

SECTION II**CLEARING AND GRUBBING****201 SCOPE**

The work under this Section shall include clearing, grubbing and disposal, in a manner approved by the Engineer of all vegetation such as trees, stumps, roots, brush; rubbish and all objectionable matters within the entire right-of-way for canals, farmditches, drainage ditches, diversion work and over borrow areas, road surfacing materials sources, stockpile areas and elsewhere mutually agreed upon by the Engineer and the Contractor all in accordance with the Drawings and these Specifications.

202 METHOD OF CONSTRUCTIONS**(a) Clearing on Lightly Vegetated Areas**

The areas over which diversion works shall be constructed, the entire right-of-way for canals, farmditches and drainage ditches, side borrow areas, borrow haul areas, aggregate sources and stockpile areas shall be cleared of all vegetation, trees and all other matters, except such trees or shrubs which the Engineer may order to be preserved. All trees and shrubs ordered to be preserved including all existing adjacent facilities, properties and utilities, if any, shall be protected from injury or damage resulting from the Contractor's operations. All combustible materials from clearing operations shall be burned thoroughly or removed from the site of work or otherwise disposed to designated areas as directed by the Engineer.

All materials to be burned shall be piled neatly and when in a suitable condition shall be burned thoroughly. Piling for burning shall be done in such a manner and in such locations as to cause the least fire risk. The Contractor shall at all times take special precautions to prevent fire from spreading and shall have available at all times suitable equipment and supplies for use in preventing and fighting fires. In this connection, the Contractor shall be liable for all costs and damages resulting from such incidents.

No clearing shall be done on any areas where there are standing crops until such crops have been harvested or unless the Contractor shall have secured written permission from NIA.

(b) Clearing on Swampy Areas and/or Second Growth Forested Areas

Clearing on swampy areas and/or second growth forested areas where canals are passing thru shall only be started when said areas are suitably dry or when directed by the Engineer. Clearing includes felling and bucking of trees using chain saws and cutting of tree branches extending over the entire right-of-way. Felled trees shall be cut into the longest usable lengths and shall be hauled and neatly stocked at designated stockpile areas.

Small trees and stumps, branches, grass and litters shall be burned in accordance with the preceding paragraph (a).

(c) **Grubbing**

Grubbing shall consist of the removal of all trees, stumps, roots, brush and rubbish from the above mentioned work areas. No roots shall be left within 50 cm. from the ground surface. It shall include necessary stripping of the natural ground surface to a depth not more than 10 centimeters by effective means to remove all objectionable materials or organic matters from the said work areas, except for damsite where stripping shall be in accordance with sub-section 403(b) of Section IV of these Technical Specifications. Stripping beyond the limit of 10 centimeters shall be subject to the approval of the Engineer and payment thereof shall be considered included under Section IV, Canal Excavation.

If required by the Engineer, stripped top soil shall be temporarily stored at the edges of the right-of-way for subsequent use on slopes to encourage vegetative growth and minimize erosion.

203 METHOD OF MEASUREMENT

The area to be measured for payment shall be within the limit of the entire right-of-way as shown on the Drawings or as staked by the Engineer during Construction Operations.

All clearing and grubbing operations for side borrow areas, borrow haul areas, aggregate sources, stockpile areas and elsewhere are considered subsidiary works required for other pay items in the Bill of Quantities and will not be measured for payment under this Section. The costs of such works shall be considered included in the contract unit price for the various items in the Bill of Quantities where clearing and grubbing are required.

204 BASIS OF PAYMENT

The cleared and grubbed areas measured as provided above shall be paid at the contract unit price per square meter in the Bill of Quantities which price and payment shall constitute full compensation for furnishing all labor, tools, equipment, supplies and all incidentals or subsidiary works (including stripping within the 10 centimeters limit) necessary for the successful completion of the work. No payment shall be made on cleared and grubbed areas where no excavation or embankment construction have been undertaken.

SECTION IV CANAL EXCAVATION

401 SCOPE

The work under this Section shall consist of excavating and removal of all classes of materials in canal prism including placing into canal embankments with excavated suitable materials, stockpiling of excavated materials suitable for embankment and backfilling, and trimming of side slopes inside canal prism and canal beds except on portion of the canal where concrete lining is required (trimming of the foundation bed will be considered included under Section XX, Concrete Canal Lining) all in accordance with the Drawings and these Specifications or as directed by the Engineer.

All excavations shall be true to lines, grades, slopes and profiles shown on the Drawings or as required by the Engineer.

402 CLASSIFICATION

All excavated materials under this Section will be classified as follows:

1. **Rock Excavation** - For purposes of classification of excavation, rock is defined as sound and solid masses or formation, layers or ledges of mineral matter in place of such hardness and texture that:

- a) Cannot be effectively loosened or broken down by ripping in a single pass with a latest model tractor mounted hydraulic ripper equipped with one digging point of standard manufacturer's design adequately sized for use with and propelled by a crawler-type tractor above 300 HP.
- b) In the areas where it is impracticable to classify the use of the ripper described above, rock is defined as sound and solid material of such hardness and texture which cannot be loosened or broken by a 2.72 kg. (6 pound) drifting pick.
- c) Can only be loosened or broken by special equipment such as jack hammer and pencil hammer attached to an excavator.

