SECTION 19
BRIDGE EXPANSION JOINTS

19.1 General

The work shall consist of designing, fabricating, furnishing and installing modular expansion joints that meet all requirements of the Contract Documents. Modular expansion joints shall be single-support-bar system comprised of fabricated assemblies of structural and sealing elements for the purpose of providing an intermediate, smooth riding, roadway surface between two structural expansive elements, capable of supporting highway loads of HS 20-44 plus *25%* in a manner to prohibit intrusion of incompressible debris and/or water into the expansion joint opening. The modular expansion joint shall be constructed of steel. Aluminum systems will not be allowed. The modular expansion joint shall seal the deck surface, concrete barriers, and walls as indicated on the Contract Drawings, and shall prevent water from seeping through the joint area. Any seeping of water through the joint will be cause for rejection of the expansion device(s). Only a continuous full length joint system will be acceptable, except where noted otherwise on the Contract Drawings to accommodate the staged construction. Each expansion joint system shall be fabricated as a single entity. The elastomeric sealing element shall utilize a strip seal designed to be easily replaceable, shall be continuous, and shall be limited to a maximum movement of 125 mm per seal. The joint seal assembly shall have a minimum 150 mm upturn at the lowest end of each assembly in order to contain deck runoff. The elastromeric sealing element shall not be cut in any way at the upturn or at any location along the length of the joint.

The Contractor shall provide all the necessary hardware including bolt assemblies or studs, epoxies and sealants, steel extrusions, neoprene blocks or pads, curb and parapet sections, other accessories and all necessary tools for the proper installation of the joint. All work and materials for the installation of the joint are to comply with the written instructions of the joint supplier. All work done shall conform to the accepted shop drawings. A representative of the supplier shall be available at the Project site during the installation of each expansion joint, the cost of which shall be included in the relevant BOQ item.

19.2 Special Design Constructions.

A. Joints Shown on Contract Drawings.

The dimensions and elements of the expansion joints shown on the Contract Drawing are conceptual in nature. However, the blockout sizes and details are based on the dimensions given. Changes in the dimensions shall take into consideration the physical limitations set forth by the design. Mitigation requiring revisions or additions to concrete, reinforcement or other facilities shall be performed at no additional cost to the Employer.

B. Movement Capabilities.

Required movement capability for the expansion joint is indicated on the Drawings.

The Fabricator shall preset the modular expansion joint during installation to accommodate for creep and shrinkage and for temperature adjustment. The design of the system shall facilitate inspection and replacement. Epoxy nosing joints shall not be permitted.

19.3 Qualified Suppliers.

The Contractor is required to identify their intended supplier of the Expansion Joints within 120 days following the Notice to Proceed. The supplier shall be required to submit a detailed schedule of submittals documenting their capability and intended approach of complying with the Contract requirements.

The Expansion Joints shall be products which have a proven successful performance record. The Contractor shall submit for the approval of the Engineer full details of the proposed joints. This shall include lists of projects in which the proposed product has been incorporated in similar structures and climatic conditions. The Contractor shall submit substantiating information on previously installed joints of the same type supporting the durability and maintenance records, certified by the supplier.

The final selection of the Expansion Joint supplier is contingent upon the acceptance by the Engineer of this submittal.

19.4 Materials

19.4.1 General

A. The modular joint system and all its component parts, including stiffening plates and anchorages, shall be supplied by the Manufacturer. The Manufacturer shall certify that all components of the modular joint system meet the requirements listed in this specification.

B. Structural steel including hollow beams, steel extrusions and milled steel shapes shall conform to ASTM A588.

C. Tie bolts, cap screws, hexagon bolts and hook bolts shall be of stainless steel conforming to ASTM F 594, Group I Alloy 304. Nuts shall be of stainless steel conforming to ASTM F 594. Group I Alloy 304. Washers and lock washers shall be of stainless steel, conforming to ASTM A 276, Type 304.

D. The PTFE for bearings shall conform to the following:

PHYSICAL PROPERTIES	ASTM TEST METHOD	REQUIREMENTS (Minimum)
Ultimate Tensile Strength	D-638	2800
Ultimate Elongation, % Min.	D-638	200
Specific Gravity, Min.	D-792	2.13

E. Stainless steel shall conform to ASTM A-167, Type 304

F. Structural steel angles, and connecting and sliding plates shall conform to ASTM A- 588.

G. Barrier cover plates shall conform to ASTM A36. Cover plates shall be galvanized in accordance with Article 11.3.7.

H. Elastomeric seal shall conform to ASTM D 2628, modified to omit recovery tests.

I. Two copies of the product data containing pertinent materials and installation data for the expansion joint device supplied on this project shall be furnished to the Engineer at the same time as the shop drawings are furnished for review and approval.

J. Exposed steel plate shall have a 2 mm non-skid surface coating in accordance with the manufacturer's recommendations.

19.5. Design Submittals and Shop Drawing Requirements.

Design submittal and shop drawings shall be prepared and submitted for review and approval. All shop Drawings shall note the name and address of the Joint System Fabricator, including the actual location (address) where the fabrication will take place.

The drawings shall also conform to the details shown on the Contract Drawings. Any variations, suggested by the manufacturer or the Contractor, shall be submitted to the Engineer for acceptance. After the Engineer has reviewed and approved the shop drawings, one complete set of the joint shop drawings shall be reviewed by the reinforcing steel fabricator in order to coordinate the reinforcing details required by the type of modular expansion joint being supplied in order to eliminate installation conflicts. The Contractor shall distribute the drawings for review and be responsible for coordination efforts.

19.6 Fabrication, Acceptance and Installation.

A. This Work is comprised of fabrication, testing and installation of a modular expansion joint in accordance with the drawings, shop drawings and the Specification.

1. Fabrication.

- All steel fabrication (shop and field) shall be done in accordance with the requirements of AASHTO (1996) DIVISION II Section 11.
- Welding Procedure Specifications shall be submitted for approval to the Engineer with the Shop Drawings and welding process shall be shown on the Shop Drawings.
- The median and fascia barriers sliding plates shall be shop assembled to fit the modular joint system. The plates may be disassembled from the joint system for shipment to the project site.
- Unless otherwise noted, each modular expansion joint system shall be fabricated as a single entity. It shall fit the full width of the structure as indicated on the Contract Drawings. The system shall be preset by the Manufacturer prior to shipment for temperature, and creep and shrinkage adjustments. Should the plans indicate that segmental fabrication is permissible, or required, each segment shall be fabricated to exactly fit that portion of the superstructure under construction. Segments shall be fitted with temporary seals. Temporary seals will not require lubricant adhesive.
- Shop inspection shall be conducted at the discretion of the Engineer.

- The fabricated joint system will be accepted at the work site by the Engineer after a visual inspection and upon receipt of the Manufacturer's Certification Report (MCR) that the materials and the fabricating procedures are in accordance with the Approved Shop Drawings and this Specification. The Manufacturer shall submit, with the MCR. a Certified Copy of the Mill Test Report (MTR) for all steel used to fabricate the joint system.

2. **Acceptance** - The fabricated joint system will be accepted at the work site by the Engineer after a visual inspection and upon receipt of the MCR and MTR.

3. **Installation** - The Contractor shall obtain all necessary instructions from the supplier or fabricator and comply with the procedures specified. The Contractor shall obtain the services of an authorized representative of the Manufacturer who shall give such aid and instruction in the use and installation of materials as may be necessary to attain the required results, shall monitor the handling, placing and testing of the joint system, and shall be present at the Project site during the installation of all the joints.

