

TENDER DOCUMENTS

CONSTRUCTION (GREY STRUCTURE) OF NATIONAL BANK OF PAKISTAN MAIN BRANCH MIRPURKHAS & REGIONAL OFFICE MIRPURKHAS BUILDING, MIRPURKHAS REGION

BIDDING & CONTRACT DOCUMENTS

VOLUME-II

- SPECIFICATIONS

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CONSTRUCTION (GREY STRUCTURE) OF NATIONAL BANK OF PAKISTAN
MAIN BRANCH MIRPURKHAS & REGIONAL OFFICE MIRPURKHAS BUILDING, MIRPURKHAS REGION

NATIONAL BANK OF PAKISTAN

CONSTRUCTION (GREY STRUCTURE) OF NBP MAIN BRANCH AND REGIONAL OFFICE BUILDING MIRPURKHAS, REGION

SPECIFICATIONS VOLUME II

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SECTION – 0100

GENERAL REQUIREMENTS

1. GENERAL

- 1.1 The General Conditions of Contract Part I & II in Volume I of Tender & Contract documents shall form an integral part of these General Requirements.
- 1.2 The Contractor shall notify all sub-contractors of the provisions of the Special and General Conditions of Contract and the General Requirements of this Specification.
- 1.3 The arrangement and divisions of these Specifications is not to be construed establishing the limits of responsibility of sub-trades.
- 1.4 The Contractor is responsible for delineating the scope of sub-contracts and for coordinating all the works.
- 1.5 All works shall be carried out in accordance with the following specifications, supplemented by detailed specifications contained in the following sections. Any inconsistencies or ambiguities shall be brought to the notice of the Engineer for his clarification/ decision. Decision and direction of the Engineer, in all such cases, shall be final and binding.
- 1.6 The Contractor shall make himself thoroughly familiar with the site conditions, foresee any and all problems likely to be encountered during execution of the works, and shall be able and ready to solve them effectively. Proposals for solutions to the problems shall be submitted to the Engineer for approval before proceeding with the work.
- 1.7 The B.O.Q, Tender Drawings, Specifications are to be read in conjunction and shall be mutually explanatory. In case of any conflict the order of preference shall be as under duly followed by the Special and General Conditions of Contract in Volume I of Tender & Contract documents.
 - i) Specifications
 - ii) Tender Drawings
 - iii) Bill of Quantities

2. APPLICABLE STANDARDS

In the absence of other Standards being required by the Contract Documents, all work and materials shall meet the requirement of the Uniform Building Code of the United States, and/or applicable American Society for Testing Materials (ASTM) Specifications, and the latest American Concrete Institute Manual of Concrete Practice and American Institute of Steel Construction (AISC) Manual relevant to the Works, except in cases where the National Building Code of Pakistan requires a

higher standard. In such cases the Pakistani Code shall govern. Where the abbreviations listed below are used, it refers to the latest code, standards, or publication of the following organizations.

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASA	American Standard Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Material
AWS	American Welding Society
BSI	British Standards Institute
BSICP	British Standard Institute Code of Practice
PCA	Portland Cement Association
PSI	Pakistan Standard Institute
AASHTO	American Association of State Highway and Transportation Official
UBC	Uniform Building Code
UPC	Uniform Plumbing Code

Should the Contractor, at any time and for any specific reasons, wish to deviate from the above standards or desires to use materials or equipment other than those provided for by the above standards, then he shall state the exact nature of the change giving the reasons for making the change and shall submit complete specifications of the materials and descriptions of the equipment for the Engineer's approval, whose decisions shall be conclusive and binding upon the Contractor.

3. **CODES, STANDARDS, CERTIFICATES**

3.1 The Contractor shall supply and have at his site office:

3.1.1 Copies of all latest editions of codes and standards referred to in these Specifications or equivalent codes and standards as approved by the Engineer.

3.1.2 Catalogues and published recommendations from manufacturers supplying products and materials for the project.

3.2 The Contractor shall provide manufacturer or supplier's certificates to the Engineer for all products and materials, which must meet the requirements of a specific code or standard as stated in these Specifications.

4. **MANUFACTURER'S RECOMMENDATIONS**

Installation of manufactured items shall be in accordance with procedures recommended by the manufacturer or as approved by the Engineer.

5. **UNITS OF MEASUREMENTS**

The FPS System of Units shall be used throughout the Project.

6. **PLANT, EQUIPMENT AND TOOLS**

The Contractor shall provide at his cost modern plant, equipment and tools, adequate and befitting to the nature, magnitude and size of this Contract, in strict compliance with the requirements of the General Conditions of Contract.

7. STORAGE & HANDLING FACILITIES

The Employer will provide the necessary space, as available with him, for constructional activities including batching plant, laboratory, workshop, storage of plant, equipment and materials and for Contractor's temporary office/camp, during the currency of the Contract. Additional space, if and as required by the Contractor, shall be arranged by the Contractor without additional cost to the Employer.

8. TEST LABORATORY AND TESTING

8.1 Testing, except as otherwise specified herein, shall be performed by testing agency approved by the Engineer and at no extra cost to the Employer. The Engineer may require all testing to be carried out under his supervision only.

8.2 The quality control testing shall be performed by the Contractor's competent personnel in accordance with a site testing and quality control program to be established by the Contractor and approved by the Engineer.

The Contractor shall keep a complete record of all quality tests performed on site.

All quality control and tests shall be carried out in accordance with applicable standards and codes.

8.3 The Contractor, after the approval by the Engineer for the source of the cement and steel, shall make available at the site sufficient stock of the materials in advance in order to allow sample testing to prove quality before they are used.

9. CONSTRUCTION & CHECKING AT SITE

The Tenderers shall provide with their Tender a list of the main Constructional equipment they would propose to use on site.

The Contractor shall submit to the Engineer in due time for approval and discussion, his proposals and plans as to the method and procedure to be adopted for the execution of permanent works involved.

The submitting of these suggestions and arrangements, and the approval thereof by the Engineer shall not relieve the Contractor of his responsibilities and duties under the Contract.

The carrying out of all work included in the Contract is to be supervised by a sufficient number of qualified representatives of the Contractor and full facilities and assistance are to be afforded by the Contractor for the Engineer or his Representative to check & examine the execution of the work.

The Engineer reserves the right to inspect all parts of the works but may at his discretion waive inspection on certain items. This shall in no way absolve the Contractor from his responsibilities. This particularly applies to the checking of materials, the plumbing of all columns/drain walls and to the levelling, setting and aligning of the various parts and of road work and to the proper fitting and adjustment of manufactured and finished materials and fixtures in position.

If the Engineer or his Representative sees that the work progress is slow in such a way that the works or parts thereof will not be completed in the time specified, then he shall order the Contractor to work overtime or in shifts and the Contractor shall comply. These arrangements will be free of all financial encumbrances and at no additional costs to the Employer.

In the event of night work, the Contractor shall provide sufficient and adequate lighting to the satisfaction of the Engineer or his Representative and shall supply the necessary manpower for satisfactory continuation of the work after normal hours.

9.1 Site

Within the Project area limits as defined on the Drawings, the Contractor shall carry out and perform the construction works, and subject to the approval of the Engineer will be permitted to construct temporary road- way camps, buildings and temporary works which he may require for the execution of the work. If the Contractor wishes to use other land for camps he shall pay all rentals or other costs connected therewith.

10. **BAR BENDING SCHEDULE**

Bar bending (reinforcement bars) schedule of all drawings shall be prepared by the Contractor and submitted in triplicate to the Engineer for approval.

11. **SHOP DRAWINGS**

11.1 The Contractor shall submit with sufficient promptness as to cause no delay in the Works, copies of all shop or setting drawings and schedules required for the Works or which have been specifically requested by the Engineer. The Engineer will check and approve with reasonable promptness such schedules and drawings for conformity with the provisions, with the design concept of the Works and compliance with the provisions of the Contract Documents. The Contractor shall make any corrections in the schedules and drawings as required by the Engineer and resubmit further sepias and prints thereof until approved by the Engineer. The Engineer will arrange to issue such copies of the approved shop drawings and schedules as may be required by any nominated sub-contractor or other contractor, but the Contractor will be responsible for making all copies necessary for his own use and the use of his sub-contractor.

11.2 Where adjoining work requires shop drawings the Contractor shall prepare and submit composite shop drawings which shall show and define the work under all affected trades. If the Contractor installs work before coordinating with other trades so as to cause interference with work of those trades, he

shall make changes necessary to correct the conditions without extra cost to the Employer.

11.3 No changes shall be made by the Contractor in the resubmitted shop drawings in excess of the corrections spelled out by the Engineer and in a separate note on the shop drawings.

11.4 No work in the shop shall be started and no material or equipment ordered until the Engineer has approved the shop drawings. It shall be the responsibility of the Contractor to submit the shop drawings on a schedule that allows reasonable time for checking and approval and subsequent fabrication. Failure to submit shop drawings in ample time for checking, correcting, and rechecking will not justify a delay in time for completion of work.

12. **AS BUILT DRAWINGS**

The Contractor shall, at all times, keep on site a separate set of prints on which shall be noted neatly, accurately and promptly as the work progresses all significant changes between the work shown on the drawings and that which is actually constructed.

At the completion of the works, the Contractor shall at his expense, supply the Engineer with reproducible copies of these drawings.

13. **PROTECTION OF THE WORKS**

The Contractor shall whenever necessary cover up and protect the works from weather and damage by his own or other workmen performing subsequent operation. He shall provide all necessary dustsheets, barriers and guard rails and clear away the same at completion.

14. **RESTORATION AND CLEANING**

Upon completion of the works the Contractor shall restore all items covered by the Contract to the satisfaction of the Engineer.

The Contractor shall do regular cleaning and cleaning away all rubbish and excess materials that may accumulate from time to time on completion and before handing over. Upon completion of the works he shall obliterate all signs of temporary construction facilities such as work areas, structures, foundations of temporary structures, stock piles of excess or waste materials, or any other vestiges of construction, as directed by the Engineer. All buildings shall be cleaned, floors and paving scrubbed and the works and site shall be left in a clean and satisfactory state for immediate use and occupation. Care shall be taken not to use any cleaning materials, which may cause damage to the surface to be cleaned.

The Contractor shall also take all necessary precautions to keep the works and site free from vermin during construction and he shall leave the works vermin free on completion. Application of pest control agents shall not commence until the specific product, name, method and extent of application have been submitted to and approved of by the Engineer.

15. **PRODUCT DATA**

Manufacturer's catalogue sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard descriptive literature shall be clearly marked to identify pertinent materials products or models. Dimensions and required clearances shall be indicated.

16. **SAMPLES**

16.1 The Contractor shall furnish for approval of the Engineer with reasonable promptness all samples as directed by the Engineer or specifically called for in these Specifications. The Engineer shall check and approve such samples with reasonable promptness only for conformance with the design concept of the Works and for compliance with the information given in the Contract Documents. All work shall be in accordance with approved samples.

16.2 Samples shall be furnished so as not to delay fabrication, allowing the Engineer reasonable time for consideration of the sample submitted.

16.3 Each sample shall be properly labeled with the name and quality of the material, manufacturer's name, name of the project, the Contractor's name and the date of submission, and the Specifications Article number to which the sample refers.

16.4 The manufacturer's installation directions shall be provided with each sample. The Contractor shall pay all transportation costs and deliver samples to the Engineer's office, Site or testing laboratory as directed by the Engineer.

16.5 Samples shall be of adequate size to permit proper evaluation of the material by the Engineer. Where variations in colour, texture, dimensions or other characteristics are to be expected, the Contractor shall submit samples showing the maximum range of variation. Materials exceeding the range of variation of the approved samples shall not be used on the Work.

16.6 In order to permit coordinated selection of colours and finishes, the Contractor shall deliver samples of all items of interior finish to the Engineer at one time. Samples of such materials will not be approved until all related samples have been submitted.

16.7 If both Shop Drawings and samples are required for the same item, the Engineer may require both to be submitted before approving either.

16.8 No acceptance or approval of any Shop Drawings or sample, or any indication or request by the Engineer on any Shop Drawings shall constitute an authorization for any increase in the Contract Sum.

17. **QUALITY OF MATERIAL**

- 17.1 All materials and supplies furnished under the Contract Documents shall be new and of standard first grade quality and of best workmanship and design. No inferior or low grade materials supplies or articles will be either approved or accepted and all works of construction shall be made in neat, first class and workmanlike manner.
- 17.2 Prior to procurement, the Contractor shall furnish to Engineer for his approval, the names of the manufacturers of all equipment and materials which he contemplates incorporating in the Works, samples of material shall be submitted to the Engineer for approval. Equipment, material supplies and articles installed or used without the Engineer's approval shall be at the risk of subsequent rejection.

18. **INSPECTION & TESTS REPORTS**

- 18.1 All equipment and materials furnished under these specifications and all work performed in connection therewith will be subject to rigid inspection by the Engineer. Acceptance of equipment and material or the waiving off inspection thereof shall in no way relieve the Contractor of his responsibility for meeting the requirements of the Contract.
- 18.2 The Contractor shall furnish to the Engineer's Representative four certified true copies of reports of the tests of all materials used in the manufacture and fabrication of all equipments and material. The result of these tests shall be in such form as to show compliance with the applicable specifications, standards and codes for the material used.

19. **TEMPORARY FACILITIES**

The Contractor shall provide, erect or install, maintain alter as necessary and remove on completion or when directed by the Engineer all such temporary facilities and services, not required by the Client, including access roads as described hereinafter and/or in the Contract Document and/or instructed and approved by the Engineer.

The temporary office shall be available for use not later than one month after the date of the site handing over. Installation of temporary services at the site shall be given priority over all other construction at the site.

19.1 Site Office

The contractor shall construct, provide and maintain Engineer's and Employer's Site Office in accordance with the provisions as laid down in the Contract document.

19.2 Temporary Roads

The Contractor shall prepare and maintain such temporary roads as may be necessary, from the site to the nearest road and also within the plot. Such roads shall be positioned strictly in accordance with the Engineer's

instructions and the Contractor shall reduce or control any dust nuisance by spraying the water as directed.

19.3 Temporary Services

19.3.1 Temporary Water Supply

The Contractor shall supply in sufficient quantity all necessary potable and other water for construction purposes for all trades at point within a reasonable distance of any building being constructed. He shall make arrangements and pay charges for water service installation, maintenance and removal thereof, and pay the costs of water for all trades.

The Employer may assist the Contractor by providing connection from the existing water distribution system at site, provided the Contractor obtains the written approval of the Engineer and the Employer and assumes full responsibility for the entire water distribution and maintenance of the system and pays all the charges, costs in this regard.

At completion of the work, the temporary water services equipment and piping shall be removed by the Contractor at his own expense.

19.3.2 Temporary Electricity

The Contractor shall make all the necessary arrangements for a temporary electricity service, pay all expense in connection with the installation, operation and removal thereof and pay the costs of electricity consumed by all trades.

A temporary lighting system shall be furnished, installed and maintained by the Contractor as required to satisfy the minimum requirements for safety and security and to the satisfaction of the Engineer.

When the permanent electrical power and lighting systems are in an operating condition, they may be used for temporary power and lighting for construction purposes provided that the Contractor obtains the written approval of the Engineer and the Employer and assumes full responsibility for the entire power and lighting system and pays all costs for operation and maintenance of the system.

At completion of construction work, or at such time as the Contractor makes use of permanent electrical equipment and devices, temporary electricity services shall be removed by the Contractor at his own expense.

19.3.3 Waste Disposal

The Contractor shall make such temporary provisions as may be required in order to dispose of any chemicals, fuels, oils, grease, bituminous materials, waste and soil waste and the like without causing pollution to either the site or the environment. Disposal of any materials, wastes, effluent, garbage, oil, grease, chemicals and the like shall be in areas specified by the concerned local authority proposed by the Contractor and subject to the approval of the Engineer. If any waste material is dumped in unauthorized areas the Contractor shall remove the material and restore the area to the condition of the adjacent undisturbed area. If necessary, contaminated ground shall be excavated, disposed off as directed by the Engineer and replaced with suitable fill material compacted and finished with topsoil all at the expense of the Contractor.

19.3.4 Fire Protection

The Contractor shall provide and maintain adequate fire protection in the form of barrels of water with buckets, fire bucket tanks, fire extinguisher, or other effective means ready for instant use, distributed around the project and in and about temporary inflammable structures during construction of the works.

Gasoline and other flammable liquids shall be stored in and dispensed from safety containers approved by the Engineer and storage shall not be within building.

Torch-cutting and welding operations performed by the Contractor shall have the approval of the Engineer before such work is started and a chemical extinguisher is to be available at the location where such work is in progress.

The Contractor shall follow the instructions and specifications of the Civil Defence Department.

19.3.5 Sign Board

The Contractor shall provide 2 (two) signboards (4'x6') to be fixed in a position to be approved by the Engineer. The Contractor shall paint on this signboard the name of the work, the names of the Contractor, the Employer and the Engineer.

20. CONSTRUCTION SCHEDULE

- 20.1 A Construction schedule based on CPM shall be maintained in accordance with the provisions of the General Conditions of Contract.
- 20.2 The schedule shall be accompanied with sufficient data and information including all necessary particulars of constructional plant, equipment, machinery, temporary Works, arrival of plant, equipment at site and their installation, method of operation, work forces employed, etc, for all activities of the Works.
- 20.3 Should the Engineer consider any alteration or addition in the Program and time schedule, the Contractor shall conform thereto without any cost to the Employer.
- 20.4 Whenever necessary and wherever the progress of the actual works shows departure, the program and time schedule shall be updated and submitted to the Engineer for his approval.

21. CONSTRUCTION PROCEDURES

The Contractor shall advise the Engineer of proposed construction procedures in accordance with the General Conditions of Contract.

