

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 slightly 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 XVI

CONCRETE DEMOLITION WORK

1601 SCOPE

The work under this Section shall include demolition, removal and disposal in a manner approved by the Engineer of all portions of the existing structures indicated to be demolished, all in accordance with the Drawings and these Specifications. All other objectionable materials shall be disposed off to the designated disposal areas as ordered by the Engineer.

1602 METHOD OF CONSTRUCTION

Contractor shall submit for approval his proposed plans and operations for undertaking the demolition of structures. The proposed plans shall show details of the proposed method of demolition, removal and disposal of materials, blasting, drilling, and other devices the Contractor may propose. The work shall conform to the lines and grades as shown on the Drawings, or as directed by the Engineer. In cases of modification or renovation of an existing concrete structure where partial demolition or chipping on the surfaces of existing structure may be required, Contractor shall perform his chipping or demolition operation in such a manner as to avoid chipping or over demolition or damage of the entire structure. Over chipping or over demolition or entirely damage structures shall be restored at the expense of Contractor in a manner satisfactory to NIA.

1603 METHOD OF MEASUREMENT

Concrete demolition of existing structures will be measured by the number of cubic meter in its original position before demolition. Measurement will be made only to acceptably demolished structures with all materials disposed off to designated disposal areas. No material demolished by Contractor beyond the lines and grades indicated on the Drawings will be included for measurement unless additional demolition has been previously authorized by the Engineer in writing.

1604 BASIS OF PAYMENT

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

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 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 XV

CONCRETE

1501 SCOPE

This Section covers all the materials as cement, aggregates, water, admixtures and proportioning, mixing, transporting, placing, finishing, curing and protecting of concrete, including supplies, equipment, tools and all other incidentals necessary for concrete works.

All the applicable provisions of the latest revision of the ACI Building Code (ACI-318-63) and American Society for Testing Materials (ASTM) shall govern in all cases not specifically provided for herein.

1502 CONCRETE COMPOSITION

Concrete shall be composed of portland cement, fine and coarse aggregates, water, and if necessary, admixtures or agents approved by NIA. The design of concrete mixtures and consistency shall be as specified in this Section.

1503 CEMENT

- a) **General.** The cement shall conform to the requirements of the standard specifications for Portland Cement (ASTM: C-150 Type 1). Special Cement may be used subject to the approval of the Engineer provided it meets the requirements of Portland Cement with regards to strength, soundness and setting time.
- b) **Storage.** Contractor shall, immediately upon delivery of cement to the jobsite, store the same in a dry, weathertight and properly ventilated structure with adequate provisions for the prevention of absorption of moisture. All storage facilities shall be subject to the approval of the Engineer and shall be such as to permit easy access for the inspection and identification. In order that cement may not become unduly aged after delivery, the Contractor shall use any cement of the same type, which has been stored at the site for 60 days or more before using cement of lesser storage age. Any cement stored at the project site over four months shall not be used unless retest proves it to be satisfactory. Sacked cement shall not be stocked higher than 14 sacks for storage for a period of not longer than 30 days and not higher than seven sacks for longer period.
- c) **Payment.** Payment for cement shall be considered included in the contract unit price for the various items of concrete in the Bill of Quantities for which cement is used.

1504 ADMIXTURES

In order to reduce the cement content and/or the amount of mixing water, and to improve the concrete workability, the Contractor may be allowed to use Admixtures and as such he shall submit to NIA for approval such Admixture he proposes to use. The Contractor shall be required to submit manufacturer's brochures and data sheets for review together with detailed proposals on how the admixtures will be used in the works. This information should be supported with mix designs and the results of trial mixes. All admixtures shall be used strictly in accordance with the manufacturer's recommendations. However no additional payment will be made by NIA to the Contractor in view of this as the cost thereof is considered included in the contract unit price for the different classes of concrete.

The following type of admixtures will be given consideration by the NIA provided that they conform to the provisions of this Paragraph:

1. Air entraining agent
2. Water reducing admixtures
3. Water reducing and retarding admixtures
4. Water reducing and accelerating admixtures

Admixtures shall be furnished in a powder or liquid form. If furnished in a solution it shall contain at least 50% solids and a mold inhibitor. The admixtures effect on the properties of Portland cement concrete mixtures shall meet the requirements of ASTM: C-494.

Admixtures will be accepted on manufacturers certification of conformance with the specifications but permission to slip on certification shall in no way relieve the Contractor of responsibility for furnishing an admixture not meeting specification requirements. Where the Engineer has reason to believe that testing is necessary to prove compliance with the requirements of these specifications, it may order these admixtures to be sampled and tested anytime. The Contractor shall provide facilities satisfactory to the Engineer for readily procuring samples for test.

Air Entraining Agent. Concrete produced with water reducing agents shall contain four to six per cent of air entraining agent by volume. The air entraining agent shall conform to the requirements of ASTM: C 260, and shall be tested in accordance with ASTM: C 233. The total calculated air content of the concrete as discharged from the mixer shall be as follows:

Coarse Aggregates Maximum Size	Total Air - Per cent by Volume of Concrete
2 cm.	5 + 1
3.8 cm.	4 + 1

The agent in solution shall be maintained at uniform strength and shall be added to the batch in a portion of the mixing water. This solution shall be batched by means of a mechanical batcher capable of accurate measurement. When a retarder dispersing agent is used in the concrete, the portion of the mixing water containing the air-entraining agent shall be introduced separately into the mixer.

Water Reducing Agent or Water Reducing and Set Retarding Agent. The Contractor may be allowed to use an approved water reducing agent, or water-reducing and set retarding agent in concrete. The ASTM designations for these admixtures are Type A and Type D, respectively. The agent used shall be either suitable calcium, sodium or ammonium salts of lignosulfonic acids or of the nonlignin, hydroxylated carboxylic and acid groups. The agent shall be of uniform consistency and quality within each container and from shipment to shipment.

The amount of water reducing, or water reducing and set retarding agent to be used in each concrete mix shall in general be within the following limits:

Lignosulfonic Acid Type	-	0.27 to 0.37 percent of solid crystalline ligning, by weight, of cement.
Hydroxylated Carboxylic Acid Type	-	0.25 to 0.50 percent of liquid, by weight of cement.

Water Reducing and Accelerating Admixture. The ASTM designation for this admixture is Type E. Water reducing and accelerating admixture may be used by the Contractor for speeding up precasting and post-tensioning operations for precast and pre-stressed beams, girders, slabs and bearing pads, if approved.

1505 WATER

The water used in concrete, mortar and grout shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities. The recommendation of the seventh edition of the U.S. Bureau of Reclamation Concrete Manual for mixing water shall be followed.

1506 FINE AGGREGATES

a) General. The term "Fine Aggregates" is used to designate aggregates in which the maximum size of particles is 5 millimeters. Fine aggregates for concrete, mortar and

grout shall be provided by the Contractor and shall consist of natural sand, manufactured sand, or a combination of both. The different components shall be batched separately, or subject to the written approval of the Engineer, or blended prior to delivery to the batching plant.

As a means of providing moisture control, the Contractor may be required to stockpile the fine aggregates over porous storage to drain excessive water and to stabilize moisture content.

b) **Quality.** Fine aggregates shall conform to the requirements of ASTM C-33 and shall consist of hard, tough, durable, uncoated rock particles. The Contractor shall exercise every possible precaution in transporting, washing and screening operations to prevent contamination of sand particles. Fine aggregates shall conform to the following requirements:

1. **Grading** -It is assumed that the sand available in natural deposits will require processing to provide a suitable gradation. Regardless of the source, the fine aggregates shall be well graded from fine to coarse and the gradation as delivered to the mixers shall conform to the following requirements unless otherwise approved:

Sieve Designation US Standard Square . <u> M e s h</u> .	Percent by Weight Passing Individual . <u> S i z e s</u> .
3/8" (9.50mm)	100
No. 4 (4.75mm)	95-100
No. 8 (2.36mm)	85- 95
No. 16 (1.18mm)	60- 85
No. 30 (600um)	25- 60
No. 50 (300um)	10- 30
No. 100 (150um)	2- 10

In addition to the grading limits shown above, the fine aggregates as delivered to the mixer shall have the fineness modulus of not less than 2.30 or more than 3.00. The grading of the fine aggregates also shall be controlled so that the fineness moduli of at least 9 to 10 test samples of the fine aggregates as delivered to the mixer shall not vary more than 0.10 from the average fineness modulus of all samples previously taken. The fineness modulus shall be determined by dividing by 100, the sum of the cumulative percentages retained on US standard sieves No. 4, 8, 16, 30, 50 and 100. At the option of the Contractor fine aggregates may be separated into two or more sizes or classifications, but the resulting sand when combined before entering the concrete mixer shall be of uniform grading within the limits specified above.

2. **Particle Shape.** The shape of the particles shall be generally spherical or cubical and reasonably free from flat or elongated particles. A flat or elongated particle is defined as a particle having a maximum dimension in excess of five times the minimum dimension.

Rocks which breaks down into such shape, regardless of the type of processing equipment used, will not be approved for use in the production of fine aggregates.

3. **Deleterious Substances.** the maximum percentages of deleterious substances in the fine aggregates as delivered to the mixer shall not exceed the following values:

	<u>Percent by Weight</u>
Materials passing no. 200 Screen (Designation 16)*	3
Shale(Designation 17)	1
Clay (designation 13)	1
Total of other deleterious substances (such as alkali, mica, soft, flaky particles and loam)	2

* The designation in parenthesis refers to methods of testing described in the seventh (7th) edition of the US Bureau of Reclamation Concrete Manual and ASTM.

