connections shall be carefully made, visible for inspection, and the testing of individual earth electrode shall be possible.
- 3.3 All materials, fittings etc. used in earthing shall conform to IS specifications and in the absence of which the approval of competent authority shall be obtained.
- 3.4 The earthing electrode shall be at a minimum distance of 2 metres away from the outer face of the building wall. A minimum clearance of twice the depth of the electrode shall be maintained between two earthing stations.

- 3.5 A brick masonry chamber to facilitate easy identification and for carrying out periodical tests and inspection shall be constructed on top of the earth pit.
- 3.6 All metal conduits, trunkings, cable sheaths, HT and MV switchgears, Transformers, distribution boards, meters, light fixtures, fans, and all other metal parts forming part of the work shall be bonded together and connected to earthing network as specified.
- 3.7 Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after passage of fault currents.
- 3.8 Joints shall be soldered, tinned and double riveted. All the joints shall be mechanically, electrically continuous and effective. Joints shall be provided against corrosion.

4 Earth Electrodes:

- 4.1 The materials of earth electrode and earth conductors shall be galvanised iron unless specified otherwise in Bill of Quantities, specifications or drawings.
- 4.2 The earth electrodes shall be free from paint, enamel, grease etc.
- 4.3 The earth electrode shall be embedded as far as practicable in a moist soil and below permanent moist level.
- 4.4 The earth electrode shall not be installed in the proximity of a metal fence.

5 Types of earth electrodes:

The earth electrodes shall be either a pipe electrode or plate electrode, the details of which are as given in the following sections of specifications, drawings and BOQ.

6 Pipe electrode:

- 6.1 Pipe electrode shall consist of 2.5 meter long single piece G.I. pipe of min. 40 mm dia. as specified and shall be cut tapered at the bottom. 12 mm dia. holes shall be drilled with 75 mm spacing between the holes and in a staggered manner as indicated in IS 3043.
- 6.2 The electrode shall be buried vertically in a specially prepared earth pit of size 35 cm x 35 cm and the earth pit shall be filled with alternate layers of charcoal, salt and fine washed sand for a minimum thickness of 150 mm. A funnel with wire mesh inside shall be fixed to the top of the GI pipe for watering purpose.

- 6.3 The earth conductor of 25 x 3 mm GI strip shall be connected to the electrode just below the funnel with proper terminal lugs and check nuts and the other end of earth conductor shall be connected to the equipotential bus of the equipments.
- 6.4 A masonry chamber with a cast iron cover hinged to the cast iron frame embedded in the top portion of the masonry shall be constructed on top of the GI pipe to house the funnel and the earth connection. The approximate size of the chamber shall be 300 mm x 300 mm and 300 mm deep.
- 6.5 The earth conductor from electrode shall be taken out of the masonry chamber through a protecting pipe embedded in the masonry.
- 6.6 The top of the masonry chamber shall be 50 mm above the finished ground level.

7 Plate Electrode:

- 7.1 The plate electrode shall consist of either copper plate of size 60cm x 60 cm x 3.15 mm or GI plate of size 60 cm x 60 cm x 6.3 mm, and as specified in the BOQ or drawings.
- 7.2 The electrode shall be buried vertically in a specially prepared earth pit, which shall be dug up to required depth, from the ground level. The earth plate shall be placed in the earth pit with its face vertical and embedded in the alternate layers of coal and salt for a minimum thickness of 15 cms.
- 7.3 The earth conductor shall of same material as of the earth electrode. For copper earth electrode copper strips shall be provided as conductor and for GI earth electrode GI strips shall be used as earth conductor. The size and material of the earth conductor shall be as specified separately in the Bill of Quantities or drawings. The earth conductors shall be connected to the earth electrode (plate) with G.I. nut bolts, check nuts and washers and welded at the edges and shall be brought up in the masonry chamber at the ground level.
- 7.4 The earth conductor shall be extended via the earth link provided in the masonry chamber. This link shall be connected to earth conductors from the earth plate and earth conductor going to equipments with two Nos. of nut bolts, check nuts and washers (all of GI) to make secured connections. This link can be removed for testing the earthing.
- 7.5 A 20 mm dia. G.I. pipe shall be provided from the masonry chamber to the top of the earth plate for watering purpose. The G.I. pipe shall be provided with a funnel at the top with wire mesh inside.
- 7.6 A masonry chamber with a cast iron cover hinged to the cast iron frame embedded in the top portion of masonry shall be constructed on top of GI pipe to house the funnel

& the earth connection. The approx. size of the chamber shall be 300mmx300mmx300mm deep.

7.7 The earth conductor from electrode shall be taken out of the masonry chamber through a protecting pipe embedded in the masonry.

7.8 The top of the masonry chamber shall be 50 mm above the finished ground level.

8 Earth conductor:

All earthing conductors shall be of high conductivity copper and or GI as specified and shall be protected against mechanical injury or corrosion. The connection of earth continuity conductors of earth bus and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cables by using suitable clamps made of non ferrous metals.

8.1 The cross-sectional area of earthing conductor shall not be smaller than half that of the largest current carrying conductor, subject to the minimum size being not less than 1.5 sq.mm for copper and 2.5 sq.mm for Aluminium conductors and the upper limit being 70 sq.mm for copper and 120 sq.mm for Aluminium. The size of the galvanised iron earth continuity conductors may be equal to the size of the current carrying conductors with which they are to be used.

8.2 As a guideline the following sizes of earth continuity conductors shall be used for earthing installation

8.2.1 Size of earth conductors for lighting and power circuits.

Cross sectional area of current carrying Cu conductor	cross sectional area of earth continuity Cu conductor

Size in sq.mm	Size in Sq.mm

1.5	1.5
2.5	1.5
4.0	2.5
6.0	2.5

8.2.2 Size of earth conductors from main switchboard to sub main switches or distribution boards.

Cross sectional area of current carrying conductor Copper/Alum.	Cross sectional area of earth continuity conductor Copper/Alum.
Size in sq.mm	Size in sq.mm
4	2.5
6	2.5
10	4.0
16	10
25	16
35	16
50	25
70	35
95	50
120	70

8.2.2 The size of an earth continuity conductor contained in a flexible cable or flexible cord shall be equal to that of the current carrying conductor.

9 Earth connection:

- 9.1 All metal clad switches and other equipment carrying single-phase current shall be connected to earth by a single connection. All metal clad switches carrying three-phase medium voltage and high voltage shall be connected with earth by two separate and distinct connections.
- 9.2 The earthing conductors inside the building, wherever exposed shall be properly protected from mechanical injury by running the same in G.I. pipe of adequate size. Earthing conductors outside the building shall be laid 600 mm below the finished ground level.
- 9.3 The over lapping of strips at joints where required shall be minimum 75 mm. The joints shall be riveted in an approved manner. Lugs of adequate capacity and size shall be used for all termination of wires above 6 sq.mm size and bare copper wire above 2.5 mm dia.

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Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance and properly tinned.

10 Connection of earthing conductor:

The earthing conductors are broadly divided in the following categories:

- 10.1 Main earthing conductor shall be taken from the earth electrode to the earth bus/connection at the main switchboard.
- 10.2 Sub-main earthing conductor shall run from the main switchboard to the sub-distribution boards.
- 10.3 Final earthing conductor shall run from the sub distribution boards to the final distribution boards.
- 10.4 Circuit earthing conductor shall run from the final distribution board to the exposed metal of the equipment to be earthed. This may run directly from final distribution boards or through earth leakage circuit breaker.
- 10.5 Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate or at the commencement of the run by an earthing conductor.
- 10.6 Earthing conductor enclosed with the current carrying conductors within the flexible cord shall be used only in case of equipments connected by flexible cord.
- 10.7 Lighting fittings, switches and accessories shall also be provided with an earthing conductor even though they may be rigidly secured / fixed with metallic conduit.
- 10.8 The electrical resistance of earthing conductors shall be low enough to permit passage of fault current necessary to operate a fuse, protective device or a circuit breaker.

11 Prohibited Connection:

Use of following as earth conductor is not recommended, and strictly prohibited for earthing an installation or even as a link in an earthing system. Neutral conductor, sprinkler pipes or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures or armour of cables and conductors, metallic conduits and lightning protection system conductors are all prohibited to be used as earth conductor.

12 Earth Resistance:

The earth resistivity of the soil where the earthing stations to be located shall be submitted to the Engineer Incharge before the earthing work starts and the approval shall be taken.

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If the earth resistance is too high and multiple electrode earthing does not give adequate low resistance to earth, then the soil resistivity immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, calcium chloride, sodium carbonate, copper sulphate, salt and soft coke or charcoal in suitable proportions.

13 Testing:

On completion of the entire installation, the earthing network shall be tested for their resistance to earth in accordance with IS 3043. The contractor shall provide all meters, instruments & labour required for the test. The test results shall be submitted in triplicate to the Engineer Incharge for approval. The following tests shall be conducted.

- a. Earth resistance of electrodes
- b. Impedance of earth continuity conductors.
- c. Effectiveness of earthing.

14 Lightning Protection:

Lightning protection network shall be provided for the specified buildings and locations for protection against lightning strikes. The network shall essentially consist of Air-termination units, down conductors, roof conductors, test terminals and earth electrodes etc. The entire system shall conform to IS requirements.

14.1 Air-terminations:

- a) An air-termination shall consist of a 1200 mm long, 25 mm dia 14 SWG Cu tube with 100 mm dia Cu sphere fixed at the top of the tube. The Cu sphere shall be fixed with 5 nos. 125 mm long and 12.5 mm dia threaded Cu spikes.
- b) The complete assembly shall be fixed at a highest possible location and shall project at least 1500 mm above the network on which it is fixed.
- c) All air termination shall be effectively secured against overturning by means of rod brackets and additional supports as required, which shall be permanently and rightly attached to the building. The method and nature of fixing should be simple, solid and permanent.

14.2 Down Conductors and Roof Conductors:

- a) GI strip of specified size shall be used as down / roof conductors and the conductors shall be without sharp bends, upturns and kinks.

- b) As far as possible, the joints shall be avoided in down/roof conductors. In down conductor below ground level there shall be no joint. However in a total system where joints are unavoidable, the jointing shall be with approved method only. The joints shall be mechanically and electrically effective. The joints may be clamped, screwed, bolted, but preferably welded. The length of overlap at the joints shall not be less than 200 mm. Contact surface at joint shall be cleaned and then inhibited from oxidation with suitable non corrosive compound.
- c) The conductors shall be adequately protected against mechanical damage but for which metal pipes shall not be used.

14.3 Test Links and Testing:

Each down conductor will be provided with a 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. Testing points shall be with Copper. The ohmic resistance of the lightning protective system with air termination but without earth connection shall be measured and should be a fraction of an ohm. Earth resistance shall be measured in accordance with IS: 3043.

14.4 Earth Terminations and Electrodes:

Each down conductor shall have an independent earth termination. It should be capable of isolation for testing purposes. Earth electrodes shall be constructed and installed in accordance with IS: 3043.

SECTION – III

Specifications for MCB DB, MCB and RCCB

1 Miniature Circuit Breaker Distribution boards:

- 1.1 Miniature circuit breaker distribution boards shall conform to IS 2675, IS 8623 and shall be suitable for operation on three phase, 4 wire, 415 V, 50 Hz, AC supply or single phase, 2 wire, 230 V, 50 Hz, AC supply.
- 1.2 The MCB distribution board shall be in sheet steel enclosures with removable type cover with additional door for protecting accidental operation.
- 1.3 Enclosure and door shall be made out of 16 SWG CRCA sheet steel and powder coated and of approved shade. The interior shall be off white finish. The DB shall be totally

enclosed with dust and vermin proof construction and shall be of double door type. The DB boxes shall be as supplied by the original manufacturer.

- 1.4 Where distribution boards are specified to be complete with an isolator as incomer, the isolator shall be double pole for SP and N distribution boards and 4 pole for TP and N distribution boards.
- 1.5 Where distribution boards are specified to be complete with MCB + ELCB as incomer, the MCB + ELCB shall be double pole for SP and N distribution boards and 4 pole for TP and N distribution boards.
- 1.6 Bus bars shall be tinned copper. The internal connections in the DB shall be by using stranded copper conductor, PVC insulated wire with copper lugs crimped at both ends. Neutral busbar and earth busbars shall also be provided in the enclosure. Neutral busbar shall have equal rating of phase busbars.
- 1.7 Distribution boards shall be provided with circuit identification by means of directory on the front cover. Upon completion of the works, the contractor shall provide and fix accurate framed circuit lists for all distribution boards. These shall consist of Perspex envelopes, fixed securely by an approved method on the inside face of each distribution board front cover into which shall be inserted a neatly typed list of circuits, indicating the number of circuits, phase, cable, size, number of points connected, circuit rating and the loading. The contractor, shall also provide and fix by means of brass screws tapped into the D.B. cover, labels, with black letter on a white background for all distribution boards, MCB + ELCB, Isolators etc. The engraving on the labels and the inscription on the circuit lists shall be approved by the Engineer Incharge before the work is carried out.
- 1.8 All incoming terminals shall be fully shrouded.
- 1.9 The conduit entry plates shall be removable type and shall be provided at top and bottom. All the conduits shall be properly terminated using glands, grips, checknuts, female adapters with bush etc.
- 1.10 Wiring shall be terminated properly using crimping type copper lugs/sockets. Identification ferrules shall be provided on all wires. Each circuit shall have an independent neutral.
- 1.11 Two No. Earth terminals shall be provided on each Distribution Board.
- 1.12 Distribution boards shall be installed surface mounted or recessed mounted as specified and erected at the locations shown.

Surface mounted DB shall be mounted on a suitable size frame made out of GI ZED section. The hole fasts of the frame shall be grouted in the wall with cement mortar and the frame shall be painted with two coats of red oxide and two coats of enamel paint of approved shade. The DB shall be mounted on this frame with proper size nut bolts.

