

## **SECTION III**

### **DIVERSION AND CARE OF RIVER DURING CONSTRUCTION AND UNWATERING FOUNDATION**

#### **301 GENERAL**

The Contractor shall be fully responsible for the successful diversion and care of the river and dewatering of all excavations, foundations and elsewhere as required to undertake construction works in the dry.

The Contractor shall construct and maintain all necessary cofferdams, channels, flumes, drains and sumps and/or temporary diversion and protective works during construction operations. The Contractor shall furnish, install, maintain and operate all necessary pumping and other equipment for the diversion and care of river and the removal of water from excavations, foundations and the various parts of the works as required for construction. After having served their purpose, all cofferdams or other protective works, unless otherwise directed by the Engineer, shall be removed or leveled to give a sightly appearance and so as not to interfere in any way with the operation of the Project.

If materials removed from "structure excavation" are used by the Contractor for the construction of cofferdams and other temporary protective works and are washed out and carried away by floods, or rendered unsuitable for "structure backfill" by virtue of such use by the Contractor, these materials shall be replaced by the Contractor at his own expenditures.

#### **302 METHOD OF CONSTRUCTION**

##### **a) Diversion and Care of River**

The Contractor shall submit to NIA for approval any amendment to his proposed schemes for handling the river during construction within 30 calendar days after the date of receipt of the Notice to Proceed.

The arrangement of the cofferdams and the materials used for their construction, the height of these structures, and the decision for scheduling diversion and care of the river shall be the responsibility of the Contractor. However, the location of the cofferdams, the materials used in these structures and the procedure of placing and compacting the fill materials shall be subject to the approval of the NIA. If steel sheet piles are necessary in the construction of the cofferdams, same shall be furnished and installed or driven by the Contractor and all expenses incurred thereof shall be considered included in the fixed lump sum price or lump sum bid price whichever is stated in the Bill of Quantities for the Diversion & Care of River during construction and unwatering foundation.

The Contractor's method of dewatering excavations and foundations shall be subject to the approval of the NIA. Where foundation excavation extend below the water table in common materials, the portion below the water table shall be dewatered in advance of excavation. The dewatering shall be accomplished in a manner that will maintain stability of the excavated slopes and bottom of the excavation and will result in all construction operations being performed in the dry. The Contractor will also be required to control seepage along the bottom of the excavation.

### **303 BASIS OF PAYMENT**

The cost of furnishing all labor, equipment and materials for construction of cofferdams, dikes, channels, flumes, sumps and other diversion and protective works, where required; maintaining the work free from water as required or removal of water from excavations and foundations; disposing of materials in cofferdams; and all other works required by this Section shall be included in the fixed lump sum price or lump sum bid price whichever is stated in the Bill of Quantities for the Diversion and Care of River during Construction and Unwatering Foundation. These items of work are not subject to price adjustment due to variation in quantities.

In order to have a working basis for making progress payments, the Contractor shall submit a detailed drawings of their proposed cofferdams covering several stages corresponding to the number of dry season period to enable computation of cofferdam fill volume. Payment for the construction of cofferdams for a certain stage can be made to the Contractor on a pro-rata basis using the cofferdam fill volume for that particular stage as proportioned against the total cofferdam fill volume for all stages and shall further be made on the following basis:

1. Fifty percent (50%) of the corresponding lump sum price will be paid after completion of the cofferdamming work.
2. Thirty percent (30%) of the corresponding lump sum price will be paid for maintenance after all works within the said enclosing cofferdam have been satisfactorily completed.
3. The remaining twenty percent (20%) of the corresponding lump sum price will be paid after the removal of all cofferdams and/or temporary diversion and protection works and corresponding clean-up operations shall have been satisfactorily undertaken by the Contractor.

All dewatering in excavations and foundations for structures along canals other than bridges and siphons which may pass across rivers are considered subsidiary works for the construction of said canal structures and will not be included for payment under this Section. The cost of such work shall be considered included under Section VI, Structure Excavation, in the Bill of Quantities.

## SECTION VI

### STRUCTURE EXCAVATION

#### **601 SCOPE**

Structure Excavation includes the removal of all materials within the structure lines including necessary dewatering operations not otherwise specified. It shall also include additional excavations within the vicinity of the structure in order to shape the ground as shown on the Drawings or as directed by the Engineer.

#### **602 CLASSIFICATION**

Structure excavation shall be classified in accordance with paragraph 402.

#### **603 CONSTRUCTION REQUIREMENTS**

All excavation requirements described in paragraph 403 are applicable under this Section.

#### **604 METHOD OF CONSTRUCTION**

All structures, where practicable shall be constructed in open excavation. The method of construction or excavations shall be in accordance with the applicable provisions of paragraph 404 and the following requirements.

Foundations shall be excavated according to the outline of the footings and floors of structure as shown on the Drawings or as directed by the Engineer, and shall be of sufficient size to permit free movement of workers.

On excavation of common materials the foundation bed upon which structures are to be placed shall be finished accurately to the established lines and grades after a thorough compaction and trimming of the foundation with the use of suitable tools and equipment. As soon as the foundation excavations have been trimmed to their final level, it should be protected from degradation by weathering. Should the foundation material soften through exposure then the soft material shall be removed and replaced at the Contractor's expense. If at any point, material is excavated beyond the lines and grades of any part of the structure, the over-excavation shall be filled with selected materials approved by the Engineer and shall be placed in layers of not more than 20 centimeters thick, moistened and thoroughly compacted by special roller, mechanical tampers or by other approved methods. A density not less than 90% of the maximum dry density determined by ASTM test D-698 is required. The cost of filling over-excavation ordered by the Engineer shall be borne by the Contractor.

On excavation of rock materials, the bottom and side surfaces of excavated rock excavation upon or against which concrete and weep holes are to be placed shall conform to the required grades and dimensions as shown on the drawings or as established by the Engineer. If at any point, materials are excavated beyond the required limits, the over-excavation shall be filled with concrete at the expense of the Contractor including the cost of all materials required.

When concrete is to be placed upon or against rock, the excavation shall be of sufficient depth to provide for the minimum thickness of concrete at all points and any deviation from the required minimum thickness of concrete shall be avoided as much as possible. The surface on which concrete will be laid shall be trimmed and thoroughly cleaned as directed by the Engineer.

When excavation of rock materials reaches the surface upon or against which concrete is to be placed, blasting shall be stopped and the remaining mass of rock shall be carefully removed by means of jack-hammer or any appropriate hand tool. The point beyond which blasting will not be allowed shall be determined by the Engineer. All damages to the rock foundation caused by improper blasting operation shall be repaired by the Contractor at his own expense in a manner acceptable to the Engineer.

All foundations for bridge pier footings shall be excavated to such depths as may be necessary to secure stable bearing for the structure. Whenever the safe bearing power of the soil as uncovered is less than that called for on the Drawings, pilings or appropriate spread footings will be used. The elevations of the bottoms of footings, as shown in the Drawings shall be considered as approximate, and the Engineer may order, in writing, such changes in elevations and dimensions of footings as may be necessary to ensure a satisfactory foundation. Bearing tests, upon written order of the Engineer, shall be taken to determine the supporting power of the soil. Cost of bearing test will be paid as "Extra Work".

If, in the opinion of the Engineer, the material at the base of the excavation is unsuitable for foundation he shall instruct the Contractor to either a) Carry out additional excavation to a depth of 50 cm. below the proposed bottom of concrete shown on the Drawings and to maximum depth of 60 cm. outside of the outermost lines of said base and replace with backfill compacted to at least 90% of the maximum dry density or b) strengthen the soft material by ramming in gravel and cobbles until a firm foundation is obtained. Measurement and payment for the backfill shall be made under Section XII, "Structure Backfill".

#### **605 METHOD OF MEASUREMENT**

Structure Excavation shall be measured by the cubic meter in its original position before being excavated in accordance with the Drawings, or as may be ordered by the Engineer. No excavation beyond the paylines shown on the Drawings will be measured for payment. For canal structures, the limit of measurement along the lines perpendicular

to the flow of water shall be the vertical planes at the outer edges of the inlet cut-off walls. The upper limits of the solid measured for payment shall be the canal bottom for canal structures or the original ground surface in case of diversion structures. The lower limit shall be the bottom of the required excavation. Excavated materials not vertically above the boundaries as specified above shall not be measured for payment. The volume measured shall not include water and other liquids removable by pumping. Such materials as mud, muck, quagmire and other similar semi-solids not removable by ordinary pumping shall be considered pay quantities and shall be measured and paid for as "Structure Excavation".

However, in case structure excavation for canal structures is done before canal excavation, the upper limit of the solid measured for payment shall be the original ground surface in accordance with the structure excavation paylines.

#### **606 BASIS OF PAYMENT**

The volume measured as provided above will be paid per cubic meter, which price and payment shall constitute full compensation for furnishing all materials, supplies, labor, equipment, tools and incidentals and subsidiary works necessary to complete the work described under this Section.

For diversion works, canal siphons and bridge structure excavations, the cost of dewatering operation unless otherwise specified in the Bill of Quantities shall be paid under a separate item in the Bill of Quantities. For all other structure excavations, dewatering operations involved are considered subsidiary works and the cost thereof shall be considered included in the unit price of structure excavation.

The Contractor shall be paid sixty percent (60%) of the pay quantities of the actual excavation acceptably accomplished in accordance with the paylines as shown on the Drawings or as directed by the Engineer. The remaining forty percent (40%) will be paid upon pouring of concrete for the foundation or upon placing of riprap, gravel blanket or grouted riprap in accordance with the Drawings and Specifications.

## SECTION XII

### STRUCTURE BACKFILL

#### 1201 SCOPE

The work under this Section shall include hauling (if necessary) and backfilling with suitable materials taken either from Structure Excavation, Canal Excavation, Side Borrow or Borrow Haul all spaces excavated and not occupied by the structure and spaces between the natural ground surface and the finish lines indicated to be filled and all other sections directed to be filled by the Engineer, all in accordance with these specifications and in conformity with the lines, grades and dimensions shown in the Drawings or as ordered by the Engineer. It shall also include the dewatering and removal of all unsuitable materials as ordered by the Engineer from the spaces to be backfilled or filled.

#### 1202 METHOD OF CONSTRUCTION

All spaces to be backfilled or filled shall be cleared of all rubbish and other objectionable matter. The excavation pit to be backfilled shall be dewatered and all mud and loose materials shall be removed before backfilling. The filling materials, with the proper moisture content determined by the Engineer, shall be deposited loose and in layers not exceeding 30 centimeters and then thoroughly compacted by ramming, rolling or by means of mechanical tampers or portable vibratory compactors to obtain at least 85% compaction behind bridge abutments, retaining walls, cut-off walls and immediately above pipes, box or barrel conduits and gradually increasing to at least 90% compaction up to the surface of the roadway in the case of approaches to bridges, Road Crossing or Culvert Structures. The time when to start backfilling operation shall be determined by the Engineer.

The compacted backfill above pipes, barrels and other conduits, shall be brought at least 60 centimeters before any compacting equipment utilized in embankment construction shall be used or allowed to pass. Additional layers above 60 centimeters can be completed by the use of roller type compacting equipment employed in embankment compaction.

Materials for structure backfill shall be as described in Paragraph 902 (c).

#### 1203 METHOD OF MEASUREMENT

Structure backfill shall be measured in cubic meters in its final compacted and uncompacted position within the limits of structure excavation paylines and surfaces of concrete in contact with the backfilled material as shown on the Drawings or as directed

by the Engineer. Volumes occupied by the structure and other features will not be included.

#### 1204 BASIS OF PAYMENT

Structure Backfill will be paid for at the contract unit price per cubic meter, which price and payment shall constitute full compensation for side borrow, borrow haul and overhaul operations and for furnishing all labor, equipment, tools and all incidentals and subsidiary works necessary for the successful completion of the work under this Section.