If the Engineer shall see that the work progress is slow in such a way that the work will not be complete in the time specified, then he shall order the Contractor to work overtime or in more shifts and the Contractor shall obey these orders free from additional payments and without any objections or request for compensation.

22. NOTIFICATION TO ENGINEER

The Engineer shall be notified daily in writing of the nature and location of the Works the Contractor intends to perform the next day so as to enable necessary inspection and measurement to be carried out. The Engineer may, if necessary, direct that longer notice be given of certain operations.

23. NIGHT WORK

When work is done at night the Contractor shall maintain from sunset to sunrise such lights on or about his work and plant as the Engineer may deem necessary for the proper observations of the work and the efficient execution thereof.

24. WEATHER

No work is to be undertaken when, in the opinion of the Engineer, the weather is so unsuitable that proper protection of the work cannot be ensured.

25. SUBMISSION REQUIREMENTS

- 25.1 Schedule submission at least thirty days before the dates when reviewed submittals will be needed.

- 25.2 Submit one reproducible transparency and 3 (three) prints of Shop Drawings & Product Data, for approval. Two copies shall be retained by the Engineer & two copies duly approved a disposal shall be returned to the Contractor.
- 25.3 Submit three samples unless otherwise specified.
26. **CO-ORDINATION WITH OTHER CONTRACTORS**
- It shall be the responsibility of the Contractor to co-ordinate and keep-up good relations with other Contractors employed on site by the Employer.
27. **ACCIDENT PREVENTION, PROTECTIVE EQUIPMENT**
- The Contractor shall comply and enforce compliance by all his sub- contractors with the highest standards of safety and accident prevention in accordance with international standards and in compliance with all applicable laws, ordinances and statutory provisions.
- All requisite barriers, fences, warning signs, lights and other safety precautions as required for the protection of persons and property on or adjacent to the site shall be provided at the Contractor's cost.
- All false work, scaffolding and handrails shall be well constructed and secured at all times. Where overhead work is being carried out, warning signs shall be installed at ground level clearly warning of the overhead work.
- All warning signs shall be in two languages, English and Urdu, and shall at all times be maintained in a clean and legible condition, to the satisfaction of the Engineer.
- Trash shall be removed at frequent intervals to the satisfaction of the Engineer.
28. **SURVEY INSTRUMENT**
- The Contractor shall maintain on site the requisite surveying instruments in perfect working conditions to enable the Engineer to check levels and lines of the work at all times.
29. **SETTING OUT**
- 29.1 Setting out shall be done in accordance with the drawings and instructions of the Engineer.
- 29.2 The Engineer will establish bench marks and/or reference lines as shown on the Drawings. All other work shall be laid out from these marks and/or lines.
- 29.3 Temporary piles and other marks used in setting out shall be removed after completion of the required work.
30. **WEEKLY PROGRESS REPORT AND PHOTOGRAPHS**

- a) During the continuance of the Contract, the Contractor shall submit weekly progress reports on forms as approved by the Engineer. Such weekly reports shall show the actual progress completed as of date of the report plotted against the schedule as given by the Contractor at the start of work and shall be broken down so as to indicate status of all activities associated with mobilization design, material procurement, manufacture, surveys works, tests with regard to the agreed contract programme.
- b) When the work commences at the Site, the Engineer shall provide the Contractor with a standard report form which shall be filled in each week and submitted by the Contractor to indicate the progress of construction, and to serve as a basis for making progress payments to the Contractor. The progress indicated on the report each month shall be mutually agreed upon by the Contractor and the Engineer's Representative at the Site before it is formally submitted to avoid delays in making progress payments.
- c) The Employer and the Engineer reserve the right to coordinate the schedules of this Contractor and other Contractors working at the Site, and to adjust and/or change any and all such schedules as required during the course of construction in order to achieve a coordinated project in harmony with the Employer's completion date.
- d) Commencing after the first week of construction, and continuing every week until completion, the Contractor shall have photographs taken, where directed by the Engineer's Representative, to show progress of his work and completion of each structure or major feature.

31. **CONTRACTOR TO NOTIFY DELAYS ETC.**

Any delay which will affect the completion of Works shall be detailed by the Contractor who shall state the action he is taking for effective completion of the Contract programme.

The Contractor shall submit a report in respect of the various sections of the Works, the equipment in use or held in readiness, a return of labour and supervisory staff, and details of any matters arising which may generally affect the progress of the work.

The Contractor shall give a summary of the detailed progress report giving the position with regard to the agreed Contract programme.

The progress reports shall be set out in a format to the approval of the Engineer, and forwarded promptly so that on receipt the information contained therein is not more than 21 days out of date.

If during execution of the Contract, the Employer considers the progress position of any section of the work to be unsatisfactory, or for any other reason relating to the Contract, he will be at liberty to convene a meeting and the Contractor's Representatives are to attend such meetings.

The Contractor's Site Office shall prepare and submit 6 copies of a weekly progress report to the Employer and Engineer's Site Office. This report shall summarize site activities and record and details where difficulties in maintaining the agreed programme are being experienced or are likely to cause subsequent delay.

The Contractor's Site Office shall also prepare and submit to the Engineer's Site Office 6 copies of a Daily Activity Report summarizing the main activities to be undertaken each day, noting special activities such as tests, alignment checks, etc. The Contractor shall be responsible for expediting the delivery of all material and equipment to be provided by him and his sub-contractors.

32. **PHOTOGRAPHS**

As soon as work commences on Site, the Contractor shall provide photographs (at least 10 to 12) of the works from positions to be selected by the Engineer. Each photographic print shall not be less than 297mm x 210mm and shall bear a printed description, a serial number and the date when taken.

The negatives of all photographs shall be held at the Contractor's Site Office, numbered and handed over to the Employer at the completion of the Contract.

The Contractor shall provide a number of selected photographs for submission with each copy of the monthly report as required by the Engineer. The Contractor shall also provide from time to time as and when required by the Engineer, further photographs of the Contract works to record or illustrate specific events.

33. **FACILITIES FOR THE ENGINEER**

33.1 Site Office

The Contractor shall construct, provide and maintain temporary Engineer's Site Office of about 300 square feet covered area with stabilized access road as per the standard specifications. Drawing for the Site Office showing details of accommodation requirements will be obtained from Engineer after receiving Letter of Award. Specifications for construction of Site Office shall be the same as provided in Volume-II of the Tender Documents.

The Engineer's Site Office shall be furnished and equipped with new and unused furniture and equipment as per the list given below:

- | | | |
|----|---|-------|
| 1. | Wooden office table with drawers and side racks (3'-6" x 2'-6"). | No. 2 |
| 2. | Wooden revolving sitting chairs with arms (standard size) | No. 2 |
| 3. | Wooden sitting chairs with arms | |

	(standard size)	No. 4
4.	Steel filing cabinet (Standard size)	No. 1
5	Charishma wooden filing cabinet (standard size)	No. 1
6.	Wooden pigeon hole rack for drawing (3x4x2ft.)	No. 1
7.	A.C Window Type (1-1/2 ton)	No. 1

However, if any equipment, furniture and installations become unserviceable for any reason whatsoever the Contractor shall promptly replace the same as and when directed by the Engineer. The Engineer's Site Office shall be connected to the Electrical System, potable water supply system, sewerage disposal system, non STD telephone lines and an interrupted supply of utilities during the Contract period.

All monthly utility bills pertaining to the Engineer's Site office would be borne by the Contractor. Failure of the contractor to do so shall make him liable to deduct utility bills cost from his due monies under the Contract and would be paid by the Employer directly to the concern department.

The Site Office shall be demolished by contractor and all fittings, fixtures and furnishing shall be the property of the Employer on completion of the Contract.

33.2 Transport

Contractor shall provide transport facility, 1300 CC Corolla Car (with fuel) along with driver for the use of consultant Engineer's site visit, as and when required for the inspection various stages of works and at the time of verification of project running and final payments/ bill etc, from consultants' office Karachi to Mirpurkhas.

34. PAYMENT OF WORK

No payment shall be made for the works involved within the scope of this section of specification unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bills of Quantities.

SECTION - 0120

CONTRACTOR'S CAMP

1. SCOPE

The work to be done under this item consists of construction, erection, installation and maintenance of the Contractor's Project Site Offices or main camp and the Contractor's sub-camps or temporary camps, if any, and shall include all offices, shops, warehouses, and other operational buildings; all housing and related facilities including accommodations for the Contractor's personnel.

The location of the Contractor's camps, including all buildings, utilities and facilities therefor, and of the camps or establishments of all persons/parties in the vicinity operating or associated with the Contractor shall be subject to approval of the Engineer.

The work to be done under this item will terminate upon the actual Completion Date. However, if directed by the Engineer or the Employer, the Contractor shall continue such work to the extent required by the Contractor's personnel during the period of maintenance. No compensation shall be paid for the continued operation and maintenance of the Contractor's Camps during the period of maintenance.

Upon completion of the Works, or at such time within the period of maintenance as directed by the Engineer, the Contractor shall remove all buildings utilities and other facilities from the Site and restore all camp areas to a neat and clean condition.

The construction, operation and maintenance of all camps of the Contractor shall comply with all applicable provisions of current Pakistan Labour Camp Rules.

Adequately equipped and properly staffed portable first aid stations or dispensaries shall be provided by the Contractor at camps and other strategic locations to administer first aid treatment at any time required and free of charge to all persons on the Site, including employees of the Engineer and the Employer.

2. PAYMENT OF WORK

No payment shall be made for the works involved within the scope of this section of Specifications unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bills of Quantities.

SECTION - 0130

STAKE-OUT SURVEY

CONSTRUCTION (GREY STRUCTURE) OF NATIONAL BANK OF PAKISTAN
MAIN BRANCH MIRPURKHAS & REGIONAL OFFICE MIRPURKHAS BUILDING, MIRPURKHAS REGION

1. **SCOPE**

Under this item the Contractor shall make the stakeout survey for construction purposes with competently qualified men, consistent with the current practices. The work shall proceed immediately upon the award of the contract and shall be expeditiously progressed to completion in a manner and at a rate satisfactory to the Engineer. The Contractor shall keep the Engineer fully informed as to the progress of the stakeout survey. The scope of this section of specifications is covered by detailed specifications as laid down herein.

2. **MATERIAL AND EQUIPMENT**

All instruments, equipment, stakes and other material necessary to perform all work shall be provided by the Contractor. These instruments and equipment shall be available to Engineer at all times for the purpose of checking the work of the Contract.

All stakes used shall be of a type approved by the Engineer, clearly and permanently marked so as to be legible at all times. It shall be the Contractor's responsibility to maintain these stakes in their proper position and location at all times. Any existing stakes or markers defining property lines and survey monuments which may be disturbed during construction shall be properly tied into fixed reference point before being disturbed and accurately reset in their proper position upon completion of the work.

3. **CONSTRUCTION**

The Contractor shall trim trees, bushes and other interfering objects, not consistent with the plan, from survey lines in advance of all survey work to permit accurate and unimpeded work by his stake-out survey crews and the Engineer's survey crews. The exact position of all work shall be established from control points, which are shown on the plans or modified by the Engineer. Any error, apparent discrepancy in or absence of data shown or required for accurately accomplishing the stakeout survey shall be referred to the Engineer for interpretation or furnishing when such is observed or required.

The Contractor shall be responsible for the accuracy of his work and shall maintain all reference points, stakes, etc. throughout the life of the contract. Damaged, destroyed or inaccessible reference points, bench marks or stakes shall be replaced by the Contractor. Existing or new control points that will be or are destroyed during construction shall be re-established and all reference ties recorded thereon shall be furnished to the Engineer. All stakeout survey work shall be referenced to the centerlines shown on the Plans. All computations necessary to establish the exact position of the work from control points shall be made and preserved by the Contractor. All computations, survey notes and other records necessary to accomplish the work shall be kept neatly and made available to the Engineer upon request and furnished to the Employer upon Contract completion.

The Engineer may check all or any portion of the stakeout survey work or notes made by the Contractor and any necessary correction to the work shall be immediately made. Such checking by the Engineer shall not relieve the Contractor of any of his responsibilities for the accuracy or completeness of his work.

Reference points, base lines, stakes and benchmarks for borrow pits shall be established by the Contractor.

All required right-of-way and easement limits shall be established, staked and referenced by the Contractor concurrent with the construction stakeout survey.

The Contractor shall place at least two offset stakes or references at each centre lines station and at such intermediate stations as the Engineer may direct. From computations and measurements made by the Contractor, these stakes shall be clearly marked with the correct centre line, station number, offset and cut or fill so as to permit the establishment of the true centre line location during construction. He shall locate and place all cut, fill, slope, line grade or other stakes and points as the Engineer may direct to be necessary for the proper progress of the work.

4. **MEASUREMENT AND PAYMENT**

No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities or herein. The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bill of Quantities.

SECTION - 1

EARTHWORKS

1. SCOPE

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

2. GENERAL

2.1 The Contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil which might be encountered during excavation or earthworks. The Employer does not guarantee or warrant in any way that the materials to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or

indicated in the Report, Drawings or in any other Contract Documents or to material obtained from boring or trial holes. The Contractor shall be deemed to have made local and independent inquiries as to, and shall take the whole risk of the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive an extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.

2.2 All excavations cut and fills shall be constructed to the lines, levels and gradients specified with necessary allowance for consolidation, settlement and drainage so that at the end of the Defects Liability Period, the ground shall be at the required lines, levels and gradients. During the course of the Contract and during the Period of Maintenance any damage or defects in cuts and fills, in structures and other works, caused by slips, falls of wash-ins or any other ground movement due to the Contractor's negligence shall be made good by the Contractor at his own cost.

3. **SITE PREPARATION**

3.1 The Contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the Contractor shall at his own expense rectify such error.

3.2 The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Engineer.

3.3 The Contractor shall construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.

3.4 The Contractor shall perform a joint survey with the Engineer's Representative, of the area where earth work is required, plot the ground levels on the drawings and obtain approval from the Engineer before starting the earth-work.

4. **FOUNDATIONS / TRENCHES**

4.1 **Excavations**

4.1.1 Excavation shall include the removal of all material of every name and nature. Excavations shall be carried out in accordance with excavation plans and sections shown on the Drawings.

4.1.2 The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as per Drawings or as directed by the Engineer. The excavation, which cannot be done by mechanical means, shall be done by manual tools. Unless otherwise specified by the Engineer, leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and backfill if approved by the Engineer shall be stockpiled within the free haulage limit from the project boundary of the works.

4.1.3 The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Engineer full details of his proposals. The Engineer may require modifications to be made if he considers the Contractor's proposals to be unsatisfactory and the Contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.

4.1.4 For major excavations, the Contractor shall submit for the prior approval of the Engineer full details and drawings showing the proposed method or procedure, supporting and strutting, etc. The design, provision, construction, maintenance and removal of such temporary works shall be the responsibility of the Contractor and all cost in these respects shall be included in the quoted unit rate for the permanent work.

- 4.1.5 The Contractor's attention is drawn particularly to his obligations under the General Conditions of Contract in respect of those works, which are in close proximity to existing buildings.
- 4.1.6 The Contractor shall preserve the completed excavation from damage due to slips and earth movements, ingress of water from any source whatsoever and deterioration by exposure to the sun and the effects of the weather.
- 4.1.7 All excavation of every description, in whatever material encountered shall be performed to the elevations and dimensions shown on the Drawings in such a manner as to avoid interruption to work in other parts of the site. The Contractor shall be responsible for injury to the other works caused during excavation period.
- 4.1.8 Excavation shall extend to adequate distance from walls and footings to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces. Undercutting will not be permitted.
- 4.1.9 All excavations in foundations shall be taken to 150 mm above the final excavation elevations shown on the drawings and the last 150 mm shall be trimmed carefully to a smooth and level surface. Immediately after trimming to the final elevation, a layer of blinding concrete shall be placed to the thickness shown on the drawings. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by lean concrete by the end of the day. It is specifically brought to the notice of the Contractor that any excavation taken down to the trimmed elevation which is left over-night or for any length of time thereafter, uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation as directed by the Engineer and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.
- 4.1.10 No excavation shall be neither covered nor any permanent work commenced until the foundation has been inspected by the Engineer and his permission to proceed is given.
- 4.1.11 If excavation for sub-structures are carried below the required level, as shown on the Drawings or as directed by the Engineer, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.
- 4.1.12 All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient dewatering equipment for this purpose. The Contractor shall design, provide and maintain effective dewatering system during excavation and construction of foundations up to plinth level so as to keep the foundation area dry. Adequate precautions shall be taken to prevent any erosion due to undercutting from underneath the previously constructed adjoining foundations.
- 4.1.13 Shoring, where required during excavation, shall be installed to protect workmen and the bank, adjacent paving, structures and utilities. The term shoring shall also be deemed to cover whatever methods the Contractor elects to adopt, with prior approval of Engineer, for upholding the sides of

excavation and also for planking and strutting to excavation against the side of roadways and adjoining properties in existing hardcore of any other material. The Contractor will be held responsible for upholding the sides of all excavations and no claim for additional excavation, concrete or other material will be considered in this respect.

