

BIDDING DOCUMENTS

for

Procurement of

Resettlement Village Construction and Emergency Riverbank Protection

Part 2 - Volume - II

Section VII - Work Requirements Technical Specification

ICB No: *RMIP/BWDB/W-02*

Project: Right Bank Management Project

Employer: Bangladesh Water Development Board

Country: *Bangladesh*

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Section VII. Works Requirements

- A. Scope of Works
- B. Technical Specification
- C. Supplementary Information
- D. Drawings (Annex – I)

1. The reference of the work from Section VII - Work Requirements Technical Specification is need to incorporate in the BoQ
2. In BoQ and item for Special Test as Provisional Sum need to incorporate.
3. Earth cladding at a depth 300mm looks low side.
4. What is the method of payment for item No. 1.11
5. In bill No. 4, you may need to incorporate some items Plaster without NCF for outside plaster and electric fan

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A. SCOPE OF WORKS

1 DESCRIPTION OF THE WORKS

The Government of Bangladesh has applied for a credit from the International Development Association (IDA) in various currencies towards the cost of River Management Improvement Project (RMIP) of Bangladesh Water Development Board. Under this credit, the Works to be executed include the reconstruction of the existing Brahmaputra Right Embankment (BRE) and associated riverbank protection to secure the embankment against bank erosion. The location of the project under the current phase includes 50 Km stretch of right bank of Brahmaputra River in between Simla Village to Hasnarpara village.

It is intended that the part of the proceeds of this credit will be applied to eligible payments under the contract for Construction of Resettlement Village and ancillary works such as filling of all the proposed resettlement village area above average flood level, delineation of plots and implementation of emergency/immediate riverbank protection works. The height of the filling for resettlement villages vary between 2.0 m and slightly more than 2.5 m including proper side slopes, placing of cladding materials to protect the slope against rain cuts and protection works against the river erosion. The total area planned for construction of resettlement village will be about 54.0 ha. In total 8 resettlement villages (area: 24.4 ha) will be developed in the riverside of reconstructed BRE and 7 resettlement villages (area 29.6 ha) will be in countryside of reconstructed BRE. All villages will be connected to the existing local roads of Herring-Bone-Bond (HBB) road. In addition, a provision of 10km of bank protection through emergency measures has also been included under this contract.

The summary of works under the contract include:

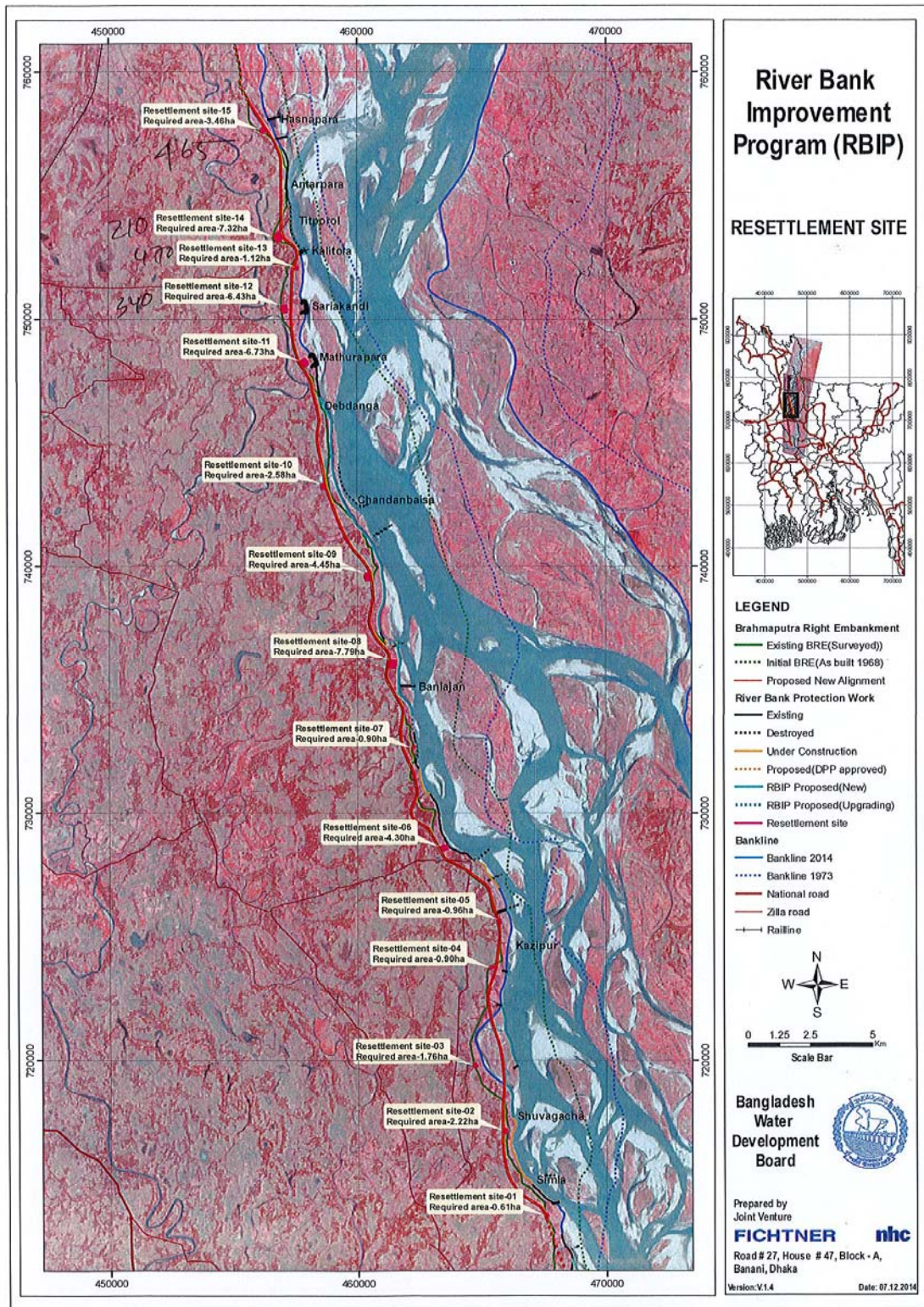
- the construction of resettlement villages consisting of site preparation, sand fill, Placing cladding material, internal drainage, connecting roads (HBB), internal roads (HBB) and surface treatments;
- Delineation/demarcation of plots for project affected people
- Construction of community facilities like mosque, prayer rooms, community centres, tube wells, internal surface drains etc
- Protective works of resettlement village area against river erosion
- Emergency/Immediate bank protection through mass dumping of geo-bags (250kg)

The location maps indicating above sites are presented in map -1. In terms of quantity, the major work items are presented in table 1 below:

Table 1: Tentative Quantity of Works.

Sl. No.	Description of Items	Unit	Quantity
1	Earth/sand fill for resettlement village	cum	1,564,080
2	Cladding-0.3m thick	cum	36,380
3	Brick Mattressing	sqm	9240
3	HBB road-3.4m wide	m	15,175
4	HBB Road-3.90m wide	m	500
5	Geo-Bag (250 kg)	Nos	1,244,000

Map – I: Location of resettlement village



B. TECHNICAL SPECIFICATION

1 GENERAL REQUIREMENTS

The Section contains General Requirement of the Employer and Technical Specifications. The work should be carried out in accordance with the approved design and specifications. If there is any changes due to site condition, the 'Engineer's instruction should govern.

1.1 Drawings

1.1.1 Bidding Drawings

The drawings are provided in Appendix -1 of this Section of Bidding Document and that shows the general features of the works and structures. Additional drawings may be delivered to the Contractor prior to the commencement of the works. The Contractor shall prepare construction and/or shop drawings as stipulated of these Specifications.

1.1.2 Additional Drawings

The drawings attached to the Bidding Documents (hereinafter referred to as "Bidding Drawings") accompany and form part of the Contract Documents. In addition to the Bidding Drawings, the Engineer may deliver additional Drawings to the Contractor and such drawings shall there upon become part of the Contract.

During the progress of the work, additional Drawings will be issued by the Engineer prior to the commencement of the works and as necessity arises to supplement and/or supersede the Bidding Drawings, and such additional Drawings shall there upon become part of the Contract.

The Contract shall be governed by figures and dimensions as given on the drawings. Where required dimensions are not shown, the Contractor shall obtain such dimensions from the Engineer before proceeding with the construction of the portion of the Works to which they refer. In every case, detailed drawings shall take precedence of general drawings.

The Contractor shall scrutinise such drawings and such further drawings issued from time to time to the Contractor. If any ambiguity, discrepancy or mistake is found in the drawings, the same shall be referred to the Engineer before proceeding with the works, and the Engineer's decision on resolving such ambiguity, discrepancy or mistake shall be final, conclusive and binding.

1.1.3 Drawings and Calculations to be furnished by the Contractor

Unless otherwise stated in the Contract, the Contractor shall prepare drawings for all Temporary Works to be constructed or supplied and installed by the Contractor.

The Contractor shall at his own expense prepare detailed Construction Drawings of the individual works (hereinafter referred to as "Shop Drawings") based on the Bidding Drawings and the additional Drawings as needed for performance of the works. All Shop Drawings prepared by the Contractor shall be submitted to the Engineer for his approval. The drawings submitted by the Contractor shall be clear and complete.

In addition to the above, the Contractor shall at his own expense prepare reinforcement drawings based on the drawings supplied by the Employer/Engineer as needed for the performance of the works. These reinforcement drawings shall include such as bar placing drawings, bar-bending drawings, bar list and any other reinforcement drawings as may be required to facilitate fabrication and placement of reinforcement

bars. All reinforcement drawings prepared by the Contractor shall be submitted to the Engineer for his/her approval.

Fabrication, manufacturing or construction of any part of the works shall not be commenced until the drawings are approved in writing by the Engineer, and thereafter no change shall be made to any drawings so approved without permission of the Engineer. Subsequent changes shall be reported by sending another set of each revised drawing to the Engineer for approval. The approval of Contractor's drawings by the Engineer shall not relieve the Contractor from any of his liabilities or responsibilities under the Contract.

The Engineer shall check or review the drawings submitted by the Contractor and shall return them with comments or approval within 10(Ten) days from the date of submission by the Contractor.

1.1.4 Right to Change Design and Drawings

When additional information regarding foundation or conditions become available as a result of excavation of work and further testing, and if found desirable to make changes in the alignment, cross-sections, dimensions or design to conform to such conditions, the Employer/Engineer reserves the right to make the necessary or desirable changes to the opinion of the Engineer.

1.1.5 "As-Built" Drawings

The Contractor shall submit one (1) set comprising one (1) negative drawings of high quality reproducible polyester transparent "Mylar" film (or similar material) from which clear copy can be made and three (3) sets of printed "As-Built" Drawings of the completed Works along with two (2) sets of CD to the Employer within 28 days after receiving the Completion Certificate.

The "As-Built" Drawings shall clearly show the lines and dimensions of the permanent construction actually made based on the original design and/or change of design from time to time ordered by the Engineer or proposed by the Contractor and approved by the Engineer.

1.1.6 Measurement and Payment

No separate payment shall be made for preparation of all construction drawings, reinforcement drawings, working drawings and shop drawings, drawing details, and as built drawings etc. to be prepared by the Contractor and submitted to the Engineer and/or the Employer in accordance with the provisions of the Contract.

1.2 Setting-Out and Survey of the Works

The Contractor shall re-survey the Base Lines, Traverse Points, Bench Marks and confirm the co-ordinates and levels of the Stations before using them for setting out the Works. Reference Bench Marks (SOB) are available in Sirajganj and Bogra. The Contractor shall immediately notify the Engineer of any discrepancies and shall agree with the Engineer any amended values to be used in the Contract, including replacement of any Stations missing from the original location.

The Contractor shall employ well-qualified and experienced surveyors for the execution of survey and setting-out works. The instruments to be used shall be of a make and type suitable for the intended works and shall be subject to Engineer's approval.

The Contractor shall be responsible for carrying and establishing the BMs, the setting-out centre-lines, longitudinal and cross sections of the ground, and position of the structures in accordance with the drawings, and any other setting-out work necessary for the execution of the Works. Before commencing the works for structures/works, resettlement village area development sites, etc, the Contractor shall survey and take levels for longitudinal profile and cross sections along the routes/locations in which the works are to be executed out at his own expenses. The Contractor shall use benchmarks approved by the Engineer for such survey works. The surface levels so determined shall be subject to the approved.

The demarcation of right-of-way/proposed area for resettlement village and all-necessary preparation connected with it shall be carried out by the Employer.

At all Resettlement villages and other work sites, the Contractor shall install Bench Marks as per direction of the Engineer. Ground levels shall be taken jointly by the contractor and the Engineer's representative both prior to commencing and after completion of earth works.

The Contractor shall level and draw the followings for all structures, fillings for resettlement village area and roads:

- Longitudinal section
- Cross-sections at an interval not exceeding 50 m before and after the execution of the Works

The formation level shall be taken as reference while cross-sections shall cover at least a width as necessary for the Works to be constructed, including related earthworks.

All field-books, calculations, maps, etc. of the survey activities shall be handed over to the Engineer, immediately after the completion of the survey. All field data, derived from the survey activities, entered in the field-books that are handed over to the Engineer, shall also be entered into EXCEL spread sheet or a compatible spread sheet in a format approved by the Engineer. The data shall be submitted on a CD.

No separate payment shall be made against the works done under this clause unless indicated in Bill of Quantities. The payment under this clause shall be deemed to have been covered under other items of works.

1.3 Layouts and Schedules Provisional

The locations, levels and dimensions as shown on the Drawings or given in the design data or structure schedules are subject to amendment. The Contractor shall undertake surveys for confirmation of alignment and levels of earth/sand fill, and riverbank protection. Details of any such amendment or confirmation of the original design will be given by the Engineer or the Engineer's Representative during the course of construction.

1.4 Topographic Survey for Emergency Bank Protection

The Contractor has to conduct a topographic survey of bank area about 10kmx500m for the reference links with the bathymetric survey conducted for the emergency bank protection.

The topographic surveys shall be done using Total Station or RTK-GPS. The method used to perform the survey (i.e. cross sections, break lines) shall be at the discretion of the Contractor and is to be accepted by the Engineer. Sufficient information shall be collected such that cross sections can be extracted at the intervals specified below and sufficient information shall be collected to allow for accurate estimation of placed or excavated volumes and to ensure design grades and lines are met.

If the Engineer cannot reproduce the cross section geometry or profiles extracted from the survey data with actual measurements on these cross section or profile alignments, the Contractor shall be responsible for the collection of additional data to satisfy this requirement.

The survey data, once processed to remove erroneous records, will be used to generate a Digital Terrain Model (DTM) which will be used to calculate volumes, and generate any required contour maps, difference maps, cross-sections and profiles. Parameters used in the development of the DTM and the extraction of results from it will be agreed upon with the Engineer. Cross-section plots shall show applicable design lines, the areas of top soil removal, cut and fill areas and calculated end area values (top soil, cut and fill values).

All survey data collected shall be provided to the Engineer upon request including raw and process data, and supporting documentation such as traverse closures, network adjustments and GPS post-processing summaries.

The payment against this clause shall be paid in accordance with the unit rates indicated in Bill of Quantities.

1.5 Bank Protection Works Survey

To ensure current topographic information, the pre-construction or pre slope preparation surveys shall be conducted not more than 2 weeks prior to the start of any earth works. Pre -placement surveys shall be conducted not more than 3 days before starting to place or dump revetment material. Similarly, the post-work survey shall be conducted not more than 3 days after completion of slope preparation, revetment placing or dumping, and survey results are to be presented to the Engineer within 3 days of completing the survey.

For monitoring and determining the final conditions of the preparation of slopes and placement of protection materials on the banks of the river, land surveys shall extend into the river a distance sufficient to prevent any gaps or discontinuities in the data set when combined with bathymetry survey data (Land and Bathymetry survey data will overlap).

The topographic Survey shall be collected with sufficient density to be able to extract cross sections/transects at 10 m intervals running perpendicular to the bank-line for bank protection work. On the floodplain, the data collection shall extend at least 10 m beyond the countryside end of the protection work; including limits of excavation for back slopes on the country side of the crest, unless otherwise stated.

Land surveys may be required to document the river bed elevations where the river bed is above the water level at the time of the pre-construction survey. In these instances, the data collection shall

extend at least 30 m beyond the point where the back-slope after excavation/dredging (assuming a 2H: 1V slope) will intersect the bed level.

No separate payment shall be made against the works done under this clause and deemed to have been covered under other items of works.

1.6 Bathymetric Survey of emergency protection area

The bathymetric survey (x-sections @200m apart) for the emergency protection area from bank line to at least 600m within the river has to be conducted by the contractor during the initial days of contract period to identify the probable emergency protection work. This exercise may need to be repeated for different reaches of the river

Bathymetry surveys used in determining the lines and grades of prepared slopes and the placement of material will be conducted using RTK-GPS used for positioning (vertical and horizontal). For water depths of 2 m or greater, the surveys will be conducted using single beam echo sounder equipment. During single beam surveys, individual depth readings shall be collected at a frequency of 20Hz or greater. Single beam transducers are to have a beam/cone angle of 3 degrees or less.

It is suggested that the survey be conducted with the vessel traversing parallel to bank or the excavated slope with the instrument head pointed into the bank along the bank for most accurate results. The Contractor can suggest alternative equipment and/or processes for conducting the survey providing these generate similar or better coverage of the underwater banks and river bed. The Engineer would have to approve any alternative method or process.

Surveys will cover the construction area and extend from LWL elevation on the bank to at least 30 m beyond the riverside of the area of interest. For excavated/dredged area, this would be 30 m further into the river from the location where the back slope intercepts the river bed while for the placement of the slope protection and apron materials, this would be 30 m on the riverside end of the apron.

To ensure current topographic information, the pre-work survey shall be done not more than 3 days before the start of wet excavation/dredging operations. Survey results (plan and cross-sections) must be available before the dredging starts. Similarly, the post-work survey shall be done not more than 3 days after completion of dredging, and survey results are to be presented to the Engineer within 3 days of completing the survey.

If the pre or post-work surveys fall behind the implementation schedule, the works shall be stopped or the Contractor shall deploy additional survey teams to make up the delay at the Contractor's own cost.

The measurement of this works will be done as indicated in Bill of Quantities and payment will be made in accordance with the unit rate.

1.7 Monitoring survey of Apron Area

As an integral part of the riverbank protection monitoring program during the critical seasonal construction and post-construction period, the Contractor shall perform bathymetric surveys along the Jamuna River accompanied by staff of the Engineer. These surveys shall be separate from those conducted for the monitoring of the Works construction or those performed as pre-construction documentation of the bank line and are paid under a specific item in the Bill of Quantities.

At each location where bank protection and protection upgrades covered by this Contract have been performed; either partially or fully, surveys shall be performed over areas that extends from 400 m upstream to 500 m downstream of the placed protection, and from the LWL elevation on the river banks to at least 100 m beyond the actual or indicated riverside edge of the aprons. The actual area to be covered in a single year will depend on the Contractor's construction schedule.

The Contractor shall process the survey data and produce coloured topographic maps from the bathymetric surveys and two differential maps each showing changes to the as-built condition and to the previously conducted survey.

Results of the bathymetric surveys, both in paper and digital copies, shall be handed over to the Engineer within one week upon completion of each survey.

The works monitoring surveys shall be paid as separate work Item as indicated in the Bill of Quantities.

1.8 Temporary Works

Not less than fourteen days before commencing any portion of the Works, the Contractor, if ordered, shall submit to the Engineer for his approval complete drawings of all Temporary Works the Contractor may require for the construction of that part of the Works.

Notwithstanding approval by the Engineer of any design for the Temporary Works the Contractor shall be entirely responsible for their efficiency, security and maintenance and for all obligations and risks in regard to such temporary works, which are specified or implied in the Contract.

Except where specific items are provided in the Bill of Quantities, the cost of all Temporary Works of every description, including de-watering, temporary diversions of canals, drains, roads, and all services shall be included in the Contracts' Rates.

1.9 Notice of Operations

The Contractor shall give full and complete written notice of all important operations, including setting out, to the Engineer sufficiently in advance to enable the Engineer to make such arrangements as the Engineer may consider necessary for inspection and for any other purpose. The Contractor shall not start any important operation without the written approval of the Engineer.

1.10 Suppliers of Materials

Before ordering a material for any description intended for the Permanent Works, the Contractor shall submit for the approval of the Engineer the name of the maker or supplier proposed and details of the place of origin and specification of the material. If requested by Engineer, the Contractor shall supply to the Engineer for his retention a copy of any such order place.

1.11 Natural Materials

The Contractor shall make all arrangements for locating, selecting and processing natural materials to comply with the Specification and shall submit to the Engineer for approval full information regarding the proposed location well in advance of commencement of working of the materials. Approval of a source does not imply that all material in that source is approved.