For newly constructed Drainage Culvert, the volume between the original ground surface and the top of the canal embankments is part of the embankment construction operation and therefore shall not be included for payment under this Section (which payment shall be included under embankment construction and compaction).

## SECTION XII

### STRUCTURE BACKFILL

#### 1201 SCOPE

The work under this Section shall include hauling (if necessary) and backfilling with suitable materials taken either from Structure Excavation, Canal Excavation, Side Borrow or Borrow Haul all spaces excavated and not occupied by the structure and spaces between the natural ground surface and the finish lines indicated to be filled and all other sections directed to be filled by the Engineer, all in accordance with these specifications and in conformity with the lines, grades and dimensions shown in the Drawings or as ordered by the Engineer. It shall also include the dewatering and removal of all unsuitable materials as ordered by the Engineer from the spaces to be backfilled or filled.

#### 1202 METHOD OF CONSTRUCTION

All spaces to be backfilled or filled shall be cleared of all rubbish and other objectionable matter. The excavation pit to be backfilled shall be dewatered and all mud and loose materials shall be removed before backfilling. The filling materials, with the proper moisture content determined by the Engineer, shall be deposited loose and in layers not exceeding 30 centimeters and then thoroughly compacted by ramming, rolling or by means of mechanical tampers or portable vibratory compactors to obtain at least 85% compaction behind bridge abutments, retaining walls, cut-off walls and immediately above pipes, box or barrel conduits and gradually increasing to at least 90% compaction up to the surface of the roadway in the case of approaches to bridges, Road Crossing or Culvert Structures. The time when to start backfilling operation shall be determined by the Engineer.

The compacted backfill above pipes, barrels and other conduits, shall be brought at least 60 centimeters before any compacting equipment utilized in embankment construction shall be used or allowed to pass. Additional layers above 60 centimeters can be completed by the use of roller type compacting equipment employed in embankment compaction.

Materials for structure backfill shall be as described in Paragraph 902 (c).

#### 1203 METHOD OF MEASUREMENT

Structure backfill shall be measured in cubic meters in its final compacted and uncompacted position within the limits of structure excavation paylines and surfaces of concrete in contact with the backfilled material as shown on the Drawings or as directed

by the Engineer. Volumes occupied by the structure and other features will not be included.

#### 1204 BASIS OF PAYMENT

Structure Backfill will be paid for at the contract unit price per cubic meter, which price and payment shall constitute full compensation for side borrow, borrow haul and overhaul operations and for furnishing all labor, equipment, tools and all incidentals and subsidiary works necessary for the successful completion of the work under this Section.

For newly constructed Drainage Culvert, the volume between the original ground surface and the top of the canal embankments is part of the embankment construction operation and therefore shall not be included for payment under this Section (which payment shall be included under embankment construction and compaction).

## **SECTION XIII**

### **EMBANKMENT CONSTRUCTION AND COMPACTION**

#### **1301 SCOPE**

The work under this Section shall consist of spreading materials taken from canal excavation, structure excavation, side borrow and borrow haul into canal embankments or protection dikes or approaches to bridges and road crossings and into all other embankments indicated on the drawings; moisture conditioning and then compacting said materials into the desired degree of compaction, all in accordance with the drawings and these specifications or as directed by the Engineer. All works associated with Side Borrow and Borrow Haul Operations, and Overhaul for canal embankment are considered subsidiary works for Embankment Construction and Compaction.

#### **1302 SOURCES OF MATERIALS**

Materials for embankment and structure backfill for canal and diversion structures may be taken from canal or structure excavation in accordance with Sections IV and VI. In case where excavated materials from canal prism or from structure excavations are insufficient or unsuitable for embankment formation, additional materials may be taken from side borrow or borrow haul areas not necessarily designated by NIA including acquisition of necessary right-of-way and access thereto. Likewise, materials for protection dikes and approaches to bridges and road crossing may be taken from sources at the Contractor's choice including acquisition of necessary right-of-way. However, possible borrow areas are indicated in the Bid Drawings or as suggested by the Engineer.

#### **1303 COMPACTION EQUIPMENT**

Compaction of canal or roadway embankments, protection dikes or approaches to bridges and road crossings or for backfill (if applicable) may be done by the use of the sheepsfoot roller, pneumatic rollers, vibratory compactors or other type of compaction equipment at the Contractor's option as approved by the Engineer. The suitability of the proposed compaction equipment to achieve the desired degree of compaction must be demonstrated during the initial phases of compaction operations. The Engineer shall have the right to require the Contractor to change compaction equipment if such equipment is deemed unsuitable in achieving the specified degree of compaction within a reasonable period of time.

Watering equipment for moisture conditioning of the embankment materials, prior to compaction, shall be designed to apply water uniformly at the rates required by NIA. Water tank trucks shall be equipped with positive shut-off valves such that no leakage will result from the nozzle when the equipment is not in used.

### **1304 METHOD OF CONSTRUCTION**

This paragraph covers the construction of all embankments designated on the drawings as compacted embankment including the placing of embankment materials to the low and over excavated areas in the canal. All compacted embankments shall be constructed to the lines, grades and dimensions shown on the drawings, or established by the NIA on a properly prepared foundations approved by the NIA. No objectionable materials shall be placed on the embankments.

Ground surface upon which the embankment is to be constructed shall be scarified to a depth of at least 15 cm. after clearing and grubbing, moisture conditioned, and compacted to not less than the required degree of compaction as shown in Table A below. Materials unsuitable for embankment foundations shall be removed as directed and replaced with suitable materials and compacted as compacted embankment.

Where canal embankment is to be constructed across low swampy ground or where the top soil is not satisfactory for foundation as determined by the Engineer, stripping of top soil of the foundation area and compaction will be ordered before construction of the embankment, stripping and disposal of the stripped material is subsidiary work and will not be measured for payment; Provided, however, that when stripping to a depth beyond 10 centimeters from the natural ground surface is ordered by the Engineer, the stripped materials below the 10 centimeters free stripping depth will be paid for under "Canal Excavation". In case stripping of the top soil exceeds 10 centimeters, the Contractor should request to NIA for a re-survey to determine the actual volume subject for payment. Verification and approval by the Administrator should be obtained first before proceeding with the stripping operation.

Embankments shall be constructed to the lines, grades and dimensions shown on the Drawings or as established by the Engineer. Embankments shall be constructed in horizontal layers which extend the full width of the embankment. Thickness of the layers shall not exceed 15 cm. after compaction. The moisture content of the material at the start of compaction shall have plus or minus 3% of the optimum moisture content as determined by the standard laboratory compaction test on soils (ASTM Designation D698). Embankment material which does not contain sufficient moisture for compaction in accordance with the above requirement shall be thoroughly mixed with additional water as directed by the Engineer. Embankment material containing excess moisture shall be permitted to dry to the proper consistency before being compacted. After a layer has been spread for the full width of the cross-section and brought to a satisfactory moisture content, it shall be compacted. The degree of compaction in each layer shall be determined by the standard field density test ASTM D-1556. Each layer should attain the required percentage of compaction before the succeeding layer is allowed to be placed. The compaction requirements for the different types of soil placed in embankments are as shown in the following table:

TABLE

Soil Classification and/or Proctor Maximum Dry Density Obtained	Minimum Compaction Required Percent of Inplace Density with Respect to Proctor Maximum Dry Density For	
	Roads, Dikes and Canal Embankments with roadway	Normal Embankment (without Roadway and Intrasite or Feeder Roads
L, SM & ML, 85-89		100%
CL, SM & ML, 90-99	100%	95%
SC, 100-109.9	95%	90%
CG, 110-119.9	95%	85%
GC, 120-129.9	90%	80%
GC, 130-and above	90%	80%

When embankments are to be made on hillsides, whether paralleling a hillside, abutting into a hillside or crossing over a hill, the slope of the original hillside shall be cut horizontally as the work is brought up in layers. Material thus cut shall be recompacted along with the new embankment material.

During construction, the Contractor shall keep the top of the embankments at such elevation and section to provide natural surface drainage at all times. If the Contractor stops work on any portion of the embankment on account of rain or impending rain, the surface shall be graded to facilitate drainage and the surfaces shall be sealed by passing rubber tired equipment or flat drum rollers over the surface. Before work is resumed on the area, the surface shall be scarified to a minimum depth of not less than 15 cm., releveled, moisture conditioned, and recompacted to the specified density.

Should the NIA determine that any portion of the surface of the embankment has become so dry or glazed during construction that bond with the succeeding layer to be placed thereon cannot be obtained, or should ruts develop on the embankment, such surface shall be scarified to a minimum depth of 15 cm., releveled, moisture conditioned and recompacted to the specified density just prior to placing of the succeeding layer of the embankment.

All surfaces of the compacted embankment shall be compacted to the lines, and grades shown on the Drawings or as directed by the Engineer with the tolerances in accordance with Paragraph 403 (b) for slopes and surfaces and a tolerance of + 10 cm. for profile surfaces and shall be graded to a uniform slope.

Canal embankments for roadways shall be constructed only up to the elevation of the base of the road surfacing material. The road shoulders shall be placed and compacted together with the road surfacing materials.

### **1305 METHOD OF MEASUREMENT**

Measurement shall be done by the cubic meter of embankment in its final accepted, compacted position less the volume for road surfacing materials if any, regardless of the origin of materials and the required degree of compaction. Computation shall be by the Average End Area Method for every 20 M station or by the applicable method suitable for the work involved. The volume shall be the theoretical volume of the embankment as computed based on the neat lines or paylines shown on the Drawings. The lower limit shall be the elevation of the ground surface after stripping and the upper limit shall be the top of the embankment.

### **1306 BASIS OF PAYMENT**

The volume measured for embankment as provided above shall be paid at the contract unit price per cubic meter, the price and payment shall constitute full compensation for any side borrow, borrow haul and overhaul operations made, stripping of foundations (where necessary), spreading, blending, moisture conditioning and compaction and trimming side slopes (where necessary) including all labor, tools, equipment and all incidentals and subsidiary works, necessary for the successful completion of the work described under this Section. Provided, however, that payment shall only be made after presentation by the Contractor of a certification issued by the NIA Materials Testing Engineer to the effect that the constructed embankment measured and covered by such progress payment has attained the required degree of compaction.

## **SECTION XVII**

### **CONCRETE STRUCTURES**

#### **1701 SCOPE**

The Contractor shall construct all concrete structures shown on the Drawings.

Concrete shall be proportioned, mixed, placed, finished and cured as specified in Section XV, Concrete, except as modified herein. The sequence of construction of the structures shall be subject to the approval of the Engineer. Where the thickness of any portion of a concrete structure is variable, it shall vary uniformly between the dimensions shown. Cement mortar plastering is not allowed in the construction of structures, unless otherwise specified elsewhere in these Specifications.

#### **1702 CONCRETE CONSTRUCTION**

All concrete construction shall conform to the provisions of Section XV, Concrete and the detailed requirements of the following paragraphs. Concrete finished shall conform to Paragraph 1519 and/or shall be as noted on the Drawings.

All structures shall be built to the specified lines, grades and dimensions. The location of all construction joints shall be shown on the Drawings or as approved by the Engineer. Construction joints shall be constructed as shown on the Drawings. The Contractor shall place and embed or attach to each structure all timber, metal or other accessories necessary for its completion as shown on the Drawings or as directed by the Engineer.

The dimensions of each structure shown on the Drawings will be subject to change as may be found necessary by the Engineer to adopt the structures to actual field conditions and conditions disclosed by excavation.

#### **1703 METHOD OF MEASUREMENT**

Measurement for payment of any and all classes of concrete will be made by the number of cubic meter computed to the neat lines of the structure, unless otherwise specifically shown on the Drawings or specified in these Specifications. In the event cavities resulting from careless excavation or from excavation performed to facilitate the Contractor's operations, as determined by the Engineer, are required to be filled with concrete. Such refilling will be made by at the expense of the Contractor. In measuring concrete for payment, the volume of all openings, embedded pipes, woodwork and metal work within the concrete will be deducted.