- 4.1.14 Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be repaired by the Contractor at his own expense. Any existing utility lines which are not known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Engineer. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the Engineer in ample time for the necessary measures to be taken to prevent interruption of the service.
- 4.1.15 Excavated material suitable for use as fill and backfill shall be stockpiled within free haulage limit from the project boundary as directed by the Engineer. This stockpiled material shall be transported back to places requiring fill or backfill.
- 4.1.16 Excavated material unsuitable for use as fill and backfill shall be disposed off by the Contractor at locations approved by the Engineer within specified free haulage limit.
- 4.1.17 Where applicable the excavation work shall include the excavation in above water table and excavation below water table. The Contractor shall submit the proposal for dewatering from the areas of excavation for the approval of the Engineer and shall provide all plant, equipment, pumps, sheeting, well points as required to keep the water table 1.0 metre below the deepest foundation as shown on the drawings till the completion of foundation works.
- 4.1.18 The Contractor shall make independent enquiries and perform and make independent observations to ascertain the water table in the areas of excavations during the period when the construction works are in progress. The Contractor shall take whole risk of any nature for fluctuation of the water table from his own findings. The Employer/Engineer does not bind himself in any way and shall not be responsible for any information given by him or any information, observations or values obtained from his reports, Drawings, and Documents or anywhere in this Document.

4.2 **Fill and Backfill**

- 4.2.1 After completion of foundation footing, foundations, walls, and other construction below the elevation of the final grades and prior to start of back filling, forms shall be removed and the excavation shall be cleaned of trash and debris.
- 4.2.2 The backfilling shall include filling under the floors and around the foundation.
- 4.2.3 The backfilling shall include loading, unloading, transporting, placing, stacking, spreading of earth, watering, rolling, ramming and compacting, etc., complete as specified herein.

- 4.2.4 Filling under floor shall be done with approved selected material obtained from required excavation or outside sources. It shall be predominantly granular material and free from slurry mud, organic or other unsuitable matter and capable of compaction by ordinary means.
- 4.2.5 The Contractor shall provide the approved quality of backfill and fill material required to complete the fill and backfill from the places designated by the Engineer.
- 4.2.6 Filling in foundations/trenches shall be placed in 150 mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the Engineer.
- 4.2.7 Material for backfilling shall be as approved by the Engineer and shall be placed in layers not exceeding 150 mm measured as compacted material and saturated with sufficient water and compacted to produce in-situ density not less than 95% of the maximum dry density at optimum moisture content, achieved in Test No.15 of BS 1377: 1975.
- 4.2.8 All fill areas shall be left neat, smooth and well compacted, the top surface consisting of the normal site surface soil, unless otherwise directed.
- 4.2.9 Depending on the capacity of the compacting equipment the Engineer may instruct increased thickness of successive layers to be placed.
- 4.2.10 Fill shall not be placed against foundation walls prior to approval by the Engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.
- 4.2.11 In case the Contractor has to arrange the fill material from outside source the quality of the fill material will be subject to the approval of the Engineer. The Engineer shall require the Contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the Contractor.
- 4.2.12 Backfilling of foundations / trenches shall be carried out only after the structural works within the excavations have been inspected, tested and approved by the Engineer.
- 4.2.13 Layers upto an elevation of 300 mm above the top of the bedding shall not be more than 150 mm in loose thickness and the remainder of the layers above that elevation shall not be more than 150 mm of compacted thickness.
- 4.2.14 If it is found necessary to alter the moisture content of the fill material in any way, then, very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests shall be carried out.
- 4.2.15 The stabilization of compacted fill/backfill surfaces shall be smooth and even and shall not vary more than 10mm in 3 metres from true profile and shall not be more than 12.5mm from true elevation.

6. DISPOSAL OF SURPLUS EXCAVATED MATERIAL

6.1 The rejected unsuitable material and surplus excavated material shall be disposed off within 5 kilometer lead measured along the most direct route from boundary of the Project, as shown on the Drawings or as directed by the Engineer.

6.2 The disposal of surplus/unsuitable excavated material shall include loading, unloading, transporting, stacking, spreading and leveling as directed by the Engineer.

7. MEASUREMENT AND PAYMENT

7.1 General

Except otherwise specified herein or elsewhere in the Contract Documents no measurement and payment will be made for the under mentioned items related to this section. The cost thereof shall be deemed to have been included in the quoted unit rate of the items of the Bill of Quantities under this section.

7.1.1 De-watering where required to keep the foundations and services line trenches dry during construction of Works.

7.1.2 Timber shoring, planking, strutting and providing slope for upholding the sides of excavations.

7.1.3 Any fill with approved material necessitated by over excavation due to fault or convenience of the Contractor.

7.1.4 Stockpiling the excavated material at approved location within free haulage limit from the Project Boundary and transporting back suitable material to places requiring fill or backfill.

7.1.5 Foundation bed preparation for service line trenches and building.

7.1.6 Extra excavation involved in providing adequate working space around sides of foundation and service line trenches.

7.1.7 Scarifying, rolling, leveling, watering and compacting the fill and backfill to required density.

7.1.8 All laboratory and field tests stipulated in these specifications.

7.1.9 Disposal of rejected surplus and unsuitable excavated material within 5 kilometers free haulage limit measured along the most direct route from boundary of the Project.

7.2 Excavation for Foundations/Trenches

7.2.1 Measurement

The quantities set out for excavation and its subsequent disposal shall be deemed to be the bulk quantity before excavating and no allowance shall be made for any subsequent variations in bulk or for any extra excavation.

Unless otherwise shown on the Drawings quantities of excavation shall be measured of acceptably completed works on the basis of vertical excavation

lines required for the nominal concrete dimensions of the structural members of foundations.

Measurement of acceptably completed works of excavation will be made on the basis of number of cubic foot of material excavated for foundation as shown on the drawing. It shall be calculated/ measured from pre-work levels and the levels shown on the drawing.

7.2.2 Payment

Payment will be made for acceptable measured quantity of excavation on the basis of unit rate per cubic foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

7.3 **Backfill/Fills/Sand fill**

7.3.1 Measurement

Measurement of acceptably completed backfill/fill of approved material sand fill works will be made on the basis of number of cubic foot of compacted backfill/fill in position in accordance with the lines, levels and grade as shown on Drawings.

7.3.2 Payment

Payment will be made for acceptable measured quantity of backfill/fill on the basis of unit rate per cubic foot quoted in the Bills of Quantities and shall constitute full compensation for all the work related.

SECTION – 2

TERMITE CONTROL TREATMENT

1. **SCOPE**

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

2. **MATERIAL**

2.1 An emulsible concentrate insecticide shall be used for dilution with water, specially formulated to prevent infestation by termites. Fuel oil will not be permitted as a diluent. Provide a working solution of the following chemical element and concentrations.

HEPTACHLOR emulsifiable to 0.5% with clean water.

Or

TERMIDOR 25EC containing FIPRONIL

Or

BIFLEX with Bifenthrin Tech 25.1%

Or

Approved Equivalent

2.2 All mixing shall be done at site and mixing proportion of insecticide with water shall be in accordance with the approved manufacturer's recommendations and shall be verified by the Engineer.

- 2.3 Pure turpentine shall be used for dilution of insecticide, in approved proportion for application to woodwork.

3. QUALITY ASSURANCE

- 3.1 In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for the work, including preparation of substrata and application.
- 3.2 A professional operator shall be engaged who shall have license in accordance with regulations of governing authorities for application of soil treatment solution.

4. EXTENT OF APPLICATION

- 4.1 Insecticide solution shall be applied with approved pressure spraying equipment maintaining a pressure of 150 psi to all applications to, on or in earth.
- 4.2 Soil treatment shall begin after all work of preparation of earth prior to installation of concrete has been done. After application, no additional earth moving or work upon sub grade should be done. No covering of earth or concrete should be applied over soil treatment until at least 24 hours after treatment has been made.
- 4.3 Insecticide solution should not be applied during wet weather, or when the earth surface is excessively wet. Application should be made to all areas beneath concrete slabs-on-grade, including sidewalks and paving abutting buildings for distance of at least 6 feet beyond building line. Solution shall be applied in amounts of not less than 5 lit./ Sq.M or 5 lit./10.76 Sq.ft. of area. If applied over gravel or sand fill, application shall not be less than 7 lit./ Sq.M or 7 lit./10.76 Sq.ft. of area. Insecticide shall penetrate to a depth of 1-inch minimum in porous earth at bottom and 2 inch to 3 inch at sides of excavations.
- 4.4 Sides of foundation excavations, grade beam, and similar areas shall be treated with solution at a rate of 0.5 lit per square feet upon inner sides of such excavations, and at all locations where concrete slabs for platforms and similar work abut the building. Similar treatment shall be made at all locations where expansion joints, control joints, column bases and similar work occur at or below grade slabs.
- 4.5 In the areas of application signs shall be fixed to show that soil treatment has been applied. Such signs shall be removed when areas are covered by other construction.
- 4.6 Care shall be exercised to insure that no marks or damage occurs to the finished structure as a result of the work under this section.
- 4.7 All woodwork for the entire project is to be insecticide treated (before application of solignum). Insecticide shall be sprayed on all surfaces of all the wooden work viz., door frames, blocking, furring, planks, boards etc. before installation. Spraying is to be done at the site, after delivery and before installation. No spraying shall be necessary after field sawing, jointing or installation of such material.

5. STANDARDS

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

6. **SAMPLES AND TESTS**

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

7. **GUARANTEE**

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests, which cause damage to wood or other organic material for 10 years from the date of acceptance of the building.

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

8. **MEASUREMENT & PAYMENT**

8.1 **General**

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost there of shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

- 8.1.1 Termite control treatment on wood works.
- 8.1.2 Turpentine & Water required for mixing insecticide solution.
- 8.1.3 Transportation of material and storage at site.
- 8.1.4 Anti-termite treatment on stock piled backfill material.
- 8.1.5 Termite control treatment to vertical surfaces.
- 8.1.6 Treatment of bed and sides of excavated foundation trenches.
- 8.1.7 Treatment of backfill.
- 8.1.8 Treatment of filled up earth.
- 8.1.9 Treatment of timber to be used.
- 8.1.10 Treatment of surrounding areas within 10 feet of the building.
- 8.1.11 Any other operation which the specialized firm may deem necessary in context to their guaranteed obligations.

8.2 **Termite Control Treatment**

8.2.1 **Measurement & Payment**

Measurement and payment of acceptably completed works of termite control treatment will be made on basis on unit rate per square foot quoted in the Bills of Quantities, & shall constitute full compensation for all the works related to the item.

SECTION - 3

STONE SOLING

1. SCOPE

The work under this section of specifications consists of furnishing all plant, labour, equipment, appliances, materials and performance of all operations required in connection with the construction of stone soling in strict accordance with the specifications and Drawings and/or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. MATERIAL

Material shall be of approved quality it shall be comprise strong hard durable stone of the approved size free from impurities, quarry sap, dust, dirt and solubility

characteristics. The stone shall be obtained from approved quarries and shall be sound, free from laminations and weak cleavages.

3. **QUALITY CONTROL**

The quality of material used in stone soling shall conform to the following.

- Maximum Los angles Abrasion value 30% determined as per ASTM C- 535-81.
- Soundness 5 cycles with sodium sulphate determined as per ASTM C-88-8.
- Specific Gravity shall be not less then 2.5 determined as per ASTM C-127- 84.
- Water Absorption shall not be more then 1.5%

4. **CONSTRUCTION**

4.1 **Preparation of Sub-grade**

Sub-grade shall be formed of suitable materials free of clods, sod, roots, stumps, brush or other objectionable material.

Sub-grade material shall be placed in successive layers not exceeding 6 inch in thickness and each layer shall be thoroughly compacted at optimum moisture content.

The sub-grade shall be compacted at optimum moisture content and loose pockets, if any, cut-out and refilled with selected materials in layers not more than 150mm thick and formed to levels and grades shown on the drawings.

Compaction shall be done by approved methods consistent with the soil/material to be compacted.

The maximum dry weight density of the sub-grade shall not be less than 95% of Modified AASHTO requirements.

4.2 **Stone Ballast Soling**

The Stone Ballast shall be well graded and broken hard of 2" mesh obtained from an approved quarry. The soling stone shall be 150mm in size from an approved quarry,

The stone shall be laid and packed to even grades and well rolled using vibratory roller/plate compactor to a consolidated thickness of not less than 6 inch or as shown on the Drawings.

The whole of the surface of the compacted stone ballast soling will be blinded with murum or any other approved gritty material/ stone dust (Khaka). After the interstices have been filled with smaller size crushed

stone, so as to effectively fill in the voids and crevices, soling area may be watered, if necessary and again thoroughly rolled with the same roller to produce a smooth and even surface free from irregularities, true to line and level.

Care is to be taken to avoid any damage to existing structures, mains or pipes while rolling operation is in progress. In places inaccessible for a roller, compaction shall be done by hand tampers weighing not less than 20 lb. or power reamers as directed by the Engineer.

5. MEASUREMENT AND PAYMENT

5.1 General

Except otherwise specified herein or elsewhere in the Contract Documents no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

5.1.1 Any losses of material, which may result from shrinkage, compaction, waste, overflow erosion, etc.

5.1.2 Sub-grade preparation.

5.1.3 Murrum or any other approved gritty material/ stone dust (Khaka).

5.1.4 Ballast material of approved quality.

5.1.5 Compaction of sub-grade and stone.

5.2 Stone Soling

5.2.1 Measurement:

Measurement of acceptably completed works of stone soling will be made on the basis of number of square foot of compacted soling in position as shown on the Drawings or as directed by the Engineer.

5.2.2 Payment:

Payment will be made for acceptable measured quantity of compacted stone soling on the basis of unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION - 4

PLAIN AND REINFORCED CONCRETE

1. SCOPE

CONSTRUCTION (GREY STRUCTURE) OF NATIONAL BANK OF PAKISTAN
MAIN BRANCH MIRPURKHAS & REGIONAL OFFICE MIRPURKHAS BUILDING, MIRPURKHAS REGION

The work under this section of the specification consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply and installation of plain and reinforced concrete work complete, in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the Contract.

2. GENERAL

- 2.1 Full co-operation shall be given to trades like electrical, mechanical and other services.
- 2.2 Suitable templates shall be provided for setting out items not placed in the forms. Embedded items and other materials for other operations shall be completed, inspected, tested and approved before concrete is placed.

2.3 For special concrete finish and for special methods of construction, formwork shop drawings shall be designed and prepared by the Contractors, at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.

3. APPLICABLE STANDARDS

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

3.1 Pakistan Standards

P S	232	Portland Cement (ordinary & rapid hardening)
P S	243	Natural aggregates for concrete
P S	279	Abrasion of coarse aggregates by the use of Los Angeles machine.
P S	280	Determination of aggregates crushing value.
P S	281	Organic impurities in sand for concrete aggregates
P S	282	Material finer than No. 200 B.S. test sieve in aggregates.
P S	283	Soundness test for aggregates by the use of sodium sulphate or magnesium sulphate.
P S	284	Sampling aggregates for concrete.
P S	285	Sieve or screen analysis of fine and coarse aggregates.
P S	286	Description and classification of mineral aggregates.
P S	421	Sampling fresh concrete.
P S	422	Slump test for concrete.
P S	560	Making and curing concrete compression test specimen in the field.
P S	612	Sulphate-resistant portland cement type 'A' and sampling fresh concrete in the laboratory.

- P S 716 Mixing and sampling fresh concrete in the laboratory.
- P S 717 Compacting factor test for concrete.
- P S 746 Definitions and terminology of cements.
- P S 849 Making and curing concrete compression test cubes.

3.2 **ASTM (American Society for Testing and Materials)**

- C 33 Concrete Aggregates.
- C 40 Organic impurities in sand for concrete.
- C 78 Flexural strength of concrete.
- C 87 Effect of organic impurities in fine aggregates on strength of mortar.
- C 88 Soundness of aggregates.
- C 94 Ready mixed Concrete.
- C 117 Material finer than No.200 (0.075mm) sieve.
- C 123 Light weight pieces in aggregates.
- C 125 Concrete and concrete aggregates.
- C 127 Specific gravity and absorption of coarse aggregate.
- C 128 Specific gravity and absorption of fine aggregate.
- C 131 Resistance to abrasion of small size coarse aggregate.
- C 136 Sieve or screen analysis of fine and coarse aggregate.
- C 142 Clay lumps and friable particles in aggregates.
- C 143 Slump of portland Cement Concrete.
- C 150 Portland Cement.
- C 156 Water retention by concrete curing material.
- C 171 Sheet material for curing concrete.
- C 172 Fresh concrete sampling.
- C 260 Air entraining admixture for concrete.
- C 289 Potential reactivity of aggregate.
- C 309 Liquid membrane forming compounds for curing concrete.

C	332	Light weight aggregates for insulating concrete.
C	494	Chemical admixtures for concrete.
C	535	Resistance to abrasion of large size coarse aggregates.
C	685	Concrete made by volumetric batching and continuous mixing.
D	75	Aggregate sampling.
D	1190	Concrete joint sealer (hot poured elastic type).
D	1751	Preformed expansion joint filler for concrete paving and structural concrete.
D	1752	Preformed sponge rubber and cork expansion joint fillers for concrete paving and structural concrete.
D	1850	Concrete joint sealer (cold application type).
E	11	Wire cloth sleeves for testing purposes.
E	96	Water vapour transmission of materials in sheet form.
E	154	Materials for use as vapour barrier under concrete slabs.
E	337	Relative humidity by wet and dry bulk psychrometer.
C	400	Requirements for water for use in mixing and curing concrete.

3.3 **British Standards**

B.S	12	Portland cement, ordinary and rapid hardening.
B.S	410	Test Sieves
B.S	812	Methods for the sampling and testing of mineral aggregates, sand fillers
B.S	882/1201	Concrete aggregates from natural sources
B.S	1881	Methods of testing concrete.
B.S	3148	Tests for water for making concrete.
B.S	4027	Sulphate-resisting portland cement.
C.P	8110	Structural use of concrete.