1.12 Disruption of Local Communities Facilities

The Contractor shall take all measures necessary to avoid nuisance and disruption to local communities. In particular the Contractor shall ensure no damage is done to crops, pasture or woodland and that the Contractor's operations do not cause flooding or pollution hazards.

1.13 Clauses Not Applicable

Any Clause in the Specification, which relates to work or materials not required by the Bill of Quantities or subsequently ordered, shall be deemed not to apply.

1.14 Delay and Increased Costs Due to Floods, Wash-out of Roads or Impassable Roads

Notwithstanding **Clause 8.4** of the Conditions of Contract no extension of time or increase in the Contract Rates shall be granted to the Contractor if he is delayed or impeded in the completion of the Works or involved in additional costs by flood, high river water levels, wash-out of roads or tracks or impassable roads.

1.15 Assistance to Engineer's Staff

The Contractor shall render all necessary assistance to the Engineer's staff and shall provide and maintain sufficient number of pegs, poles, paints, survey equipment and tools, straight edges, staging, moulds, templates, profiles and all other requisites for checking the Contractor's setting-out and the measurement of the Works.

The Contractor shall provide such full time or part time surveyors as may be required. The cost of all labourers, surveyors, survey equipment and tools, and materials required by the Engineer and his staff

for checking the setting-out and the measurement of the Works shall be covered by the Contractor's expense and no separate payment shall be made thereof.

1.16 Standards and Supplemental Specifications

Unless otherwise stated in the Contract, all workmanship, materials, and equipment shall comply with the relevant American, British and Bangladesh Standard viz. AASHTO, ACI, AISC, ASTM, AWS, AWWA, BSI, DIN, DNA, ISO, SSPC, U.S. Fed. Spec and USBR

Wherever reference is made in the Contract to specific standards and codes to be met by the materials, Plant, and other supplies to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the contract.

1.17 Construction Program

Within **twenty (20)** days from the date of Letter of Acceptance the Contractor shall submit to the Engineer for approval a complete and practicable construction programme (**GCC Clause 8.3**) showing the orderly performance of the Works. The Construction Programme shall show in detail the proposed method of operations, including purchase and delivery of materials and equipment, as well as the construction. The Construction Programme shall show in a bar chart each major item of the Works and the Temporary Works on separate horizontal lines, sequence of operation and the period required for the completion of each activity. The Construction Programme shall when approved by the Engineer become a part of the Contract.

- a) a statement giving the numbers and categories of supervisory and technical staff and skilled/unskilled labour to be employed on the Works;
- b) a list and type/details of Contractor's Equipment (including vehicles) which the Contractor proposes to employ on the Works stating whether they are to be acquired from inside or outside Bangladesh including programmed dates for order and delivery;
- c) a list detailing the purchase and delivery of materials and Plant from both inside and outside of Bangladesh;
- d) details of the Contractor's methods of working for all operations including construction by sequence. The programme shall also indicate the proposed temporary flow diversions and arrangements for de-watering illustrating the sequence of various critical stages of construction;
- e) a statement and outline layout giving the proposals for location or locations and sizes of constructional camps, accommodation, offices, workshops and stores at the Site; and
- f) details of the programme for the construction of the works from the date of receipt of the Notice to Commence, including a complete resource allocation showing the number of units and allotted times for each unit of Contractor's Equipment, Plant, materials and labour allocated for each part of the works.

The construction programme shall be reviewed and revised if necessary at intervals mentioned in PCC of the Document.

No separate payment shall be made to the Contractor for complying with this Sub-Clause.

1.18 Reports, Meetings and Data of the Works

The Contractor shall furnish to the Engineer, at the Contractor's own costs, at regular monthly interval and in a form and number of copies determined by the Engineer, with the followings:

- a) physical progress for the preceding month and estimated progress for the report month;
- b) completion schedules (target and actual) based on the approved Construction Programme;
- c) estimated expenditures for the report month;
- d) inventory of construction equipment and materials on which an advance was made by the Employer as provided in the Conditions of Contract;
- e) a tabulation of construction equipment, listing the major items and pieces of equipment which were utilised for performance of the Works during the preceding month;
- f) a tabulation of employees, showing the supervisory staff and the numbers of several classes of labourers employed by the Contractor in the preceding month; purchase and expenditure report covering the Plant and materials furnished by the Contractor for the Works; and any report which may be specifically requested by the Employer and/or the Engineer.

1.19 Measurement and Payment

No separate payment shall be made for preparation of all documents, correspondence, returns and reports etc., to be prepared by the Contractor and submitted to the Engineer and/or the Employer in accordance with the provisions of the Contract.

All costs including Contractor's margin, overhead, taxes, etc, incurred by the Contractor shall be deemed to be included in the unit rates of the Bill of Quantities.

The payment against the video recording and photographs shall be made as per the unit rate indicated in Bill of Quantities.

1.20 Protection of Real Estate

The Contractor shall control the movement of his crews and equipment on right-of-way including access routes approved by the Engineer so as to minimise damage to crops and property and shall endeavour to avoid marring the lands. Ruts and scars shall be obliterated and damage to land shall be corrected and the land shall be restored as neatly as practicable to its original conditions.

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

No separate payment shall be made to the Contractor for complying with the stipulations of this Sub-Clause.

1.21 Safety Measures and Public Convenience

The Contractor shall provide necessary protection for all persons and properties at all times. The Contractor shall submit to the Engineer for his approval a "Safety Manual" with full details of safe construction methods. The Contractor shall comply with the stipulations of the safe construction methods specified in the "Safety

Manual”, to the extent that such provisions do not conflict with the applicable laws of Bangladesh. The Contractor shall take all necessary measures to protect the work and prevent accidents during the construction. He shall provide and maintain sufficient night-lights, barricades, guards, temporary sidewalks, temporary bridges, danger signals, watchmen and necessary alliances and safeguards to properly protect life and property. He shall also protect all excavations, equipment and materials so that the public are not be endangered.

No separate payment shall be made to the Contractor in complying with the provisions of this Sub-Clause.

1.22 Precautions

The Contractor is to execute the Works in such a manner that he/she does not damage or interfere with existing services which are located in proximity to the Site. The Contractor shall be responsible for any damage or interference, which may be caused to these services due to execution of the Works and shall carry out all necessary repairs at his own expense and to the satisfaction of the Engineer.

No excavating machines shall be used in the immediate surroundings of cables and/or pipe-lines, unless approved by the Engineer.

Temporary Works which have to be made in the surroundings of the system during the execution of works, shall be maintained by the Contractor and shall be removed as soon as practicable.

1.23 Interference with Existing Works

The Contractor shall not interfere in any way with any existing works whether they are the property of the Employer or of a third party and whether the position of such works is indicated to the Contractor by the Engineer or not, except where such interference is specifically described as part of the Works either in the Contract or in the Engineer’s instructions.

The Contractor shall at his own expense provide and erect to the approval of the Engineer such supports as may be required to protect efficiently all structures or works which may be endangered by the execution of the Works and he shall remove such supports on completion of the Works or otherwise take such permanent measures as may be required by the Engineer to protect the structures or works.

1.24 Temporary Fencing

If and where required the Contractor shall erect and maintain suitable and approved temporary fencing to enclose such areas of the works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Conditions of Contract. Where temporary fencing has to be erected alongside a public road, footpath, etc., it shall be of the type required by the concerned authorities and shall be erected to their satisfaction.

The Contractor shall fence his labour camps and other compounds and his housing sites in an approved manner so as to exclude all wild or stray animals.

Fences crossed by the Works and forming boundaries of plots outside the area occupied by the Works shall not be cut through or destroyed for more than the distance necessary to permit the erection of new fencing etc, and the Contractor shall make the ends of the cut fences reasonably secure.

The Contractor shall regularly inspect all such fencing, and any defects, which may occur, shall be made good without delay. Temporary Fencing shall remain in position until the Works are completed and the Site cleared of all plant, materials and/or other waste matter.

No separate payment shall be made to the Contractor for complying with the provisions of this Sub-Clause.

1.25 Notice Board

The Contractor shall erect a notice boards of a size of not less than 1 m by 2 m at each work site. The notice board shall be painted and the description therein shall be approved by the Engineer. The board shall be erected at a suitable place prior to the commencement of the work and shall be maintained in good condition during the contract period. All information on the signboards will be written in English and Bangla. The signboards will be positioned as directed by the Engineer. Each signboard shall show:

- the name of the Project (including Loan Number)
- the name of the Employer
- all other details of the Contract or as directed by the Engineer.

The Contractor shall not erect any advertisement signboard on or along the Site without the written approval of the Employer.

The measurement under this item 1.25 shall be made in numbers and payment shall be made in accordance with the unit rate presented in Bill of Quantities.

1.26 Clean Up the Site

Prior to the issue of the latest Defect Liability Certificate by the Employer the Contractor shall remove from the Site all plant and equipment, tools, rubbish, concrete forms, boulders, bricks and other materials not incorporated in the permanent works.

No separate payment shall be made to the Contractor for complying with the provisions of this Sub-Clause.

1.27 Engineer's Transport

1.27.1 General

The Contractor shall supply vehicles and boats as described below and quantified in the Bill of Quantities, for the duration of the Contract until the issue of the Taking-Over Certificate or end to provide such facility, for the exclusive use of the Engineer.

Upon completion of the Works the vehicles and boat shall become the property of the Contractor.

Vehicles

- 5 seater 4WD Double Cab Pickup (4WD, manual, 2.5l turbo diesel, with canopy, or equivalent approved vehicle)
- Road legal on/off road motorbikes (125 CC)
- Boats

Vehicles

- O 6m work boat

1.27.2 Road Vehicles

The makes and models of road vehicles to be supplied shall be to the approval of the Engineer. The vehicles shall be suitable for Bangladesh conditions with a proven record of reliability and there must be an existing servicing/spare parts network available in Bangladesh.

All vehicles shall have factory installed air conditioning (dual units and coolbox facilities for 4wd station wagons and jeeps) and shall be fitted with seat belts for both the driver and passengers, and shall be provided with first aid kit and fire extinguisher.

The vehicles shall be in completely running condition when supplied and shall not be removed from the Site other than with the prior approval or upon the request of the Engineer.

The vehicles shall not bear any name, logo or advertising material.

The motorbike shall be fitted with a rack for carrying survey and testing equipment. The rack is not to interfere with the capability to transport 2 persons on the machine

All vehicles shall be maintained in accordance with the manufacturer's routine maintenance and service requirements. Vehicles off the road for maintenance or repair for a period greater than 12 hours shall be temporarily replaced with a substitute vehicle of similar performance and rating.

The Contractor shall provide, without charge to the Engineer, all the necessary oil, fuel and maintenance, as well as paying the costs of all toll charges, insurance and all taxes.

The Contractor shall undertake, without charge to the Employer, all daily and routine maintenance, and all overhauls and repairs from whatever cause as may become necessary. During these events a similar vehicle shall be made available as a replacement.

The Contractor shall provide 1 No. full-time driver for each vehicle (except the motorbikes) until the issue of the Taking-Over Certificate or ending of lease with the Contractor. Allowance shall be made for drivers to work shifts up to 12 hours per day.

1.27.3 Boats

All boats shall be supplied within 60 days of Commencement Date, as new and to a type and manufacture as approved by the Engineer. The boats shall be work boats as described below.

1.27.4 Work Boats

The work boats shall be light speedy small craft of nominal 6m length with a capacity for 6 passengers. They shall be of a type acceptable to the Engineer. The craft may be fixed hull with a cabin shelter and inboard engine or large inflatable with rigid floor and outboard motor, and they shall have a cruising speed of at least 20 knots when fully laden. Detailed specifications shall be proposed by the Contractor for approval by the Engineer. The Contractor shall be required to supply fuel and maintain these light craft and provide the crew until the issue of the Taking - Over Certificate, without charge to the Employer. The craft shall be supplied with sufficient life jackets for all persons that can safely be

carried. The vessels shall be provided with a radio transceiver to operate within the system provided by Clause 0.11. The work boats shall be for the exclusive use of the Engineer.

The Contractor shall provide 1 No. boatmen and 1 helper to operate the work boats until the issue of the Taking-Over Certificate. Allowance shall be made for personnel to work shifts up to 12 hours per day.

Measurement and Payment against the works under 1.27 shall be made in accordance with the unit rate indicated in BOQ.

1.28 Contractor's Temporary Facilities

The Contractor shall be responsible for arranging near each work site adequate land for his offices, stores, warehouse, motor pool, laboratory, workshops, pre-cast concrete factory, staff quarters and labour camp. Separate accommodation and toilet facilities to be kept for male and female workers. The Contractor shall be also responsible for construction, maintenance, operation and subsequent removal or handing over if the Engineer requests, of such temporary facilities as his office, stores, warehouse, motor pool, laboratory, workshops, Cement Concrete Blocks yard, Geo Bag yards, staff quarters and labourer camps including feeding and accommodation. These facilities shall be equipped with adequate electricity and potable water supplies. Bangladesh labour law would be strictly followed in administering the workers (labours).

The Contractor shall submit for approval of the Engineer within fourteen (14) days from the date of the Notice to Commence his detailed plan and/or construction drawings of his offices, stores, warehouse, motor pool, workshops, pre-cast concrete factory, staff quarters and labourer camps that he proposes to construct or rent, including his proposals for water and power supply and sewage facilities. All buildings and facilities shall conform to the Employer's standards.

1.29 Quality Control Plan (QCP)

The Contractor shall within twenty (20) days from the date of the Notice to Commence submit a **Quality Control Plan**. The plan shall include testing schedules, list of material sources, quality control procedures and other items as required by the Engineer. The plan shall also indicate testing equipment and consumables. The Contractor shall implement the quality control procedures in compliance with the approved Quality Assurance Plan.

1.30 Sanitation

The Contractor shall arrange high standard of sanitation to be maintained throughout the Camp and the Works. He shall construct and maintain at his own cost a system of surface drainage and waste disposal, which shall be approved by the Engineer before any work commences. Sanitary conveniences for the use of persons employed in the works shall be provided and maintained by the Contractor in accordance with the appropriate laws and regulations in force in Bangladesh to the extent and in such a manner and at such places as may be approved by the Engineer, and all persons connected with the works shall be obliged to use them.

1.31 Medical Arrangements and First Aid Facilities

The Contractor shall make arrangements according to the regulations enforced in Bangladesh for treatment on the site of casualties and sick persons.

The arrangements shall include the minimum provision of a Dispensary with in-patient facilities with a minimum of four beds, a qualified resident dresser and assistant, and for regular visits by a qualified medical practitioner. The Contractor shall make his own arrangements for treatment of casualties on the Site in such first-aid units as may be thought necessary.

In addition, the Contractor shall manage and operate appropriate ambulances for the transportation of injured or sick employees to nearby hospitals at Sirajganj, Bogra or other places. This facility shall be available for the Employer's, Engineer's, Subcontractors' and Contractor's personnel and workmen.

The measurement and payment against this shall be done as per the provision made in Bill of Quantities.

1.32 Recreation

The Contractor is to make arrangements for the provision of adequate recreational facilities for the employees living in the Camp. He shall submit to the Engineer for his prior approval, proposals for providing these facilities.

No separate payment shall be made for this provision.

1.33 Fire Protection

The Contractor shall construct, equip and administer at his cost fire control points in such positions and of such size as will provide an adequate service for the protection against fire of the Camp and all building stores and property on the Site. He shall install and maintain a proper warning system to ensure that fire-fighting equipment can be brought into action without delay.

1.34 Lighting

The Contractor shall install and maintain at his own cost a system of lighting to provide a reasonable degree of illumination over the area of the Contractor's offices and camp. He shall submit details of his scheme for the approval of the Engineer before any work commences.

1.35 Measurement and Payment mention which item in BoQ cover it.

All costs including Contractor's margin, overhead, taxes, etc, incurred by the Contractor in complying with requirements of this Sub-Clause shall be deemed to be included in the respective lump sum price for the Contractor's temporary facilities as indicated in corresponding Item of the Bill of Quantities.

Payment for Contractor's temporary facilities such as offices, quarters, labour camps, water and electricity supply system, laboratory and medical facilities shall be made in the fixed percentage of these works in accordance with the unit rate indicated in Bill of Quantities. Eighty per cent (80%) of total lump sum price of these temporary works shall be paid to the Contractor upon completion of these temporary facilities, and the remaining twenty per cent (20%) of the total price will be paid after removal.

1.36 Contractor's Transport

The Contractor shall make his own arrangements for the transport where necessary of his staff and workmen to and from the site of the works at his own expenses. No payment shall be made on this item, and such costs in this item are deemed to be covered in other items of works.

1.37 Construction and Maintenance of Temporary Access Road

The Contractor shall construct and maintain the temporary access roads including temporary access bridges necessary for construction of the Works and transportation of the materials. The access roads to the borrow pits and for constructing the embankment and roads shall be constructed by rehabilitating and reinforcing the existing roads, where available. The access roads shall be constructed in such a manner that all of the temporary access road and bridge ensure the traffic of heavy equipment and trucks during the whole construction period. The Contractor shall also pay compensation to the owner(s) if he constructs the temporary access roads on a privately owned land.

Not less than 14 days before he intends to start construction of any part of the temporary access roads, the Contractor shall submit to the Engineer the detailed construction programme, and drawings of:

- a) the temporary access roads including temporary access bridges; and
- b) any other temporary works which he considers necessary for proper execution of the works.

The Contractor shall not start the construction of any temporary access road until the Engineer's approval thereto has been obtained. However, such approval shall not relieve the Contractor of any liability or obligation under the Contract.

On completion of the works such as canal, drain, road, bridge, culvert, etc., he shall remove such access road and bridge from the site as directed by the Engineer.

The public and village roads may also be used as temporary access road. The Contractor shall maintain and repair them to the satisfaction of the authorities concerned.

The Contractor shall facilitate the use of such roads for other contractors of the Project and public in a friendly co-operative manner without maintenance of the roads required by them.

All costs including Contractor's margin, overhead, taxes, etc, incurred by the Contractor in complying with requirements of this sub-clause shall be deemed to be included in the lump sum price of Contractor's mobilization of the Bill of Quantities.

1.38 Disposal and Care of Ground/Surface Water, Dewatering Foundations Temporary Diversions.

Disposal of all water encountered during the execution of the Works under the Contract shall be the responsibility of the Contractor. Control of ground water shall be accomplished in a manner that will preserve the bearing quality of the foundation soils, will not cause instability of the excavation slopes, and will not result in damage to existing structures.

The Contractor shall be responsible for and shall repair at his own expense any damage caused by flooding, water, or failure of any part of the dewatering facilities or protective works.

1.39 Environmental Protection Works

The Environment is defined to mean surrounding area including human and natural resources to be affected by the execution and completion of Works.

The Contractor shall take all precautions for safeguarding the environment during the course of the construction of the Works. He shall abide by all prevailing laws, rules and regulations governing pollution and environmental protection. In particular, the Contractor shall fully comply with the environmental protection mitigation measures specified in the related EIA Guidelines published by the Ministry of Environment and Forests, of Government of Bangladesh as well as the Environmental Management Plan approved for River Management Improvement Project. The contractor shall update/prepare Environmental Management Action Plan and execute them during period of construction. The payment against these activities shall be made in accordance with provisions made in Bill of Quantities.

1.40 Permits, Licenses or Approvals

The Contractor shall, in performing the Contract, comply with the applicable Laws of Bangladesh. The Contractor shall pay all taxes, duties and fees, and obtain all permits, licenses and approvals, as required by the applicable Laws in relation to the execution and completion of the Works and the remedying of any defects. At the request of the Contractor the Employer will provide reasonable assistance to the Contractor in obtaining: (a) copies of the laws of the country relevant to the contract; and (b) any permits, licenses and or approval required by the laws of Bangladesh in performing the contract.

1.41 Establishment and Operation of Laboratory for Testing Materials and Works

The Contractor shall establish and maintain a field laboratory near the work site in a semi-permanent/permanent building of about 150 Square meter plinth area with testing equipment and apparatus required for testing materials and works.

The laboratory established by the Contractor shall be administrated and maintained by the Contractor, including the supply of electric power and water, etc. The Contractor shall also provide testing equipment and apparatus and technician, labours, vehicles and consumable necessary for carrying out the required tests.

