

## SECTION 03100 - CONCRETE FORMWORK

### PART 1 - GENERAL

#### 1.01 THE REQUIREMENT:

- A. The Contractor shall furnish all materials for concrete formwork, bracing, shoring and supports and shall design and construct all forms, bracing, shoring and falsework, all in accordance with the requirements of the Contract Documents.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Supplemental General Conditions. 00800
- B. Contractor Submittals. 01300
- B. Reinforcement Steel. 03200
- C. Joints in Concrete. 03290
- D. Cast-In-Place Concrete. 03300

#### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

##### A. Codes:

The Building Code, as referenced herein, shall be the latest International Building Code (IBC).

##### B. Government Standards:

PS 1-74 U.S. Product Standard for Concrete Forms, Class I.

##### C. Commercial Standards:

ACI 347R Recommended Practice for Concrete Formwork.

#### 1.04 QUALITY ASSURANCE:

- A. Tolerances: The variation from established lines and grades shall not exceed 1/4-inch in ten (10) feet and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the "Suggested Tolerances" specified in Section 3.3 and 3.4 of ACI 347.

### PART 2 - PRODUCTS

#### 2.01 GENERAL:

- A. Except as otherwise expressly accepted by the Engineer, all lumber brought on the job site for use as forms, shoring or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:

Walls	-	Steel or plywood panel
Columns	-	Steel, plywood or fiberglass
Roof and Floor Slabs	-	Plywood

All Other Work

- Steel panels, plywood or tongue and groove lumber

## 2.02 FORM AND FALSEWORK MATERIALS:

- A. Materials for concrete forms, formwork and falsework shall conform to the following requirements:
  - 1. Lumber shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS10.
  - 2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine plywood manufactured especially for concrete formwork and shall conform to the requirements for PS 1 for Concrete Forms, Class I, and shall be edge sealed.
  - 3. Form materials shall be metal, wood, plywood or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade shown. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.
- B. Unless otherwise shown, exterior corners in concrete members shall be provided with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise shown.
- C. Forms and falsework to support roof and floor slabs shall be designed for the total dead load, plus a live load of 40 psf (minimum).

## 2.03 FORM TIES:

- A. Form ties with integral waterstops shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-inch and all such fasteners shall be such as to leave holes of regular shape for reaming.
- B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when approved by the Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie.

## PART 3 - EXECUTION

### 3.01 GENERAL:

- A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of all forms. Forms which are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced at the Contractor's expense. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework and shoring shall comply with applicable Local, State and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly

installed. During concrete placement the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

- B. Concrete forms shall conform to the shape, lines and dimensions of structural components as called for on the Drawings and shall be free from surface defects and sufficiently tight to prevent leakage.

### 3.02 FORM DESIGN:

- A. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and end of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The form joints shall be tight so as to prevent the loss of water, cement and fines during the placing and vibrating of the concrete. The bottom of the wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Adequate cleanout holes shall be provided at the bottom of each lift of forms.

### 3.03 CONSTRUCTION:

- A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed.
- B. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. Pipe stubs and anchor bolts shall be set in the forms where required.
- C. Form Ties:
  - 1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified for "Finish of Concrete Surfaces" in Section 03300 entitled, "Cast-In-Place Concrete". Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.
  - 2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane taped plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

### 3.04 REUSE OF FORMS:

- A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view.

3.05 **REMOVAL OF FORMS:**

- A. Careful procedures for the removal of forms shall be strictly followed and this work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. For roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders attain a minimum compressive strength of seventy-five percent (75%) of the 28-day strength specified in Section 03300 entitled, "Cast-In-Place Concrete". No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained seventy-five percent (75%) of the specified 28-day strength and has been in place for a minimum of seven (7) days, unless it can be shown that there is sufficient strength developed. Forms for all vertical walls and columns shall remain in place at least forty-eight (48) hours after the concrete has been placed, except for periods of cold weather when forms shall remain in place at least seventy-two (72) hours after concrete has been placed.

3.06 **MAINTENANCE OF FORMS:**

- A. Forms shall be maintained at all times in good condition, particularly as to cleanliness, strength, rigidity, tightness and smoothness of surface. After forms have been removed from a concrete placement they shall be immediately and thoroughly cleaned and repaired and surface treated before reuse. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Oil shall be kept off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.07 **FALSEWORK:**

- A. The Contractor shall be responsible for the design, engineering, construction, maintenance and safety of all falsework, including staging, walkways, forms, ladders and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements specified herein.
- B. All falsework shall be designed and constructed to provide the necessary rigidity and to support the required dead load plus a minimum of 40 psf live load. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time. Falsework shall be placed upon a solid footing, safe against undermining and protected from softening. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed and braced in such a way as to avoid any possibility of damage to the structure. Falsework supported off finished floor slabs shall be set in such a way to protect the finish floor surface from being scared, chipped or gauged.

END OF SECTION 03100

## SECTION 03200 - REINFORCEMENT STEEL

### PART 1 - GENERAL

#### 1.01 THE REQUIREMENT:

- A. The Contractor shall furnish, fabricate and place all concrete and masonry reinforcement steel, including all the tie wires, clips, supports, chairs, spacers and other accessories, all as shown and specified in the Contract Documents.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Supplemental General Conditions. 00800
- B. Contractor Submittals. 01300
- C. Cast-In-Place Concrete. 03300
- D. Concrete Formwork. 03100

#### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

##### A. Codes:

The Building Code, as referenced herein, shall be the latest International Building Code (IBC).

##### B. Commercial Standards:

ACI 315	Details and Detailing of Concrete Reinforcement.
ACI 318	Building Code Requirements for Reinforced Concrete.
WRI	Manual of Standard Practice for Welded Wire Fabric.
AWS D 1.4-79	Structural Welding Code - Reinforcing Steel.
ASTM A 82	Specification for Steel Wire, Plain, for (Latest Edition) Concrete Reinforcement.
ASTM A 185	Specification for Welded Steel Wire Fabric (Latest Edition) for Concrete Reinforcement.
ASTM A 615	Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
CRSI	Manual of Standard Practice (Latest Edition)
CRSI	Placing Reinforcing Bars (Latest Edition)

#### 1.04 CONTRACTOR SUBMITTALS:

- A. The Contractor shall furnish to the Engineer reinforcing steel placing drawings. These drawings shall show the number, grade, size, length, mark, location and bending diagrams for all reinforcing steel and related products, together with lists of bent and straight bars in

accordance with the ACI Detailing Manual (latest edition) of the American Concrete Institute and the requirements specified herein and shown on the Contract Drawings. The Engineer may or may not review the placement drawings. Any review of the placement drawings by the Engineer will be limited to general compliance with the Contract Documents and will not be returned to the Contractor. Reinforcing steel placement will be checked in the field using the design drawings. Any discrepancies, errors or omissions from the requirements of the Contract Documents shall be corrected prior to placement of concrete and at the sole expense of the Contractor.