3.4 **ACI (American Concrete Institute)**

117	Standard Specifications for tolerances for concrete construction and materials.
201.2	Guide to durable concrete.

- 211 Recommended practice for selecting proportions for normal and heavy weight concrete.
- 214 Recommended practice for evaluation of strength test results of concrete.
- 301 Specifications for structural concrete for building.
- 304 Recommended practice for measuring, mixing, transporting and placing concrete.
- 305 Hot weather concreting.
- 308 Standard practice for curing concrete.
- 309 Recommended practice for consolidation of concrete.
- 318 Building code requirement for reinforced concrete.
- 347R Guide to Formwork for concrete.
- 351.1R Grouting for support of equipment & machinery.
- UBC Uniform Building Code

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

4. MATERIALS

4.1 Aggregates

- 4.1.1 The sources of supply of all fine and coarse aggregates shall be subject to the approval of the Engineer.
- 4.1.2 All fine and coarse aggregates shall be clean and free from clay, loam, silt and other deleterious matter. If required, the Engineer reserves the right to have them washed by the Contractor at no additional expense. Coarse and fine aggregates shall be delivered and stored separately at site. Aggregates shall not be stored on muddy ground or where they are likely to become dirty or contaminated.
- 4.1.3 Sulphate content of aggregates shall not exceed 0.40 percent by weight for each individual source of coarse and fine aggregate. Chloride content of aggregates shall not exceed 0.05 percent by weight for each source of coarse and fine aggregate. Total sulphate (SO₃) content of concrete shall not exceed 4.0 percent by weight of the cement. Total chloride content of concrete shall not exceed 0.15 percent by weight of the cement.
- 4.1.4 Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of PS 243 and/or BS 882 and/or ASTM C-33.

- 4.1.5 Coarse aggregate shall be gravel or crush stone of hard, durable material free from laminated structure and conforming to PS 243 and/or BS 882 and/or ASTM C-33 size number 467 as follows for use in foundations:

<u>Total Passing Sieve</u>	<u>Percent by weight</u>
50.80 mm (2 in.)	: 100
38.10 mm (1.5 in.)	: 95-100
19.00 mm (0.75 in.)	: 35-70
9.51 mm (0.38 in.)	: 10-30
4.76 mm (0.19 in.)	: 0-5

Coarse aggregate for all cast-in-place concrete other than foundations shall conform to ASTM C-33 size number 6, as follows:

<u>Total Passing Sieve</u>	<u>Percent by weight</u>
25.00 mm (1.0 in.)	: 100
19.00 mm (0.75 in.)	: 90-100
12.50 mm (0.5 in.)	: 20-55
9.50 mm (0.38 in.)	: 0-15
4.75 mm (0.19 in.)	: 0-5

- 4.1.6 Unless otherwise specified the nominal maximum size of aggregate for cast-in-place reinforced concrete slabs and other members, shall be 19mm, if feasible. If there are difficulties in placing such a concrete the maximum size may be restricted to 12 mm provided the requirements for strength are satisfied.
- 4.1.7 Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the work, the grading of the aggregates shall be controlled by obtaining the 19mm maximum nominal size, the different sizes being stocked in separate stock piles and recombined in the correct proportion for each batch at the batching plant / concrete mixer. The materials shall be stock-piled for a period before use so as to drain nearly to constant moisture content (as long as site and other conditions permit, preferably for at least a day). The grading of the coarse and fine aggregates shall be tested at least once for every 100 tons supplied, to ensure that the grading is uniform and same as that of the samples used in the preliminary tests.

4.2 Cement

- 4.2.1 Cement shall be fresh and of approved origin and manufacture. It shall be one of the following as may be specified by the Engineer.
- Ordinary or Rapid Hardening Portland cement complying with the requirements of PS 232 or BS 12 or ASTM C-150. (Type -I).
 - Sulphate Resisting Portland Cement complying with the requirements of PS 612 or BS 4027 ASTM C-150. (Type - V).
- 4.2.2 Unless otherwise specified, ordinary Portland Cement complying with the requirements of BS 12 or ASTM C-150 type-1 shall be used.

- 4.2.3 For fair faced concrete if required, an approved cement with a view to obtain a light shade concrete as approved by the Engineer shall be used.
- 4.2.4 The Contractor shall supply to the Engineer at fortnightly intervals, reports of tests for conformance with the relevant specified standard in respect of the samples of cement from the work-site. These tests shall be carried out in a laboratory approved by the Engineer.
- 4.2.5 Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.
- 4.2.6 There shall be sufficient cement at site to ensure that each section of work is completed without interruption.
- 4.2.7 Cement reclaimed from cleaning of bags or from leaky containers shall not be used.
- 4.2.8 The Contractor shall provide and erect (at his cost) in a suitable plain, dry, well ventilated, weather-proof and water proof shed of sufficient capacity to store the cement.
- 4.2.9 The cement shall be used as soon as possible after delivery and cement which the Engineer consider has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise shall be rejected and removed immediately from the site at the Contractor's expense. Any cement in containers damaged so as to allow the contents to spill or permitting access of the atmosphere prior to opening of the container at the time of concrete mixing shall be rejected and removed immediately from the site at the Contractor's expense.
- 4.2.10 Mixing together of different types of cement shall not be permitted.

4.3 **Water**

Only clean water from the city supply, or from other sources approved by the Engineer shall be used. The Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where doubt exists as to the suitability of the water, it shall be tested in accordance with B.S. 3148 or CE CRD C 400. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, the Engineer may refuse to permit its use.

In case of doubt, the Engineer may require that concrete mixed with water proposed to be used should be tested to have a compressive strength not lower than 90 percent of the strength of concrete mixed with distilled water.

4.4 **Additives**

If required, all additives shall be from a manufacturer approved by the Engineer.

Air Entraining Admixtures shall conform to ASTM C260. Other Admixtures shall conform to ASTM C494.

4.5 **Bitumen**

All material for bitumen shall consist of plastic bitumen grade 10/20. Expansion / Isolation joint shall be filled with hot bitumen of approved grade, as shown on the drawings.

4.6 **Vapour Barrier**

Polyethylene sheeting conforming with ASTM E154 and 0.2mm thick as a minimum. Other similar material having a vapour permeance rating not exceeding 0.5per meter as determined by ASTM E96, will be considered unless noted otherwise.

4.7 **Joint Fillers**

ASTM D1751, preformed, resilient bituminous type or ASTM D1752, preformed sponge rubber.

4.8 **Joint Sealants**

ASTM D1190, ASTM D3569, ASTM D3406, hot-pour type.

4.9 **Waterstops**

Provide flat, dumbbell type or center bulb type water stops at construction joints where shown. Web thickness not less than 5mm for units up to 125mm wide, and not less than 10mm for widths over 125mm. Provide polyvinyl chloride (PVC) waterstops of approved manufacturer.

4.10 **Expansion Joints**

Expansion joints shall be provided wherever indicated on the Drawings or as directed by the Engineer. In no case shall the reinforcement, corner protection angles, or other embedded items be permitted to extend continuously through any expansion joint.

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

4.11 **Dowels for Columns**

All dowels for columns to be embedded in existing columns using Adhesive Hilty's HIT-Hy150 / Spit Epcon. Depth and diameter of holes for dowel shall be as per manufacturer's specification or as shown on the drawings.

5. **NOMINAL CONCRETE MIXES**

5.1 **Proportions of Mix**

5.1.1 Cement and aggregates:

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

5.1.2 The Contractor shall regulate and arrange mixing of the ingredients for the designed mix of the concrete by weight-batching. The cost of designing the mix shall be borne by the Contractor.

5.1.3 Water/Cement ratio:

Unless otherwise specified in these Documents/Drawings, the water/cement ratio for all structural concrete shall not exceed 0.45 for water tight structures and 0.55 for other structures except class 'D' and class 'E' concrete.

5.1.4 Workability:

Admixtures may be used where necessary to achieve required workability, with the Engineer's approval. 'Workability' shall be determined by the slump or compaction factor tests as directed by the Engineer and these shall be performed in accordance with the methods given in PS 422 and PS 177 or ASTM C-143. The slump or compaction factor for each grade of concrete shall be determined during the preliminary Test mixes and the value obtained shall not be modified without the written consent of the Engineer. Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 75 mm or less if consolidation is to be by vibration, and 100 mm or less if consolidation is to be by methods other than vibration. A tolerance of upto 25 mm above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated, as per satisfaction of Engineer.

5.2 Strength requirements for concrete

5.2.1 Portland cement concrete when aggregates comply with B.S. 882.

5.2.2 Concrete made with Portland cement shall comply with the strength requirements of Table 1:

Table 1 : Strength requirements for Portland cement concrete with aggregates complying with B.S. 882.

Class	Minimum Cube Crushing Strength at 28 days (MPa)
A	31.0
B	26.0
C	21.0
D	10.50
E	7.0

5.2.3 The strengths given in Table 1 are based on the assumption that average temperature is 20 degree C. Where accurate records of temperature are kept, allowance may be made for change of temperature or the cubes may be tested at the equivalent maturity.

5.2.4 The Contractor shall submit mix design by weight for each grade of concrete. Manufacture 12 Nos. test cubes 150mm x 150mm x 150mm in accordance with the Mix design batching by weight and test 3 cubes each at 3, 7, 14 & 28 days intervals in the presence of Engineer, and submit all relevant data and results of tests for approval of the Engineer. The Contractor shall obtain approval from the Engineer in writing for each Mix design before producing the actual concrete for the Works.

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

5.3 Batching

5.3.1 All cement, including cement supplied in bulk, shall be batched by weight. A bag of cement may be taken as 50 kg.

5.3.2 Aggregates shall be batched by weight, due allowance being made for water content. Aggregates may be batched by volume only with the prior permission of the Engineer. The apparatus for weight-batching may be an integral part of the mixer or a separate unit of a type approved by the Engineer. It shall be accurate within 2% and shall be checked for accuracy at least once a week.

5.3.3 The quantity of additives shall be as prescribed by the manufacturer or as directed by the Engineer.

5.3.4 Where the batching plant is of the type in which cement and aggregates are weighed in the same compartment, the cement shall be introduced into the compartment between two sizes of aggregates.

5.3.5 Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue to flow for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

5.4 Mixing

5.4.1 The concrete shall be mixed in an approved batch mixer. It shall be fitted with the manufacturer's plate stating the rates, capacity and the recommended number of revolutions per minute and shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water measuring device.

5.4.2 Mixing shall continue for the period recommended by the mixer manufacturer or until there is apparently a uniform distribution of the materials and the mass is uniform in colour, whichever period is longer. However, minimum mixing time shall not be less than 1½ minutes.

If it is desired to use a mixing period of less than 1-1/2 minutes, the Engineer's approval shall be obtained in writing.

- 5.4.3 Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three quarters of the required mixing time shall take place after the last of the mixing water has been added.
- 5.4.4 The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10 percent of their original height.
- 5.4.5 Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be retempered, but shall be discarded.

5.5 **Transporting**

- 5.5.1 The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means which will prevent segregation or loss of or addition to ingredients. It shall be deposited as nearly as practicable in its final position so as to avoid rehandling or flowing. All skips vehicles, or containers used for transporting the concrete shall be thoroughly clean.
- 5.5.2 During hot or cold weather, concrete shall be transported in deep containers, on account of their ratios of surface area to mass, which reduces the rate of loss of water by evaporation during hot weather and loss of heat during cold weather.

5.6 **Placing**

- 5.6.1 Before placing of concrete, formwork shall have been completed; water shall have been removed; reinforcement shall have been secured in place; expansion joint material, anchors and other embedded items shall have been kept in position; and the entire preparation shall have been approved.

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

- 5.6.2 Concrete shall be deposited continuously, or in layer of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the Contract Documents or as approved by the Engineer. Placing shall be carried out at such a rate that the concrete, which is being integrated with fresh concrete, is still plastic. Concrete, which has partially hardened, shall not be deposited. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their services unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.
- 5.6.3 The actual sequence of construction proposed by the Contractor shall be subject to the Engineer's approval before construction starts on any part of the structure, and this sequence shall not be varied without the Engineer's approval.

- 5.6.4 The concrete shall be placed as soon after it has been mixed as is practicable. Once the concrete has left the mixer, no more water shall be added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing is too low for it to be compacted fully and to an acceptable finish by whatever means available.

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

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

- 5.6.5 Concrete shall be deposited as nearly as possible in its final position to avoid re-handling. In no circumstances may concrete be railed or made to flow along the forms by the use of vibrators. Concreting shall be carried on as a continuous operation using methods, which shall prevent segregation or loss of ingredients.
- 5.6.6 The free fall of concrete shall not be allowed to exceed two meter and where it is necessary for the concrete to be placed more than this depth, it shall not be dropped into its final position, but shall be placed through pipes fed by a hopper. When a pipe is used for placing concrete the lower end shall be kept inside, or close to the freshly deposited concrete. The diameter of the pipe shall be not less than 225 mm.
- 5.6.7 Workmen carrying concrete to the site, and all other workmen, shall move only along runways or planks placed for the purpose and no person shall be allowed to walk on the reinforcement.

5.7 Consolidation

- 5.7.1 All concrete shall be consolidated by vibration, spading, rodding or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Only competent workmen shall operate vibrators. Use of vibrators to transport within forms shall not be allowed.

Vibrators shall be inserted and withdrawn at points approximately 450 mm apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not excessive so as to cause segregation, generally from 5 to 15 sec. A spare Vibrator shall be kept on the job site during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented, if necessary, by spading to work the coarse aggregate back from the formed surface.

- 5.7.2 If there is any tendency for the mix to segregate during consolidation, particularly if this produces excessive laitance, the mix proportions shall be modified to effect an improvement in the quality of the concrete to the satisfaction of the Engineer and in conformity with the provisions of Clause 5.

- 5.7.3 Vibrator shall not be allowed to contact the formwork for exposed concrete surfaces.
- 5.7.4 Mechanical vibrators shall be of a type approved by the Engineer to suit particular conditions.
- 5.7.5 Over-vibration or vibration of very wet mixes shall be avoided.

5.8 Curing and Protection

- 5.8.1 Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures and mechanical injury, and shall be maintained with minimum moisture loss at a relative constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval of the Engineer.
- 5.8.2 For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing, as approved by the Engineer.
- Ponding or continuous sprinkling.
 - Application of absorptive mats or fabric kept continuously wet.
 - Application of waterproof sheet materials approved by the Engineer.
 - Application of other moisture-retaining covering as approved.
 - Application of a curing compound conforming to ASTM C309. The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheet, which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.
- 5.8.3 Moisture loss from surface placed against wooden forms or metal forms, and exposed to heating by the sun, shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured until the end of the time prescribed as follows by one of the methods specified above.
- 5.8.4 Curing in accordance with sub-clauses above shall be continued for at least 10 days in the case of all concrete except concrete with rapid-hardening Portland Cement, for which the period shall be at least 3 days. Alternatively, if tests are made of cubes kept adjacent to the structure and cured by the same methods and to the same intensity, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the minimum specified works cube strength. If one of the first four curing procedures specified above is used initially, it may be replaced by one of the other specified procedures any time after the concrete is one day old

provided the concrete is not permitted to become surface dry during the transition.

- 5.8.5 When the mean daily outdoor temperature is less than 5°C (41°F), temperature of the concrete shall be maintained between 10 and 20 degrees C (50°F-68°F) for the required curing period specified above.

When necessary, arrangements for heating, covering insulation or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature with measures to avoid concentration of heat. Combustion heaters shall not be used during the first 24 hours, unless precautions are taken to prevent exposure of the concrete to exhaust gasses, which contain carbon dioxide.

- 5.8.6 When necessary, provision for wind-breaks, shading, spraying, sprinkling, ponding or wet covering with a light coloured material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operation will allow.

- 5.8.7 Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 3°C (5.4°F) in any one hour or 10°C (18°F) in any 24 hour period.

- 5.8.8 Concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibrations, during the curing period. All finished concrete surfaces shall be protected from damage by construction equipment, materials or methods by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

5.9 Works in Extreme Weather

- 5.9.1 Unless adequate protection is provided, and approval is obtained, concrete shall not be placed during rain.

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

- 5.9.2 When the temperature of the surrounding air is expected to be below 5°C during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 13°C for sections less than 300 mm in any dimensions nor 10°C for any other sections.

When necessary, concrete material should be heated before mixing and carefully protected after placing. In general, heating of mixing water alone to about 60°C may be sufficient for this purpose. Dependence should not be placed on salt or other chemicals. Calcium chloride up to a maximum of 1-1/2 percent of the weight of cement may be used to accelerate the rate of hardening only with prior written permission of the Engineer. Use of calcium chloride in excess of 1-1/2 percent is harmful. No frozen material or concrete damaged by frost shall be removed. It is recommended that concrete exposed to the action of freezing weather should have entrained air and the water content of the mix should not exceed 25 litres per bag of cement.

If water of aggregate is heated above 38°C, the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 38°C.

- 5.9.3 During hot weather, the temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 32°C. For mass concreting, this temperature should not exceed 21°C. When the temperature of the concrete exceeds 32°C, precautionary measures approved by the Engineer shall be put into effect. When the temperature of the steel is greater than 50°C, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. The ingredients shall be cooled before mixing, or ice flakes, or well crushed ice may be substituted for all part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

Other precautions recommended by ACI Standard 305 shall also be adopted.