The contractor shall provide the following staff:

- Laboratory Technician- 1 no
- Lab Assistant- 2 nos
- Support Staff – 2 nos

The following tests are to be performed by the Contractor at site and the testing apparatus and equipment might require (indicative) for performing the following tests:

1 Soil Testing

- Determination of moisture content
- Determination of liquid limit

- Determination of plastic limit
- Determination of plasticity index
- Determination of particle size distribution (down to sieve size 200)
- Determination of dry density/moisture content relationship
- Determination of dry density of soil on the site

2 Concrete Testing

- Aggregate moisture tests for determination of water cement ratio
- Slump test
- Making and curing test cubes/cylinders
- Compression testing of test cubes/cylinders

3 Fine and Coarse Aggregate Testing

- Flakiness index
- Elongation index
- Particle size and grading
- Silt content by field settling test
- Aggregate impact value
- Aggregate crushing value
- 10 per cent fines value
- Soluble sulfates
- Chloride content

Sand

- Particle size and grading
- Fines (< 0.075 micron) content

Water Testing

- Total dissolved solids and electrical conductivity:
- Sulfate content
- Chloride content

Cement Testing

- Initial & final setting time
- Fineness
- Compressive strength

The Contractor shall when instructed by the Engineer or the Engineer's Representative to carry out any test in the presence of the Engineer or the Engineer's Representative, or shall provide all necessary testing engineers, laboratory assistants and labours required to the Engineer free of charge. The Contractor shall ensure that the Engineer and his staff have unrestricted access to these facilities free of any charge. In addition, the contractor shall conduct the others tests (not mentioned above) as instructed by the engineer through other credible laboratories. The Engineer may suggest such laboratories.

The payment the establishment of laboratory shall be made as provisioned in Bill of Quantities. Similarly, the operation cost of the laboratory shall be made on the basis of operation month as indicated on BOQ.

2 SITE CLEARANCES AND REMOVAL OF EXISTING STRUCTURES

2.1 Clearing and Grubbing

During the Contractor's operations the removal of weeds, organic materials, unsuitable materials, shrubs, vegetation and small trees with a girth not exceeding 0.3 m measured 1 m above ground level may be required, in which case, the Contractor shall remove such materials, shrubs, vegetation and trees after obtaining prior written approval from the Engineer. All trees and shrubs to remain in place shall be protected from damage. Where clearing is required, in the right-of-way and borrow area outside the right-of-way, all combustible materials from clearing operations shall be burned or removed from the Site of work or disposed of as directed. However, the felled trees shall not be burned; but shall be deposited at the area designated by the Engineer.

All materials to be burned shall be piled neatly and when in a suitable condition shall be burned completely. Piling for burning shall be done in such manner and in such location as to cause the least fire risk. All burning shall be so performed that the cleared materials will be reduced to ashes. The Contractor shall at all times take special precautions to prevent fire from spreading and shall have at all times, suitable equipment and supplies for use in preventing and fighting fires.

Grubbing shall consist of the removal of the stumps, jungle growth, brush and rubbish from the work areas to be occupied by permanent structures, embankments, resettlement village area and from the surface of borrow areas, stockpile sites and elsewhere as directed by the Engineer.

No tree felling will generally be permitted unless essential for the construction of the works and no tree shall be cut without the written permission of the Engineer.

Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for Clearing and Grubbing, no separate payment shall be made for such work and all costs therein shall be deemed to be included in the unit rates for various types of excavation/embankment construction/filling area for villages.

2.2 Tree Removal

Where shown on the Drawings or directed by the Engineer trees exceeding 0.3 m girth measured 1 m above ground level shall be uprooted or cut down as near to ground level as possible and the root ball extracted separately. The Contractor shall clearly demarcate and count the number of trees to be removed and mark them as instructed by the Engineer. No tree shall be felled without obtaining such approval from the Engineer. The prior permission for cutting trees shall be obtained from concerned authorities as per the prevailing laws of Bangladesh.

The Contractor shall take necessary precautions to prevent damage to structures and public property. If necessary, trees shall be cut in sections from the top downwards. In order to prevent damage to trees that are to be left standing, trees shall be felled towards the centre of the area being cleared.

The trees shall be felled, and the roots shall be dug out as far as possible, or directed by the Engineer. The earth-filling in the area where roots have been dug out shall be compacted in 200 mm layer-wise with a suitable compacting machine.

The trees shall not be burned, but shall be transported to an area designated by the Employer and shall be stacked and deposited. Such timber shall not be used by the Contractor for any purpose and the felled trees shall be property of the Employer/Government.

The Contractor shall be responsible for any theft and unauthorized removal of the felled trees, and shall maintain a register showing the number of trees felled and stored in the designated area.

Payment for removal of trees and roots including chopping branches, transportation, loading, unloading, stacking at the designated area by the Employer shall be made at the unit rate per square metre as indicated on corresponding Item of Bill of Quantities.

Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for Removal of Trees, no separate payment shall be made for such work and all costs therein shall be deemed to be included in the unit rates for various types of excavation/embankment construction or structures.

2.3 Notice of Commencement

The Contractor shall give to the Engineer notice of his intention to commence the Clearing and Grubbing operations. The works shall not be commenced until written approval has been received from the Engineer.

2.4 Stripping of Top Soil

Stripping shall consist of the removal of all organic materials such as sod, topsoil and roots from all embankment foundations, from areas where the excavated material is to be further used in embankments, from the base of all roads and in all other areas shown on the Drawings or directed by the Engineer, and the stockpiling or disposal thereof.

Materials from stripping which are suitable for topsoil shall be selected during stripping operations and stockpiled for further use as directed by the Engineer.

Materials not suitable for topsoil or further use shall be disposed of in spoil banks as instructed by the Engineer.

Materials from stripping shall be stockpiled or disposed thereof as provided in relevant clauses of this Specifications. The disposal of all materials wasted from stripping shall be subject to the approval of the Engineer.

Measurement for payment for all stripping operations shall include only the stripping, on locations instructed by the Engineer and to a depth of 150 mm or as shown on the Drawings.

Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for Stripping, no separate payment shall be made for such work and all costs therein shall be deemed to be included in the unit rates for various types of earthworks under the contract.

2.5 Removal of Existing Structures

Existing brick or boulder or concrete (plain concrete or reinforced concrete) structures shall be removed totally or partly where shown on the Drawings or directed by the Engineer and the materials thereof shall become property of the Contractor. The Contractor shall remove such dismantled materials from

the Site as directed by the Engineer or shall be incorporated into new works as approved by the Engineer. In case that such removed materials such as boulder or concrete block are used in a new structure, no payment for such removal works shall be made under this Clause.

Where a structure is removed and a new structure is not required, the Contractor shall place backfill and compact it up to the elevations of the existing ground surface as directed by the Engineer.

Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for removal of existing structures, no separate payment shall be made for such works and all costs therein shall be deemed to be included in the unit rates of other works.

3 EARTHWORKS

3.1 Excavation

3.1.1 General

Excavation shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of permanent works in accordance with the requirements of these Specifications, to the lines, grades and cross-sections shown on the Drawings or as otherwise directed by the Engineer. This work shall also include the hauling and stacking, or hauling of suitable materials to sites of embankment/resettlement village construction, disposal of unsuitable cut materials in specified manner, dewatering and pumping, and the trimming and finishing of excavation lines to such widths, depths and profiles as shown on the Drawings, or to such dimensions and levels as may be instructed by the Engineer.

The Contractor shall give to the Engineer, at least 7 days written notice of his intention to commence excavation works on any part of the Site. Such requests shall include details of initial and final levels, drainage works, foundation layout, etc. The excavation shall not commence until written approval has been received by the Contractor from the Engineer.

If, from any cause whatsoever, excavations other than for concrete works are carried out beyond their true line and level, the Contractor shall at his own cost make good to the required line and level with approved material and in such manner as the Engineer may direct.

If, from any cause whatsoever, excavations for concrete works are carried out beyond their true line and level other than at the direction of the Engineer, the Contractor shall at his own cost fill in to the required line and level with concrete of similar grade to that intended to be used.

When any excavation has been executed and trimmed, the Engineer shall be informed accordingly so that he may inspect the completed excavation, and no excavation shall be filled in or covered with concrete until it has been inspected and the Contractor has been authorised to proceed with the work.

All excavation work shall be classified as common excavation, irrespective of the types of materials encountered, and shall be paid at the unit rates shown in the Bill of Quantities.

3.1.2 Disposal of Excavated Materials

In so far as practicable, excavated materials from drains and structures shall be used, as much as possible, in such permanent construction works as cladding material or backfill, as required under the Specifications and as per standard engineering norms and practices for the given conditions of the soil.

Except for the materials stockpiled in the yards as directed by the Engineer, excavated materials shall be deposited or disposed of in spoil banks as directed by the Engineer. The deposited or disposed of materials shall be levelled and trimmed to reasonable lines as instructed by the Engineer.

Where practicable, suitable materials for cladding shall be excavated separately from the materials to be wasted, and the suitable materials shall be placed in the designated final locations directly from the

excavation, or may be placed in temporary stockpiles and later placed in the designated locations, as per standard engineering norms and practices for the given conditions of the soil.

The excavated materials, which are suitable for filling or cladding, shall be placed temporarily in stockpiles approved by the Engineer until the moisture content is reduced sufficiently to permit them to be placed in the embankment in conformity with the Specifications.

The cost of depositing, and/or disposing of, including proper treatment of spoil banks, shall be included in the relevant excavation items of the Bill of Quantities. Only the cost of hauling the excavated materials to the spoil banks, the right-of-ways and embankment sites designated by the Engineer shall be paid as stipulated in Filling of Earth, if any in case provisioned in corresponding Bill of Quantities.

3.1.3 Excavation in Drains

The excavation in drains shall apply to excavation work in all types of drains. The cross sections of drains are to be in accordance with the approved drawings or shop drawings as approved by the engineer.

Measurement for payment of excavation in drains shall be made in cubic metre of earth excavated from the ground surface or stripped surface, if any, to the neat lines and grades as shown on the Drawings or as per standard engineering norms and practices for the given conditions of the soil.

Payment for excavation in drains, measured as above, shall be made at the unit rate per cubic metre as indicated on corresponding Items of the Bill of Quantities. Such unit rate shall include the costs of all labour, materials and construction equipment necessary for excavation, trimming of side slopes, placing the material in the spoil banks shown on the Drawings or as directed by the Engineer, disposing of the unsuitable or surplus material, disposing of ground and surface drainage water encountered, and all work necessary to maintain the excavation in good order during construction, except the cost of the required haulage to be paid for as provided if any.

3.1.4 Excavation and backfill for Structures

Excavation for structures shall include excavation of all soils, sand, gravel and boulders, stockpile of soil suitable for re-use and disposal of soil unsuitable for re-use as instructed by the Engineer.

Excavation for structures shall be carried out in a safe manner and to the lines and levels shown on the Drawings, or to such lines and levels as may be approved by the Engineer.

The bottom and side slopes of excavation work against which concrete is to be placed shall be finished accurately to the dimensions shown on the Drawings or prescribed by the Engineer, and the surface so prepared shall be moistened with water and tamped or rolled with suitable tools or equipment for the purpose of securing firm foundations. If, at any point, the natural foundation material is disturbed or loosened during the excavation process or otherwise, it shall be compacted in place, or it shall be removed and replaced with suitable earth materials or concrete as directed by the Engineer and at the expense of the Contractor.

If, at any point of excavation, material is excavated beyond the established lines and grades, it shall be re-filled and compacted by tamping or rolling in layers of not more than 150 mm thickness at the Contractor's expense.

After the completion of foundation works by either concrete or Brickwork, the backfilling shall be done by using the selected excavated materials. The back filling of structures shall be compacted as directed by the engineer.

Excavation for structures shall be measured for payment in cubic metre to the lines and levels shown on the Drawings. The quantities to be measured shall be the net cubic content of the voids formed by the removal of the materials enclosed between the bottom of the footing and the existing ground level by a surface generated by vertical lines passing through the periphery of the bottom of the footing. No measurement shall be made for any excavation over the limited excavation described above.

Over-excavation of width, length, cutting of slopes, shoring and planking shall be deemed as convenience for the Contractor in executing the work and shall not be measured and paid separately. Backfill to be measured shall also be limited to this void only with due consideration to the nature of the structure.

Payment of excavation for structures as well as the back filling, measured as above, shall be made at the unit rate per cubic metre as indicated on corresponding Item of Bill of Quantities, depending upon the location of the structure. Such unit rates shall include the costs of all labour, materials and construction equipment necessary for excavation, placing the materials in spoil banks as directed, disposing of the unsuitable or surplus material, disposing of ground and surface drainage water encountered, and all work necessary to maintain the excavation in good order during construction,

3.2 Filling for Resettlement Village Sites

Resettlement village filling shall include filling within the acquired area according to lines and levels shown on the Drawings or as directed by the Engineer. The type of soil to be used for filling shall be only limited to sand sourced from Jamuna river or sandy materials as approved by the Engineer. The contractor can use dredging equipment for this purpose. The materials for filling shall not contain any stumps, brush, weeds, roots, clods and any matter that may decay.

Not less than seven (7) days before he intends to commence the works, the Contractor shall submit to the Engineer for his approval the details of his proposed method of obtaining fill materials. The Contractor shall not commence any work necessary for furnishing the materials until the Engineer's approval has been obtained.

The entire ground surface to be under fill area shall be scarified or ploughed thoroughly and be compacted to meet requirements as specified by these Specifications. This operation shall commence only after the completion of stripping, as specified in Sub-Clause 2.4 of these Specifications.

Before commencing filling, and from time to time as may be considered necessary by the Engineer, the Contractor shall carry out compaction trials in the presence of the Engineer on each type of soil to be used. He shall carry out all necessary laboratory and field testing as required by the Engineer and shall submit to the Engineer the results of all tests.

Following the completion of compaction trials, the Contractor shall submit to the Engineer, for his approval, proposals for the compaction of each type of material. The Contractor's proposal shall include reference to the types of equipment, operating weights and tyre pressure, method of adjusting moisture content, number of passes and loose depth of each layer.

If, in the opinion of the Engineer, the results of the compaction trials indicate that the Contractor's proposed equipment and methods will achieve the densities specified, the Engineer shall approve the same.

Notwithstanding the Engineer's approval of any of the Contractor's equipment or methods, the Contractor shall at all times be solely responsible for executing the works in accordance with the Specifications.

The entire earthwork in resettlement village, and backfilling of structures, shall be spread in layers of uniform thickness not exceeding 200 mm over the entire width. The moisture content of the spread material shall be checked prior to commencement of compaction. If it is found to be outside the specified limits, the same shall be adjusted by watering or drying to the permissible limits specified, only then the soil shall be compacted by mechanical rollers to not less than the specified percentages of the maximum dry density. The compacted layer shall be tested by the Contractors for checking the density and other parameters in accordance with the frequencies specified in Sub-Clause 3.4.1 of these Technical Specifications.

For the filling of re-settlement area, if the results of the field density tests show less than the specified density (Related density for sand 35%) in a certain layer, the whole reach will be rejected and re-compaction shall be required. Successive layers shall not be placed until the Engineer approves the layer under construction.

3.2.1 Borrow Areas for Filling of Re-settlement Village Area

The materials used for filling the re-settlement village sites shall be obtained from river bed or adjacent char lands within the river proposed by the Contractor and approved by the Engineer. The maximum depth of the borrow area shall be approved by the Engineer. The Contractor shall pay the compensation/cost to the owners of land of such borrow areas in case the land is owned by the individual.

These costs of burrow pit shall be included in the relevant unit rates for the earthwork for filling. No separate payment shall be paid for compensation for the land for burrowing earth materials.

3.2.2 Construction of Re-settlement Village Area

Before the material for the first layer of the fill is placed, the base for the resettlement area shall be prepared, as provided for in Sub-Clause 3.1.1 hereof, and shall be moistened or dried and compacted in the manner hereinafter specified.

The sand/material used in the construction of the embankment shall be extracted from the river by dredging or excavation on low lying sand bars and chars. Such locations shall be identified by the Contractor and accepted by the Engineer prior to the commencement of any filling.

Dredged or lifted material is to be stockpiled in staging areas for dewatering prior to placement in the re-settlement village site.

The resettlement area filling shall be performed using mechanical means with material taken from stockpiles. The material to be used for fill shall be suitable earth/sand and shall not contain any stumps, peat, logs, weeds, roots, or any organic matter that may decay and shall be capable of being compacted to the required standards. The filling shall not be performed by Hydraulic filling.

The filling of materials shall be placed and compacted in uniformly spread layers not exceeding 200 mm in thickness. Unless otherwise permitted by the Engineer, layers of fill material shall be horizontal, except for any gradient required for drainage, and the thickness of each layer shall be uniform over the area to be filled.

The construction of the works shall be controlled in such a manner that any compaction of the fill material resulting from the passage of Constructional Plant or haulage vehicles is uniform. Fill material shall not be deposited by end-tipping, by pushing loose material down slope faces or by other methods which may result in segregation or inadequate compaction of the fill material.

The filled sand shall be compacted to 35% relative density and cladding shall be compacted to 85% maximum dry density at optimum moisture content with reference to laboratory density test AASHTO.

The natural moisture content and the optimum moisture content of the material shall be checked before compacting it. If they are found to be outside the specified limits, the same shall be made good.

The Contractor shall have deemed to take into account the fact that the materials encountered may vary widely with respect to their in situ moisture content and the moisture content at which the materials are to be compacted. Accordingly, the materials may have to be wetted by adding water, or dried to the required degree, along with intimate mixing of the entire mass of the materials.

Where placing and spreading operations will be carried out by hand method which deposits materials directly from the excavation by human power, with the Engineer's approval, the materials shall be thoroughly compacted by mechanical tamper or other approved means. The distribution of materials shall be such that the tamped materials will be homogeneous and free from lenses, pockets, streaks or other discontinuities.

Unless otherwise permitted by the Engineer, filling shall be undertaken evenly over the full width. The surface of the fill area at all time during construction shall be maintained at such a cross-fall as to prevent ponding of rain water.

Different layers shall be constructed one after another. In the time that might elapse between the acceptance of a lower layer and the placing of the overlying layer, if any damages such as cracking, rutting, corrugations, pot holes, erosion, etc. are caused to the lower layer due to whatever reasons, such damages shall be repaired by the Contractor at his own cost. The methods employed for repairing damages shall include scarification with re-compaction or reconstruction using new materials, as directed by the Engineer.

Finishing operations shall include the work of shaping and trimming the side slopes to conform to the levels, cross-sections and dimensions shown on the Drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain. Slopes after trimming work shall be compacted by mechanical tamper or approved means.

3.2.3 Haulage of fill material

In general, the event that haulage of excavated materials exceeds an initial haulage of 30 meter, the haulage shall be counted as additional lead. Every 15meter beyond initial 30 meter lead shall be counted as 1 lead.

The Payment for the haulage including all leads and lifts shall be made only for the excavated materials wasted to spoil banks, or carried for use in the filling for Resettlement village area, or backfill work as directed by the Engineer.

The items provided on BOQ for filling of resettlement village area or other filling items shall be inclusive all leads and lifts as required. The measurement of these shall be done accordingly. No additional lead or lift for these items shall be considered.

Unless otherwise specifically provided, no separate payment shall be made for the haulage of earth.

3.2.4 Measurement

Filling shall be measured in cubic meters based on the pre and post sections of accepted fill constructed and completed in accordance with the Specifications, to the lines, levels and grads required or as directed by the Engineer.

Payment for fill and cladding shall be made at the unit rate per cubic meter as included in the Bill of Quantities. The unit rate shall include all costs of materials/compensation to the land owner of burrow areas in case burrow area is located on private land, placing materials in layers, furnishing water, moistening or drying the materials and compacting the materials and trimming and compacting the slopes, including all costs of labour, materials and construction equipment.

3.3 Surface Cladding Placement

A cladding layer is to be placed on the slopes of the Filled Area of Res-settlement Village. Material used for the cladding shall be of clay in nature. The thickness of the cladding is shown in the drawings. It is expected that the cladding material shall be placed parallel to the fill face. The cladding shall be placed in layers approximately 300 mm thick. The required compaction of the cladding is to be 85% MDD (ASTM D 1557). The moisture content of the placed cladding may vary by a maximum of 2% (18.6% $\pm$ 2%). Upon completion, the surface of the cladding shall be left smooth.

The method used for the monitoring of the placed cladding thickness shall be established by the Contractor in consultation with the Engineer. This may be through surveys. The measurement and payment for the cladding material shall be cubic meters (cum) as measured in place

3.4 Field Tests

The Contractor shall carry out tests to determine the natural and optimum moisture content and the maximum dry density of soils in a given area. Then the Engineer shall determine the allowable moisture content range of the materials and the maximum thickness of each layer after spreading. The Engineer may change the allowable moisture content range of the materials prescribed in Sub-Clause 3.1.5 and 3.1.6 hereof after field tests.

The frequency of tests shall be as follows:

Particle Size:	every 2,000 cum or every change in source
Atterberg's Limits:	every 2,000 cum or every change in source
Moisture Density Relationship:	every 2,000 cum or every change in source
Natural Moisture Content:	every 500 sqm
Field Density:	every 500 sqm

No separate payment shall be made for the fill tests. All costs of furnishing, materials, labours, construction equipment and executing, the field tests shall be included in the unit rates for applicable fill items in the Bill of Quantities.