Recessed mounted DB shall be erected in the chase/cut portion of the wall. The cutting of the walls shall be done while constructing the wall and shall be of adequate size to comfortably accommodate the DB. The cut portion shall be smoothened and made plain and shall be fine finished. The DB shall be fixed in this chased portion with suitable clamps and bolts. The top cover of the DB cabinet shall be projecting out of the wall surface and free from any obstruction so as to open the same smoothly.

2 Miniature Circuit Breakers:

- 2.1 MCB's shall be manufactured in accordance with IS 8828 having a short circuit breaking capacity category 10 kA at both 240 volts 50 Hz. and 415 V, 50 Hz and complying with the test requirements for both reference calibration temperatures of 20 degree C and 40 degree C.
- 2.2 All miniature circuit breakers shall be rated to withstand the fault currents of the circuits they protect without causing any interference in any other protective device associated with the distribution system. At the same time the design of the circuit breakers shall be such that, it will protect the circuit for which it is intended and not cause or allow other protective devices to operate when fault conditions apply.
- 2.3 Miniature circuit breakers shall be capable of carrying its full rated current continuously without tripping out.
- 2.4 All the miniature circuit breakers shall be fitted with a magnetic undelayed tripping mechanism. These shall have overload and short circuit elements.
- 2.5 Time current characteristic of the MCB shall match with that of HRC fuses..

3 Residual current operated circuit breakers (RCCB)

- 3.1 RCCB's shall be manufactured in accordance with IS 12640 and IS 8828 having a short circuit breaking and earth fault protection up to 9 KA at both 240 Volts 50 Hz and 415 V, 50 Hz and complying with the test requirements as per IS 2640.
- 3.2 RCCB shall be designed to interrupt the circuit during an earth fault, overload or short circuit. All RCCB shall be high sensitive and calibrated to trip the power supply when the residual current is more than 50 % of its calibrated rating. This means that a 30 mA

sensitivity RCCB should trip when the residual current is in the range of 15 to 30 mA and a 300 mA RCCB should trip when the residual current is in the range of 150 to 300 mA.

- 3.3 The RCCB's shall be truly current operated, which means that it shall be totally independent of the main voltage for tripping. RCCB must operate for nominal voltage well below the maximum safe value of 10 volts. RCCB shall interrupt the circuit within 30 millisecond at a leakage current of 30 mA.
- 3.4 RCCB shall be provided with a neutral advance mechanism. RCCB shall be functioning even in the event of failure of neutral and/or any one or two of phase supply conductor. RCCB shall be provided with trip free mechanism ensuring that the device cannot be reclosed / reset if the fault persists. RCCB shall be functioning even in the case of interchange of load and supply side connections.
- 3.5 Test button shall be provided to check the correct operation of the unit.
- 3.6 RCCB shall be designed for a very long life of a minimum of 20,000 operations and shall be capable of withstanding inrush current of 4 to 8 times the rated current. For the proper functioning the RCCB should not require any connection of earthing on the device.
- 3.7 The device should have high tripping accuracy of less than 5% of rated tripping current. The RCCB shall be provided with clear indication to show whether the tripping is due to current leakage or overload/short circuit.
- 3.8 The MCB section of RCCB shall be provided with arc chambers and vents are also to be provided to release the arcing products in the atmosphere, so as to increase contact lift and to prevent damage to the insulation. The self-extinguishing thermoset plastic material shall be used for body and shall have a modular construction. The device should be vibration proof.

4 Moulded Case Circuit Breakers (MCCB)

MCCB's used shall be suitable for 415 V, AC, 50 Hz supply and shall be capable of withstanding electrical and mechanical stress due to short circuit capacity as specified for individual requirement. The MCCB shall be compact in size, dust and vermin proof with quick make and break operating mechanism. The construction shall be such as to ensure maintenance and current setting adjustment without removing the MCCB from the panel. The MCCB shall be suitable for interlock with panel door on which it is mounted.

SECTION - IV**Specifications for Medium Voltage Distribution Panel Boards****1 Scope:**

This section shall cover supply, assembly, installation, connection, testing and commissioning of medium voltage distribution panel boards as described in this specifications, drawings and schedule of quantities.

2 System:

All the medium voltage distribution panel boards shall be suitable for operation on three phase, 4 wire or single phase, 2 wire with normal system voltage of 415/240 volts, 50 Hz, A.C. supply with solidly grounded neutral system.

3 Weather condition at site:

The panel boards shall be suitable for continuous operation and designed to withstand heaviest conditions at site.

- a) Temperature range: 40 to 45 ° C
- b) Relative humidity: 50 to 80 %
- c) Weather: Dusty

4 Applicable IS Standards:

The panel boards to be supplied under this specification shall confirm to latest editions of relevant Indian Standards and Indian Electricity rules and regulations. The following Indian Standards shall be complied with.

IS 4237: General requirements for switch gear and control gear for voltage not exceeding 1000 V.

IS 2208: HRC cartridge fuse links upto 610 V.

IS 2705: Current transformers

IS 1248: Electrical Indicating Instruments.

IS 375: Switch gear bus-bars, main connection and auxiliary wiring, marking and arrangement for.

IS 2147: Degree of protection provided by enclosures for low voltage switchgear and control gear.

IS 2675: Enclosed distribution fuse boards and cutouts.

IS 2557: Danger notice plates.

IS 1567/4047: Specifications for switch fuse units.

IS 3072 (I): Installation and maintenance of switchgears.

5 General:**5.1 Shop drawing:**

Prior to fabrication of the panel boards, the contractor shall submit for the approval of the Engineer Incharge, the shop / vendor drawing and design calculations indicating type, size, short circuit rating of all the electrical components used, busbar size, internal wiring

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size, panel board dimension, colour, mounting detail etc. The contractor shall submit manufacturer's catalogues of the electrical components installed in the panel boards.

5.2 Inspection:

At all reasonable times during production and prior to transport of the panel boards to site, the contractor shall arrange and provide all the facilities at manufacturer's plant for inspection and testing and any stage inspection agreed upon.

5.3 Test certificates:

Testing of panel boards shall be carried out at factory or at site as specified in Indian Standards in the presence of Engineer Incharge. The test results shall be recorded on prescribed forms. The test certificates for the test carried out at factory or at site shall be submitted in duplicate to the Engineer Incharge for approval.

6 Cubical type Panel boards:

6.1 Construction:

6.1.1 Structure

The panel board shall be metal enclosed sheet cubical, compartmentalized suitable for indoor or outdoor installation having dead front, floor mounting type. All M.S. sheets used in the construction of panel boards shall be 16 SWG (1.6 mm) thick unless specified otherwise in the item and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam welded, all welding slag ground off and welding pits wiped smooth with plumber metal.

The panel boards shall be totally enclosed, completely dust and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be lockable and fully gasketed with foam rubber or neoprene rubber strips.

All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with bolt and nuts. Self-threading screws shall not be used in the construction of panel boards. Suitable base channels (min size 75 mm x 75 mm x 5 mm thick) shall be provided at the bottom. A Clearance of 300 mm between the floor of the panel board and the bottom of the lower most units shall be provision Panel boards, if necessary shall be preferably arranged in multitier formation. The panel boards shall be of adequate size with a provision of spare space (as jointly decided with the Engineer Incharge) to accommodate possible future additional switchgear. The size of the panel boards shall be designed in such a way that the internal space is sufficient for hot air

movement, and the electrical component does not attain temperature more than 40 degree Celsius. Opening for natural ventilation shall be provided and shall have screens or grills made of brass or stainless steel wire mesh.

The panel boards shall be provided with removable sheet steel plates at top and bottom with knockout holes of appropriate size and number in conformity with the number, and size of incoming and outgoing conduits /cables.

The panel boards shall be designed to ensure maximum safety during operation, inspection, connection of cables, maintenance and repairs etc. with bus bar system energized. Means shall be provided to prevent shorting of power and /or control terminals due to accidental drop of maintenance tools etc. inside the panel board. Partitions between feeder compartments, bus bar chamber, cable alleys, vertical panels etc. shall be provided to take care of this aspect. The panel boards shall be sufficiently rigid to support the equipment without distortion under normal and short circuit condition; they shall be suitably braced for short circuit duty.

For buses and cables, access shall be limited from front and top only. All other equipment shall be mounted on the front side, (unless specified otherwise for any specific panel) and shall be accessible from the front. All joints and connections shall be made by cadmium plated high tensile steel bolts, nuts and washers secured against loosening.

It shall be possible to insert any new cable and to connect all load side wiring with the bus bar energized, without any special precautions. Opening of the busbar chamber shall be possible with special tools only.

6.1.2 Protection clause:

All the outdoor panel boards shall have protection clause of IP 55. The complete board shall be double jacketed with insulation material to withstand outdoor temperature. All the indoor panel boards shall have protection clause IP 52.

6.1.3 Powder coating:

All sheet steel work shall undergo a seven tank process of degreasing pickling in acid, cold rinsing, phosphatising, passivating and then treated with powder coating treatment. The finishing shall be of shade as approved by the Engineer Incharge. The interior surface shall have similar finish.

6.1.4 Circuit compartments:

Each switch fuse units / MCCB / Changeover switch and meters shall be housed in a separate compartment and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly inter locked with the breaker/switch fuse units in "ON" and "OFF" position. However it shall be possible to bypass this interlock for inspection purpose.

6.1.5 Instrument compartment:

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Separate and adequate compartment shall be provided for accommodating instruments, indicating lamps, control contactors /relays, and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker/switch fuse units busbar and connections.

6.1.6 **Busbars and wiring:**

The busbars shall be of three-phase four wire system with separate neutral and earth bar. The busbar and interconnection between busbars and various components shall be with high conductivity, hard drawn, electrolytic copper strips.

The busbar shall be of rectangular cross section designed to withstand full load current for phase busbars and full rated current for neutral busbars and shall be extensible on either side. The busbar shall have uniform cross-section through out the length. The rating of the busbars shall be as specified in BOQ and/or drawings.

The busbars and interconnections shall be insulated with color coded insulation tapes/covers. The busbars shall be supported on unbreakable, non-hygroscopic insulated supports at sufficiently close intervals to prevent sagging and shall effectively withstand electromagnetic stresses in the event of short circuit. The busbars shall be housed in a separate compartment. The busbar shall be isolated with 3 mm thick hylum sheet to avoid any accidental contact. All busbars connection shall be done by drilling holes in busbars & connecting by chromium plated brass bolt and nuts. Additional cross section of bus bars shall be provided in all distribution boards to cover up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts. All interconnections between busbars and circuit breakers/switches and between circuit breakers/switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating tapes/covers.

All interconnections in the panel shall be with Cu busbars for switchgears of ratings 63 A and above. For switch gears below 63 A, flameproof Cu wires to be used with lugs crimped at both ends.

All busbars shall be tinned copper strips of the given cross section. Unless otherwise specified all bus bars are to be designed taking maximum current density of 800 Amp per sq inch.

All busbars are to be covered with heat shrinkable PVC sleeves of red, yellow, blue and black colours to indicate various phases and neutral bar clearly.

6.1.7 **Terminals:**

The outgoing terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformers for instruments metering shall be mounted on the terminal blocks. No direct connection of incoming or outgoing cables to internal components of the panel board is permitted. Only one conductor may be connected in one terminal. Adequate no of spare terminals of required size shall be left in each compartment.

6.1.8 **Wire ways:**

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A horizontal wire way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

6.1.9 Cable compartments:

Cable compartments of adequate size shall be provided for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate proper supports shall be provided in the cable compartments to support cables. All outgoing and incoming feeder terminals shall be brought out to terminal blocks in the cable compartment.

6.1.10 Earthing:

Tinned copper earth bars of suitable size shall be provided for the entire length of the panel. Provision shall be made for connection from this horizontal earth bar to the earth pit on both side of panel board. The earth continuity conductor of each incoming and outgoing feeder shall be connected to the vertical earth bar.

All non-current carrying parts and the framework of panel board shall be connected to this earth bar. All doors and movable parts shall be connected to earth bus with flexible copper connections. Armour of the cable shall be properly connected with earthing clamp, and the clamp shall be bonded with the earth bar.

6.1.11 Name plate, labels and directory:

A nameplate with switchgear designation shall be fixed at the top of the panel board. A separate nameplate giving feeder details shall be provided for each panel.

Engraved nameplates shall be of 3-ply (red-white-red or black-white-black) lamincoid sheets. Size of the letters shall be 5 mm. Nameplates shall be fastened by screws and not by adhesive. Size of letter for Main nameplate shall not be less than 20 mm.

Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the panel board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet. PVC labels shall be provided for spare circuits also.

Panel boards shall be provided with a directory indicating the area or loads served by each circuit breaker, the rating of breakers, size of conductors, etc. The directory shall be mounted in metal holder with a clear plastic sheet on inside surface of the front door.

6.1.12 Danger notice plates:

Danger notice plates with symbol as per IS shall be provided on panel boards.

6.1.13 Panel Keys

One set of panel keys and special tools etc. shall be supplied with each panel board.

6.1.14 Internal components:

The panel boards shall be equipped complete with all type of required number of circuit breakers, switch fuse units, contactors, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, busbars, cable boxes, cable glands etc., and all

the necessary internal connections/wiring as required and as indicated on relevant drawings.

Components necessary for proper complete functioning of the panel boards, but not indicated on the drawings and specifications shall be supplied and installed.

All part of the panel board carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the panel boards.

The derating of the different items resulting from the prevailing conditions like room temperature shall be allowed for while selecting the components.

All units of the same rating and specifications shall be fully interchangeable.

SECTION -V

1. Switches:

Switches shall be air break type as per IS 4047. The switch operating handle shall be front mounted and interlocked with the door when the switch is in ON position. The live parts shall be shrouded with suitable insulating barrier so as to prevent accidental contact with the live parts after opening the cubicle front door.