5.10 Construction Joints

- 5.10.1 Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be approved by the Engineer.
- 5.10.2 Joints not shown on the drawings shall be so made and located as to least impair the strength of the structures and shall need prior approval of the Engineer. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset a distance equal to twice the width of the secondary beam. Joints in walls and columns shall be at the underside of floor slabs or beams, and at the top of footings or floor slabs. Beams, brackets, column, capitals, haunches and drop panels shall be placed at the same time as slabs. Joints shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
- 5.10.3 Reinforcing steel shall continue across the joints. Key and inclined dowels shall be provided as, and where directed by Engineer. Longitudinal keys at least 40 mm deep shall be provided in all joints in walls and between walls and slabs or footings.
- 5.10.4 When the work has to be resumed on a surface which has hardened, such surface shall be roughened in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.
- 5.10.5 The hardened concrete of construction joints and of joints between footings and walls or columns, between walls or columns and beams or floors they support, joints in un-exposed walls and all others not mentioned herein shall be dampened (but not saturated) immediately prior to placing of fresh concrete.
- 5.10.6 The hardened concrete of joints in exposed work, joints in the middle of beams, and slabs; and joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout similar in proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least 12 mm thick on

horizontal surfaces. The fresh concrete shall be placed before the grout has attained initial set.

5.10.7 When the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle, and brushed, care being taken to avoid dislodgement of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm in thickness, and shall be well rammed against old work, particular attention being paid to corners and closed spots.

5.10.8 Stop ends for movement joints or construction joints shall be made by splitting them along the lines of reinforcement passing through them, so that each portion can be positioned and removed separately without disturbance or shock to the reinforcement or the concrete. Stop ends made of expanded metal or similar material may only be left permanently in the concrete with prior written approval of the Engineer. Where such stop ends are used, no metal may be left permanently in the concrete closer to the surface of the concrete than the specified cover to the reinforcement. Wood strips inserted for architectural treatment shall be kerfed to permit swelling without pressure on the concrete.

5.11 **Embedded Items**

5.11.1 Sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.

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

5.11.2 All embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with approved readily removable material to prevent the entry of concrete into the voids.

5.12 **Precast Concrete**

5.12.1 **Scope**

This Sub-Section includes fabrication and installation of all precast concrete units, and related work.

5.12.2 **Material**

Cement, concrete and reinforcing steel shall conform to the applicable requirements of the IN SITU CONCRETE WORKS, except as otherwise specified herein. The Contractor shall be responsible for the design of concrete mixes and for meeting the strength requirements.

5.12.3 **Formwork**

Forms and formed surfaces shall conform to the applicable portions of the IN SITU CONCRETE WORKS, and to the following:

- a. Forms shall be made and maintained to the grade, alignment and dimensions shown in the drawings.
- b. Beds and forms shall be adequately cleaned before reuse.

5.12.4 Fabrication

- a. **Precast Units** shall be of the sizes and shapes indicated on the Drawings. The finished units shall be straight and true with all edges sharp, straight and square and all flat surfaces in a true plane, such as specified in the Drawing.
- b. **Tolerances:** The casting, bowing warping and dimensional tolerance for precast units shall be maintained in accordance with the following:
 - 1. Overall dimension for widths of each unit, plus or minus 10mm; and length, plus or minus 20mm.
 - 2. Bowing or warping: not to exceed 20mm in any direction.
 - 3. Insert locations: Plus or minus 10mm in any direction.
- c. **Reinforcement** shall be provided, where required, in precast units and shall be of sizes, shapes and spacing as shown on the Drawings.
- d. **All anchors** Inserts, Lifting Devices (galvanized, if required) and similar items shall be and placed and secured in the forms prior to casting and shall be as shown on the Drawings.
- e. **Concrete** shall be mixed, handled, conveyed, placed and finished in strict conformance with the applicable requirements of the IN SITU CONCRETE WORKS.
- f. **Curing** of precast units shall be carried out in strict conformity with the applicable requirements of the in situ concrete works.

5.12.5 Identification and Marking

Each precast member shall be marked to indicate its type, serial number and date of fabrication. Identification marks shall correspond to the drawings.

5.12.6 Handling and Storage

- a. Precast units shall be handled, transported and stored in a manner, which will avoid undue strain, cracking, other damage. Damaged or defective units shall be repaired or replaced as directed by the Engineer.
- b. Units in which the departure from true dimensions is such that they will not come together satisfactorily with adjacent units, within the limits of their allotted positions or which produce an unacceptable irregularity in the finished units of the work, shall be rejected.

5.12.7 Cleaning

All precast units shall be delivered to the job site in the cleanest condition possible. During installation, utmost care shall be taken to prevent staining or marring the precast units. Upon completion of the erection, the precast work shall be left clean, and free of stains and all other noticeable defects on exposed surfaces.

5.12.8 Installation

- a. All precast work shall be accurately set in its assigned position, carefully plumbed and aligned and securely anchored to the structure in accordance with the Drawings.
- b. The Contractor shall furnish and install all loose shims, wedges, leveling grout, plates, etc. for the units to be secured to the structure as indicated on the Drawings. The Contractor shall provide all other members as indicated for the attachment of the precast work to the structure, as noted on the Drawings.

5.12.9 Testing and Inspection

Testing and Inspection shall be done in strict conformity with the applicable requirements of the in situ concrete work.

6. TEST OF CONCRETE QUALITY

6.1 Sampling of concrete for testing shall be done as per relevant PS or ASTM standards and at the Engineer's direction. Making and curing of test specimens shall be in accordance with PS 560, PS 849. The Contractor shall employ a competent person, whose first duty shall be to supervise all stages of preparation and placing of the concrete. All test specimens shall be made, and site tests carried out under his direct supervision.

6.2 Preliminary 5 cube strength tests shall be performed in accordance with PS 560, PS 849 and BS1881 directed by the Engineer.

6.3 The usual test for concrete with maximum size of aggregate up to 40 mm is the 150 mm cube tested in compression. Details of making and curing compression test cubes are given in PS 560, PS 849 and B.S. 1881 and details of the testing are given in Part 8 of B.S. 1881.

6.4 For all grades / classes of concrete, preliminary cube strength test with the mixes and materials to be used shall be performed in accordance with PS 560, PS 849 and B.S. 1881 before the work is begun and subsequently whenever any change is to be made in the materials or in their proportions of materials to be used, or as required by the Engineer. The strengths shall comply with the standard of quality specified in accordance with Table 1 for preliminary tests. The cost of such testing shall be borne by the Contractor.

6.5 Test sample shall be taken at the mixer or as directed by the Engineer. The test specimens shall be cured in accordance with P.S. 560, PS 849 and B.S. 1881.

6.6 Records shall be kept of all test cubes identifying the mix used, the section of work for which the concrete was used and the date poured.

6.7 The tests shall be carried out in a laboratory approved by the Engineer. The laboratory shall be an independent organization, or such other undertakings approved by the Engineer. Original test reports received from the laboratory shall be submitted to the Engineer.

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6.8 The five test cubes are to be tested for compressive strength as specified in B.S. 1881. These tests shall be carried out at site or in a laboratory approved by the Engineer. Two cubes shall be tested at the age of seven days and three at 28 days and the strengths determined are to comply with the standard of quality specified.

6.9 For all grades of concrete, the appropriate strength requirement shall be considered to be satisfied if none of the strengths of the cubes are below the specified cube strength, or if the average strength of the three cubes is not less than the specified cube strength and the difference between the greatest and the least strength is not more than 10% of the average.

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

7. FINISHING OF FORMED SURFACES

7.1 General

7.1.1 After removal of forms, the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the Contract Documents.

7.1.2 When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 10 square meter in an inconspicuous location Designated by the Engineer before proceeding with the finish in the specified location.

7.1.3 Allowable deviations from plumb or level and from the alignment, profile grades, and dimensions are specified in clause 9. Tolerances for concrete construction defined as 'tolerances', are to be distinguished from irregularities in finish as described herein. The finish requirements for concrete surfaces shall be as generally specified in this clause and as indicated on the Drawings. Finishing of concrete surfaces shall be performed only by workmen who are skilled in concrete finishes. The Contractor shall keep the Engineer informed as to when finishing of concrete will be performed. Unless inspection is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within the limits herein after specified.

Surface irregularities are classified as abrupt or gradual. Offsets caused by displaced or misplaced form sheathing or lining or sections, or otherwise defective form lumber will be considered as abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered as gradual irregularities, and will be tested by use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces. The length of the template will be 2 metres for testing of formed surfaces and 3 metres for testing of unformed surfaces.

7.2 As-cast Finishes

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

7.2.1 Rough form finish:

No selected form facing materials shall be specified for rough form finish surfaces. The holes and defects shall be patched. Fins exceeding 5 mm in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

7.2.2 Fair face finish:

Fair face finish applies to concrete formed surfaces, the appearance of which is considered by the Engineer to be of special importance, such as surfaces of structures prominently exposed to public view. Location of surfaces of concrete structures requiring fair face finish are shown in the Drawings. Surface irregularities, measured as described in sub-clause 7.2.1, 'Rough form finish', all not exceed 5 mm for gradual irregularities and 2.5 mm for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints. Abrupt irregularities at construction joints and elsewhere in excess of 2.5 mm and gradual irregularities in excess of 5 mm shall be reduced by grinding so as to conform to the specified limits. Abrupt irregularities at construction joints shall be ground on 1 to 20 ratio of height to length.

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

7.3 **Finishes of Unformed Surfaces:**

7.3.1 **Monolithic Concrete Floor Finish**

Where monolithic concrete floor finish is shown on the Drawings, placing shall proceed continuously for the full thickness of the course or RCC slab without change in concrete mix. Mixing water shall be the minimum required for proper placing, and will be as specified by the Engineer. After placing, floors, and other surfaces shall be floated with a wood float to a true surface and to elevation as shown on the Drawings. Where indicated on the Drawings, floor surfaces shall be steel trowel finished.

Toweling shall be the minimum amount consistent with maintaining a smooth dense surface, and shall not be done until the mortar has hardened sufficiently, to prevent excess fine material from being worked to the surface, and shall produce a dense uniform surface, free from blemishes and trowel marks.

Gradual surface irregularities shall not exceed 5 mm. The addition of water, dry cement, or dry cement mortar, to the surface of the concrete to facilitate finishing will not be permitted.

8. REPAIR OF DEFECTS

8.1 General

8.1.1 Any concrete failing to meet the specified strength or not formed as shown on drawings, concrete out of alignment, concrete with surfaces beyond required tolerances or with defective surfaces which cannot be properly repaired or patched in the opinion of the Engineer shall be removed at Contractor's cost.

The Engineer may reject any defective concrete and order it to be cut out in part or in whole and replace at the Contractor's expense.

8.1.2 All ties, bolt holes, and all repairable defective areas shall be patched immediately after form removal.

8.2 Repair of Defective Areas

8.2.1 Defective and honeycombed concrete shall be removed down to sound concrete. The area to be patched and an area at least 150 mm wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing No.25 BS Sieve and shall then be well brushed into the surface.

8.2.2 The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not less than 1 part cement to 2-1/2 parts sand by weight. White Portland cement shall be substituted for a part of the gray Portland cement on exposed concrete in order to produce a colour matching the color of the surrounding concrete, as determined by a trial patch.

8.2.3 The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

8.2.4 After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface to permit initial shrinkage; it shall be left undisturbed for at least 1 hour before being finally finished. The patched area shall be kept damp for at least 7 days. Metal tools shall not be used in finishing a patch in a formed wall, which will be exposed.

8.2.5 Where as-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as-cast surfaces shall not exceed 0.2 square metre in each 100 square metres of as-cast surface. This is in addition to form tie patches, if the project design permits ties to fall within as-cast areas.

8.2.6 Any patches in as-cast architectural concrete shall be indistinguishable from surrounding surfaces. The mix formula for patching mortar shall be determined by trial to obtain a good colour match with the concrete when both patch and concrete are cured and dry. After initial set, surfaces of patches shall be dressed manually to obtain the same texture as surrounding surfaces.

8.2.7 Patches in architectural concrete surfaces shall be cured for at least 7 days. Patches shall be protected from premature drying to the same extent as the body of the concrete.

8.3 Tie and Bolt Holes

After being cleaned and thoroughly dampened, the tie and bolt holes shall be filled solid with patching mortar. If architectural appearance requires, these holes may be filled partially creating the desired round clear holes pattern on surfaces exposed to view.

8.4 Proprietary Materials

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

9. ANCHORING DOWEL BARS

After removal of roof finishes the column tops shall be marked and existing concrete surfaces shall be roughened. Holes for dowel bars shall be drilled, of the diameters and depths as recommended by manufacturer of adhesive material. All holes shall be cleaned prior to the placing of adhesive material or dowels as per manufacturer's specifications.

10. CONCRETE CONSTRUCTION TOLERANCES

All tolerances shall be as per ACI 317.

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

10.1 Variation from the plumb (or the specified batter for inclined walls). (allowable variation)

10.1.1 In the lines and surfaces of columns and walls, and in rises

In any 3 metres of length or height 6 mm

Maximum for the entire length or height 25 mm

10.1.2 For exposed corner columns, control joint grooves and other conspicuous lines

In any bay or 6 metres maximum 6 mm

Maximum for the entire length or height 13 mm

10.2 Variation from the level or from the grades indicated on the drawings.

10.2.1 In beam soffits, and in arises measured before removal of supporting shores.

In any 3 metres of length 6 mm

In any bay or in any 6 metres maximum 10 mm

Maximum for the entire length 19 mm

10.3 Variation of the linear structure lines from established position in plan and related position of columns and walls.

In any bay or 6 metres ± 13 mm

Maximum for the entire length ± 25 mm

10.4 Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.

Up to 12" (300mm) - 6 mm
+10 mm

More than 12" (300mm) - 10 mm

10.5 **Footings**

10.5.1 Variation in dimensions in plan

Minus 13mm

Plus (plus variation applied to concrete only,
not to the reinforcing bars or dowels).
(formed) 50mm

10.5.2 Misplacement or eccentricity

2 percent of the footing width in the
direction of misplacement but not more
than (applies to concrete only, not to
reinforcing bars or dowels). + 50mm

10.5.3 Reduction in thickness

Minus 5 percent of specified thickness

10.6 **Tolerances for precast concrete construction**

Forms must be true to size and dimensions of concrete members shown on the plans and be so constructed that the dimensions of the finished products will be within the following limits at the time of placement of these units in the structure, unless otherwise noted on structural architectural drawings:

10.6.1	Overall dimensions of members	-1.5mm (1/16) in every 3 metres (10 ft.)
10.6.2	Cross-sectional dimensions	
	Section less than 75mm (3 in)	-1.5mm (1/16 in)
	Section over 75mm (3 in) and Less than 450mm (18 in)	-3mm (1/8 in)
	Sections over 450mm (18 in)	-6mm (1/4 in)
10.6.3	Deviations from straight line in long sections, not more than	3mm(1/8in) in every 3 metres (10 ft)
10.6.4	Deviation from specified camber	\pm 1.5mm (1/16) in per 3 meters (10 ft.) of span.
	Maximum differential between adjacent Units in erected position	6mm(1/4 in)

11. ACCEPTANCE OF STRUCTURE

11.1 General

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

11.2 Dimensional Tolerances

- 11.2.1 Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of clause 9 shall be considered potentially deficient in strength and subject to the provisions of Sub Clause 10.4.
- 11.2.1 Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of Clause 9 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance. Permission is required if excess material is to be removed in accordance with this clause.

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

11.2.4 Inaccurately formed concrete surfaces exceeding the limits of Clause 9 or of Clause 6.5 of Section 'Formwork' shall be removed and replaced, and those that are exposed to view, may be rejected, or shall be repaired, or removed and replaced, as directed by the Engineer.

11.3 **Appearance**

11.3.1 Architectural concrete with surface defects exceeding the limitations described in relevant Clauses of this section shall be removed and replaced.

11.3.2 Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only by approved methods.

11.3.3 Concrete not exposed to view is not subject to rejection for reason of defective appearance.

11.4 **Strength of Structure**

11.4.1 Strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements which is relevant to the strength of the structure, including but not necessarily limited to the following conditions:

- Concrete strength requirements not considered to be satisfied in accordance with Clause 6 hereof.
- Reinforcing steel size, quantity, strength, position or arrangement at variance with the requirements as specified under section 'Reinforcement' or in the Contract Documents.
- Concrete, which differs from the required dimensions or location in such a manner as to reduce the strength.
- Curing less than that specified.
- Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
- Mechanical injury, construction fires, premature removal of formwork, likely to result in deficient strength.
- Poor workmanship likely to result in deficient strength.

11.4.2 Structural computations and/or additional testing may be required when the strength of the structure is considered potentially deficient.

11.4.3 Core tests may be required when the strength of the concrete in place is considered deficient.

- 11.4.4 If core tests are inconclusive or impractical to obtain or if structural computations do not confirm the safety of the structure, load tests may be required and their results evaluated, in accordance with ACI Standard 318.
- 11.4.5 Concrete work judged inadequate by structural computations or by results of a load test shall be reinforced with additional construction, if so directed by the Engineer or shall be replaced, at the Contractor's expense.
- 11.4.6 The Contractor shall bear all costs incurred in providing the additional testing and/or computations required by this section.

12. MEASUREMENT AND PAYMENT

12.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

- 12.1.1 Supplying, fixing, striking etc. of formwork including fair face formwork, if required.
- 12.1.2 Supplying and installing all type of joints in structure except expansion joints
- 12.1.3 All sampling, mixing, testing and concrete mix design as specified.
- 12.1.4 Making and testing of concrete cube specimens
- 12.1.5 Providing pockets and voids.
- 12.1.6 Anchor bolts & other embedded parts.
- 12.1.7 Bitumen seal in plinth protection, ramp and isolation joint as shown on the drawings.
- 12.1.8 Providing grooves on concrete surfaces as shown on the drawing.
- 12.1.9 Curing, repair work, scaffolds, water stops and admixtures.
- 12.1.10 Supplying admixtures, retarders and plasticizers in concrete.
- 12.1.11 All work items related to installation of precast member/elements in place, as shown on the drawings, unless otherwise specifically mentioned in the BOQ.
- 12.1.12 Supply & placing Pipe Sleeves for rain water drainage
- 12.1.13 Expansion joints
- 12.1.14 Dismantling of dummy concrete.