Placement of the expansion joint assemblies shall be scheduled to meet the following requirements:

Expansion Joint Locations	Earliest Installation Date
West and East Abutment	45 Days after stressing all longitudinal tendons in the Final span to be created.

Each joint seal assembly shall be adjusted to the following set of criteria at the time of setting by the Contractor after acceptance by the Engineer:

a. Age and support condition of the structure.

b. Internal temperature of the structure.

c. Design movement rating of the joint seal assembly.

The structure temperature shall be measured on the underside of the concrete bottom slab at each end of the superstructure segment adjacent to the expansion joint.

Details at the barriers (median and fascia), joint splicing (for construction staging only) and any other required details shall be shown on the shop drawings and are subject to the acceptance of the Engineer.

Immediately prior to installation, the joint system shall be inspected by the Engineer for proper alignment, and complete bond between the neoprene sealer and the steel, and proper stud placement and effectiveness. No bends or kinks in the system shall be allowed (except as necessary to follow the roadway grades), nor shall the straightening of such bend or kinks be allowed. Any joint system exhibiting bends or kinks shall be removed from the Work site, and replaced by a new joint system al the expense of the Contractor. The neoprene seal not fully bonded to the steel shall be fully bonded at the expense of the Contractor. Studs shall be inspected visually, and shall be given a light blow with a 4 lb. Hammer. Any stud which does not have a complete end weld, or does not emit a ringing sound when struck a light blow with a hammer, shall be replaced. Studs located more than one inch in any direction, from the

location shown on the shop drawings, shall be carefully removed and a new stud placed in the proper location. All stud replacements shall be at the expense of the Contractor and accepted by the Engineer.

The joint seal assemblies shall be placed to the final established deck elevation prior to the placement of adjacent sections of the Concrete Overlay for Structural Slabs. The pourback material shall be poured to the finished designed deck elevation which shall create a paving dam against which the concrete deck overlay course shall be placed. The concrete surrounding the joints shall be well vibrated in order to attain impervious concrete in the vicinity of all joints. Care shall be taken to ensure that the joint and/or its anchorages, are not disturbed from their correct location. The anchorages, where practicable, shall be tied to existing deck slab reinforcement. Drilling for anchorages into the new structure to remain will not be permitted. In the event drilling is absolutely necessary, and upon the Engineer's approval, after the anchor bolt has been set in the predrilled hole, the hole shall be epoxy grouted with an approved material.

Any mechanical devices, supplied by the joint system Manufacturer, used to set the joint system to the proper width shall be returned to the manufacturer by the Contractor. In order to perform the Work of installing the joint systems in a proper manner, some portions of the bridge concrete barriers (fascias and median) cannot be constructed until after the expansion device is installed. At such times that the necessary concrete is placed, existing surfaces shall receive a coating of Portland Cement Bonding Grout. The grout shall be placed immediately prior to concrete placement.

The modular expansion joint system Manufacturer's instructions for the proper installation of the joint system shall be entered on the shop drawings. Shop drawings which lack Manufacturer's installation instnictions will be returned without examination.

During the initial stages of the joint system installation, the Contractor shall have present at the installation site, a Representative of the Joint System Manufacturer. This person shall be competent in all respects regarding the proper installation procedures to be used. The Representative shall advise the Contractor of, and certify to the Engineer that, the proper procedures are being followed. All certifications to the Engineer shall be in writing.

The modular expansion joint system shall be installed in strict accordance with the Manufacturer's instructions, and the advice of their Official Representative. A minimum of 30 days prior to the intended installation, the Engineer shall be supplied with two copies of the written instructions.

All metal surfaces in contact with the neoprene sealer shall be blast cleaned in accordance with the requirements of Steel Structures Painting Council Surface Preparation No. 6 (SSPC-SP6) - Commercial Blast Cleaning. After cleaning, all cleaned surfaces shall exhibit a clean quality of CSA2, or better, as defined by Steel Structures Painting Standard SSPC Vis.1.

The cleaned metal surfaces shall be protected from rusting until such time as the sealer and lubricant adhesive are placed against the metal surface. Any cleaned metal surface upon which rusting appears shall be recleaned in accordance with the foregoing.

The modular expansion joint system shall be set to the proper width for the ambient temperature at the time of setting. This information must be indicated on the Shop Drawing.

If the joint system has been fabricated in segments, they shall be field spliced to created a single, unbroken system. After the joint system has been field spliced and completely installed over the full width of the structure, the temporary seals shall be removed and replaced with permanent seals. After the temporary seals are removed, all metal surfaces which will be in contact with the permanent seals shall be commercially blast cleaned (SSPC-SP6) to visual standard CSA2 as defined in SSPC Vis.1.

After the modular joint system has been set to its final line and grade, the recess opening shall be filled with 42/20 Concrete. Prior to concrete placement, all existing concrete surfaces shall be coated with Portland Cement Bonding Grout.

The placement of each joint seal assembly shall be supervised by a representative of the joint seal supplier present at the Project site to insure the proper placement of said assemblies. Costs associated with such supervision shall be included in the relevant BOQ Items. Following the installation of each joint seal assembly, the Contractor shall install protective plating across the top of the assembly to protect it from construction traffic damage, as directed by the Engineer.

19.7 PERFORMANCE

The Contractor shall provide a ten-year written guarantee of the satisfactory operation and durability of the Bridge Expansion Joints. Cracked welds, broken bolts, fatigue of other cracks in steel components or welds, tearing or failure of the sliding surfaces of the seals or break down of the corrosion protection shall constitute unsatisfactory operation and durability of the Bridge Expansion Joints. The Contractor shall repair or replace the Bridge Expansion Joints, or parts thereof, at the Contractor's expense, as necessary to restore them to full serviceability, within the period of the guarantee. The guarantee shall extend ten years from the date of completion of the contract.

The manufacturer of the Bridge Expansion Joints shall certify the bearings to have a function life of at least 40 years and furthermore shall clearly specify any routine inspection and maintenance operations that are considered critical to ensure the specified longevity of the Joints.

SECTION 21
WATER PROOFING

Replace Article 21.5 with :

21.5 Protective Painting of Concrete

21.5.1 General

The following Specification covers the furnishing and application of rubberised bitumen to all buried surfaces of concrete to within 150mm of finished ground level.

21.5.2 Submittals

The Contractor shall submit to the Engineer for approval three samples in one litre containers of the rubber bitumen emulsion.

The Contractor shall submit to the Engineer independent test certificates that material to be furnished complies with Specification requirements.

21.5.3 Materials

The rubber bitumen emulsion shall be a water bound emulsion containing not less than 65% of bitumen with the fine particles of rubber dispersed in the bitumen. The consistency shall be such that it can be applied to the surface by brush at normal air temperature. The rubber content shall be not less than 10% in the dried film.

21.5.4 Application

Before the application of rubberised bitumen emulsion the concrete surfaces shall be thoroughly cleaned of dirt, dust, grease and other extraneous matter and lightly brush dampened immediately prior to application of the emulsion.

The priming coat shall be made up by mixing 0.23 kg of approved powder detergent with 45 litres of clean water and adding this to 4.5 litres of emulsion. The priming coat shall be applied at the approximate rate of 9 litres per $30m^2$.

The second coat consisting of undiluted emulsion shall be applied as soon as the priming coat is dry, at the approximate rate of 9 litres per $15m^2$.

The emulsion shall be applied by brush or spraying strictly in accordance with the manufacturer's instructions. It shall not be applied during rain or when rain is expected.