#### 1.05 QUALITY ASSURANCE:

- A. If requested by the Engineer, the Contractor shall provide a certified copy of the mill test report showing physical and chemical analysis for each heat of reinforcement steel delivered.

### PART 2 - PRODUCTS

#### 2.01 REINFORCEMENT STEEL:

- A. Reinforcement steel for all cast-in-place reinforced concrete construction shall conform to the following requirements:
1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement with supplementary requirement S-1, or as otherwise shown.
  2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and the details shown. Welded wire fabric with longitudinal wire equal to or less than 4.0 size wire shall be either furnished in flat sheets or in rolls with a core diameter or not less than 10-inches. Welded wire fabric with longitudinal wires larger than 4.0 size shall be furnished in flat sheets only.
  3. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.
- B. Accessories:
1. The Contractor shall furnish and install all accessories including necessary chairs or bolsters, concrete blocks (dobies), tie wires, supports, spacers and other devices to position reinforcement during concrete placement.
  2. Wire bar supports shall be made of plain cold-drawn steel wire with pre-molded, gray-colored, plastic tips to the legs of the support. The plastic shall have a thickness of 1/8-inch or greater at points of contact with formwork and extend upward on the wire a minimum of 1/2-inch. Wire sizes and geometric dimensions shall be made in accordance with Table II of the latest edition of CRSI Manual of Standard Practice.
  3. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Where the concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.
  4. The wire tie shall be 16-gauge or heavier, black annealed.

#### 2.02 MECHANICAL COUPLERS:

- A. Mechanical couplers shall be provided where shown and where approved by the Engineer. The couplers shall develop a tensile strength which exceeds one hundred fifty percent (150%) of the yield strength of the reinforcement bars being spliced at each splice.

### PART 3 - EXECUTION

#### 3.01 GENERAL:

- A. All reinforcement steel, welded wire fabric, couplers and other appurtenances shall be fabricated and placed in accordance with the requirements of the Contract Documents, including referenced specifications, codes and standards.

#### 3.02 FABRICATION:

- A. Reinforcement steel shall be accurately fabricated to the dimensions and shape shown in the Contract Documents. Fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings. Bends shall conform to bend dimensions defined as standard in accordance with details in the ACI Detailing Manual and/or CRSI Manual of Standard Practice, unless otherwise shown. Bars shall be bent cold and shall not be bent or straightened in a manner that will injure the material. All hooks shall conform to bend dimensions defined as ACI Standard Hooks.
- B. The Contractor shall fabricate reinforcement bars within the tolerances shown in the ACI Detailing Manual and/or CRSI Manual of Standard Practice.
- C. Reinforcing bars delivered to the field shall be tagged with durable material and marked in a legible manner with waterproof markings. Tags shall show the grade, number of pieces, size and mark or length of bars.

#### 3.03 PLACING:

- A. Reinforcing steel shall be accurately positioned as shown on the Contract Documents and shall be adequately supported and wired together to prevent displacement. All reinforcement steel shall be supported or spaced off the forms by concrete or metal supports which are rigid enough to prevent any displacement or the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement. Concrete blocks shall not be used as spacers between mats. All concrete blocks used to space reinforcement steel off vertical formed surfaces shall be tied to the steel with wire ties which are embedded in the blocks. For reinforcement including welded wire fabric over formwork, the Contractor shall furnish concrete or metal supports with plastic covered legs for bar supports.
- B. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.
- C. Bars additional to those shown which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at its own expense.
- D. Placing Tolerances: Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 or ACI 318, except where in conflict with the requirements of The Building Code.
- E. Bars may need to be moved to avoid interference with other reinforcement steel, conduits or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.

Additional bars may be necessary to prevent cracking or provide additional reinforcement in this case and shall be provided by the Contractor at its own expense.

- F. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than three (3) feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

#### 3.04 SPACING OF BARS:

- A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than 1-inch.
- B. Where reinforcement in beams or girders is placed in two (2) or more layers, the clear distance between layers shall be not less than 1-inch.
- C. In columns, the clear distance between longitudinal bars shall not be less than 1-1/2 times the bar diameter, more less than 1-1/2 times the maximum size of the coarse aggregate, more less than 1-1/2 inches.

#### 3.05 SPLICING:

- A. General: Reinforcement bar splices shall only be used at locations shown, unless otherwise acceptable to the Engineer.
- B. Splices of Reinforcement: The length of lap for reinforcement bars, unless otherwise shown shall be in accordance with ACI 318, Section 12.15.1 for a class C splice.
- C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each two (2) running feet. Wires shall be staggered and tied in such a manner that they cannot slip.
- D. Bending or Straightening: Reinforcement shall not be straightened or re-bent in a manner which will injure the material. Bars with kinks or bends not shown shall not be used. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be field-bent, except as specifically permitted by the Engineer.

#### 3.06 CLEANING AND PROTECTION:

- A. Reinforcing steel delivered to the jobsite shall be suitably stored off the ground and protected from oils, mud, concrete splatter and all conditions conducive to corrosion until embedded in concrete.
- B. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be re-inspected and, if necessary, re-cleaned.

END OF SECTION 03200

## SECTION 03290 - JOINTS IN CONCRETE

### PART 1 - GENERAL

#### 1.01 THE REQUIREMENT:

- A. The Contractor shall construct all construction joints, expansion joints and control joints in concrete at the locations shown and formed in accordance with the details shown in the drawings.
- B. Waterstops shall be provided in all construction and expansion joints of hydraulic or below grade structures unless specifically noted otherwise on the drawings.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete Framework. 03100
- B. Reinforcement Steel. 03200
- C. Cast-In-Place Concrete. 03300

#### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

##### A. Federal Specifications:

TSS-S-00227E(3)                      Sealing Compound, Elastomeric type, multi-component (for Caulking, Sealing, Glazing Buildings and Other Structures)

##### B. Commercial Standards:

ASTM C 920-86                      Specification for Elastomeric Joint Sealants

ASTM D 624-81                      Test Method for Rubber Property - Tear Resistance

ASTM D 1752-84                      Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

#### 1.04 CONTRACTOR SUBMITTALS:

- A. Waterstop: Prior to production of the waterstop material required under this Contract, the Contractor shall submit for review complete product data, including qualification samples of extruded sections of each size and shape to be used. The submittal shall also include the manufacturer's certification that the water stop material meets the physical requirements as outlined under paragraph 2.01, herein.