The sum of the percentages of all deleterious substances shall not exceed 5% by weight. Fine aggregates producing a color darker than the standard in the colometric test for organic impurity (USBR designation 14 or ASTM C-40) may be rejected. Fine aggregate having specific gravity (USBR Designation 9 or ASTM C-128, saturated surface dry basis) of less than 2.60 may be rejected. The fine aggregate may be rejected if the portion retained on No. 50 (300 um) screen, when subjected to five cycles of sodium sulphate test for soundness (USBR designation 19 or ASTM C-88) shows an average loss of more than 18% by weight. Fine aggregates delivered to the batching plant may be rejected if it contains more than 0.10% soluble sulphate for any one sample or more than 0.10 for an average of at least 9 out of 10 consecutive test samples of finished sand, when samples are taken hourly. The percent soluble sulphate in fine aggregates shall be determined in accordance with the method of test prescribed in subparagraph 4. below.

4. **Sampling** - Sampling of fine and coarse aggregates shall be done in accordance with paragraph 1509. The source from which fine and coarse aggregates is to be obtained shall be selected well in advance of the time when the materials will be required in the work. Unless otherwise specified, all test samples shall be taken under the supervision of the Engineer in sufficient time as approved to permit adequate testing and examination of results sufficiently in advance of the time for use in concrete. Routine control test and analysis of the fine and coarse aggregates at various stages in the processing operation shall be made. The approval of a source shall not be construed as containing approval of all

materials from the source, and the Contractor will be held responsible for the specified quality of all such materials used in the work.

(c) Storage - Fine aggregates shall be stored in such a manner as to avoid the inclusion of any foreign materials in the concrete. The storage or stockpile shall be constructed so as to prevent segregation. Depositing of materials in storage and its removal therefrom shall be done in such a manner as to result in increasing the uniformity of the grading insofar as this is practicable. All fine aggregates shall remain in free drainage storage for at least seventy-two (72) hours prior to use. Sufficient live storage shall be maintained at all times to permit continuous placement of concrete.

(d) Measurement and Payment - Fine aggregates will not be measured for payment. The cost of excavation, stockpiling, transporting, processing, blending, handling and other costs for providing fine aggregates shall be considered included in the unit price bid for the various items in the Bill of Quantities for which fine aggregates are used.

1507 COARSE AGGREGATES

(a) General - The term "Coarse Aggregate" is used to designate aggregates of such sizes as to fall within the range of 0.5 cm. to 7.5 cm or any size or range of sizes within such limits. The coarse aggregates shall be reasonably well graded within the nominal size ranges hereinafter specified. Coarse aggregate for concrete shall be furnished by the Contractor and shall consist of crushed rock or mixture of natural gravel and crushed rock as provided in paragraph 1508. Coarse aggregate, as delivered to the batching plant shall have a uniform and stable moisture content. Any rewashing found necessary to provide clean aggregates shall be done prior to finish screening. Rewashing shall not be performed in finish screen.

(b) Quality - Coarse aggregates shall conform to the requirement of ASTM C-33 and shall consist of hard, dense, uncoated durable rock fragments.

1. **Grading** - The coarse aggregates shall be well graded from fine to coarse. It shall be separated into the following specific size groups. The grading of the aggregates within the separated size groups as delivered to the mixer shall be as follows:

S I Z E G R O U P S

Sieve Sizes		Per Cent by Weight Passing Individual Sizes				
US Std. Sq. Mesh		12.5 mm	18 mm	37.5mm	50mm	75mm
6"	(150 mm)	-		-	-	-
3"	(75mm)	-		-	-	100
2-1/2"	(63 mm)	-		-	100	90-100
2"	(50 mm)	-		100	95-100	35-70
1-1/2"	(37.5mm)	-		90-100	-	0-15
1"	(25 mm)	-	100	20-55	35-7	-
3/4"	(19 mm)	100	90-100	0-15	-	0-5

1/2"	(12.5mm)	90-100	-	-	10-30	-
3/8"	(9.5 mm)	40-70	20-55	0-5	-	-
No. 4	(4.75mm)	0-15	0-10	-	0-5	-

Coarse aggregates shall contain not more than 1.5 per cent of materials passing the No. 200 sieve by meshing, nor more than 5% of soft fragments.

It shall have an abrasion loss of not more than 45 per cent at 500 revolutions.

Unless otherwise directed, the maximum sizes of aggregates to be used in concrete for the various parts of the work shall be in accordance with the following:

<u>General Use</u>	<u>Maximum Aggregate Diameter</u>
Lean Concrete to control water intrusion and other miscellaneous uses	37.5 mm
Concrete for Footings, Walls, Slabs Beams, 0.22 to 0.75 meters thick	37.5 mm
Concrete for thin walls, slabs, beams, less than 0.22 meters thick	19 mm
Concrete for reinforced concrete pipes	12.5 mm

In all cases, the diameter of the aggregate shall not exceed 1/2 the distance between the reinforcing steel bars of the members being placed.

2. **Particle Shape** - The particle shape of the crushed coarse aggregate shall be generally spherical or cubical and reasonably free from flat or elongated particles. A flat or elongated particle is defined as a particle having a maximum dimension in excess of five times the minimum dimensions. Rocks which breaks down into such shape will not be approved for the production of aggregate.

3. **Deleterious Substances** - The deleterious substances in any size of coarse aggregate, as delivered to the mixer, shall not exceed the following values:

	<u>Per Cent By Weight</u>
Material Passing No. 200 (Screen Designation 16)*	1/2
Shale (Designation 18)	1
Clay Lumps (Designation 13)	1/2

- * The designations in parenthesis refers to methods of Testing described in the seventh edition of the U.S. Bureau of Reclamation Concrete Manual and ASTM.

The sum of the percentages of all deleterious substances in any size, as delivered to the mixer, shall not exceed 3% by weight. Coarse aggregate may be rejected if it fails to meet the following requirements:

- 1) **Petrographic Examination** - If more than 10% of poor aggregate particles can be identified in physical quality test and in case 20% of the particles would be classified with respect to the chemical quality (USBR Desig. 7 or ASTM C-295).
- 2) **Sodium-sulphate Test for soundness** (USBR Desig. 9 or ASTM C-88)- If the weighted average loss, after 5 cycles is more than 10% by weight.
- 3) **Specific Gravity** (USBR Desig. 10 or ASTM C-127) - If the specific gravity (saturated surface-dry basis) is less than 2.60.
- 4) **Sampling** - All sampling of coarse aggregates shall be in accordance with Paragraph 1509.

c) Storage - Coarse aggregate storage or stockpiles shall be built in such a manner as to avoid the inclusion of any foreign materials in the concrete and to prevent segregation and excessive breakage. Water sprayers shall be installed to keep that portion of the coarse aggregate stockpiles saturated which is intended for immediate use in the concrete. Sufficient live storage shall be maintained at all times to permit continuous placement of concrete.

d) Measurement and Payment - Coarse aggregates will not be measured for payment. The cost of excavation, stockpiling, processing, blending, handling and other cost for providing coarse aggregates shall be considered included in the unit price bid for the various items in the Bill of Quantities for which coarse aggregates are used.

1508 PRODUCTION OF FINE AND COARSE AGGREGATES

(a) **Source of Aggregates** - Fine and coarse aggregates for concrete, and fine aggregate for mortar and grout may be obtained by the Contractor from any approved source. Approval of deposit shall not be construed as constituting approval of all materials taken from the deposit, and the Contractor shall maintain the specified quality of all such materials used in concrete works. If the aggregates are to be obtained from deposits or quarry sources not previously tested and approved by NIA, Contractor shall submit, for preliminary test and approval, a representative, 90 kilograms (approximately 200 pounds) sample of the fine aggregate and of the 0.5 centimeters to 2 centimeter size of coarse

aggregate and a 45 kilograms (approximately 100 pounds) sample of each of the other sizes of coarse aggregate proposed for use in the work, at least 90 days before the materials are required for use.

(b) **Developing Aggregate Deposit.** The Contractor shall carefully clear the area, from which aggregates are to be taken, of trees, roots, brush, sod, soil, unsuitable sand and gravel or aggregates, and other objectionable matter. The portion of the deposit used shall be located and operated so as not to detract from the usefulness of the deposit or of any adjacent property and so as to preserve, insofar as practicable, the future usefulness or value of the deposit. Waste materials removed from aggregate borrow areas shall be disposed of in approved locations.

(c) **Processing Raw Materials.** The Contractor shall employ processing equipment which will ensure well-shaped particle in all aggregate sizes and a minimum of particle which are flat or elongated. Processing of raw materials shall include screening, washing, and blending if necessary to produce fine and coarse aggregate meeting the requirements of Paragraphs 1506 and 1507. Processing of aggregates produced from any source shall be done at an approved site. Water used for washing aggregates shall conform to Paragraph 1505. To utilize the greatest practicable yield of suitable materials in the portion of the deposit being worked, the Contractor may crush oversize material and any excess materials of the size of coarse aggregate to be furnished, until the required quantity of each size has been secured, provided, that the crushed aggregates shall be blended uniformly with the uncrushed aggregates. Crushing and blending operations shall at all times be subject to approval by the Engineer.

Aggregates, as delivered to the mixers, shall consist of clean, hard and uncoated particles. When required, dust shall be removed from the coarse aggregate by adequate washing.

(d) **Moisture Control.** The free moisture control of the fine aggregate and smallest size group of coarse aggregate as delivered to the mixers shall be controlled so as not to exceed the value of 6.0 and 1.5, respectively, expressed as a percentage by weight of the saturated, surface dry aggregates. The percent variation of free moisture content in fine aggregate and the smallest size of coarse aggregate shall not exceed 0.5% and 2.0%, respectively, during any one hour of mixing plant operation. The free moisture of the other sizes of coarse aggregates shall be the least amount when delivered to mixers and variations shall be the least practicable under all job conditions. Sand shall have a uniform and stable moisture content. Under no conditions shall the other sizes of coarse aggregates be delivered to the mixing plant bins dripping wet. The Contractor may accomplish the required moisture control by use of free drainage storage, mechanical dewatering devices, or any other satisfactory means of dewatering.