Backfilling shall not be commenced until the second coat of emulsion is dry.

SECTION 22
SLOPE PROTECTION

Replace the whole of Section 22 with the following:

22.1 Dry Earthwork

22.1.1 General

This Article of the Specification covers the requirements for tile dry earthwork, comprising both excavation and fill work, required for:

a) formation of the crests of the bank for the river revetment works;

b) reshaping/trimming of the existing river bank and formation of the crest of the new embankment to be constructed there;

c) excavation and storage of silty soil for use in the bank;

d) placing and compacting of cladding layers on the crests of the bank;

e) filling to the required level the area allocated for the Engineer's offices, and the Engineer's laboratory and accommodation. The requirements for earthworks for road embankments, including bridge approach embankments and the area for the possible future toll plaza, and embankments to irrigation canals are contained in Section 29 of this Specification.

At the interface of water and land, some excavation with land-based equipment below the water line may be required. Such excavation will be deemed to be dry excavation work.

22.1.2 Codes and Standards

The following standards apply to work covered in this Section:

AASHTO, ASTM, BS or alternative equivalents approved by the Engineer.

22.1.3 Dry Earthwork

22.1.3.1 Excavation

a) Excavation shall consist of all necessary removing and satisfactory disposal at material of whatever geological formation, quality, consistency or description to such depth or dimension as may be necessary to execute and to complete the Works;

b) No permanent work shall be commenced in the excavation until the excavation has been approved by the Engineer in writing;

c) Excavation shall be neatly carried out to the lines and levels shown on the Drawings except where the Engineer directs the removal of unsuitable material;

Unsuitable material shall mean other than suitable material and shall comprise:

- materials from swamps, marshes and bogs;
- peat, logs, stumps and perishable materials;
- clay of liquid limit exceeding 90 and/or a plasticity index exceeding 65.

d) Any over-excavation beyond the limits of required excavation shown on the Drawings shall be replaced and compacted by the Contractor at his own expense with materials as approved and directed by the Engineer;

e) The Contractor shall take all necessary precautions to prevent slips in excavations and shall at his own expense restore any damage or defect and remove to spoil-dumps any surplus material caused by slips;

f) Insofar as is practicable materials from excavation shall be placed directly from the excavation into the designated final locations, or shall be placed in stockpiles for later use in the works.

22.1.3.2 Dry Filling and Compaction

a) The Contractor may carry out the dry filling operations by any means he considers most suitable subject to the Specification and any stipulations in the Contract;

b) Prior to commencement of filling operations, the Contractor shall submit for written approval by the Engineer his proposed method for placing and compacting fill, and shall carry out compaction trials if required by the Engineer;

c) For building up the crests of the bank the Contractor may use material from adjacent areas, provided that he shall make his own arrangements for the acquisition of such material from outside the Site limits. The fill shall not contain any vegetable matter, topsoil, wood, trash and other objectionable materials which may be compressible or which cannot be properly compacted and shall preferably be obtained from the upper 2m of the borrow area. Alternatively the Contractor may use dredged material from the river bed. However if this material is not placed directly in the works, such fill shall be treated as dry fill;

d) For placing the various cladding layers shown on the Drawings the Contractor shall use material stockpiled in accordance with Article 22.1.3.3 and from borrow areas in the neighborhood provided the requirements of Article 22.3.3(e) are met;

Clayey soil for cladding layers shall have an intermediate or high plasticity (BS 5930). The percentage of clay minerals (viz particles smaller than 0.002mm) shall not be less than 15 percent;

e) The quality, compaction, moisture content and finish of previously placed fill shall be approved in writing by the Engineer before the placing of subsequent layer of fill material;

f) Longitudinal joints in any two successive layers shall be staggered by a minimum distance of 3m;

g) The Contractor shall handle and water the fill material in such a way that during compaction the moisture content of the fill material shall be equal to its Optimum Moisture Content plus or minus 2 percent as determined with the Moisture-Density Relation Test AASI-ITO T99 (Standard Compaction);

h) For compaction the Contractor shall use sheep's foot rollers and/or vibrating rollers as may be necessary to obtain the specified density;

i) Dry fill shall be compacted in layers having a loose thickness (before compaction) of not more than 250 mm;

j) The cladding layer on the outer faces of the embankment as shown on the Drawings cannot be compacted on slope. Accordingly, this material is to be placed and compacted in horizontal layers not exceeding 200 mm loose thickness and compacted using plant of suitable size and nature to achieve the specified field density requirements. The Contractor shall make provision for constructing this cladding layer over-width initially then trimming back the outer faces to the profile shown on the Drawings.

k) The fill shall be compacted to minimum 95% of Maximum Dry Density determined by AASHTO T99. The in-situ density of the fill shall be determined in accordance with AASHTO T191 or other method to the approval of the Engineer; (such as NDM Methods).

l) One in-situ density test shall be carried out for every 500 m^3 of compacted fill.

22.1.3.3 Stockpiling of Top Soil

The Contractor shall excavate the surface layer of silty top soil from (nominally 150mm thick) from areas designated for Engineer's facilities and accommodation shown on the Drawings and store it at a location as directed by the Engineer. Silty soil shall also generally be excavated from areas to be raised with sand obtained from the dredging operations. After filling the area with dredged sand up to the required level, the above silty soil shall be spread uniformly on the raised area.

22.1.3.4 Tolerances

a) Tolerances on excavated levels below water level shall be +100mm and -150mm, measured in vertical direction, provided that the excavated slopes shall be sufficiently

smooth. Deviations in excess of 1:20 measured in any direction from the theoretical slope shall not be acceptable;

b) Tolerances on excavated levels above water level shall be ±75mm

c) Tolerances on dry fill slopes receiving revetments shall be ±75mm

d) The Contractor shall make provision for recording settlements, where so required by the Engineer.

22.1.3.5 Performance Tests

a) Unless otherwise specified or agreed by the Engineer tests on fill materials shall be carried out by the Contractor at his own cost under the supervision of the Engineer. The Contractor shall carry out such tests to the satisfaction of the Engineer to ascertain compliance with the Specifications;

b) The Contractor shall adequately and satisfactorily perform the tests in conformity with the specified standards in due time; test results shall be recorded and issued on standard test forms as approved in writing by the Engineer;

c) Tests to be carried out to AASHTO:

- Soil classification tests:

-	Moisture content	-	T265
-	Atterberg limits	-	T89, T90
-	Particle size distribution	-	T88

- Soil compaction tests:

-	Moisture density relations	-	T99
-	Field density	-	T191

22.1.3.6 Stock Piling of Earth Material

a) The Contractor shall submit a detailed plan for stock piling of earth material within 30 days after receipt of the Letter of Acceptance. Stockpiles may be located in the Contractor's own working area. Should the Contractor wish to stockpile dry earth materials at locations not forming part of the Site, then he shall make his own arrangements therefor;

b) The Contractor shall take all necessary steps to ensure that material of a stock pile shall not be contaminated or mixed with other materials;

c) Any material dumped at locations in a way not approved by the Engineer or anywhere spoiled as a result of the Contractor's operations shall be removed by the Contractor immediately, at the Contractor's expense.

22.2 Dredging and Hydraulic Fill

22.2.1 General

Dredging will be required to form the slopes of the bank. The formed slopes are subsequently to be covered with protective revetments. Dredging will also be required as part of temporary works for construction access, raising of working sites, and similar operations. The dredged spoil shall be stockpiled for future use, disposed off Site or be replaced in the river, as directed by the Engineer. All temporary and permanent movements of dredged material shall have the prior approval of the Engineer in writing.