All formation of materials as defined above whose volume is one (1) cubic meter or more will be classified as rock.

2. **Common Excavation** - Excavation of any materials and boulders (whose volume is less than one cubic meter) that can be ripped to be loosened by, a dozer of equal or below 180 HP capacities.

3. **Hard Excavation** - Excavation of any materials and boulders (whose volume is at least one cubic meter) that can only be ripped to be loosened by a dozer of above 180 HP to 300 HP.

403 CONSTRUCTION REQUIREMENTS**(a) Explosives and Blasting****1) *Explosives***

Caps or other exploders or fuses shall in no case be stored in the same place in which dynamite or other explosives are stored, transported or kept. The location and design of powder magazines, the methods of transporting explosives and the precautions taken to prevent accidents shall be in accordance with the provisions of all laws, orders, regulations and decrees that are in force in the Philippines or may be issued from time to time by the Government.

The Contractor shall maintain an inventory for storage and withdrawal of powder stocks and detonators. The NIA shall be notified immediately of any loss or theft of explosives. The Contractor shall provide such reasonable and adequate protective subversive action or sabotage to any property. Only reliable personnel shall be permitted to store and handle explosives.

Explosives, if used, shall be of such quantity and power and shall be used in such locations so as to minimize opening of seams and disturbing of material outside the prescribed limits of excavation. As excavation approaches its final limits, the depth of holes for blasting and the quantity of explosives used for each hole shall be reduced so that the underlying or adjacent material will not be disturbed or shattered. Whenever further blasting might injure the surface of the final excavation, as determined by the Engineer, the use of explosives shall be discontinued.

The cost of furnishing, hauling, storing and handling all explosives shall be included in the contract unit price of the work for which they are required.

2) *Blasting*

Blasting will be permitted only when proper precautions are taken for the protection of persons, the works, and public or private property. The Contractor shall satisfactorily cover all shots in deep cut excavations and shall take extra precautions on all blasting work as maybe required by the NIA. The Contractor shall blast to the extent necessary and in such a manner that the excavation will not be unduly large or irregular, nor unduly disturb the ground and make it unstable, nor shatter the rock, if encountered, upon or against which concrete is to be placed, nor injure concrete already placed or existing structures at the site or in the vicinity thereof. Whenever, in NIA's opinion, the Contractor's operations are liable to result in unduly large excavations or unstable ground, as to injure the rock, concrete or structures, the Contractor shall drill shorter holes and use lighter charges. Approval by the NIA of any of the Contractor's blasting operations shall not relieve the Contractor of his responsibility under this paragraph.

The Contractor shall submit his drilling and blasting operations for approval of the Engineer before commencing with his blasting works. No blasting operations shall be undertaken without the approval of the Engineer.

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.

(b) Sections and Slopes

Excavation sections, profiles and slopes shall be cut true and straight in conformity with the lines and grades shown on the Drawings within the following tolerances, measured normal to the excavated surfaces:

Item	Tolerances
1. Side slopes above minimum elevation of operating roads	+ 30 cms.
2. Profile of operating roads, access roads and protection dike	+ 9 cms.
3. Profile of invert of canals	+ 3 cms.
4. Side slopes inside canal prism for Canals and laterals	+ 15 cms.
5. Side slopes outside canal prism for canals and laterals	+ 15 cms.

The extreme of the above tolerances shall not be continuous over a distance of 40 meters measured at any place, in any direction, parallel to the excavated surface.

(c) Excavation Beyond Established Lines

Precautions shall be taken to preserve, in an undisturbed condition, materials beyond the designated limits of excavations as shown on the Drawings except unsuitable materials ordered removed by the Engineer. Materials loosened beyond the excavation limits as a result of excavation operations shall be considered defective work and shall be

compacted or removed and replaced with compacted embankment at the Contractor's expense, as directed by the Engineer.

404 METHOD OF CONSTRUCTION

Canal excavation shall include all excavation works in the canal prism whether common, indurated or rock materials, except additional excavations at structure sites which is specified to be done and measured for payment under excavation for structure.

The Contractor shall only excavate after the area of operation is acceptably cleared and grubbed. Excavation of all canals shall be in accordance with the cross section, lines and grades shown on the Drawings. On portion of the canal where concrete lining is required, canal excavation shall not extend beyond the neat lines of the underside face of the canal lining as shown on the Drawings. The Contractor must exercise care not to extend his excavation beyond the limits called for in the Drawings. Excavation operations shall be such that all materials suitable for embankment or back filling and filling shall be separated from objectionable materials which are to be wasted. All surfaces from excavation shall be trimmed to the required slopes and grades within the specified tolerances under paragraph 403 (b). Blasting if permitted by the NIA, shall be in accordance with paragraph 403 (a), "Explosives and Blasting".

In sections of deep cut in which the canal section is continuous with the roadway section and its side slopes, excavation for roadway shall be included under this Section. If slides occur on excavated slopes or if run-off flows deposit additional materials in excavations before acceptance of the works, the removal of said slides and/or deposits shall be at the expense of the Contractor.