1509 AGGREGATE SAMPLING AND TESTING

Sampling of the aggregate materials approved for use in the work shall be done by the contractor in accordance with ASTM Sampling Method at 10 days in advance of the time when placing of concrete is expected to begin. Aggregate studies and tests will be made by the contractor at its own expense. It shall be the responsibility of the Contractor to designate the source(s) of aggregates early enough to give NIA sufficient time to obtain the necessary samples and have them subjected to tests.

The samples of aggregates shall be obtained and tested in accordance with the following ASTM standard methods:

Sampling aggregate	- C 75
Sieve Analysis	- C 136
Amount of material finer than 200 sieve	- C 117
Organic impurities	- C 40
Mortar Strength	- C 87
Soundness	- C 88
Soft Particles	- C 235
Abrasion	- C 131
Clay lumps	- C 142

No aggregate shall be used until official advice has been received that it has satisfactorily passed all tests, at which time written authority shall be given for its use. Material from source which has been previously tested and shown satisfactory compliance with all the requirements given herein may be used without further testing upon written permission of NIA. Test reports for previous tests must be available before approval can be given.

During construction, aggregates will be sampled as delivered to the mixer to determine compliance with specification provisions. Test shall be made in accordance with the applicable ASTM Standards. Routine control test and analysis of aggregates at various stages in processing, transporting, stockpiling, retraining, and batching, if used will be made by the contractor. The Contractor shall provide such facilities as may be considered necessary for the ready procurement of representative test samples. All test will be made by the contractor under the supervision of NIA.

1510 CLASSIFICATION AND PROPORTIONING OF CONCRETE MIXTURES

(a) **Classification and Design Mixtures.** The mixture for all classes of concrete shall be designed by the Contractor and approved by NIA to obtain the compressive strength at the age of 28 days as specified below:

Class	Minimum Strength (kg/cm ²)	Maximum Aggregate Size (mm)	Minimum Cement (kg/m ³)	Maximum Water/Cement Ratio
X	300	19	375	0.55
Y	210	12.5	350	0.60
AA	210	19	325	0.60
A	210	37.5	300	0.60
B	170	50	250	0.70
C	170	75	225	0.70
Z	140	75	200	0.85
Blinding (Concrete)	70	37.5	150	no limit

(b) **Aggregate Content.** - Concrete mixtures shall be designed to use the largest size and the maximum amount of coarse aggregate as practicable for the intended use of the concrete.

(c) **Consistency.** - The amount of water to be used in the concrete shall be regulated as required to secure concrete of the proper consistency and to adjust for any variation in the moisture content or grading of the aggregates as they enter the mixer.

It shall be such consistency that it will flow around reinforcing steel bar but individual particles of the coarse aggregate when isolated shall have coating of mortar containing its proportionate amount of sand. The consistency shall be gauged by the ability of the equipment to properly place it and not by the difficulty in mixing or transporting. Addition of water to compensate for stiffening of the concrete before placing will not be permitted. Uniformity in concrete consistency from batch to batch will be required.

The slump of the concrete at the time of placing shall not exceed 5 centimeters in heavy concrete sections and at top of walls, piers and parapets, 10 centimeters for pumped or air placed concrete, and 7.5 centimeters for concrete elsewhere.

The Engineer reserves the right to require a lesser slump whenever concrete of lesser slump can be consolidated readily into place by means of the vibration specified in Paragraph 1517.

(d) Notwithstanding the approval by NIA of the design mixtures and the above specified minimum cement content for different classes or gradation of aggregates, the Contractor shall be responsible that all the concrete meet the desired strength.

1511 MEASUREMENT OF MATERIALS

All materials from which the concrete will be manufactured shall be mechanically measured by weight, except as otherwise specified and/or authorized by the Engineer and admixture solutions which may be measured by volume.

Measuring devices shall be suitably designed and constructed for the purpose and shall be weighing separately the cement, fine and coarse aggregates. The accuracy of all weighing devices shall be such that successive quantities can be measured to one per cent of the desired weights. Cement in standard bags (40 kilograms) need not be weighed. The water measuring devices shall be of such type and make to be readily controlled to obtain an accuracy of one-half per cent of the desired quantity of water.

Whenever volumetric proportioning and measurement is permitted due to failure or malfunction of weighing devices the equivalent volumetric proportions of weighed representative samples of the concrete ingredients shall be computed taking into consideration bulking effect of cement and variations of moisture content of the aggregates.

When sack or bag cement is used, the quantities of aggregates for each batch shall be for one or more full sack of cement. No batch requiring a fractional sack of cement will be tolerated.

1512 MIXING AND DELIVERY

Ready-mixed concrete shall be mixed and delivered to the point designated by the Engineer by means of one of the following combination of operations:

- Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck mixer operating at agitator speed or in nonagitating equipment when approved by the Engineer. (Known as central-mixed concrete).

- Mixed completely in a truck mixer at the batching point or while in transit. (Known as transit-mixed concrete).

- Mixed completely in a truck mixer at the point of delivery following the addition of mixing water. (Known as truck-mixed concrete).

Truck mixers and truck agitators shall be operated within a capacity not to exceed 63 or 80 percent, respectively of the gross volume of the drum and at a speed of rotation for mixing or agitating as designated by the manufacturer of the equipment. A truck mixer or truck agitator used for transporting concrete that has been completely mixed in a stationary mixer shall be operated within the limits of capacity and speed of rotation designated by the manufacturer for agitating, except that the agitator capacity shall in no event exceed 80 percent of gross drum volume.

When a stationary mixer is used for the complete mixing of the concrete, the mixing time for mixers having a capacity of 10 cubic yards (7.6 m³) or less shall be not less than

60 seconds. For mixers of more than 10 cubic yards (7.6 m³) capacity, the mixing time shall be determined by the Engineer. The time is valid provided mixer efficiency tests prove the concrete is satisfactory for uniformity and strength. Mixing time shall be measured from the time all cement and aggregates are in the drum. The batch shall be so charged into the Mixer that some water will enter in advance of cement and aggregates, and all water shall be in the drum by the end of the first one-fourth of the specified mixing time.

When a truck mixer is used for complete mixing, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment on the metal plate on the mixer as mixing speed. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determination of the number of revolutions of mixing.

When a truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transport shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When a truck mixer or truck agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within 1 hour after the addition of the cement to the aggregates. Each batch of concrete delivered at the job site shall be accompanied by a time slip issued at the batching plant, bearing the time of charging of the mixer drum with cement and aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 30°C (85°F) or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. When a truck mixer is used for the complete mixing of the concrete, the mixing operation shall begin within 30 minutes after the cement has been added to the aggregate.

- The concrete when discharged from truck mixers or truck agitators, shall be of the consistency and workability required for the job. The rate of discharge of the plastic concrete from the mixer drum shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open. If additional mixing water is required to maintain the specified slump and is added with the permission of the Engineer, a minimum of 20 revolutions of the truck mixer drum at mixing speed shall be required before discharge of any concrete.

When approved by the Engineer, central-mixed concrete which is designated for the purpose may be transported in suitable non-agitating equipment.

When non-agitating equipment is used for transportation of concrete the following requirements shall apply.

- Bodies of equipment shall be smooth, water-tight, metal containers equipped with gates that will permit control of the discharge of the concrete. Covers meeting the approval of the Engineer shall be provided for protection against the weather.

- The concrete shall be delivered to the site of the work in a thoroughly mixed and uniform mass and discharged with a satisfactory degree of uniformity. Slump tests of representative samples taken during the discharge shall not differ by more than 2 inches (50.8 mm). Discharge shall be completed within 30 min. after introduction of the mixing water to the cement and aggregates.

Concrete delivered in outdoor temperatures lower than 5°C (40°F) shall arrive at the work having a temperature not less than 15.6°C (60°F) nor greater than 32.2°C (90°F).

The volume of concrete mixed or transported shall not be less than 15 percent of the gross volume of the drum.

1513 RE-TEMPERING

Concrete, mortar and grout mixers which have developed initial set shall not be used. Concrete, mortar and grout which have partially hardened shall not be retempered or remixed.

1514 SAMPLING AND TESTING OF CONCRETE

The Contractor shall provide the required samples of Concrete to be furnished by the Contractor without cost to NIA. Sampling will, in all cases be performed by the contractor under the direct supervision of the Engineer and Contractor shall provide without cost to NIA all available tools and labor as may be required. Concrete sampling shall be carried on during concrete operations at the rate of one standard sample for each 75 cubic meters of concrete or fraction thereof placed during each continuous placing operations but in no case shall there be less than one sample for each day concreting. Each standard sample shall consist of three standard cylinders (6-inch diameter by 12-inches high.) The Contractor shall keep a record of the samples and the portion of the structures and volume represented which shall be available to NIA on demand.

Sampling shall conform to ASTM Designations C-172, preparation, storage and curing to ASTM Designation C-31 and testing to ASTM Designation C-39. NIA shall have the sample tested by an approved testing laboratory at the expense of the Contractor.

1515 CONVEYING AND PLACING CONCRETE

(a) **General.** Approval of the Engineer shall be obtained before starting any concrete pour. Concrete placement will not be permitted when, in the opinion of the Engineer, conditions prevent proper placement and consolidation. Before concrete is placed, all saw dust, chips, and other construction debris and extraneous matters will be removed from the interior of forms, struts, stays, and braces, serving temporarily to hold the forms in correct

shape and alignments, pending the placing of concrete at their location, shall be removed when the concrete placing has reached an elevation rendering their services unnecessary as may be. These temporary members shall be entirely removed from the forms and not to be buried in concrete. Surfaces of existing concrete left after partial demolition against which new concrete is to be placed, shall be cleared thoroughly of all loose concrete coatings or concrete dust by brushing or other effective means followed by thorough washing or jetting. Such surfaces shall be kept moist for at least 24 hours before pouring the new concrete.

Concrete shall be placed only in the presence of the Engineer or his duly authorized representatives. Any and all concrete placed in the absence of the Engineer or his duly authorized representatives will not be considered for measurement and payment, and shall be removed at the discretion of the Engineer with the Contractor assuming all losses.