3.4.1 Soil Sampling and Testing

The Contractor shall carry out control tests on fill materials as required in the Specifications, as and when required by the Engineer. The Engineer shall have unrestricted access to soil laboratories and their test results. Tests required are:

Moisture content	IS 2720 Part II or BS 1377 - 1A
Grain size analysis	BS 1377 - 7B and 7C
Liquid limit	BS1377 - 2A
Plastic limit	BS1377 - 3
Compaction test	IS 2720 Part VIII
Field density tests	Earth Manual, USBR

The Contractor shall provide the necessary equipment, labour and transport for carrying out the sampling and testing in the specified laboratory. The soil samples shall be stored and tested at the laboratory under the direction of the Engineer.

The payment against this activity is included under the unit rate of Laboratory Operation (Bill No 1, Item -1.03)

3.5 Backfill for Structures Is this item exists in BoQ? Please clarify when backfill is a separate paid item.

The materials used for backfill of structures shall be suitable material recommended for filling, unless otherwise specified and obtained from excavations for structures, canals, drains and rivers or from borrow areas as directed by the Engineer. Backfill material shall be placed in layers, each with a maximum thickness of 200 mm unless otherwise specified, the placing and compacting of all backfill materials shall conform to the standard applicable requirement.

Prior to the commencement of placing backfill, all materials adjacent to structures such as concrete wastage, forms, stones, etc. shall be cleared to the satisfaction of the Engineer. Backfill materials shall be placed in such a manner as will ensure satisfactory compaction without damage to the structure. Compaction adjacent to all structures shall be carried out by engine-driven tampers, small vibratory rollers or approved hand tools.

The surface of the backfill material shall be compacted so as to give a slightly cambered surface to facilitate drainage, and the backfill material shall be watered or allowed to dry, if necessary, in order to maintain or achieve the specified moisture content for compaction.

The dry density of the clayey soil in the compacted materials shall not be less than ninety five (95) per cent of the maximum dry density.

Compaction of backfill materials above placed concrete shall not be permitted with vibrating rollers within 1.0 metre vertically of the surface of the concrete, except with the prior approval of the Engineer.

Measurement for payment of backfill for structures shall be made as 20% of the structural excavation was measured according to the prescribed lines, grades and dimensions shown on the Drawings or as directed by the Engineer.

Payment of backfilling shall be made at the unit rate per cubic metre of as indicated on corresponding items of the Bill of Quantities as discussed in on clause 3.1.4. The payment of backfilling shall be made at unit rate as specified in Bill of Quantities.

3.5.1 Compaction of Fill and Backfill

The Contractor will perform compaction for the preparation of all structural foundations, for backfill adjacent to all structures, for all embankments covering new embankment and re-sectioning. Compacted fill or backfill shall consist of approved material spread and compacted in layers approximately horizontal and of uniform thickness with a slight outward slope and of a compacted depth not exceeding 200 mm. The moisture content of the soil shall be carefully controlled either by natural drying or wetting with a fine spray.

3.6 Fine Dressing and Close Turfing

This work shall consist of furnishing all topsoil, grass and fertilizers and placing and incorporating the same on fill slopes and other locations or directed by the Engineer.

3.6.1 Description

Fine dressing and close turfing including ramming, watering until the turf grows properly, maintaining etc. on the slopes of fill should be done with 75mm thick good quality turba or charkanta sods of size 200mmx200mm. Other grass types proven to grow well under the local conditions may also be used subject to the prior approval of the Engineer.

3.6.2 Materials

Grass shall be harmless to persons and animals and not of a kind recognized as a nuisance to agriculture. It shall be free of disease and noxious weeds, deep-rooted and sufficiently rapid growing and spreading to give complete cover over the planted area within the final construction inspection period.

The term “grass” embraces turf and sods and, if the Engineer permits, may include plants of other types capable of giving effective protection. Fertilizer shall be approved lime or mixtures of plant nutrients or both. Fertilisers shall consist of standard commercial materials such as Nitrogen-Phosphate-Potassium shared in ratio of 16:5:12 or in other suitable ratio approved by the Engineer. The application rate shall be determined through soil analysis of soil samples taken from the area to be grassed.

3.6.3 Construction

Sodding or turfing shall be done by planting sods or turfs, as indicated on the Drawings, to give continuous cover over the whole area. They shall be planted with their roots system substantially undamaged, well buried in firm material, and packed around the moist earth in which they have grown.

Grass planting shall be started well in advance of the monsoon season to ensure establishment of growth before the rain sets in and shall not be performed when the ground is muddy or when the soil or weather conditions would otherwise prevent proper soil preparation and subsequent operations

The Contractor shall maintain the grass at his expense until the end of the Defect Liability Period. Maintenance shall consist of preserving, protecting and replacing grass and such other work as may be necessary to keep it in a satisfactory condition to prevent erosion and present a dense and uniform appearance. The Contractor shall be responsible for satisfactory growth and shall water, fertilize, and mow the grass at such intervals as will ensure good ground cover of live grass all through the Defect Liability Period.

3.6.4 Measurement and Payment

The quantity measured for payment shall be in square meters of finished and accepted work i.e. of turfed or sodded surface whether horizontal or sloping of required and accepted grassing well established in place.

The unit rate shall be deemed to include the cost of furnishing all labour, material, incidentals for carrying out the work including preparation of grass-bed, fertilizing and planting of grass as specified, watering, maintenance and all other procedures specified herein. The Payment of the item grass turfing shall be in square meter as indicated in Bill of Quantities.

4 CONCRETE FOR STRUCTURES

4.1 General

4.1.1 Standards and Codes of Practice

All concrete work shall be carried out in accordance with British Standard BS 8110 unless otherwise specified herein. Conversion of stresses and densities in kN shall be made using the following factor:

1 kN = 102.0 kg (force)

Stone chips shall have to use for all structural concrete.

4.1.2 Costs of Testing and Sampling of Concrete and Concrete Materials

The costs of all sampling, transport of samples and testing in connection with the concrete shall be in accordance with the Conditions of Contract and the Technical Specifications and such costs are to be borne by the Contractor. These costs shall be deemed to be included in and covered by the unit rates for concrete as shown in the Bill of Quantities.

4.1.3 Failure to Meet Specified Requirements

If the specified requirements have not been met, the Contractor shall take such remedial action as the Engineer or Engineer's Representative may order, and shall, before proceeding further with concreting, submit for their approval details of the action proposed to ensure that the concrete still to be placed in the Works shall comply with the Specifications.

4.2 Materials

4.2.1 Cement

4.2.1.1 Quality and Type

The cement to be used in the Works shall be ordinary Portland cement complying in all respects with BS 12. For the purposes of cement testing under BS 12, the Site shall be deemed to have a tropical climate.

4.2.1.2 Tests on Cement

Before any cement is ordered in quantity or brought to the site, the Contractor shall submit to the Engineer a detailed list of the sources, country or countries of origin and manufacturer's brand names of the types of cement, which he proposes to use.

The Contractor shall submit to the Engineer, without charge, test certificates relating to each consignment of cement. Each certificate shall show that a sample of the consignment has been tested by the manufacturer or by an approved laboratory and that it complies in all respects with the requirements of the Technical Specifications.

The cement will be tested in accordance with and shall meet the requirements of the relevant Code. When required by the Engineer the Contractor shall supply to the Engineer samples of cement taken on delivery to, or during storage on the Site, for testing at the Contractor's laboratory without extra charge.

No cement from any consignment shall be used without the approval of the Engineer and the Contractor shall maintain a record of the locations of the concrete made from each consignment which record shall be available for inspection by the Engineer. If for any reason the Contractor wishes to vary the source, country or manufacturer in respect of any type of cement at any time during the Contract, he shall give adequate notice of every such variation and shall carry out all tests called for by the Engineer on the proposed substitute cement, and shall obtain written approval of the variation before ordering any substitute material.

The Engineer may call for new tests, at the Contractor's expense, in particular if the cement has been stored for a long time, to check the cement is still conforming to the requirements.

4.2.1.3 Delivery and Storage of Cement

Cement shall be delivered to the site in properly sealed paper bags or other approved containers, stamped with date of delivery and marked sound. Cement from abroad shall be packed in sealed plastic bags inside the paper bag. Cement shall be delivered in quantities sufficient to ensure the proper progress of the Works and the quantities held in stock on site shall be to the approval of the Engineer.

Each consignment of cement shall be stored separately so as to provide easy access for inspection and testing. After they have been approved by the Engineer, consignments shall be used in the order in which they were delivered. Any cement, which shall prove to have been exposed to damage by water will be rejected upon delivery.

Cement delivered in bags shall be stored in a weather-proof, waterproof and reasonably airtight building provided solely for that purpose. The floors of the building shall be raised at least 30 cm above the ground level to prevent the absorption of moisture. It is not permitted to store bags to a greater height than 2 metres. Storage in the open may be permitted on small works by the written authority of the Engineer, in which case the cement shall be placed on a raised platform and amply protected by waterproof coverings to the approval of the Engineer.

Cement, when being transported to the site in Lorries or other vehicles, shall be adequately protected from the weather and from contamination by dust, sand or any organic materials. In the case of delivery of cement in bulk, the cement shall be stored in a properly designed silo. The silo must be provided with walls properly insulated against sun radiation.

No cement shall be taken from the storage, unless it is needed for immediate use.

4.2.1.4 Cement Measured by Weight

All cement used in the Works shall be measured by weight. Cement from partly filled or unsealed bags shall not be used.

4.2.1.5 Rejection of Cement

Notwithstanding the receipt of the test certificate as required by Sub-Clause 4.2.1.2 - Tests on Cement, and the approval of the Engineer, the Engineer may reject any cement as a result of further tests on

compressive strength and chemical composition. The Engineer may also reject cement, which has deteriorated owing to inadequate protection or other causes, or in any other case where the cement is not to his satisfaction. Re-tests, if required, are at the Contractor's expense. The Contractor shall remove all rejected cement from the site without delay and at the Contractor's expense.

4.3 Coarse Aggregate

(1) Aggregates shall be hard, strong, durable, dense and free from injurious amount of adherent coatings, clay, lumps, dust, soft or flaky particles, shell, mica, alkali, organic matter and other deleterious substances. The various sizes of particles of which an aggregate is composed shall be uniformly distributed throughout the mass.

(2) Approval of a source of aggregate by the Engineer shall not be construed as constituting the approval of all materials to be taken from that source and the Contractor shall be responsible for the specified quantity and quality of all such materials used in the Works. Aggregates shall not be obtained from sources, which have not been approved by the Engineer.

(3) The Contractor shall provide means of storing the aggregates at each point where concrete is made such that:

- (a) Aggregates shall be stored on a hard and dry patch of ground covered with a 50 mm thick layer of lean concrete or hard base;
- (b) Each nominal size of coarse aggregate and the fine aggregate shall be kept separated at all times;
- (c) Contamination of the aggregates by the ground or other foreign materials shall be effectively prevented at all times;
- (d) Each heap of aggregate shall be capable of draining freely;
- (e) The aggregates shall be handled so as to avoid segregation.

(4) The Contractor shall make available to the Engineer such samples of the aggregate as he may require. Such samples shall be collected at the point of discharge of aggregate to the batching plant/mixing machines. If any such sample does not conform to the Specification, the aggregate shall promptly be removed from the site and the Contractor shall carry out such modifications to the storage arrangements as may be necessary to secure compliance with the Specification.

4.3.1 Stone chips

The coarse aggregates shall be crushed stone chips (20 mm downgraded or as specified in the design) and well-shaped. The amount of clay, fine silt and fine dust occurring in a free state or as a loose adherent shall not exceed one percent by weight.

Stone chips (20mm downgraded) shall only be used in structural concrete.

Coarse aggregates shall be well graded within the grading given in the table below: Percentage by Weight Passing Standard Sieves

20 mm maximum size	
Sieve Size (mm)	% Passing (w)

25	100
20	95-100
12.5	20-55
10	05-20
5	0-5

Stone Chips shall satisfy the following criteria:

- Water absorption as determined by STP 7.5 (or AASHTO T-85) or BS-812 shall not be more than 2 % and soft fragments <2% by mass
- Materials passing through 0.075 mm Sieve <0.50% if Clay, < 1.5% if fractured dust by mass
- The Aggregate Impact Value (AIV) shall not exceed 30% limit as per BS 812: Part 3, Chapter 6.
- The percentage of wear according to Los Angeles Test shall not be more than 35 as per ASTM C535. The Flakiness Index <30% and TPFV> 150 KN

4.3.2 River Singles

The river singles can be used as coarse aggregate for concreting works for manufacturing of Cement Concrete Block. The river single be 40 mm size down graded and shall confirm all the properties as described for stone chips under clause 4.3.1.

4.3.3 Brick Chips

Coarse aggregate for Class E2 concrete shall be brick chips, Jhama khoa made from first class bricks in accordance with Specification stated below. The pieces of aggregate shall be angular or rounded in shape and have a granular, non-powdery surfaces. The coarse aggregates shall be well graded in accordance with Clause 4.3.1 and to the satisfaction of the Engineer.

First class bricks and picked Jhama bricks shall comply with the following requirements:

- | | |
|-------------------------------|--|
| (a) Shape etc: | Sound, hard and well burnt, uniform in size, shape and colour, homogeneous in texture and free from flaws and cracks. A fractured surface shall show a uniform compact structure, free from holes, lumps or grits. |
| (b) Unit Weight: | 1st class: not less than 1100 kg/m ³
Picked jhama: not less than 1200 kg/m ³ |
| (c) Minimum crushing strength | 1st class :14 N/mm ² and above |
| (d) Maximum water absorption | Increase in weight after one hour absorption in water shall not more than 15% of dry weight for 1 st class bricks and 25% for 2nd class bricks. |
| (e) Dimensions | 240 mm x 120 mm x 70 mm (The variation in dimension shall not be more than 5mm in length, 2.5mm in breadth & 1.5mm in height). |

4.3.4 Fine Aggregates

Fine aggregates shall be non-saline and consist of hard, dense, durable materials and shall be free from injurious amounts of clay lumps, lightweight materials or other deleterious substances.

Fine aggregate should meet the standards specified in AASHTO Standard Specification M-80. Following shall be deleterious substance tolerance:

- Friable particle < 0.5% by mass
- Coal and lignite < 0.5% by mass
- Passing 0.075 mm < 3% by mass

Fine aggregates shall have a fineness modulus (FM) equal to or greater than 1.5 and conform to the following requirements in table 4.1:

Table 4.1: Fineness Modulus of Aggregates

Sieve No.	Sieve Size (mm)	Percentage by weight passing
4	4.76	95-100
16	1.18	45-80
50	0.30	10-30
100	0.15	2 – 10
Pan	-	3 - 7

4.3.5 Water

The water used for concrete mixing and curing shall be fresh water, clean and free from any substances injurious to the finished product. It shall be taken from an approved source and free from objectionable quantities of silt, organic matter, alkali, salt and other impurities. Whenever required to do so by the Engineer, the Contractor shall take samples of the water being used or which is proposed to be used for mixing concrete and test them in accordance with BS 3148. No concrete shall be made with unapproved water.

4.4 Admixtures

No materials of any description shall be used in any concrete mix other than aggregates, cement and water as defined in these Technical Specifications, unless specified otherwise or with the written approval of the Engineer in each and every case, or as otherwise instructed by him.

The Engineer shall only approve additives for which properly documented evidence is available, showing that the 28-day characteristic cube strengths produced with such additives are not less than the strengths of the corresponding plain concrete mixes. The Engineer may, in addition, order cubes to be made and tested at the Contractor's expense of concretes containing such additives before giving his approval to the incorporation of any of the proposed additives in concrete used for the permanent Works.

Additives (if applied) shall not produce concretes, which are less dense, more porous, have inferior surface structures, or are more susceptible to humidity or temperature movement than the corresponding plain concrete mixes. Under no circumstances shall any additive containing calcium

chloride be used in any concrete mix, grout or mortar. Additives shall be used with caution and every care shall be taken to prevent over-dosage.

The Contractor should note that any commercial description of any additive issued by manufacturers shall not be accepted when proposing such an additive for the approval of the Engineer. In order to save delay, the Contractor shall submit the complete description about the chemical composition of any additive, and of its anticipated effect on the particular mixes in which it is proposed to be used, including the reason for its necessity.

All additives shall be supplied to the Works in containers or packages clearly marked with the recommended dosage for each type of mix in which they are to be used.

As far as possible, powder additives shall be supplied in individual sacks containing the exact amount for one charge of a standard mixer. Liquids or powders, which are to be used as solutions, shall be dispensed by means of an appliance fixed to the mixer, whereby weight, volume or dosing time can be recorded.

All additive dispensers shall be thoroughly cleaned before commencing each day's work and at every interruption of the Works.

Samples for checking the calibration and dosage of additives shall be taken at regular intervals and records kept to enable correlations to be made with test cubes and the positions of concrete containing additives in the structure.

Any cement containing additives shall be supplied in bags or containers clearly marked to show the nature and quantity of such additives, and shall be stored separately from any other type of cement.

Before using any additive or combination of additives in any mix, the Contractor shall be required to prepare trial batches of concrete, at his own expense, for the approval of the Engineer to establish the compatibility of the additives with the cements and aggregates actually in use on the Site. As far as possible, such trial batches shall be mixed and compacted under similar conditions of temperature and humidity to that likely to be experienced by the bulk of the concrete to be used in the Works.

Selected specimens from these trial batches shall be tested at suitable times for hardness, colour match, surface finish, water absorption and density, and shall be compared with similar specimens of plain concrete without additives. The compaction, workability and slump of the mixes with and without additives shall be similarly compared.

Notwithstanding any previously given approval, the Engineer may withdraw such approval at any time with respect to any mix containing additives if the performance of the particular additive under actual site conditions is not completely satisfactory.

Any batch of concrete which has received an excessive dose of an additive or which shows deterioration after placing, as a result of incorrect use of additives, shall be cut out or otherwise replaced at the Contractor's expense. Claims for extra payment caused by delay, due to the rejection of any additive or mix containing an additive, will not be accepted. In case plain mixes are not adequate and additives are required, the Engineer reserves the right to specify other particular additives and/or methods. The price quoted by the Contractor for concrete works shall be deemed to include the cost of mixing, transporting, placing and compacting concrete containing additives when applicable.

These provisions shall also cover the use of additives in special grouts used for grouting the steel Seal Plates.

4.5 Concrete Properties/Tests and Placing /Compaction

4.5.1 Concrete Properties and Tests

4.5.1.1 Classes and Grades of Concrete

The concrete used in the Works shall be of the grades or classes shown on the Drawings or indicated in the Bill of Quantities or instructed by the Engineer. The characteristics of the mixes of concrete to be used in the Works shall be as given in Table 4.2 unless otherwise approved by the Engineer.

4.5.1.2 Compressive Strength Compliance

The compressive strength of the concrete shall be based on the compression testing of 150 mm concrete cubes, made and tested in accordance with BS 1881, Parts 1, 3 and 4 on the testing equipment installed by the Contractor in the Site Laboratory under the supervision of the Engineer.

The compressive strength of the concrete is specified by the specified compressive strength in Table 4.2 for each class of concrete. The concrete in the Works shall be considered to comply with the compressive strength requirements specified in Table 4.2.

The structural concrete to be used in this case is concrete class-B with stone chips (20mm down graded) as coarse aggregate. The concretes in other area shall be Class E2 with brick/pick Jhama chips (25mm downgraded) as coarse aggregate. For cement concrete block, the concrete shall be of class E2 with river singles as coarse aggregate.

The trial mix for the concretes with the specified strength shall be developed to achieve the minimum desired strength (20 N/mm² and 9 N/mm²).