## **1704 BASIS OF PAYMENT**

Payment for any and all classes of concrete in various parts of the work will be made at the applicable contract unit prices per cubic meter which price and payment shall include cost for furnishing all materials, equipment and labor, and all operations required in the construction as specified under Section XV, Concrete, except that payment for reinforcing bars and joint materials will be made at the applicable separate contract unit prices in the Bill of Quantities.

If during the implementation of the project, the sources of aggregates differ from those chosen by the Contractor considered in the derivation of his unit bid price for concrete, the Contractor shall not be entitled to any claim for unit price adjustment as a result of such alteration of sources.

## **1705 CONCRETE FOR ALL STRUCTURES**

### **(a) General**

The item "Concrete for All Structures" in the Bill of Quantities include all concrete in diversion works (except Rubble Masonry), canal structures and road structures such as siphons, bridges, drainage culverts, road crossings, pipe crossings, ungated thresher crossings, control structures, drop structures, headgates and turnouts and all other structures not otherwise specified elsewhere in these Specifications.

Small concrete structures, at the option of the Contractor, may be installed as precast units provided that precast structures installed in place are equal in all respect to cast-in-place construction as specified in these specifications.

Concrete for diversion works, canal structures and other structures will be measured and paid for as specified in Paragraphs 1703 and 1704, respectively. Structures not fully and acceptably completed will not be measured for payment. Precast structures installed and acceptably completed in place shall be paid for as specified in Paragraph 1704.

All materials used like cement, admixtures, aggregates and steel reinforcing bars shall conform to the provisions of Section XV, Concrete and Section XXIII, Reinforcing Steel Bars, respectively. Classes of concrete to be used shall be those specified in the Drawings.

### **(b) Curing and Joints**

All concrete shall be cured in accordance with paragraph 1522, except that concrete for canal siphon shall be cured until the concrete test cylinders shall have attained a strength of at least 210 kg. per square cm. (3,000 pounds per square inch).

The Contractor shall construct expansion and construction joints at sections specified on the drawings all in accordance with the provisions of paragraph 1517 and Section XXI, Concrete Joints and Joint Materials, and elsewhere in these Specifications.

## **1706 PRE CAST CONSTRUCTION**

### **(a) Scope and Description**

Pre-casting of reinforced concrete may be resorted to as an alternative to poured-in-place concrete for certain structures such as headwalls and collars, parshall flumes, turnouts, division boxes, and other structures. Should the Contractor choose to employ pre-cast construction on these structures, he must so inform the Engineer in writing, submitting in detail his proposed design, modifications of concrete sections, concrete specifications, reinforcements and schemes of construction of all pre-cast units. The NIA may further required the Contractor to submit all other additional informations as may deemed necessary.

The NIA may approve the construction proposed on precasting of concrete with or without correction. The approval, however, does not relieve the Contractor of any responsibility if such work does not meet specified results.

Reinforced concrete pipes and concrete hollow blocks are not considered pre-cast construction, hence, are excluded under this Section.

### **(b) Transporting and Placing**

Extreme care should be observed in handling, storing, moving and erecting to avoid cracking, twisting, or other distortions that would result to cracking or damage to the precast concrete. Pre-cast concrete members shall be handled, transported and erected in an upright position and the points of support and directions of the reactions with respect to the members shall be approximately the same as when the member is in final position.

### **(c) Sampling and Testing**

The individual components of precast concrete structures, shall conform to the applicable provision of Section XV, Concrete and will be subject to the usual test for reinforced concrete.

### **(d) Measurement and Payment**

Measurement of concrete in pre-cast structures will be measured by the number of cubic meter. It shall be computed to the neat lines as if these structures were constructed to the details shown on the Drawings.

The Contractor will be paid for all pre-cast structures acceptably installed or completed in place. He shall be paid for each pre-cast unit as if the units were constructed to the details shown on the Drawings, regardless of the actual dimensions of the pre-cast unit.

#### **1707 LEAN CONCRETE**

In the construction of siphons, the bottom of the cast-in-place concrete barrels will be exposed to high velocity flow of seepage during pouring which will absorb or wash out the cement in the concrete poured. To minimize the effect of seepage, a blinding concrete with minimum strength of 70 kg/sq. cm. shall first be poured to the lines, grade and dimensions on which the barrels will be constructed as shown on the Drawings.

Lean concrete shall be measured and paid for as specified in paragraphs 1703 and 1704, respectively.

#### **1708 STAFF GAGES**

The Contractor shall install two vertical staff gages, one upstream and one downstream, in all parshall flumes and turnouts with valve structures and in all check structures in the laterals as shown on the Drawings or as directed by the Engineer. The porcelain plated or enameled steel staff gages and other materials and accessories necessary for the installation shall be supplied by the Contractor.

Installation of staff gages will not be measured for payment including all the channels, anchors, anchor bolts and other metal materials necessary to install the staff gages at the parshall flumes and check structures. The cost of installation and other materials supplied by the Contractor shall be included in the contract unit price for concrete in the respective structure where gages are required.

## **SECTION XIX**

### **RUBBLE MASONRY**

#### **1901 SCOPE**

The work under this Section shall include furnishing all materials, supplies, tools and equipment; construction of all necessary form work; placing rubble stone and concrete binder on an approved foundation and form work; the removal of forms and curing of the rubble masonry, all in accordance with the Drawings and these Specifications or as directed by the Engineer.

#### **1902 MATERIALS**

Rubble stones shall consist of field stones that are clean, sound, durable, resistant to the action of water, and must have specific gravity of at least two and six tenths (2.6), and diameters ranging from 15 centimeters to 60 centimeters, sixty per cent (60%) which comprises the bigger sizes. Stones shall have the prior approval of the engineer before their use. Materials for concrete binder shall be in accordance with the applicable provisions of Section XV. Concrete binder shall be Class "A" concrete with 37.50 millimeters maximum size of aggregates.

#### **1903 METHOD OF CONSTRUCTION**

Preparation and handling of the concrete binder shall be in accordance with Section XV. The stones shall be thoroughly wet before they are installed in place. The entire surface of every stone shall be thoroughly covered with concrete binder. In general, one cubic meter of rubble masonry will require one-half cubic meter of concrete binder. Actual variation in this proportion will not entitle the Contractor to any price adjustment. It is expected that the whole rubble masonry especially in the case of dam and apron as well as other structures should be well encased and covered by the concrete so that it forms the hearting of the body of dam and apron and will act contiguous with the concrete shell. This can be achieved by tamping the stones into the concrete using heavy wooden blocks handled by one or two people. After the bed has been prepared as required the first layer of mortar should be laid and rubble embedded in them. The thickness of mortar should be such that each rubble could be embedded at least 50 % of its longest dimension in the mortar so that when the next layer of mortar is poured the rubble which has been embedded is not disturbed. The next layer of boulders can be arranged in the mortar now placed following the same procedure. This will ensure that all the boulders are fully covered with mortar and they are well entrenched and stable in the mortar so that they are not disturbed when subsequent layers of mortar stones are poured. The stones shall be well set such that no stone will project beyond the lines indicated on the Drawings. The concrete binder shall be properly worked into the spaces between stones so that no void is left within the rubble masonry. In case reinforcements are

placed, no stone shall be closer than four inches (10 centimeters) to the nearest reinforcing bars. Rubble masonry shall be cured by water for five days.

The general construction procedure should be always to start from lowest elevations so that the sub-grade on which the concrete is laid is not disturbed by the seepage forces when the higher layers are excavated and prepared for concrete pouring.

In situations where rubble masonry is directly constructed on the sub-grade, the sub-grade should be prepared exactly as for any other concrete structures. In these cases, also the first layer can consist of concrete of 15 centimeters thickness in the case of minor structures and 20 centimeters in the case of major structures. The concrete manufacture etc. will be as specified under Section XV and the strength will be as of Class "A" concrete.

#### **1904 METHOD OF MEASUREMENT**

"Rubble Masonry" will be measured in cubic meters in its final position based on the neat lines of the structure as shown on the Drawings.

#### **1905 BASIS OF PAYMENT**

The volume measured as provided above will be paid at the contract unit price per cubic meter, which price and payment shall constitute full compensation for furnishing all materials, supplies, labor, tools, equipment and all incidentals or subsidiary works necessary for the successful completion of the work described under this Section.

## SECTION XXIII

### REINFORCING STEEL BARS

#### 2301 SCOPE

All reinforcing steel bars required for the works as detailed in the Construction Drawings or as directed by the Engineer shall be furnished by the Contractor.

The work under this Section includes the hauling of all reinforcing steel bars required for the works to the project site, storing, cutting, bending and proper placing, all in accordance with the drawings and these Specifications.

The length for each size of reinforcing steel bar to be furnished by the Contractor shall be computed by taking the theoretical length of steel bars shown on the drawings multiplied by 1.07 to get the approximate length required for the work. All reinforcing steel bars shall be furnished in commercial standard lengths and the Contractor shall cut and bend the reinforcing steel bars to the detail and dimensions shown on the Drawings.

#### 2302 MATERIALS

All reinforcing steel bars to be furnished by the Contractor shall be Grade 40 or PS 275, deformed type and conforming to the requirements of ASTM A-615. The nominal dimensions and unit weights of bar designation shall be in accordance with the following table:

Nominal Bar Diameter	Unit Weight (kg/m.)	Nominal Dimensions	
		Cross Section Area (sq.mm.)	Perimeter (mm.)
6 mm.	0.222	28.27	18.85
8 mm.	0.395	50.27	25.13
10 mm.	0.616	78.54	31.42
12 mm.	0.888	113.10	37.70
16 mm.	1.579	201.10	50.27
20 mm.	2.466	314.20	62.83
25 mm.	3.854	491.90	78.54
28 mm.	4.833	615.75	87.96
32 mm.	6.313	804.25	100.53
36 mm.	7.991	1,017.90	113.10

The nominal diameter of a deformed bar is equivalent to the diameter of a plain bar having the same weight per unit length of the deformed bar.

## **2303    CONSTRUCTION REQUIREMENT**

Workmanship shall be at the highest grade and shall be in accordance with the latest standard practice of the industry.

1. **Cutting and Bending.** Cutting and bending of reinforcing bars may be done in shop or at the job site. All bending works shall be in accordance with the latest standard practice and by approved machine methods. Radii for bends and hooks will be specified on the approved detailed reinforcement Drawings in accordance with sound design procedures.

2. **Placing.** Reinforcement shall be laid, anchored and embedded in the concrete as shown on the Drawings or as directed by the Engineer. Unless otherwise directed, the spacing of reinforcement bars shall be measured along the center line of the bars. Reinforcement shall be inspected for compliance with requirements as to size, length, splicing, position and number after placement based on the approved reinforcement drawings.

Before reinforcement are placed, the surfaces of the bars and the surfaces of any metal bar support shall be cleaned of heavy flaky rust, loose scales, dirt, grease or other foreign substance which, in the opinion of the Engineer, are objectionable. Heavy flaky rust that can be removed by firm rubbing with burlap or equivalent treatment is considered objectionable. After being placed, the reinforcing bars shall be maintained in a clean condition until completely embedded in concrete.

Reinforcing bars shall be accurately placed and secured in position so as to avoid displacement during the pouring of concrete. Special care shall be exercised to prevent any disturbance of the embedded reinforcement during the setting of concrete. Metal chairs, hangers, spacers or other approved support may be used by the Contractor for supporting reinforcing bars. Metal supports shall be galvanized when they are to be exposed to view on completed concrete surfaces or where it is use will contribute in any way to the discoloration or deterioration of the concrete.

3. **Relation of Bars to Concrete Surfaces.** The minimum cover for all reinforcements shall conform to the dimensions shown on the detailed reinforcement Drawings.