Concrete shall be conveyed from mixer to forms, as rapidly as practicable, by methods which will prevent segregation, or loss of ingredients. In case of circular siphons, pumpcrete shall be used. There shall be no vertical drop greater than 1.50 meters except where suitable equipment is provided to prevent segregation and where specifically authorized by the Engineer. Belt conveyors, clutch or similar continuously exposed flow, will not be permitted.

(b) Concrete on Earth Foundation. All concrete shall be placed upon clean and dump surfaces free from standing or running water. Prior to placing concrete, the earth foundation shall be satisfactorily compacted in accordance with these Specifications.

(c) Concrete on Rock or Other Concrete. Rock surface or hardened concrete upon or against which concrete is to be placed shall be clean, free from oil, standing or running water, mud, drummy rock objectionable coatings, debris, loose and semi-detached or unsound fragments. Fault, fissures and seams in rock shall be cleaned to a satisfactory depth and to firm rock on the sides. Immediately before concrete is placed, all surfaces shall be cleaned thoroughly by the use of high velocity, air water jets, wet sand blasting or other satisfactory means. When required by the Engineer, roughening by grooving with pneumatic tool, of existing concrete surfaces against which concrete is to be placed may be required. All surfaces shall be wetted before placing concrete and approximately horizontal surface shall be covered immediately, before the concrete is placed, with a layer of mortar not to exceed 15 millimeters in thickness and of the same cement-sand ratio as used in the concrete.

(d) Lift in Concrete. The permissible depth of concrete placed in one lift will be as shown in the detailed Drawings or as directed for each structure by the Engineer. Unless otherwise authorized or shown, lifts of mass concrete shall not exceed 1.5 meters in height, and a minimum of 72 hours shall elapse between the placing of each successive lifts. Lifts of three meters will be permitted in piers and walls. Height of lift specified herein will not apply where the use of slip form has been approved. All concrete, when placed and vibrated shall be approximately horizontal layers not to exceed 50 centimeters in thickness unless otherwise specifically authorized. The placement of concrete surfaces shall not have

reached their initial set before additional concrete is placed thereon. Slabs shall generally be placed in one lift unless the depth is so great that this procedure will produce objectionable results.

(e) **Consolidation of Concrete.** Consolidation of concrete shall be by the use of mechanical vibratory equipment. The vibrating equipment shall be of the internal type and shall at all times be adequate in number of units and the power of each unit shall be capable to properly consolidate all concrete. The frequency of vibration shall not be less than 6,000 revolutions per minute. Form or surface vibrators shall not be used, unless otherwise specified in other Sections of this Technical Specifications. The duration of vibration shall be limited to that necessary to produce satisfactory consolidation without causing objectionable segregation. In consolidating each layer of concrete the vibrating head shall be allowed to penetrate under the action of its own weight and revibrate the concrete in the upper portion of the underlying layer.

At least one spare vibrator in working order shall be available at any location where concrete is being placed.

(f) **Finishing of Concrete Lift Surfaces.** The manipulation of the concrete adjacent to the surface of the lift in connection with completing lift placement shall be the minimum necessary to produce not only the degree of consolidation desired in the surface layer of concrete but also a surface with the desired degree of roughness for bond with the next lift. Surface vibration or excessive surface working will not be permitted. All unfinished top surface not covered by forms and which are not to be covered by additional concrete or backfill, shall be carried slightly above grade, as directed, and struck off by board finish.

(g) **Placing Concrete Through Reinforcement.** In placing concrete through reinforcement, care shall be taken so that no segregation of the coarse aggregate occurs. On the bottom of beams and slabs, where the congestion of steel near the forms makes placing difficult, a layer of mortar of the same cement-sand ratio as used in the concrete shall be first deposited to cover the surface.

(h) **Depositing Concrete in Water.** When specifically authorized, concrete may be deposited in water. The methods and equipment used shall be subject to approval of the Engineer.

1516 FORMS

(a) **General.** Forms shall be used wherever necessary to confine the concrete during vibration and to shape it to the required lines. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position. The strength and rigidity of the forms shall be such that formed surfaces will conform to specification requirements relating to surface irregularities and tolerances for concrete construction. Forms shall be tight to prevent loss of mortar from the concrete.

Chamfer strips shall be placed in the corners of forms for exposed exterior corners so as to produce beveled edges. Interior corners and edges of formed joints shall not be beveled unless the requirement therefore is shown on the Drawings.

The tolerance limits specified in Paragraph 1521 and the surface irregularity limits specified in Paragraph 1521 are the maximum permissive limits of misalignment or irregularity surface which may occur despite workmanlike effort to construct and maintain the forms to the specified surfaces. These limits pertain only to inadvertent and occasional irregularities, even though these irregularities are within the maximum permissive limits, will be rejected. Accordingly, these limits, shall not be construed to be tolerances for aligning forms or determining acceptability of form materials.

Stub walls shall not be used, except that stub walls shall be used for walls having fillets at the bottom.

Concrete in such stub walls shall be re-vibrated after adjacent floor concrete is placed.

Forms for finishes F2 and F3 shall be constructed with grade strips at the horizontal construction joints, unless the use of groove strips is specified on the Drawings. Such forms shall be removed and reset from lift to lift, they shall be continuous from lift to lift. Sheathing of reset forms shall overlap the previous lift by not less than 25 mm. Forms shall be tightened against the concrete so that the forms will not spread and permit abrupt irregularities or loss of mortar or paste. Supplementary bolts or form ties shall be used as necessary to hold the reset forms against the concrete.

Forms for all wall openings shall be constructed so as to facilitate loosening.

(b) Form Sheathing and lining. Wood sheathing or lining shall be of such kind of quality and shall be so treated or coated that there will be no chemical deterioration or discoloration of the formed concrete surfaces. The type and condition of form sheathing and lining, and the fabrication of forms for finishes F2, F3 and F4 shall be such that the form surfaces will be even and uniform. The ability of forms to withstand distortion caused by placement and vibration of concrete shall be such that formed surfaces will conform with applicable requirements of these specifications pertaining to finish of formed surfaces. Where finish F3 is specified, the sheathing or lining shall be placed so that the joint marks on the concrete surfaces will be in general alignment, both horizontally and vertically.

Plywood used for sheathing or lining shall be high density overlaid plywood specially manufactured for use in construction concrete forms as approved. Materials used for form sheathing or lining shall conform with the following requirements, or other materials producing equivalent results as approved by the Engineer.

<u>Req'd Finish of Formed Surface</u>	<u>Wood Sheathing or Lining*</u>	<u>Steel Sheathing or Lining**</u>
F1	Any grade, surfaced on 2 edges (S2E) with no limits to defects except	Steel Sheathing permitted Steel Lining permitted

imposed by other requirements of these specifications.

F2	Selected lumber, surfaced on side and two edges (SIS2E) or plywood sheathing or lining.	Steel Sheathing permitted Steel Lining permitted
F3	Selected lumber, surfaced on four sides (S4S) or plywood sheathing or lining.	Steel Sheathing permitted Steel lining not permitted
F4	For plane surfaces, selected lumber surfaced on four sides (S4S) T & G or plywood. For warped surfaces, the lumber shall be free from knots and other imperfections and which can be cut and bent accurately to the required curvatures without splintering or splitting.	Steel sheathing permitted.

* The lumber shall be free from warp and knotholes and shall have no knots larger than five centimeters in diameter. All knots shall be sound and tight. There will be no pitch pockets, barb or lack of wood on the face of the lumber against which concrete is to be placed.

** Steel sheathing denotes steel sheets not supported by a backing of wood boards.

(c) **Form Ties.** Embedded ties for holding forms shall remain embedded and, except for F1 finish, shall terminate within the concrete approximately two diameters or twice the minimum dimensions of the tie from the formed faces of the concrete. Embedded ties for F1 finish shall terminate within the concrete or shall be cut-off flush with the faces of the concrete, at the Contractor's option.

The ties shall be so constructed that ends and end fasteners can be removed by unskilled workmen without causing spalling at the faces of the concrete.

(d) **Cleaning and Oiling of Forms.** The surfaces of the forms in contact with the concrete shall be free from encrustations of mortar, grout or other foreign material when the concrete is placed. The surfaces of the forms to be in contact with the concrete shall be coated with an approved coating which will enable the ready release of the forms and will not contaminate the concrete surfaces. Except as provided below, forms for surfaces which are to be painted shall be coated with straight, refined, pale, paraffin mineral oil, or other approved coating, and the coating for steel forms shall consist of refined mineral oil suitably compounded for the purpose.

(e) **Forms of Curved Surfaces.** Curved surfaces have been dimensioned at several sections. The Contractor shall interpolate intermediate sections as necessary and shall construct the forms so that the curvature will be continuous between sections. Where

necessary to meet requirements for curvature, the form lumber shall be built up to laminated splines cut to make tight, smooth form surfaces. The forms shall be constructed so that the joint marks on the concrete surfaces generally will follow the line of water flow. After the forms have been constructed, all surface imperfections shall be corrected, and all surface irregularities at packing faces of form materials shall be dressed to the specified curvature.

(f) **Forms for Slopes or Battered Surfaces.** Forms for sloped or battered surfaces shall be built so that the sheathing can be placed board-by-board immediately ahead of concrete placement so as to enable ready access for placement, vibration, and inspection of the concrete. The sheathing shall be built so that the sheathing can be removed board-by-board from the bottom to top.

(g) **Forms for Open Channel Transitions.** When warped surfaces of transitions are not backformed, natural or compacted earth shall be shaped to the specified surface and covered immediately with a plaster coat of cement-sand mortar at least 0.95 centimeter.

Forms for the warped surfaces shall be tied securely to the floor slab and braced against spreading. In the upper surface, forms shall be butt and removed as specified in sub-paragraph (j), so as to enable ready access for placement, vibration, inspection, and repair and finishing of the concrete.