The maximum dredging depth for the bank will be substantial: approximately 1.5m measured from the existing ground level of the flood plain.

Hydraulic filling will be required for the part of the river revetment works.

22.2.2 Dredging

22.2.2.1 Equipment

The Contractor shall employ dredging equipment which shall have a theoretical (combined) dredging capacity, having due regard to inevitable delays, well in excess of the actual capacity required to complete the dredging in the working periods available.

Dredging equipment shall be equipped with such instruments and devices, including positional equipment, slope dredging computers, as are necessary to accurately finish slopes of the permanent works within the tolerances specified.

22.2.2.2 Working Methods

The Contractor shall, until completion of the slope protection works to any component of the river revetment works or any relevant part thereof, be solely responsible for the stability of any permanent or temporary slope.

To limit the risks of slope failures, dry excavation shall be carried out before wet excavation/dredging to remove overburden. In addition, the Contractor shall restrict the height difference between subsequently dredged layers ("bench height") as much as possible, but in any case not more than 2m in areas adjacent to permanent slopes. The Contractor's particular attention is drawn to the large differential heights which will exist between the ground level of the flood plain and the "underside" of the first layer which could possibly be dredged with a cutter suction dredger during low water levels in the river. To avoid or limit the risk of slope failure near the permanent works, the Contractor shall reduce this "bench height" near permanent slopes, which could reach 8m or more if no special measures were taken to reduce the bench height.

The Contractor is free to select the gradients of temporary slopes, subject to a limitation of the risk of a slope failure to a level acceptable to the Engineer, but slopes should not be steeper than 1:2.5.

To reduce the risk of flow slides due to the presence of higher mica content/loose sand packing or any other reason, all slopes shall first be formed slowly by an initial cut not encroaching within 3m of the final slope, but parallel to that slope at a mean horizontal distance of 4m. After a period of ten days the final trimming of the slope to the design profile may be made, working from the top downwards.

The Contractor shall submit detailed slope stability calculations for the approval of the Engineer, whereby due attention shall be given to the influence of the work method proposed by the Contractor. Notwithstanding any approval of stability calculations for any temporary or permanent slope, the Contractor shall remain fully responsible for the stability of such slopes. Such approval of the dredging plan by the Engineer will not relieve the Contractor from his responsibility of safe dredging.

The work plan for the dredging operations (see also Article 22.2.5) shall be subject to the prior written approval by the Engineer.

22.2.3 Hydraulic Fill

22.2.3.1 General

All material dredged shall be deposited in the disposal areas approved by the Engineer. Temporary disposal areas include the Contractor's working area and areas required to be raised as per direction of the Engineer.

Except as required for temporary works like access to working areas and filling the Contractor's working area, no deposition of dredged material in the Rupsa river will be accepted, unless prior approved by the Engineer in writing.

22.2.3.2 Placing of Fill by Hydraulic Means

Fill material placed by hydraulic means, in disposal areas shall be allowed to achieve its own natural consolidated density.

Prior to placing any fill by hydraulic means unsuitable material as specified in Clause 22.1.3.1(c) as well as trees, shrubs and structures shall be removed from the area to be filled.

Excavated material reclaimed by hydraulic dredging plant or equipment shall be placed in such a way that a uniform fill will be obtained, avoiding pockets or layers of silt and/or clay. When necessary, the Contractor shall divide the areas to be filled, by the construction of temporary containment bunds of suitable sand filled bags, into compartments of adequate dimensions,

The Engineer may order the Contractor to excavate any pocket of fines and backfill such excavation with material which meets the specifications for fill.

Sand discharged to form the body of the bank to be constructed in the river, shall be placed and improved with such methods and underwater devices as are necessary to achieve a minimum relative density of 60%. The achieved relative density shall be determined using a

cone penetrometer in the presence of and to the approval of the Engineer. Generally, this fill should be placed in relatively thin layers (say 0.5 m) with a specially shaped discharge device for under water discharge, close to the river bed. This discharge device shall during discharge operations be evenly moved over the area to be filled so as to achieve an even filling.

The working method for the discharge of return water, silt and other fines during dredging and reclamation operations requires the approval from the Engineer prior to commencement for those operations.

The fines separated from dredged material placed on shore shall be disposed of at locations to the approval of the Engineer. For silt retaining areas, the Contractor shall design the type and size of the overflow system which may consist of drop inlets, adjustable weirs or any other structure with a discharge pipeline or route to the river (if applicable).

Where necessary, the Contractor shall execute temporary earthworks and install pipelines and return water pumps to keep fill areas and adjacent areas clear of water.

After completion of the hydraulic fill operations the Contractor shall remove all temporary earthworks, structures and equipment at his own expense.

22.2.3.3 Water Measurement

Any water discharged at the site, into natural or existing water courses other than the Rupsa River in connection with the dredging works, shall never contain more than 4,000 ppm of soil material. Retaining dikes shall have such, properties that fine soil particles will not percolate through the dike. The Contractor is not allowed to pump any water in enclosed areas with the purpose to dilute the effluent from the area in order to try to meet the requirements of maximum content of 4,000 ppm in the effluent.

All the equipment, structures and devices the Contractor intends to use for the management, transport or discharge of water requires the prior written approval of the Engineer.

22.2.4 Containment Bunds (above and under water)

For the bank to be constructed in the river a substantial part of the body of the bank is to be formed using hydraulic fill sand to be obtained from the dredging operations.

To contain the placed hydraulic fill material within the geometry of the bank, containment bunds will have to be provided prior to filling in slope. Containment bunds are expected to be required between the existing river bed and the water level. As the water level will vary during the construction period, the height of the containment bunds and number of steps will vary along the alignment of the bank. The Contractor shall decide the size and shape of the containment bunds depending on the material to be used and the Contractor's working procedure. In any case the Contractor shall be fully responsible for the stability of the outer slope of the containment bunds during placement of the hydraulic fill and to form the required permanent outer slope under the revetment work.

The Contractor shall use approved materials for the construction of the containment bunds.

Suitable materials such as sand bags, boulders and broken bricks will in principle be accepted by the Engineer, provided that the individual particles of the material to be applied would cause no or minimal damage to the geotextiles of the slope protection works to be constructed subsequently, and that fines from the hydraulic fill cannot migrate into voids in the containment bunds.

The Contractor may also use geotextile bags, of approved quality and size, filled with sand (FM not less than 1.5) to form the containment bunds. In this case concrete block revetment can be placed on the slope without placing any geotextile layer (fascine mattress) provided the relevant slope is formed as per design and at least a single layer of geotextile bag remains between the concrete block and hydraulic fill or natural ground. Where the geotextile bags are used in this way the geotextile fabric of the bag shall meet the requirement of Article 22.4.6.

22.2.5 Working Plan

The Contractor shall submit details of working methods, including details of equipment and survey and positioning equipment involved, to the Engineer within 45 days after receipt of the Order to Commence. Dredging operations required for temporary works shall be included in the plan.

A detailed plan shall include:

- type of equipment proposed, including details of performance, both floating and land based,
- lengths of floating and land based pipe lines proposed,
- working method and sequencing of dredging work,
- working method and sequencing of reclamation work, including details of containment bunds,
- drainage provisions,
- slope stability calculations for temporary slopes,
- details of protective bunds in the river required for protection of permanent works during their construction,
- quality assurance plan and provisions.

Approval of the Contractor's work plan will only be given after the Contractor has demonstrated to the satisfaction of the Engineer that the minimum requirements of the Specification can be met. It is anticipated that approval of the Engineer will be given within 20 days of receipt of a satisfactory proposal.