#### 1.05 QUALITY ASSURANCE:

- A. Waterstop Inspection: Waterstop installation shall be subject to rigid inspection. No waterstop shall be cast in concrete without the Engineer's inspection. Not less than twenty-four (24) hours notice shall be provided to the Engineer for scheduling such inspections.
- B. Waterstop Field Samples: Prior to use of the waterstop material in the field, a sample of a fabricated mitered cross and a tee constructed of each size or shape of material to be used shall be submitted to the Engineer for review. These samples shall be fabricated so that the material and workmanship represent in all respects the fittings to be furnished under this

Contract. Field samples of fabricated fittings (crosses, tees, etc.) may be selected at random by the Engineer for testing by a laboratory at the Owner's expense. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

- C. All field joints in waterstops shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets and other defects. All defective joints shall be replaced and all weathered, damaged or otherwise faulty material shall be removed from the site and disposed of by the Contractor at its own expense.
- D. Waterstops shall be stored on site where it will not be subjected to freezing temperatures or exposed to the direct rays of the sun.
- E. Construction Joint Sealant: The Contractor shall prepare adhesion and cohesion test specimens as specified herein from each shipment of material received at the jobsite. Sealant shall be stored at room temperature and shall not be stored longer than seventy-five percent (75%) of the manufacturer's stated shelf life.
- F. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure:
  - 1. Sealant specimen shall be prepared between two concrete blocks (1-inch by 2-inch by 3-inch). Spacing between the blocks shall be 1/2-inch. Coated spacers (2-inch by 1-1/2 inch by 1/2-inch) shall be used to ensure sealant cross-sections of 1/2-inch by 2-inches with a width of 1/2-inch.
  - 2. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall not exceed twenty-four (24) hours.
  - 3. Following curing period, the gap between blocks shall be widened to 1-inch. Spacers shall be used to maintain this gap for twenty-four (24) hours prior to inspection for failure.

#### 1.06 GUARANTEE:

- A. The Contractor shall provide a three (3) year written guarantee of the entire joint sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the Owner, at no additional cost to the Owner, any such defective areas which become evident within said three (3) year guarantee period.

## PART 2 - PRODUCTS

### 2.01 PVC WATERSTOPS:

- A. General: Waterstops shall be extruded from an elastomeric plastic compound consisting of virgin polyvinylchloride and additional plasticizers and stabilizers necessary to meet or exceed the requirements and performance criteria of these Specifications and the Corps of Engineers Specifications CRD-C572. No reclaimed scrap or reprocessed material shall be used.
- B. Flatstrip, Center-Bulb and Multi-Rib Waterstops: Flatstrip, center-bulb and multi-rip waterstops shall be detailed and as manufactured by: Vynlex Corp or approved equal; provided, that at no place shall the thickness of flat strip waterstops, including the center-bulb type, be less than 3/8-inch. Prefabricated joint fittings shall be used at all intersections of the ribbed-type waterstops.
- C. Physical Properties: When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

<u>Physical Property, Sheet Material</u>	<u>Value</u>	<u>ASTM Test Method</u>
Tensile Strength-Min (psi)	1750	D 638
Ultimate Elongation-Min (percent)	350	D 638
Low Temp. Brittleness-Max (-35 Deg F)	Pass	D 746
Stiffness in Flexure-Min (psi)	400	D 747
<u>Accelerated Aging (CRD-C572)</u>		
Tensile Strength-Min (psi)	1500	D 638
Ultimate Elongation-Min (percent)	300	D 638

## 2.02 HYDROPHILIC WATERSTOPS

- A. General: Hydrophilic waterstops may be substituted for PVC waterstops, only when approved by the Engineer. Hydrophilic waterstops may not contain bentonite.
- B. Hydrophilic waterstops shall be manufactured by: Asadi Denka Kogyo K.K. distributed by Mitsubishi International Corp; SYNKO-FLEX Products, Huston Texas; Sika Corporation . Santa Fe Springs, CA. Hydrophilic waterstops shall be install according to the manufactures recommendations.
- C. Physical Properties: When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

<u>Physical Property</u>	<u>Value</u>	<u>ASTM TEST Method</u>
Hardness	30	2240
Tensile Strength	100	D412
Elongation %	500	D412
Specific Gravity	1.18	D792

## PART 3 - EXECUTION

### 3.01 GENERAL:

- A. Unless otherwise shown, waterstops of the type specified herein, shall be fully continuous for the extent of the joint. The Contractor shall take suitable precautions and means to support and protect the waterstops during the progress of the work and shall repair or replace at its own expense any waterstops damaged during the progress of the work.
- B. Suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.
- C. Splices in waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is essential that the splices have a tensile strength of not less than sixty percent (60%) of the unspliced materials tensile strength and the continuity of the waterstop ribs and of its tubular center axis be maintained.

### 3.02 INSTALLATION OF WATERSTOP:

- A. All joints with waterstops involving more than two (2) ends to be jointed together and all joints which involve an angle cut, alignment change or the joining of two (2) dissimilar waterstop sections shall be prefabricated by the Contractor prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.
- B. Adequate provisions must be made to support the waterstops during the progress of the work and to ensure the proper embedment in the concrete. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints. The center axis of the waterstops shall be coincident with the joint openings. Maximum density and imperviousness of the concrete shall be ensured by thoroughly working it in the vicinity of all joints.
- C. Adequate means shall be provided to prevent waterstops from being folded over by the concrete as it is placed. Unless otherwise shown, all waterstops shall be held in place with light wire ties on 12-inch centers which shall be passed through the edge of the waterstop and tied to the curtain of reinforcing steel. In placing concrete around horizontal waterstops, with their flat face in a horizontal plane, concrete shall be carefully worked under the waterstops so as to avoid the formation of air and rock pockets.
- D. Where a hydrophilic waterstop is called for in the Contract Documents, it shall be installed in accordance with the manufacturer's instructions. The bentonite waterstop shall be located at the center of the joint and it shall be continuous around the entire joint. Bentonite waterstop shall not be used in joints with only one curtain of reinforcing steel. Where a bentonite waterstop is used in combination with PVC waterstop, the bentonite waterstop shall overlap the PVC waterstop for a minimum of 6-inches.

### 3.03 JOINT CONSTRUCTION:

- A. Joint Location: Construction joints, expansion joints and control joints shall be provided where shown. When not shown, construction joints shall be provided at 25-foot maximum spacing for all concrete construction, unless noted otherwise. The location of all joints shall be submitted for acceptance by the Engineer.
- B. Special care shall be used in preparing concrete surfaces at joints where bonding between two (2) sections of concrete is required. Unless otherwise shown, such bonding will be required at all horizontal joints in walls and wall to slab joints. Surfaces shall be prepared by sandblasting and washing for removal of laitance or any objectionable material. Joints shall be kept clean until the concrete is placed. Vertical joints shall be clean and free of concrete fins, rock pockets or any objectionable material.
- C. Sealant grooves shall be formed as shown on the drawings and shall be protected from damage until final application of the sealant. Care shall be taken to prevent chipping of the sealant groove during removal of forms.

END OF SECTION 03290

## SECTION 03300 - CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.01 THE REQUIREMENT:

- A. The Contractor shall furnish all materials for concrete and shall construct, form, batch, place, cure, protect, repair and do all work required to produce finished concrete that meets or exceeds the requirements of the Contract Documents.
- B. The following types of concrete shall be covered in this Section:
  - 1. Structural Concrete: Concrete to be used in all cases except where noted otherwise in the Contract Documents.
  - 2. Sitework Concrete: Concrete to be used for curbs, gutters, sidewalks, fence and guard post embedment, underground duct bank encasement and thrust blocks.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Supplemental General Conditions. 00800
- B. Contractor Submittals. 01300
- C. Concrete Formwork. 03100
- D. Reinforcement Steel. 03200
- E. Joints In Concrete. 03290

#### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

##### A. Codes:

The Building Code, as referenced herein, shall be the latest edition of the Uniform Building Code (UBC) 1991 UBC, of the International Conference of Building Officials (ICBO).