(h) **Forms for Bridges.** Forms for girders and slabs shall be cambered as specified by the Engineer.

Forms shall be constructed so that form marks will conform to the general lines of the structure. Column form marks shall be spaced symmetrically.

Form bolts or clamps shall be used to fasten forms. The use of ties consisting of twisted wire loops will not be permitted. Bolts or clamps shall be positive in action and shall be of sufficient strength and number to prevent displacement of the forms. They shall be of such type that they can be entirely removed or cut back one inch or more below the finished surface of the concrete leaving no metal within one inch of the concrete surface. All forms for the outside surfaces shall be constructed with rigid wales at right angles to the studs and all form clamps shall extend through and fasten such wales.

Forms for exposed surfaces shall be constructed of plywood or material which will produce an equivalent surface. Form panels shall be furnished and placed in uniform widths of not less than 90 centimeters and in uniform lengths of not less than 1.8 meters, except where the dimensions of the member formed are less than the specified panel dimensions. Plywood panels shall be placed with the grain of the outer piles perpendicular to the studding of joists, unless otherwise permitted by the Engineer. Where form panels are attached directly to the studding or joists, the panels shall not be less than 1.6 centimeters thick, and the studding or joists, shall be spaced not more than 30 centimeters center to center. Form panels less than 1.6 centimeters thick, which otherwise conform to the requirements specified in this Paragraph, may be used with a continuous backing of

surfaced material 1.9 centimeters thick. Form panels more than 1.6 centimeters thick attached to studding or joists spaced at 30 centimeters center to center may be used, provided the deflection of the panel between studding or joists does not exceed that of a 1.6 centimeters panel attached to a studding or joists spaced at 30 centimeters center to center. All form panels shall be placed in a neat, symmetrical pattern subject to the approval of the Engineer.

(i) **Falsework for Bridges and Other Superstructures.** False work for the support of a bridge or other superstructure shall be designed and constructed to support the loads that would be imposed where the entire structure placed at one time.

Suitable jacks, wedges or camber strips shall be used in connection with falsework or centering to set the forms to the required grade or camber and to take up any settlement in the formwork either before or during the placing of concrete.

(j) **Forms for Large Circular Siphons.** The Contractor shall submit to NIA a detailed Drawings for a collapsible steel forms to be used as inner forms of the monolithic barrels. The length of one section of the barrels is at every 9.15 meters bar length intervals as shown on the Drawings. The outer forms intervals as shown on the Drawings. The outer forms of the concrete barrels shall be made with butt joints throughout and form surfaces to be in contact with concrete shall be smooth and true. All forms shall be sufficiently tight with suitable gaskets provided at all form joints and gates to prevent leakage of mortar. Forms shall be braced and sufficiently stiff to withstand, without detrimental deformation, all operations incidental to the proper placement of concrete within the forms. All forms shall be cleaned and oiled before pouring concrete.

(k) **Removal of Forms.** Forms shall be removed as soon as possible to enable the earliest practicable repair of surface imperfections, but in no case shall they be removed before approval of the Engineer. Any needed repair or treatment shall be performed at once, and be followed immediately by the specified curing. Forms shall be removed with care so as to avoid injuring of the concrete and any concrete so damage shall be repaired.

In field operation that are not controlled by beam or cylinder test the removal of forms and supports shall be governed by the following:

<u>Type of Structure</u>	<u>Time of Removal After the Last Pouring</u>
Arch, beam, girders and slabs	14 days
Slab in close span of less than three meters	7 days
Side forms for beams, railings parapets, balustrade, walls and columns	Not less than 12 hours and more than 48 hours

1517 CONSTRUCTION JOINTS

(a) **General.** After the top surface of a lift is finally compacted, it shall be immediately and carefully protected from direct rays of the sun, pedestrian traffic, materials being placed thereon, running water, heavy rains, or any activity upon the surface that in any manner will affect the setting of the concrete. Unless otherwise specified, vertical and horizontal joints on exposed faces shall be chamfered as shown on standard detailed drawings and formed to produce a uniform and neat appearance.

(b) **Cleaning.** Horizontal construction joints on lifts with relatively open and accessible surfaces may be prepared for receiving the next lift by either wet sand blasting or by cutting with an all-water jet, as specified below. If the surface of the lift is congested with reinforcements, or is relatively inaccessible or, if for any other reason the Engineer considers it undesirable to disturb the surface of a lift before final set has taken place, surface cutting by means of air-water jets will not be permitted and the use of wet sand blasting or light brush hammering will be required. After approved cleaning, the surface of the construction joints shall be kept continuously wet for at least 12 hours immediately prior to placing concrete. A mortar coating of approximately one centimeter in thickness shall be applied to all approximately horizontal surfaces immediately prior to the placing of the next lift of concrete. The mortar shall have the same cement sand ratio as the concrete. Any free water on the joint surface shall be removed prior to placing the mortar. The Contractor shall ensure that the surface of any horizontal joints (and the formwork in general) is completely clean of any dust, weed, wood showings or other deleterious material prior to the placing of concrete.

1. **Air-Water Cutting** - Air-Water cutting of construction joint shall be performed after initial set has taken place but before the concrete has obtained its final set. The surface shall be cut with a high pressure air-water jet to remove all laitance and expose clean, sound aggregate, but not to undercut the edges of the larger particles of aggregate. After cutting, the surface shall be washed and rinsed as long as there is a trace of cloudiness of the wash water.

2. **Wet Sandblasting**. When employed in the preparation of construction joints, wet sandblasting shall be performed immediately before placing the following lift. The operation shall be continued until all unsatisfactory concrete and laitance, coatings, stain, debris, and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose materials.

3. **Cleaning Vertical Construction Joint**. The vertical construction joints shall be cleaned by wet sand blasting or by brush manner.

1518 REPAIR OF CONCRETE

No repair of work or plaster finish of formed concrete in structures will be permitted, unless otherwise provided in these Specifications or directed by the Engineer in writing.

All defective concrete shall be removed and replaced with the Contractor assuming all expenses and losses. Plastering without permission will be assumed as defective works. If directed, the Contractor shall notify the Engineer of the start of the repair work at least 24 hours in advance thereof and shall repair concrete only in the presence of the Engineer or its authorized representative, unless inspection of such repair work is waived.

Drypack shall be used for filling holes having at least one surface dimension smaller, if any greater than the hole depth; for narrow slots cut for repair of cracks for grout pipe recesses; and for tie-rod fastener recesses as specified. Drypack shall not be used for filling behind reinforcement or for filling holes that extend completely through a concrete section. Mortar filling, placed under impost by use of a mortar gun, maybe used for repairing defects on surfaces designated to receive F1 and F2 finishes where the defects are too wide for drypack filling and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest the surface. Concrete filling shall be used for holes extending entirely through concrete sections; for holes in which no reinforcement is encountered and which are greater in area than 900 square centimeters and deeper than 20 cm.; and for holes in reinforced concrete which are greater in area than 400 square centimeters and which extends beyond reinforcement.

Workmanship methods, preparation of concrete for repair, materials, and curing shall be as directed. Only workmen skilled in the repair of concrete shall perform such work. Repairs of defective concrete shall be made within 48 hours after removal of forms.

Surfaces to which concrete is to be bonded shall be clean and dry when coated with epoxy.

Surfaces of concrete to be repaired with sealing compound method shall be cured by the water curing method for one day before application of the sealing compound. All repair shall be sound and free from shrinkage cracks and drummy areas after they have been cured and have dried 30 days.

Surfaces of repairs which will be exposed to view shall blend inconspicuously with surrounding concrete surfaces.

Fins and encrustations shall be removed from surfaces which will be exposed to view.

1519 FINISHES AND FINISHING

(a) **General.** Allowable deviations from established lines, grades and dimensions are set forth in Paragraph 1521. These allowable deviations are defined as "tolerance" and are to be distinguished from surface irregularities in finish as described herein. The class of finish and the requirements for finishing concrete shall be as specified in this Paragraph.

Finishing of concrete surfaces shall be performed only by skilled workmen. The Contractor shall advise the Engineer as to when concrete will be finished. Unless inspection

is waived in each specific case, finishing of concrete shall be performed only in the presence of the Engineer. Concrete surfaces will be tested by the Engineer to determine that surface irregularities are within the limits hereinafter specified.

Surface irregularities are classified as "abrupt" or "gradual". Offsets caused by displaced or misplaced form sheathing or lining or form sections or by loose knots in forms or otherwise defective form lumber will be considered abrupt irregularities, and will be tested by direct measurements. All other irregularities will be considered to be gradual irregularities, and will be measured as the departure from the testing edge of an approved template held parallel to and in contact with the surface. The template shall consist of a straight-edge or the equivalent thereof for curved surfaces.

(b) **Formed Surfaces.** The classes of finish for formed concrete surfaces are referred to by symbols F1, F2, F3 and F4 faces. Grinding will not be required on formed surfaces except as necessary to reduce protrusions to specified limits. Recesses from removal of form ties shall be filled with dry pack or epoxy mortar at the Contractor's option: except that filling recesses in Finish F1 surfaces will be required only if the recesses are deeper than 2.5 centimeters in walls, less than 30 centimeters thick or if unfilled, recesses would reduce the required cover over reinforcements.

The filled recesses shall blend inconspicuously with the surrounding concrete surfaces or concrete that will be exposed to view.

The classes of finish and their application are as follows:

Finish F1 - Finish F1 applies to formed surfaces where fill material or concrete is to be placed. The surfaces require no treatment after form removal except for repair of defective concrete and specified curing. Correction of surface irregularities will be required only for depressions which exceed 2.5 centimeters, when measured as described in sub-paragraph (a).

Abrupt irregularities on surfaces to which pre-molded joint filler is to be applied shall not exceed 0.30 centimeter.

Finish F2 - Finish F2 applies to all formed surfaces not permanently concealed by fill materials or concrete, or not required to receive Finish F3. Surface irregularities, measured as described in sub-paragraph (a) shall not exceed 0.60 centimeter for abrupt irregularities and 1.20 centimeters for gradual irregularities.