4. **Splicing.** All splices in reinforcement shall be as shown on the Drawings or as directed by the Engineer. The lapped ends to bars shall be either supported sufficiently to permit the embedment of the entire surface of each bar in concrete or shall be securely wired.

5. **Welding.** Welding of bars shall be performed only where shown on the Drawings or as authorized in writing by the Engineer and shall conform to the requirements of AWS: D12.1, latest revision. All welders employed shall show proof of

their welding qualifications to the Engineer. All welding shall be done using metal arc welding, pressure gas welding, submerged arc welding or thermit welding. All electric shall be acceptable to NIA. Coverings of low hydrogen electrodes must be thoroughly dry when used. The surfaces to be welds shall be clean and shall be free from rust and dirt. All welds shall develop the full strength of the bar or the smaller bar when two different sizes are welded. Test will be required of not more than five percent of the welds. Approved testing equipment for testing welds shall be furnished by Contractor.

**6. Protection.** Reinforcement to remain exposed and intended for future concrete embedment shall be protected from corrosion or other damages in an approved manner where directed. The reinforcement protection shall be of such nature that it can be thoroughly cleaned without difficulty prior to encasement in concrete.

#### **2304 PREPARATION OF REINFORCEMENT DRAWINGS**

Contractor shall submit for the approval of NIA detailed reinforcement drawings in accordance with Article GC-47. These drawings will include bar-placing drawings, bar bending drawings, bar list, and any other reinforcement drawings as may be required to facilitate placement and checking of reinforcing bars. No work shall be done by contractor until such approval has been secured from NIA.

The Reinforcement Drawings submitted shall show the name of the structure location by stationing where the reinforcement drawings is intended and all the necessary informations required by NIA. It shall likewise bear the stamp or seal of Contractor as evidence that the Drawings have been checked by Contractor.

Contractor shall be held responsible for any delay in the progress of the work occasioned by his failure to observe the requirements and the time for the completion of the contract will not be extended on account of his failure to promptly submit said drawings in strict adherence herewith.

#### **2305 SAMPLING FOR TESTING AND ACCEPTANCE OF MATERIALS THAT FAIL TO MEET CONTRACT REQUIREMENTS (FOR STEEL BARS FURNISHED BY CONTRACTOR)**

Sampling of reinforcing steel bars furnished by the Contractor for incorporation in the Permanent Works shall be carried out by NIA at the manufacturer's stockyard before delivery to the project site. The NIA authorized representative shall, at random, take two representative samples of reinforcing steel bars per lot covered by the manufacturer's mill certificate. A lot shall consist of all steel bars of the same heat or blow as shown in the mill certificate, and the same nominal cross-section and grade. Samples shall be tested at the manufacturer's testing laboratory, if any, or to any approved Government testing laboratory at Contractor's expense. A lot or lots represented by samples tested which failed to meet specified requirements shall be rejected and will not be counted for delivery to the project site. Sampling and testing

shall be in accordance with ASTM requirements. All deliveries shall be subject to prior approval of NIA.

The NIA reserves the right to accept steel bars that fail to meet the contract requirement provided that the deficiency is not more than nine percent (9%) of the requirement per each type of test and provided further that a corresponding reduction in the unit price will be made. The percentage of reduction equal to the percentage of deficiency based on the minimum requirement of the ASTM A-615 Standard. For example, if the value of the test result for one type of test is five per cent (5%) below the minimum requirement, the unit price for payment will be reduced by 5%. If the non-compliance with the test requirements is on two or more tests, the price reduction will be the summation of the percentage of the deficiencies.

## **2306 METHOD OF MEASUREMENT**

### **A. Furnishing and Stockpiling**

Measurement for payment for the furnishing and stockpiling of reinforcing steel bars shall be made on the actual deliveries to the project site and after presentation of the following documents:

- a) Delivery receipt duly acknowledged by the Engineer and the Project Auditor or their duly authorized representatives
- b) Manufacturer's certificate showing the details of manufacture, composition and physical properties of the steel bars.
- c) Certificate of acceptance by the Engineer of the actual quantity delivered at the site

### **B. Cutting, Bending and Placing**

Measurement for payment of reinforcing steel bars will be made on the weight of reinforcing steel bars actually placed with the concrete structure and drilled holes for anchorage in accordance with the Drawings and Bar Schedule approved by NIA or as directed by the Engineer and weights will be computed based on the published manufacturer's weights or in the absence thereof, on the weights specified in the table presented in Paragraph 2302. Steel bars in laps or splices indicated in the approved reinforcement Drawings, as required by NIA will be measured for payment. Additional steel bars in laps which are authorized for the convenience of the Contractor and such items as wires, clips, chairs, or other devices for securing the steel bars in place will not be measured for payment. Where weld splices are specified on the Drawings, weld splices will not be measured for payment but the weight for its equivalent lap splices will be measured for payment instead. Where contractor chooses to weld reinforcement bars for his convenience and welding is not specified, no separate payment will be made for such

welds. Where Contractor substitute welded splices for lapped splices, separate payment will not be made for such welds, but instead the weight for the lapped splices shown on the Drawings will be measured for payment.

### **2307 BASIS OF PAYMENT**

Payment for reinforcing steel bars measured as provided above, will be paid for at the contract unit price per kilogram which price and payment shall constitute full compensation for furnishing all labor, tools, equipment and all incidentals and subsidiary works necessary for the successful completion of the work described under this Section.

As indicated in the Bill of Quantities, payment per kilogram of reinforcing steel bars (same measurement as provided above) shall be made separately and in accordance with the following schedule:

- a) Ninety percent (90%) of furnishing and delivery cost which shall include all labor, tools, equipment and supplies involved in the manufacture, and delivery to the project site which includes loading, hauling, unloading and stockpiling at the delivery site;
- b) Ten percent (10%) of furnishing and delivery cost shall be paid upon successful completion of the works under this Section.
- b) installation cost which shall include all labor, tools and equipment involved in cutting, bending and placing into permanent structures and all incidentals necessary for the successful completion of the work under this Section.

## **SECTION XXVII**

### **GROUTED RIPRAP**

#### **2701 SCOPE**

The work under this Section shall include furnishing and placing appropriate sizes of stones or spalls for riprap and grouting the riprap with cement mortar, in accordance with the Drawings and these Specifications or as directed by the Engineer. The stones and spalls shall be obtained from quarry areas or stockpile areas designated by the Engineer.

#### **2702 MATERIALS**

Stones for riprap shall be at least 15 centimeters in diameter and shall be sound, tough, durable, dense and resistant to the action of air and water with a specific gravity of at least two and six tenths (2.6).

Mortar for grouted riprap shall consist of one part cement to three parts sand by volume and sufficient water to produce a thick and creamy mixture conforming to the provisions of Section XV, Concrete.

#### **2703 METHOD OF CONSTRUCTION**

##### **A) NON-SLOPING GROUTED RIPRAP**

The foundation bed shall be moistened, well compacted and brought to the required elevation. The stones shall be well laid with close joints by hands. The stones shall be well arranged in such a manner that the stones can resist disturbance. If big spaces occur between stones and formation bed, said spaces shall be well packed with spall of appropriate sizes of stones. The stones so arranged shall be moistened before placing the grout. All spaces between the stones shall be completely filled with grout from bottom to top and the surface swept with stiff broom. The first layer shall consist of at least 15 centimeters mortar and the boulders should be embedded in this mortar. Thus the mortar poured is worked into the interstices so that the whole mass of boulders from bottom to top is covered and connected with mortar and will act as one mass. The grouted riprap shall be cured with water for a minimum period of three (3) days.

##### **B) SLOPING GROUTED RIPRAP**

The slope where the grouted riprap is going to be constructed should be well cured and compacted and trimmed to the required grade and elevation. If the grouted riprap is on the slopes of the embankment, the embankment is constructed to the required degree of compaction. The first layer of 15 centimeters thick mortar should be laid to a height of 60 centimeters to 90 centimeters and to a length which can be handled conveniently so that there is no initial set of mortar. The stones shall be well laid with close joints by hands and shall be well arranged in such a manner that the stones can resist disturbances. If big spaces occur between stones and formation bed, said spaces shall be well packed with spalls of appropriate sizes of stones. The stones so arranged shall be moistened before placing the grout. This will act as base to the subsequent lifts. The next lift can be 1 to 1.25 meters height. Thus the whole sloping grouted riprap should be constructed in 1 to 1.25 meters height lifts at a time. All spaces between the stones shall be completely filled with grout from bottom to top and the surfaces swept with stiff broom. Thus the mortar poured is worked into the interstices so that the whole mass of boulders from bottom to top is covered and connected with mortar and will act as one mass. The grouted riprap shall be cured with water for a period of three (3) days.

The general construction procedure should be always to start from lowest elevations.

#### **2704 METHOD OF MEASUREMENT**

Grouted riprap will be measured by the number of cubic meter of materials acceptably placed and computed based on the neat lines as shown on the Drawings.

#### **2705 BASIS OF PAYMENT**

The volume measured as provided above shall be paid at the contract unit price per cubic meter, which price and payment shall constitute full compensation for furnishing all labor, tools, equipment, supplies and materials and all incidentals or subsidiary works necessary for the successful completion of the work described under this Section. Excavation involved under this Section is not considered a subsidiary work hence, it will not be measured for payment under this Section. Rather, it will be measured and paid for under "Structure Excavation".

## **SECTION XXVIII**

### **GRAVEL BLANKET**

#### **2801 SCOPE**

The work under this Section shall include furnishing, placing on approved subgrade and compacting the graded sand and gravel to the thickness indicated on the Drawings or as established by the Engineer.

If required on the drawings, the furnishing and installation of filter fabric shall also be included in this Section.

#### **2802 MATERIALS**

Materials for the gravel blanket shall meet all the requirements for 50 mm coarse aggregate specified in paragraph 1507.

#### **2803 PLACING**

The material shall be dumped on the prepared subgrade and spread in layers having an uncompacted thickness of not more than 25 centimeters. Each layer shall be compacted to achieve a relative density of 70% as determined by USBR Test E-12 by four complete passes of a vibratory compactor. The Contractor has the option to adopt any method of compacting the layers of materials approved by the Engineer.

If filter fabric is required on the drawings, the Contractor shall install or lay said fabric on prepared subgrade prior to dumping of materials.

#### **2804 METHOD OF MEASUREMENT**

Gravel Blanket will be measured by the cubic meter of materials acceptably placed and computed based on the neat lines and dimensions shown on the Drawings.

If materials placed by the contractor are more than what is required, the excess materials will not be measured for payment.

Filter fabric shall be measured separately and shall be paid in accordance with the provisions of Section XXIX, Filter Drain.

#### **2805 BASIS OF PAYMENT**

The volume measured as provided above shall be paid at the unit contract price per cubic meter, which price and payment shall constitute full compensation for furnishing all materials, supplies, labor, tools, equipment and all incidentals or subsidiary

works necessary for the successful completion of the work described under this Section. Excavation involved under this Section is not considered a subsidiary work, hence it will not be measured for payment under this Section. Rather, it will be measured and paid for under Structure Excavation.

## SECTION XXIX

### FILTER DRAIN

#### 2901 SCOPE

The work under this Section shall include furnishing, placing on approved subgrade and compacting graded sand and gravel in layers and to the thickness and dimensions indicated on the Drawings, including furnishing and construction of weep holes to provide outlet for filter and flap valve, if any, all in accordance with these Specifications or as directed by the Engineer.