##### B. Commercial Standards:

ACI 214-77	Recommended Practice for Evaluation of Strength Test Results of Concrete.
ACI 301-79	Specifications for Structural Concrete for Buildings.
ACI 315-80	Details and Detailing of Concrete Reinforcement.
ACI 347-88	Recommended Practice for Concrete Formwork.
ASTM C 156-80a	Test Method for Water Retention by Concrete Curing Materials.
ASTM C 31-84	Methods of Making and Curing Concrete Test Specimens in the Field.
ASTM C 33-84	Specification for Concrete Aggregates.

ASTM C 39-83b	Test Method for Compressive Strength of Cylindrical Concrete Specimens.
ASTM C 94-83	Specification for Ready-Mixed Concrete.
ASTM C 114-83b	Method for Chemical Analysis of Hydraulic Cement.
ASTM C 136-84a	Method for Sieve Analysis for Fine and Coarse Aggregate.
ASTM C 143-78	Test Method for Slump of Portland Cement Concrete.
ASTM C 150-84	Specification for Portland Cement.
ASTM C 157-80	Test Method for Length Change of Hardened Cement Mortar and Concrete.
ASTM C 192-81	Method of Making and Curing Concrete Test Specimens in the Laboratory.
ASTM C 260-77	Specification for Air-Entraining Admixtures for Concrete.
ASTM C 494-82	Specification for Chemical Admixtures for Concrete.
ASTM C 618-85	Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement.

1.04 **CONTRACTOR SUBMITTALS:**

- A. **Mix Designs:** Before placing any concrete, the Contractor shall submit to the Engineer, for review, the complete details of all concrete mix designs which he proposes to use including proportions and gradations of all materials for each class and type of concrete specified herein. The mix designs shall be designed by a certified testing laboratory acceptable to the Engineer. The mix design submittal shall also include test results from at least one (1) trial batch of each class and type concrete. From each trial batch six (6) 6-inch X 12-inch test cylinders shall be cast in accordance with ASTM C 31. Three (3) of these cylinders shall be compression tested in accordance with ASTM C 39 at 7-days and the other three (3) at 28-days. Test results shall include full information on each cylinder as to mix and slump in accordance with ASTM 143. Three (3) drying shrinkage specimens shall also be cast and tested in accordance with ASTM C 157 on each type of structural concrete (4,000 psi) mix design. All costs for such mix design including mix design tests shall be borne by the Contractor.
- B. If fly ash concrete is proposed by the concrete supplier, the Contractor shall submit to the Engineer for review the design mix for fly ash concrete together with the design mix for Portland Cement (non-fly ash) concrete as specified in this Section. The Contractor shall furnish a Certificate of Compliance signed by the supplier identifying the type of fly ash and stating that the fly ash complies with ASTM C 618 and these specifications, together with all supporting test data including a certified chemical and physical analysis report prior to the use of the fly ash the sample represents. The supporting data shall also contain test results confirming that the fly ash in combination with the cement and water to be used meets all strength requirements and is compatible with air-entraining agents and other admixtures.
- C. When a water-reducing admixture is to be used, the Contractor shall furnish mix designs for concrete both with and without the admixture.

- D. Delivery Tickets: Where ready-mix concrete is used, the Contractor shall provide certified weighmaster delivery tickets at the time of delivery of each load of concrete. Each certificate shall show the total quantities, weight of cement, sand, each class of aggregate, admixtures and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix. Each certificate shall also state the mix number, total yield in cubic yards, the time the batch was dispatched and when it arrived on the job.
- E. Submit certified cement mill test reports including the total alkali content.

1.05 QUALITY ASSURANCE:

- A. Mix design tests on component materials and for compressive strength and shrinkage of concrete shall be performed as specified herein. The mix shall not at any time be changed without approval of the Engineer, except that at all times the batching of fine aggregate shall be adjusted to compensate for the moisture content. Satisfactory means shall be provided at the batching plant for checking the moisture content of the fine aggregate. The details of concrete mixes submitted for approval shall include information on the correction of the batching for varying moisture contents of the fine aggregate.

To avoid unnecessary or haphazard changes in consistency, the aggregate shall be obtained from a source which will ensure a uniform quality.

- B. During the progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with the standards of quality specified herein. These tests will be made in accordance with ASTM C 31, ASTM C 39, ASTM 179 and ASTM C 157. The testing expense during construction, except for the trial batch or mix design testing, will be borne by the Owner. Four (4) cylinder specimens will be cast and tested for each 50-cubic yards of concrete placed, or at least once per day per structural concrete placement. One (1) test cylinder will be tested at 7-days and two (2) at 28-days. The remaining cylinders will be held to verify test results if needed. The costs of additional tests, including non-destructive tests and core drilling, needed to verify or investigate the quality of concrete that is questionable as to meeting the specification shall be borne by the Contractor.
- C. Concrete for testing shall be supplied by the Contractor at no cost to the Owner, and the Contractor shall provide assistance to the Engineer in obtaining samples and disposal and cleanup of excess material.
- D. Evaluation and Acceptance of Concrete:
  - 1. Concrete is expected to reach a higher compressive strength than that which is indicated in Paragraph 2.05, B., as compressive strength. The strength level of the concrete will be considered satisfactory if the average strength of the two (2) 28-day specimens equals or exceeds the required strength and no individual specimen strength falls below the required strength by more than 500 psi. Where an individual strength test falls below the required strength by more than 500 psi, the Engineer shall have the right to ask for cores taken in accordance with ASTM C 42 and ACI 318, all at the Contractors expense.
  - 2. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.
  - 3. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at the cost of the Contractor.
- E. Shrinkage Tests: Additional shrinkage tests will be made by the Engineer during construction to ensure continued compliance with these specifications.

- F. Ready-mix concrete shall conform to the requirements of ASTM C 94.
- G. The Engineer shall have access to and have the right to inspect all batch plants, cement mills and supply facilities providing products under these specifications. Batch plants shall have current certificates that all scales have been tested and are certified within the tolerances as set forth in the National Bureau of Standards Handbook No. 44.
- H. Construction Tolerances: The Contractor shall set and maintain concrete forms and perform finishing operations so as to ensure that the completed work is within the tolerances specified herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the specified permissible variation from lines, grades or dimensions shown. Where tolerances are not stated in these specifications, permissible deviations will be in accordance with ACI 347.

The following construction tolerances are hereby established and apply to finished walls and slab unless otherwise shown:

<u>Structural Component</u>	<u>Tolerance</u>
Variation of the constructed linear outline from the established position in plan.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation from the level or from the grades shown.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation from the plumb.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch.
Variation in the thickness of slabs and walls.	Plus 1/4-inch; Plus 1/2-inch.
Variation in the locations and sizes of slab and wall openings.	Plus or minus 1/4-inch.