Finish F3 - Finish F3 applies to formed surfaces of the stoplog guides, exposed faces of abutments, wing walls, girders, curbs, parapet railings, and decorative features on bridges. Surface irregularities, measured as described in sub-paragraph (a) above, shall not exceed 0.60 centimeter for gradual irregularities and 0.30 centimeter for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints.

Finish F4 - Finish F4 applies to formed surfaces for which accurate alignment and evenness of surfaces are of paramount importance from the standpoint of eliminating destructive effects of high velocity flows. Formed surfaces to receive an F4 finish includes formed surfaces exposed to high velocity flowing water.

Except as hereinafter provided, abrupt irregularities on surfaces to receive F4 finish, when measured as described in sub-paragraph (a), shall not exceed 0.60 centimeter for irregularities parallel to the direction of the flow and 0.30 centimeter for irregularities not parallel to the direction of the flow. Gradual irregularities on surfaces to receive an F4 finish shall not exceed 1.60 centimeters.

Abrupt irregularities on formed surfaces exposed to high velocity flows shall be eliminated by grinding on a bevel of 1:20 ratio of height to length.

The Contractor will not be entitled to any extra payment or compensation for reducing or eliminating irregularities on formed concrete surfaces which do not meet specification limits.

(c) Unformed Surfaces - The classes of finish for unformed concrete surfaces are referred to by symbols U1, U2, U3, or U4. Exterior surfaces will be sloped for drainage where shown on the Drawings or as directed by the Engineer. Exterior surfaces which otherwise would be level shall be sloped for drainage. Unless the use of other slopes or level surfaces is indicated on the Drawings or directed by the Engineer narrow surfaces, such as tops of walls and burbs, shall be sloped approximately 3 centimeters per meter of width; broader surfaces, such as walks, roadways, platforms, and decks shall be sloped approximately 2 centimeters per meter. These classes of finish and their applications are as follows:

Finish U1 - Finish U1 (screeded finish) applies to unformed surfaces that will be covered by fill material or by concrete. Finish U1 is also used as the first stage of finishes U2 and U3. Finishing shall consist of sufficient leveling and screening to produce even uniform surfaces. Surface irregularities, measured as described in sub- paragraph (a) shall not exceed 0.60 centimeter.

Finish U2 - Finish U2 (floated finish) applies to unformed surfaces not permanently concealed by fill material or concrete, or not required to receive finishes U3 and U4. Finish U2 is also used as the second stage of finish U3. Floating may be performed by use of hand or power driven equipment. Floating shall be started as soon as the screeded surface has stiffened sufficiently, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. If finish U3 is to be applied, floating shall be continued until a small amount of mortar without excess water is brought to the surface, so as to permit effective trowelling. Surface irregularities measured as described in sub-paragraph (a), shall not exceed 0.60 centimeter.

Finish U3 - Finish U3 (trowelled finish) applies to inside floors of buildings. When the floated surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel trowelling shall be started. Steel trowelling shall be performed with firm pressure, so as to flatten the sandy texture of the floated surface and produce a dense uniform surface, free from blemishes and trowel marks. Surface irregularities, measured as described in sub-paragraph (a), shall not exceed 0.60 centimeter.

Finish U4 - Finish U4 applies to canal lining. The finished surface shall be equivalent in evenness, smoothness and freedom from rock pockets and surface voids to that obtainable by effective use of a long-handled steel trowel. Light surface fitting and light trowel marks will not be considered objectionable. Surface irregularities measured as described in sub-paragraph (a), shall not exceed 0.60 centimeter for bottom slabs and 1.20 centimeter for side slopes.

(d) Moisture Control for Unformed Surfaces - In warm, dry or windy weather the moisture control measures specified herein shall be taken to inhibit loss of moisture from the surface of the concrete. Such surfaces shall be fog-sprayed, covered completely with white polyethylene sheet, or otherwise treated as approved. The curing specified in Paragraph 1520 shall be started as soon as the concrete hardens, however, the surface of the concrete shall be kept wet during the change in curing methods.

If surfaces are fog sprayed, the fog spray shall maintain a sheet of moisture on the concrete but shall not displace cement or create a wet surface during finishing operations. Surfaces shall be fog sprayed during and immediately following finishing operations, and fog spraying shall be interrupted only to enable finishing operations. Such interruptions shall be of minimum duration and shall occur only in the immediate area being finished.

Plastic shrinkage cracks which occur before the concrete hardens shall be closed. Shrinkage cracks shall be closed by working; cracks shall not be sealed by trowelling only.

1520 CURING

(a) General

All concrete except interior surfaces, shall be cured for a period of not less than 14 consecutive days.

All horizontal slabs or surfaces shall be cured by water curing in accordance with sub-paragraph (c) and all inclined or vertical surfaces of concrete shall be applied with membrane curing immediately after removal of forms to prevent dehydration in accordance with sub-paragraph (b) except that membrane curing shall not be allowed for mass concrete and for construction joints. Contractor shall have all equipment needed for adequate curing and protection of the concrete on hand and ready for use before actual concrete placement begins. The curing medium and method or the combination of mediums and methods used shall be subject to the approval of the Engineers.

(i) Floors, stair threads, and horizontal construction joints shall be cured for 14 days by a covering of damp sand or curing mats, except that curing of construction joints surfaces may be discontinued in less than 14 days when the surfaces are to be covered with fresh concrete. The sand or curing mats shall not be kept so wet as to allow water to drain from it and stain concrete walls. The sand or curing mats shall be removed after the expiration of the curing period.

(ii) Interior Surfaces

Concrete surfaces of interior walls, including ceilings and surfaces of construction joints and vertical construction joints will require no curing other than resulting from forms being left in place for at least two days. Interior walls shall be washed during and after completion of concrete operations at higher elevations. The washing shall be sufficient to keep the walls free from drips or runs of material that would cause streaking or staining of the concrete. Stair risers and large repairs on interior walls shall be cured for at least four days by damp mats but the mats shall not be wet enough to cause dripping of water on completed concrete. Small repairs and filled core holes on interior walls shall be cured for at least four days by masking tape or similar covering.

(b) Membrane Curing Method.

The concrete shall be sprayed uniformly with sealing compound in accordance with the manufacturer's written recommendation, copies of which shall be furnished to the Engineer for approval in advance of the material being used. The sealing compound shall conform to AASHTO Designation: M-148, Type II. The component shall be of uniform consistency and quality within each container of each shipment and from shipment to shipment. Sealing compound used in confined spaces shall not be toxic to workmen. The Contractor shall furnish a manufacturer's certificate of compliance for the compound prior to its use on the work. The certificate shall identify the batch and include certified test results covering all requirements of the specifications for the sealing compound material.

Sealing compound shall be applied to unformed concrete surfaces immediately upon completion of moisture control measures taken as specified in Paragraph 1519 (d). Where such measures are not required, sealing compound shall be applied as soon as the concrete is hard enough to preclude damage from application of the sealing compound. The Engineer will require that the side slopes and bottom of the canal lining be sprayed separately unless the surfaces are ready, simultaneously, to receive the sealing compound.

Sealing compound shall be applied to formed concrete surfaces immediately upon removal of the forms as specified in Paragraph 1516. The moisture control measures shall be taken until the forms have been removed. Formed surfaces shall be sprayed with water immediately after the forms have been removed until the surfaces are saturated. The sealing compound shall be applied as soon as the surface film or water has disappeared but while the surface is still damp.

Sealing compound shall be applied in one coat to provide a continuous uniform membrane. Special care shall be taken to ensure coverage of edges, corners, and rough spots of formed surfaces. The compound shall be agitated continuously in the spray pressure tank.

Concrete repair work shall be performed after the sealing compound has been applied and is dry to touch. In the event that application of sealing compound is delayed or interrupted, water shall be applied as approved, until application of sealing compound is started or resumed.

Any membrane that is damaged or is determined to be defective within 28 days after application shall be repaired or replaced without delay, as approved. If the Contractor's operations require traffic on coated surfaces, the membrane shall be protected from damage.

Payment for membrane curing shall be included in the contract unit price for concrete in the Bill of Quantities where they are required.

(c) Water Curing

Water curing shall start as soon as practicable after placement of the concrete and shall continue until completion of the specified curing period or until covered with fresh concrete. Concrete, if cured by water, shall be kept wet by ponding method or by covering with an approved water saturated materials, or by a system of perforated pipes, mechanical sprinklers, porous hose, or by any other methods approved by the Engineer which will keep all surfaces to be cured continuously (not periodically) wet.

Water used for curing shall be free of chemicals which may have an adverse effect on the concrete. For example, water containing sulfates or chlorides is not acceptable.

1521 TOLERANCES FOR CONCRETE CONSTRUCTION

(a) **General.** Permissible surface irregularities for the various classes of concrete surface finish, specified in Paragraph 1519 are defined as "finishes", and are to be distinguished from tolerances that are consistent with modern construction practice, yet governed by the effect that permissible deviations will have upon the structural action or operational function of the structure. Deviations from the established lines, grades and dimensions will be permitted to the extent set forth herein.

Where tolerances are not stated in the Specifications or Drawings for any individual structure or feature thereof, permissible deviations will be interpreted in conformity with the provisions of this paragraph. Concrete work that exceeds the tolerance limits specified will be rejected and shall be corrected or removed and replaced, as ordered.

(b) Tolerance for Canal Structure

1. Concrete canal lining:

Departure from established alignment

- 5 cm. on tangents
- 10 cm. on curves

Departure from established profile grade

- 2.50 cm.

Reduction in thickness of lining:

10 per cent of the specified thickness; provided that the average of all thickness measurements made in 40 meters of lining shall be not less than the specified thickness, and provided further that the quantity of concrete actually used in 40 meters of lining shall be not less than the theoretical quantity, based on the lines shown on the Drawings.

Variation from specified width of section at any depth	-	3 cm.
Variation from established depth of lining	-	3.7 cm.