#### 2902 MATERIALS

Filter materials shall consist of unweathered sand and gravel obtained from river bed deposits or from designated quarries. To meet the gradation requirements, crushing, screening and washing may be required. The materials shall be composed of tough, durable particles, reasonably free from thin, flat and elongated pieces and shall be well graded between the following limits:

U. S. Standard Seive Size	Percent Passing by Weight			
	1st Stage	2nd Stage	3rd Stage	Bedding
2 inches			100	100
1 inch		100	5-35	70-90
1/2 inch	100	90-100	0-5	45-75
No. 4	85-100	70-90		25-60
No. 8	70-95	40-75		15-45
No. 16	50-85	10-40		0-20
No. 30	25-70	0-20		
No. 50	5-50			
No. 100	0-30			
No. 200	0-10			

#### 2903 METHOD OF CONSTRUCTION

The bed for the filter drain shall be excavated to the required elevation and dimension shown on the Drawings and then properly compacted as directed by the Engineer. The materials shall be damped and spread on the prepared bed and each layer shall be compacted by a suitable compactor to a degree approved by the Engineer. Placement of succeeding layers will be allowed only after the Engineer has approved the placement and compaction of the preceding layer. When concrete is to be placed directly

on the filter, the entire surface upon which concrete is to be placed shall be covered with a layer of reinforced building paper before concrete is placed.

**2904 METHOD OF MEASUREMENT**

Filter drain will be measured by the number of cubic meter of materials acceptably laid, compacted and provided with weepholes for outlets and flap valves, if any.

**2905 BASIS OF PAYMENT**

The volume measured as provided above shall be paid at the contract unit price, which price and payment shall constitute full compensation for furnishing all materials, supplies, labor, equipment, tools and all incidentals or subsidiary works necessary for the successful completion of the work described under this Section. Reinforced building paper required to cover the filter shall be included in the unit bid price for applicable concreting works.

## SECTION XXXII

### STEEL SHEET PILES

#### 3201 SCOPE

All steel sheet piles required for the works as detailed in the Construction Drawings shall be furnished by the Contractor unless otherwise specified in the Bill of Quantities.

#### 3202 DRIVING STEEL SHEET PILES

A trench well below the bottom of the pile cap shall be excavated and where necessary falsework to support the sheet piles shall be erected.

Driving the steel sheet piles shall be done with the use of drop or steam hammer or by any similar approved driving equipment. The use of water jets will not be allowed.

Pile driver lead shall be constructed in such manner as to afford freedom of movement of the hammer and shall be held in position by sufficient guys. Unless authorized by the Engineer, the use of follower will not be allowed.

The steel sheet piles shall be driven vertically to the full length, true to the lines and grades indicated on the Drawings and they shall interlock with each other from the top to the bottom. Steel sheet piles that deflect badly or refuse to penetrate further on account of obstructions in the subsoil shall not be forced. In such cases, the driving of steel sheet piles down the line shall continue, leaving the obstinate pile or piles projecting above the rest. The obstructions shall thereafter be removed by excavation when all parts of the piling wall have been properly set. It is best to place the sheet piles in the line and then work them down gradually rather than drive each pile down to the required grade in a single operation. Whenever necessary, suitable falsework shall be provided to serve as guides in driving the sheet piles into proper position. After driving the steel sheet piles to the required grade, the trench shall be backfilled in manner satisfactory to the Engineer.

Should it be found impractical to drive the steel sheet piles, open excavation shall be restored to and the steel sheet piles shall then be placed in accordance with the Drawings. The steel sheet piles shall be braced to maintain their vertical position during the process of backfilling of the excavation trench. Backfilling shall be done simultaneously on both sides and shall progress at the same rate. Materials for backfill and degree of compaction will be determined by the Engineer. Steel sheet piles installed in this manner shall be considered as driven. No allowance for extra compensation will be allowed when this method is employed.

**3203 METHOD OF MEASUREMENT**

Steel sheet piles will be measured per linear meter of steel sheet piles delivered and accepted to the project site and acceptably driven to grade as shown on the Drawings.

**3204 BASIS OF PAYMENT**

As indicated in the Bill of Quantities, payment shall be made separately for:

a) Supply and Delivery Cost

For the supply and delivery of steel sheet piles which includes loading, hauling, unloading and stockpiling at the jobsite.

b) Driving Cost which include all labor, tools and equipment needed in driving the steel sheet piles (the length of steel sheet piles to be paid as measured above shall be limited from the tip of piles to the ground surface elevation) and all incidentals necessary for the successful completion of the work under this Section.

## SECTION XXXIII

### STEEL GATES AND LIFTING MECHANISM

#### **3301 SCOPE**

The Contract work calls for the fabrication, supply, delivery and installation supervision of steel gates, stoplog, lifting mechanism, embedded parts including all accessories and field painting all in accordance with these specifications and the drawings:

#### **3302 STANDARDS AND SPECIFICATIONS**

All materials and equipment to be incorporated in the works shall conform to the latest applicable standards and specifications as specified in the Contract Documents or to approved equivalent applicable standards and specifications established and adopted in the country of manufacture of the materials and equipment.

Reference to standards and specifications or to materials shall be considered as followed by the words "or equivalent". Contractor may propose equivalent standards, specifications and materials which shall conform to that specified.

If Contractor proposes equivalent standards and specifications or equivalent materials, Contractor shall state the exact nature of the change, and shall submit complete standards and specifications of the materials for the approval of NIA.

Such submittals shall be along with the bid and failure to do so, or purchase of any proposed equivalent materials prior to approval of NIA, will be at the Contractor's risk.

Abbreviations of the titles of official bodies which issue standards or specifications whenever referred to in these specifications are as follows:

ASTM	-	American Society for Testing Materials
AISC	-	American Institute of Steel Construction
AISI	-	American Iron and Steel Institute
ANSI	-	American National Standards Institute
AISE	-	Association of Iron and Steel Engineers
AWS	-	American Welding Society
JIS	-	Japanese Industrial Standards
SSPC	-	Steel Structures Painting Council
AGMA	-	American Gear Manufacturers Association
SAE	-	Society of Automotive Engineers

**3303 MATERIALS**

**A. General**

All materials shall be new and shall be the best available for the purpose for which they will be used, considering strength, ductility, durability for the intended service and best engineering practice.

Materials to be used for the various components of gates and hoists shall conform to the following specifications:

Components	Material	International Specifications
Fixed wheel gates frames, girders, sill beam, rail beams, guide frames, seal clamps and other miscellaneous fabricated parts	Structural Steel	ASTM A36 Specifications for Structural Steel
Gate Wheels & Guide Rollers	Wrought Steel	ASTM A-504/A-148 Specifications for Wrought Carbon Steel
Wheel pins	Corrosion Resistant Steel	ASTM A-276 Specifications for Hot-Rolled and cold finished corrosion resisting steel bars Type 316
Seal seats and clamp plates for rubber seals	Corrosion Resistant Steel	ASTM A-240 Specifications for Chromium-Nickel Stainless Plate, Sheet and Strip
Standard steel bolts, nuts and washers	Galvanized Steel	ASTM A-307 Specifications for Low Carbon Steel Externally Threaded Fasteners
High strength steel bolts, nuts and washers	Carbon Steel	ASTM A-325 Specifications for Steel bolts and studs with suitable nuts and plain washers
Rope drum	Cast steel	ASTM A-27/ASTM A-36 Specifications for mild to medium strength carbon steel castings for General Applications
Gears/Pinions	Cast Steel/Forged Steel	ASTM A-27/ASTM A-291 Specifications for Alloy and Carbon Steel Forgings for Gears and Pinions
Worm Gear	Phosphor Bronze	SAE 65
Worm	Case hardened Ground Steel	AISI-3120

Iron Castings		ASTM A-48, Class 30
Stems & Shaftings	Carbon Steel	ASTM A-108, Grade 1018 or Grade 1117 Specifications for cold finished carbon steel bars and shaftings
Wire Rope	Improved Plow Steel	R R W-410 Fed. Specifications
Bronze bushings, bearings, washers	High Lead Tin Bronze or Manganese Bronze	ASTM B-144 or B-147
Covers	Mild Steel	ASTM A-36
Bronze casting for lift nut, thrust nut	Manganese Bronze	ASTM B-147 Specifications for Manganese Bronze Sand Castings- Alloy 8A
Anti-friction Bearing		Ball & Roller Bearings shall be equivalent to those manufactured by SKF Industries
Gear Housing Oil Seals		Spring loaded and made of synthetic compound enclosed in a metal retainer, "Synthetic Seals" or equivalent
Lubricating Fitting		Alemite type 1610-3 or equivalent

Rubber Seal

The rubber seal shall be molded from natural or synthetic rubber containing not less than one percent by weight of copper inhibitor and shall have the following physical properties:

Property	Limit	ASTM-Test
a) Shore A Durometer Hardness	65 + or - 5	D-675
b) Minimum Elongation	450 percent	D-412
c) Ultimate Tensile Strength (min.)	14.5 N/sq.mm	D-412
d) Water Absorption (70 <sup>0</sup> C - 7 days)	Less than 10% by weight	D-471
e) Tensile strength after accelerated ageing test of 48 hours in oxygen at 70 <sup>0</sup> C and 2.1 N/sq.mm pressure	80 or more percent of strength before ageing	D-572
f) Compression Set (Max.)	30 percent	D-395

**B. Tests of Materials**

- i. All materials, supplies, parts, assemblies used for the work to be done under these Specifications shall be tested according to modern approved methods

for the particular type and class of work. Certified copies in triplicate of the tests made and results thereof shall be made available to NIA as soon as possible. The data shall be in such a form as to provide means of assessing compliance with the applicable relevant specifications for the material tested. The Contractor shall state in his tender the place of manufacture, testing, inspection of the various components of the work included in the contract.

- ii. Wherever required, at their discretion, NIA may nominate an Inspector to inspect the tests or trials on their behalf. Sufficient notice must be given by the Contractor to the Inspector to enable him to reach the site of tests/trials except the pay and expenses of the Inspector shall be included in the quoted price. All authorized representatives of NIA shall have free access to the work premises of the contract at all reasonable times and shall be provided by the Contractor full facilities and safety to inspect the process of manufacture and the materials used. NIA will reject any material/work that in their opinion does not conform to the specifications and will order the same to be removed and replaced or altered at the expense of the Contractor to conform to the specifications.
- iii. If materials are not referred to in the applicable Standard Specifications but are required to have certain physical and /or chemical properties, such properties shall be checked by two chemical samples for each 5 tons of materials and fractions thereof in each lot. For lots less than 250 kilograms, Contractor's warrants will be acceptable in lieu of actual tests provided heat treatment of the fabricated parts using such materials is not required. A lots shall consist of all materials of the same physical size and conditions submitted at one time in which the material is from the same melt or heat and on which any subsequent heat treatment has been performed at the same conditions. Not more than two heat treatment to attain the desired physical properties shall be permitted.
- iv. Notwithstanding the above tests, examination and inspection, the Contractor shall be responsible for the acceptability of the finished work.

### **C. Manufacturing/Fabrication Program**

- i. The fabricator/manufacturer shall prepare a manufacturing/fabrication program in Bar Graph Form showing the activities and its sequencing in sufficient details such that the contract works can be properly monitored from commencement to completion.
- ii. The fabricator/manufacturer shall submit said program within thirty (30) calendar days after the date of receipt of Notice of Award.
- iii. The fabricator/manufacturer shall show the target dates for commencing and completing the principal activities as required for in the contract works including but not limited to the following:

- a. procurement of materials and the like
- b. fabrication and manufacture
- c. painting
- d. delivery dates

#### **D. Pre-fabrication Inspection Works**

- i. The fabricator/manufacturer shall be required to submit mill and/or manufacturer's certificate for the steel materials, welding electrode, paints, etc. intended for use in the works.
- ii. Materials to be used in the fabrication shall be adequately sampled and tested to check its compliance with the specification/standard requirements.
- iii. No fabrication work and/or use of materials in such works shall commence unless materials for said works are duly inspected, tested, and certified by NIA or his authorized representatives as to conformity with the specification/standard requirements.
- iv. NIA technical inspector shall prepare and submit inspection and acceptance report on materials for use in the fabrication works.