Large canals like main canals should preferably be excavated with the use of motorized scrapers, excavating in successive layers of about 30 centimeters followed subsequently by trimming of the side slopes using a Grader. Medium sized canals like laterals should preferably be excavated by initially using a D-6 or D-7 Bulldozer for the upper layers and then excavating the bottom layers and side slopes with the use of a Backhoe. Should the Contractor proposes to do excavation works by some other means, prior approval of the Engineer must be secured.

405 FINISHING CANAL AND ROADWAYS

Upon completion of all construction operations, the canal section, including slopes of canal embankments, and roadway embankments, shall be finished as specified and shown on the Drawings. Canal beds, canal embankments and side slopes shall be trimmed and shaped to the finished cross-section to produce smooth surfaces and slopes, and uniform cross-sections.

Stockpiling of materials on finished canal sections, roadways and embankments shall not be permitted. All finished works and surfaces shall be cleaned of all dirt and foreign materials.

The Contractor shall also be required to clear the entire right-of-way and areas outside the limits of the right-of-way for all excess of objectionable materials, if such

excess or objectionable materials are the result of the Contractor's operation as determined by the Engineer.

All weeds and other objectionable growth, roots, excess earth, debris, loosened rock larger than 7.5 centimeters shall be removed and disposed off in approved sites outside the right-of-way as specified or directed by the Engineer.

The entire canal sections including roadways, side slopes and structure approaches shall be left in a neat and presentable condition.

406 METHOD OF MEASUREMENT

Canal Excavation will be measured for every cubic meter of material excavated from the canal prism. Measurement shall be made in its original position after undertaking clearing and grubbing including stripping operations and computed by the Average-End Area method for every 20-meter section of finished canal within the paylines or neat lines shown on the Drawings, acceptably excavated and formed into embankments or used for structure backfill, or wasted as directed.

Hauling of excavated materials within the free haul distance of 200 meters for disposal to waste areas and trimming of side slopes in canal prism and canal beds except on portion of the canal where concrete lining is required, are considered subsidiary works under canal excavation, thus, shall be paid under this Section and the cost thereof shall be considered included in the contract unit price for Canal Excavation. Hauling beyond the free haul distance of 200 meters (for waste materials only) and spreading of excavated materials into canal and roadway embankments and structure backfill shall be paid under Sections IX & XII, respectively. Hauling or overhauling for disposal of excavated materials into canal embankments is a subsidiary work for Embankment Construction and Compaction, thus, it will not be measured for payment and the cost thereof is considered included in the contract unit price for Embankment Construction and Compaction.

407 BASIS OF PAYMENT

The volume measured as provided above shall be paid per cubic meter, which price and payment shall constitute full compensation for furnishing all materials, supplies, labor, equipment, tools and all incidentals necessary for the successful completion of the work described under this Section and for all subsidiary works except for hauling of excavated materials beyond the free haul distance of 200 meters for disposal to waste areas which shall be paid under Section IX, OVERHAUL, and except for trimming of side slopes on portion of canals where concrete lining is required which shall be considered as a subsidiary work under Section XX, Concrete Canal Lining.

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 XIII

EMBANKMENT CONSTRUCTION AND COMPACTION

1301 SCOPE

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

1302 SOURCES OF MATERIALS

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

1303 COMPACTION EQUIPMENT

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

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

1304 METHOD OF CONSTRUCTION

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

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

Where canal embankment is to be constructed across low swampy ground or where the top soil is not satisfactory for foundation as determined by the Engineer, stripping of top soil of the foundation area and compaction will be ordered before construction of the embankment, stripping and disposal of the stripped material is subsidiary work and will not be measured for payment; Provided, however, that when stripping to a depth beyond 10 centimeters from the natural ground surface is ordered by the Engineer, the stripped

materials below the 10 centimeters free stripping depth will be paid for under "Canal Excavation". In case stripping of the top soil exceeds 10 centimeters, the Contractor should request to NIA for a re-survey to determine the actual volume subject for payment. Verification and approval by the Administrator should be obtained first before proceeding with the stripping operation.

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

TABLE

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

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

During construction, the Contractor shall keep the top of the embankments at such elevation and section to provide natural surface drainage at all times. If the Contractor stops work on any portion of the embankment on account of rain or impending rain, the surface shall be graded to facilitate drainage and the surfaces shall be sealed by passing rubber tired equipment or flat drum rollers over the surface. Before work is resumed on

the area, the surface shall be scarified to a minimum depth of not less than 15 cm., releveled, moisture conditioned, and recompactd to the specified density.

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

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

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

1305 METHOD OF MEASUREMENT

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

1306 BASIS OF PAYMENT

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

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 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.

SECTION XX CONCRETE CANAL LINING

2001 SCOPE

The work under this Section shall include the trimming of foundations and the construction of the canal lining with the necessary construction joints as specified herein.

2002 METHOD OF CONSTRUCTION

1. Trimming Foundation for Canal Lining

Trimming work will consist of excavation and removal of earth materials bounded by the exposed upper and underside surfaces of the canal lining including the portion where gravel blanket is to be laid except on portion where filter drain is to be constructed.