Variation in surface:

Invert, in 3 meter	-	0.60 cm.
Side slopes, in 3 meter	-	1.20 cm.

2. Bridges, inlets, chutes and structures:

Departure from established alignment	-	1.20 cm.
Departure from established grades	-	1.20 cm.

Variation from the plumb or the specified batter in the lines and surfaces of columns, piers, walls and in arises:

Exposed in 3 meters	-	1.20 cm.
Backfilled in 3 meters	-	2.00 cm.

Variation in cross-sectional dimensions of columns, walls, piers, slabs, beams and similar parts

Minus	-	0.60 cm.
Plus	-	1.20 cm.

3. Bridge Slabs:

Variation in thickness of slab:

Minus	-	0.30 cm.
Plus	-	0.60 cm.

Variations from specified width over curbs	-	0.60 cm.
Variations from specified grade of top of curb in cambered position	-	0.60 cm.
4. Foundations:		
Variations in dimensions in plan:		
Minus	-	2.50 cm.
Plus	-	5.00 cm.
Variations from established grade:		
Minus	-	1.20 cm.
Plus	-	2.00 cm.
Misplacement of eccentricity:		
2 percent of the footing width in the direction of misplacement but not more than	-	5.00 cm.
5. Bridge Seats:		
Variation of any one bearing from established elevation	-	0.30 cm.
Difference in elevations of bearings for adjacent spans, maximum	-	0.60 cm.
Difference in elevations of bearings for zone span on any one pier, maximum	-	0.30 cm.
Horizontal misplacement for any one bearing, maximum	-	0.70 cm.
Variation in the sizes and locations of slabs and wall openings	-	1.20 cm.
Skills and side walls for radial gates and similar watertight joints:		
Variation from the plump level		not greater than 0.30 cm. in 3 meters
6. Stop Log Slots:		
Variation from a common plane between the sealing surfaces of each pair of related stop log slots shall be no greater than	-	0.15 cm.

Variation of widths of stop log guides:

Minus	-	0.30 cm.
Plus	-	0.60 cm.

(c) Tolerances for Cast-In-Place Concrete Pipe:

Departure from established alignment or from established grade	-	2.50 cm.
--	---	----------

Variation in thickness at any point: Minus 2-1/2% or 0.60 cm. whichever is greater
Plus 5% or 1.20 cm. whichever is greater

Variation from inside diameter	-	0.5%
Variation in surface invert	-	0.60 cm. in 3 meters

(d) Tolerances for Placing reinforcement steel:

Variation from indicated protective cover:

For 5 cm. cover	-	0.60 cm.
For 7.5 cm. cover	-	1.20 cm.
Variation from indicated spacing	-	2.50 cm.

1522 FAILURE TO CURE

The Engineer shall have the authority to suspend the work whole or in part, by written order, for such period as he may deem necessary for failure on the part of the Contractor to perform proper curing of the concrete work and to withhold payment for the corresponding work pending results of test, that shall subsequently be made on these concrete works. The Contractor shall immediately secure core samples of such members and from parts of the structure as shall be designated by the Engineer and shall have them tested in a Testing Laboratory approved by the NIA. If the results of tests are found satisfactory, payment of the concrete in question shall be made and the work ordered resumed, but if the results of test are unsatisfactory to meet the structural requirements, the Contractor shall remove, wholly or partly, the concrete work in question at the discretion and upon written order of the Engineer and the Contractor shall replace such parts at his own expense.

1523 FAILURE TO MEET CONCRETE REQUIREMENTS

All concrete designed, prepared and placed by the Contractor for bridges that fails to meet the specified strengths shall be removed and replaced by the Contractor at his own expense. For other structures, concrete that fails to meet the specified strengths may be accepted provided the Contractor shall pay as liquidated damages the amount based on the following schedule:

<u>Percent (%) lower than the specified strength</u>	<u>Reduction in Price per cu.m. of Concrete</u>
Up to -5	less 10% of contract unit price
Above -5 to -10	less 20% of contract unit price
Above -10 to -20	less 30% of contract unit price

Concrete for all structures other than bridges which are more than twenty percent (20%) lower than the specified strength shall be removed and replaced by the Contractor at his own expense.

1524 PROTECTION OF CONCRETE WORKS

The Contractor shall protect all concrete against injury until final acceptance by the NIA. Final acceptance shall be construed to mean acceptance of the whole work after the Contract has been completed or satisfactory terminated.

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 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 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 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 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 XXXV

MISCELLANEOUS METALWORKS AND MATERIALS

3501 SCOPE

The work under this Section shall include furnishing, delivering and installing all miscellaneous metalworks and materials shown on the drawings which shall include but not limited to the following:

1. Trashracks or screens including frames, guides and anchors
2. Steel ladder rungs
3. Steel gratings including frames, guides and anchors
4. G.I. Pipes guardrails and handrails
5. Bearing plates for bridges
6. Bearing pads and filler board for bridges
7. Perforated drain pipes
8. Embedded metals including plates, anchors, angles, strap anchors, bolts, nuts washers, flanges, fittings, bends, tees, cross, elbow and other metals or materials which are not paid for under other items in the Bill of Quantities
9. Timber

All metalworks treated in this Section shall conform to the following standards or their approved equivalent standards:

- | | |
|-----------|---|
| ASTM AG | General requirements for delivery of rolled steel plates, shapes, sheet piling bars for structural use |
| ASTM A36 | Structural Steel |
| AWS D1-1 | Structural Welding Code |
| AWS | Code for Arc and Gas Welding in Building construction |
| ASTM A307 | Specification for Low-Carbon Steel Externally and Internally Threaded Std. Fasteners |
| ASTM A325 | High Strength Bolts for Structural Steel Joints including Suitable Nuts and Plain Hardened Washers |
| ASTM A108 | Cold Finish Carbon Steel Bars and Shafting |
| AISC | Manual of Steel Construction |
| ASTM A123 | Zinc (Hot Galvanized) Coatings on products fabricated from rolled, pressed and forged steel shapes, plates, bars and strips |

ASTM A53 Welded and Seamless Steel Pipe

Metal Grating Metal Grating Institute Handbook
Pittsburg, Pa. U.S.A

ASTM 120 Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and
Seamless Steel Pipe for Ordinary Uses

AISC Specification for Design, Fabrication and Erection of Structural
Steel for Buildings

ASTM A153 Galvanized Steel Pipes

3502 FABRICATION

Details of design and fabrication not covered by the drawings nor by these specifications shall conform to the applicable provisions of the latest "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" including all supplementary provisions of the American Institute of Steel Construction.

All metalworks and materials furnished by the Contractor and all works performed will be subject to rigid inspection. No metalworks or materials shall be delivered to the jobsite until inspection at the Contractor's fabricating plant has been made, in accordance with the provisions of these specifications.

Shearing and cutting by torch or electric arc shall be performed carefully, and all portions of the work which will be exposed to view after completion shall be finished neatly. Re-entrant cuts and copes shall be shaped notch-free to a radius of at least 12 millimeters.

In bolted connections, all holes shall be cylindrical, unless otherwise shown on the drawings, perpendicular to the members, and clean cut and without burned or ragged edges. Holes in materials more than 20 mm thick shall be drilled. All other holes may be punched or drilled to full size. Unless otherwise shown on the drawings, drilled holes shall be 1 mm larger than the nominal diameter of the bolt. Outside burrs resulting from drilling shall be removed with a tool making a 1 mm bevel. Likewise for punched holes, unless otherwise shown on the drawings, the diameter of the punch for punching to full size shall also be 1 mm larger than the nominal diameter of the bolt. The diameter of the die shall be not more than 1.50 mm larger than the diameter of the punch.

Welding shall be done by the shielded-arc method except where otherwise specifically permitted by the Engineer. Welding rods shall be furnished by the Contractor and shall be of heavily coated type designated for all position welding, and the size, type and nomenclature of the rods shall be subject to approval by NIA. Welds shall be made as indicated on the drawings and in accordance with the conventional symbols of the

American Welding Society (AWS). Welding shall be done in accordance with Sections 3, 4, 5 and 6 of the AWS' code for Arc Welding and Gas Welding in Building Construction, latest revision. All butt welds shall have complete penetration. Teeming of multiple layer welds will not be permitted.

3503 INSTALLATION

All metalworks and materials shall be installed in accordance with the details shown on the Drawings. Care shall be taken to insure that all parts of metalworks are installed in correct position and alignment. Metalworks to be embedded in concrete shall be located accurately and shall be held in correct position and alignment during placing and setting of the concrete. Anchor bolts shall be set and held in position before concrete is placed, unless otherwise approved. Where it is impractical to embed anchor bolts or ladder, stairways or other comparatively light metal work before the concrete is placed and when it is necessary to anchor parts where inserts or anchor bolts have not been provided, holes shall be drilled in the concrete and expansion anchors with bolts shall be installed as directed. The surfaces of all metalworks to be in contact with or embedded in concrete or grouting mortar shall be cleaned.

Suitable blockouts shall be constructed in the concrete where required for installation of railing posts and other metalworks. After installation of the metalworks, blockouts shall be filled with concrete or grout as shown on the drawings. Contractor shall drill or drill and tap, as required all holes in metalwork required for installation of the metalwork.

Contractor shall drill all holes in concrete required for the installation of expansion anchors. Contractor shall slot or cut or split metalwork in the field as required for installation.

3504 TRASHRACKS OR SCREENS

Trashracks or screens shall be a substantial all welded sectionalized steel structure, generally as shown on the drawings. Special care shall be taken to insure that all members shall be in exact position and alignment. Vertical members shall be welded to horizontal members. Trashracks shall be prime coated and painted in accordance with Section XXXVI, Painting Metalworks.

3505 STEEL LADDER RUNGS

Steel ladder rungs shall be furnished and installed in accordance with details shown on the drawings. Bars used for steel ladder rungs shall be cold drawn steel wire conforming to the provisions of ASTM Designation A32 or its latest revision. The wire gage or bar size and spacing shall be as designated on the Drawings.