#### **E. Inspection Works During Actual Fabrication**

- 1. The NIA should assign a knowledgeable and experienced technical inspectors, to conduct inspection.
- 2. The NIA's authorized technical inspector shall be entitled at all reasonable time free access to the manufacturer's/fabricator's plant to conduct inspection during fabrication, to ascertain that all the works shall comply in all aspect with the standards and requirements set forth in the contract documents.
- 3. The NIA technical inspectors shall monitor progress and conduct of the fabrication works and prepare and submit progress report on said works at regular intervals.

#### **F. Final Inspection Works**

- 1. Intake Gates, Main Canal Gates, Lateral and Turnout Gates
  - i. The NIA technical inspector shall conduct final inspection based on the approved fabrication drawings and specifications.
  - ii. The gates should be properly marked with the corresponding identification as per approved schedule of dimension such as size of gate, lateral, stationing for proper identification by the end user.
- 2. Sluice Gate, Barrage, Stoplog and Radial Steel Gates

- i. The NIA technical inspector should see to it that all component parts should be properly pre-assembled at the fabricator's/manufacturer's shop to ascertain the proper fitness of all adjoining parts and should be properly punch mark before disassembling for guidance and reference during field installation.
- ii. The NIA shall issue certificate of pre-delivery inspection and acceptance of completed fabrication works as a basis for the final inspection and acceptance by the field office of deliveries made at the site.

### **3304 WORKMANSHIP**

#### **A. General**

- i) All works shall be performed in accordance with the best modern practice of the manufacturer of high grade machinery. All parts shall have accurately machined mounting and bearing surfaces so that they can be assembled without filing, chipping, or remachining. All parts shall conform accurately to the design dimensions and shall be free from any defect in workmanship or material that will impair their services. All attaching bolt holes shall be accurately drilled to the layout indicated on the approved drawings. The steel gates shall be completely shop assembled to insure the proper fit and adjustment.

#### **B. Welding**

##### *i) General*

Whenever welding is specified or permitted, the electric arc welding process, manual or machine welding shall be used.

Contractor shall provide adequate amount of materials for each type of welding and shall specify the materials on all relevant drawings. Contractor shall also provide detailed drawings showing joint preparation required for each type of welding to be carried out on the site.

##### *ii) Preparation*

The parts to be joined by electric welding shall be cut precisely to the correct size by machine methods suitable for the type of weld to be used and to allow the proper penetration and good fusion of the weld with the base metal. The cut surfaces shall not have visible defects such as scabs, superficial defects caused by shearing or torch cutting operations or any other damaging effect. The surfaces of a 40 mm wide strip on each side of the plate adjacent to the edge and

the edges to be welded shall be free from rust, oil, grease and other foreign matter.

iii) *Lamination*

Any plate in which lamination has been discovered after cutting shall be rejected unless the laminated portion of plate is local and can be cut out and replaced by the welding of a sound plate in the cut out area with the approval of NIA. Repaired surfaces shall be ground smooth to assure neat appearance.

iv) *Welding Methods and Welder's Qualifications*

The welding method that would be employed by the Contractor shall be submitted to NIA for approval. Welds shall be balanced as far as possible to minimize distortion. Welding shall conform to AWS D1.1, Parts Procedures (Welding of Stressed Structural Components) not only with regard to workmanship but also with regard to qualifications of welders. Welders should be certified in the trade and such certification shall be submitted to NIA.

v) *Electrodes*

Contractor shall indicate on all detailed drawings the type and size of electrode he proposed for use for shop and/or field welding.

In general, welding electrodes for structural steel shall conform to Table 1.17.2 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

Contractor shall provide the net quantity plus ten percent (10%) of each type of electrode required to complete each field welded joint.

**C. Non-Destructive Testing**

i) *General*

All tests shall be conducted with the approval of NIA and the cost of tests shall be borne by the Contractor.

Radiographic, ultrasonic, magnetic particles or liquid dye penetrant tests shall be conducted on components as specified below. Where ultrasonic or magnetic particle tests indicate the possibility of a flaw, the suspected part shall be tested by radiography. All flaws shall be removed by thermal or mechanical gauging processed and replaced by welding. The replacement weld and contiguous parts of the original weld, if any, shall then be tested radiographically. All radiographs shall become the property of NIA.

The acceptability of parts inspected by magnetic particle and liquid dye penetrant test and the acceptability of use of these methods will be subject to agreement between Contractor and NIA.

ii) *Welds*

Radiographic examination shall be applied to the whole length of butt welds in plate furnishing stressed members.

Ultrasonic examination shall be applied to all other stressed groove welds.

Radiographic and ultrasonic examination shall be in accordance with AWS D1.1, Section 6.

iii) *Castings*

Castings shall be of fine grain quality and the surfaces which do not undergo machining, particularly those of steel or iron in contact with water, shall be dressed smooth in the foundry with all joints blended into adjacent surfaces and shall be free from foundry irregularities, such as projections, ridges, hollows, honeycombing, pock marks, blow holes and crack or chip marks, so that they will not require surface smoothing operations prior to painting. All defects shall be fully explored and castings shall be repaired, plugged or welded to the satisfaction of NIA.

iv) *Carbon Steel Plates and Shapes*

Carbon steel plates, shapes, bars, etc. for welded construction shall conform to materials specifications ASTM A-36, Steel shapes shall be in accordance with ASTM specifications. Plates from which webs, flanges and other stressed members are cut shall be ultrasonically tested for laminations according to ASTM A-578 at the place of manufacture.

v) *Forgings*

Forgings shall conform to ASTM A-668 Class D and shall be free from defects affecting their strength and durability, including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive non-metallic inclusions and segregations.

The largest fillets compatible with the design shall be incorporated wherever a change in section occurs.

Tool marks or tearing of the metal by the finishing tools will not be acceptable on the surface of fillets. Such marks if it occurs, shall be removed by grinding or polishing. All finished surfaces of forging shall be smooth and free from tool marks.

All forgings in excess of 150 mm diameter shall be subjected to examination internally for the detection of flaws and to heat treatment for the relief of residual stresses.

#### **D. Fastenings**

- i) All screws, bolts, studs and nuts shall be of International Standard (Metric) form of threads. Bolt heads and nuts shall be hexagonal. Hexagonal recesses shall be provided in the head of countersunk head bolts and machine screws. The bolt length shall be such as to ensure that at least two full threads are projecting after the nut has been tightened.
- ii) Nuts and bolts for pressure containing parts shall be of best quality bright steel machined on the shank and bearing faces of head and nut.
- iii) Where there is risk of corrosion, bolts shall be finished flush with the top of the nut after tightening, except in cases where the connected components are required to be frequently removed for replacement or adjustment when the bolts and nuts shall be of corrosion resisting steel or bronze.

All nuts shall be provided with washers, parallel or taper as appropriate. Mechanical locking devices of an approved form shall be provided where there is a possibility of nuts becoming loose due to vibration. Spring type washers will not be permitted where they maybe damaged any protective coating. Special locking compounds may be used as an alternative to mechanical devices subject to NIA approval.

#### **E. Structural Work**

- i) Unless otherwise, specified, design and fabrication of structural parts shall conform to the applicable provisions of the AISC "Specifications for the Design, Fabrication and Erection of Structural Steel in Building" of the AISC "Code Standard Practice for Steel Building and Bridges".

#### **F. Machine Work**

All tolerances, allowances and gauges for metal shall conform to the ASA Standard B42, Tolerances, Allowances and Gauges for Metal Fits, for the class of fits as required.

Finished contact or bearing surfaces shall be true and exact to secure full contact. All holes or field assembly with bolts shall be accurately located and drilled for shop assembly. Journal surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to insure proper operation when assembled. All drilled holes for bolts shall be accurately located and drilled from template.

### **3305 PROTECTION OF MACHINED SURFACES**

Machined finished surfaces shall be thoroughly cleaned of foreign matter. Finished surfaces of large parts and other surfaces shall be protected with wooden pads or other suitable means. Unassembled pins and bolts shall be oiled and wrapped with moisture resistant paper or protected by other approved means.

### **3306 FABRICATION**

#### **a. General**

All members shall be free from twist, bonds or other deformations, and all surfaces that will be in contact shall be thoroughly cleaned before assembling.

All parts shall be cut accurately to the dimensions shown on the drawings. All edges shall show sound metal, free from laminations, surface cracks and other injurious defects.

Bumping or heating will not be allowed. Parts shall be adjusted to fit, and shall be firmly bolted or otherwise held securely together so that surfaces are in closer contact before welding is commenced. Close adherence to the dimensions and tolerance called for in the drawings is required.

#### **b. Straightening**

Rolled materials shall be straight and true before being laid out or worked. Necessary straightening shall be accomplished by methods that will not injure the metal. Sharp kinks or bents will be considered causes for rejection.

#### **c. Bending**

Where bending or forming of plates or shapes is required, the plates or shapes shall be bent to the proper curvature by cold forming. Heating shall not be employed except with specified approval of the Administrator, and special precautions, therefore shall be taken to avoid overheating. Prior to rolling or bending the plates, the edges shall be pressed properly to the correct curvature, as

determined by templates, to produce continuity from the edges. Corrections of curvature by hammering will not be permitted.

d. Shearing, Chipping and Flame-Cutting

All plates or shapes shall be cut accurately to shape and size, with the edges to be joined by welding formed properly to suit the selected type of welding and to allow thorough penetration of the weld metal. Sheared edges shall be machined to a depth of not less than one-quarter of the thickness of the materials, to remove surface cracks caused by the shearing operation. Flame-cut edges shall be uniform and smooth and shall be free from loose scale and slag accumulations before being welded. Whenever possible, flame-cutting shall be guided by mechanical means. No materials shall be cut by electric arc. Chipping shall be done neatly and accurately, and exposed edges, shall be smooth.

e. Preparation for Field Welding

All necessary chipping, grinding, leveling and other preparation for joints or splice to be made by field welding shall be done in the shop.

f. Punching

In punch works, holes in materials having a thickness of less than three-quarter of an inch may be punched to full size. Holes in material having a thickness equal to or greater than three-quarter of an inch shall be drilled to full size. All holes shall be clean-cut, without torn or ragged edges.

g. Drilling, Reaming, Countersinking and Tapping

Unless otherwise called for on the drawings and except where reaming or tapping is required or where tight bolts are to be used, full sized drill and/or reamed holes shall be not less than 1.59 millimeter not more than 2.38 millimeter larger than the nominal drilled and/or reamed perpendicular to the face of the member and if necessary, shall be drilled to a template. Countersinking, where required, shall be true and square with the holes. Outside burns shall be removed. Tapped holes shall be drilled to the proper diameter for the tap used and shall be tapped carefully so that the threads will be continuous, smoothly cut, and free from imperfection.

h. Tolerance

Contact faces of gates and guides shall not depart more than 1 millimeter from a plane surface. Bottom contact edges shall not depart more than 2 millimeters from the designated planes. Fits, tolerance and finish when not

specified, shall conform with the best modern shop practice in the manufacture of finished products of similar nature.

i. Lubrication

Before assembly all bearing surfaces, journals, grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly each lubricating system shall be filled with an approved lubricant.

**3307 GENERAL DESCRIPTION OF THE INSTALLATION AND OPERATING ARRANGEMENT**

**A. Sluice Gates**

Sluice gates as shown on the Drawings are to be installed to desilt the sluiceway. The gates shall be of fixed wheel type. Each gate shall consist of an upstream skin plate supported by vertical and horizontal stiffeners spaced at required intervals which in turn shall be supported by end vertical girders. Wheels are to be mounted on the end vertical girders and provided with necessary bronze bushings. The total horizontal load on the gate shall be transmitted through the wheels on to the wheel track plates fixed on the piers with necessary embedments. Rubber seals on sides and bottom shall be provided on the upstream side of the gate to render the gate leak proof.