The Contractor must exercise extra care in order that trimming work will not extend beyond the neat lines of the underside of the canal lining. Over excavation or trimming work will not be permitted. In case of slight over excavation, backfilling with soil is not permissible but instead, the Contractor will be obliged to backfill with concrete (as part of the lining) with no additional cost to NIA.

Any under excavation of the earthworks should not be permitted since this will result in either the lining closing them of the canal being undersized.

2. Pouring of Concrete

Concrete for canal lining shall conform to the provisions of Section XV. The surface of the lining shall be finished as specified for finish under Finish U4 in Paragraph 1519, Section XV, Concrete.

When concrete lining operations are stopped for the day because of equipment breakdown or delayed by other causes. the end of fresh concrete shall be bulkheaded to a vertical surface and a construction joint be provided.

Construction joints in canal lining shall be provided at spaces shown on the Drawings and shall be constructed in accordance with Paragraph 1517, Section XV, Concrete.

2003 METHOD OF MEASUREMENT

Concrete canal lining will be measured in cubic meters in placed and computed based on the neat lines and dimensions shown in the Drawings, unless otherwise specified.

2004 BASIS OF PAYMENT

Payment of concrete for canal lining measured as provided above will be made on the contract unit price per cubic meter, which price and payment shall constitute full compensation for furnishing all materials, labor, supplies, tools, equipment and all incidentals and subsidiary works necessary for the successful completion of the work described under this Section.

SECTION XXIII REINFORCING STEEL BARS

2301 SCOPE

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

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

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

2302 MATERIALS

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

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

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

2303 CONSTRUCTION REQUIREMENT

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

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

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

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

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

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

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

5. **Welding.** Welding of bars shall be performed only where shown on the Drawings or as authorized in writing by the Engineer and shall conform to the requirements of AWS: D12.1, latest revision. All welders employed shall show proof of their welding qualifications to the Engineer. All welding shall be done using metal arc welding, pressure gas welding, submerged arc welding or thermit welding. All electric shall be acceptable to NIA. Coverings of low hydrogen electrodes must be thoroughly dry when used. The surfaces to be welds shall be clean and shall be free from rust and dirt. All welds shall develop the full strength of the bar or the smaller bar when two different sizes are welded. Test will be required of not more than five percent of the welds. Approved testing equipment for testing welds shall be furnished by Contractor.

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

2304 PREPARATION OF REINFORCEMENT DRAWINGS

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

The Reinforcement Drawings submitted shall show the name of the structure location by stationing where the reinforcement drawings is intended and all the necessary information's 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 XXIV

REINFORCED CONCRETE PIPES

2401 SCOPE

The work under this Section shall include furnishing or the fabrication or manufacture of reinforced concrete pipes, laying or installation including jointing and construction of collars of the reinforced concrete pipes for culverts, drainage crossings and other structures as shown on the Drawings and at such other places designated by the Engineer all in accordance with the Drawings and these Specifications. All reinforcing bars to be used in the fabrication or manufacture of reinforced concrete pipes shall be furnished by the Contractor.

2402 TYPES OF R.C. PIPES

The type of reinforced concrete pipes as shown on the Drawings shall be as follows:

1. Type A-1 Pipes subjected to 10-ton truck loading with minimum of 60 cm overfill

2. Type A-2 Pipes subjected to 20-ton truck loading with minimum of 60 cm overfill

2403 MATERIALS

The quality of materials shall conform to the applicable provisions of Section XV, Concrete and Section XXIII, Reinforcing Steel Bars.

Concrete for pipes shall be Class "Y" which shall have a cement factor of 392.12 kilograms per cubic meter of concrete and a minimum compressive strength of 3,000 pounds per square inch in 28 days. The maximum size of aggregates shall be one half inch. Reinforcing bars shall be as indicated in the Drawings. Lapping of ends of the ring bars shall not be less than 48 bar diameter.

2404 MANUFACTURE OF R.C. PIPES

Under these specifications, the Contractor could purchase finished products of R.C. pipes or fabricate them in accordance with these specifications.

The pipes shall meet the requirements of the standard specifications for Reinforced Concrete Culvert Pipes ASTM: C361-571 or latest revision. The pipes manufactured according to these specifications shall further meet the requirements as specified on the Drawings.

For pipes with one line of circumferential reinforcement, the nominal protective covering of concrete over the ring bars shall be 25% to 50% of the shell thickness reckoned from the inner surface of the pipe. For pipes with two lines of circumferential reinforcement, the following shall be adhered to:

1. Each line of circumferential reinforcement shall be assembled into a cage which shall contain sufficient member of longitudinal tie bars.
2. The distance between the two layers shall not be less than the diameter of the longitudinal tie bars plus 1/4 inch.
3. The two line layers shall be provided with spaces and tied together to form a single rigid cage.

For 20 centimeters R.C. Pipes (and smaller diameter) the thickness shall be 0.5 centimeters and reinforced with 3-strand barbed wire consisting of 10 centimeters pitch spiral and six longitudinal ties.