22.2.6 Tolerances

The tolerances of dredging works required for the permanent works, measured in a vertical plane are ±250mm.

Notwithstanding the above, the smoothness required in finished dredged slopes shall be to the standard required for the proper placement of the geotextile as determined by the Engineer in the field. Refer also to Clause 22.4.11.

The tolerances on the level of the filled areas shall be ±100mm.

It is expected that the Contractor will provide the services of suitably experienced construction divers to verify that these tolerances have been achieved.

22.3 Revetment Works

22.3.1 General

This Article of the Specification covers the requirements for the construction of revetment (slope protection) works.

Because the actual river morphology and bathymetry at the time of construction may have changed significantly from that used for design, the design of the east bank may require modification. The Contractor must schedule his work plan in such a manner that the time required for such design modifications (normally eight weeks) will not hamper the overall progress. No extension of time or financial claim shall be accepted for such design change.

The following types of revetment will be applied:

a) Concrete block pitching on geotextile underlayer;
b) Dumped concrete block rip rap on fascine mattress, placed under water;
c) Dumped concrete block rip rap in launching apron.

In addition to these types of revetment, protection will also be provided to bank along the perimeter of reclaimed areas and along approach roads to be constructed under this Contract. Such protection will consist of a cladding layer of clayey material to be placed on the dredged and/or excavated material. Requirements for testing of clayey material are covered in Article 22.1.3.5.

22.3.2 Codes and Standards

Codes and standards applicable to materials and workmanship are mentioned in the relevant articles of this Specification.

22.3.3 Materials

a) Geotextiles and accessories shall comply with the requirements of Article 22.4.

b) Stone shall comply with requirements of Article 22.5.

c) Concrete shall comply with the requirements of Article 22.7.

d) Bamboo for fascine grids on geotextile mats shall be local bamboo having a diameter at the lower end of not less than 0.1m, a diameter at the upper end of not less than 0.05m and a length of not less than 5m. The part of the bamboo having diameter less than 0.05m shall not be used in the work.

e) Clayey soil for cladding layers shall have an intermediate or high plasticity (AASHTO T89, T90); the percentage of clay minerals (viz, particles smaller than 0.002mm) shall not be less than 15 percent.

f) Gravel for filter between geotextile and concrete block pitching shall have the gradation of D15: 1.10mm, D50: 5.00mm, D85: 19.00mm.

22.3.4 Types of Slope Protection and Specific Requirements

22.3.4.1 Concrete Block Pitching on Geotextile Underlayer-A

Concrete block pitching shall be used for road embankment slope protection above a level of + 1.5m PWD. It shall be laid on a slope of 1(V) to 2.5(H), on a gravel and geotextile Type-I underlayer.

The surface of the slope to be protected shall be trimmed to an even finish so that when the geotextile underlayer is laid, it is in full contact with the slope.

Gravel shall be laid on 0.1m thickness.

Concrete blocks shall have a normal size of 0.35 x 0.35 x 0.35 m and shall be laid with the down slope joints staggered. The blocks shall be accurately cast with smooth, parallel faces, such that when laid they butt closely up to one another leaving no gaps.

22.3.4.2 Concrete Block Pitching on Geotextile Underlayer-B

Concrete block pitching shall be used for river bank up to L.W.L. slope protection above a level of + 1.0m PWD. It shall be laid on a slope of 1(V) to 12 (H), on a gravel and geotextile Type-I underlayer.

The surface of the slope to be protected shall be trimmed to an even finish so that when the geotextile underlayer is laid, it is in full contact with the slope.

Gravel shall be laid on 0.1m thickness. Concrete blocks shall have a normal size of 0.25 x 0.25 x 0.25 m and shall be laid on 2 layers with the down slope joints staggered. The blocks shall be accurately cast with smooth, parallel faces, such that when laid they butt closely up to one another leaving no gaps.

22.3.4.3 Rip Rap on a Fascine Mattress

This type of protection consists of mixed sized concrete blocks placed on a fascine mattress. The mixed portion is 20% of 0.3 x 0.3 x 0.3 m, 50% of 0.25 x 0.25 x 0.25 m and 30% of 0.35 x 0.35 x 0.35 m. The mattress shall be a composite geotextile, consisting of a woven top layer and a non woven bottom layer needle punched together, with a grid of bamboo fascines (1.00 x 1 .00m). The mattress shall be completely covered with concrete block to a minimum thickness of 0.7 m as shown on the Drawings.

The Contractor shall take such measures as are necessary to prevent damage to the geotextile when placing of concrete block. To this end he will be allowed to replace up to 15% of the theoretically required volume of concrete block to be placed by stone boulders with a nominal grading size of 0.l0m, provided that the boulders are placed directly on top of the geotextile to a layer thickness not anywhere exceeding 0.10m.

Dimensions of individual mattresses will depend on the construction method used by the Contractor and the sizes of his equipment. Individual mattresses should be as large as possible in order to reduce the amount of overlaps; and in any case not less than 25m wide.

Overlaps of mattresses shall be at least 2m wide and shall be applied in the direction of the current (i.e. the upstream mattress shall overlay the downstream mattress). Where it is necessary to overlap mattresses in the direction of the revetment slope, the lower mattress shall overlay the upper mattress. Adequate provision to ensure correct overlays shall be included in the Contractor's Quality Assurance Plan.

Non-rectangular mattresses may be constructed in order to be better fit the required geometry. However, minimum overlaps must be maintained, and the edges of any mattress must be straight lines or smooth curves, with no abrupt changes of dimension. In general, the longest dimension of a mattress will be laid parallel to the predominant slope.

A grid of fascines, in a 1m by 1m pattern, shall be fixed to the geotextile. The grid of fascines shall have a total height of approximately 0.2m (0.1m+0.1m). To achieve the necessary flexibility of the fascines it will be necessary to use split bamboos. At overlaps the thickness of the grid shall be reduced to 0.05m (approximately one half bamboo). No rocks shall be allowed between the fabrics forming the overlap between individual mattresses.

22.3.4.4 Alternatives to the fascine mattress

Alternative forms of construction to the fascine mattress may be substituted by the Contractor subject to prior written approval of the Engineer and provided that the alternative is in no way inferior to the fascine mattress.

Alternatives might include, but are not limited to:

- a composite geotextile impregnated with sand such that the material will readily sink under its own weight;

- sand - filled geotextile containers used in the formation of underwater stable slopes.

Refer also to Article 22.4.6

22.3.4.5 Concrete Block at the Edge of a Mattress

Where rip rap is to be placed at the edge of a mattress, it shall , unless otherwise detailed on the Drawings, be placed directly on to the natural river bed, with a minimum thickness and surface slope as specified. Mixed sized concrete blocks shall be used. The mixed portion is 20% of 0.3 x 0.3 x 0.3 m, 50% of 0.25 x 0.25 x 0.25 m and 30% of 0.20 x 0.20 x 0.20 m.

22.3.5 Working Plan

Notwithstanding requirements as to the submittal of method of work statements as part of the tender, the Contractor shall submit details of working methods, including details of plant and survey and positioning equipment involved, to the Engineer within 45 days after receipt of the Order to Commence. In the required submittal the Contractor must accurately describe the process proposed with which he can achieve the minimum required dimensions indicated in the Drawings and Specification.