(Delete the classes of the concrete which are not used in the design)

Table 4.2: Classes of Concrete

Concrete Class		*Min ^m 28 day Cylinder Strength (N/mm ²)	Maximum size of the coarse aggregate (mm)	Minimum Cement Content (kg/m ³)
A1		25.0		
A2		22.0		
B		20.0		
C		18.0		
D		16.0		
E1		10.5		
E2		9.0		
E3		6.0		

The tentative use of the above classes of concrete shall be as follows:

Class A	For RCC plies and RCC machine made pipes
Class B	For major RCC structures i.e. pump houses, and massive structures
Class C	For general structural concrete and precast concrete

Class D	For small structural elements
Class E	For mass concrete in structures and cc blocks
Class F	For blinding Concrete

4.6 Construction Method

4.6.1 Mixing of Concrete

All concrete shall be mixed in modern mechanically operated mixers capable of combining aggregate, cement and water into a uniform mixture and discharging without segregation. The mixer machine without hopper shall not be allowed for mixing and wooden box shall have to use to discharge coarse and fine aggregate into the hopper. Unless otherwise permitted by the Engineer, hand mixing of concrete is prohibited. Mixing should be done thoroughly to ensure that concrete of uniform color and consistency is obtained. Mixing time shall be at least one minute after the last ingredient has been added to the mixer or so much more time as may be recommended by the Engineer. Vibrator shall be used in casting. The shutters shall not be opened until the concrete is firmly set. Honeycomb in surfaces shall not be acceptable. The Contractor shall submit specifications and samples of any admixture or additives that are proposed to be used to the Engineer at least 28 days prior to the commencement of construction.

i) Concrete Mix Design

When designing the concrete mix, the contractor shall consider the followings:

- Strength
- Water/cement Ratio (<0.45)
- Minimum cement content
- Minimum Filler content $<0.25\text{mm} + \text{cement}$ for 20 mm 435kg/m³
- Coarse Aggregate (as per 4.2.2)
- Fine Aggregate (as per 4.2.3)
- Workability (Slump $< 75\text{mm}$)
- Temperature

ii) Trial Mixes

After the Contractor has received approval for the cement and aggregate to be used, he shall prepare trial mixes with concrete of designed proportions to prove and establish workability, strength, water cement/ratio, surface criteria etc. Methods of transporting fresh concrete and the compaction equipment shall be provided to the Engineer for his approval. The trial mixes shall be made and compacted in the presence of the Engineer, using the same type of plant and equipment for each trial mix, cylinders or cubes shall be made and tested in accordance with and shall be used for the Works.

The margin of the trial mix should be taken as 1.5 times of the characteristics strength of the concrete. From each trial mix, cylinders or cubes shall be made and tested and from the same mix as that from which the test specimens are made, the workability of the concrete shall be determined by the slump test in accordance with STP 9.1. The remainder of the mix shall be cast in a steel mould approved by the Engineer and compacted. After 24 hours the sides of the mould shall be struck and the surface examined in order to satisfy the Engineer that an acceptable surface can be obtained with the mix.

The trial mix proportions should be approved if the required strength is obtained from tests carried out and the consistency and surface is to the satisfaction of the Engineer.

When a mix has been approved, no variations shall be made in the mix proportions, or in the type, size, grading zone or source, of any of the constituents without the consent of the Engineer, who may require further trial mixes to be made before any such variations are approved.

Until the results of trial mixes for a particular class have been approved by the Engineer, no concrete of the relevant class shall be placed on the Works.

4.6.2 Slump Test

The Contractor shall make available one or more slump cone at site. The Contractor shall undertake slump tests of the freshly made concrete in accordance with BS 1881 and the slump shall be within the range of 50 to 100 mm unless otherwise indicated in the drawings or approved by the Engineer. If the range does not comply with the mix, it should not be used. Slump tests shall be carried out on each batch of concrete of 50m³ or less frequently if or as directed by the Engineer. The records of slump tests shall be maintained in a register and be made available to inspection. Water cement ratio shall not exceed 0.45, unless otherwise indicated in the Drawings or approved by the Engineer.

4.6.3 Water Cement Ratio

The maximum water cement ratios specified shall be the ratios by weight of free water to cement in the mix based on the aggregates being in a saturated surface dry condition. The Contractor shall test aggregates for moisture content and so determine the water/cement ratio of the fresh concrete. Water cement ratio shall not exceed 0.45, unless otherwise indicated in the Drawings or approved by the Engineer. Throughout concrete production the actual water cement ratio shall be strictly monitored and the batch quantities of aggregates and water regularly adjusted to maintain the design water cement ratio. Determinations of water/cement ratio shall be carried out as required by the Engineer and the calculations submitted to him/her.

4.6.4 Concrete Cylinders

The sampling of concrete for concrete cylinders shall, where possible, be undertaken at the place of deposition of the concrete in the structure. Each sampling shall provide sufficient concrete to make 6 (six) cylinders. Samples shall be taken for each 20 m³ for structural concrete of concrete batched or at a frequency agreed by the Engineer. The cylinders shall be cured properly and sent to a recognized laboratory through the representative of the Engineer. All cost of such tests shall be borne by the Contractor.

After stripping, each cylinder shall be indelibly marked with the date taken and engraving signature of quality control in charge, and the prescribed number be sent regularly for test to a testing laboratory acceptable to the Engineer. If the specified values are not obtained from cylinder tests on any concrete mix, no further concrete of that mix shall be used in the Works and the Contractor shall establish the cause of the failure and undertake such remedies as are necessary. The Contractor shall demonstrate by trial mixes and the results of cylinder tests that the revised mix is in accordance with the specification. The above-mentioned activities be recorded in a register and be made available as and when asked for.

4.6.5 Non-destructive Testing

The Contractor shall provide on site a 'rebound' (Schmidt or similar) testing hammer and be calibrated time to time for use by the Engineer for checking the in-situ strength of the concrete. Testing shall be carried out at the frequency and in the locations directed by the Engineer. Any concrete structures found to be of strength less than specified will be removed from the Works site and replaced by the Contractor.

4.6.6 Concrete Placing and Compaction

Concrete shall be conveyed from the mixer/batching plant as rapidly as possible by methods, which will prevent segregation or drying out and ensure that the concrete is of the required workability at the point and time of placing. The re-mixing of concrete will not be permitted. The concrete shall be placed in clean, oiled formwork and compacted before initial set has occurred, and any event, not later than thirty minutes from the time of mixing. The concrete shall be placed in layers not greater than 450 mm thick and each layer thoroughly compacted by power driven internal type vibrators supplemented by hand spading and tamping. The vibrators shall at all times be adequate in numbers, amplitude and power to compact the concrete properly and quickly throughout the whole of the volume to be compacted. The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation.

The concreting shall be carried out in such a way that the exposed faces of concrete shall be plain, smooth, sound and solid, free from honeycombing and excrescences. After compaction the exposed concrete shall be struck off smooth with hand held steel floats. No plastering of imperfect concrete faces will be allowed. The Engineer's approval in writing shall always be obtained before any concrete is placed in the Works. The contractor shall take all measures to avoid cold joint and unexpected construction joint.

4.6.7 Curing Concrete

Concrete shall be protected from the effects of sunshine, dry wind, rain, running water or mechanical damage for a continuous period, until the concrete has reached at least three quarters of its 28 day strength, but for not less than 10 days. The Contractor shall submit his proposals to achieve this protection for Engineer's approval. The water used for concrete curing shall be fresh water, clean and free from any substances injurious to the concrete. The use of saline water for curing purposes will not be permitted. Curing and protection of concrete may be done following the methods: (a) by water spray in continuous operation or a layer of water; (b) by covering with Hessian or similar absorbent material, or sand, kept continuously wet; (c) after thorough wetting, by covering with a layer of water proof fabric kept in contact with concrete surface; (d) All materials, spray equipment and an ample supply of water for curing shall be ready on site before any concreting starts. Concrete that is, in the opinion of the Engineer, not cured according to the approved curing procedure will be regarded as inferior and shall not be paid.

4.6.8 Measurement and Payment

The concrete of the several different grades and types completed in place in accordance with the specifications stated herein and/ or as per provisions of the BOQ or as shown on the Drawings or as directed by the Engineer shall be measured in Cubic Meter for each class of concrete. In computing quantities, the dimensions used shall be those shown on the Drawings. No deduction from the

measured quantity shall be made for drainage, pipes less than 200 mm diameter, conduit, chamfers, reinforcement bars, expansion joints and water stops.

Reinforcing steel bars shall be measured for payment as described in the specifications section 7 of this specification.

All temporary work like Formwork, scaffolding (false work), construction joints, curing etc. shall not be measured separately but shall be deemed to be an integral part of the concrete items and constructed as per design and drawing. Payment for Concrete will be made on **Cubic Meter** (as Specified in the Bill of Quantities).

5 FORMWORK

5.1 General

Formwork shall include all temporary moulds for forming the concrete, including the 'herring bone' steel, together with all temporary structures required to support such moulds.

The Contractor shall submit drawings and calculations showing details of the formwork he intends to use, to the Engineer for approval.

The drawings shall show the materials proposed and indicate details of construction, such as sizes of members and spacing, and position of waling, struts, bolts and wedges.

Formwork shall not be constructed until the drawings and the calculations, if applicable, have been approved by the Engineer. Such approval shall not relieve the Contractor of the responsibility for the sufficiency of the formwork. Any changes or modifications to the formwork required by the Engineer shall be borne by the Contractor.

Formwork shall be of suitable design and substantial construction to carry the loads resulting from placing and vibrating wet concrete and any incidental loads such as construction loads, wind and other forces, without inadmissible bulging, distortion or deflection.

Formwork shall be sufficiently tight to prevent loss of water or mortar from the concrete. Special attention shall be paid to formwork where pokers or shutter vibrators are to be used.

5.2 Materials

Formwork for the concrete structures shall be made from plywood, Timber or steel.

The plywood shall be resistant to deterioration by water and shall be fixed and jointed in such a manner as to give a perfectly smooth and even finish to the concrete. It shall have a thickness of not less than 17.5 mm.

The steel formwork shall be accurately aligned and with close fitting joints. The outside of the steel formwork shall be painted in a light colour to prevent extreme temperatures due to solar radiation.

With the approval of the Engineer, the formwork shall be made from good quality seasoned timber, free from loose knots, shakes and warped surfaces.

This timber shall not be less than 30 mm in thickness and the board faces in contact with concrete and the board edges shall be planed smooth and joints shall be tongued and grooved.

The Contractor shall submit to the Engineer, before commencing construction, a set of forms complying with the above requirements, but such submission to the Engineer or approval by him shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.

5.3 Fixing of Formwork

Formwork shall be fixed in perfect line and true plane, with no crevices and joints, and shall be securely braced, supported and wedged so as to retain its position without displacement or deflection during the placing and compaction of the concrete.

Joints in formwork shall be made so that no leakage of grout can occur from the concrete. All joints shall be either horizontal or vertical, unless the form of the finished concrete requires them to be otherwise. Chamfers measuring 30 mm by 30 mm are to be made to all exposed edges of concrete, unless otherwise indicated in the Technical Specifications or ordered by the Engineer.

Subject to the approval of the Engineer, internal ties may be used. All such fastening shall be so arranged that when the forms are removed, no metal left permanently in the work shall be within 50 mm of any surface.

The use of wire ties for supporting the forms shall not be permitted in concrete walls which are to be subject to water, or when the finished surface, required as determined by the Engineer, is to be permanently exposed; wire ties used for other concrete works shall be cut off flush with the concrete surface, after the forms are removed.

Connections shall be so formed as to permit the easy removal of the forms without hammering, etc., and without the necessity of levelling against the surface of the concrete.

Adequate access holes shall be left for the purpose of inspecting, cleaning out the forms and for placing and compacting the concrete.

Scaffolding (if required) shall be firmly constructed to the satisfaction of the Engineer. No separate payment shall be made for scaffolding.

Before placing any concrete, all bolts and the like (if required and which are to be built in) shall be fixed in their correct positions, and cores and other devices for forming holes, openings, etc., shall be fixed to the forms. No holes shall be cut in any concrete unless approved by the Engineer.

Surfaces of the forms to be in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, grooves, splits or other defects.

A non-staining commercial mineral oil or other approved material shall be applied to the faces of the forms before concreting to prevent adherence to the concrete. Care shall be exercised to prevent the material applied to the faces of the forms from coming in contact with the reinforcement, but if this should inadvertently occur, the reinforcement shall be cleaned to the satisfaction of the Engineer.

When forms have been built and have been prepared ready for concreting, they will be inspected by the Engineer and no concrete shall be placed until the forms have been approved by him. In order to avoid delays in obtaining approval, the Contractor shall inform the Engineer, at least 24 hours in advance, of his intention to have the forms ready for inspection.

5.4 Dimensional Tolerances

Any deviation on the minus side in measurements of the finished concrete works is not permitted.

Unless specifically indicated on the duly approved Drawings, tolerances on the plus side can only be accepted up to a range of 4% at the most with a maximum of 5 mm.

5.5 Cleaning and Re-using of Shuttering

Before any concrete is placed, the forms shall be properly cleaned and washed out with water and air under pressure to remove saw-dust, shavings and all other foreign matter. All water shall then be trained and mopped out from the formwork.

If side forms are to be re-used, all surfaces shall be cleaned and shall be completely free from remains of concrete or mortar.

If, in the opinion of the Engineer, moulds are not acceptable for re-use, they shall be either properly repaired or be substituted by other moulds. Substituting moulds shall comply with the requirements as specified above.

5.6 Removal of Forms

Forms shall be removed only under skilled supervision and in such a manner as to not damage the concrete. Forms shall not be removed before the concrete is sufficiently set and hardened. Nevertheless, the forms shall not be struck without the prior approval of the Engineer. The minimum periods which shall elapse between placing concrete and the removal of the forms are given in Table 6.1

Table 6.1: Removal of Forms

Type of formwork		Minimum net period before removal in days
Vertical :	Columns and walls	3
Soffit :	Slabs	2121
	Beams	77
Drops :	Slab	
	Beams	

Compliance with the above requirements shall not relieve the Contractor of his obligation to delay the removal of the forms if the concrete has not sufficiently set. Due to variations in site temperatures and depending on the curing conditions, the Engineer may, at his discretion, vary the time listed above.

Any damage to the concrete, which may occur by the removal of the forms or by overloading, shall be fixed at the Contractor's expense and to the satisfaction of the Engineer.

5.7 Finishing of Concrete

Surface finishing shall be classified as follows:

- Ordinary finish;
- Wire Brush finish.
- Power Trowel finish

5.7.1 Ordinary Finish

If not otherwise specified, exposed surfaces shall be given an ordinary finish.

Immediately following the removal of forms, fins and irregular projections shall be removed from surfaces. On all surfaces, the cavities produced by form ties and all other holes, broken corners or edges, and other defects shall be thoroughly cleaned, and after having been thoroughly saturated with water shall be carefully pointed and trued with an approved non-shrinkable polymer modified cement mortar with at least the same qualities of the adjacent concrete. The concrete shall then be rubbed if required or cured. Construction joints in the work shall be left carefully tooled and free of mortar and concrete. The resulting surfaces shall be true and uniform.

Exposed surfaces not protected by forms shall be struck off with a straight-edge and finished with a wood float to a true and even surface. The use of additional mortar to provide a grout finish will not be permitted.

5.7.2 Wire Brush Finish

All surfaces that will come into contact with cementations grout or epoxy bonding grout shall be ridged finished by means of a wire brush.

As soon as the forms are removed, and while the concrete is still comparatively green, the surface shall be thoroughly and evenly scrubbed with stiff wire or fibre brushes, using a solution of muriatic acid in the proportion of one part acid to four parts of water until the cement film or surface is completely removed and the aggregate particles are exposed, leaving an even pebbled texture presenting an appearance grading from that of fine granite to coarse conglomerate, depending upon the size and grading of aggregate used. When the scrubbing has progressed sufficiently to produce the texture desired, the entire surface shall be thoroughly washed with water to which a small amount of ammonia has been added, to remove all traces of acid.

5.7.3 Power Trowel Finish

Where indicated in the drawings as power trowel finish, the surface will be finished with a steel trowelled 3 mm thick floating coat of neat cement.

Immediately after trowelling and removing excess laitance, a well-mixed cement slurry consisting of ordinary Portland cement or coloured cement and water solution shall be mixed with hardener and sprinkled over the surface in a uniform layer at maximum rate of 2.5 kg per square metre. The cement slurry shall then be steel trowelled perfectly smooth.

Measurement and Payment

For the concrete works as mentioned in corresponding Bill of Quantities under this contract includes the cost of formwork supplying fixing and removal. Hence no separate measurement and payment shall be made for form work.

6 REINFORCEMENT

6.1 Description

This work shall consist of furnishing and placing bars of the grade, type and size shown in accordance with these specifications and in conformity with the requirements shown on the Drawings.

6.2 Materials

6.2.1 Bar Reinforcement

All mild steel bar, made from billet shall have a yield stress not less than 276 N/mm, minimum tensile stress not less than 483 N/mm² and shall conform to ASTM A 615 or the latest such equivalent standard or other specification that is considered by the Engineer to apply.

All high yield steel bars shall be deformed bars with a yield stress not less than 414 N/mm² and shall conform to ASTM A 615 or the latest such equivalent standard or specification.

The use of cold twisted bars is not permitted. Steel for all bars shall be produced by open hearth, basic oxygen or electric arc furnace methods, unless otherwise called for on the Drawings or in special provisions. The chemical composition of the bars shall contain phosphorous 0.05% max and 0.05% sulphur max. Minimum tensile stress shall be 483 N/mm²; minimum percentage of elongation 20% minimum; dimensional tolerance below 28mm bars shall be +/- 0.5mm and weight tolerance between calculated weight and actual weight shall be within + / - 3.5%.

When required by the Engineer, the Contractor shall submit three copies of mill sheets of steel bars for the approval of the Engineer before each shipment, and inspection at site will be made by the Engineer in accordance with the Specifications and the above mill sheets.

6.2.2 Wire Mesh

Wire mesh shall conform to the requirements of AASHTO Standard Specification M 55 – Welded Steel Wire Fabric for Concrete Reinforcement.

6.2.3 Binding Wire

Reinforcement binding wire shall be best black annealed mild steel wire, approximately 1.6 mm in diameter.

6.2.4 Bar Sizes

AASHTO Standard Specifications refer to the Imperial measurement system. However, metric sizes of steel are shown on the Drawings and shall be used.

6.2.5 Ordering Material

The name of the proposed supplier (or names of proposed suppliers) of the reinforcement shall be submitted as soon as possible to the Engineer for his approval. The Contractor shall also submit all relevant data on the steel required by the Engineer, Such as breaking strength; yield strength, characteristics on elongation, chemical composition etc. The copies of orders placed shall be submitted to the Engineer.

The Bar reinforcement shall be transported in standard bundles, tagged and marked in accordance with the Code of Standard Practice of the Concrete Reinforcing Steel Institute.

No steel shall be delivered without a manufactures certificate guaranteeing the yield stress, which shall be submitted to the Engineer.

The steel shall be stored on Site and marked in a way that later enables identification of the steel corresponding to each certificate.

6.2.6 Additional Tests

The Contractor shall cut out steel samples as directed by the Engineers and an approved Testing Instantiation shall test these bars according to the Engineer's Instructions. The Contractor shall pay for expenses incurred in connection with cutting out, transporting and testing of the samples. In general, three samples shall be tested from each batch of a particular size of reinforcement delivered to the site.

6.2.7 Protection and Storage

Reinforcement for structures shall be handled and stored in a manner that will prevent bending out of the desired shape and any accumulation of dirt, oil and paint. When placed in the works it shall be free from dirt, oil grease, paint mill scale and loose or thick rust.

6.2.8 Bending, Binding and Placing

(i) Cutting and Bending

Bars shall be cut and bent cold to the dimensions indicated and with equipment and methods approved by the Engineers.

Stirrups and tie bars shall be bent around a pin having a diameter not less than four times the minimum thickness of the bar. Bends for other bars, Where full tension in the bar may occur, shall be made around a pin having a diameter not less than twenty times the bar diameter. Hooks shall conform to American Concrete Institute Standard Building Code Requirements for reinforced concrete ACI 318-83, or as shown on the Drawings.

(ii) Placing Supporting and Fastening

All bar reinforcement shall be placed, supported and secured prior to any concreting operations. The reinforcement shall be checked and approved by the Engineer before pouring of concrete.

Cover blocks required for ensuring that the reinforcement is currently positions shall be as small possible consistent with their purpose of a shape and material acceptable to the Engineer, and designed so that they will not overturn when the concrete is placed. If made of concrete the maximum size of aggregate shall be 6 mm and the mix proportion shall be one part of Portland cement to 2 parts of sand by weight. Wire shall be cast in the block for the purpose of tying it to the reinforcement. The wire must

not be closer than 30 mm from the concrete surface. The use of small stones or wood blocks shall not be permitted.

The reinforcement shall be held securely in place at the exact position and at the exact spacing as indicated on the Drawings by the use of wire ties at bar intersections, supports and cover blocks. Wire ties shall be securely tied and folded so that they do not project beyond the planes formed by the reinforcing bars. The adequacy of the supports and ties to secure the reinforcement properly shall be subject to the approval of the Engineer.

(iii) Splicing

Reinforcing shall be furnished in the lengths indicated on the Drawings. When the Contractor wishes to use more splices than are indicated and / or necessary, the Contractor shall furnish Working Drawings to the Engineers for approval in accordance with the guidelines provided on the Contract Drawings. If such additional splices are approved, the extra weight occasioned by such splices shall be included in the measurement of reinforcement for payment.