2405 INSPECTION, SAMPLING AND TESTING

R.C. Pipes to be fabricated or manufactured by the Contractor shall be subject to periodic inspection by NIA during the process of fabrication or manufacture. Sampling for testing shall be done during said inspection.

R.C. Pipes purchased by Contractor shall be sampled for testing after delivery to Contractor's stockyard.

Sampling for test, not more than three pieces, shall be taken at random among the pipes in a lot. A lot shall consist of 50 pieces of the same size and type delivered at a time to Contractor's stockyard.

The lot represented by the samples tested which failed to meet the specified requirements shall be rejected and Contractor shall immediately remove from the stockyard the pipes comprising the lot.

The samples for testing shall be tested in accordance with ASTM: C-497, and shall meet the physical requirements of ASTM: C-76. Cost for sampling and testing shall be at the expense of Contractor. Pipes with injurious defects revealed subsequent to acceptance of pipes at Contractor's stockyard or fabrication site shall be rejected.

2406 REJECTION

R.C. pipes shall be subject to rejection on account of failure to meet any of the specification requirements. Individual sections of the pipe maybe rejected due to the following:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of joint.
2. Defects that indicate imperfect proportioning, making and molding.
3. Surface defects indicating honeycombed or open texture.
4. Damaged ends, where such damage would prevent making a satisfactory joint.

2407 MARKING

The following information shall be clearly marked on each section of R.C. Pipes delivered:

1. The type of pipes, A-1, A-2 or A-3 and so on, and the diameter for the proper identification of the pipe.
2. Date manufactured, and trade-mark of the manufacturer if purchased from other manufacturers.

2408 CURING

Reinforced Concrete Pipes shall be cured in accordance with the provisions prescribed in Section XV, "Concrete".

2409 TRANSPORTATION AND DELIVERY OF R. C. PIPES

Contractor shall load and transport the R.C. Pipes to the installation site in a manner as to avoid damage to pipes. The R.C. Pipes shall be handled carefully with belt slings or other approved devices. The width of belt or other approved handling devices shall be adequate to prevent any damage. The R.C. Pipes shall be at no time be dropped but shall be lowered carefully and slowly into position. Any R.C. Pipe damaged during loading from the Manufacturer's plant or Contractor's fabrication site, or when in transit to the delivery site, or during unloading, or during installation will be rejected.

2410 EXCAVATION

Excavation for R.C. Pipes shall be performed in accordance with Section VI, Structure Excavation. Notwithstanding the provisions of Section VI, where rock or other unyielding materials will be encountered, the rock or unyielding materials shall be similarly removed to a depth not less than 15 cm. below the established grade and shall be refilled with suitable materials thoroughly compacted throughout. Recesses shall be excavated for any collar involve.

2411 LAYING OR INSTALLATION OF R.C. PIPES

The R.C. Pipes shall be laid carefully, ends fully and closely jointed, and true to the lines and grades as shown on the Drawings. Belts or other approved devices shall be provided for lowering the pipes when they are placed in trench. Each pipe section shall be securely attached to the adjoining sections unless otherwise specified, shall be filled with stiff mortar composed of one part Portland cement and one-half parts of sand. Cement, sand and water shall conform to the requirements for these materials given for concrete. The mortar shall be placed so as to form a durable, water-tight joint. After each section of pipe is laid and before the succeeding section is laid, the lower portion of the hub shall be plastered thoroughly on the inside with mortar to such depth as to bring the inner surfaces of the abutting pipes flush and even. After the section is laid, the remainder of the joint shall then be wiped and finished smooth. After the initial set, the mortar on the outside shall be protected from the air and sun with a cover thoroughly wetted earth or burlap. After the setting of the mortar of the joint, the construction of the reinforced concrete collar shall be done in accordance with the drawings. Any pipe which is not in true alignment or which shows any undue settlement after being laid, or is damaged shall be removed and relaid or replaced without extra compensation.

2412 BACKFILLING

2413

After the pipes have been installed and the mortar joints and reinforced concrete sufficiently set, selected materials from excavation or borrow shall be placed alongside the pipes in layer not exceeding 15 centimeters, in thickness and compacted thoroughly. The backfilling of pipes shall be done simultaneously at both sides and shall conform with the provisions prescribed in Section XII, Structure Backfill. When the construction calls for placing high embankment over the pipes, special instruction regarding the method of backfilling shall be given by the Engineer.

2413 METHOD OF MEASUREMENT

Reinforced Concrete Pipes of the various sizes and types specified in the Bill of Quantities will be measured by the number of pieces or by the number of linear meter of pipe as specified in the Bill of Quantities furnished and acceptably installed, jointed and provided with collar.

2414 BASIS OF PAYMENT

The various sizes and types of pipes measured as provided above will be paid at the contract unit price per linear meter of the respective types and sizes of R.C. pipes.

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

- a) Furnishing and delivery cost which shall include all labor, tools, equipment, supplies and other incidentals involve in the manufacture and delivery to the site which includes loading, hauling, unloading and stockpiling at the delivery site.
- b) Installation cost which shall include all labor, tools, equipment involved and all incidentals necessary for the successful completion of the work under this Section.