## PART 2 - PRODUCTS

### 2.01 CONCRETE MATERIALS:

- A. Except as otherwise specified, all cement shall be standard brand Portland Cement conforming to ASTM C 150 for Type II, low alkali. Portland Cement shall contain not more than 0.60 percent total alkalis. The term "alkalis" is defined as the sum sodium oxide (Na<sub>2</sub>O), potassium oxide (K<sub>2</sub>O), calculated as sodium oxide (.658 K<sub>2</sub>O). Only one (1) brand of cement shall be used for exposed concrete in any individual structure. The cement shall be suitably protected from exposure to moisture until used. Certified mill test reports for each shipment of cement to be used shall be submitted to the Engineer. Mill test reports shall include the alkali content.
- B. Water shall be potable, clean and free from objectionable quantities of silty organic matter, alkali, salts and other impurities. The water shall be considered potable, for the purpose of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.
- C. All concrete aggregates shall be obtained from pits acceptable to the Engineer, shall be non-reactive, sound, uniformly graded and free of deleterious material in excess of allowable limits

specified. Combined aggregates shall be well graded from coarse to fine sizes, and be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Lightweight sand for fine aggregate will not be permitted. Aggregates shall conform to ASTM C 33.

1. **Coarse Aggregate:** Coarse aggregate shall consist of gravel, crushed gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter or other foreign substances. Thin or elongated pieces having a length greater than four (4) times the average thickness shall not exceed fifteen percent (15%) by weight. Deleterious substances shall not be present in excess of the following percentages by weight, and in no case shall the total of all deleterious substances exceed one and one-half percent (1.5%):

Soft Fragments	1.5%
Shale	1.5%
Coal and Lignite	0.25%
Clay Lumps	0.25%
Materials Finer than No. 200 Sieve	0.50%

\*Except that when material finer than No. 200 sieve consists of crusher dust, the maximum amount maybe 1%.

Except as otherwise specified or approved in writing by the Engineer, coarse aggregate shall be graded as specified in ASTM C 33, size No. 57.

2. **Fine Aggregate:** Fine aggregate for concrete or mortar shall consist of clean, natural sand or a combination of natural and manufactured sands that are hard and durable. Deleterious substances shall not be present in excess of the following percentages by weight of contaminating substances. In no case shall the total exceed three percent (3%):

Removed by Decantation (Dirt, Silt, Etc.)	3%
Shale	1%
Clay Lumps	1%

Fine aggregate shall not contain strong alkali nor organic matter which gives a color darker than a standard color when tested in accordance with ASTM C 40. Fine aggregate shall have a fineness modulus not less than 2.50 nor greater than 3.00. Except as otherwise specified, fine aggregate shall be graded from coarse to fine in accordance with the requirements of ASTM C 33.

- D. Admixtures of any type, except as otherwise specified, shall not be used unless written authorization has been obtained from the Engineer. The use of calcium chloride will not be permitted.

1. All concrete shall contain five percent (5%), plus or minus one percent (1%) entrained air of evenly dispersed air bubbles at the time of placement. The air-entraining agent shall contain no chloride and conform to ASTM C 260, or U.S. Army Corps of Engineers Specifications CRD-C13. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. The Engineer, or Owner and his duly authorized representatives reserve the right, at any time, to sample and test the air-entraining agent or the air content of concrete received on the job by the Contractor. Air entrainment in the concrete shall be tested by ASTM C 138, ASTM C 231 or ASTM C 173. If any sample tested does not have the specified air content, a second test shall be performed. If the second test does not meet the specified air content, the concrete represented by the test shall be removed from the job.

2. A "super plasticizer" water reducing agent may be used at the Contractor's option, subject to approval by the Engineer, for concrete in hydraulic structures. It shall be done at the risk of Contractor to meet strength requirements. The amount of cement in the mix shall not be reduced. The slump may be increased to a maximum of 8-inches. Quantities of admixtures and procedures shall be in accordance with the manufacturers published recommendations. The super plasticizer shall conform to ASTM C 494, Type F or G. The admixture shall be a second-generation type, free of chlorides and alkalis, composed of a synthesized sulfonated complex polymer which shall be added to the concrete mixer at the batch plant.

3. Fly ash/pozzolan shall conform to ASTM C 618, including the requirements of Table 1A, therein, and the following supplementary requirements:

a. Class C Fly Ash

Loss on ignition, maximum	1%
SO <sub>3</sub> content, maximum	4%
Moisture content, maximum	1%
R = (CaO - 5%)/(Fe <sub>2</sub> O <sub>3</sub> ), maximum	4.5

b. Class F Fly Ash

Loss on ignition, maximum	1%
SO <sub>3</sub> content, maximum	3%
Moisture content, maximum	1%
R = (CaO - 5%)/(Fe <sub>2</sub> O <sub>3</sub> ), maximum	1.5

2.02 CONCRETE CURING MATERIALS:

A. Materials for curing concrete shall conform to the following requirements:

1. Concrete curing compound shall be Hunt Process Clear ARB as manufactured by Hunt Process Co., Santa Fe Springs, CA; or equal. The curing compound shall contain a fugitive dye so that areas of application will be readily distinguishable.
2. Polvethylene sheet for use as concrete curing blanket shall be white and shall have a normal thickness of 6 mils.
3. Burlap mats for use as concrete curing blanket shall weight not less than 9-ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

2.03 CONCRETE DESIGN REQUIREMENTS:

- A. General: The concrete mixes shall be designed to produce a concrete of such consistency and composition so as to obtain maximum density and minimum shrinkage. Mix designs with more than forty-one percent (41%) of sand of the total weight of fine and coarse aggregate shall not be used.
- B. Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall not be less than that specified in the following Table:

<u>Type of Work</u>	<u>Min. 28-Day Compressive Strength psi</u>	<u>Maximum Size Aggregate in.</u>	<u>Minimum Cement W/C per cu yd (94# sacks)</u>	<u>Maximum Ratio (by wt.)</u>
Slabs on grade, footings, floor slabs, and all other concrete items not specified elsewhere.	4,000	1	6.0	0.50
Sitework Concrete	3,500	1	6.0	0.50
Lean Concrete	2,500	1	4.5	0.60

C. Adjustments to Mix Design: The mixes used shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability and surface finish and the Contractor shall be entitled to no additional compensation because of such changes.

D. At the Contractors option, fly ash/pollozan may be used as a partial cement replacement in concrete as follows:

1. Fly ash shall replace not more than fifteen percent (15%) by weight of the Portland Cement in the design mix. The design mix shall contain a minimum of six (6) sacks of cement per cubic yard before the replacement is made.
2. Fly ash for hydraulic/liquid containing structures shall be Class C fly ash. Fly ash concrete for all other structures shall be Class C or F fly ash.