All splices for high yield deformed steel bars and mild steel plain steel bars shall have lap lengths as shown on the Drawings. Lap splices shall generally be located at points of minimum tension in bars. Except where otherwise shown on the Drawings lap splices shall be made with the bars placed in control and security wired together.

Welding of reinforcement steel shall be done only if detailed on the Drawings or approved in writing by the Engineer. Before the Engineer may approve of such welding, the Contractor shall submit and test any samples as the Engineer may require and make due allowance for the time elapsing before results are available.

(iv) Substitutions

Substitutions of bars shall be permitted only with specific authorization by the Engineer and at the expense of the Contractor. If bars are substituted they shall have a cross sectional area equivalent to the design area, or larger. If substitutions of bars are permitted the Contractor shall produce working drawings and reinforcing detailing at this own expense and to the approval of the Engineer.

6.3 Measurement and Payment

The quantity of reinforcement to be measured under this Section shall be computed weight in kilograms of material used and accepted as shown on the Drawings provided that the quantity shall not include the reinforcement in any item of work for which the basis of payment includes the reinforcement. In computing the weight to be measured, the theoretical weights of bars of the cross section shown on the Drawings or authorized shall be used.

The computed weight shall not include the extra material incurred when bars larger than those specified are used, or the extra material necessary for splices when bars shorter than those specified are used with permission of the Engineer, or the weight of any devices used to support or fasten the reinforcement in the correct position including any necessary chairs.

However, payment shall be allowed for lap splices not shown when the bars are longer than 12 meters. Only, one lap splice per every 12 meters will be paid for. The payment shall be made in accordance with the unit rate of corresponding items of the Bill of Quantities.

7 PROTECTIVE WORKS

7.1 Filter Materials

Filter materials shall be comprised of fine and coarse filter materials as described on the Drawings. The Filter materials shall be as specified on the Drawings and either one or combination of followings:

- (i) A fine filter comprised of natural sand.
- (ii) A geotextile filter as stated under 8.1.3 of this document.

7.1.1 Fine (Sand) Filter

Sand (fine) filter shall be comprised of fine filter materials as described on the Drawings.

7.1.2 Materials

The fine filter shall consist of natural sand of FM = 1.0 to 1.5. The material shall not contain any flint, chip or lime. The quantity of silt, clay and dust, determined in accordance with the decantation method given in BS 812, shall not exceed 3% by weight of the sample. The content of mica shall not exceed 3% by weight of the sample. The material shall not contain any deleterious material in such form or in sufficient quantity as to affect adversely on the geo-textile filter above.

7.1.3 Construction/Placing

Minimum 100mm sand ($FM \geq 1.0$ or 1.5, as specified in the drawing) shall be placed on prepared, well dressed and compacted slope/surface as directed in engineering drawing and by the engineer.

7.1.4 Measurement and Payment

The volume of sand placed shall be measured in cubic meter. The Payment of Sand Filter shall be in Cubic Meter as per unit rate indicated in corresponding item of Bill of Quantities.

7.1.5 Geo-textile Filter Fabric

7.1.5.1 Description

All geo-textile fabric shall meet in full the requirements of Physical, Mechanical and Hydraulic properties. The geo-textile manufacturer must be ISO 9000 certified by an accredited register. Geo-textile in standard rolls shall be clearly marked at regular intervals (every square meter or continuous marking at 1 m distance) with the product name and grade. Marking in every 100 sqm. is required to identify the supplier. Each roll of geo-textile shall be protected in a plastic foil wrapper, clearly labeled with the roll number, production of lot number and description of the product, product name, grade and manufacturers details. Geo-textile filter shall be

extended up to 1000 mm. Geo-textile filter shall be protected from ultra violet ray and any sort of damage during handling and placing.

7.1.5.2 Materials

The geo-textiles shall be manufactured from polypropylene or polyester fabric and shall be **non-woven needle-punched and** not solely thermally bonded. The thermal bond shall not influence the flexibility under water. The required porosity of geo-textile shall be minimum 80%. Porosity is a calculated value out of tested material characteristics and the specific weight of the fibers.

The properties of geo-textile to be delivered to the site shall meet or exceed the technical values of the following table.

<u>Properties</u>	<u>Test Standard</u>	<u>Test Values</u>
Thickness	Under 2 Kpa pressure $\geq$ 3.00 mm	3.0 mm to 3.01 mm
Opening size 0 90	EN ISO 12956	≥ 0.06 and ≤ 0.08 mm
Mass per unit area	BS EN 965	≥ 400 g/m ²
CBR Puncture Resistance	EN ISO 12236	≥ 4000 N
Tensile strength (machine direction or MD and cross machine direction CMD)	EN ISO 10319	≥ 20.0 KN/m
Elongation at maximum force (MD)	EN ISO 10319	$\geq 60\%$ and $\leq 100\%$
Elongation at maximum force (CMD)	EN ISO 10319	$\geq 40\%$ and $\leq 100\%$
Permeability (velocity index for a head loss of 50 mm – V_{H50})	EN ISP 11058	$\geq 2 * 10^{-3}$ m/s
Abrasion	Following RPG of BAW, Germany, O_{90} according to EN ISO 12956 and thickness according to BS EN 9641	After test: Tensile strength $\geq 75\%$ of specific tensile strength, thickness $\geq 75\%$ of original value, $O_{90} \leq 0.90^{*2}$ mm
UV resistance	ASTM D-4355	$\geq 70\%$ of original tensile strength before exposure

7.1.5.3 Construction/Laying

As detailed on the drawings or as directed by the Engineer, the Geo-textile fabrics shall be placed above the inverted filter on the surface of slope of embankment as per design and drawing. The fabric shall be placed in position, providing machine seamed joints (with 100% polypropylene or nylon thread) or 35cm lap in dry condition or minimum 100cm lap under

water including protecting the geo-textile materials from UV sun ray and from any other damages.

7.1.5.4 Measurement and Payment

Measurement for payment for installing geo-textile fabric shall be made based on the area in square meters measured parallel to the face on the slopes as shown on the drawings or as directed by the Engineer. No additional payment shall be made for fabric used to provide specified laps. The Payment item Geo-textile Filter Fabric shall be in Square Meter in accordance with the unit rate provided in Bill of Quantities.

7.2 Precast Cement Concrete Block (CC Block)

7.2.1 Description

Pre-cast concrete blocks shall be made to the dimensions shown on the Drawings or as specified in the in the Bill of Quantities or as *directed by the Engineer*. The materials and workmanship shall comply with the specifications in all respect and to the satisfaction of the Engineer. Unless otherwise shown on the drawings, the pre-cast concrete blocks shall be made from concrete Class E2 (clause 4.5 of this Tech specification) with minimum compressive strength of 9 N/mm². The aggregate to be used for such block shall be river singles.

The Contractor may, subject to the approval of the Engineer, modify the geometry of the block slightly to facilitate its handling and placing e.g. by incorporating cylindrical holes or horizontal recesses. He shall at his own cost ensure that the finished weight of the block is the same as that of the blocks shown on the Drawings by adjusting the linear dimensions of the block accordingly. Any consequent modifications to the design of the blocks shall be undertaken by the Contractor at his own cost and to the approval of the Engineer.

7.2.2 Materials

Materials for manufacturing Cement Concrete Block shall be as specified in Section 4 (concrete) of this specification.

7.2.3 Concrete Mix Design

The concrete mix for Cement Concrete Block shall be as specified in Section 4 (concrete) of this specification. For manufacturing of CC Block, the river singles shall be used as coarse aggregate.

7.2.4 Water Cement Ratio

The Water Cement Ratio for Cement Concrete Block shall be as specified in Section 4 of this specification.

7.2.5 Formwork for CC blocks

Formwork and moulds shall be constructed to ensure designed uniform shapes and block sizes. They shall be of steel sheet of minimum 18 gauges with arrangement of nuts and bolts or other

mechanism so that they can be easily removed in two parts without any repair to the cast CC Block. Wherever any defect is noticed in a formwork, should immediately be replaced as per direction of Engineer or Engineer's Representative.

7.2.6 Numbering of Blocks

Each block shall be marked with a consecutive number and the date of casting. The Contractor shall maintain a register with signature of quality control personnel of the number, date of casting, date and location of placing of each block and shall make the register available at all times for inspection by the Engineer.

7.2.7 Stockpiles of Blocks

Blocks shall not be stockpiled until they have been cured for at least 21 days. They should be stockpiled with consecutive numbers and in measurable stack. The stacks shall not contain more than 4 layers and shall not be stacks very closed to the riverbank.

7.2.8 Damaged Blocks

Blocks, which are damaged during stockpiling, transport or handling, shall be rejected and removed from the site. The contractor has to supplement the damaged or rejected number of blocks at his/their own cost.

7.2.9 Measurement and Payment

Measurement of concrete blocks shall be made on numbers (size-wise) as manufactured and cured as stated in the Bill of quantities. The payment of Concrete Blocks shall be made as stated in square meter as presented in BoQ (2.05 including placing).

7.2.10 Cement Concrete (CC) Block Placing

The C.C Blocks shall be placed on the slope of embankment to cover the surface over a geotextile fabric filter and granular filter underneath in the profiles shown on the drawing and in the launching apron in the proportions shown in the drawings.

Pre-cast concrete blocks shall be made to the dimensions shown on the Drawings viz. 40cmx40cmx40cm; 40cmx40cmx30cm; 40cmx40cmx20cm; 30cmx30cmx30cm or as specified in drawing.

The C.C Blocks shall be placed on the slope of embankment to the profiles shown on the drawing. Below Lowest Water Level (LWL), C.C. blocks shall be laid by controlled dumping. Dumping of CC Blocks below LWL must start early February or at such time while the river attains its LWL and must be accomplished no later 30th April (or as specified in the design. In no way dumping shall be carried over to the next season. The entire revetment/protective work length should be divided in some suitable panels/batches and dumping area shall be delineated by string with the aid of GPS and buoy. Dumping shall be done in maximum 3 separate batches/ panels simultaneously in continuous reach. The material of each

batch/panel shall be stored in several stacks. After full development of the launching of each batch/panel as per design then dumping in new batch/panel can start”

The placing of blocks shall start from the toe and progress up the slope of the embankment at the segment where launching apron has been fully developed as per design. Above LWL the blocks shall be laid on the filter in rows parallel to the direction of the current. The blocks in each row shall be staggered half a block width from those in the row below. Adjacent blocks in the same row shall be laid with a gap between them of the minimum dimensions given below:

<u>Block size</u>	<u>Gap (mm)</u>
0.60 m and less	10
Larger than 0.60m	15

The blocks shall be laid in a manner so as not to damage or displace the underlying filter. The outer face of the built revetment above LWL shall have a smooth and even appearance. Any damage to the filter during overlaying shall be repaired by the Contractor at his own cost.

7.2.11 Placing sequences for CC blocks:

1. Placing / random dumping blocks at apron in river side slope shall be placed first.
2. Placing / dumping blocks shall be started from the last end of river side.

7.2.12 Measurement and Payment

The block quantity shall be re-measured in stacks for placing/dumping before laying / dumping to be verified from approved work records for material placed at correct location up to the quantities shown on the drawing. Work records shall only be approved when placing of blocks has been witnessed by the Engineers supervisory staff and ensured in post measurement through bathymetric survey, where necessary, jointly carried out with Contractor’s fully equipped boat/barge made available for the purpose by the Contractor. Payment for placing Concrete Block shall be in square meter as in the Bill of Quantities (item 2.05 of Bill of Quantities).

7.3 Laying of Geo Bags for Protective Works

The geo bag used for the protective work shall be of filled with sand FM >1 and laid on river bed as apron, embankment slope, and downstream and upstream protection of hydraulic structures as per the approved engineering design and drawings. The contractor shall fill the geo bag of specified size as per the drawing, and lay on the site. The specification of geo-textile shall specified in relevant sub-section of this specification.

7.3.1 Preparation and Sewing of Geo-bags

- i) The geo-bags shall prepared by sewing on two longitudinal sides as per drawing. The transverse (top) side shall be kept open for subsequent closing.
- ii) Sewing should be done by machine at machine or cross-machine direction.

- iii) The number of stitch in every 25 mm should not be less than 6 nos. the stitch shall be double thread chin stitch (type 401 under ISO 4915/DIN 61400) or two thread type with lock stitch (type 301 under ISO 4915/DIN 61400).
- iv) At the bottom end of each seam (at the folded side) the stitch shall be locked either by stitching one time back and forth for a length of minimum 25mm from the end of the bag, or by joining the ends of the two threads e.g. by gluing, knotting or other appropriate methods, acceptable to the Engineer.
- v) The two lines of stitches shall be within 5 mm distance with a margin of 25 mm from the edge of the geo-textile to the centerline between the two seams. The tolerance is 3 mm in each direction.
- vi) The thread used for stitching should be of the same material as the geo-textile or of materials more durable than the material of geo-textile (e.g. 100% polypropylene or polyester) and equivalent stability to UV exposure as the geo-textile material.
- vii) All dumping is subject to acceptance of the Engineer after testing of samples,

7.3.2 Sand Fill

Sand for sand fill shall consist of hard, dense, durable materials free from injurious amounts of clay lumps, lightweight materials or other deleterious substance. The FM = 1 or more with having size of material than 0.075 mm shall not be more 3%.

7.3.3 Storing Geo-textile Bags

The Contractor must build secured temporary storing facilities of geo-bags at site in order to protect the Geo-bag from UV ray.

7.3.4 Filling, Sewing and Stacking of Geo-bags

The filling sand shall be non-saline clean natural sand and have a fineness modulus ≥ 1.00 . The amount of silt, clay and fines shall not exceed 5%. The geo-textile bag shall be filled up with dry specified sand. The fill volume and weight of each bag shall not be less than 0.1664 m³ and 275 kg respectively. After filling the bag shall be checked by weighing scale and close the mouth by specified seam (04 lines) using double needle sewing machine.

7.3.5 Dumping Plan

The contractor shall have to conduct bathymetric survey, prepare dumping plan mentioning global positional coordinate based on the bathymetric survey using applicable software and submitting to the Engineer for approval prior to commencement of dumping work.

7.3.6 Dumping of Bags

The bag dumping shall be performed using flat top barge, anchored and positioned by double drum mooring winch. Bags for use in launching apron shall be stockpiled to the satisfaction of the Engineer. Prior to the commencement of dumping, the contractor's proposal ensuring the quality & quantity should have been approved by the Engineer.

- i) The dumping shall be started at the far end in the river and proceeds towards the river bank. The contractor shall maintain dumping register duly signed by the quality control personnel. The quantity of bag to be dumped shall be recorded in the register with date and shall make the register available at site for inspection.
- ii) Dumping of bags below low water level must start early December or at such time while river attains its LWL and must be accomplished no later 30 April or as specified in the design.
- iii) The entire revetment / protective work length shall be divided into suitable panels or batches and dumping area shall be delineated by GPS coordinate using total station. Dumping shall be done in suitable batches / panel simultaneously in continuous reach with the aid of barge or floating pontoon. The material of each batch / panel shall be stored in several stacks. After full development of launching apron of each batch / panel as per design, then dumping of new batch / panel can be started.
- iv) The dumping volume will be checked by taking Pre-work and Post-work cross sections. The dumping area shall be verified by engaging divers who identify the uncovered area through installation of buoy. The contractor shall take immediate action to cover the identified bare area through dumping geo-bags.
- (v) The dumping work with respect to location and number of bags will be determined by the Engineer prior to dumping.

7.3.7 Measurement

Measurement of item Dumping of Geo-textile Bag shall be made on Each Number of bags dumped.

7.3.8 Payment

Payment shall be made at the unit rate per bag as included in the Bill of quantities. The unit rate includes all cost of bags, sand, sewing thread, buoy, labour, all equipment, filling, sewing, stacking, transportation and dumping bag etc. including survey.

8 BRICKWORK

8.1 General

This section shall apply to of brickwork up to plinth and any other place or places as required conforming to the levels, dimensions, and designs as shown on Drawings or as directed by the Engineer.

The work to be performed under the provision of this section includes the supply of all labour, materials, tools and equipment, and the performance of all work necessary for the construction of the brick masonry required as shown on the Drawings or as directed by the Engineer.

8.2 Materials

Unless otherwise specified or directed all brickwork shall be with first class bricks set in cement mortar of required proportions. The sand use in this work shall have a minimum fineness modules of ≥ 1.5 . Water for mixing the mortar shall be free from impurities.

8.3 Soaking of Bricks

Before use in works all bricks shall be soaked in clear water for a minimum period of 6 hours. Soaking shall be discontinued two hours before use so that at the time of laying they are skin dry. Such soaked bricks shall be stacked on a clean place where they shall not be spoilt by dirt, earth or any other objectionable materials.

8.4 Mortars

(1) Unless otherwise specified in the Drawings, cement mortar for brick masonry shall consist by volume in proportion as specified in the BoQ or drawing. In each mortar just enough water shall be added and the components mixed and thoroughly incorporated together to give a workability appropriate to its use. Mortar shall be used whilst freshly mixed and no softening or re-tampering will be allowed.

(2) Mortar shall be mixed in an approved method unless hand-mixing is specifically permitted by the Engineer and in a manner as to accurately determine and control the quantity of each ingredient in the mortar. The cement and sand shall be first mixed dry until thoroughly mixed before adding mixing water.

(3) Only a sufficient quantity of sand and cement shall be mixed with water as can be used within 30 minutes after the addition of water. The adding of additional water to, and re-tempering, cement mortar that stiffened because of evaporation of water, shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.

(4) Mixing troughs and pans shall be washed clean at the end of each day's work.

8.5 Brick Masonry Construction

- (1) The method and equipment used for transporting and placing the bricks and mortar shall be such as will not damage the brick or delay the use of mixed mortar. All equipment and tools used for mixing or transporting mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.
- (2) All brickwork shall be placed only after the foundation surfaces have been prepared satisfactorily in accordance with the specifications and the Engineer's instructions;
- (3) All bricks to be used in brickwork with mortar joints shall be completely soaked in water for a minimum period of 6 hours before they are used. The bricks shall be used within two hours of taking out of water. All bricks shall be free from water adhering to their surface when they are placed in the brickwork;
- (4) Before laying bricks in foundation, a layer of not less than 10 mm of mortar shall be spread to make the surface on which the brick work will be laid even. Immediately thereafter, the first course of bricks shall be laid.
- (5) Bricks shall be laid in English bond unless otherwise directed by the Engineer and shall be set with both bed and vertical joints filled with mortar and shall be bedded in by firmly tapping with the handle of the trowel. The face with the frog mark shall be placed upward to ensure that the frog mark is filled with mortar. Bricks shall be skillfully laid with the level courses, uniform joints, square corners, plumb vertical and true surfaces, except when otherwise shown on the Drawings or directed by the Engineer;
- (6) The bricks used on face shall be selected whole or uniform size and with true rectangular face. Only full bricks shall be used in the brickwork unless absolutely necessary for breaking joints or maintaining bond.
- (7) Each course shall break the joints with the course below. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. In thick walls or foundations, not only the face joints but the joints inside also shall break course;
- (8) The thickness of mortar in any joint shall not be less than 6 mm and not more than 10 mm and the height of four courses as laid shall not exceed more than 25 mm the height of four dry bricks stacked one upon the other;
- (9) All brick work shall be truly plumb and shall always be carried up regularly along their entire length throughout the structure.
- (10) The surface of each course shall be thoroughly cleaned from all dirt before another course is laid on top of it. If the mortar in any course has begun to set, the joints shall be raked out to a depth of 25 mm before any subsequent course is laid. When the top course has been exposed for more than two weeks, it shall be removed and the surface below thoroughly cleaned before any more courses are added;
- (11) When fresh masonry is to be placed against the existing surface of structures, these surfaces shall be cleaned of all loose materials, roughened and wetted as directed by the Engineer so as to effect a good bond with the new work.

All brickworks (250mm thick or above) shall be constructed with 1:6 (cement: sand) mortar and all 125mm thick brickwork shall be constructed with (1:4) (cement: sand) mortar by volume.

Measurement and Payment

The measurement of brick shall be in square meter in case the thickness of brickwork wall is less than 0.25 meter. The thickness 0.25 m or above shall be measured in volume in cubic meter. The payment shall be made accordingly to unit rate as agreed in Bill of Quantities.

9 PLASTERING

The work covered by this item consists of providing plaster of any specified thickness and proportion on surfaces of brickwork and concrete for protection of masonry surface and concrete and also for giving an aesthetic appearance.

Before commencing plastering work, all drawings, finishing schedules will have to be checked thoroughly to identify the surfaces receiving the particular type of plastering.

All concealed utility service lines, conduits, pipes, clamps, door/window frames and other such inserts must be in position before plastering commences. Chiseling and patch repairing of plastering shall not be permitted.