2. Fuses:

All power and control fuses shall be link type. Screw type fuses are not acceptable. All fuse links shall be HRC type and shall generally conform to IS 2208. Rewirable fuses are not acceptable. All fuses shall be readily accessible for replacement. It shall not be necessary to remove any piece of equipment or to disconnect wiring before replacing fuses using fuse puller.

3. Control switches:

Ammeter selector switches shall have make before break feature on its contacts. The selector switches shall generally have four positions for reading three phase currents and neutral. The voltmeter selector switch shall also have four positions and the fourth shall be OFF position. Remote trip /off selector switch shall be lockable in OFF position.

4. Indicating lamps:

The indicating lamps shall be LED type.

5. Measuring and Indicating instruments:

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All measuring and indicating instruments shall be Digital type, in square pattern moving from 90 deg. scale, 96mm x 96mm, flush mounting type. Instrument shall be of accuracy class 1 as per IS 1248. Ammeters for motor and other feeders shall be graduated for full load current of motor with a compressed scale at the end for at least 6 times full load current. The KW meter and PF meter shall be suitable to measure unbalanced loads on 3-phase 4 wire system. PF meter shall be in 0.5 - 1 - 0.5 range. CT's shall be resin cast, with class 1 accuracy and 15 VA burden. The energy meters shall be CT operated electrolytic type.

6. Push buttons:

Push buttons shall be suitable for panel mounting type and comprise of a contact element and an actuator. The contacts shall be of silver alloy and of 10 A continuous current rating. Each push button shall be provided with 1 NO + 1 NC contacts, but if required 2 NO + 2 NC contacts be provided. Colour of the knob shall be as per IS.

7. Packing and transport:

The bigger size panel boards shall be shipped to site in wooden crates. They shall be wrapped with polythene sheets before being placed in crates to prevent damage to the finish. Crates shall have skid bottoms for handling. All panels shall have one set of two silica gel bags, which shall be checked periodically both while in storage and while in service. The smaller size panel boards shall be transported to site with polythene sheets wrapped all along and wooden frame to cover the same.

8 Storage at site:

The panels shall be stored in a well ventilated, dry place and suitable polythene covers shall be provided for necessary protection against moisture.

9 Installation:

The panel boards shall be installed at the location as indicated in the drawings. The contractor shall submit for approval a shop drawing indicating room size, panel size and method of installation prior to installation.

The cubicle type panel board shall be installed on suitable foundation. Foundation shall be as per the dimensions supplied by the panel manufacturer. The foundation shall be flat and level. Suitable grouting holes shall be provided in the foundation. Suitable MS base channel shall be embedded in foundation on which the panel can be directly installed. If the panel is provided with an angle iron pedestal or base plate the same shall be grouted firmly in the floor. The panel boards shall be properly aligned and erected in plumb and bolted to the foundation by bolt parallel to the walls.

After installation of the panel boards, various components of the boards shall be checked and be put in working order. The cables laid through cable trench or on cable trays/racks etc. shall be terminated on the bottom plate or top plate as the case may be, by using siemens type brass compression glands. The individual cables shall then be led through the panels to the required feeder compartments for necessary terminations. The cables

shall be clamped to the supporting arrangement. The switchboard earth bus shall be connected to the local earth grid. Connection of cables shall be by crimping type Cu lugs using hand operated or hydraulic crimping tool as per cable sizes.

10 Testing:

1) Testing at factory:

Panel boards shall be inspected at factory at pre-assembly stage and any modifications or changes as suggested shall be incorporated. The panel boards shall be again inspected and tested at the factory after assembly of all components and completion of all inter-connections and wiring. The tests shall include all routine and type tests as per relevant IS.

2) Testing and pre-commissioning checks at site:

Panels shall be commissioned only after the successful completion of the following tests. The tests shall be carried out in the presence of the Engineer In-charge.

2.1 Pre-commissioning checks:

- 1) Check all panels are aligned in line and properly erected in plumb.
- 2) All withdrawals portions shall be capable of smooth extraction and isolation.
- 3) All main and auxiliary bus bar connections shall be checked and tightened.
- 4) All wiring terminations and bus bar joints shall be checked and tightened.
- 5) Wiring shall be checked to ensure that it is according to the drawing.
- 6) Before fitting the covers, all chambers, compartments, cable alleys etc. shall be checked for complete cleanliness and removal of foreign matter if any, particularly the tools used for erection, cut pieces of cable armour etc. Covers shall be properly fixed with all fixing screws in places.
- 7) All mechanical interlocks shall be checked and all fuses and links shall be inserted.
- 8) Earthing connections shall be checked.
- 9) Operational checks on all circuit breakers or switchgear shall be carried out, both mechanically and electrically to check that correct indications are provided for closed and open positions.
- 10) The panels shall be checked to ensure that moisture ingress has not taken place during transit and storage.

2.2 Testing at site:

On completion of installation the following tests shall be carried out:-

1. Insulation Resistance Test
2. Polarity Test of Switch
3. Earth Continuity Test

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4. Earth Electrode Resistance Test

- The insulation resistance shall be measured by applying between earth and the whole system of conductors or any section thereof with all breakers in place and all switches closed and except in earthed concentric wiring, all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure, provided that it need not exceed 500 volts for medium voltage circuits.
- The insulation resistance in Mega ohms measured between all conductor connected to one pole or phase conductor of the supply and all the conductor and switches in "ON" Position and its value shall be less than as specified.
- The insulation resistance in Mega ohms measured as above shall not be less than 50 Mega ohms divided by the number of outlets or when PVC insulated cables are used for wiring 12.5 mega ohms divided by number of outlets.
- Where as whole installation is being tested, a lower value than that given by the formula, subject to a minimum of a 1 mega ohm, is acceptable.
- The terms "outlets" includes every point along with even switch except that a switch combined with a socket outlet, appliances or lighting fitting is regarded as one outlet.
- Polarity test of Switch.
- In a two wire installation a test shall be made to verify that all switches in every circuit have been fitted in the same conductor throughout and such conductor shall be labeled or marked for connection to the phase conductor or to the non-earthed conductor of the supply.
- In a three wire or four wires installation a test shall be made to verify that every non linked single pole switch is fitted in a conductor which are labeled or marked for connection to one of the phase conductor of the supply.
- The installation shall be connected to the supply for testing. The terminals of switches shall be tested by a test lamp one load of which is connected to the earth. Glowing of test lamp to its full brilliance when the switch is in "On" position irrespective of appliance in position or not shall indicate that the connected to the right polarity.
- Testing of earth continuity path: The earth continuity conductor including metal conduits and metallic envelope of cables in all cases shall be tested for of electric continuity earth and the electrical resistance of the same along with the earthing load but

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excluding any added resistance or earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

- Measurement of earth electrode resistance.
- Two auxiliary earth electrodes, besides the test electrode, are placed at suitable distance from the electrode .

A measured current is passed between the electrode "A" to be tested and an auxiliary current electrode "C" and the potential difference between the electrode "A" and auxiliary potential electrode "B" is measured. The resistance of the test electrode "A" is then given by.

$$R = \frac{V}{I}$$

Where R. Resistance of the test electrode in ohm.

V. Reading of the voltmeter in volts.

I. Reading of the ammeter in amps.

- Stray currents flowing in the soil may produce serious errors in measurements of earth resistance. To compare this hand driven generator is used.
- If the frequency of the supply of hand driven generator coincides with the frequency of stray current there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.
- The auxiliary electrodes shall be of 13 mm diameter. Mild steel rod driven up to 1 meter into the ground.

8.34 All the three electrodes shall be so placed that they will be independent of the resistance area of each other. If the test electrode is in the form of rod, pipe or plate, the auxiliary current electrode "C" shall be placed at least 30m away from it and auxiliary potential electrode "B" shall be placed mid way between them.

- Unless three consecutive readings of test electrode resistance agree the test shall be repeated by increasing the distance between electrodes “A” and “C” upto 50m and each time placing the electrode B midway between them.
- On these principles “Meager Earth Tester” containing a direct reading ohm meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of each resistance of electrodes.
- On completion of an electric Installation (or an extension to an installation) a certificate shall be furnished by the contractor countersigned by the certified supervisor under whose direct supervision the installation was carried out . This certificate shall be in the prescribed form as given in appendix “E” in addition to the test certificate required by the local Electric Supply Authorities.
- All relays and protective devices shall be tested for correctness of settings and operation by introducing a current generator and an ammeter in the circuit.
- Insulation test shall be carried out both before and after high voltage test.

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TECHNICAL SPECIFICATION FOR SUB-STATION WORK

S.NO	ITEM	SPECIFICATIONS
1.0	GENERAL	160 KVA. 11KV /415 V, 3-phase, 50 Hz. Transformer shall be copper wound suitable for outdoor installation, oil-immersed, naturally cooled, off-load tap changing, Transformer shall be complete in all respect i.e termination of cable including termination kit on H.T side lugs on L.T side shall be provided by contractor. However the cable shall be provided by the LICl.
2.0	STANDARD	The Transformer shall generally conform to all provisions of IS-2026 amended to date: - (Part-I) 77 with amendments 1 to 3 (Part-II) 77 with amendments 1 & 2 (Part-III) 81 & (Part-III) 77 with amendments 1.
3.0	OPERATIONAL REQUIREMENTS	Transformer shall be capable of continuous operation 24 X 7 Hrs. Transformer should be designed such that when operated on nominal 11KV primary voltages', the secondary output voltage should be 415 Volts. For taking care of variation under load conditions from nominal 11KV primary supply, OFF load tap changing facility should be provided for obtaining 415 Volt on secondary side. The Transformer shall be free from abnormal hum or vibration. The design shall be such as not to cause any undesirable interference with Radio or communication circuits.
4.0	INSULATING OIL	The insulating oil used in Transformer shall comply with the requirement of IS 335 /1993 (4 th revision) amended to date(Specification for insulating oil for transformer and switchgear).
5.0	COOLING	The Transformer shall be oil immersed natural air-cooled with required radiator fins to dissipate the heat.
6.0	CABLE TERMINATION BOX	The Transformer shall be provided with cable endbox on H.V suitable for connection to H.T., 3 core 90 Sq.mm armoured Alluminium conductor cable along with cable glands of suitable size. Bare Bushings on H.V side suitable for connection to incoming Overhead line 11 KV. On low voltage side, the cable end box shall be provided for suitable connection to 300 Sq.mm

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		Alluminium conductor PVC insulated armoured 3.5 core L.T cable along with cable glands of suitable size, bare indoor heat shrinkable termination kit shall be used for termination of H.T cable. Termination box on L.T side shall be provided with removable gland plate.
7.0	ACCESSORIES & OTHER FITTINGS	The following minimum accessories / fixtures/attachments and fittings shall be provided as per requirement of design of Transformer:- a) Diagram and Rating (marking) plate :01 No. b) Earthing terminals :02 Nos c) Lifting Hooks :02Nos d) Directional Rollers :04 Nos e) Thermometer Pocket with Thermometer :01 No f) Dial type Thermometer min/max indicator :01 No g) Oil conservator Tank with :01 No i. Oil level gauge :01 No ii. Silica gel breather with pipe :01 No b) Air release plug :01 No c) Explosion vents & pressure relief device with trip contacts :01 No d) OFF LOAD tap changing arrangement with locking :01No e) Oil drain valve with plug :01 No f) Cable box on HV & LV side :01 No g) Oil filling nipple with cap :01No h) Filter valve with plug :01No i) Any other item as per OEM :As required.
8.0	EARTHING	The body and neutral of the transformer shall be earthed as directed.
9.0	PAINTING	All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents, as required, to produce a smooth surface free of scales, grease and rust. The steel surfaces after cleaning shall be given a coat of high quality red oxide or yellow chromate primer followed by final coat. The internal surfaces in contact with insulating oil shall be painted with heat resistant insulating varnish which shall not

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		react with and not soluble in the insulating liquid used. The paint shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or to be removed by abrasion due to normal handling. Where the painting is damaged during transit, installation etc. touch up painting shall be done by tenderer at site.
10.0	RATING PLATES	Each transformer shall be provided with a rating plate of weather proof material, fitted in a visible position, showing the appropriate items as per IS:2026 (part-I) amended to date, the entries on the rating plate shall be legibly marked (by etching, engraving or stamping)
10.1	TESTS	General, Routine and Type tests as per mutually accepted procedure based upon IS:2026(Part-I)77 with amended up to date, shall be witnessed at the manufacturer's works and site by the client.
1.10.2	GENERAL OBSERVATIONS	Workmanship Material Provision of all accessories Literature and certificates Misc.
1.10.3	ROUTINE TEST	Measurement of Insulation Resistance Measurements of Resistance of winding Oil dielectric strength test. Out put voltage test Measurement of NO load loss & current, full load Loss & current. Measurement of impedance voltage/short circuit impedance. Measurement of efficiency & regulation at various loads.
1.10.4	FUNCTIONAL TEST	Test on different Tapping Positions. A heat run test (Temperature rise test) will be conducted at works of manufacturer in presence on client, without any damage. Any other test found necessary as per specifications and site conditions.
1.10.5	TYPE TEST	Tenderer must process and produce type test certificate for similar capacity/equipment. If type test certificate is not available then tenderer shall have to conduct the following tests at manufacturer in the presence of indenter at their own

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		expenses:- Lighting impulse Test Dynamic Short Circuit Test.
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Please note: The scope of work includes complete installation of plinth mounted sub-station including necessary liaison with the state electricity utility and electrical safety department for getting the necessary approvals and energization of the sub-station. The work shall be complete only after energization of the sub-station from the state electricity authority.

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TECHNICAL SPECIFICATIONS

Fire Hydrant System

Sprinkler System

Fire Alarm System

1. SCOPE WORK

The scope of the work covers supply of materials, installation, testing and commissioning of Fire Hydrant System, Sprinkler system and Fire Detection & Alarm systems.

Copies of drawings of buildings and schedule of quantities are enclosed in the tender document. All the equipment and installation shall conform to specifications contained in Indian Standards.