2.04 CONSISTENCY:

A. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

<u>Part of Work</u>	<u>Slump (inches)</u>
Footings and Slabs	3-inches + 1/2-inches, - 1 inch.
Other Work	3-inches $\pm$ 1-inch.

With High Range Water Reducer Added 8-inches maximum.

2.05 TRIAL BATCH AND LABORATORY TESTS:

A. Before placing any concrete, the Contractor shall submit the certified trial batch results of each class of concrete having a 28-day strength of 3,500 psi or higher, based on the preliminary concrete mixes submitted by the Contractor. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractors preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain three (3) drying shrinkage, and six (6) compression test specimens from each batch. The costs for the trial batch tests shall be borne by the Contractor.

B. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39.

Three (3) compression test cylinders will be tested at 7-days and three (3) at 28-days. The average compressive strength for the three (3) cylinders tested at 28-days for any given trial batch shall not be less than one hundred twenty-five percent (125%) of the specified compressive strength.

- C. A standard sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements for ASTM C 136. Values shall be given for percent passing each sieve.

## 2.06 SHRINKAGE LIMITATION:

- A. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10-inches, fabricated, cured, dried and measured in accordance with ASTM C 157 modified as follows: Specimens shall be removed from molds at an age of 23± hours after trial batching, shall be placed immediately in water at 70 degrees F. ±3 degrees F. for at least thirty (30) minutes, and shall be measured within thirty (30) minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F. ±3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7-days. This length at age 7-days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F. ±3 degrees F. and fifty percent (50%) ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21 and 28-days of drying after 7-days of moist curing.

The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. the average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing during shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be specified herein.

- B. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age (specified in Paragraph 2.07), shall be 0.036 percent or 0.042 percent, respectively. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements.
- C. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than twenty-five percent (25%).
- D. If the required shrinkage limitation is not met during construction, the Contractor shall take all necessary action, at not additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content ratio; washing or aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

## 2.07 GROUT:

- A. Grout to be placed in the Clarifier and Launderers shall be a mixture of one part Portland cement to 4-1/2 parts sand. Water content shall be such that the grout can be readily spread, yet not wet enough to cause trouble with surface water or laitance, or failure to stay in place after screeding. All grout mixes and mixing procedures shall be submitted in accordance with

section 1300-Contractor Submittals, and shall be subject to review and approval by the Engineer prior to commencing the grouting operations.

- B. Procedures for Grout placement shall be approved by the equipment supplier, to insure that no equipment is overstressed, as well as proper placement tolerances. Equipment Supplier shall have final say on grouting procedures and final tolerances.

### PART 3 - EXECUTION

#### 3.01 MIXING CONCRETE:

- A. Mixing equipment shall be subject to the Engineers approval. mixers shall be of the stationary plant or truck mixer type. Adequate equipment and facilities shall be provided for accurate measurement and control of all materials and for readily changing the proportions of the material. The mixing equipment shall be maintained in good working order and shall be capable of combining the aggregates, cement and water within the specified time into a thoroughly mixed and uniform mass and of discharging the mixture without segregation. Cement and aggregate shall be proportioned by weight.
- B. The batch plant shall be capable of controlling and delivering of all material to within one percent (1%) by weight of the individual material. If bulk cement is used, it shall be weighed on a separate visible scale which will accurately register the scale load at any stage of the weighing operation from zero to full capacity.

Cement shall not come in contact with aggregate or with water until the materials are in the mixer ready for complete mixing with all mixing water. The procedure of mixing cement with sand or with sand and coarse aggregate for delivery to the jobsite for final mixing and an addition of mixing water will not be permitted. Retempering of concrete will not be permitted. The entire batch shall be discharged before recharging. The volume of the mixed material per batch shall not exceed the manufacturers rated capacity of the mixer.

Each mixer shall be equipped with a device for accurately measuring and indicating the quantity of water entering the concrete, and the operating mechanism shall be such that leakage will not occur when the valves are closed. Each mixer shall be equipped with a device for automatically measuring, indicating and controlling the time required for mixing. This device shall be interlocked to prevent the discharge of concrete from the mixer before the expiration of the mixing period.

Transit-mixed concrete shall be mixed and delivered in accordance with ASTM C 94. After the drum is once started, it shall be revolved continuously until it has completely discharged its batch. Water shall not be admitted to the mix until the drum has started revolving. The right is reserved to increase the required minimum number of revolutions allowed, if necessary, to obtain satisfactory mixing, and the Contractor will not be entitled to additional compensation because of such an increase or decrease.

- C. Mixed concrete shall be delivered to the site of the work and discharge shall be completed within one (1) hour after the addition of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees F. or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed forty-five (45) minutes. The use of non-agitating equipment for transporting concrete will not be permitted.
- D. Truck mixers shall be equipped with counters so that the number of revolutions of the drum may be readily verified. The counter shall be of the resettable type and shall be actuated at the time of starting mixers at mixing speeds. Concrete shall be mixed in a truck mixer for not less than seventy (70) revolutions of the drum or blades at the rate of rotation designated by

the manufacturer of equipment. 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 determining the number of revolution of mixing.

### 3.02 PREPARATION OF SURFACES FOR CONCRETING:

- A. Earth surfaces shall be thoroughly and uniformly wetted by sprinkling prior to the placing of any concrete. These surfaces shall be kept moist by frequent sprinkling up to the time concrete is placed thereon. The surface shall be free from standing water, mud and debris at the time of placing concrete.
- B. The surfaces of all horizontal construction joints shall be cleaned of all laitance, loose or defective concrete and foreign material. Such cleaning shall be accomplished by sandblasting followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.
- C. No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel and preparation of surfaces involved in the placing have been completed and accepted by the Engineer at least four (4) hours before placement of concrete. All reinforcement, anchor bolts, sleeves, inserts and similar items shall be set and secured in the forms where shown or by shop drawings and shall be acceptable to the Engineer before any concrete is placed. Accuracy of placement is the responsibility of the Contractor. All surfaces of embedded items that have become encrusted with dried grout from concrete previously placed shall be cleaned of all such grout before the surrounding or adjacent concrete is placed.
- D. All form surfaces in contact with the concrete shall be thoroughly cleaned of all previous concrete, dirt and other surface contaminants prior to use. Damaged form surfaces shall not be used.  
  
Wood form surfaces in contact with the concrete shall be coated with an approved release agent prior to form installation. The release agent shall be non-staining and non-toxic after thirty (30) days. Mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface of steel forms. All steel forms shall have the contact surfaces coated with an approved release agent. The release agent shall be effective in preventing discoloration of the concrete from rust and shall be non-toxic after thirty (30) days.
- E. Where concrete is to be cast against old existing concrete, the old concrete shall be thoroughly roughened to exposed, hard aggregate by sandblasting or chipping. Any additional surface preparation shall be as called for in the drawings.
- F. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or diverted out of the forms and clear of the work. No concrete shall be deposited under water or allowed to rise on any concrete until the concrete has attained its initial set. Pumping or other necessary dewatering operations for removing ground water, if required, shall be the responsibility of the Contractor and will be subject to review by the Engineer.
- G. Pipe, conduit, dowels, sleeves and other ferrous items required to be embedded in concrete construction shall be adequately positioned and supported prior to placement of concrete. There shall be a minimum of 2-inches clearance between embedded items and any of the concrete reinforcement. Securing embedments in position by wiring or welding them to the reinforcement will not be permitted.