**B. Intake Gates**

- i) Intake Gates of different sizes as shown on the drawing are to be installed to regulate the flow of water through the intake. The gates shall be of sliding type. Each gate shall consist of a downstream skin plate supported by vertical stiffeners spaced at required intervals and horizontal girders which in turn shall be supported by end vertical girders. The total horizontal load on the gate shall be transmitted to the vertical frame fixed on the piers with necessary embedments. The details of construction are shown in the NIA bid drawings.
- ii) The gates are to operate at water level corresponding to normal and high flood level condition and the operation is hydraulically unbalanced.
- iii) The gates are to be operated through manually operated pedestal lift with rising stem, of adequate capacity.

**C. Flap Gate**

a. *General*

Flap gates are to be installed to allow free flow through the gate and to close automatically to prevent backflow should a head reversal occur.

b. *Flap Cover and Frame*

The flap gate cover shall be made of steel and shall consist of an upstream skin plate supported by vertical and horizontal stiffeners spaced at required intervals. Music note type rubber seals shall be provided on the two sides as well as on the top and bottom of the upstream side of the flap to render the gate leak proof. These rubber seals shall be fixed to the flap by means of clamp steel plate and stainless steel bolts.

The flap gate shall be provided with arms mounted on steel hinges of the double pivot type using stainless steel pins and bronze bushings. A concrete counterweight shall be provided and attached to the arms in such a way that its position is adjustable in order to ease the opening of the flap gate. Final position of this counterweight will be determined by the field office.

All edges of the gate opening where the music note type rubber seal is in contact shall be provided with stainless steel seal seats. This seal seats shall be fixed/welded to the steel frames embedded on the concrete.

**3308 STRUCTURAL DESIGN CRITERIA FOR GATES**

a. General

The design shall ensure that:

- 1) The gates shall be reasonably watertight.
- 2) They shall be capable of being raised or lowered by the hoist at the speed specified.
- 3) Since all the gates are for regulation, they shall be held in partially open position within the range of travel to pass the required discharge without undue vibration.

b. Wheels and Wheel Tracks

- 1) The gate wheels shall be suitable to withstand the stresses developed due to the loads they carry.
- 2) The wheels and wheel tracks shall be machined true and shall operate smoothly without vibration and without undue drift.
- 3) The hardness of wheel track shall be 50 points Brinell Hardness Number (BHN) higher than the BHN of the wheel tread.

c. Wheel Bearing

- 1) The wheel bearing shall be bronze bushing with grooves for lubrication.

d. Wheel Pin

- 1) The wheels shall be mounted on fixed pins and the pin shall be harder than the bushing. Wheel pin shall be of stainless steel and the contact surfaces shall be finished smoothly.
- 2) The wheel pin shall be of cantilever type with support from the cantilever box of the end vertical girder. The rigidity of cantilever box should be ensured.

e. Seals and Accessories

- 1) Seals shall be fixed by means of stainless steel seal clamps and galvanized steel bolts to ensure positive water pressure between the seal and the gate and to bear tightly on the seal seat to prevent leakage. Edges of seal clamp adjacent to seal bulb shall be rounded.
- 2) Side rubber seals shall be flat or angle shape type - Bottom seal may be of wedge type.
- 3) The initial interference of side rubber seals shall be 3 mm pre-compression. The projection of bottom wedge seal shall be 6 mm. Suitable chamfer shall be provided at the bottom of skin plate/clamp plate to accommodate the bottom wedge seal in compressed position.

f. Guides and Sill Frames

- 1) The guide frames and sill frames shall be composed of steel plates and steel sections so built up as to suit the gate structure. They shall be securely fixed in concrete by means of anchor members to ensure that all hydraulic loads exerted on the gate will be safely carried and transmitted to the concrete works.
- 2) The guide frames shall be true and shall be sufficient for the lifting height of the gate.
- 3) The side seal seat shall be stainless steel with a minimum width of 75 mm. The seal seat shall be fixed on the seal seat base by welding. The fixing of the seal seat on its base shall ensure rigidity and watertightness. The seal seat shall be finished smooth and the edges shall be rounded/chamfered to prevent damage to the seal.

- 4) All the seal seat base including the sill beam shall be embedded in concrete.
- 5) Sill beam flange width shall not be less than 100 mm and the length shall cover the entire waterway. The seal seat (stainless steel plate) welded to the top flange shall be at least 25 mm wider than the top flange width of sill beam. It shall be flushed with surrounding concrete. Each end of sill beam shall have provision for the connection of each side vertical frame to facilitate their location.

g. Embedded Parts

- i) All structural parts of the guides, seal seats, wheel tracks shall be constructed straight and be free from twists and warping. The ends of sections of side guides shall be machined so that when assembled, the finished surfaces of adjoining sections shall be flushed and ends shall butt firmly to form watertight joints. The faces of all seal seats shall be in a true common plane and this plane shall be parallel to the plane tangent to wheel-track face. The ends of track sections shall also be machined smooth and square so that when tracks are assembled to the track base, the ends of adjoining sections shall butt firmly.

**3309 HOISTS**

**A. Hoist for Sluice Gate**

1. *General*

- a) The Contractor shall provide manually operated rope drum hoist of adequate capacity complete in every respect along with hoist supporting units and all accessories that would be required for the satisfactory operation of the sluice gates.
- b) Each hoist mechanism shall consist of gear reducers, wire ropes, rope drums, shaftings, bearings, sprockets for diesel engine drive and all other mechanical accessories for the satisfactory operation of hoist.
- c) The hoisting equipment shall be designed to raise, lower and hold the gate in any position between fully opened and fully closed positions. Hoisting equipment shall be enclosed in dust proof housing with suitable lugs and eye bolts for handling.
- d) The complete equipment shall rest on a steel base framework which shall rest on the pier top.

**B. Mechanical Parts**

### 1. *General*

- a) The components of the hoist mechanism shall be so proportioned as to take the severest load coming on individual components.

### 2. *Wire Rope*

- a) The wire rope shall be made from improved plough steel of 6 x 37 construction with steel center, right regular lay, preformed and lubricated.
- b) A turnbuckle shall be provided on one side of the wire rope connecting the gate and hoist to equalize the tension in the rope. Turnbuckle and wire rope fitting shall be galvanized.
- c) The breaking strength of wire rope shall be as per standard manufacturer's specifications.
- d) The strength of socket end of wire rope shall be approximately equal to the strength of the rope itself. The ends shall be safely secured against twisting.

### 3. *Drums*

- a) The groove drum shall be of such size that there will be not more than one layer of rope on the drum when the rope is in its fully wound position.
- b) The length of drum shall be such that each lead-off rope has minimum two full turns on the drum when the gate is at its lowest position and one spare groove for each lead-off of the drum when the gate is at its highest position.
- c) If the ends of the drum are flanged, the flanges shall project to a height not less than two rope diameters above the rope. A spur gear secured to the drum may be regarded as forming as one of the flanges.
- d) The lead angle (fleet angle) of the ropes shall not exceed 5 degrees or 1 in 12 on either side of helix angle of groove in the drum.
- e) The drum shall be made of cast steel.
- f) The drum shall be machined groove. Grooving shall be finished smooth and edges between groove rounded. The contour at the bottom of the grooves shall be circular over an angle of at least 120 degrees. The groove radius shall be 0.53 times the diameter of rope. The depth of groove shall not be less than 0.35 times the diameter of the rope.

- g) The pitch of the grooves shall be such that the clearance between adjacent turn of rope is at least:

1.5 mm for ropes up to 12 mm diameter

2.5 mm for ropes over 12mm diameter up to 30 mm diameter and

3.0 mm for ropes of over 30 mm diameter

- h) The ends of the rope shall be fixed to the drum to such a way that the fixing device is accessible. Each rope shall be wound at least two turns before it is fixed (dead wrap).

#### 4. *Gearing*

- a) The reduction units of the hoist shall be composed of spur gears, bevel gears, worm and worm gears. The gears shall be machined cut with smooth finish.
- b) Tooth form of spur and bevel gears shall be 20 degrees full depth involute system.
- c) Spur and bevel gears shall be of cast steel, forged steel or surface hardened steel. The gears and pinions shall be made from two different grades of materials; the higher strength grade material for the pinion.
- d) Standard worm and worm gears shall be high grade reduction unit of good efficiency suitable for long service life. The proportioning of parts therein shall be in accordance with the best engineering practice. The bearing section of the rotating shaft shall be fitted with anti-friction bearings designed for thrust and radial loads and the helical angle of the worm shall be designed for self-locking.
- e) Keys in gear trains shall be fitted and secured that they should not work loose when in service.
- f) Gears shall have removable housing with provision for convenient access for lubrication. All bolts and cap screws shall be provided with lock washers. All machined units shall be thoroughly cleaned to ensure that they are free of cutting and objectionable and abrasive material.

#### 5. *Shafts*

- a) The shafts shall be designed for appropriate torque/load that is being transmitted. Shafts shall have liberal factor of safety for strength and rigidity and shall have adequate bearing surfaces. They shall be finished smooth and, if shouldered, shall be provided with fillets of large radius.

- b) All shafts shall be designed for safety against simple bending, pure torsion and the combined effect of bending and torsion.

#### 6. *Bearings*

- a) All the running shafts shall be provided with ball, roller or bush bearings. Selection of bearings shall be done on consideration of duty, load and speed of the shaft.
- b) Bearings shall be easily accessible for lubrication and/or replacement.

### C. **Intake Gate Hoists**

#### 1. *General*

Intake gate hoist shall be manually operated. The pedestal lift shall be crank operated and the direction of rotation of the crank to open the gate shall be clearly indicated on the lifting mechanism.

#### 2. *Manual Operation*

- i) The manual operation should be designed in such a manner that the continuous effort per man does not exceed a crank force of 98 Newtons (10 Kgf) with 400 mm of crank radius at a continuous rating of 24 RPM.

#### 3. *Gate Stem, Coupling and Stem Guides*

- i) Stems shall be of cold finished steel. Each stem shall be of adequate size to safely withstand operation of the gate (both raising and lowering) under the specified head and shall be furnished in sections of suitable length with necessary couplings to facilitate removal and replacement, if necessary. The couplings shall be of the same materials as the stem and shall be safely pinned, bolted or threaded and keyed to the stem. The bolts and pins shall be of stainless steel. The stems shall be provided with suitable stop nuts with provision for adjustment to prevent damage to the bottom of the gate due to overrun of the gate when closing.
- ii) Stem guides shall be as recommended by the manufacturer and shall be adjustable in two directions. Stem guides shall be provided with either bronze-bushed cast iron or steel collars bolted into place.

#### 4. *Pedestal and Lifting Mechanism*

- i) The pedestal shall have a cast bronze lift nut threaded to fit the operating stem. Ball thrust bearings shall be provided above and below the flange of this lift nut to take the computed maximum thrust developed in opening and closing the gate.
- ii) Gears shall be of cast steel accurately machined with cut teeth and smooth operating with drive shafts running in bronze sleeve bearing of ample size.
- iii) All gears and bearings shall be enclosed in a cast iron housing. The gears and bearings shall be easily accessible for maintenance and lubrication. The housing shall be adequate to withstand the tropical climate.
- iv) The lift mechanism shall be provided with a cast iron or structural steel pedestal machined and drilled to accommodate the gear housing and suitable for bolting to the operating floor.
- v) The crank shall be of cast iron and detachable and provided with a rotating handle.

#### **D. Lubrication**

##### *1. General*

- i) All bearings, journals and locations where sliding between parts takes place shall be provided with adequate means of lubrication.
- ii) Adequate seals shall be provided wherever necessary to prevent the escape of lubricants during normal operation and the entry of foreign matter.
- iii) All the equipment covered under the scope of this contract shall be handed over to NIA in running order with all moving parts properly lubricated and fully charged with the recommended lubricant.
- iv) Contractor shall provide a list of all recommended lubricants for each location and the compatible types of lubricant from the product line of all major companies in the Philippines.