A detailed plan shall include:

- the layout of individual mattresses;
- proposed method of installation and control of tolerances;
- provisions for overlaps, particularly for the rip rap on fascine mattress
- the average quantities of materials to be used to achieve the minimum requirements of the Specification;
- provisions for stockpiling, handling and storage of materials;
- performance of survey and positioning systems proposed for placing of materials;
- a quality assurance plan including a monitoring system to verify that the approved working processes and/or methods effectively meet the Specification.

Approval of the Contractor's proposals will only be given after the Contractor has demonstrated to the satisfaction of the Engineer that the minimum requirements can be met.

Such demonstration will be based on the construction of appropriate trial panels of each revetment type. The trial panels will be of a size large enough to suit the Contractor's working method. Trial panels may form part of the permanent works once a satisfactory standard has been achieved.

22.3.6 Tolerances

The dimensions for slope protection works given in the Specification and in the Drawings are minimum dimensions. Nevertheless it is realized that the thickness of, for instance, the rip rap on the fascine mattress will not be constant.

In the Contractor's proposal for a work plan, as referred to in Article 22.3.5. the characteristic parameters for the thicknesses of the rip rap layer shall be such that none shall have a smaller thickness than the minimum thickness specified. Any area where the measured thickness is less than the minimum thickness will not be acceptable and the Contractor will be required to add more concrete block to increase the thickness.

Measurement of layer thickness shall generally be based on levels taken before and after placement of the concrete block. In the dry part the post work levelling may be done with a levelling staff fitted with a half ball of diameter 150mm, at the bottom of the levelling staff. Measurement for thickness of riprap shall normally be made in lines 5 to 7m apart along the slope of the revetment work and in each line levels shall be recorded in one meter intervals. The levelling staff could however be placed any where as directed by the Engineer to measure the thickness of the rip rap.

For underwater measurement hydrographic survey of sufficient accuracy in conjunction with experienced construction divers must be done to determine the layer thickness.

22.4 Geotextiles and Accessories

22.4. 1 General

This Article of the Specification covers the requirements for the manufacture, handling (transport, storage, assembly, treatment on site), testing and installation of all geotextile and accessory materials required for the Works. Requirements for application/use of geotextiles in the Works are also described in Article 22.3 of this Specification.

The following types of geotextile will be required:

a) woven
b) non woven
c) composite (woven and non woven).

All fabrics shall be manufactured by and purchased/obtained from reputable manufacturer(s) of geotextile. The manufacturer(s) shall have ample experience in the fabrication of the type of fabric(s) required and shall have adequate production capacity to meet the delivery schedule.

Before ordering any quantity of geotextile, the Contractor shall submit samples and test reports from an approved independent testing laboratory for each type of geotextile. Only geotextiles represented by approved test specimen shall be used.

22.4.2 Codes and Standards

Geotextiles shall be manufactured and tested in accordance with the appropriate IIS, DIN, BSEN, JIS or ISO standards.

The manufacturer of the geotextiles should be accredited to ISO 9001, or equivalent national standard.

All geotextile materials delivered to the site must be clearly labelled with the name of the manufacturer and the identify of the product in accordance with BSEN 30320: 1993, or equivalent national or international standard. The minimum roll width of any geotextile shall be 5.5m.

22.4.3 Geotextile Type 1

Geotextile Type 1 is for use under the concrete block/dumped concrete block pitching and will form the main filter/stabilizing layer in the fascine mattress. It shall have the following characteristics:

- non-woven needle-punched polyester or polypropylene fabric
- minimum thickness 3.0 mm
- minimum mass per unit area 300 g/m^2
- minimum tensile strength (BSEN ISO 10319)
  - machine direction 25 kN/m
  - cross machine direction 25 kN/m
- permeability (when new, no loading), not less than 4x10^{-3}m/s
- effective opening size (O_{90}), not less than 60 microns and not more than 100 microns.

22.4.4 Geotextile Type 2

Geotextile Type 2 is for use under the dumped concrete block pitching and will from the main filter/stabilizing layer in the fascine mattress. It shall have the following characteristics:

- it shall comprise two layers needle-punched together to form a single fabric, each layer being separately identifiable (by colour or marking)
- the fine filter layer shall be manufactured from polyester fibres and shall have a minimum thickness of 3 mm
- the coarse filter layer shall be manufactured from polypropylene fibres and shall have a minimum thickness of 3 mm
- the overall thickness of the geotextile shall be less than 6 mm
- the minimum mass per unit area shall not be 750 g/m^2
- minimum tensile strength (BSEN ISO 10319)
  - machine direction 25 KN/m
  - cross machine direction 75 KN/m
- permeability (when new, no loading), not less than 4x10^{-3} m/s
- effective opening size (O_{90}), not less than 60 microns and not more than 100 microns.

22.4.5 Geotextile Type 3 (The Fascine Mattress Geotextiles)

The concept of the fascine mattress is to provide the geotextile underlayer to dumped concrete block, with a means of floating it into position and sinking it onto the prepared slope. The fascines (bamboo, see Article 22.3.4.3) provide a degree of rigidity and flotation whilst the mattress is being positioned, and further help to retain the dumped concrete block on the slope.

In order to fasten the fascines to the mattress, the Type 1 geotextile described in Article 22.4.3 shall have an additional upper layer comprising a woven geotextile needle-punched to the geotextile filter layer to form geotextile Type 3. The primary function of the woven geotextile is to facilitate the tying of the fascines to the geotextile without the need to puncture the filter layer. A secondary function is to increase the puncture resistance of the mattress. A woven geotextile with loops on a one meter square grid will facilitate the fastening, but the Contractor shall determine the appropriate fastening system to suit his working method.

The characteristics of the woven geotextile shall be such as to ensure that the mattress remains integral during the positioning and sinking process, and the bamboo fascines remain attached to the geotextile until the whole mattress is covered with dumped concrete block. The woven fabric shall be a polypropylene fabric, stabilized against long ten thermo-oxidation (100 years) with a minimum weight 300 g/m^2.

The details of the mattress fabrication shall be subject to the approval of the Engineer, but on no account will the Contractor be allowed to puncture the geotextile filter layer as a means of tying on the fascines.

22.4.6 Geotextiles for Use in Alternative Forms of Construction to the Fascine Mattress.

Where the Contractor proposes to use an alternative method to the fascine mattress for providing a stable filter layer underneath the dumped concrete block, the approval of the Engineer must be sought well in advance.

Approval will not be unreasonably withheld, provided that the Contractor can demonstrate to the Engineer's satisfaction that the alternative system will provide a stable filter underlayer to the rock which is in no significant way inferior to that provided by the fascine mattress.

In the case of a sand-impregnated geotextile the Specification will be as for Type 1 geotextile with the addition of the sand layer.

In the case of the formation of under water slopes using sand-filled geotextile bags to form containment bunds for hydraulically placed fill, the specification for the geotextile from which the bags are manufactured need not inferior to Type 1 geotextile. This is because the filtration and stability characteristics of the sand-filled geotextile bags will be a function of both the geotextile and the sand fill.

22.4.7 Joining of Geotextiles to Form Mattresses

Where geotextile rolls are to be joined to form a larger mattress, the joins shall be in accordance with the manufacturer's instructions. The joins may be made at the place of manufacture, or on site, subject to satisfactory demonstration that the joining process will not impair the strength, filtration or permeability characteristics of the geotextile when installed beneath the rock protection.

22.4.8 Lapping of Geotextiles

Overlaps between fascine mattresses are specified in Article 22.3.4.3.

Elsewhere laps between geotextiles shall be sufficient to ensure that the filtration function of the geotextile is not compromised during the placing of the revetment.

In no case shall laps be less than 300 mm.