12.2 Plain and Reinforced Concrete

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12.2.1 Measurement

Concrete shall be measured as executed but no deduction shall be made to the following:

Volume of any steel embedded in the concrete.

Volume occupied by water pipes, conduits etc. not exceeding 25 square centimeters each in cross-sectional area.

Voids not exceeding 0.1 square metre. If any void exceeds 0.1 square metre total void shall be deducted.

Voids, which are not to be deducted as specified above, refer only to openings or vents, which are wholly within the boundaries of measured areas. Openings or vents, which are at the boundaries of measured areas, shall always be subject to deductions irrespective of size.

Concrete work shall be classified and measured separately as listed under items of Bills of Quantities.

Junction between straight and curved works shall in all cases be deemed to be included with the work in which they occur.

Measurement of walls shall be taken between attached columns or pilaster. The thickness of attached columns, or pilaster shall be taken as the combined thickness of the wall and the columns, or pilaster. Attached or isolated columns, pilaster, and the like (except where caused by openings) having a length on plan over four times the thickness and are caused by opening in wall shall be classified as walls.

Columns shall be measured from the top of footing beams or floor surfaces to the underside of beams or slabs as the case may be.

Where the width of beams is less than the width of columns, the extra width at the junction shall be included in the beams.

The depth of the beams shall be measured from bottom of the slab to the bottom of the beams except in case of inverted beams where it shall be measured from top of slab to the top of beam. The cross-section of the beam shall be the actual cross-section below or above the slab.

Measurement of acceptably completed works of plain and reinforced cement concrete will be made on the basis of number of cubic foot concrete placed and compacted in position within the neat lines of the structure as shown on the Drawings or as directed by the Engineer.

12.2.2 Payment

Payment will be made for the acceptable measured quantity of plain and reinforced cement concrete on the basis of unit rate per cubic foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

SECTION - 5

FORMWORK

1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in any floor and roof and floor and at any height in connection with the supply and installation of formwork for the purpose of shuttering in concreting work, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract. The works include all formwork required at any floor and at any height required for the completion of the work as per drawings/specifications.

2. GENERAL

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

3. **APPLICABLE STANDARDS**

Latest editions of the following are applicable to these specifications, as and where required:

ACI 301 Specifications for Structural Concrete for Buildings.

ACI 318 Building Code Requirements for Reinforced Concrete.

ACI 347R Guide to Formwork for Concrete.

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

4. **MATERIALS**

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

4.1 Timber

Form framing, sheathing and shoring.

4.2 Plywood

Form sheathing and panels.

4.3 Steel

- Heavy forms and false work
- Column and joint forms
- Permanent forms
- Welding of permanent forms

4.4 Form Ties Anchors and Hangers

For securing formwork against placing loads and pressures.

4.5 Coatings

To facilitate form removal.

4.6 Steel Joists

For formwork support.

4.7 Steel frame shoring

For formwork support.

5. DELIVERY AND STORAGE

5.1 Delivery

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

5.2 Storage

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

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

6. WORKMANSHIP

6.1 Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

Where required details and locations of special forms to be used are set out on the drawings. The Engineer shall refuse any formwork in any part of the building, which has been constructed with a non-approved formwork. The Engineer shall refuse any concreting which will not be perfect or may not conform to the approved model.

6.2 Earth cuts shall not be used as forms for vertical surfaces of reinforced concrete work unless required as such or permitted by the Engineer.

6.3 Mud centering shall not be permitted without the prior approval of the Engineer.

6.4 a) Formwork shall be of wrought timber, steel, plywood, proprietary building boards and such special materials, as may be shown on the drawings or approved by the Engineer, which give the required finish to the surface of concrete. Wooden formwork shall be free from loose knots and shall be well seasoned.

b) The responsibility of the safe design of the formwork shall be entirely that of the Contractor.

c) No wooden props, bamboo, ballies, etc., shall be used as supports to beams or roofs and floors. Only steel pipe scaffoldings (tubular) to be used for all works.

d) Only wooden planks of approved quality and thickness of 2 inches minimum on the sides of beams shall be allowed.

e) All the erected formwork shall be inspected and approved in all respects by the Engineer or his representative prior to concreting.

f) Where concrete will be exposed to view, special care shall be taken in the selection of the form material and the construction of the forms, to the end that the concrete will be smooth, uniform in texture, true in line and face and free from honey-combing and other projections. All sides and joints on the forms shall be flush (without lipping) and inconspicuous, wood used for such work shall be thoroughly cleaned before each reuse and shall be free from cracks, splinters, nails, or other defects effecting the appearance of the concrete.

- 6.5 The formwork shall conform to the shape, lines and dimensions as shown on the plans and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete, and shall be sufficiently tight to prevent loss of liquid from the concrete.

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

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

6.6 Forms for architectural concrete shall be designed to produce the required finish or finishes. Deflection of facing materials between studs as well as deflection of studs and walers shall be limited to 0.0025 times the span or as otherwise specified. Forms shall be designed to permit easy removal. Prying against the face of the concrete shall not be allowed. Only wooden wedges shall be used.

- 6.7 Where natural plywood-form-finish, grout-cleaned-finish, smooth-rubbed- finish, scrubbed-finish or sand-floated-finish is required, forms shall be smooth (faced with plywood, liner sheets, or pre-fabricated panels) and true to line, in order that the surfaces produced will require little dressing to arrive at true surfaces. Where any as-cast finish is required, no dressing shall be permitted in the finishing operation.
- 6.8 Where as-cast surfaces, including natural plywood-form-finish are specified, the panels of material against which concrete is cast shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features.
- 6.9 Where panels for as-cast surfaces are separated by recessed or otherwise emphasized joints, the structural design of the forms shall provide for locating form ties, where possible, within the joints so that patches of tie holes will not fall within the panel areas.
- 6.10 Forms shall not be re-used if there is any evidence of surface wear and tear or defect, which would impair the quality of the surface finish. Forms shall be thoroughly cleaned and properly coated with form oil before re-use.
- 6.11 The formwork shall be designed so that the soffits of slabs and sides of beams, columns and walls may be removed first, leaving the forms to the soffits of beams and their supports in position.
- 6.12 Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Unless otherwise specified in the Contract Documents chamfer strips shall be placed in the corners of forms to produce beveled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of formed joints will not require beveling unless required by the Contract Documents.

- 6.13 Positive means such as wedges or jacks for accurate adjustment and for proper removal of shores and struts shall be provided and all settlement shall be monitored during concrete placing operation. Forms shall be securely braced against lateral deflections.
- 6.14 Where concreting of thin members is required to be carried out within formwork of considerable depth, temporary openings in the sides of the formwork shall be provided where necessary to facilitate the placing and consolidation of concrete. Small temporary openings shall also be provided at the bottom of the formwork for columns, walls and deep beams to permit the cleaning out of debris and observation immediately before concrete is deposited.
- 6.15 Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameter or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view except that in no case shall this distance be less than 3/4 inch. When the formed face of the concrete is not to be permanently exposed to view, form ties may be cut off flush with the formed surfaces. Precaution shall be taken not to rotate form ties.
Through bolts may be permitted provided that they are greased to allow for easy withdrawal and the holes subsequently made good. Through bolts are not to be used on water-retaining structures and basement walls.
- 6.16 At construction joints contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by no less than 1 inch. The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint so as to maintain a true surface.
- 6.17 Wood forms for wall opening shall be constructed to facilitate loosening, if necessary to counteract swelling of the forms.
- 6.18 Wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.
- 6.19 Formwork shall be so anchored to shores or to other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will not occur.
- 6.20 Runways or planks for moving labour and equipment shall be provided with struts or legs and shall be supported directly on the formwork or upon the structural member without resting on the reinforcing steel.
- 6.21 All surfaces of forms and embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before placing fresh concrete.
- 6.22 Forms shall be sufficiently tight to prevent leakage of grout or cement paste. Board forms having joints opened by shrinkage of the wood shall be removed and replaced. Plywood and other wood surfaces not subject to shrinkage shall be sealed against absorption of moisture from the concrete by either:
- (1) a field applied, approved form oil or sealer, or
 - (2) a factory applied non-absorptive liner.

When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with the concrete against which fresh concrete will be placed. Care shall be taken that such approved composition is kept out of contact with the reinforcement. Where as-cast finishes are required, materials, which will impart a stain to the concrete, shall not be applied to the form surfaces. Where the finished surface is required to be painted, the material applied to form surfaces shall be compatible with the type of paint to be used.

- 6.23 For reinforced concrete, in no circumstances shall forms be struck until the concrete attains 75% of ultimate strength.

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

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

- | | | |
|---|-----------------------|--------------------------|
| - Walls, columns and vertical sides of beams. | 48 hours or as may be | decided by the Engineer. |
| - Side of slab (shores of props left under). | 6 days. | |
| - Beams soffits (shores or props left under). | 12 days. | |
| - Removal of shores or props to slabs. | | |
| 1. Spanning upto 12 feet. | 10 days. | |
| 2. Spanning over 12 feet. | 16 days. | |
| - Removal of shores or props to beams. | | |
| 1. Spanning upto 18 feet. | 18 days. | |
| 2. Spanning over 18 feet. | 25 days. | |

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

The number of shores or props, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab and beams, as the case may be.

Proper allowance shall be made for the decrease in rate of hardening of concrete in cold weather and the above minimum duration must be increased when the mean daily temperature is below 20° C.

- 6.24 When repair of surface defects or finishing is required at an early age, forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.

- 6.25 Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed by the specified curing.
- 6.26 Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete.
- 6.27 All formwork shall be removed without such shock or vibration as would damage the reinforced concrete. Before the top plank and struts are removed, the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occurs with all cement in the cold weather.
- 6.28 When reshoring or repropping is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is underway no live load shall be permitted on the new construction. In no case during reshoring shall concrete in beam, slab, columns or any other structural member be subjected to combined dead and construction loads in excess of the load permitted by the Engineer for the developed concrete strength at the time of reshoring.

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

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

- 6.29 Floors supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half the capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations are permitted.

The reshoring or re-propping shall extend over a sufficient number of storeys to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that the design superimposed loads of the floors supporting shores or props are not exceeded.

- 6.30 It is generally desirable to give forms for reinforced concrete an upward camber to ensure that the beams or slabs (specially cantilever slabs) do not have a sag when they have taken up their deflection, but this should not be done unless permitted by the Engineer.
- 6.31 No loads, other than man and light plant required in connection with the actual work in hand, shall be allowed on suspended floors until 28 days after concreting where ordinary Portland Cement is used and 14 days when rapid hardening Portland Cement is used.
- 6.32 Prior to placing concrete, all forms shall be inspected and all debris and extraneous matter removed. The form oil or release agent shall not react with concrete to affect the strength nor shall it give any colour.

7. MEASUREMENT AND PAYMENT

No payment will be made for the works involved within the scope of this section of the specifications unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of relevant items of the Bills of Quantities.

SECTION - 6

REINFORCEMENT

1. SCOPE

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

2. APPLICABLE STANDARDS

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

British Standard

B.S 4449 Carbon steel bars for the reinforcement of concrete.

B.S 4466 Specifications for bending dimensions and scheduling of bars for the reinforcement of concrete.

ACI Standard

ACI 315 Details and detailing of concrete reinforcement.

ACI 318 Building Code Requirements for Reinforced Concrete and commentary.

ASTM Standard

A 82 Cold – Drawn steel wire for concrete reinforcement.

A 305 Minimum requirement for the deformations of deformed steel bars for concrete reinforcement.

A 615 Deformed Billet Steel Bars for Concrete Reinforcement.

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

3. MATERIAL

- 3.1 Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements as per ASTM A 615 Grade 60 for deformed hot rolled billet steel bars with specified minimum yield strength of 60000psi.
- 3.2 Reinforcement shall be free from all loose or flaky rust and mill scale, or coating, including ice, and any other substance that would reduce or destroy the bond.

4. COMPLIANCE WITH SPECIFICATIONS

The Contractor shall submit certificates of compliance from the manufacturer stating that the supplied reinforcement conforms to the specifications. In addition, wherever and if directed by the Engineer, conformance of the supplied reinforcing bars with the specifications shall be demonstrated by the Contractor through laboratory tests, in accordance with the relevant standards.

5. DELIVERY & STORAGE

5.1 Delivery

Steel reinforcement bars shall be kept in bundles firmly secured and tagged. Each bar or bundle of bars shall be identified by marks as per relevant standards.

5.2 Storage

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

6. BAR BENDING SCHEDULES

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

The Engineer's approval, however, will not relieve the Contractor of his responsibility in this regard.

7. FABRICATING, BENDING & PLACING

7.1 Reinforcement is to be accurately placed as shown in the drawings, and secured against displacement by using 16 gauge G.I wire ties or suitable slips at intersections and supported from the formwork by using concrete, metal or plastic chairs and spacers or hangers of an approved pattern. Where concrete blocks are used for ensuring the cover, they shall be made of mortar not leaner than 1 part of cement to 2 parts of sand.

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

7.2 Bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the bar bending schedule approved by the Engineer.

7.3 The cutting tolerance for all bars shall be + 25 mm

7.4 Fabrication tolerances shall be as per ACI-315

7.5 Placing tolerances shall be as per ACI-318 & 317.

7.6 Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to approval of Engineer.

7.7 Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all columns dowels.

7.8 Reinforcement shall not be bent or straightened in a manner that will injure the material.

No bars shall be bent twice in the same place, nor shall they be straightened after bending.

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

7.9 No splice of reinforcement shall be made, except as shown on the working drawings.

7.10 Welding of reinforcement shall not be done unless permitted and approved by the Engineer.

- 7.11 Exposed reinforcement intended for bonding with future extensions is to be effectively protected from corrosion. Protection is also to be provided to reinforcement partly built into concrete where the exposed part is to be built into later concrete.
- 7.12 No concreting is to be carried out until the reinforcement has been checked and approved by the Engineer.
- 7.13 All detailing shall be done as per ACI-315, ACI-318 and ACI-350R, as and where required.
- 7.14 Standard or actual weight whichever is lesser shall be used for calculation of weight.

8. MEASUREMENT & PAYMENT

8.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

8.1.1 Providing and installing chairs, supports, hooks, hangars, spacers, binding wires, corrosion protection and laps not shown on Drawings including wastage and rolling margin.

8.1.2 Testing of plain and deformed steel bars.

8.2 Reinforcing Bars (Deformed, or plain)

8.2.1 Measurement

Measurement for acceptably completed works of reinforcing bars shall be made by weight according to bar bending schedules approved by the Engineer.

8.2.2 Payment

Payment will be made for acceptable measured quantity of reinforcement on the basis of unit rate per metric ton quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION - 7

BRICK MASONRY

1.0. SCOPE

The work under this section of the specification consists of furnishing all plant, labour, equipment, appliances, materials and in performing all operations in connection with supplying and constructing brick masonry, complete in strict accordance with this section of the specifications and applicable drawings and subject to the terms and conditions of the Contract. The scope of this section of specification is covered with detailed specification as laid down herein.

2.0 APPLICABLE CODES AND STANDARDS

Latest editions of the following ACI codes and ASTM Standards referred to herein, are applicable to these Specifications.

ACI Codes

ACI 530 Building Code Requirements for Masonry Structures

ACI 530.1 Specifications for Masonry Structures

ASTM Standards

ASTM C 62 Building Bricks (Solid Masonry units made from clay or shale)

- ASTM C 216 Facing Bricks (Solid Masonry units made from clay or shale)
- ASTM C 67 Sampling and Testing Bricks
- ASTM C 270 Mortar for Unit Masonry
- ASTM A 615 Deformed and plain billet bars for concrete reinforcement

3.0 SUBMITTALS

3.1 Manufacturer's Data

Submit two copies of the manufacturer's specifications and other data for each type of brick and accessory required. Instructions shall be included for handling, storage, installation, and protection of units and accessories.

3.2 Samples

Submit three samples of each type of brick and accuracy required, also samples of the full range of exposed texture to be used in the completed work.

3.3 Test Reports

Reports for compressive strengths of brick and mortar; and tensile tests of reinforcing steel.

3.4 Certificate of Compliance

Cement.

Reinforcing Steel.

4.0 MATERIALS

4.1 Cement & Aggregates

All Portland cement shall conform to the requirements of ASTM C-150.

All aggregates for mortar shall conform to the requirements of ASTM C-144.

All water used in the manufacture of bricks and in the preparation of mortar shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities. The water shall be tested in accordance with BS-3148, where directed by the Engineer.

4.2 **Mortar**

Mortar shall conform to the requirements of ASTM, C-270. Mortar shall be of type S having a minimum compressive strength of 1800 psi.

Proportioning for mortar shall be in accordance with the requirements of ASTM C-270. However it shall not be less than 1 part of cement to 3 parts of sand.

Methods and equipment used for mixing mortar will be such so as to accurately determine and control the amount of each separate ingredient entering into the mortar. Mortar shall be mixed only in sufficient quantities for immediate use and shall be used within 30 minutes after mixing.

Stiffened mortars shall be re-tempered by adding water to restore the required consistency.

Mortars not used within 2-1/2 hours after initial mixing shall be discarded. The mixers shall be thoroughly cleaned and washed at the end of each day's work.

4.3 **Bricks**

Building bricks shall conform to the requirements of ASTM C 62. Size of building bricks shall be 9" x 4 1/2" x 3" and as approved. The Contractor shall submit samples of building bricks for approval prior to commencement of work. Defective bricks shall not be used.

5.0 **PLACING**

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar. Bricks shall not be placed during heavy rains to washing away the mortar from the brick. Mortar already spread, which becomes diluted by rain, shall be discarded and replaced before continuing with the work. All bricks to be used in brick masonry shall be soaked in water for three to four hours before they are used to ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.