The installation of the systems shall conform to norms as per NBC 2005 - Part 4, IS 3844 and TAC. The installation of Fire Detection & Alarm system shall comply with the latest edition of relevant NFPA 72 E and IS: 2189 standards. The scope of work also includes preparation and submission of drawings for obtaining approvals (NOC) for the system from local authorities like State Fire Dept. and liaison works with the departments. All incidental expenses in connection with the same shall be borne by the contractor. For all approvals / NOC, statutory fees shall be remitted by the contractor initially. However, it shall be reimbursed on submission of original receipt.

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FIRE HYDRANT SYSTEM

1. STANDARDS

The manufacture, identification of material and testing of equipment covered in this specification shall comply with the latest editions as on date of opening of tenders of the appropriate standards of the following. Unless otherwise specified, Indian Standards are preferred. All the appliances and accessories shall carry IS or International certification and shall be of approved make.

- IS: 1239 Mild steel, black ERW pipes, with fittings.
- IS: 3589 Mild steel, black ERW pipes 200 mm dia, and above, with fittings.
- IS: 10221 Code of practice for coating and wrapping of underground mild steel pipelines
- IS: 823 Welding procedure
- IS: 2062 Steel for General Structural Purposes
- IS: 780 Cast iron sluice valve
- IS: 903 Nozzle, Branch pipe, Female and Male couplings (Gun metal)
- IS: 5290 Fire hydrant valve, gun metal with cap & GI chain.
- IS: 908 Fire hydrants
- IS: 8423 Water shield controlled percolation hose.
- IS: 325 Induction motors
- IS: 900 Installation of motors
- IS: 13947 SDFUs
- IS: 1554 PVC/PVC Al. power/control cables
- IS: 1652 Batteries
- IS: 694 PVC insulated cables (light duty) for working voltage upto 1100 volts.
- IS: 1554 PVC insulated cables (heavy duty) for voltage upto 1100 volts.
- IS: 1554 — do — for voltage 3.3 kV to 11 kV
- IS: 5959 Specification for polythelene insulated PVC sheathed heavy duty electric cables, voltage not exceeding 1100 V
- IS: 5959 — do — voltage 3.3 kV to 11 kV
- IS: 5578 Guide for marking of insulated conductors
- IS: 1255 Code of practice for installation and maintenance of power cables.
- IS: 3043 Code of practice for earthing.
- IS: 5216 Guide for safety procedures and practices in electrical work.

In case where the offer deviates from the specified standards, the tenderer shall indicate clearly in the offer the alternative standards proposed to be adopted and details thereof.

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Unless otherwise mentioned, all applicable codes and standards shall be of the latest editions as published by the Indian Standards and all other such as may be published by them during the tenure of the contract, and shall govern in respect of workmanship, properties of materials, installation and methods of testing. In case where suitable Indian Standards or TAC norms are not available, generally accepted codes and practices as approved by the LIC shall be adopted. Any changes or modifications directed by the LIC shall also be incorporated by the contractor during execution of the work.

2. PUMPS AND ACCESSORIES

Pumps shall be direct-coupled and not belt-driven. Parts of pumps like impeller, shaft sleeve, wearing sleeves, etc. shall be of non-corrosive metal such as brass or bronze. Pumps shall be capable of furnishing not less than 150% of the rated capacity at a head not less than 65 % of the rated head. The shut-off rate shall not exceed 120% of the rated head in the case of horizontal pumps. Each pump shall be provided with a pressure gauge on the delivery side between the pump and the non-return valve and a name plate showing the delivery head, capacity and the RPM. Pumps shall be securely mounted on a robust bed plate of horizontal type, and shall be free from vibration at all varying loads.

The two electric driven main pumps shall be interconnected through pressure switches and panel board such that only one electric pump shall operate first in the event of low system pressure and the latter operates automatically in case of failure of the former within a specified switchover time or fall in pressure.

The Jockey pump shall have automatic starting and stopping arrangements to maintain the system pressure. In the event of low system pressure, the jockey pump shall operate to maintain the system pressure. Sequence of operation of pumps are mentioned in the section 'Inspection and Testing'.

3. HYDRANTS SYSTEM AND PIPING

1 MS Pipes

The MS pipes used shall be of standard IS 1239, heavy duty type (Class C), electric resistance welded and shall be free from scale, cracks, surface flaws and other defects. For pipes 200 mm dia. and above IS 3589 shall be applicable.

2 Above ground (AG) / Exposed pipes

Above ground (AG) / exposed pipe lines and fittings shall be coated with two coats of zinc chromate primer and two coats of enamel paint as per IS approved colour code. The surfaces shall be properly cleaned before applying the primer. AG pipes shall be supported at regular intervals on masonry, RCC, truss, beams, roofs, trenches etc. Air release valves shall be provided in the hydrant lines at an interval of 50 m.

The spacing of pipe supports shall be as shown below:-

Pipe dia. in mm

80, 100 and 125 : 3.5 m

150, 200 and 250 : 5.0 m

around the pipes and the overlap is maintained at 15 mm. The material shall conform to IS 10221.

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3 **Hydrant valves**

The external/internal fire hydrant valves shall be of oblique type single headed of 63 mm dia. conforming to IS-5290 suitable for connecting to 80 mm pipe. The hydrant shall be complete with hydrant valve, orifice plate, other fittings, etc. The hydrant couplings shall be flanged stainless steel with instantaneous female spring-lock of 63 mm dia. and valves shall be of screw down type. Orifice plates of suitable design shall be provided for hydrants where pressure exceeds 7 Kg per Sq. cm.

The number of fire hydrants in a main of 80 mm dia. shall not feed more than one hydrant, that having a dia. of 100 mm shall not feed more than two hydrants, that having a dia. of 125 mm shall not feed more than three hydrants. The pressure at the most highest end hydrant in the hydrant mains shall be restricted to 3.5 Kg per Sq. cm. All hydrant outlets shall be situated 0.9 m above floor level.

4 **Hose pipes**

The hose pipes for hydrants shall be 15/7.5 m long, 63 mm dia. water shield controlled percolation canvas conforming to IS-8423 with stainless steel 63mm size male coupling at one end and female coupling at other end conforming to latest IS. If hose is kept in hose boxes alongside hydrants, each box shall contain two lengths of hoses. For use of each hydrant in staircase landing or with each internal hydrant, two lengths of hose 7.5 m shall be provided and in case of external hydrants two lengths of 15 m shall be provided. All the hoses and branch pipes/nozzles shall be kept inside the boxes as per standard practices.

5 **Hose reel**

The hose reel shall consist of 30 m long 20 mm dia. high pressure braided rubber lined hose mounted on heavy duty circular MS drum complete with gun-metal shut-off valve, nozzle, etc. The hose reel bracket shall be of MS fabricated or cast iron swing type suitable for 90 deg. smooth and free rotation in vertical plane conforming to IS-884.

6 **Hose boxes**

The fire hose boxes shall be of size 750x250x600 mm, 16 SWG sheet steel with front side glass of 4 mm thick, lockable hinged door and painted with one coat of primer and two coats of synthetic enamel paint of approved colour..

7 **Couplings**

All couplings shall be of the instantaneous spring-lock type and the nozzles shall be of not more than 16 mm in dia. All couplings in the branch pipes and nozzles shall be of stainless steel and shall comply with relevant IS code. The hose shall be attached to the coupling.

8 **Foot valve**

It shall conform to IS:4038 standard and shall be of ball type, C.I. metallic and with G.M. trim & grey C.I. / galvanized steel perforated screen with flanged connection, nut bolts, gasket, washers etc. to be connected only for negative suction. It shall be tested certified for hydraustatic test pressure, for Body : 8.5 kg/cm² and Seat : 2 kg/ cm² .

9 **Fire brigade outlets**

The fire brigade collective breaching shall be with 150 mm flange outlet connection with gun-metal twin-Siamese collecting head having 4 instantaneous outlets with built-in check valves. The fire brigade breaching shall be connected to the sump and the main header.

10 **Air cushion tank**

The air cushion tank shall be of 300 mm dia. and 1500 mm height fabricated out of 8 mm MS sheet steel and shall be complete with 20 mm dia. air release valve and associated piping work, etc. It shall be constructed with air outlet at the top. Drain valves of gunmetal

shall be provided at the lowest points of the piping work to enable draining of water from the system. The drain valves assembly shall include nipple and PVC rubber hose.

11 **Sluice Valve (SV)**

It shall be of IS 780 standards. Construction shall be of inside screw, non-rising stem for water purpose and flanged type. Pressure class shall be of PN 1.0 and tested to 15 kG/Sq.cm pressure. Seat ring shall be of gun metal as per IS 318. Gasket packing shall be of CAF / Graphited asbestos.

12 **Non Return Valve (NRV)**

It shall be of IS 5312 standards. Construction shall be of swing type with bolted cover for water purpose and flanged end construction. Pressure class shall be of PN 1.0 for water purpose and flanged type.

13 **Gun Metal Gate Valve**

It shall be of IS 778 standards. Construction shall be of globe and lift type with screwed bonnet and inside female screwed construction. Packing shall be of asbestos. Pressure class shall be of PN 1.0. End connection shall be of screwed type.

14 **Pressure gauges**

It shall be of dial type with Bourden tube element of SS 316. The dial size shall be 150 mm dia. and scale division shall be in metric unit marked in black on white dial. It shall be comprised with snubber, isolation cock, nipples, tail, connecting pipes, etc.

15 **Fittings**

Fittings installed shall be of MS conforming to IS-1239 (Part-I & II). All fittings shall be able to withstand at least a pressure of 150 % of the maximum working pressure. Welded fitting according to the laid down welding procedure are permitted. Welded parts shall be suitably coated after welding as per the requirement of the areas. Welded joints are not permitted for fittings of less than 50 mm dia.

16 **Pressure switches**

It shall be of industrial type, single pole, double throw electric pressure switching designed for starting or stopping equipment within the pressure of the system drops or exceeds the pre-set limits. All switches shall have ¼" BSP (F) inlet connection and screwed cable entry for fixing cable gland.

17 **Flanges**

The flanges shall be of heavy duty type manufactured from material as per standards mentioned having flat face as per requirement and its dimensions shall also satisfy appropriate standards. All bolt holes in flanges shall be drilled. The drilling of each flange shall be in accordance with relevant Indian Standards. The gaskets used in all flange joints shall be of standard size and are to be approved, verified and checked before use. Fixing of gasket is to be as per standard procedures so as to ensure efficient and quality type joints. The flange faces shall be true and perpendicular to the axis of the pipes, and if due to other various reasons, such as, but not necessarily limited to the process and / or layout requirements, it is not feasible, the Contractor shall ensure that the joints shall be drawn up in order to provide even and adequate uniform pressure on gaskets. All flanges shall be installed such that the bolt holes straddle the normal centerlines.

18 **Welding procedure**

The welding procedure shall only be carried out by fully trained and experienced welders and shall conform to IS-823. LICI reserves the right to set the correct welding procedure, if not satisfied. The welding electrode shall be of reputed make with ISI mark, and shall have suitable coating complying with relevant Indian Standards.

INSPECTION AND TESTING

(Hydrant System)

1 Inspection - General

All site fabricated work/ material shall be subject to inspection in cleaned condition, prior to erection. At no event, site fabricated work /material shall be installed in position without inspection and approval by LICl. The Contractor shall ensure that each stage of fabrication is carried out in compliance with the procedures specified in the TAC manual and IS standards as applicable and/or specified in this document.

The contractor shall conduct sample tests of all the materials supplied at reputed laboratories/agencies as directed by LICl at his own cost and test reports are to be submitted. Inspecting officials of LICl and Local Authorities shall have the right to access the premises of the work at any time with or without giving prior notice. All the formalities or procedures for conducting the inspections by the authorities as required by them shall be arranged by the contractor free of cost.

All testing shall be carried out in the presence of LICl / statutory authorities and test registers shall be maintained by the contractor. The contractor shall provide all material, tools, equipment, instruments, services and personnel required to perform the tests and remove debris/water resulting from cleaning and after testing free of cost.

The original test certificates of all tests conducted are to be forwarded to LICl. After conducting the tests, any defects found on materials, equipment, piping, etc. shall be got rectified / repaired by the Contractor without any extra cost.

2 Testing

Before energizing electrically operated equipment, care shall be taken to meet the local electrical rules and regulations, earthing of the body, verifying availability of safe insulation resistance value, etc. Also confirm the motor enclosure to the level of protection required for the particular application.

a. Pumps

The pumps shall be tested according to the standard recommendations of the manufacturer. The following parameters are to be recorded and plotted and submitted to the LICl.

- a. Discharge Q
- b. Pressure P or Head H
- c. Motor voltage and current.
- d. Efficiency

The power consumption is to be computed and cross-checked with manufacturers data. Any abnormalities, if noted, shall be brought to the notice of the manufacturer and necessary corrective action be taken before commissioning and handing over, without any extra cost. Manufacturers test certificates shall also be submitted to LICl for verification.

b. Piping

All piping shall be tested by filling water, removing air locks, foreign materials, etc. and applying pressure at 1.5 times of the maximum working pressure and see that the pressure drop is within 0.5 Kg per Sq. cm over a period of 2 hours. The testing shall be carried in sections by blocking both ends or closing the valves provided. After completion of the installation and connecting to the mains of pumping system the installation shall once again tested and rectify breakage if any or replace the defective material, free of cost.

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At least 10% of the total weld joints on pipes shall be tested by radiography as per TAC requirement. Holiday tests for wrapping and coating of MS pipes is essential as per IS-10221. Holiday tests may preferably be carried out by flexible and detachable ring probe which shall enable the entire 360 deg. of the surface of the pipe to be scanned.

c. Electrical system

The following tests are recommended:-

- i) Earth resistance
- ii) Cable Insulation
- iii) Trial run and testing of diesel engine.
- iv) Resistance of metal conduits/sheaths (Earth continuity test)

Insulation of the cables shall be not less than one mega ohm when tested with a 500 volts meggar for any particular section of the wiring.