##### *2. Grease Lubrication*

- i) Unless otherwise specified, all greasing shall be effected by high pressure hand grease gun.
- ii) All fittings shall, if possible, be of the same size.
- iii) Underwater equipment shall be charged with lithium based grease, for other locations the grease shall be calcium based.

### *3. Oil Lubrication*

- i) Gear boxes shall be provided with an oil level sight glass or dipstick, a screw capped filling hole and drain cock.
- ii) Where pressure oil lubrication of bearings is adopted, a filter and overload facility shall be provided in an accessible position.
- iii) All opening or joints in the gear box casing shall be provided with gaskets to avoid oil leakage.
- iv) Contractor shall provide the net quantity plus ten percent (10%) of the required oils and grease for the first filling and charging of the equipment at site.
- v) The oil shall be delivered in steel drums and grease in steel kegs. The containers shall be non-returnable.

### **3310 LIFTING MECHANISM INSTALLATION, TESTS AND ADJUSTMENTS**

The installation of the lifting mechanism and anchorage shall be in accordance with the details as shown on the Drawings. The Contractor shall send qualified and experienced Installation Supervisor who will supervise the installation of the lifting mechanism.

Lifting mechanism shall be installed complete with gear reductions, couplings, shafting, shaft bearings, drums, wire ropes, anchor bolts and all other materials for complete assembly. Lifting mechanism shall be assembled and accurately placed in correct alignment by the use of shims and wedges between the sole plates or base plates and concrete. Dry packing shall be done after the dry-pack has set.

After the lifting mechanism have been completely installed, adjusted and made ready for operation, the Contractor shall conduct test runs for the gates and lifting mechanism. All units shall be tested for normal operating speed to ensure that all necessary clearances and tolerances have been provided and that no binding occurs in any moving part. The cost of performing all the required test shall be borne by the Contractor.

All tests shall be performed in the presence of an authorized representative of NIA. All data shall be certified correct and submitted to NIA. All defects found during the test as a result of the installation work shall be corrected accordingly to the satisfaction of NIA.

### **3311 EMBEDDED PARTS**

Special attention shall be given to the method by which embedded parts are aligned during erection and secured against movement during the placing of the second stage concrete.

The proposed method which is indicated on the Drawings utilize adjusting anchors welded at one end to anchor plates embedded in first stage concrete and fastened by means of two adjusting nuts at the other end to the embedded parts.

### **3312 ANTI-CORROSION MEASURES AND PAINTING**

#### **a. General**

- i. The steel gate shall be designed to minimize as much as possible the effects of localized corrosion. Drain holes shall be provided in all locations where the entrapment of water can occur.
- ii. All steel surfaces except stainless steel surfaces shall be coated and/or painted with a protective film specified under Section C below.
- iii. Crevices over which the protective film can bridge shall be retouched or repaired prior to coating.
- iv. Boxed in members shall be provided with access holes or shall be treated internally with an effective coating material.
- v. All coating or paint materials to be used shall be original sealed container bearing the manufacturer's label revealing complete identification of content and shall be subject to inspection by NIA prior to coating and/or painting. The NIA shall have the right to reject any paint material supplied under these specifications which is found to be defective.

#### **b. Surface Preparation and Shop Painting**

Upon completion of fabrication and machining works but prior to application of coating materials, the Contractor shall notify NIA in writing that the surface preparation for painting is in progress. Coating application shall commence only after the NIA or their duly authorized representatives have inspected and subsequently approved the surface preparation in accordance with these specifications.

NIA or their designated inspectors shall undertake from time to time, inspection of the painting works while it is in progress. NIA shall be at liberty to reject outright any deviation to material specifications and procedure noted during inspection.

Notwithstanding such inspection, the Contractor shall be held responsible for the acceptability of the finished work.

All oil, grease, soil and other contaminants shall be removed from steel and cast iron surfaces by the use of clean solvent, emulsion, cleaning compound or other methods which involve cleaning action.

Following the solvent, the surfaces shall be cleaned of all defective or damage areas of existing paint, and of all loose rust, loose mill scale and other foreign substance in accordance with the requirements for surface preparation as specified hereunder.

i. Immersed Steel

Except where otherwise specified, all steel surfaces and all parts of structures that have surfaces which are exposed and/or permanently immersed in water, shall be blast cleaned by commercial blast cleaning (SSPC-SP6) then painted with 2 coats of coal tar epoxy paint conforming to U.S. Military Specifications MIL-P23236 (Ships) Type I, Class 2 to produce a total dry film thickness of 400 microns (16 mils.),

ii. Steel Exposed to Atmosphere (Lifting Mechanism and Accessories including Enclosures)

Except where otherwise specified all steel and cast iron surfaces of lifting mechanism and accessories including its enclosure which are exposed to atmosphere shall be blast cleaned by commercial blast cleaning (SSPC-SP6) then applied with 1 coat of Alkyd Red Lead Primer. After proper drying time is attained apply 2 coats of Alkyd Enamel finish to attain a total dry film thickness of 175 microns (7 mils.).

iii. Embedded Steel Work

Where not otherwise specified, all steel surfaces which will be embedded or against which concrete will be placed shall be cleaned by power tool cleaning (SSPC-SP3) then painted with 1 coat of cement latex milk consisting of 10 parts of Portland Cement (by weight), 5 parts of water and 1 part modified latex emulsion.

iv. Repair of Paint Film

The Contractor shall retouch or repair areas of steel gates which maybe damaged during transit from shop to the site of delivery.

All paints shall be applied in conformity with SSPC-PAI Shop, Field and Maintenance Painting, by skilled personnel fully experienced in this type of work.

### **C. Machine Surfaces**

All finished surfaces of ferrous metals that will be exposed during shipment or while awaiting installation shall be cleaned in accordance with a coating of heavy, gasoline rust preventive compound.

### **D. Stainless Steel Surfaces**

No painting is required for finished or unfinished stainless steel parts.

## **3313 PREPARING FOR TRANSPORTATION**

- i) Shipment of fabricated works to the Project Office should be made only upon issuance of pre-delivery inspection and acceptance report to the fabricator/manufacturer by the NIA Office.
- ii) The Project Office reserves the right to conduct its own final inspection upon arrival at the project office before issuance of final acceptance report and any findings made thereat should be noted in the final inspection report for appropriate action by the Central Office.
- iii) All parts shall be prepared for transportation so that slings for handling maybe attached readily wherever the parts are to be moved. When it is unsafe to attach slings to the boxes/crates, boxed parts shall be packed with sling attached to the part and the slings shall project through the box or crate so that attachments can be made easily.
- iv) All exposed finished surfaces shall be adequately protected against abrasion and injury during transportation and all long and slender pieces shall be safely supported and blocked.
- v) Rubber seals shall be dismantled after shop assembly and shall be transported separately. They shall be so packed and protected that their size, shape and physical properties are not affected during transportation.
- vi) The gates shall be prepared for transportation as to involve the minimum amount of field assembly.

### **a. Packing**

- i) The bid price shall include and provide for securely protecting and packing the equipment so as to avoid the damage during transport. All packing shall allow for easy removal and checking at site. Special precaution shall be taken to prevent rusting of the parts. Gas seals or other methods if proposed to be used shall have the approval of NIA. Each carton or package shall contain a packing memorandum mentioning the name of the Contractor, the number and date of the Contract and the name of the office placing the order.
- ii) The equipment shall be insured for loss or damage during transit to the field, the cost being borne by the Contractor.
- iii) Notwithstanding anything stated above, the Contractor shall be entirely responsible for loss, damage or depreciation to the equipment and materials.

**b. Marking**

Each part of gates, hoist and embedded parts which need to be transported from the shop to the field site as separate piece shall be marked to show the unit of which it is a part and match marked to show its relative position in the unit to facilitate assembly in the field. Unit marks and match marks shall be made with heavy steel stamps and paints. Each piece, sub-assembly or package to be transported separately shall be labeled or tagged with transportation designation consisting of the Specification number and the mark number of such piece or the number of parts grouped in such assemblies or package.

**3314 ACCEPTANCE OF WORKS**

After the steel gates have been installed in the field, it will be operated and tested by the NIA and when so operated and tested it shall meet all the requirements of the specifications. The gates shall be raised and lowered several times for the full length of the travel. The primary requisite for acceptance shall be that each gate operates smooth and shall be watertight.

**A. Tests**

- i) The Contractor shall carry out such tests on the gates and hoist equipment as maybe required by the Engineer. Contractor shall be responsible for all modifications and adjustments required for the works as a result of such tests.
- ii) The test shall include:
  - a) operational tests in the dry
  - b) operational tests with fully hydrostatic load
  - c) leakage test

- iii) Test maybe repeated, if necessary, until they successfully carried out to the satisfaction of the Engineer.
- iv) The tests will be carried out at the convenience of the Engineer the cost thereof shall be borne by the Contractor.

#### B. Operational Tests in the Dry

Operational tests in the dry shall be carried out after completion of erection when all the power supply have been connected and adjusted. The tests shall include at least two complete traverses from the maximum raised position to the full seating position. Manual operation will also be similarly tested. All adjustments, clearances, brakes, motors and controls, etc. shall be checked for proper operation.

#### C. Operational Test under Hydrostatic Head

- i) These tests shall simulate the actual operating conditions as closely as possible.
- ii) At least one complete traverse will be made on the sluice and intake gates from the fully closed position to the normal raised position as follows:
  - a) With the gate initially in the fully closed position raise it to the normal open position until stopped by the limit switch;
  - b) Lower the gate to the fully closed position;
  - c) Ascertain proper operation against over-travel;
  - d) Record and report fan speed, motor torque and current while raising and fan speed during closing;

#### D. Leakage Tests

Leakage test shall be carried out with the gate lowered on the sill. Before the observation for leakage, the gate shall be raised and lowered by about one meter, several times to dislodge any debris that might have lodged on the side seals. The leaking shall then be measured. Excessive leakage shall be rectified until it is reduced to 15 (fifteen) litres/minute/metre length of the seal.

### **3315 MANUALS**

The fabricator/manufacturer shall prepare and furnish NIA and the installation contractor's staff, the installation procedure, operation, and maintenance manuals for all of the works as provided for in the Contract Documents.

### **3316 METHOD OF MEASUREMENT**

Measurement for furnishing and installation of gates and stoplog will be made on the number of assemblies of the different classes and sizes acceptably installed and tested.

### **3317 BASIS OF PAYMENT**

The cost for the supply and delivery of various steel gates will be paid at the contract unit price per assembly or the lump sum price whichever is stated in the Bill of Quantities, which shall include all equipment and materials prescribed in this section and directed by the Engineer.

The cost for the installation provided under this item will be paid at the contract unit price which shall constitute full compensation for furnishing all labor, materials, tools, equipment, supplies and all incidentals and subsidiary works necessary for the successful completion of the works.

Payment for the work provided under this item will be made separately for the supply and delivery, and installation of various gates and lifting mechanism as follows:

#### a) Supply and delivery

For the supply and delivery of various gates and lifting mechanism, eighty percent (80%) of the respective unit price in the Bill of Quantities shall be paid upon delivery to the project site in accordance with this technical specification acceptable to NIA.

All equipment/materials delivered at the site, shall be kept by the Contractor and will be responsible for any loss or damage of the equipment/materials until they are installed. Any loss or damage to the equipment/materials shall be replaced by the Contractor at his own expense.

Twenty percent (20%) shall be paid upon installation of the equipment and materials, and ready for operation as certified by the Engineer.

#### b) Installation

One hundred percent (100%) of the respective unit price of each installation works which shall include labor, consumable materials, subsidiary works and other incidentals required for the successful completion of the works shall be

paid upon complete installation of the respective equipment/ materials all in accordance with the drawings and accepted by the Engineer.