The cost of collars in R.C. pipes are considered included in the contract unit price of installation per linear meter of R.C. pipes.

Excavation and backfilling works are not considered subsidiary works under this Section, hence payments shall be made under "Structure Excavation" and "Structure Backfill", respectively in the Bill of Quantities.

SECTION XXXX GRAVEL BLANKET

4001 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.

4002 MATERIALS

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

4003 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.

4004 METHOD OF MEASUREMENT

Gravel Bedding 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.

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 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 for NIA employees, complete with facilities (specified in item 2 below).

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.

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.

MISCELLANEOUS SECTION

**SECTION IX
OVERHAUL****901 SCOPE**

Overhaul shall include the hauling of materials excavated from Canal Excavation or Structure Excavation and to be disposed either for roadway embankment, normal embankment, freeboard embankment, fill, structure backfill, or for disposal to waste disposal areas suggested by NIA or at the Contractor's choice including acquisition of right-of ways thereto.

902 DISPOSAL OF EXCAVATED MATERIALS**a. General**

NIA shall determine the suitability of all excavated materials in the various portions of the work in accordance with the provisions specified herein.

b. Compacted Embankment

Materials from excavation which are suitable for compacted embankment (such as canal embankments, roadway embankments, protection dikes, etc.) shall be dense and homogeneous when compacted. The materials shall be free from all organic materials and of all materials larger than 12 centimeters in maximum dimension.

Materials suitable for the construction of compacted embankment shall be those solid having a classification as determined by the Engineer in the following order of preference: GC (Clayey Gravel), SC (Clayey Sand), CL (Inorganic Clay), SM (Silty Sand) or ML (Inorganic Silt).

All materials from excavation suitable for compacted embankment formation within the free haul distance must be used for embankment.

c) Compacted Backfill

Materials from excavation which are suitable for compacted backfill shall be the same as those which are suitable for compacted embankment, except that it shall be free of all materials larger than 7.5 centimeters in maximum dimension and that compacted backfill behind bridge abutments and retaining walls shall conform to the materials specified in the Drawings.

d) Free Board Embankment

All excavated materials that are free of oversized material and of organic matter as determined by the Engineer may be utilized for the construction of free board embankment.

e) Waste Materials

Waste materials consisting of all excess excavated suitable materials and objectionable materials for canal embankment and compacted backfill shall be placed in waste disposal areas outside the NIA right-of-way chosen by the Contractor, levelled and sloped to drain as directed.

903 METHOD OF MEASUREMENT

Overhaul of waste materials will be measured by the cubic meter. The volume of waste materials to be measured for payment shall be computed based on the Net End Area versus Stationing Diagram and Mass diagram for each Lateral or canal which shall be submitted by the Contractor to the Administrator for approval.

Overhaul for canal embankment is a subsidiary work under Embankment Construction and Compaction (ECC) hence, it will not be measured for payment, as the cost is already considered included in the contract unit price of ECC.

904 BASIS OF PAYMENT

Payment for Overhaul for Waste Materials shall be per cubic-meter, which price and payment shall constitute full compensation for furnishing all labor, supplies, tools, equipment and all incidentals necessary for the successful completion of the work including acquisition of right-of-way and access thereto for disposal areas chosen by the Contractor. Payment for overhaul for waste materials shall only be made when said Net End Area versus Stationing Diagram and Mass Diagram, where the volume measured for payment are based, has been approved by the Administrator.

If during the implementation of the project, there are changes in disposal area(s)/distance(s) other than those suggested by NIA, the contract unit price of any item of work affected shall be reviewed by NIA to determine the reasonable price adjustment. The price adjustment, either additive or deductive shall be subject to approval by the Administrator.

The approved contract unit price resulting from the said price adjustment shall be used in computing the amount to be paid to the Contractor.

For billing purposes, the Contractor shall submit to NIA a written certificate duly certified correct by the Engineer the actual disposal area(s) with corresponding hauling distance(s) as a requisite for payment.

**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>Mesh</u>	Percent by Weight Passing Individual <u>Sizes</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 break 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:

	Percent by <u>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	2

particles and loam)

- * 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 consists 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 break 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
Other deleterious substances	1

* 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 Design. 7 or ASTM C-295).
- 2) **Sodium-sulphate Test for soundness** (USBR Design. 9 or ASTM C-88)- If the weighted average loss, after 5 cycles is more than 10% by weight.
- 3) **Specific Gravity** (USBR Design. 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 to 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 imposed by other requirements of these specifications.	Steel Sheathing permitted Steel Lining permitted
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 AASHO 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 XXI CONCRETE JOINTS AND JOINT MATERIALS

2101 SCOPE

This Section covers the details of construction of expansion and contraction, and construction joints in concrete including joint materials. Concrete joints and joint materials shall be in accordance with the Drawings and these Specifications.

2102 JOINTS IN CONCRETE

(a) Construction Joints

Unless otherwise specified in these Specifications or shown in the Drawings, the location of all construction joints in concrete work shall be subject to approval by the Engineer, and the joints shall be constructed in accordance with Paragraph 1517 of Section XV. To prevent feather-edges, construction joints which intercept surfaces at a relatively small angle shall be sloped, adjacent to the intersection, approximately normal to such surfaces to form a 15 to 20 centimeters offset.