Adequate provision to ensure correct overlays shall be included in the Contractor's Quality Assurance Plan.

22.4.9 Testing of Geotextile

The geotextile manufacturer(s) shall provide production test certificates at the rate of one set per 10 rolls delivered to site. Certificates shall be delivered to the Engineer at least 10 days before that batch of geotextiles is to be incorporated into the works.

Tests shall be carried out by an approved testing laboratory on samples taken from each quantity of 10,000 m^2 of geotextile. The samples shall be selected by a representative of the Engineer at the manufacturer's premises, unless the Engineer has allowed, in writing, the Contractor to select the samples himself Each specified parameter shall be tested for at least three times for each sample and the sample size shall be large enough for at least five of each test.

Testing of geotextile samples should also be done at site at 1 sample for each 25,000m^2 of geotextile. The Engineer will have the option to test those samples in any approved laboratory if sufficient testing facilities are not available at site.

The Contractor shall bear the expenses of all the routine tests. Notwithstanding the submission of reports to the effect that the geotextile conforms to the Specification, the Engineer shall at all times be entitled to have additional samples of geotextile tested (for any of the properties specified in Article 22.4.3 and 22.4.4) if he suspects that the geotextile does not conform to the Specification. The Engineer shall only select samples from ends of rolls or from already cut geotextile.

22.4.10 Transportation, Storage and Handling of Geotextile

All materials specified in this Article 22.4 shall be transported, handled and stored fully in accordance with the manufacturers recommendations. Geotextiles shall be kept in their

protective wrapping provided by the manufacturer's until they are required for use in the Works. Rolls shall not be stacked more than five rolls high and no other material shall be stacked on top of the geotextiles.

Products susceptible to UV degradation shall be wrapped to prevent UV exposure until immediately prior to usage. Unused portions shall be re-wrapped until used. Geotextiles used in the Works shall not be exposed to direct sunlight for more than 24 hours prior to being covered up by the revetment material.

Geotextile fabrics arriving on the site in containers shall be unpacked and stored until usage in locations or in a manner well sheltered from the sun. Sufficient ventilation under the shelter shall be provided so as to minimize the effects of high temperature thermo-oxidation.

22.4.11 Installation of Geotextiles

Geotextiles are required to provide an underlayer to the various slope protection (revetment) systems. The underlayer separates the revetment from the foundation material, allowing the passage of water but resisting movement of the fine soils which make up the bed and banks of the river.

The geotextiles shall be installed as described in this Specification, in the positions and to the lines and levels shown on the Drawings.

The method of installation shall not impose stresses or strains likely to cause damage to the geotextile. In this context, damage shall mean significant change in the specified properties, and/or puncturing or tearing of the fabric. The geotextile shall be free of folds and creases after placing.

The method of installation shall ensure that the geotextile is in continuous contact with the surface on which it is placed, without stretching or bridging over humps or hollows. This requirement establishes the dredged slope surface tolerances referred to in Clause 22.2.6. Construction plant must not operate directly on a geotextile.
When the revetment material is being placed on the geotextile, it must be done in such a manner as to avoid the risk of the fabric being punctured or the overlaps being displaced. In particular, the Contractor shall limit the height from which concrete blocks are dropped onto the geotextile. For concrete blocks dropped through water there shall be no restriction of the total drop, but the concrete blocks shall be released as close to the water surface as is practical for the type of plant utilized.

Concrete blocks shall be placed rather than dropped onto the geotextile. In the case of geotextiles placed under water, the Contractor shall demonstrate to the satisfaction of the Engineer, that his method of placing shall achieve the quality of construction implied by this Specification. The use of underwater inspection techniques is expected to be employed in the construction. In particular the Contractor shall demonstrate to the Engineer that:

- minimum laps have been maintained;
- no rock gets placed between overlapping mattresses;

- the underside of the geotextile is in contact with the underlying material;
- the fascines remain firmly connected to the mattress after sinking.

22.5 Rock For Riprap and Pitching

22.5.1 General

This Article of the Specification covers the requirements for collection, sorting, transportation, storage and handling of rock. Rock shall be angular rock obtained from blasting operations in a mass hard rock quarry. Boulders with smooth or rounded surfaces shall not be accepted regardless of source.

The source(s) from which rock will be obtained shall have sufficient capacity, to ensure timely completion of the slope protection works.

In selecting quarry sites, either in Bangladesh or elsewhere, the Contractor shall establish that there is sufficient quantity and sufficient output capacity to meet the construction schedule for the slope protection works and any temporary works for which the Contractor may require rock or stone boulders.

Rock used in the construction of the temporary works may subsequently be used in the permanent works, if this suits the Contractor's working methods and programme, provided that the grading of the rock recovered from the temporary works still conforms to the Specification.

22.5.2 Codes and Standards

The codes and standards to be followed are generally AASHTO, ASTM and B.S. or other equivalent standards approved by the Engineer.

Note:STP = Tests described in "Standard Laboratory Test Procedures Manual for Quality Control Laboratories", Bangladesh Road Research Laboratory (BRRL), June 1983

22.5.3 Requirements for Rock

Rock shall be supplied as per the following categories:

Table 22.1: Rock Grading:

Percentage by weight lighter than (%)	Acceptable Range of Stone Weights (kg)		
	Type A	**Type B**	**Type C**
100	100-160	150-250	150-250
80	75-110	110-160	110-160
50	50-80	65-100	65-100
33	35-55	50-75	40-65
15	15-30	25-40	1-20

The Contractor, when collecting or ordering rock (from an approved source, as detailed later in this Article), shall make due allowance for the inevitable breakage during handling and transport of the rock.

Rock, as placed in the Works, shall comply with the requirements given hereafter.

(a) The rock material shall not be polluted, and shall be free from dirt, sand, rock dust and elongated or flaky stones.

(b) The rock shall be free of cracks and veins which could lead to breakage during loading, unloading and dumping.

(c) Rocks shall be angular, rather than rounded, and shall all be of similar shape. The ratio between the smallest and the largest dimension of a single stone shall not be less than 0.5 as determined by the box method described in BS 812.

(d) Aggregate Crushing Value as determined by STP 7.7 shall be less than 30%. Ten Percent Fines Value as determined by STP 7.8 shall be minimum 125KN.

(e) The average specific gravity shall be a minimum value of 2.65 kg/in^3 in oven dry condition as per AASHTO T85.

(f) The weighed average loss of material in the magnesium sulphate soundness test (5 cycles) shall not be more than 12% by weight as per AASHTO T 104.

(g) Water absorption of rock material shall be 6% maximum as per AASHTO T85.

(h) The percentage of wear as determined by the Los Angeles Abrasion Test shall not be more than 30 as per ASTM C535.

(i) The rock material shall comply with the grading requirements.

22.5.4 Source(s) of Supply

Rocks shall be obtained only from sources approved in writing by the Engineer. The Contractor shall not obtain rock from other sources without the Engineer's written approval.

The information as outlined in this Article shall reach the Engineer as part of the programme to be submitted in accordance with Article 14 of the Conditions of Particular Application. Before the Engineer's approval is given for any proposed quarry source(s) an inspection of the source(s) by 3 No. representatives of the Engineer (including the Supervision Consultant, Sr. Materials Engineer and Sr. River Training Specialist) will be required. Such inspection is to be arranged by the Contractor, and all associated costs are to be borne by the Contractor and included in the unit rates for rock supply. Moreover, the Contractor shall within 4 months of the contract commencement date submit a comprehensive plan for an alternative source of supply of rock, including designation of the quarry, test data on the rock, permits, means of quarrying and crushing equipment required and source, and means of transport. The purpose is to enable a change in source of supply with minimum of delay in the event the primary source becomes unavailable for any reason.