### 3.03 PLACING CONCRETE:

- A. No concrete shall be placed without prior inspection of the forms, reinforcing and embedded items and approval from an authorized representative of the Engineer. The Contractor shall notify the Engineer at least twenty-four (24) hours in advance of any scheduled concrete placement and shall call for final inspections no later than four (4) hours in advance of the scheduled placement. The Contractor shall notify the Engineer at least two (2) hours in advance of setting the opposite side of wall forms so that the construction joint preparation, water stop installation and reinforcing steel inspections can be conducted. It is the Contractors responsibility to see that the forms are properly cleaned and oiled before being set, the construction joints properly prepared, reinforcing steel is securely and properly supported in the correct position and that all embedment items including electrical conduit is correctly installed before calling for inspections. The Engineer may at his option require the use of placement cords if deemed necessary.
- B. Placement of concrete shall conform to the requirements and recommendations of ACI 301, 304 and 318, except as modified herein.
- C. Concrete which upon or before placing is found not to conform to the requirements specified herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these specifications, or which is of inferior quality, shall be removed and replaced at the expense of the Contractor.
- D. No concrete shall be placed during rain or snow storms, unless completely covered to prevent storm water from coming in contact with it. Sufficient protective covering material shall be kept on hand at all times should rain or snow storms arise during concrete placement operations.
- E. Concrete shall be deposited at or near its final position to avoid segregation caused by rehandling or flowing. Concrete shall not be deposited in large quantities in one place and worked along the forms with vibrator or other means. Concrete shall be uniformly distributed during the placing process and in no case after depositing shall any portion be displaced in the forms more than 2-feet in horizontal direction. Concrete shall be deposited in forms in horizontal layers not to exceed 24-inches in depth and shall be brought up evenly in all parts of the form. The rate of placement of concrete in forms shall not exceed 5-feet of vertical rise per hour. As the concrete is placed it shall be consolidated thoroughly and uniformly by mechanical vibration to secure a dense mass, close bond with reinforcement and other embedded items and smooth surface. The mechanical vibrator shall penetrate not only the freshly placed concrete, but also the previously placed lift to ensure the lifts become monolith. New concrete shall be placed against previously placed concrete, not away from it. When concrete is placed on a slope, placement shall begin at the lower end of the slope and progress to the upper end for the full width of the placement. Consolidation by mechanical vibration shall follow directly behind placement and the rate of placement shall never get ahead of the consolidation crew. Concrete placement shall continue without avoidable interruption, in a continuous operation until the end of the placement is reached.
- F. The drop of concrete into slab or wall forms shall be vertical. Concrete shall not be dropped through reinforced steel, but deposited in forms using a hopper with a drop chute to avoid segregation and to keep mortar from coating the reinforcement steel and forms above the in-place concrete. In no case shall the free fall of concrete exceed 4-feet below the end of the hopper or chute.
- G. If it takes more than 20-minutes to get back to place concrete over concrete previously placed, the depth of the layers being placed at one time shall be reduced, and/or placing equipment increased, until it is possible to return with the placing operation to previously placed concrete within 20-minutes. If concrete is to be placed over previously poured

concrete and more than 20-minutes have elapsed, then a layer of grout not less than 1/2-inch thick shall be spread over the surface before placing the additional concrete.

- H. The placement of concrete for slabs, beams or walkways cast monolithically with walls or columns shall not commence until the concrete in the walls or columns has been allowed to set and shrink. The time allowed for shrinkage shall be not less than one (1) hour.
- I. Concrete shall be placed with the aid of approved mechanical vibrators. Vibration shall be supplemented by manual forking or spading adjacent to the forms on exposed faces in order to secure smooth dense surfaces. The concrete shall be thoroughly consolidated around reinforcement, pipes or other shapes built into the work. The vibration shall be sufficiently intense to cause the concrete to flow and settle readily into place and to visibly affect the concrete over a radius of at least 18-inches.

Sufficient vibrators shall be on hand at all times to vibrate the concrete as placed. In addition to the vibrators in actual use while concrete is being placed, the Contractor shall have on hand one (1) spare vibrator in serviceable condition. No concrete shall be placed until it has been ascertained that all vibrating equipment, including spares, is in serviceable condition.

Special care shall be taken to place the concrete solidly against the forms so as to leave no voids. Every precaution shall be taken to make all concrete solid, compact and smooth, and if for any reason the surfaces or interiors have voids or are in any way defective, such concrete shall be repaired as directed by the Engineer. No defective work shall be patched or repaired without the prior inspection and approval of the Engineer.

- J. The temperature of concrete when it is being placed shall be not more than 90 degrees F. nor less than 40 degrees F. in moderate weather, and not less than 50 degrees F. in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the specified minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F., the Contractor shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.
- K. Concrete shall not be placed on a frozen subgrade or subgrade that contains frozen materials. All ice and snow shall be removed from inside forms and from reinforcing steel and embedded items. The temperature of all surfaces that the concrete will contact shall be raised above the freezing point for at least 12-hours prior to placing new concrete.

The minimum temperature of fresh concrete as mixed shall be 60 degrees F. for ambient temperature above 30 degrees F.; 65 degrees F. for ambient temperature 0 degrees F. to 30 degrees F.; and 70 degrees F. for ambient temperature below 0 degrees F. The minimum temperature of fresh concrete after placing shall be 55 degrees F. for the first 72-hours.

The use of calcium chloride shall not be permitted.

In general, the Contractor shall adhere to the recommendations as outlined in ACI Standard 306 for cold weather concreting, except as required herein.

### 3.04 PUMPING OF CONCRETE:

- A. Pumping of concrete will be permitted only with the Engineers approval. The pumping equipment must have two (2) cylinders and be designed to operate with one (1) cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor shall have a standby pump or crane and concrete bucket on site during pumping to provide assurance

the concrete will be placed without cold joints in the event of pumping equipment breakdown. The minimum diameter of the hose (conduits) shall be 4-inches. Pumping equipment and hoses (conduits) that are not functioning properly, shall be replaced. Aluminum conduits for conveying the concrete will not be permitted.

- B. Concrete samples for slump and test cylinders will be taken at the discharge end of the pumping conduit.

### 3.05 ORDER OF PLACING CONCRETE:

- A. The order of placing concrete in all parts of the work shall be acceptable to the Engineer. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 7-days before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the two (2) adjacent wall panels have cured at least 14-days.
- B. The surface of the concrete shall be level whenever a run of concrete is stopped. To ensure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one (1) hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel.