In case of cables encased in metal conduit or metallic sheathing, the total resistance of the conduit or sheathing from the earthing point to any other position in the completed installation shall not exceed 2 Mega Ohms.

d. Hydrant system

The entire hydrant system shall be tested in the presence of LICl to ascertain the functioning of each system, equipment, etc. as desired by LICl. The contractor shall hand over the system only if it is proved that the system performs as per the specifications.

SEQUENCE OF OPERATION OF PUMPS

The electric driven pumps shall be interconnected through pressure switches and panel board such that only main pump operates in the event of low system pressure and the stand by pump operates automatically in case of failure of the former within a specified switchover time or fall in pressure.

The starter panel shall continuously monitor the mains supply on all the 3 phases for total/partial failure and system pressure through pressure switches. The electric driven pumps shall start both in auto /manual modes. The pumps shall not be stopped automatically afterwards and it shall be stopped manually.

The contractor shall carry out necessary arrangements for the supply and installation of items like timer, sensors, control cabling, etc. in the panels to function the pumps as described

The Jockey pump shall have automatic starting and stopping arrangements to maintain the system pressure. Jockey pump shall not be in operation while the main pump is in operation. Jockey pump shall be operated by both auto /manual modes. Under normal conditions, the water pressure in the hydrant lines shall be 9 kg/sq.cm. and the auto/manual switch shall be in the auto mode. When the pressure drops to 8 kg/sq.cm., the jockey pump shall start automatically through pressure switches arrangements and when pressure develops to 9 kg/sq.cm the pump shall stop automatically.

SPRINKLER SYSTEM

1. Sprinklers

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The design of sprinkler system is designed for a Design Density of 5 lpm/Sq.m and Assumed Maximum Area of Operation (AMAO) is 360 Sq.m. The minimum sprinkler discharge pressure shall be 0.35 bar and 'K' factor shall be 80. Sprinkler shall not be reconditioned or repaired. Defective sprinklers shall be replaced with new ones. Sprinklers and multiple controls shall not be painted except for the identification purpose. Sprinklers shall be of 'Conventional Pendent' type with size 15 mm dia. It shall produce a spherical type of discharge with a proportion of water being thrown upward the ceiling. Sprinklers shall have temperature rating for 68 deg. C with Red colour code. It shall be of Quartzoid Bulb suitable for installation indoor as well as outdoor and shall have a maximum coverage of 12 Sq.m per sprinkler.

Arrangement of sprinklers

Sprinklers shall be installed with the deflector parallel to the slope of the ceiling. Sprinklers shall be not spaced at less than 2 m. The distance between the boundary and sprinklers when measured along the range pipe shall not be more than 0.5 times the spacing between the sprinklers and range pipes. As far as possible, sprinklers shall be located away from the columns. Sprinklers shall not be connected directly to distribution and main pipes. Sprinklers shall not be provided in the following areas of the building:

- ✓ Stairs, spaces below stair headings.
- ✓ Toilets.
- ✓ Rooms containing electric power distribution apparatus.
- ✓ Control rooms.

Number of sprinklers that can be installed on range pipes is as given below:

25 mm dia. Range pipe: 2 nos. max.

32 mm dia. Range pipe: 3 nos. max.

40 mm dia. Range pipe: 4 nos. max.

50 mm dia. Range pipe: 9 nos. max.

Number of sprinklers that can be installed on distribution pipes is as given below:

32 mm dia. distribution pipe: 3 nos. max.

40 mm dia. distribution pipe: 6 nos. max.

50 mm dia. distribution pipe: 9 nos. max.

65 mm dia. distribution pipe: 18 nos. max.

2. Alarm valve

Alarm valves shall be fitted on the main supply pipe immediately above the main control valve leading to the sprinkler installations. The alarm valve shall have the following accessories:

Main Stop Valve - 1 No. shall be fitted immediately downstream of the alarm valve and shall be at fire brigade access level.

Test Valve - 1 No. shall be provided to test the hydraulic alarm or any electric alarm pressure switch if provided by drawing water from the downstream side of a wet alarm valve. It shall be installed close to the alarm valve.

Drain valve - 1 No. shall be fitted to allow drainage from immediately downstream of the alarm valve.

Water motor alarm – 1 No. shall be fitted as close as possible to the alarm valve. It shall be installed with its gong on the outside of an exterior wall. A strainer readily accessible for cleaning shall be fitted between the motor nozzle and alarm valve connection. The water outlet shall be positioned so that any flow of water can be seen. The pipe work to the water motor shall be galvanized. Any device to reduce the frequency of false or intermittent alarms fitted to the installation shall be suitable for sprinkler service.

Pressure gauge - No. shall be fitted immediately downstream of the alarm valve. Pressure gauges fitted shall comply with relevant IS standards. The scale sub-division shall not exceed 0.2 bar for a maximum scale value upto and including 10 bar.

3. **MS Pipes**

The MS pipes used shall be of standard IS 1239, heavy duty type (Class C), electric resistance welded and shall be free from scale, cracks, surface flaws and other defects. For pipes 200 mm dia. and above IS 3589 Class '2' shall be applicable.

a. **Exposed/Above ground (AG) pipes**

Exposed/Above ground (AG) pipe lines and fittings shall be coated with two coats of zinc chromate primer and two coats of enamel paint as per IS approved colour code. The surfaces shall be properly cleaned before applying the primer. AG pipes shall be supported at regular intervals on masonry, RCC, truss, beams, roofs, trenches etc. Air release valves shall be provided in the hydrant lines at an interval of 50 m.

The spacing of supports shall be as shown below:-

Pipe dia. in mm

80, 100 and 125 : 3.5 m

150, 200 and 250 : 5.0 m

b. **Fittings**

Fittings installed shall be of MS conforming to IS-1239 (Part-II). All fittings shall be able to withstand atleast a pressure of 150 % of the maximum working pressure. Welded fitting according to the laid down welding procedure are permitted. Welded parts shall be galvanised or suitably coated after welding as per the requirement of the areas. Welded joints are not permitted for fittings of less than 50 mm dia. Air release valves are to be provided in the main ring wherever necessary to permit air locks in the delivery side of the pipe lines.

c. **Flanges**

The flanges shall be of heavy duty type manufactured from material as per standards mentioned having flat face as per requirement and its dimensions shall also satisfy appropriate standards. All bolt holes in flanges shall be drilled. The drilling of each flange shall be in accordance with relevant Indian Standards. The gaskets used in all flange joints shall be of standard size and are to be approved, verified and checked before use. Fixing of gasket is to be as per standard procedures so as to ensure efficient and quality type joints. The flange faces shall be true and perpendicular to the axis of the pipes and if due to other various reasons, such as, but not necessarily limited to the process and / or layout requirements, it is not feasible, the Contractor shall ensure that the joints shall be drawn up in order to provide even and adequate uniform pressure on gaskets. All flanges shall be installed such that the bolt holes straddle the normal centerlines.

d. **Supports for sprinkler piping system**

Sprinkler pipes shall be supported from the building structure which itself shall be capable of supporting the water filled pipe work and shall not impair the performance of sprinklers

under fire conditions. Pipe work shall not be used to support any other loads. Supports shall not be welded or fastened directly to the pipe work. The thickness of all parts of pipe supports shall not be less than 3 mm. Wherever possible, pipes shall be supported from non-combustible building elements. Pipe works in corrosion areas shall be of either stainless steel or suitably protected against corrosion. Standard pipe hangers such as solid ring, swivel ring, clip, band hanger, bracket, ceiling flange, clamp, etc. shall be used for supports. The spacing between the pipe supports measured along the line of connected pipes shall not be less than the following:

Up to 65 mm : 4.0 m

65 mm to 100 mm : 6.0 m

100 mm : 6.5 m

e. Welding procedure

The welding procedure shall only be carried out by fully trained and experienced welders and shall conform to IS-823. Engineer-in-Charge reserves the right to set the correct welding procedure, if not satisfied. The welding electrode shall be of reputed make with ISI mark, and shall have suitable coating complying with relevant Indian Standards. Welded joints shall not be permitted for pipes having diameter less than 50 mm, but it shall be screwed using sockets.

INSPECTION AND TESTING

(Sprinkler system)

Sprinklers

It shall be factory tested for operation characteristics and chemical tests. Necessary test results shall be submitted before supply. If required the above tests shall be conducted as per the requirement of the Engineer-in-Charge at the time of installation at no extra cost.

Sprinkler alarm valve

The pump shall start automatically and the supply pressure at the appropriate flow rate. The drain valve fitted above the alarm valve shall be opened and the time taken for the alarm gong to operate be noted. There shall not be a significant variation in the timing. The pressure at the "C" guage of the alarm valve shall be noted at the full load condition of the pump and the value should match with that of the specification. The proper functions of the alarm gong associated with the alarm valve and its level of audibility shall be checked. An audibility level of 85 db above the background noise level is required. Necessary testing equipment shall be arranged by the contractor free of cost.

While conducting the tests, the water flowing through the test valve shall be equivalent to the flow through one sprinkler. It should auto start the pumps and activate the alarm motor and gong. When the test valve is closed, the water flowing through the test valve should stop.

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FIRE ALARM SYSTEM

1. Manual Call Points (MCPs)

It shall be of 'break glass' type, and 1.5mm thick welded sheet steel or 3 mm thick cast aluminium. The front glass shall be breakable. The MCPs shall be recess mounted suitable to support the fire panel. It shall form an integral part of the fire detector system. The housing shall be dust/vermin proof properly sealed with rubber lining. The glass frangible element shall keep a push button pressed inside such that in the event of breaking the glass, the push button is released to actuate an alarm in the control panel.

Where sheet steel is used for, this shall be thoroughly cleaned off dust, dirt, grease and rust if any and two coats of anti rust primer shall be given both inside and outside. This shall be followed by two coats of synthetic enamel paint in fire red colour on the external surface that will be visible on installation. In the case of cast aluminium body for a call box, the surface shall be neatly finished with red colour paint. The following words shall be painted on the front of the call box in contrasting colour with a letter size of not less than 5mm.

"BREAK GLASS IN CASE OF FIRE"

Installation requirements:-

Manual call points shall be located at exit space and shall be installed at a height of 1.4 m above the floor at an easily accessible position. They shall be installed at easily accessible, well illuminated positions, preferably in a contrasting background so that they are easily noticeable from either direction. They may be semi-recessed so as to project by 10mm. They shall be installed free from obstructions.

2. Hooters

The loop hooters shall be so arranged that when any alarm operates all the hooters through out the premises shall be activated. The hooters at the fire alarm shall be electronic type having frequency of suitable frequency range. The hooters shall be capable to produce a sound output of 90 db at 1 m. Hooters shall be of loop powered and no separate power is required.

Fire alarm hooters shall not be used for any purpose other than for fire operations. When installed flush with a false ceiling these shall match the ceiling surface. Necessary provisions such as metal/ wooden boxing or frame work, if required, to accommodate the hooters shall be provided in the ceiling. It shall be installed at a height not lower than 2.4 m, except when recessed in a false ceiling of lower height, in such cases the hooters shall be recessed at false ceiling level.

The panel hooters in the respective panels shall be actuated automatically as soon as fire alarm signal is initiated from any trigger device connected to them. These shall also be sounded when there is a fault alarm signal within their areas of control. The sound shall be continuous and of the same characteristics from all fire alarm hooters in a building.

The isolator module shall mount in a standard suitable size electrical box or in a surface mounted back box. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

3. **Fire Alarm Control Panel**

The fire alarm control panel shall be designed to give reliable and continuous operation for long time with several advantages features. The panel shall be conventional type suitable for 2 wire loops system. Being modular in design, it shall be very easy for maintenance and testing of the system. Fire Alarm panel consists of following plug in type modules

1. Power module.
2. Charger module.
3. Control module.
4. Loop modules.

The fire alarm control panel shall be housed in a steel enclosure. It shall also be finished with hard wear textured epoxy paint/ powder coated. Cable entries shall be provided on the top and bottom of the panel.

The system capacity shall be based on the number of devices and control modules. Each devices in the system shall be identified by its unique address position on the two wire loop. The panel retains command over the alarm process, LED indicators, automatic test feature and loop hooters.

a. **Basic system Functional Operations**

When a fire alarm/trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- ✓ The system Alarm LED shall flash or the system trouble LED shall flash.
- ✓ A local piezo-electric signal in the control panel shall sound.
- ✓ The LCD display shall indicate all information associated with the fire alarm/trouble condition, including the type of alarm point and its location within the protected premises.

b. **Enclosures**

The control panels shall be housed in cabinets suitable for surface or semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

The back box and door shall be constructed of min. 16 gauge sheet steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.

The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

c. **Power supply**

The power supply units shall operate on 240 Volts AC, 50Hz, and shall provide all necessary power for the smooth operation of system. In case of failure of main power supply the power supply unit shall draw power from a set of standby batteries. The capacity of the battery set shall be sufficient to meet the required hours full functioning of the complete system under alarm conditions. It shall provide a battery charger using dual-rate-charging techniques for fast battery recharge. It shall charge completely discharged batteries within a 12-hour period. It should provide meters to indicate battery voltage and charging current.

d. Batteries and External Charger

Battery

Battery shall have sufficient capacity to power the fire alarm system for not less than two hours in alarm condition and at least 8 hours in normal condition. The batteries are to be completely maintenance free.

External Battery Charger

Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 230 volt 50 hertz source. It shall be rated for fully charging a completely discharged battery within 12 hours while simultaneously supplying any loads connected to the battery. It shall have protection to prevent discharge through the charger. It shall also have protection for overloads and short circuits on both AC and DC sides.

4. Control Cable

The control cable for wiring fire alarm system shall be 3 x 1.5 sq.mm PVC Copper cable. Cables shall be laid as per relevant installation standards. The size of these cables are specified in schedule of requirements.