Bricks shall be laid "frog" upward with mortar joints and in stretcher bond or as approved by the Engineer. Both bed and vertical joints shall be 3/8" in thickness completely filled with mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints

drawn straight. Work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

They shall be laid true to line, level and plumbs, All joints shall be perfectly straight, parallel and sharp. Facing brick of irregular shape, size, damaged and defective edges and faces shall be rejected outright. Works done with defective edges and faces shall be rejected and the Contractor shall replace, without additional cost, all defective and unacceptable works.

Exterior faces of the walls shall be finished by striking the joints as the work proceeds. Tooling shall be done when the mortar is partially set but still sufficiently plastic to bound. The joints shall be struck by raking the green mortar after the brick work has been laid and finish the joints with a pointing tool. Horizontal joints shall be struck to form a weathered joint and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints.

6.0 CURING AND REPAIR

All brick masonry shall be water cured and shall be kept wet for at least seven days by an approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements of the specifications for water used in the manufacture of bricks.

If, after the completion of any brick masonry work, the brick is not in alignment or level, or does not conform to the lines and levels, shown on the drawings, or shows a defective surface, it shall be removed and replaced by the Contractor, without additional cost to Engineer. Repair or patching of the defective area will not be acceptable unless allowed, in writing, by the Engineer.

7.0 SCAFFOLDING

The Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the Engineer shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor without additional cost to the Engineer.

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

8.0 TOLERANCES

All tolerances shall be as per requirements of ACI-530.1

9.0. DAMP PROOF COURSES

All damp proof courses unless otherwise specified shall be 2 inches thick, consisting of cement concrete having a 28 day minimum cube strength of 21 N/mm², mixed with approved quality water proofing compound as per manufacturer's specifications and shall be laid at required levels as per drawings and instructions of the Engineer. The damp proof course shall be tamped, consolidated, leveled and edges and corners made to the requirements of the relevant drawings including finishing and curing complete.

No separate payment will be made for providing and laying damp proof course.

10.0 **CLEANING AND PROTECTION**

At the completion of the work, all holes, and defective mortar joints shall be cut and repointed. Exposed masonry shall be protected against staining or other damage and excess mortar shall be cleared off the surfaces as the work progresses. All exposed masonry shall be clean, smooth, fine and shall be of acceptable finish approved by the Engineer.

11.0 **ANCHORAGE OF MASONRY**

All masonry units shall be anchored to structural elements in accordance with UBC-88 or as per detail shown in drawings.

12.0 **MEASUREMENT AND PAYMENT**

12.1 **General**

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the undermentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

121.1.1 Cutting & chiseling of masonry wherever required.

12.1.2 Cement sand mortar used in laying bricks including wastage.

12.1.3 Curing and repairing the masonry work.

12.1.4 All joint reinforcing bars, reinforcing anchor bars and dovetail anchors.

12.1.5 Providing and laying damp proof course.

12.2 **Brick Masonry**

12.2.1 **Measurement**

In case of different thickness of slab in different areas or room or for any other reason whatsoever, if chiseling of masonry is required the Contractor shall do so at his own cost. Where, for any reason whatsoever, the height of the wall is short of ceiling height of the actual height shall be made good with Class "C" concrete. This concrete shall neither be measured nor be paid under item of concrete but will be paid for under item of masonry. Similarly where the lintel heights are such that the Contractor has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiseling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate for masonry.

Measurement of acceptably completed works of brick masonry will be made on the basis of number of cubic feet provided & installed in position as shown on the drawing or as directed by the Engineer.

12.2.2 Payment will be made for acceptable measured quantity of brick masonry on the basis of unit rate per cubic feet quoted in the Bills of Quantities & shall constitute full compensation for all the works related to the item.

SECTION - 8

CEMENT PLASTER

1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances, and materials and in performing all operations in any floor and at any height connection with providing and installation of cement plaster, and specified external rendering complete in strict accordance with this section of the Specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2. GENERAL

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- 2.1 Except as may be otherwise shown on surfaces specified, all plaster work, both internal and external shall be ordinary Portland Cement plaster of the required thickness as shown on the drawings.
- 2.2 Plastering shall not commence until all electric conduits, drainage and sanitary pipes, inlets to tanks, brackets, clamps, doors and window frames and all sorts of inserts and embedded items are fixed in position. It shall be the responsibility of the Contractor to make sure that all such work is carried out by other contractors before starting of plaster work. Chiseling and repairing of cement plaster shall not be permitted without the approval of the Engineer.
- 2.3 Sample of materials shall be submitted to the Engineer for his approval prior to use in the works.
3. **MATERIAL**
- 3.1 Cement for plaster shall be Ordinary Portland Cement (B.S 12 or P.S 232) or Sulphate resisting cement (B.S 4027 or P.S. 612) as specified and shall conform to requirements specified in the section "Plain and Reinforced Concrete".
- 3.2 Sand for plaster shall comply with the requirements of BS 1199, BS 1200 or the draft Pakistan Standard "Sand for Plaster" as directed by the Engineer.
- 3.3 Water for plaster shall conform to requirements specified in the section for "plain and reinforced concrete".
- 3.4 All materials and workmanship for plaster, not explained in these Specifications, shall comply with the requirements of relevant BS CP 211 and CP 221 as directed by the Engineer.
4. **PROPORTIONING AND MIXING**
- 4.1 Measurement of materials by volume shall be by containers of known capacity to maintain consistent proportions. No lumpy or caked material shall be used. Mixing equipment boxes and tools shall be clean. Materials shall be proportioned as specified on the Drawings, in the Bill of Quantities or as directed by the Engineer. Mixing shall be continuous until all ingredients are evenly distributed and thoroughly mixed.
- 4.2 Only limited water shall be added for proper workability and such quantity of mortar shall be prepared which can be consumed in thirty minutes after preparation. Preparation of mortar in bulk quantity for use during the entire day or for any other time more than that stipulated above is expressly prohibited. Retempering shall not be permitted and all mortar which has begun to stiffen shall be discarded.
- 4.3 Plaster ingredients shall be thoroughly mixed either by hand on a clean cement concrete platform or by a mechanical mixer, as directed by the Engineer.
5. **PREPARATION OF SURFACE TO BE PLASTERED**
- 5.1 Concrete surface to be plastered shall be cleaned to remove all grease, form oil and other surface impurities, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface of all-concrete

ceilings, beams and columns shall be lightly hacked by approved means to give the required key for plastering.

- 5.2 All masonry surfaces to be plastered shall be cleaned to remove all matter, which will otherwise adversely affect the adhesion of plaster to the surface concerned. The surface shall be washed with clean water and kept damp for 24 hours before further treatment. The surface thus prepared shall be treated uniformly with cement and sand slurry. The slurry to be used shall be one part cement to one part sand by volume with water added to make a stiff creamy mix. The slurry shall be applied with a stiff brush on surface, which has previously been well wetted. The surface so treated shall be left to cure for 3 days.

6. APPLICATION OF PLASTER

- 6.1 The plaster of thickness less than the specified thickness shall be rejected. If the plaster is to be more than 12 mm thick, it shall be done in two coats. The surface of first coat shall be made rough before the second coat is applied.

The plaster shall not have wavy surface and shall be perfectly in plumb. The edges and corners shall represent a straight line. The plaster shall be kept wet continuously for at least ten (10) days. No extra payment shall be allowed for jambs, junctions, corners, edges, round surfaces or for more than one layer of plaster required due to any unevenness in the work done by the Contractor. The plasterwork is to cover all conduits, pipes etc fixed in the walls and ceiling. Wherever specified, metal lath shall be nailed firmly before plastering is commenced. The plaster surface shall be tested frequently with a 3 m straight edge and plumb bob.

- 6.2 Plaster containing cracks, blisters, pits, discolouration or any defects shall not be acceptable. Any such plaster or loose plaster shall be removed & replaced with plaster in conformity with these specifications and as additionally directed by the Engineer.

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

7. METAL LATH

Metal lathing shall be fabricated from sheet steel and shall be of uniform quality and free from flaws broken strands, cracks and corrosive pitting, shall be rectangular and true to shape and shall comply with BS-1369.

All lathing shall be galvanized. Where plastering material depends entirely on the lathing for its key, these shall be not less than two complete mesh openings per 1-1/8" in one direction and the width of the aperture shall not be less than 3/16".

Sheets shall not be less than 1.6 kg/sq.m when fabricated, using 0.7 mm thick steel sheet. Where used on smooth surfaces to form a key it shall be not less than 1.2

kg/sq.mm when fabricated, using 0.5 mm thick steel sheet. Tying wire shall be 1.2 mm diameter galvanized annealed iron wire.

Sheets shall be welded to angle iron frame as shown on drawings.

8. ANGLE AND BEADS

Angle beads, stop beads, depth gauge beads, edging profiles, plaster dividing profiles, interior angle profiles, plaster borders and the like shall all be manufactured from sheet steel and galvanized after fabrication, all beads shall be perforated at edges to ensure good adhesion of the plaster work. Thickness and dimensions shall suit particular locations and plaster thickness.

All angle beads, stop beads, depth gauge beads and the like are to be fixed in accordance with the manufacturer's instructions, at all corners, stops, joints, etc. as per directions of Engineer In-charge.

9. INTERNAL / EXTERNAL PLASTER

9.1 Where specified in the Drawings external surface shall have an average 20 mm thick plaster finish, consisting of a base coat of 1:4 cement sand mortar in Grey cement and the finish coat of smooth plaster as shown on the Drawings and as directed by the Engineer.

9.2 Where specified in the Drawings all internal plaster shall have an average 12 mm thick consisting of base coat of 1:6 cement sand mortar in grey cement and finish coat of smooth plaster as shown on the Drawings and as directed by the Engineer.

9.3 Stucco Plaster

Wherever specified in the drawings external stucco plaster shall consist of 1:2, one part white cement & 2 parts approved shade of marble chips zero size mixed with approved pigment to achieve desired shade. Wherever shown on drawings, groves shall be provided with aluminum U/Y channels. The contractor shall prepare mockup samples of stucco plaster for the approval of Engineer. The plaster shall be applied with machines and the final rough surface/texture/shade shall be as per the approved sample, direction and approval of the Engineer-Incharge.

10. CLEANING AND PROTECTION

10.1 Rubbish and debris shall be removed as necessary to make way for work of other trades and as directed by the Engineer. As each room or space is completed all rubbish, debris, scaffolding and tools should be removed to leave the room clean.

10.2 Prior to plastering all aluminum windows, finished metals should be covered by sheet of plastic or tarpaulin to protect it from damage.

10.3 Protect finished plaster from injury by any source. Contractor shall also protect walls, floors and work of other trades from plaster materials.

11. TOLERANCES

Surfaces of plaster work shall be finished with a true plane to correct line and level with all angle and corners to a right angle unless otherwise specified and with walls and reveals plumb and square.

Maximum permitted tolerances shall not exceed 3 mm in 2 metre variation from plumb or level in any exposed line or surface and 1.5 mm variation between planes of abutting edges or ends.

12. MEASUREMENT AND PAYMENT

12.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective item of the Bill of Quantities.

The rates quoted by the Contractor in the Bill of Quantities shall include work to be executed under these specification in any floor and at any height except where otherwise specifically stated in the relevant item of Bill of Quantities and the Contractor shall not be entitled to any claim or claim any compensation on this account.

12.1.1 Metal lath over reinforced concrete and masonry joint.

12.1.2 Joints, junctions, corners, beads, drip course edge, roundings, and aluminum U/Y channels in groves. Etc.

12.1.3 More than one layer due to any unevenness in the finished works and base coat plaster in stucco plaster including marble chips/colour pigments.

12.1.4 Cutting & patching of all defective works.

12.1.5 Surface preparation, cleaning and protection as specified.

12.1.6 Marble chips & pigments in stucco plaster.

12.1.7 Roughning of first coat of plaster before application of 2nd coat incase where overall required plaster thickness exceeds 13mm.

12.1.8 Pudlo or approved equivalent water proofing agent.

12.2 Plain Plaster

12.2.1 Measurement

Deductions shall not be made for ends of joints, beam posts, etc., and openings not exceeding 5 square foot each and no

addition shall be made for reveals, jambs, soffits, sills, etc. of these openings non for finishing the plaster around ends of joints, beams posts, etc.

In case of opening of area exceeding 5 square foot each, deduction shall be made for the openings and also no addition shall be made for reveals jambs, soffits, sills, etc., of these openings.

Measurement of acceptably completed works of plaster will be made on the basis of number of square foot of the surface area plaster as shown on the Drawings, or as directed by the Engineer.

12.2.2 Payment

Payment will be made for acceptable measured quantity of plaster on the basis of unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 17

STRUCTURAL STEEL WORKS

1. SCOPE

This Section covers general requirements of steel, steel work fabrication, methods including precautions for erection of steel structures and other general requirements incidental to steel work.

2. GENERAL

The applicable requirements of this section as determined by the Engineer shall apply to all structural steel works under this contract. The work covered by this section, consists of supply of all material, labour, plant, equipment and appliances including welding, bolts, nuts, washers, anchor bolts, embedded parts etc, fabrication and erection in accordance with the specifications and as per drawings and as directed by the Engineer.

3. APPLICABLE STANDARDS

Latest edition of the following standards are relevant to these specifications, wherever applicable:

AISC	Code of standard practice
AISC	Specifications for Architecturally exposed structural steel.
ASTM	Specifications for structural joints using ASTM A325, or A490 Bolts.
ASTM	Specifications for materials.
AISC	Manual of steel construction.
SSPC-SP6	Steel Structures Painting Council specifications.
AWS	Specifications for welding of steel structures.
BS 449	Use of structural steel in buildings.

4. DRAWINGS

4.1 Design and Working Drawings

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

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4.2 Workshop Drawings

Workshop drawings shall then be prepared by the Contractor from the working drawings, taking into consideration the instructions, mentioned in following paragraphs:

- 4.2.1 The sizes-sections of members/parts of the structures shall be standard rolled steel sections according to German/British/ American or approved standards. The Contractor, before tendering, shall prepare material requirement lists, ensure its availability at the time of actual fabrication and in case certain sections are not available, he will select suitable available alternatives subject to the approval of the Engineer.

Workshop drawings shall be prepared by taking into consideration the points enumerated below:

- Fabrication in convenient sub assemblies and each shop assembly to be given an erection mark.
- Milling (machining of bases of supporting plate) for erection without adjustments.
- Provision of basic elements with erection devices.
- In-Keeping with the requirements of computed strength of all connections and joints of structures not foreseen in the design and in the working drawings.
- Other requirements having an influence on the technology of fabrication, transportation and erection of steel structures.
- Uniformity of elements and parts of the steel structures should be maintained for mass fabrication.

4.2.2 Contents of Workshop Drawings:

Workshop drawings shall consist of :

- i) An erection scheme in size 685mm x 965mm within boundary lines having the following information.
- Location of erection elements in respect of axes and Marks as well as picking points of these elements with respect to each other or with the existing steel or reinforced concrete structures.
 - Erection joints showing erection welding thickness and lengths, bolts or rivet diameter and numbers.
 - Chart showing list of assembling marks having columns such as Mark, Description, Quantity, Weight of each Mark, Total weight and Remarks with grand total in the end.
 - Width of each column of chart shall be 25, 40, 15, 15, 15, 30 and 45 mm each respectively with a minimum spacing of 4 mm.

- Chart showing List of Erection Bolts, nuts and Washers in tabulated form, detailing information such as size, quantity, weight and notes of 20, 10, 20, 10, 10, and 15mm wide etc. and their grand totals.
- The Mark for shop assemblies of each erection scheme shall have a different index, for example, scheme of trusses, purlins etc. shall have Marks A1, A2, A3 onwards and another scheme of columns beams etc. shall have Marks B1, B3 and onwards. While marking on the plans, elevations, sections and details of the index shall be omitted.
- The recommended scale of erection scheme is 1:50, 1:100, 1:200 for joints 1:5, 1:10 or 1:20.
- Except in special cases all scheme drawings shall be made in single fairly thick lines.
- Erection Scheme shall contain the following notes:
 - . Erection shall be done using the erection, welding and bolts of normal sizes and accuracy according to the joints of the scheme.
 - . Quality and type of electrode.
 - . Measures against unscrewing of bolts.
 - . Erection shall be carried out according to the standard for fabrication and erection of steel structures.
 - . Painting instructions.
 - . References to design and working drawings.
- ii) The working drawings in size of 685 mm x 965mm within boundary lines shall contain the following information:
 - Each Shop Assembly (Mark) shall be drawn separately showing necessary lines, elevations sections with reference to axis, centre lines, location of holes, cleats, plates, lugs etc. fully dimensioned with part numbers.
 - Bolts, holes sizes and symbols.

Bolt Size (Metric)	M8	M10	M12	M16	M20	M22	M24	M27	M30	M36
Hole Diameter	8.4	11	13	17	21	23	25	28	31	37
Bolt Size (Inch)	5/16	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8

Hole Diameter 3/8 7/16 9/16 11/16 13/16 15/16 1-1/16 1-3/16 1-5/16 1-7/16

Hole Symbol

Shop Bolt

Erection Bolt

Drilled and Bolted at Site

Welding Symbols

Symbol Section Elevation

- Geometrical Setting out dimensions necessary for the assembly of an element. Location and details of joints as calculated by the fabricators/Engineer.
- Instruction for welding, dimensions of weld (Seams) processing of edges, methods of welding, quality of welded material, length of welds on every element, requirements for welding and method of their control. Specification for Electrode selected according to specification of steel.
- Standards and quality of steel used.
- Instruction for painting, primer and finish coats with derusting process.
- Recommended scale for working drawings are preferably 1:10 or 1:20 and for joints and details 1:1, 1:2, or 1:5.
- For pipes to be fabricated from plate developments of all bends, reducers, meeting pipes, transitions etc. shall be shown with all ordinates duly calculated.
- Notes for working drawings shall be as follows:
 - List of symbols for bolts and holes used.
 - List of symbols for welds used.
 - Edge distance (general)
 - Welding thickness (general)
 - Material quality of steel used.
 - Type and quality of electrodes to be used.
 - Tests for welding if any
 - Reference to related erection scheme drawings
 - Reference to design and working drawings.