Joint sealant materials and placement shall be as specified in Paragraph 1003. The cost of constructing construction joints shall be included in the contract unit price of concrete where they are required.

In structures requiring watertightness and in which waterstops are specified for construction joints or as shown in the Drawings, construction joints introduced by the Contractor, as approved by the Engineer, for the convenience of the Contractor shall be equipped with waterstops at the expense of the Contractor.

(b) Contraction and Expansion Joints

Contraction and expansion joints of the types shown in the Drawings shall be constructed at the locations indicated. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before the concrete is placed on the other side of the joint. The surface of the concrete first placed at a contraction and expansion joint shall be cleaned and coated with sealing compound before the concrete on the other side of the joint is placed. The Contractor shall furnish the sealing compound conforming to ASTM: C309. The cost of constructing contraction and expansion joints shall be included in the contract unit price of concrete where they are required.

2103 JOINTING AND COATING MATERIALS

1. Waterstops

(a) General

The Contractor shall furnish and install polyvinyl chloride or waterstops in the shapes and dimensions as specified and in the locations as shown in the Drawings or as directed by the Engineer. For convenience of placement in forms, a waterstop utilizing a

split flange may be used; however, prior to placement of final concrete, the split flange portion shall be jointed in an approved manner such that no concrete or mortar can enter between the two split portions of the flange.

(b) Workmanship

The Contractor shall furnish all materials, equipment and electric energy required for making field splices and installing the waterstops. Field splices for waterstops shall be made by cutting the waterstops as required, heating the ends to the melting point and jointing them to form the desired splice. The heating of the splice ends shall be made by means of the splicing machine recommended by the waterstop manufacturer or by any other approved electric heating device.

(c) Types of Waterstops

(1) Rubber Waterstops - shall be fabricated from natural or synthetic rubber and shall have the following characteristics:

Tensile strength, pounds per square inch, minimum -	2,100
Elongation at break, per cent, minimum -	450
Shore durometer (Type A) -	60 to 70
Change in volume, water immersion percent maximum (two days at 70 degree Centigrade) -	5
Ozone resistance (four hours at 90° + 50° Fahrenheit) -	No Cracks
Tensile strength after oxygen pressure test (48 hours, 70° Centigrade, 300 pounds psi) percent of tensile strength before aging, minimum. -	80

(2) Polyvinyl Chloride Waterstops - shall be manufactured by extrusions process from an elastometric plastic compound, the basic resin of which is 100 per cent polyvinyl chloride (PVC). The product shall be dense, homogeneous and free from holes and other imperfections, and shall have the following physical properties:

Specific gravity - 1.33 + 0.03 at 73° Fahrenheit	ASTM:D792
Tensile Strength - 2200 to 2500 psi at 73° Fahrenheit	ASTM:D412
Ultimate Elongation - 360% to 400% at 73° Fahrenheit	ASTM:D412
Brittleness - 55° Fahrenheit temperature	ASTM:D746
Durometer - 65-75	ASTM:D676

(d) Inspection and Tests

1. Rubber waterstop shall be tested in accordance with appropriate sections of Federal Test Method Standard No. 601. The ozone concentration when tested shall be 85 to 100 parts per million.

2. Polyvinyl Chloride waterstop shall be tested in conformity with the requirements of Specifications CRD-C572 of the U.S. Army Corps of Engineers. It shall conform to the ozone resistance required for rubber waterstop.

(e) Measurement and Payment

Measurement for payment of Rubber or PVC waterstops will be made for the number of linear meters of waterstops acceptably placed and measured along the centerline of the waterstop.

Payment for waterstop will be made at the contract unit price per linear meter, which price and payment shall include all costs of furnishing, placing and testing of the Rubber or PVC waterstop as described above.

2. PREFORMED JOINT FILLER (Bituminous type)

Preformed joint filler 25 millimeters in thickness shall be furnished and placed by the Contractor in the joints where shown in the Drawings or as described by the Engineer. The joint filler shall be preformed bituminous type (Asphalt or Tar) conforming to ASTM: D994-71.

The preformed filler shall be cut and placed as shown on the Drawings. The filler material shall be held securely in place against the completed side of an expansion joint by copper or brass nails precast in the first placed concrete provided that an adhesive suitable for the purpose may be used when approved. Joints in the filler material shall be made tight and shall be taped so that mortar from the concrete will not seep into the joints or the joint filler material. The joint filler shall be handled carefully and stored under cover away from the direct rays of the sun in a manner so as to prevent damage to the materials.

Preformed strips of expansion joint filler shall be of such character as not to be deformed or broken by ordinary handling when exposed to atmospheric conditions and shall not become brittle in cold weather. Pieces of the joint filler that has been damaged shall be rejected.

Measurement for payment of the preformed bituminous type joint filler will be in square meters based on the required neat lines of filler acceptably placed, and the area of all openings will be deducted.

Payment of the preformed bituminous type joint filler will be made at the contract unit price per square meter, which price and payment shall include all cost of furnishing and placing of the joint filler as described above.