All Joints of masonry shall be raked out to a depth of 10mm. All brick faces shall be made free of dust, cement mortar, algae, moss, dirt etc. by washing with water. The surface shall also be soaked with water before plaster is applied.

When a flat smooth surface such as ceiling or a surface of exposed concrete is plastered, the surface shall be roughened beforehand by picking thoroughly with a suitable sharp, picking tool and also be watered.

Cement shall be Ordinary Portland cement sand shall be as specified in the schedule of rate. Mix proportion for brick work shall be 1:6 or 1:4 cement mortar. Sand shall be screened by a 100 mesh wire netting sieve and washed to get free from clay and other salts. It shall be carefully washed in water to get rid of the trouble of saltpeter action in plaster and dampness to the wall due to efflorescence's. The mortar for plaster should be mixed dry in the proportion as specified and wet mixing shall be in small quantity to avoid initial setting of cement before it can be used up. Mixing of mortar on a finished floor must not be allowed.

Before the application of plaster, the surface shall be soaked with water so that water from the mortar is not absorbed by the dry surface. The cement and sand properly mixed with water in the proportion as specified shall be laid on the clean walls to a thickness of 12mm. Thicker plaster on average up to 20mm may be necessary for the uneven face of the wall. Laid plaster shall be finished by straight edge and trowel. Adequately long straight edge shall be used to bring the surface to true plane and level. After finishing the plaster with trowels and after some hours steel trowel shall be used to make the plaster smooth. Care should be taken to see that Usha is not used just after laying of the plaster when it is too soft. Neither should it be used after it has completely hardened up. It should be used after the plaster has commenced to set, so that there is no mark of Usha in the plaster for obtaining a perfectly smooth surface having no undulation.

When a flat smooth surface like ceiling is to be plastered, the same method shall be applied but the thickness shall be only 6mm. The use of 'Usha' in the ceiling plaster is very important as this is the only way how the ceiling plaster can be conveniently made smooth and even. It should be remembered that the lack of attention on this point shall give a poor finish to the ceiling, leaving trowel and uneven 'Usha' mark which speaks seriously on the aesthetic look and the finish of the room. Particular attention shall be given to this by the field officer.

A full wall or ceiling of a room will preferably be completed at a time.

Curing of plaster shall be done for 7 days. Brass hand sprayers or water pipes shall be used for curing plastered surface.

Measurement and Payment

The measurement of plastering shall be made in area in square meter of executed works. The payment shall be made as per the agreed rate presented in corresponding Bill of Quantities.

10 DAMP PROOF COURSE

A damp proof course is a continuous layer of damp resisting material provided with the objective of protecting the superstructure of a building against dampness.

Coarse aggregate shall consist of picked jhama chips graded from 12mm to 6mm. Fine aggregate shall be 50% local sand of P.M. 1.2 and 50% Sylhet sand of F.M. 2.5 minimum. Cement shall be ordinary Portland cement type-1. Water shall be clean and free from chemicals and salt.

The surface over which the damp proof course is to be laid shall be thoroughly scrapped to remove mud, dirt etc. and washed clean with clean water.

The mix proportion shall be 1:1.5:3 and thickness 40mm. Shuttering shall be done on both sides of the wall. The shuttering shall be strong and so fixed that it does not get disturbed during compaction and the concrete slurry does not leak out. The concrete prepared by mixing the ingredients shall be laid and tamped roughly to make a dense mass. After 24 hours of its laying, the concrete layer shall be cured for at least 7 days. After curing is complete the surface shall be left to dry out to receive a coat of hot bitumen. The dried surface of concrete shall be properly cleaned with brush and finally with a piece of cloth soaked in Kerosene oil. A coat of Bitumen 80-100 penetration/ heated to 300°F shall be applied uniformly on the hardened and dry concrete surface using 30 lbs per 100 sq ft per coat. Bitumen shall be applied with brush. The top surface of the D.P.C. shall be in the same level of floor finish and shall not be carried across doorways or other openings. The upper layer of cement concrete floors shall be continued over such openings and shall be laid at the same time as floor.

A damp proof course shall not be less than 15cm above the highest level of the ground and shall be above the normal level to which water splashes from the ground when it is raining.

The damp proof course should be continued unbroken throughout the length and thickness of wall.

The base of D.P.C. layer shall be even. The uneven base shall cause the retention of air voids between the base and the D.P.C., which is not desirable.

Measurement and Payment

The measurement of Damp Proof shall be made in area in square meter of executed works. The payment shall be made as per the agreed rate presented in corresponding Bill of Quantities.

11 PATENT STONE FLOORING

The work covered by this item consists of providing artificial patent stone flooring with cement concrete in the proportion of 1 part cement, 2 part sand (50% local sand of FM 1.2 and 50% Sylhet sand of FM 2.5) and four parts of clean, twice washed 12mm downgraded picked jhama chips and finishing the top with neat cement.

The materials will include Cement: Ordinary Portland Cement Type-1, Sand : Sand shall be 50% local sand of FM 1.2 and 50% Sylhet sand of F. M. 2.5. Coarse aggregate: Coarse Aggregate shall be 12mm (1/2") down graded picked jhama chips. Samples of sand and coarse aggregate shall be approved by the Engineer-in-charge before use.

Before proceeding with the work a sample panel of flooring shall be prepared for approval by the Engineer. The sub-floor over which the artificial stone flooring will be laid shall be thoroughly picked and washed clean of laitance, dust, dirt and other foreign materials. Following the preparatory work, the sub-floor shall be thoroughly wetted with clean water by ponding at least overnight prior to the application of the flooring. All excess water shall be removed ahead of the application of the bonding slurry, so that the concrete surface is uniformly damp but not glistening wet.

A creamy bonding slurry of cement shall be applied and well-scrubbed into the surface with stiff bristle brushes. Only as much' bonding slurry shall be mixed and applied as will be covered by the succeeding coat before the slurry dries out. In general not over 10m² (100 sft) shall be slurred at one time in order to maintain a 'live glue' for bonding. Apply and brush in the slurry in small areas not excluding 2.5 sqm. Excess or dead slurry shall be constantly removed from the base by broom.

Before laying the concrete mix, temporary dividers shall be installed to pour concrete in 'chequered board' plan. The temporary dividers may be of metal strips or wooden battens of true line and shape. The top of the dividers shall be perfectly level with the level of the finished floor desired.

Concrete mix shall be applied promptly in specified thickness after slurring before the paste has hardened or dried. The method of measuring and mixing cement, sand and khoa shall be as per specification described for cement concrete. The mixture shall be spread evenly between the battens. It shall be brought to an even grade by means of a strike board, then beaten and prodded with wooden pattas to thoroughly consolidate it until the mortar comes to the surface and smoothed off with a wood float so as to give a surface free from depressions or irregularities. If any depression has to be filled a small quantity of the finer materials in the proportions specified may be used but this should be avoided as far as possible.

Minimum 1.5 mm thick/ neat cement finishing shall be done using cement powder strained through fine cloth and paste of cement shall be rubbed in the surface with the help of small steel trowels working on the surface carefully and repeatedly using at least 4 passes over the entire area till the neat cement finish is very smooth, polished, plane and hard.

The sequence of filling in the panels shall be on "chequered board" plan. The casting of the complementary sets shall be done at least 48 hours after the first set is cast and dividers removed. The top shall be moist, cured for at least 7 days by banding with a cement sand lean mortar band and not with mud. The flooring shall not be subjected to moderate use before 14 days and to severe use before 28 days.

Flooring must be done according to "chequered board" plan after every 48 hours of doing the earlier one. Cement colored patent stone flooring shall be done after about 10 to 12 days after the finishing work is completed.

Measurement and Payment

The measurement of Flooring shall be made in area in square meter of executed works. The payment shall be made as per the agreed rate presented in corresponding Bill of Quantities.

12 GLAZED TILE WORK

The work covered by this item consists of providing glazed tiles on walls and floors.

Glazed tiles if specified as local shall be manufactured by BISF or any other reputed company as specified by the Engineer. Setting bed for wall shall be cement mortar with proportion 1:3 and for floor 1:2. Colour and size of glazed tile shall be as specified by the Engineer. For walls, the top of the glazed tiles shall be in the same line with full tile at the top. No cut piece tile shall be laid at the top. For maintaining level in the bathroom, a slope is provided towards outlet of water, as such bottom lines of the four walls shall be at different levels. First a line shall be drawn on the four walls of the bathroom in such a way that the height of the wall up to which tiles -, shall be laid shall be a multiple of the height of the selected tile, so that no cut piece tile is required to be laid above this selected bottom line. Area below the selected line shall be fitted up by cut piece tiles of different heights according to the slope of the floor. Floor tiles shall be laid only after completion of wall tile work.

Glazed tiles shall be laid true to levels and in plumb line. The tiles shall be press laid in such way that no hollow space remains between the tiles and the base mortar.

If there is a false ceiling in the bath room and the wall tiles are laid up to the bottom of the false ceiling, then the ceiling plaster of the false ceiling shall be done after laying the wall tiles to maintain perfect horizontal line between the junction of top level of the tiles and the plastered bottom of the false ceiling.

The joints of the tiles shall be filled with white cement to arrive at uniform and smooth joints. The tiles shall be cured at least 7 days. Floor tiles shall be non-slip or as specified in the Schedule of items of work and as directed by the: ' Engineer.

Floor tiles shall be laid by maintaining proper slope towards drain on cement mortar bed of proportion. Proper care shall be taken so that no hollow space remains in the mortar bed. The joints shall be filled in with white cement.

Measurement and Payment

The measurement of Tile works shall be made in area in square meter of executed works. The payment shall be made as per the agreed rate presented in corresponding Bill of Quantities.

13 DOORS AND WINDOWS

This includes Doors are frame-work of timber, The most type of door shutter in building to be used Flush doors and types of windows include Glazed windows: aluminum-hinged

13.1 Wood work

The door and window frames shall be properly made and joined with mortise and tendon joint. The edges must be strictly in; straight lines and the corner at perfect right angles. The wood work shall be well planed, dressed, framed and fixed in position in consideration of ., opening of the shutter whether it will flush with the wall or at right angles and not necessarily in the center line of the wall.

The surface of the frame in contact with the masonry or R.C.C shall be painted with coal tar or good.-quality paint. The frames shall then be fitted vertically in position in the opening true to plumb and fixed with MS, clamp size 33 mm x 6 mm x 375 mm set in C.C. (1:2:4) within masonry of ; R.C.C. 3 in each vertical of door and 2 in each vertical of window.

The clamp shall be fixed to the frame by not less than 3 Nos. of 6 mm Long screws.

The shutters shall be of penciled; battened/flushed, louvered, Venetian, glazed or as directed. They shall be made of best seasoned wood as specified. The styles, rails, panels etc. of the shutter shall be accurately cut or molded and fitted to the dimensions shown in the drawings, and joint joints will be put together with glue and/or screws as necessary. The panels shall be raised, flushed feather tongued into the styles and rails with square corners and edges on both sides. The doors and windows may be of one, two or three or more leaves as specified and to be provided with cleats on hinges or other method specified for keeping the shutter open and also buffer blocks to prevent beating or dashing against the jambs.

Specimen of doors and windows with all fittings has to be made and got approved by the Engineer before fitting and fixing at site.

13.2 Steelwork

All steel shapes used shall be product of reputable manufacturer and shall conform to the BSTI specifications. The sections, sizes and profile shall be true to size and shape as per requirement for the specific works. Joints shall be done by welding.

13.3 Aluminum Works

All aluminum sections shall conform to U. S. Architectural Aluminum Manufacturer's Association (AAMA) & BNBC 93 standard.

The thickness and size of the channel for different parts of the doors/windows conform to the specification as provided in the tender schedule as per Schedule of Rates of PWD. It must be kept in mind that different types of doors and windows, and different parts of the doors and windows may have different sections and thicknesses. For example, wall frame may have different size and thickness than the shutter frame. Site engineer should compare the size and thickness of different parts of the doors and windows with those provided in the Schedule of Rates and drawings as provided in the Analysis of Rates.

Proper care shall be taken so that windows are made water tight by providing specified neoprene gasket.

The windows should be of high strength section made of aluminum alloy having a minimum thickness of 1.8mm unless otherwise shown in the drawing. All the exposed surfaces shall be given a dark bronze anodic oxide hardcore coating of 10 microns in thickness and uniform color tone conforming to the approved sample with all necessary locks, handles and all other accessories for fitting, fixing.

The windows should be properly fixed to walls by screw and plastic plugs and the plastered surface should be true to plumb, so that no gap is formed after the sections are fixed to walls.

Glass thickness shall be minimum 5mm. While fixing the glass, neoprene and sealant should be used to make it water tight.

Measurement and Payment

The measurement and payment of these items shall be made as indicated in corresponding Bill of Quantities.

14 DISTEMPERING AND PLASTIC PAINT

14.1 DISTEMPER

The work covered by this item consists of finishing the plastered surfaces with two coats of synthetic polyvinyl distemper applied over a prime coat of chalk wash with glue or sealer. This is exclusively for interior decoration and the distempered surface is non-washable.

Materials

- High quality SPD of approved Brand
- Shell lime
- Whiting
- Putty
- sealer
- Clean water

The surface to receive distemper shall be thoroughly rubbed with sand paper, to be made free from all dirt, grease, loose paint and other, foreign materials. If necessary, the surface shall be washed with water and dried. If during this process, any part of the old smooth surface gets damaged, it shall be repaired and the plaster applied so that the surface of the new work lies evenly with the old. Any depressions, holes in the plaster shall be repaired with approved putty.

After the repaired patches are thoroughly dry, the wall shall be washed over twice with a solution made from equal proportion of whiting and best shell lime. Distemper is applied upon the base thus prepared.

Sample of distempering work shall be done on selected surface for approval of the Engineer before final application.

Only proprietary distemper shall be used and the manufacturer's instruction for mixing and applying them must be followed.

Distemper paste from the sealed container shall be dumped in a separate container. Quantity of water as per manufacturer's instruction shall be added in the same container and stirred and mixed until it attains the desired consistency.

Distemper shall be applied on the surfaces by proper distemper brushes so as to leave no mark. The brush shall be dipped in the mix and stroked on the walls horizontally. The mason shall work in such a manner that no overlap is visible when the surface is finished.

Each coat shall be perfectly dry before the succeeding coat is applied over it.

Two coats of distemper shall be applied over the prime coat.

14.2 Plastic paint

This paint is used both for interior and exterior decoration. The painted surface is easily washable with soft soap and water.

Materials

- High quality plastic paint of approved Brand.
- Putty
- Sealer
- Clean water
- Whiting
- Shell lime

Mixing shall be as per manufacturer's specification and approved procedure Surface preparation, application and precaution shall be same as stated in case of distemper.

Measurement and Payment

The measurement of painting works shall be made in area in square meter of executed works . The payment shall be made as per the agreed rate presented in corresponding Bill of Quantities.

14.3 PAINTING on Wood Works and Steel Surface

The work covered by this item consists of painting wood works of doors and windows and iron and steel work in door and windows/ steel trusses, grills, gates etc. and varnishing, coaltaring and oiling wood works.

Materials

- High quality synthetic enamel paint of approved Brand
- Sand paper.
- Putty:

Made of 2 parts of whiting (absolutely dead stone lime) 1 part of white lead, mixed together in linseed oil and kneaded (OZ linseed oil to 1 lb of whiting will do) with wooden mallets until/ thoroughly incorporated. After kneading it is left for 12 hours when it is kneaded again to give; smooth workable paste. Desired pigments could be added if colored putty is needed.

- Thinner

Spirits of turpentine is the most commonly used thinner. It is inflammable, evaporates rapidly. Use of thinner in excess in paint reduces the protection value of the coating, flattens the color); and lessens the gloss of the linseed oil. At the most 5 to 8 percent thinner may be used. When warmed gently, turpentine shall not have smell of resin or coal tar, when shaken vigorously it should not proth, on evaporation it should not leave any residue and paper coated with, turpentine and left to dry should remain unstained and should then taken freely. Thinner shall, be used of the same Brand as of the Brand of painting.

Before purchasing the materials the contractor shall submit list showing the brand, name and Type of paints proposed to be used for the work. Manufacturer's catalogue, specification sheet, expiry date of use shall be submitted to the Engineer for approval.

No material shall be used without approval of the engineer. All rejected materials shall be; removed from site immediately.

All painting materials shall be of the best: quality and be delivered to the site in Sealed original container bearing approved manufacturer's level.

Materials to be used in the work shall conform to BSTI standards and reputed manufacturers, specification.

Materials and tools shall be stored in a single place at the site. Storage area shall be maintained in a neat and clean condition with surroundings protected from dampness and damage. Inflammable materials shall be stored in sealed containers, waste shall be removed at the end of each day. Every precaution shall be taken to prevent fire. Storage area shall be accessible to the Engineer at all time.

Before application of paint to wood, steel or any other surface, samples shall be prepared as directed on a piece of same kind of materials upon which the paint shall be applied. Color and sample maybe varied until it is approved by the Engineer.

Rough cloths or other approved protective materials shall be furnished and laid in all areas where painting and finishing is being done so as to adequately protect flooring and other work from damaging during execution of painting work. Under no circumstances paints shall be allowed to spit on floors, specially mosaic where stains shall be almost impossible to remove.

14.4 Wooden surface

Whole success of painting operation depends upon satisfactory preparation of the. Surface to be painted and the great majority of defects which occur are due to faulty preparation. Wood work shall not be painted unless it is absolutely dry. It shall also not be done in the monsoon months. Before applying, the wood work must be roughly cleaned and all projection removed. Knots and holes, if any, shall be filled using filler made with a mixture of red lead and glue in equal quantities called knotting, compatible with the finishing specified and tinted if required to of camoiitlage repairs. Nail holes, cracks and other inequalities shall be filled up by stopping to bring the surface to a level with glazing, putty. Glazier putty is also called ordinary putty. It is a paste of very thick consistency which is applied to fill up holes, cracks before applying a paint.

Dry wood, work shall be brought to a smooth and even surface by rubbing it with sand paper of different grades from coarser to finer ones.

14.5 Works Iron and Steel

The finishing of iron and steel works in building is one of the most important aspects of the finishing of building because iron and steel are subjected to. Reduction by corrosion. Generally the Application of any coating, lining materials, adhesive or paint requires its first essential, a perfectly clean surface. This is of very great importance while dealing with the painting of iron and steel. Any paint coat applied on greasy or oily steel surfaces will lack proper adhesion and will lead to failure of the paint film. Removal of rust and mill scale is more difficult but of equal importance. A good all purpose degreaser is mineral turpentine oil. Oil and grease can also be removed by gasoline or benzene but should be carefully handled because of its inflammable character. Corrosion is generally more rapid and severe in hidden places and pockets where water and rubbish collects. Before painting rust scales and dirt should be removed by means of iron brushing, scrapers or other effective methods, Bristle and wood fiber brushes can be used for removing the loose dust. Special attention should be given to the cleaning of comers, reentrant angles, weld spatters. Iron and steel work must be thoroughly dry before being painted.

After the preparation of iron and steel surfaces and prior to the application of decorative cover, the first primer coat shall be applied. The primer coat may be red lead paint or red oxide primer. The correct

timing of the application of the primer coat is a very important factor particularly when humidity is high and dew settles on surfaces in the evening or night. Roughly speaking painting of steel work can be started at about 10. A. M. which is generally the time when all dew has evaporated. Thinner shall not be added to the primer on the pretext that consistency of the paint supplied by the manufacturer is too thick. A minimum of 2 coats of primer paint should be applied specially in the case of those primers where pigment themselves have rust inhibitive property.

After the application of the primer coats, an undercoating is often recommended to be applied prior to the application of the finishing coats. The object of the undercoating is to provide a heavy- pigmented layer that will give full bodied colour in conjunction with the finishing coat-but from' protective point of view, two finishing coat is better than one under coat and one finishing coat. If any steel member is to be encased by concrete, it shall be painted with a coat of cement slurry.

Measurement and Payment

The measurement of painting works shall be made in area in square meter of executed works . The payment shall be made as per the agreed rate presented in corresponding Bill of Quantities.