5. Conventional Detectors

All types of detectors shall be of manually programmable type using dip-switches or handheld programmer or from fire control panel. The detector shall have no moving parts of components subject to wear. It shall be possible to test the detector in the field. The response of a detector shall always be clearly visible from outside by a flashing light on the base. The detector shall connect to the control unit via a fully supervised two-wire circuit. A built barrier shall prevent entry of insects into the sensor. The detector shall be designed for fast and simple cleaning.

All electronic circuits must be solid state devices and virtually hermetically sealed to prevent their operation from being impaired by dust dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. All radioactive parts of the source, if any, shall be fully gold plated. The detector shall be inserted into or removed from the base by a simple push-twist mechanism to facilitate easy exchange for cleaning and maintenance.

The smoke & heat detectors shall fit into a common type standard base. The standard base shall be supplied with a seal plate, preventing dirt, dust, condensation or water reaching the wire terminals or the detector points. Detectors shall be provided with a MS box for entry and termination of armoured cable and to protect detectors terminals.

At the time of installation and prior to commissioning, every detector shall be allotted an identification number. Detectors shall not be either partially or totally recessed in ceiling or wall. Detectors shall be suitably protected where they are liable to be subjected to mechanical damage. Detectors shall not be painted or coated or covered in any manner after installation as this will adversely affect the sensitive of operation.

Smoke detectors

It shall be of optical type. Smoke detectors shall quickly respond to smoke containing small particles normally produced and automatically adjusts sensitivity without needing operator intervention.

TECHNICAL SPECIFICATIONS FOR STRUCTURED CABLING & ALLIED WORKS

GENERAL INSTRUCTIONS TO TENDERERS

- The tenderers are required to quote for the items mentioned in the schedule of quantities as per relevant specifications. The final price should be inclusive of all the components mentioned in the said configuration.
- The latest versions of the operating and the applications software whichever are available at the time of delivery, should be supplied and pre-loaded, if applicable.
- The tenderers are required to provide the technical literature of the equipment listed in the schedule of requirements such as data sheets, etc..
- **SUPPLY OF EQUIPMENT / MATERIALS:**
The equipments / materials shall fully meet the requirements of relevant parts of this specification
- **DOCUMENTS:**
- Documentation shall be of such quality and detail that competent telecommunication personnel are able to maintain the equipment.
- All documents shall be in English / Hindi language.
- **SCOPE OF WORK:**
- A Local Area Network is to be set-up using structured cabling with required connections at site.
- The scope of the project includes laying-out the cables. The structured cabling between the "Information Outlet" and Jack Panel / hub / Switches as per schedule of quantities suitably wired either on the ground, false ceiling or on the wall surface in a manner that is safe as well as aesthetically acceptable to LIC. PVC conduits/Channels/MS pipes would be used for wiring wherever necessary.
- Supply, Installation of Passive Components (and Active components, if required) as detailed out in the Schedule read in conjunction with the Technical specifications, to make the installation fully functional. This shall be done in consultation with the LIC.
- Testing & Commissioning of the Network after completion of the entire installation work (or specified area if required).
- Testing, Configuring servers & Clients for Network Management and commissioning of Network Management System if applicable.
- The supplier has to provide requisite training about System Administration, Configuration & Network Management to LIC notified two personnel in case the active components are supplied by him.
- Should be in a position to Provide Resident Engineer/ Network Administrator for Managing the Network or if required at additional Man Month Rates.

LOCAL AREA NETWORK SETUP:

A Local Area Network is to be set-up using structured cabling with required connections at various Departments. This has to be done in close coordination with the Engineering Department and IT Department of LIC to ensure the network provides proper connectivity and design requirements and compatibility with the

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existing network set-up of LIC. Structured Cabling work should include information on horizontal, backbone and campus cabling.

- Structured cabling solution shall consist of any or all of the following subsystems:
- Work location subsystem
- Horizontal subsystem
- Administration subsystem
- Backbone subsystem
- Equipment room subsystem
- Campus subsystem, if applicable

The final Engineering diagrams and documentation shall include the following

- Layout of all distributed Frames
- Cable Tray, conduit and Raceway Plans
- Campus Distribution Plan, if applicable
- Equipment room plans as applicable
- Work Area Floor plans
- Building Control Plans, if applicable
- Cable records and Assignments

It is not the intention of this Tender for the supply of Active components which is proposed to be done by the IT Department of LIC. However, in case, it is required to provide Active components, should such a situation arise, the contractor shall provide the same in consultation with the Department and complete the requisite work. Local Area Network Setup Active components will involve :

- Supply & Installation of Floor switches and Backbone Switches
- Suppliers will be completing Local Area Network. Setup of Active components which will involve Supply, installation, Commissioning and Warranty services.
- In case the active components are supplied by LIC the same shall be installed and all necessary cooperation must be extended for testing and commissioning of the network

6 Post Implementation Support

The Tenderer shall give adequate support and manpower as required by the Department till the work is fully commissioned and properly configured to make it compatible with the existing network and all end user devices connected to it.

GENERAL NETWORKING PARAMETERS

The general networking parameters should conform to the standard parameters for the structured cabling which provides a single network infrastructure with a high degree of future expansion inherent in the design. The cabling system should be able to support full range of IT requirements including Voice, Data, Video & Security systems. The floor cabling to be of Cat-6 cable to ensure data frequencies should be up to 350 MHz. (Performance tested at 600 MHz frequency). The main Back Bone cabling and the network components should cater for supporting the full range of IT requirements of the Zonal office.

CABLING PHILOSOPHY

The cabling should cater for the whole Network in the respective floor (as also with the existing network if applicable) and offer the following :

- Ability to move from system to system without changing the cable network.

- Flexibility for moves and changes.
- A versatile cable system capable of handling video, audio, security & control in addition to data and voice.
- Reduced network management overhead.
- Enhanced vendor independent hardware choice. Independently isolating certain areas from the Network, when required, due to faults.

CABLING LAYOUT

A structured cabling system must be built according to **ANSI / TIA / EIA-568-A / 568-B** standards. Accordingly there shall be six functional sub systems as follows.

Entrance Facility :

The entrance facility introduces cables and associated hardware into the building. It is the demarcation point between carrier and the organisation. The over-voltage protection devices are located here. Entrance facilities could be used for public network services, private network services or both.

Backbone Cabling :

Backbone cabling provides interconnections between telecommunications closets, equipment rooms and entrance facilities. It consists of the backbone cables main and intermediate cross-connects, mechanical terminations and patch cords or jumpers used for cross-connection. Backbones may connect closets within a building or between buildings.

Telecommunication closet

The telecommunications closet is where the horizontal distribution cables are terminated. All recognised types or horizontal cabling are terminated on compatible connecting hardware. Similarly, recognised backbone cables are also terminated in the closet. Cross-connection is done with jumpers or patch cords to provide flexible connectivity for extending various services to users at the telecommunications outlets.

Horizontal Cabling

Horizontal Cabling consists of the physical media used to connect each outlet to a closet.

Work area

Work area components extend the telecommunications outlet / connector end of the horizontal cabling system to the station equipment. All adapters, filters or converters that are used to adapt the electronic equipment to the structured cabling system must be external to the telecommunications outlet.

Topology

The proposed structured cabling system shall use star topology. Each work area telecommunications outlet must be connected to a cross-connect in a telecommunications closet. All cables from an area in the respective floor, therefore, run back to one central point for administration. Each telecommunications closets must be star-wired back to the equipment room for the building. In a campus environment, where the cabling extends to two or more buildings, each building is star-wired back to one main administration area.

Unshielded Twisted Pair (UTP) Cables

Cat 6 Product Specifications:

The CAT- 6 cable is envisaged to be used for Data in the horizontal cabling (i.e between Rack to respective Information Outlets). The cable shall meet / supported by the ANSI / TIA / EIA-568-A (568-B) standard.

Cat 5e Product Specifications:

The CAT- 6 cable is envisaged to be used for voice in the horizontal cabling (i.e between Rack to respective Information Outlets). The cable shall meet / supported by the ANSI / TIA / EIA-568-A (568-B) standard.

FIBRE OPTIC CABLE :

The fibre optic cable is envisaged to be used as back bone for the racks. Hence the cabling between HC in the Telecommunications Closet (TC) and the TC at 2nd floor west wing (or 3rd floor East Wing in case L3 switch is housed at that location) shall be of Multimode Fibre optic cable (MMOFC). The MMOFC intended is a 6 core cable. The cable shall meet the ANSI / TIA / EIA-568-A (568-B) standard.

Installation

- Proper installation practices are vital for high performance. Installation tasks such as pulling cables or untwisting cables may degrade overall system performance. Extreme tension on the cable could stretch the twists, or untwist the pairs or increase attenuation. The 568-A / 568-B standard specifies that the pairs in a CAT-6 cable should never be twisted more than half-inch from the point of termination. Additional twisting will increase crosstalk and reduce protection from EMI/RFI. The use of proper pull techniques, pull cords and cable lubricants will prevent this type of damage.
- The cable is bent as it passes through walls, ceilings, floors, ducts and corners. It is crucial not to exceed the minimum bend radius of the cable being installed.
- Terminating the cables involves stripping away some of the protective insulating material and untwisting the conductors. Do not remove more insulation material than necessary.
- After terminating the cables, they have to be 'dressed' or managed. This involves arranging the cables in such a way so as to provide strain relief. Thin plastic strips shall be used to bundle the cables.
- The labeling and marking will be done on each terminal box and cable to identify the pairs. The labeling & marking shall be done in consultation with LIC
- The cables / wires will be run in already laid Raceways / PVC / MS conduits.
- Special care will be taken to isolate wires/ cables from electrical wires and a minimum separation will be maintained to prevent induction / interferences.
- The wiring on the terminal boxes and the colour code scheme of the cable pairs will be in accordance with the standard practice used for such installations.
- The following cable layout documentation will be prepared :
- Main cable distribution layout to the floors with one typical floor distribution layout.
- Cable distribution layout to include detailed cable and terminal box layout on the Plan of the respective floor.

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- Layout diagram of main and intermediate cross connects, mechanical terminations and patch cords and jumpers used for cross connection. Lay-out of Telecom Closet.
- Cable system measurement report. This should consist the detailed summary of the cable installed giving the quantities, make, size and type.
- Detailed cable measurement Sheet Area Wise. This should include the complete record of cable and stores installed in the area giving type, quantities and make.
- Cable test report for cable supplied.

Structured Cabling System

- The cabling and associated work shall be carried out in accordance with the industry standards.
- The cabling solution should be flexible and capable of including new facilities or technologies, as they become required or available.
- The Cabling solution should cover its capacity and functionality with minimum components.
- The vendor shall label all cables and cords, distribution frames and outlet locations, according to industry standards.
- The solution should support analog and digital applications, data, Local Area Net Works and video on a common cabling platform.
- The bidder should provide 20 year Passive product Warranty and Application Assurance from the manufacturer. The responsibility of obtaining the certification from the manufacturer, if required, rests with the Contractor.
- The vendor shall use the existing trenches, conduits for cabling.
- The cabling system proposed by the vendor shall meet the specifications as prescribed in ANSI/EIA/TIA, ISO 11801 and EN 50173 standards.
- The actual quantities of the various items shall depend upon their actual consumption at the time of installation.
- All the conduits and casing capping used during installation used by Contractor should have the ISI mark certification.
- All the cabling components should preferably be from single manufacturer

EQUIPMENT / DATA RACK

The rack shall be of one of the approved makes as listed in the list of approved makes. The rack shall be made out of mild steel of not less than 1.6mm thick and powder coated after due procedures as required. The rack shall be 42U size with suitable cable managers in the sides. The rack shall be provided with casters for facilitating easy movement and shall have screw type adjustable base.

At the Top and bottom of the rack there shall be removable gland plate with requisite knockouts for entry of cables & conduits. The front door shall be of glass contained in an MS frame. The side doors shall be provided with suitable slots at the bottom half portion to facilitate the entry of air. All the doors shall be lockable preferably with a single key. Further all the doors shall be removable, after opening the locks, to facilitate easy working during maintenance. The racks shall be provided with four fans at the top for forced cooling of the components. (Approx. capacity of each fan shall be 90 CFM).

The profile of the rack shall be got approved before placing the order. Power strip with 5 Nos. of 5A / 6A 3 Pin universal or 5 pin sockets, 2 Nos.15A sockets, 1 No.

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Fuse with base & grip and 1 No. neon indicator shall be provided on one of the sides of the rack at the rear portion. The quoted rate for the rack is deemed to be inclusive of the above strips also.

CAT 6 Specifications

- **Cat 6 UTP cables :**
 - 4 pairs, Unshielded twisted pair solid cable, 23 AWG Cat 6 ratings.
 - Meets and exceeds EIA/TIA 568-B.2-1 Cat 6 specifications
 - Centralized separator to reduce the noise level
 - Performance tested at 600 MHz frequency
 - Supports Giga applications
2. **Cat 6 Information Outlet:**
- a. **Face Plate**
- High Impact Plastic Body ABS FR Grade
 - Spring Shuttered Front Access
 - Flush or Surface mountable with a back mount frame.
- b. **Keystone Jack Module with bezel**
- Performance exceeds EIA/TIA 568-B.2-1 Cat 6 specifications
 - Flame retardant Plastic body UL-94V-0 rated
 - Spring contact : 50 micron over 100 micron nickel
 - Current rating : 1.7 Amps
 - Contact resistance : 15 Ohms max
 - Insulation resistance:500M-Ohms min
3. **Cat 6 Patch Cords:**
- a. **Patch cable**
- Multi-strand and highly Flexible 4 pair 100 Ohms patch cables
 - Should meet and exceed TIA/EIA 568-B.2-1 cat 6 specifications
 - Pairs separated by PE former to control the noise.
 - HDPE insulation over the conductors
 - In different colors (floorwise) .
- b. **RJ 45 connector**
- Three piece, two layered design
 - Gold contacts, 50 micron gold over nickel; polycarbonate housing UL94V
 - Voltage : 30V Current: 1.5A
 - Contact Resistance : 20 M –Ohms
 - Connection : 8P8C
 - Wiring : 24- 26 AWG

CAT 5e Specifications

4. **Cat 5e Information Outlet:**
- a. **Face Plate**
- High Impact Plastic Body ABS FR Grade
 - Spring Shuttered Front Access
 - Flush or Surface mountable with a back mount frame.

b. Keystone Jack Module with bezel

- Performance meets or exceeds EIA/TIA 568-B.2-1 Cat 5e specifications
- Flame retardant Plastic body UL-94V-0 rated
- Spring contact : 50 micron over 100 micron nickel
- Current rating : 1.7 Amps
- Contact resistance : 15 Ohms max
- Insulation resistance:500M-Ohms min

5. Cat 5e patch panel:

- Performance should meet or exceed TIA/EIA 568-B.2-1 cat 6 specifications
- Aluminum Metal Frame 1.2 mm thick, 82 x 44.5mm, light weight.
- Three front bezels of 8 ports each made of high impact FR grade ABS
- Two side bezels to give extra grip and elegance.
- Cable manager provided with cable tie cutouts for firm grip on the cables. Made up of High Impact FR grade ABS.
- Tested by ERTL and UL in channel performance as per the standards.