3. JOINT SEALANT

a) General

Joints so designated on the drawings or cracks or where directed by the Engineer shall be sealed with Thioflex 600 polysulphide liquid polymer. Thioflex 600 is a tough, rubber-like substance which will seal the joints against infiltration of water throughout repeated cycles of joint expansion and contraction. It is a combination of two materials, i.e., a base compound and a curing agent. Thioflex 600 is packed in dual container tins containing the correct proportions of base compound and curing agent. Thioflex 600 should be used as fresh as possible and must be used before the date of expiration as marked on each pack. Thioflex 600 should be stored under dry conditions at temperature not exceeding 27°C (80°F).

b) Inspection and Tests

Each pack of the base compound and curing agent shall be subject to inspection and approval by the NIA before acceptance or shipment. The NIA reserves the right to be present to observe the manufacturing process.

Samples shall be submitted to the NIA for testing at least thirty (30) days before use. Regardless of previous tests, material that has not been used after the expiry date as marked on each pack shall be rejected,

The base compound and curing agent packed in dual container tins shall each identify the name of the manufacturer, the manufacturer's lot number, the date of manufacture, expiry date and shall bear instructions for mixing and application.

c) Materials

Materials shall conform to American Standards Association Specification A-116.1 - 1960.

d) Placing

Joints so designated on the drawings or as directed by the Engineer that are to be sealed with thioflex 600 polysulphide liquid polymer shall be formed to the correct dimensions and thoroughly cleaned to the satisfaction of the Engineer. All dirt, dust, mortar, laitance, scale, oil, loose materials and other foreign materials must be removed by wire brushing and where possible, the joints shall be blown out with compressed air. Wet joints must be thoroughly dried by means of a hot air blower or a propane gas torch. Where so designated these joints shall be primed with the approximate thioflex primer applied strictly in accordance with the manufacturer's printed instructions prior to sealing. Thirty six (36) liters of thioflex 600 will require one and one-tenth (1.1) liters of thioflex primer.

The sealing compound shall be applied to all designated joints with the use of Gun Grade all in accordance with the manufacturer's standards conforming to the American Standards Association Specification A-116.1-1960. The Gun Grade pack yields one and one-half (1.5) liters of mixed materials.

e) Curing

The curing time of the mixed material will vary with temperature. High temperature and low temperature will correspondingly decrease and increase the curing time. The temperature of the material to which the thioflex 600 is applied as well as the ambient air temperature will affect the setting and curing time. Since the mixed materials tends to heat up as it cures, the setting and curing time can also be affected by the volume of material applied.

f) Method of Measurement

Joint sealant will be measured by the number of liters acceptably placed as shown on the drawings or as directed by the Engineer.

g) Basis of Payment

The joint sealant measured as provided above shall be paid at the contract unit price per liter, which price and payment shall constitute full compensation for furnishing all materials, tools, labor and all incidental and subsidiary works necessary for the successful completion of the work.

2104 JOINT IN BRIDGE DECK

Joints in bridge deck shall be formed with expanded polystyrene faced with tempered hardboard on the side of the polystyrene against which concrete is to be placed.

Upon completion of the deck, the joint shall be saw cut as shown in the Drawings and the joint sealed. Saw cutting of the deck at curbs shall be completed prior to construction of the curb.

Grooves shall be saw-cut with a self-propelled concrete saw fitted with diamond blades and equipped with an accurate depth indicator. Grooves shall be within a tolerance of 0.3 centimeter of the depth and width shown in the drawings. Following saw cutting, the lip of the groove shall be ground as shown in the drawings.

Prior to sealing the saw-cut joint in the bridge decks, expansion joint filler, hardboard, concrete spillage, and other materials shall be removed from the waterstop and the joint washed with water under pressure followed with abrasive blast cleaning and high pressure air jets to remove all residue. Expansion shall be removed from the entire depth of joints in deck slab overhangs, curbs, sidewalks, and railings. Waterstop shall be protected from abrasive blast cleaning in an approved manner. Joint surfaces shall be dry at the time the sealer is placed.

Except otherwise provided, payment for joints in bridge deck shall be included in the unit contract price of concrete for which they are required.

2105 GROUT

Grout shall be composed of portland cement, sand and water proportioned and mixed as specified in this Paragraph.

Grout shall be furnished and placed in recesses and holes, on surfaces, under structural members, and at other locations as shown in the drawings or as specified by the Engineer.

The proportion of cement to sand measured by volume, shall be one to two. Materials shall conform to the provisions of Section XV, Concrete. The water cement ratio shall not exceed 0.50. The grout shall be mixed until smooth and free of lumps, but in no case mixed less than three minutes. Grout which is not placed within 45 minutes after mixing shall be wasted.

Concrete areas to be in contact with grout shall be cleaned of all loose or foreign materials that would in any way prevent bond between the grout and the concrete surfaces and shall be kept thoroughly moistened with water for a period of not less than 24 hours immediately prior to placing of the grout. After placing, all surfaces of grout shall be cured.

Payment of work for Grouting, unless otherwise specified, shall be considered included in the various items in the Bill of Quantities where it is required.