If the primary source is in a foreign country, the secondary source shall not be in the same country.

22.5.5 Testing at the Source(s)

(a) Tests on rock materials at the source(s) shall be carried out by the Contractor, at his own expense. The Contractor shall adequately and satisfactorily perform the tests to confirm the specified standards in due time; test results shall be recorded and issued on standard test forms as approved in writing by the Engineer. All the materials necessary to perform the required tests shall be provided by the Contractor.

(b) Rock material shall be sampled and tested at the quarry site(s) at least twice and not more than times for each quantity of 10,000 tonnes. Test results on the approved forms shall be submitted to the Engineer for review at least 10 days before shipment to the site.

(c) The rock samples shall be tested for conformity with the Specification, as detailed below.

(d) The rock shall be visually inspected for coverage with mud and clay.

(e) The rock shall be visually inspected for cracks and veins which could lead to breakage.

(f) The ratio between the smallest and the largest dimension shall be determined according to BS 812: Part I.

(g) The Aggregate Crushing Value shall be determined according to STP 7.7. The Ten Percent Fines Value shall be determined according to STP 7.8.

(h) The specific gravity and water absorption of the rock material shall be determined according to AASHTO T85.

(i) Loss of material in a magnesium sulphate solution shall be determined according to AASHTO T104.

(j) Maximum Abrasion shall be determined according to ASTM C535.

(k) The grading of the rocks shall be confirmed by a combination of sampling and weighting, backed up by more frequent visual inspection.

(l) In the event that the results of the tests at the source(s) do not comply with the Specification, production of rock material shall be stopped until the producer has adjusted the production process and/or quarry operations in such a way that the produced stone material complies again with the Specification.

22.5.6 Testing at Destination

(a) Tests on rock materials, sampled as described below, shall be conducted under the supervision of the Engineer. The results of these tests will be used by the Engineer to determine compliance with the Specification in the Engineer's Laboratory or otherwise. Test results shall be recorded and issued on standard test forms. All the materials necessary to perform the required tests shall be provided by the Contractor, under the Engineer's supervision.

(b) Rock material delivered to site will be sampled randomly three times for each quantity of 5,000 tonnes.

(c) These three samples will be merged into one sample of at least 200 rocks for grading test and from the same lot the Engineer will select the material to be tested in the laboratory. Notwithstanding this sampling procedure, the Engineer may require the taking of additional samples from any consignment of rock if he has reason to suspect that it does not meet the Specification. All sampling and testing costs shall be borne by the Contractor.

(d) Samples for testing may be taken before or during the unloading of the rock material at the site from the means of transport. The Contractor shall deliver the merged sample to the Engineer's Laboratory where the tests will be performed.

(e) The tests to be performed are specified in Article 22.5.5 sub (d), (e), (f), (g), (h), (j) and (k).

(f) Should the Contractor want to re-use rock from any temporary works for incorporation into the permanent works, then such rock shall be sampled and tested for compliance with the Specification after it has been recovered from the temporary works and stockpiled. Based on the test results, the Engineer will determine whether such material can be incorporated in the permanent works.

(g) In the event that a supply or a part of a supply of rock material does not comply with the Specification that supply or part of that supply will be rejected, and removed from the site unless approved otherwise by the Engineer.

22.5.7 Stock Piling

(a) The Contractor shall submit a detailed plan for stockpiling of rock and stone material within 45 days after receipt of the Commencement Date. Stockpiles may be located in the Contractor's own working area. Should the Contractor wish to stockpile rock and stone materials at locations not forming part of the Site, then he shall make his own arrangements.

(b) The Contractor shall take all necessary steps to ensure that material of a stockpile shall not be contaminated or mixed with other materials.

(c) Any material dumped in a way not approved by the Engineer or spoiled as a result of the Contractor's operations shall be removed from the site by the Contractor immediately.

22.5.8 Delivery of Rock to the Employer

Upon Completion of the Works, the Contractor shall deliver to the Employer for his future use additional quantities of rock. The same testing procedure as indicated in Article 22.5.6 shall apply. Rock shall be stockpiled in the quantities and at the locations indicated on the Drawings or as directed by the Engineer.

22.6 Stone Boulders

Stone boulders, which may be used under the angular rock material as described in Article 22.3.4.2, should be naturally available rounded boulder and must comply with Article 22.5.3 (a), (b), (d), (e), (f), (g), and (h).

If the source of boulder material is from Sylhet (Bangladesh), testing of material at source (Article 22.5.5) will not be required. However the boulders should be tested at site as specified in Article 22.5.6 "Testing at Destination" and must comply with the Specification.

22.7 Concrete Blocks

22.7.1 General

Concrete for Concrete Block Revetment shall be Class 20/20 and shall conform to the requirements of Section 8 (Concrete Structures) of this Specification.

In addition, the Contractor shall comply with the following workmanship requirements:

- Concrete blocks shall have smooth finished surfaces and sharp edges. No plaster finishing will be accepted;
- The size of the concrete blocks shall not deviate from the each required size of 350 x 350 x 350 mm, 300 x 300 x 300 mm, 250 x 250 x 250 mm and 200 x 200 x 200 mm and each face shall be a perfect square;
- Handling of concrete blocks shall not be allowed before 7 days of curing.

- Casting of blocks may be done over another concrete block provided the lower block has been cured at least for 7 days and the two blocks are separated with suitable material, e.g. thick polythene etc.;
- Concrete blocks showing cracks, broken edges or honeycomb in the surface shall not be accepted;
- Concrete blocks containing protrusions, etc. shall not be accepted.
- Each block shall be marked with the date of casting.

22.7.2 Stock Piling

(a) The Contractor shall submit a detailed plan for stockpiling of concrete block within 45 days after receipt of the Commencement Date. Stockpiles may be located in the Contractor's own working area. Should the Contractor wish to stockpile concrete block at locations not forming part of the Site, then he shall make his own arrangements.

(b) The Contractor shall take all necessary steps to ensure that material of a stockpile shall not be contaminated or mixed with other materials.

(c) Any material dumped in a way not approved by the Engineer or spoiled as a result of the Contractor's operations shall be removed from the site by the Contractor immediately.

22.8 Working Records for Engineer's Inspection

The Contractor shall maintain records of all items of works executed in each day as follows in addition to his own working records:

a) Dredging

1. Operation of dredger in hours
2. Quantity of earth excavated, quantity of earth filled
3. Locations of dredging and filling including levels of the dredged and filled areas

b) Slope Protection Work

1. Number of concrete blocks manufactured
2. Area of concrete block pitching-A
3. Area of concrete block pitching-B
4. Number or area of fascine mattresses fabricated/sunk in position
5. Area and location of riprap with dumped concrete block
6. Volume and location of dumped concrete block at the edge of a mattress

c) Materials

1. Quantity of each type of materials arrived at Site and relevant stockpile locations.
2. Quantity of each type of material consumed in work.

The Contractor shall produce all these working records as and when required by the Engineer in addition to the weekly returns submitted by the Contractor in accordance with Article 0.5.3 of this Specification. The Engineer shall have access to all daily records of the Contractor for verification such as dredger log books, daily incoming and outgoing material register, weigh bridge records, daily operational roster of all plant and equipment, import invoices etc.

The Engineer shall have the right to be on board the dredger and other water based equipment and may request any of the working documents for the Engineer's inspection.