Ladder rungs embedded in concrete shall be free of mortar, oil dirt, loose mil scale, loose rust and other coatings that would destroy or reduce the bond. Bars shall conform to

the dimensions shown on the drawings. Bars with links or improper bends or other deformations shall not be used or made as rungs.

3506 STEEL GRATINGS

Gratings shall be provided as indicated on the drawings. Steel gratings shall be fabricated from steel shapes and flat bars provided with stiffeners and welded to form a rigid structures as shown on the drawings.

Flat bars of sizes and spaces shown on the drawings shall be welded at their ends into continuous rolled steel angles and provided with stiffeners. The sizes and dimensions of angles or stiffeners shall not be less than those shown on the drawings.

Steel gratings used as cover for the intake barrel manhole shall be provided with rollers on both ends as shown on the drawings, such that this cover could be opened by sliding. Roller guides shall not be shorter than the length shown on the drawings.

3507 GALVANIZED IRON PIPE GUARDRAILS AND HANDRAILS

Galvanized iron pipe guardrail and handrail shall be provided at operating platforms and other places shown on the drawings. Sizes and dimensions shall be as shown in detail on the drawings. All railings shall be of threaded ends and furnished with complete joint fittings.

Vertical members for guardrails shall be installed plumbed and horizontal members parallel to the surface of anchorage. Vertical members shall be installed in prepared sockets, braced in true alignment and secured permanently by either threaded floor flange which is anchored to the concrete structure by means of expansion bolts as shown on the drawings or by cement grout consisting of 1 part cement and 3 parts sand (by wt.) mixed to a consistency as directed by the Engineer. Bolts in bolted connections shall be firmly tightened.

Galvanized surfaces that are abraded or damaged during installation shall be thoroughly wire brushed removing all loose and cracked coating and then painted with two coats of high zinc- dust content paint conforming to the requirements of Federal Specification MIL-P-21035 or approved equal.

3508 BEARING PLATES FOR BRIDGES

Bearing plates, bars, rockers, assemblies, and other expansion or fixed devices for bridges shall be constructed in accordance with the details shown on the Drawings and shall be hot-dip galvanized after fabrication conforming to ASTM Designation A120 or its latest revision.

The bearing plates shall be set level and the rockers and other expansion devices shall be set to conform to the temperature at the time of erection or to the setting specified.

When bearing assemblies or masonry plates are shown on the Drawings to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above grade and shall be finished by grinding or other approved means to a true level plane which shall not vary perceptively from a straight edge placed in any direction across the area. The finished plane shall not vary more than 0.30 centimeter from the elevation shown on the Drawings.

When elastic bearing pads, or preformed fabric pads are shown on the Drawings, the concrete surface on which pads or packing are to be placed shall be wood float finished to a level plane which shall not vary more than 0.40 centimeter from a straight edge placed in any direction across the area. The finished plane shall not vary more than 0.30 centimeter from the elevation shown on the Drawings.

3509 BEARING PADS AND FILLER BOARDS

Bearing pads of sizes indicated on the Drawings shall be neophrene, hardness 60 and filler boards shall be canex board or as indicated on the Drawings. The concrete surfaces on which bearing pads are to be placed shall be wood float finished to a level plane which shall not vary more than 0.15 centimeter from a straight edge placed in any direction across the area. The finished plane shall not vary more than 0.30 centimeter from the elevation shown on the Drawings.

3510 PERFORATED DRAIN PIPES

Perforated drain pipes shall be installed at locations shown on the drawings and as directed by the Engineer. The sizes and type of materials to be used shall be as indicated on the drawings.

3511 BOLTS, ANCHORS, ANGLES, NUTS, WASHERS AND OTHER METALS

Except for studbolts, the length of connection bolts shall be in 6 mm variations and when in the structure, the bolts shall extend at least six millimeters beyond the nuts. Anchor bolts and studbolts shall be as shown on the Drawings. Threads of anchor bolts shall be given a heavy coat of rust preventive compound in the shop. Washers shall be used under heads of all connection bolts where shown or called for on the drawings. Bevelled washers shall be used on sloping flanges.

3512 GROUT AND MORTAR

Grout and mortar for miscellaneous metalworks shall be mixed in the proportions and to the specified consistency in accordance with the requirements of Section XV, Concrete. Before placing grout and mortar, the surfaces of concrete on which grout will be placed shall be roughened and shall be cleaned of all laitance, loose or defective concrete coatings and other foreign materials by effective means followed by thorough washing and such surfaces shall be kept moist for at least 24 hours.

3513 TIMBER

This work shall consist of timber structures constructed to the dimension, lines and grades shown on the Drawings and in accordance with the specification. The timber shall be treated or kiln dried.

In handling treated timber, care shall be exercised so as not to break or penetrate the treatment with any tool or handling equipment. Any damage timber shall be replaced without any extra compensation. Any cut made or hole bored in treated timber that exposes untreated wood shall be given 3-coats of hot creosote oil before the exposed part is assembled.

All timber shall be of the specie specified in the drawing, shall be sound, free from knots, splits, ring separation, wormholes or any defects which will impair its strength or render it unfit for its intended use.

All timber which is to be stored on the job for any length of time, prior to its use in the structure, shall be neatly stacked in piles to prevent warping or distortion. Untreated timber shall be open stacked at least 300 mm above the ground and shall be close-stacked and piled to prevent warping. The ground underneath and in the vicinity of all piles shall be cleared of all weeds and rubbish.

3514 METHOD OF MEASUREMENT

Measurement for payment of miscellaneous metalwork and materials will be made either on the weight of metalwork in kilogram or on the number of assembly or pieces actually installed in accordance with the table as follows:

<u>Metal/Material</u>	<u>Measurement</u>
1. Trashrack or screens including frames, guides and anchors	Kilogram/Set
2. Steel ladder rungs	Kilogram
3. Steel grating, including frames guides and anchors	Kilogram
4. G.I. Pipe guardrails and handrails	Kilogram/L.M.
5. Bearing Plates for Bridges	Piece
6. Bearing Pads and Filler Boards for Bridges	Piece
7. Perforated drain pipes	Kilogram/L.M.

8. Embedded metals including plates, anchors, angles, strap anchors, bolts, nuts and washers, flanges, fittings, bends, tees, cross, elbows and other metals or materials which are not paid under other items in the Bill of Quantities

Kilogram/Lump sum

9. Timber

Set/Assembly or bd. ft.

Weights shall be computed based on the theoretical weight of such material duly certified by the manufacturer.

3515 BASIS OF PAYMENT

Payment for miscellaneous metalwork will be made at the contract unit price per kilogram, per piece, or per assembly whichever is called for in the Bill of Quantities which price and payment shall constitute full compensation for furnishings all labor tools, materials and all incidentals and subsidiary works necessary for the successful completion of the miscellaneous metalworks and materials described under this Section.

SECTION I

TEMPORARY WORKS

101 SCOPE

(a) Temporary Works

The Contractor shall furnish all materials, labor, equipment, tools and install such temporary works as are necessary for the successful completion of the Contract Work. The Contractor shall negotiate the site for his construction camp, office and work areas.

These temporary works and construction plant shall include but will not be limited to the following:

1) Construction camp for housing, feeding and accommodating of all the Contractor's employees. The Contractor shall also, within close proximity of his camp, provide an office and sleeping quarter for NIA employees, complete with facilities (specified in item 2 below) and shall have a minimum floor area of 80 square meters.

2) Facilities such as potable water, drainage, lighting, sewage, disposal, sanitation, first aid and fire protection facilities.

3) Workshops, warehouses, site offices, stockpile areas, storage areas for materials, equipment, spare parts, fuel and oil.

4) All other temporary facilities not specifically listed but nevertheless required for the proper functioning of the camp set-up and construction activities.

Temporary works shall conform to all government standards and codes and shall meet the sanitary requirements of the Department of Health.

Contractor shall submit to the Assistant Administrator for Project Development and

102 BASIS OF PAYMENT

Payment for furnishing of all materials, equipment and labor for the temporary works, mobilization of construction equipment including demobilization work, shall be made at the fixed lump sum price or lump sum bid price whichever is stated in the Bill of Quantities upon completion of the above-mentioned item.

SECTION XXXXVII
HEALTH AND SAFETY: BASIC PERSONAL PROTECTIVE EQUIPMENT

4701 SCOPE

The work under this Section shall include materials for providing basic personal protective equipment such as construction hard hats, safety shoes and gloves for all the contractor's workers, supervisors and visitors that will take part in the construction.

4702 MATERIALS

All materials for basic protective equipment to be furnished by the Contractor shall comply to the best quality and standards submitted in the Construction Health Safety Program.

- 1. Hard Hat** shall consist of a shell and 6-point headgear suspension with chin strap and must be approved by required testing agency. The shell part shall be free of dents, cracks or any damage that might reduce protection to its wearer. The following assigned colors depending on the nature of work may be followed.

White is for Site managers, foremen, engineers or supervisors usually wear white hats on site.

Yellow is for general laborers and earth moving operators.

Blue is for Carpenters and other technical operators including electricians

Green is for safety inspector but can also be used by new workers on the site or probationary staff.

Orange is for Lifting operatives, Banks-man slingers / signalers or traffic marshals but mainly lifting operatives wear orange hard hats so the crane operator can pick them out from other operatives

Red is for Fire Marshal's usually with sticker ("Fire Marshal").

Brown is for welders and other workers with high heat applications.

Grey is often worn by site visitors.

- 2. Gloves** shall be generally made of material that protects against minor cuts, abrasions, and heat for skilled workers such as welders.

3. **Safety Shoes** shall be durable that has protective reinforcement in the toe which protects the foot from falling objects.

4703 BASIS OF PAYMENT

The basic personal protective equipment as provided above shall be paid at the contract unit price per lump sum in the Bill of Quantities and shall be collected upon completion of the project.