6. Cat 5e Patch Cords:**a. Patch cable**

- Multi-strand and highly Flexible 4 pair 100 Ohms patch cables
- Should meet and exceed TIA / EIA 568-B.2-1 cat 6 specifications
- Pairs separated by PE former to control the noise.
- HDPE insulation over the conductors
- In different colors (floorwise) .

b. RJ 45 connector

- Three piece, two layered design
- Gold contacts, 50 micron gold over nickel; polycarbonate housing UL94V
- Voltage : 30V Current: 1.5A
- Contact Resistance : 20 M –Ohms
- Connection : 8P8C
- Wiring : 24- 26 AWG

7. LIU : Lightguide Interface Unit :

the OFC shall terminate in a LIU. All the six cores shall be terminated and the balance 6 connectors in the LIU shall be blanked off suitably as per standard practice. The LIU shall meet the requirements of IEEE.

LIU connectors :

- The connectors shall be of LC SC type
The Tenderers may note that, for Terminations:
- For MMOFC One termination involves termination of all the six cores (or 12 cores if it is a 12 core cable) in LIU or the switch as the case may be. Thus one termination means one end of the cable fully terminated. One cable terminated on both the ends means 2 terminations.
- Similarly for 100 pair cable / 50 Pair cable pair cable (for voice) : One termination involves termination of all the 100 pairs / 50 Pairs pairs cable in the krone or

equivalent as the case may be. Thus one termination means one end of the cable fully terminated. One cable terminated on both the ends means 2 terminations.

- The Tenderer should provide 20 year Passive product Warranty and Application Assurance from the manufacturer. The responsibility of obtaining the certification from the manufacturer rests with the Tenderer and the quoted rates by the tenderer is deemed to be inclusive of the same.

Specification Required for Switches if applicable :

- IEEE Standards Compliance
- Ethernet: IEEE 802.3, 10BASE-T
- Fast Ethernet: IEEE 802.3u, 100BASE-TX
- Fast Ethernet: IEEE 802.3, 100BASE-FX
- Gigabit Ethernet: IEEE 802.3z, IEEE 802.3x, IEEE 802.3ab
- IEEE 802.1D Spanning-Tree Protocol
- IEEE 802.1p CoS Prioritization
- IEEE 802.1Q VLAN
- IEEE 802.1x
- IEEE 802.1w,
- IEEE 802.3x Flow Control
- 1000BASE-X (GBIC)
- 1000BASE-SX
- 1000BASE-LX/LLX
- RMON I and II standards
- Cables & Patch Cords
- MMOFC 6 core Halogen Free fire Retardant
- Cat 5e EIA / TIA 568 A /B
- Cat 6 EIA / TIA 568 –B.2-1
- Information Outlets
- Cat 5e EIA / TIA TSB - 40 A
- Cat 6 EIA / TIA 568 –B.2-1
- Patch Panels
- Cat 5e EIA / TIA TSB - 40 A
- Cat 6 EIA / TIA 568 –B.2-1
- All features supported must be IEEE standard based features to avoid any interoperability issue with other vendor switch.

**TECHNICAL SPECIFICATION FOR SUPPLY, INSTALLATION, TESTING
AND COMISSIONING OF 08 PASSENGERS LIFT.**

SL. NO.	HEAD	DETAILS
1	NO & TYPE OF LIFT	01 No Passenger Lift.
2	CAPACITY	544 Kg, 08 Passengers.
3	SPEED	1.0 Meter per Second.
4	TRAVEL	Stilt & Four upper floors.
5	STOP & LANDING	5 Stops & 5 Landings. All five openings are on same side.
6	SIZE OF THE LIFT WELL AND CAR INSIDE	1800 mm (W) X 1800 mm (D).(SIZE OF LIFT WELL AFTER FINISHING) 1100mm (W)X 1300mm(D) X 2135 (H)(Approx. Size of Car inside)
7	POWER SUPPLY	415 $\pm$ 10% Volts. 3 phase, 4wire, 50Hz.
8	OPERATION /CONTROL	Full collective control- Simplex
9	MACHINE	Squirrel Cage Induction type or PMS type as per latest I.S. and latest technology.
10	DRIVE	VVVF/ ACVF
11	INDICATORS IN LIFT LANDING	Digital (7Segments) Position & Direction Indicator.
12	DETAILS OF CAR ENCLOSURE	The gauge of stainless steel sheet for car enclosure and door will be of 18 SWG. Car frame shall be of M.S. Car panel will be of stainless steel hairline finish.
13	CAR DOOR / GATE	Automatic Power Operated, Centre Opening Door of 800mm. Stainless Steel with Hair line finishes both Car & Landing Door Entrance/Car Opening.
14	Travel Height	Approximately 15 Meter.
15	INTER COMMUNICATION SYSTEM	Two station Press & Speak Hands Free Intercom. The intercom facility will be in between car & machine room or ground floor.
16	LANDING DOOR	Centre opening door of clear size 800mm x 2000 mm, power operated for every lift, there shall be access to a landing, be fitted with a landing door. Such door shall be fitted with efficient inter-locking or other devices so as to secure that the door cannot be opened except when the lift car is at landing & the lift car cannot be moved away from the landing until the door is closed and locked.

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17	DOOR OPERATION	Fully Automatic Power Operated VF / D.C. Closed loop Double Door, Centre Opening with Vision Panel & Infra red Screen.
18	SIGNAL	Digital Luminous Button & Indicators at Floors. Digital Car Position in the Car. Car Operating Panels with Luminous Buttons. O/L Warning Alarm with Luminous Indicator in Car. If Over Loaded. Alarm Bell operated on Dry (SMF) Battery. Fire man switch.
19	BUFFER FOR CARS & COUNTER WEIGHT	Heavy Duty Spring Loaded Buffers as per latest I.S.
20	SAFETY / PROTECTION	SMF Battery Operated Automatic Rescue Devise. The Rescue operation should function in the event of a power failure.
21	OTHER PROVISION	Supply & fixing MS Tee Section & MS Channel for fixing Brackets etc in Lift well.
22	EMERGENCY ALARM & LIGHT	Dry cell battery (SMF) operated UPS of suitable capacity for emergency alarm and light in car shall be provided
23	OVER LOAD ALARM	Facility to be provided so that door cannot be closed due to overloading.
24	FIREMAN'S SWITCH	To be provided at main landing terminal.
25	Attendant Key	To be provided in car.
26	Infra Red Screen	To be provided.
27	Voice Announcement System	This system is to be provided in the car to announce the position of the elevator in the hoist way as the car passes or steps at a floor served by the elevator.

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**TECHNICAL SPECIFICATION FOR SUPPLY, INSTALLATION, TESTING
AND COMISSIONING OF 10 PASSENGERS LIFT.**

SL. NO.	HEAD	DETAILS
1	NO & TYPE OF LIFT	01 No Passenger Lift.
2	CAPACITY	680 Kg, 10 Passengers.
3	SPEED	1.0 Meter per Second.
4	TRAVEL	Stilt & Four upper floors.
5	STOP & LANDING	5 Stops & 5 Landings. All five openings are on same side.
6	SIZE OF THE LIFT WELL AND CAR INSIDE	1800 mm (W) X 1800 mm (D).(SIZE OF LIFT WELL AFTER FINISHING) 1200mm (W)X 1400mm(D) X 2139 (H)(Approx. Size of Car inside)
7	POWER SUPPLY	415 $\pm$ 10% Volts. 3 phase, 4wire, 50Hz.
8	OPERATION /CONTROL	Full collective control- Simplex
9	MOTOR	Squirrel Cage Induction type or PMS type as per latest I.S. and latest technology.
10	DRIVE SYSTEM	VVVF/ ACVF
11	INDICATORS IN LIFT LANDING	Digital (7Segments) Position & Direction Indicator.
12	DETAILS OF CAR ENCLOSURE	The gauge of stainless steel sheet for car enclosure and door will be of 18 SWG. Car frame shall be of M.S. Car panel will be of stainless steel hairline finish.
13	CAR DOOR / GATE	Automatic Power Operated, Centre Opening Door of 800mm. Stainless Steel with Hair line finishes both Car & Landing Door Entrance/Car Opening.
14	Travel Height	Approximately 15 Meter.
15	INTER COMMUNICATION SYSTEM	Two station Press & Speak Hands Free Intercom. The intercom facility will be in between car & machine room or ground floor.
16	LANDING DOOR	Centre opening door of clear size 800mm x 2000 mm, power operated for every lift, there shall be access to a landing, be fitted with a landing door. Such door shall be fitted with efficient inter-locking or other devices so as to secure that the door cannot be opened except when the lift car is at landing & the lift car cannot be moved away from the landing until the door is closed and locked.
17	DOOR OPERATION	Fully Automatic Power Operated VF / D.C. Closed loop Double Door, Centre Opening with Vision Panel

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		& Infra red Screen.
18	SIGNAL	Digital Luminous Button & Indicators at Floors. Digital Car Position in the Car. Car Operating Panels with Luminous Buttons. O/L Warning Alarm with Luminous Indicator in Car. If Over Loaded. Alarm Bell operated on Dry (SMF) Battery. Fire man switch.
19	BUFFER FOR CARS & COUNTER WEIGHT	Heavy Duty Spring Loaded Buffers as per latest I.S.
20	SAFETY / PROTECTION	SMF Battery Operated Automatic Rescue Devise. The Rescue operation should function in the event of a power failure.
21	OTHER PROVISION	Supply & fixing MS Tee Section & MS Channel for fixing Brackets etc in Lift well.
22	EMERGENCY ALARM & LIGHT	Dry cell battery (SMF) operated UPS of suitable capacity for emergency alarm and light in car shall be provided.
23	OVER LOAD ALARM	Facility to be provided so that door cannot be closed due to overloading.
24	FIREMAN'S SWITCH	To be provided at main landing terminal.
25	Attendant Key	To be provided in car.
26	Infra Red Screen	To be provided.
27	Voice Announcement System	This system is to be provided in the car to announce the position of the elevator in the hoist way as the car passes or steps at a floor served by the elevator.

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GENERAL CONDITIONS FOR SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF LIFT

The work shall be carried out in accordance with the Prevalent Lift Act, Code of Practice for Supply, Installation Testing & Commissioning of Lift for Passenger use as per latest IS / IE Rules. For supervision of Lift installation work, The original equipment manufacturer of the lift shall depute qualified and experienced persons.

SCOPE OF WORK

The scope of this work comprises the supply, installation, testing and commissioning of two nos. passenger elevators with independent fully automatic, simplex fully collective control with / without attendant operation. The rates are inclusive of all necessary material, labour, tools, plants, transportation and incidentals etc. required in planning, execution and completion of the work in totality including obtaining the lift license from statutory authority for operation of the elevators as required.

STANDARD AND CODE:

- Design of elevator and components and their installation and working shall meet the requirement of the relevant Indian Standard Specifications, in particular, IS-14665, IS-1860, IS-4666
- All wiring shall be in accordance with IS 732:1963 or its latest version with National Electrical Code.

PROVISION OF LIFT MACHINE:

Directly on the top of the lift inside the shaft.

SOUND REDUCTION ARRANGEMENT:

Suitable sound reducing rubber pads/cork pads shall be provided under the machine bedplate to reduce the transmission of the vibrations.

CARS & COUNTER WEIGHT BUFFERS:

Heavy-duty spring loaded buffers for both car & counter weight as per standard shall be provided.

GUIDES FOR CAR & COUNTER WEIGHTS:

New guide rails shall be provided.

GATES/DOORS FOR CAR & LANDING:

Doors for Car & Landing to be Stainless Steel with Hair Grain / hairline finish are to be provided and the doors of both Car & Landing should be Power Operated Centre Opening.

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GEARS:

Gearless shall be provided as per standard requirements.

ELECTRIC MOTORS:

New motor of ample capacity with high torque and low starting current designed for lift service and suitable for 415/433/440V, 50 Hz, AC Supply and of Squirrel Cage Induction type and suitable for Variable speed control drive to suits the frequent starts and stoppages and silent in operation shall be provided.

BRAKES:

Brakes shall be provided as per standard requirements.

REVERSE PHASE RELAY:

This shall be provided on the controller to protect the lift equipment against phase reversal, low voltage and phase failure.

CONTROLLER:

The controller shall be Microprocessor Based of the latest design incorporating all modern safety devices and should function on a variable voltage and phase failure.

DRIVE & DRIVING SHEEVE:

It shall be provided according to the specifications to suit the main hoist way ropes and should be Micro processor based single automatic push button / duplex, Collective Selective on either direction and with or without attendant.

HOISTWAY ROPES:

The ropes shall be made of best quality high tensile steel wire and shall confirm to latest IS Specifications.