15.1 Construction of HBB Road

- (1) Box cutting or Excavation shall mean the removal of materials so that structures can be constructed to the lines, grades and dimensions shown on the Drawings. The Contractor shall prepare, submit and obtain approval from the Engineer for excavation plans including details of any surface or sub-surface dewatering prior to the start of any excavation.
- (2) Excavated materials shall be stockpiled for either backfilling, or deposited in spoil tips. Excavated material shall not be stockpiled at the top edge of cut slopes. The location of work areas and stockpiles and the use of excavated materials shall be as directed by the Engineer. All excavated material, which meets the specification of fill work, unless otherwise ordered by the Engineer, shall be utilized for the fill work.
- (3) Except as may be directed by the Engineer, excess excavation for the convenience of the Contractor or over excavation performed by the Contractor for any purpose or reasons, shall be at the expense of the Contractor. If the excavation for foundations exceeds the depths specified, back filling shall be undertaken as fill works at the expense of the Contractor. If back filling is to be undertaken it shall be done by sand and shall have a fineness modulus (FM) between 1.0 or as directed by the Engineer.
- (4) 1st class Brick shall be laid on flat in single layer (soling), on prepared and levelled bed with sand ($FM \geq 0.5$) as per design . A single layer of flat brick soling of first class bricks shall be placed on the sub-base with the long edge of each brick in a transverse direction.
- (5) On Brick flat soling Brick on edge in Herring Bone Bond (HBB) with 1st class bricks, shall be laid including levelling, sand blinding ($FM \geq 0.5$) as per design,

- (6) Brick on end edging with 1st class bricks (single layer, 75mm thick) along the outer edges of interior road shall be laid at both the edges. where the surface drain is provided.
- (7) Brick on end edging with 1st class bricks (single layer, 125mm thick) along the outer edges of approach road shall be laid at both the edges.
- (3) The road paving shall be laid between the specified brick edging. The brick edging shall be constructed in accordance with the Drawings.
- (4) Sand ($FM \geq 0.8$) shall be laid for construction of road sub-grade in layers of maximum 150mm thick and compacting to attain minimum CBR-8% by using mallet/vibrio compactor as approved by the Engineer.
- (6) The joints between edging, flat soling and HBB bricks shall be filled with sand and watered into place.

15.2 Measurement and Payment

Measurement for flat and HBB soling shall be made in sqm and that for 75mm and 125mm edging of executed work shall be made in linear meter. The payment against flat and HBB soling shall be made separately for each and that for edging shall be made separately for each as per BoQ.

C. Supplementary Information

13. Information Provided

The following information is provided for the guidance of the Contractor and is given in good faith. No warranty is given by the Employer or the Engineer as to accuracy or relevance of the information.

13.1 Locally Produced Materials

13.1.1 Cement

Most of the major international cement manufacturers are represented in Bangladesh so providing a wide choice of suppliers. They are represented by the Bangladesh Cement Manufacturer's Association, c/o Bashundhara Group, Sena Kalyan Bhaban, 195 Motijheel, Dhaka.

13.1.2 Aggregates

Bangladesh's largest hard rock quarry, operated by the Madhyapara Granite Mining Company Limited (www.mgmcl.org.bd) – a company of Petrobangla under the Ministry of Power, Energy & Mineral Resources, is situated in Dinajpur District in the north of Bangladesh. It produces mixed rock sizes from crushed rock to boulders over 400 mm from the underground hard rock mine. Contact details for the company are available from the website. Aggregates are also available from operations involving the crushing of river rocks generally sourced from the north eastern portion of the country

13.1.3 Geotextiles

There are at least three firms in Bangladesh that are actively supplying substantial quantities of geotextile material for use in the water sector and also export products. Khidmat Edar (BD) B.J. Geo-Textile Ltd. and Dird Felt Ltd. produce non-woven needle punch geotextile in various thicknesses commonly made of Polyester/PP.

13.1.4 Bricks

Bricks are readily available in Bangladesh. The quality varies greatly due to differences in the source of the base material, the means used to heat the kilns, and the quality controls (or lack of) established by the different operators. The best quality bricks generally come from gas fired kilns where the temperatures are controlled and generally the quality of the base material is better. Other kilns use a variety of material (coal, wood) for heating and the base material is usually from sources nearby. These produce second and third rate quality bricks and a single firing can produce a range of bricks from under to over burnt.

13.1.5 Sand

Sand is available for concrete and grout from Chhatak, Sunamganj, Toke, and the Madhyapara Mine. Sand for the filling of the Geo bags can be from the above sources or from the river if appropriate methods are employed to remove excess fine material

13.2 Meteorological Data

The Contractor is referred to the Bangladesh Meteorological Department (<http://www.bmd.gov.bd/>) for meteorological data. However, some preliminary data is presented below.

Bangladesh has a tropical monsoon climate which can be characterized into three seasons:

- Pre-monsoon from mid-April to mid-June
- Monsoon from mid-June to mid-October

- Dry from mid-October to mid-April

The principal features of the climate are summarized below:

1. Rainfall: The average annual rainfall in central Bangladesh is about 1800-1900 mm with the highest rainfall generally occurring between June and September.
2. Temperature: Average high summer or monsoon temperatures at the site are approximately 31 to 32°C. April generally has the highest temperatures (average high reaching 35°C) while June is the warmest month. January is the coolest month with an average temperature of approximately 18°C.
3. Humidity: Relative humidity varies in the pre-monsoon and monsoon months from about 75% to 95%, reducing to about 35-50% in the dry season.
4. Wind: Bangladesh experiences light winds for much of the time, but severe storms occasionally occur. These arise from two principal sources, namely:
 - a. The "nor-waster" thunderstorm squalls which mainly occur in March and April, and are often accompanied by violent hailstorms, and occasional tornados; and
 - b. Tropical cyclones which arise in the Bay of Bengal chiefly during April-May and October-November. Cyclones are associated with very high winds which often generate an accompanying storm surge. The destructive effect of these storms is largely confined to the coastal areas bordering the Bay of Bengal as their intensity is rapidly dissipated once they make landfall.

13.3 Hydrological Data

Bangladesh Water Development Board (BWDB) maintains a number of water level gauging stations on the right bank of the Jamuna River within or close to the priority reach. The main gauging stations with long recorders are:

1. Fulchari (gauge SW46.9R) located approximately 35 km upstream of the priority reach
2. Mathurapara (gauge SW15J) located approximately 6 km upstream of the priority reach (left bank).
3. Kazipur (gauge (SW 49 A) located approximately 14 km upstream of the downstream extent of the priority reach
4. Sirajganj (gauge SW49) located 8.5 km downstream of the priority reach.

Water levels from the gauging station at Sirajganj (SW49), available since 1945, have been used as the reference for design layouts. Reference water levels through the priority reach have been established through linear interpolation based on the available records from the above gauging stations or the results of numerical modelling. Local levels through the reach may differ due to local influences and the general river slope between the stations. Water level characteristics in the Priority Reach based on the Sirajganj gauging records are shown in Figure 15–1 and Figure 15–2.

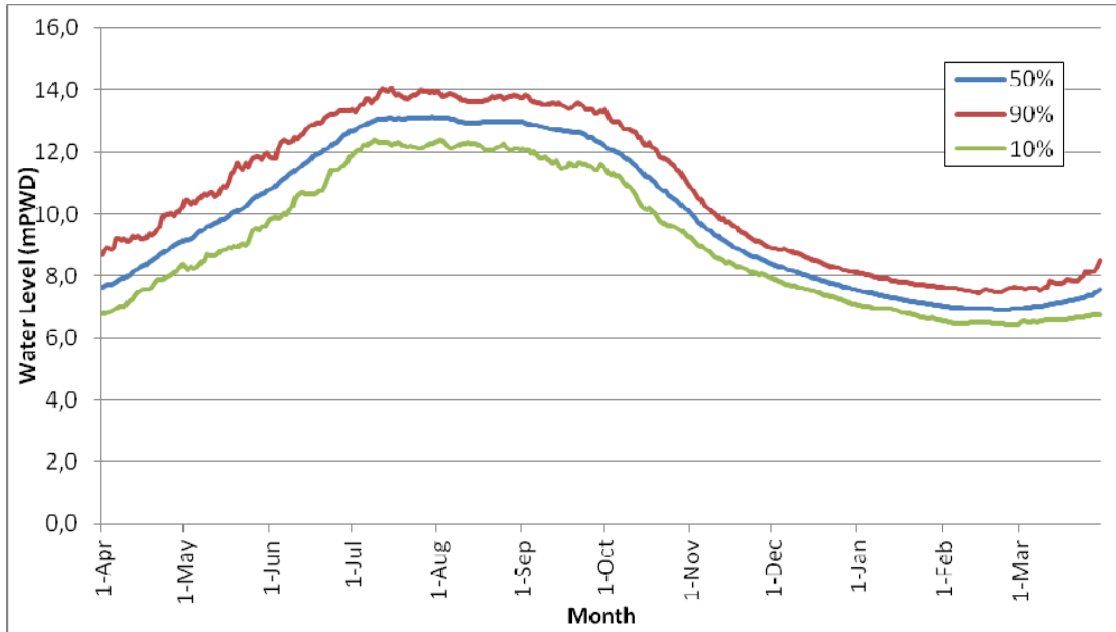


Figure 15-1: Hydrograph at Sirajganj based on Daily Water Level from 1945 to 2013

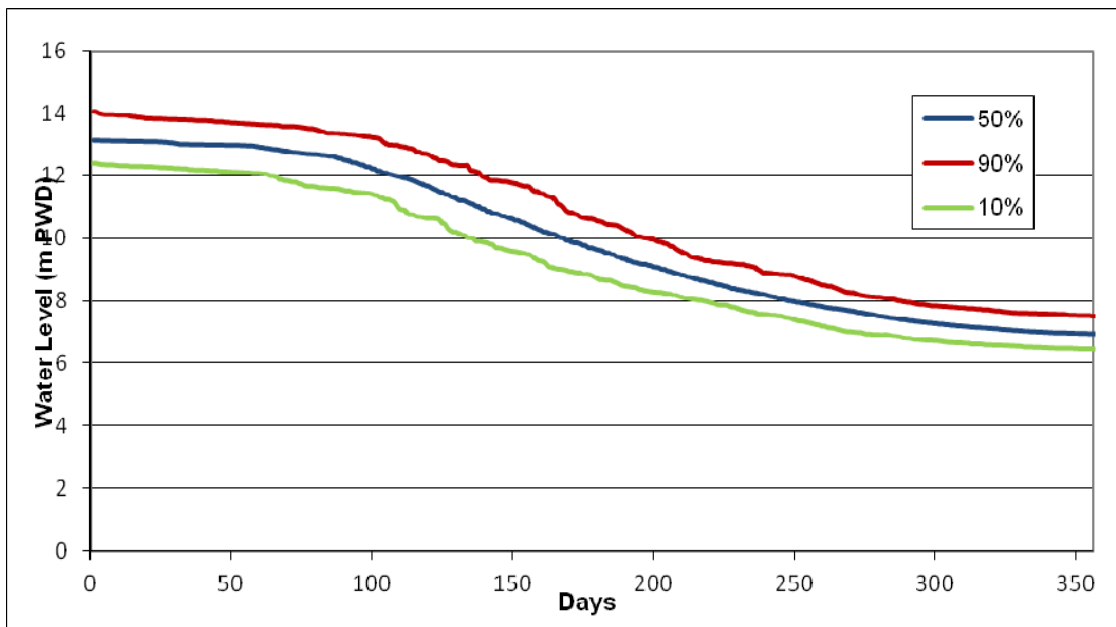


Figure 15-2: Duration Curve at Sirajganj based on measured Daily Water Level from 1945 to 2013,

The flow of the Jamuna is characterized by the seasonal snow melt in the Himalayas and monsoon rainfall in the catchment area of the Brahmaputra/Jamuna River. In an average year at Sirajganj, the river starts rising by the start of March from lower levels of approximately 7 m PWD to the higher levels of 13.5 to 14 m PWD which are reached in July – August. At Sirajganj the Low Water Level (LWL) is 6.9 m PWD and the Design Flood Level (DFL) is 15.5 m PWD. For comparison, the floodplain elevation outside of the BRE averages between 12.5 m and 13.5 m in the region around Sirajganj.

During the high water period, which can last up to the end of September, several peaks in discharge and water level may occur. At the end of September or early October, the river recedes to the lower levels again, which are reached by the end of January.

The Contractor should familiarize themselves with water level changes and expected trends, published daily during the monsoon season by the Flood Forecasting and Warning Center, BWDB, (<http://www.ffwc.gov.bd/>) and by regularly recording the Contractors own water levels, and notify the Engineer immediately in writing when the scheduled work based on the normal floodplain level will not be possible.

13.4 Flow Velocities and Tides

Through the priority reach the Jamuna River is a braided system. The primary channel can shift dramatically over a relatively short period of time and there are significant changes in the planform over the monsoon. Surface velocities vary significantly across the channel and by season. Values in the order of 2.5 - 3 m/s were observed within the main flow channel during ADCP measurement during the 2013 monsoon. Velocities along the banks will depend on in channel sand bar and char development, and changes in channel alignment. The water levels at the site are not tidal influenced.

The Contractor must become familiar with the river conditions and take these conditions into consideration during the formulation of the Contractor's methodology.

13.5 Seismology

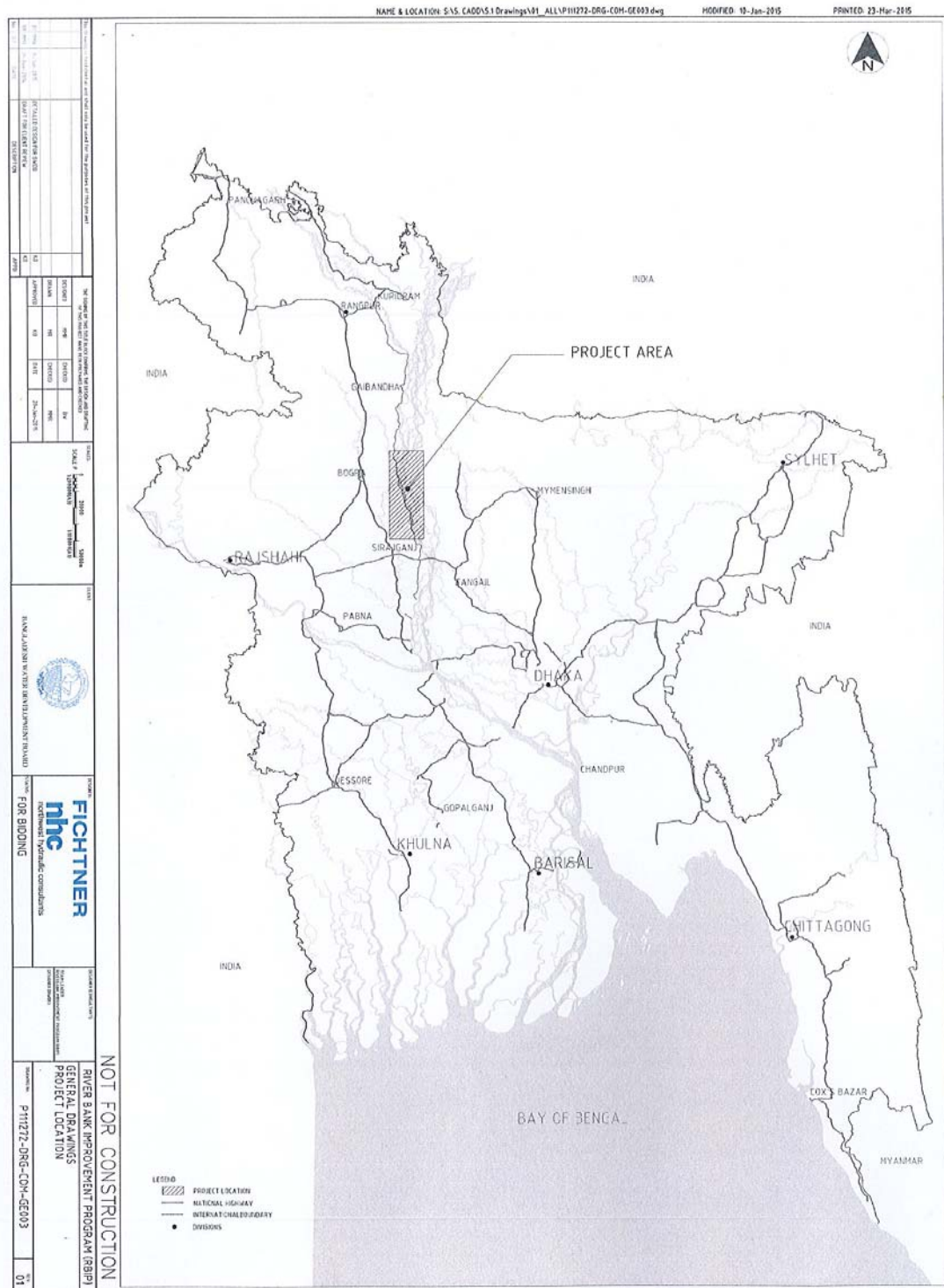
The region in which the Project is situated is seismically active, as the Indian Subcontinent tectonic plate collides with the Asian mainland plate. There are six active tectonic blocs that could affect the Sites:

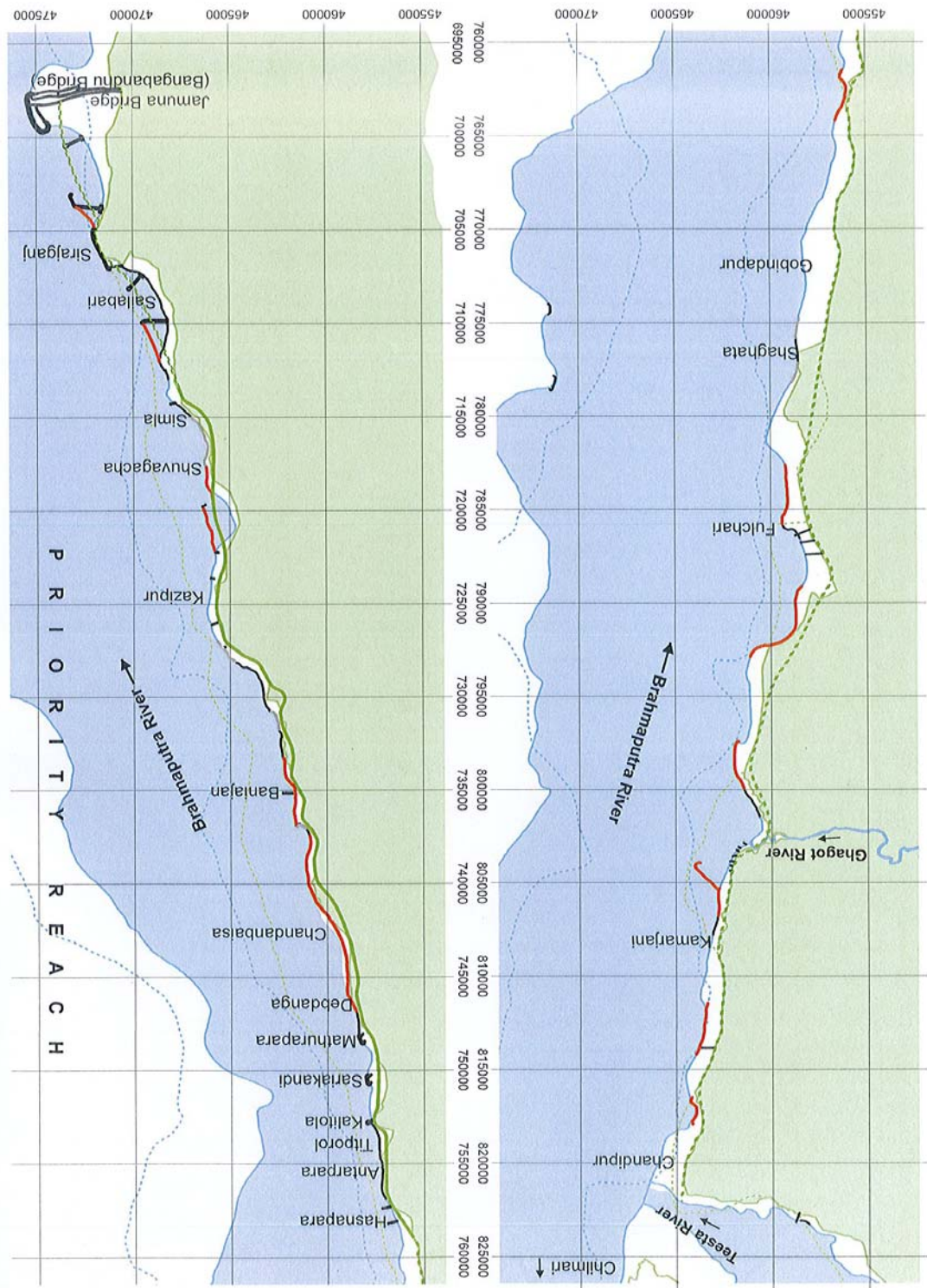
- Bogra Fault Zone
- Jamuna Fault Zone
- Sylhet Fault Zone
- Shillong Plateau Fault Zone
- Meghalaya Plateau Fault Zone
- Main Boundary Fault Zone

This seismicity and soil characteristics in the top 20 m of the area makes it sensitive to liquefaction.

Location Map

Project Location Map is presented in following page.





D. Drawings

The list of drawings is presented in table D. 1 in following page.
The drawings compiled and provided in separate volume.