- Part list.

5. MATERIAL

Except otherwise stated in the drawings, the material specifications shall conform to the following.

Wherever necessary the Contractor may use equivalent alternative material subject to approval of the Engineer.

5.1 Structural Steel

- Structural steel for structures not requiring welding shall conform to the requirements of ASTM A 7 (for bridges and buildings) and ASTM A 36.
- Structural steel for structures requiring welding shall conform to the requirements of ASTM A 36 or equivalent.

5.2 High Strength low alloy steel

- High strength low alloy steel shall conform to the requirements of ASTM A 441 or equivalent.

5.3 Sheet Steel

Sheet steel for structures where no welding is required shall conform to the requirements of ASTM A336 (for Cold Rolled Carbon Steel Sheets, commercial quality) or ASTM A415 Standard specifications for Cold Rolled Carbon Steel Sheets, commercial quality). For structures where welding is required sheet steel shall conform to the requirements of ASTM A 425.

5.4 Steel Forging

Steel forgings shall conform to the requirements of ASTM A 235 (tentative specifications for carbon steel forgings for general industrial use) class of forging shall be indicated on the drawings.

5.5 Steel Casting

Steel casting shall conform to the requirements of ASTM A 27 Standard specifications for Mild to Medium Strength Carbon Steel Castings for general applications) and ASTM A 148 (Standard specification for high strength steel castings for structural purposes). Grade of casting shall be shown on the drawing.

5.6 Filler Metal for Welding

Welding Electrodes for manual shielded metal arc welding shall conform to the specifications for mild steel covered Arc-welding Electrodes, AWS A5.1 latest edition or the specifications for low-alloy steel covered Arc-welding Electrodes, AWS A 5.5 latest edition, Equivalent locally manufactured electrodes by Pakistan Oxygen shall also be used subject to the approval of the Engineer.

Welding electrodes shall be E70xx. All welding shall be carried out by qualified welder only using approved & qualified welding procedures.

5.7 Bolts, Nuts and Washers

Bolts and Nuts shall conform to the requirements of ASTM A 307 (Standard specification for low alloy carbon steel) externally and internally threaded standard fasteners. Bolts shall be of Grade A for general application with square or hexagon heads as specified in the drawings. Turned bolts shall also conform to the requirements of ASTM A 307. Except that the tolerance of the unthreaded portion of the bolt body shall be + 0.0, - 0.15 mm of the diameter.

5.8 High Strength Bolts

All shop connections, except as noted herein or on the drawings, shall be made with High Strength Bolts in friction type connections, or by welding.

High strength carbon steel bolts including nuts and washers shall conform to the requirements of ASTM A 325 (Standard Specification for high strength bolts for structural steel joints including nuts and plain hardened washers of dimensions conforming to the requirements of USASI B18.2 - 965 (square and hexagon bolts and nuts for regular semi-finished hexagon bolts and heavy semi-finished hexagon nuts). All field connections, except noted, shall be made with H.S. Bolts in friction type connection.

5.9 Washers

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

5.10 Cast Iron

Shall conform to the requirements of ASTM A 48 (Standard specifications for Gray Iron Castings).

6. CONNECTIONS

All connections shall be designed and detailed for forces shown on the drawings, if any, or 50% of the effective capacity of the member, whichever is greater. A minimum of two bolts or equivalent welding shall be used per connection.

Shop connection may be welded or bolted. Field connections shall be bolted unless noted otherwise on design drawings.

7. ALLOWABLE STRESSES

7.1 Allowable stresses for steel shall be considered as tabulated in Appendix A of specifications for the design, fabrication and erection of structural steel for buildings; Part 5 of the Manual of Steel Construction published by the American Institute of Steel Construction.

7.2 Allowable stresses for welds, rivets, bolts and threaded parts shall be as per AISC specifications.

8. FABRICATION

8.1 Straightening Material

Rolled material, before being worked upon, must be straightened within tolerances by ASTM specifications A6. Straightening necessarily shall be done by mechanical means or by the application of a limited amount of localised heat. Temperature of heated areas, as measured by approved methods, shall not exceed 1100 F for A 514 steel or 1200 F for other steels.

8.2 Cutting

As far as possible cutting must be done by shearing. Oxygen cutting shall be done where shear cutting is not possible and shall preferably be done by Machine. All edges shall be free from gauges, notches or burs. If necessary the same shall be removed by grinding.

8.3 Holes punching drilling

Holes shall be punched where thickness of the material is not greater than the diameter of bolt or rivet + 3mm. Where the thickness of the material is greater, the holes shall either be drilled or sub-punched and then reamed to size. The die for all sub-punched holes and the drill of all sub-drilled holes shall be at least 2mm smaller than the nominal diameter of the rivet or bolt. Holes for A 514 steel plates over 1/2" thick shall be drilled.

8.4 Welding

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

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

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

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

8.5 Tolerances

A variation of 1mm is permissible in the overall length of members with both ends finished for contact bearing. The bearing surface is to be prepared to a common plane by milling. Members without end finished for contact bearing which are to be framed to other steel parts of the structure shall have a variation from detailed length not greater than 3mm.

9. TEST ASSEMBLY

- 9.1 Fabricated shop assemblies of all components such as Purlins, Girts, Bracing etc. will be test assembled together after fabrication, prior to field erection.
- 9.2 Test assembly work and procedure should be planned during fabrication process. Major fabrication work of locating of gussets etc. marking and drilling of holes for inter connecting joints, spliced connections leveling, placing of bracings, should be done simultaneously with test assembly.
- 9.3 Each test assembly will be inspected by the Engineer's Representative and will be dismantled only after his approval in writing.

10. SURFACE PREPARATION/PAINTING/GALVANIZING

10.1 Surface Preparation

The surface preparation should conform to Steel Structures Painting Council specifications SP-6.

- a. All structural steel material i.e. rolled steel sections, plates, flat bars, chequered plates shall be cleaned free from loose scale, rust, burrs slag, etc. by means of sand blasting.
- b. The sand used for this purpose shall be free from earth, dirt, clay and moisture.
- c. The size of sand particles and air pressure size of the hose nozzle shall be correlated to give proper and acceptable surface.
- d. Material which is to be used for fabrication of components to be galvanized later on shall not be cleaned. (See Clause 10.4).

10.2 Painting

- a. Immediately after surface preparation all material should be given one prime coat of rust preventive paint.
- b. After fabrication and test assembly all shop assemblies shall be given one shop coat of prime paint and then one coat of enamel paint.
- c. One final coat of enamel paint shall be applied after erection of all components.
- d. The type of primer and enamel paints to be applied shall be as specified on the drawings.
- e. The thickness of each coat of paint shall be in accordance with the paint manufacturer's recommendation and as per drawings.
- f. All other requirements for the specified paint system shall be in accordance with the paint manufacturer's specification /recommendations.
- g. Article b to f are applicable to all steel work covered under this section of specification i.e. including miscellaneous steel work (article 13).
- h. The Contractor shall use the best quality of the type of paint specified and shall get the same approved by the Engineer.

- i. All surfaces of steel work shall be painted as specified under section "painting" of the technical specifications
- j. **Steel Work/Surfaces not to be painted**
 - i. Steel work to be encased/embedded in concrete or surface in contact with concrete or grout shall not be painted, but shall be given a cement wash after sand blasting.
 - ii. Machined finished surfaces shall not be painted but shall be coated with rust preventive compound, approved by the Engineer immediately after finishing. Such surfaces shall also be protected with wooden pads or other suitable means for transportation. Unassembled pins, keys, and bolt thread shall be greased and wrapped with moisture resistant paper.
 - iii. Contact surfaces of connections using high strength bolts in friction type connections shall not be painted. Such surfaces of all components after fabrication shall be cleaned free of paint, grease, burrs slag by means of sand blasting. No coating whatsoever then be applied to such surface. The surface roughness for high strength friction grip bolts is a very important factor therefore components will not be erected unless approved by the Engineer.

10.3 Zinc Coating (Galvanizing)

Components should be galvanized after complete fabrication i.e. welding, drilling etc.

The process should consist of removal of rust and mill scale by pickling in hydrochloric acid or sulphuric acid followed by water wash and prefluxing with ammonium chloride.

The fluxed components should then be passed through a drying oven prior to immersion in a bath of virtually pure molten zinc.

Wherever specified by the Engineer, zinc coating shall be applied in a manner and of a thickness and quality conforming to the requirements of ASTM A 123, standard specifications for zinc (Hot galvanized) coating on products fabricated from rolled, pressed, and forged steel shapes, plates, bars and strips.

11. INSPECTION AND TESTS

- 11.1 Manufacturer's Works Test Certificate for all material used shall be furnished by the Contractor for Engineer's scrutiny and approval.
- 11.2 Rolling tolerance of all shapes and profile according to AISC shall be in accordance with the provisions of the American Society for Testing and Materials Designation A.6. These shall be checked by the Contractor before being worked upon and shall be rejected if found not within limits.
- 11.3 The Contractor shall arrange for analysis and test of all material rolled locally at a testing laboratory selected by the Engineer.

11.4 Nevertheless, neither the fact that the materials have been tested nor that the manufacturers works test certificates have been furnished, shall effect the liberty of the Engineer to reject, after delivery, material found not according to these specifications.

11.5 **Inspection and Testing of Welding**

11.5.1

General

- Welding shall be inspected and tested by an approved testing laboratory during fabrication and erection of structural steel as follows:
- The testing laboratory shall be responsible for conducting and interpreting the tests. It shall state in each report whether or not the test specimens conform to all requirements of the Contract Document and shall specifically note any deviations therefrom.
- Certify all welders and make 100 percent visual inspections and tests as follows. Record types and locations of all defects found in the welding work, the measures required and performed to correct such defects.
- In addition to the requirements of AWS D 1.1, Paragraph 8.15, each weld shall be visually free of slag, inclusions and porosity.
- In addition to visual inspection of all welds magnetic particle, ultra-sonic and radiographic inspection shall be made of all welds as specified below. Magnetic particle tests shall be made on the root pass and finished weld. The method of magnetic particle test shall be in accordance with ASTM E 109. Any type of crack or zone of in-complete fusion or penetration shall not be acceptable.
- Radiographic testing technique and standards of acceptance shall be in accordance with AWS D 1.1.
- Ultra sonic testing technique and standard of acceptance shall be in accordance with AWS D.1.1.
- Welding inspection and test reports showing evidence of the quality of welding shall be submitted by the Contractor. For each section of weld inspected and tested, furnish a report, which clearly identifies the work, the welder's identification, the areas of inspections and test, the acceptability of the welds, and signature of the inspector or laboratory incharge. Each report shall be completed at the time of inspection or test. For radiographic examination, furnish a complete set of radiographs in addition to the reports. All inspection and testing shall be carried out in presence of the Engineer or his representative.

11.5.2 **Test Methods**

Use the following test methods as specified. The following list is in descending order. When a particular test method is specified for a joint and highest method practicable. The alternative method will be subject to approval. NDT procedures and techniques shall be in accordance with AWS D 1.1. section 6.7.

- a. Radiographic Method: In addition to the requirements of AWS D 1., comply with ASTM E 94.

b.

Ultrasonic method.

c.

Magnetic particle method.

- d. Liquid Penetration Method: Visible-dye, solvent removable method only.

11.5.3 Requirement for ten percent Examination

- a. Examine 300 mm section of weld in each 3m increment of each welder's work as directed by the Engineer. If the examination meets the acceptance standards of AWS D 1.1, the 3m of weld represented will be accepted.
- b. If the examination fails to meet the acceptance standards, examine two additional 300 mm sections in the 3m increments, as directed by the Engineer. If both of these examinations meet the acceptance standards, the 3m of weld represented will be accepted. Repair the defects detected in the first examination and re-examine.
- c. If one or both of the examinations fails to meet the acceptance standards, examine the remaining weld of the 3m increments. Repair the areas that do not meet the acceptance standards and reexamine.

11.5.4 Repair and Re-testing of Welds

Repair defective welds in accordance with AWS D 1.1, or replace the weld, and Re-test repaired and replaced welds by the same method and acceptance standard used to examine the original weld, In addition, when defective welds are found, the testing laboratory shall determine the cause of the defective welding and institute immediate corrective action.

All defective welding shall be repaired or replaced at the Contactor's expense.

12. ERECTION

12.1 Bracing

The frame of steel skeleton buildings shall be carried up true and plumb within the limits defined in Section 7(h) of the AISC code of standard practice, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected including the equipment and the operation of the same. Such bracing shall be left in place as long as required for safety.

Wherever piles of material, erection equipment and other loads are carried during erection, proper provision shall be made by the contractor to take care of the stresses resulting from such loads.

12.2 Alignment

No riveting, permanent bolting or welding shall be done at site during erection until as much of the structure as will be stiffened thereby has been properly aligned.

12.3 Joints using High Strength Bolts

All structural joints using high strength bolts shall be executed and inspected in accordance with "AISC Specification for Structural Joints" using ASTM A 325 or A 490 bolts.

13. MISCELLANEOUS STEEL WORK

13.1 General

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

13.1.1 Steel stairs.

13.1.2 Steel Ladders.

13.1.3 Steel pipe handrails.

13.1.4 Steel protection angles.

13.1.5 Steel doors, windows, gates, ventilators/louvers.

13.1.6 Steel fencing.

13.1.7 Grating and chequered plate covering.

13.1.8 Embedded plate, anchor bolts and other miscellaneous items.

Drawings, material, fabrication, surface preparation shall conform to the applicable requirements of clauses 3, 4, 6 and 7 of these specifications. Any proposed deviation due to field conditions and availability of local material shall be submitted to the Engineer for approval.

13.2 Steel Stairs

- General: Structural steel stairs complete with grating treads or chequered plate treads, landings, supporting structures, hand rail, supports etc. shall be furnished and installed in accordance with working drawings. All components shall be galvanised to maximum extent practicable as shown on the drawings.
- Material: Except otherwise indicated in the working drawings, materials shall conform to the requirements of ASTM A 36-63T (Tentative specifications for structural steel).

13.3 Steel Ladders

Steel ladder shall be welded assemblies with or without safety cages fabricated in accordance with the drawings. Material and standard of fabrication shall be the same as specified for stairs.

13.4 Steel pipe handrails

Steel pipe handrails consisting of posts, handrail, knee rails and toe rail shall be fabricated in suitable units having two posts or three posts in one unit with erection joints between handrail and knee rails. Handrails of platforms galleries etc. of considerable length may not be shop fabricated as complete units consisting of posts etc. In case of such handrails the posts may be fabricated of the required height having one end with necessary arrangement for fixing to the platform or floor beams etc. and other end shop prepared to take the top handrail. Top handrail, knee rail and toe rail may be brought at site in stock length. The same may then be cut and welded at site. Locally manufactured pipes, M.S or G.I may be used for the hand railing. These shall however conform to the requirements of ASTM A 53-65 or shall be of equivalent requirements.

13.5 Steel protection angles

Steel protection angles required for the protection of concrete work shall be erected true to line and level. Steel angles shall be fixed in position by using anchors.

13.6 Steel Door, Windows, Ventilators, Louvers and Gate Frames: Frames shall be fabricated from locally available hot rolled angle, tee channel or pipe sections as specified in the drawings. Material shall however conform to ASTM A 36.

Shutters: Shall be made of any of the sections noted above with skin plate of at least 18 S.W.G. as shown in the drawings.

Accessories such as hinges, anchors, bolts, locks and handles shall conform to the requirements shown on the drawings or as directed by the Engineer.

After fabrication one coat of zinc chromate or synthetic resin primer in a light grey colour shall be applied.

13.7 Steel Fencing

Steel fencing shall be made from welded wire mesh bolted on the steel angles or channel frame as shown on the drawings or as directed by the Engineer.

14. MEASUREMENT & PAYMENT

14.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

14.1.1 Providing nuts, bolts, screw, rivets, heads, fillets, welds and welding rods.

14.1.2 Galvanized and prime coating of paint.

14.1.3 Providing and installation of glazing in position.

14.1.4 All embedded parts unless otherwise specified in the Bill of Quantities.

14.1.4 Painting.

- 14.1.5 Steel grills and fly proof of shutters.
- 14.1.6 Locks, handle, hinges, hold fast, stopper etc.
- 14.1.7 Filling of Class "C" concrete in M.S. Bollard pipe.

14.2 MS fencing and spiral stairs etc.

14.2.1 Measurement

Measurement of acceptably completed works of MS fencing and spiral stair etc. will be made on the basis of weight in kilogram of MS doors provided and fixed in position as shown on the Drawings or as directed by the Engineer.

14.2.2 Payment

Payment will be made for acceptable measured quantity of MS fencing and spiral stairs etc. on the basis of unit rate per kilogram quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

14.3 MS Grilled roll up shutter

14.3.1 Measurement

Measurement of acceptably completed works of MS grilled rollup shutter will be made on the basis of actual area in square foot of grilled roll up shutter provided and fixed in position as shown on the Drawings or as directed by the Engineer.

14.3.2 Payment

Payment will be made for acceptable measured quantity of m.s. grilled rollup shutter on the basis of unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.