COUNTER WEIGHT GUARD:

New Counter Weight and Guard are to be provided.

GUIDE SHOES:

These shall be Spring Loaded and shall be of Phosphor Bronze or PVC/ Nylon adjustable guide shoe.

SAFETY DEVICES:

- a) Latest type Safety Devices shall be provided to prevent Car from falling in the event of slackening or rupture of suspension ropes.
- b) Speed Governor, Limit Switches, Final Limit Switches and automatic Electromagnetic Locks shall be provided as per latest design and requirements.

c) **ARD SYSTEM :**

Automatic Rescue Device operated on SMF batteries should be provided to enable the lift to reach the nearest floor and open the door in case of failure of Electricity.

OVERLOADING:

Audio Visual Signal "OVER LOADED" should be provided in the car & the lift should not start when the car lift is overloaded.

INFRA RED SENSOR SCREEN:

Infra Red Sensor Screen should be provided to the doors to avoid closing of doors when the passenger move in or move out from the lift car.

LIFT CAR:

Lift Car should be of the followings:-

- Stainless Steel with Hairline Finish on all four sides
- Granite Flooring,
- False Ceiling with plain acrylic diffuser. The frame of suspended false ceiling shall be powder coated aluminum.
- Recessed type LED Fittings, pressure fan with anodized aluminum grill.
- Control Panel with or without Attendant Mode operation,
- Overload Warning Signal with display and sound etc as per standard.
- Fireman's Switch

WIRING:

All wiring shall be carried out in ISI Marked PVC/ M.S. Conduits. The wires to be used for the wiring shall be PVC insulated Copper Conductor FRLS wire of ISI approved makes. The wiring shall confirm to the latest relevant I.E Act & Regulations.

DESIGN STANDARD:

All materials, plant, equipment in the lift system shall confirm to the highest standard & latest design.

SCAFFOLDING:

The contractor shall make his own arrangement for necessary scaffolding required for execution of this lift work.

PAINTING

All exposed elevator metal work shall be given one shop coat of corrosion inhibiting paint before erection and two coats of oil paint of approved make & shade after installation.

INTERCOM

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Each lift shall be provided with intercom in the car and master control, one no at guard room and one no in Lift Machine Room / near to lift shaft at desired place. This also includes all the wiring, equipments etc as required and this system shall be connected to the emergency electric power of the lift.

TRAILING CABLE:

The controlling cable of reputed make & ISI marked shall be flexible and shall be suitably suspended to relive strain in the individual conductor.

TEST AFTER INSTALLATION:

After the completion of the lift work and before the same put into operation, the test as follows shall be carried out by the Contractor :-

- i. To determine Insulation Resistance between various wiring and the Earth.
- ii. To determine Earth Continuity of Electrical Installation.
- iii. To determine that the Motor Brake, Door Locking Devices etc.
- iv. To determine that the Motor attains the rated speed at the rated load.
- v. To determine that the speed gear stops the lift car while carrying the rated load.
- vi. Two tests shall be carried out – one with contract load and the other with empty car with ropes attached and all electrical apparatus attached.
- vii. Dead Load test shall be carried out by subjecting the equipment to the maximum dead load for half an hours. The equipment should be capable of retaining this load for the specific period without signs of permanent distortion.
- viii. Testing of the Safety Devices provided to prevent the Car from falling in the event of slackening or rupture of suspension ropes.

The entire tests shall be carried out to the satisfaction of the LIC of India as well as the Electrical Inspector and other authorities associated with lift and all arrangements including test instruments and electricity shall be arranged by the Contractor and necessary clearance /test certificate for operation of lift shall be obtained from the concerned Authority/Authorities and submitted to LIC of India prior to commissioning of the lifts and the quoted amount to include for the same.

Requisite inspection charges as required by the inspection authorities are to be deposited with the state treasury. This amount shall be reimbursed on submission of the copy of the treasury challans.

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TECHNICAL SPECIFICATION FOR SUPPLY, INSTALATION, TESTING AND COMMISIONING OF SOLAR WATER HEATING SYSTEM

FLAT PLATE SOLAR WATER HEATING SYSTEM

The solar water heating system of 1500 LPD capacity and 500 LPD at 60 °C will be installed at LICI, Sales Training Center, Pandeypur, Varanasi, Uttar Pardesh.

STANDARDS

The details of the standard which contain minimum performance requirement along with the test method are as follows.

1. Solar Flat Plate Collector

- a) IS12933 (Part-1) : 2003, Solar flat plate collector – Specification, part 1- Requirement
- b) IS12933 (Part-2) :2003, Solar flat plate collector-Specification, Part-2- Components
- c) IS12933(Part-3) :2003,Solar flat plate collector–Specification, part-3- Measuring Instruments
- d) IS 12933 (Part-5) :2003 , Solar flat plate collector-Specification, part-5- Test Method

2. MNRE Specification for test procedure

Test procedure for Thermo-symphonic solar water heating systems are available on MNRE web site www.mnre.gov.in should be followed.

Test Report & Testing laboratory /center

The Solar Collector must be tested at any test centers in the country which is recognized by BIS for carrying out certification testing for solar water heating system as per Indian Standard. Only Collector as per BIS specification No- 12933 solar flat collector and also BIS marked will be supplied.

Other requirement of water heating system

1. Overall dimension of collector

Size	Length (in mm)	Height(in mm)	Width(in mm)
A	1860± 10	100±10	1240± 10
B	2120 ± 10	100± 10	1040± 10
C	2060± 10	100± 10	1055± 10

2. **Cover plate :-** The cover plate shall be single piece tempered / toughened glass and minimum of 4 mm thick, free from bubbles and rough surface as per the latest BIS specification (IS: 12933 part-2: 2003) The solar transmission of the cover plate shall be minimum 82% at near normal incidence.

3. **Collector Box: -** The collector box shall be made of aluminium section only. Type, grade, size, workmanship and finish of the material used shall be as per

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latest BIS specification. The minimum thickness of Aluminium shall be as under.

Channel Section for sides	1.6mm
Sheet for bottom	0.7mm
Support for glass retaining	1.2mm
Sheet for entire body	1.0mm

4. Absorber:-The absorber consists of risers, headers and sheet for absorber.

- (a) Material :- Copper sheet and copper tubes
- (b) Thickness :- 34 SWG (IS-191)
- (c) Copper tubes (Riser) : Diameter = 12.7 mm($\pm$.5mm)
Thickness =24 SWG (IS-2501)
- (d) Header Diameter = 25.4 mm ($\pm$.5mm)
 Thickness = 22 SWG
 Projection = 40mm ($\pm$.5mm) outside the collector box including the flanges.
- (e) Space between riser tubes: Maximum 12 cm from centre to centre of the riser.
- (f) Bonding between riser and sheet. - Full length of all risers shall be welded with absorber sheet. In case of brazing / soldering / TIG welding of continuous nature, unbrazed / unsoldered portion should not exceed more than 10 % of the length of the riser. For brazing / soldering, minimum 60% tin solder or suitable brazing material shall be used. The flux used for soldering / brazing shall be non greasy.
- (g) Header- riser joints:- The assembly of riser with the header shall ensure the tube protrusion inside the header not exceeding 3mm. The riser shall be brazed / welded with header.
- (h) Absorber coating: - ***In all systems selective coating shall be used. The selective coating shall have emissivity <0.2 and absorbitivity > 0.92.***
- (i) Absorber area:- 2 sq.m per 100 LPD at 60 °C.

Testing of riser –Header: - Riser and header assembly designed for working pressure up to 245 kPa (2.5 Kg/cm²) shall be tested for leakage at a minimum hydraulic pressure of 490 kPa (5Kg/cm²). The system designed for higher pressure than 245 kpa, the assembling shall be tested at a pressure twice the designed pressure.

Collector box installation:-

- (a) Back & side insulation: - Minimum 50mm thick insulation of rock wool / glass wool / mineral wool shall be provided. Thermal resistance of insulation materials shall be minimum 0.96 square meter °C /W for back insulation and minimum 0.48 square meter °C /W for side insulation. The collector box insulation shall conform to latest BIS specification. (IS 3346).
- (b) Aluminium foil of thickness of .016 mm $\pm$ 0.005 mm shall be used for covering the back as well as side insulation.
- (c) Back and side insulation shall withstand at 175°C.

Gaskets and grommets: - The load of the absorber should not be on the insulation. It should be taken by the collector box. Insulation should not be allowed to slide. Gasket used for sealing the glass with collector box may be of Neoprene / Silicon / EPDM rubber channel section. Grommets for sealing the collector box and the header joint may be one of the following types and shall fit properly so that no dust can pass through the joints:

- a) Neoprene rubber,
- b) EPDM,
- c) Silicon rubber

Grommet and gaskets shall be capable of withstanding temperature up to 125° C and shall conform to thermal shock test.

Header flanges: - Copper / brass flanges of 62mm ± 3mm diameter and minimum thickness of 4mm with provision for 4nos of brass nut and bolts with diameter of 5mm - 6mm shall be used. Flanges shall be brazed to header and brazing tested for leakage to test pressure. In no case crude solder flanges shall be used. Assembly of the flanges should be at right angle to the header area to ensure proper assembly at the side of the insulation.

Heating of supply water: Heating of supply water shall be of indirect type (through heat exchanger) and first fill of make water and subsequent top up of the same during Defect Liability Period (D.M water) shall be arranged by the vendor without any extra cost.

Assembly of the Collector:-

- a) The collector shall be assembled in such a way that the weight of the absorber is distributed uniformly on the side wall of the collector box.
- b) The entire assembly shall be free from surface defects. All sharp edges and corners shall be rounded off. The exposed surfaces shall be properly made corrosion resistant.
- c) The air gap between the cover plate bottom and the absorber surface shall be within 20mm to 40mm.
- d) The glass should be firmly held, without strain taking in to account the expansion of glass. Top surface along with the edge between the glass and the aluminium angle shall be caulked with suitable sealant such as zinc oxide based or rubber based or silicon rubber based or epoxy based compound.

Gasket for Flanges:- 3mm thick compressed asbestos fiber or Neoprene rubber gasket shall be used for sealing the joints between flanges.

Collector Support frame: - The structure shall be in a position to withstand wind velocity of 200 Km/hr. The structure shall be made with angle iron stronger than 35mm X 35mm X 5mm and shall have the vertical support at top and bottom edge of the inclined plane of the collector at a distance of 2.5 m or less. The vertical support shall be firmly grouted to the roof or in the ground in case of ground mounted system. The grouting blocks shall be minimum 25cm X 25cm X 15cm and finished properly. In case of grouting is carried out on a roof already water proofed with asphalt, the back support of the collector may be anchored to the parapet or the size of the grouting block shall be increased to provide for a dead load weight anchoring of 75 Kg per leg of the vertical stand.

The collector support frame shall be rectangular shape i.e. having all four sides touching the collector edge. The cement pedestals should be made after chipping

of the existing rooftop to provide proper gripping and strength. Structure should be such that collector's bottom side is at least 30 cm above the ground/roof level. In case of inclined roof, the collector housing frame along with the vertical angle shall be mounted & fixed using suitable necessary structure keeping in view the load bearing capacity of the roof top ensure the stability against storm. The collector should be properly clamped and tightened with frame and supporting structure at both the ends by 20mmX 2mm size MS strip consisting rubber packing to avoid chemical reaction between the collector bodies and clamp. Last row of collector supporting structure should be grouted throughout its length opposite to collector facing with c.c. work ratio 1:2:4 of size 25cm X 30cm (d x h i.e. height X width) and then plaster with cement.

Painting of stand: - Proper cleaning and degreasing of the surface should be done before painting. Two coats of zinc chromate red oxide primer shall be applied followed by one coat of enamel paint. Suitable anticorrosion paint should be applied after proper treatment.

Storage tank

Materials: - The storage tank should be made of stainless steel SS 304/316 . The thickness of the SS Sheet should be 18 gauge (1.2mm). Socket and internal fittings should be stainless steel.

Insulation: - Insulation should withstand temperature of 100 ° C. Thin polythene sheet shall be used as covering between the glass wool and the cladding sheet besides the retaining materials such as chicken mesh etc. Aluminium sheet of thickness, 22 SWG / GI sheet of minimum 24 SWG shall be used for cladding the tank insulation. External of the tank should be properly insulated so that hot water temperature does not decrease by more than 5 degree C in about 16 hours times.

The storage tank shall be properly installed at site using enameled coat appropriate size angle iron stand, girder cement pedestals of 1:2:4 ratio or any other specific provision suitable to site to ensure the stability against heavy storm etc.

Piping:-

½ inch to 2 inch dia ISI marked GI pipe, medium class of IS 1239 shall be used for piping. 50 mm thick rock wool insulation of 48 Kg/cum density be used for hot water pipes. Thin plastic sheet shall be used as covering between rock wool and aluminum cladding besides other retaining materials like chicken mesh etc. 26 SWG thick aluminum sheet shall be used for cladding the insulated pipe. The pipe line should be properly supported and fixed with clamp with the help of suitable size stand/civil structure (cement concrete ratio 1:4). ISI mark gunmetal strainer of standard make should be fitted in the main cold water supply line before the system.

Valves/Nipple/tees/bend/taps:-

Gunmetal valve as per ISI specification shall be used. Nipple / tees and bends shall be of medium class G I (B-class) / brass or copper. Gunmetal valve in each row shall be provided. TAPs of stainless steel ISI mark or reputed make shall be provided.

Temperature gauge:- Temperature gauge (ISI mark) :- one for hot water storage tank / outlets – dial type – duly calibrated and suitable for temperature ranges (0 to 120 ° C)

Cold water tank: -

- a) Only Syntax or equivalent materials and it should be as per the capacity of the solar water heating system. Supply of cold water tank is not within the scope of the supplier. The same is to be provided by LIC of India. The supplier should install / grouted on suitable stand and do necessary connection for proper function of the system.

Make up tank: - A suitable make up water tank should be provided with the system. Materials may be syntax or equivalent.