### 3.06 TAMPING AND VIBRATING:

- A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets and bringing only a slight excess of water to be exposed surface of concrete during placement. Vibrators shall be high speed power vibrators (8,000 to 10,000 rpm) of an immersion type in sufficient number and with (at least one) standby units as required.
- B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are horizontal, the concrete shall be worked under the waterstops by hand, making sure that all air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration, over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.
- C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred or worked with suitable appliances, tamping bars, shovels or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the results herein specified with fifteen (15) minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall be kept from contact with the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner than causes segregation of its constituents.

### 3.07 FINISHING CONCRETE SURFACES:

- A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles and dimensions shown are defined as tolerances and are specified in Paragraph 1.05, H., herein. These

tolerances are to be distinguished from irregularities in finish as described herein. ; Aluminum finishing tools shall not be used.

B. Unformed Surfaces: After placing and consolidating concrete, all unformed top surfaces of slabs, walls, curbs, gutter and steps, shall be brought to a uniform finished surface. The classes of finish specified for unformed concrete surfaces are defined as follows:

1. Finish U1: Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.
2. Finish U2: After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating or surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where shown or as determined by the Engineer.
3. Finish U3: After the floated surface (as specified for Finish U2) has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples and trowel marks. The finish shall be smooth and free of all irregularities.
4. Finish U4: Steel trowel finish (as specified for Finish U3) without local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise shown. The resulting surface shall be rough enough to provide a non-skid finish.

C. The schedule for finished unformed surfaces shall be as follows:

Unformed Concrete Surface Schedule

<u>Area</u>	<u>Finish</u>
Grade slabs and foundations to be covered with concrete or fill material.	U1
Floor slabs to be covered with grouted tile or topping grout and slabs to be covered with built-up roofing.	U2
All building and machine room floors, basin floors not receiving a grout topping, channel floors, top of interior walls, top of interior curbs, steps and walkways. Grout Surfaces in Bottom of Clarifier and DAF.	U3
Exterior walkways, curb, gutter, sidewalk and steps, top of valve or meter vaults, electrical pull boxes and catch basins. Grout surface in Clarifier and DAF Launderers.	U4

D. Floor Sealer Hardener (Surface Applied):

1. Floor hardener shall be applied where shown or noted on the drawings.

2. Floors to receive hardener shall be cured, cleaned and dry with all work above them completed. Apply zinc and/or magnesium fluosilicate evenly, using three (3) coats, allowing 24-hours between coats.
3. The first coat shall be 1/3 strength, second coat 1/2 strength and third coat shall be 2/3 strength. Each coat shall be applied so as to remain set on the concrete surface for fifteen (15) minutes. If sodium silicate is used, it shall be applied evenly, using three (3) coats, allowing twenty-four (24) hours between coats, and the material shall be applied full strength at the rate of one (1) gallon per 300 square feet. Approved proprietary hardeners shall be applied in conformance with the manufacturer's instruction. After the final coat is completed and dry, surplus hardener shall be removed from the surface by scrubbing and mopping with water.

E. Formed Surfaces: Immediately following the removal of forms, the concrete shall be inspected for defects such as rock pockets, grout loss, damage from stripping forms, surface defects such as fins, offsets, bulges, excessive bug-holes and stains. All defective concrete work shall be removed and replaced or repaired to the satisfaction of the Engineer. Any work which has not been constructed in accordance with the plans and specifications will be considered defective.

Correction of defective work shall be as directed by the Engineer and specified herein. No defective work shall be patched, repaired or covered without prior inspection and approval of the Engineer.

Holes left by tie-rod cones or taper ties shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with non-metallic grout.

The classes of formed concrete surfaces are defined as follows:

1. Finish F1: No special treatment is required after form removal except for curing, repair of defective concrete treatment of surface defects, removal of fins and projections, filling of tie holes and filling of depressions and bug-holes 3/8-inch or larger in width or depth with mortar.
2. Finish F2: All defective concrete shall be repaired, all fins, offsets, bulges and projections ground smooth, filling of tie holes and filling of depressions and bug-holes 1/4-inch or larger in width or depth with mortar.
3. Finish F3: All defective concrete shall be repaired; all fins, offsets, bulges and projections ground smooth and tie holes filled with grout. The entire surface shall then receive a light stoning or grinding using a No. 50 or No. 60 grit carborundum stone or grinding wheel to remove any laitance and curing film and to open up bug-holes hidden beneath the thin surface grout film. The surface shall then be given a stoned-sand type architectural finish as follows:
  - a. The concrete surface shall be pre-wet for several hours or overnight before treatment.
  - b. While the surface is still damp, spread a sand mix, consisting of one (1) part of Type II Cement and one to one and a half (1 to 1-1/2) parts of fine sand passing the No. 70 screen mixed with enough water and an emulsified bonding agent to have the consistency of thick cream. The sand mix should be spread thinly over the damp surface with a rubber float and rubbed in over the entire area leaving only a minimum amount of material on the surface necessary to produce a sand texture, approximately 1/32-inch in thickness.

- c. The surface shall be kept continually damp for seventy-two (72) hours following this finish treatment.

F. The schedule for formed surface finish shall be as follows:

Formed Concrete Surface Schedule

<u>Area</u>	<u>Finish</u>
Formed concrete surfaces to be covered by backfill or coated with below grade waterproofing systems.	F1
Formed concrete surfaces in water channels, below water surface of basins, inside meter and valve vaults, inside cells of hydraulic splitter boxes and weirs.	F2
Formed concrete surfaces inside buildings and machine rooms and all exposed exterior surfaces of foundations, basins, vaults, hydraulic structures and curbs.	F3

3.08 CURING AND DAMPPROOFING:

- A. General: All concrete shall be cured for not less than fourteen (14) days after placing, in accordance with the methods specified herein for the different parts of the work and described in detail in the following paragraphs:

Surface To Be Cured

<u>Area</u>	<u>Method</u>
Construction joints between footings and walls and between floor slab and columns.	1
Wall sections with forms removed, encasement concrete and all concrete surfaces not specifically provided for elsewhere in this Paragraph.	2
Floor slabs on grade in hydraulic structures and roof and slabs not on grade.	3

- B. Method 1: The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, or until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 1.

- C. Method 2: The surface shall be sprayed with a liquid curing compound applied in accordance with the manufacturers printed instructions. Care shall be exercised to avoid damage to the seal during the curing period. Should the seal be damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

Curing compound specified shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within one (1) hour after removal of forms from contact with formed surfaces. Repairs to formed surfaces shall be made within the said one (1) hour period. If repairs cannot be made with the one (1) hour period they shall be delayed until after the curing compound has been applied. When repairs are to be made to an area

on which curing compound has been applied, the area involved shall first be sandblasted to remove the curing compound, following which repairs shall be made as specified herein.

- D. Method 3: Immediately after the concrete has been finished, it shall be given a coat of curing compound in accordance with Method 2, Paragraph 3.08, C. herein. No less than one (1) hour nor more than four (4) hours after the coat of curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blanket material shall be clear 6 mil minimum polyethylene. The blankets shall be laid with the edges lapped not less than 12-inches and held in place by tape or other suitable means to prevent the blankets from separating or being removed by wind.

The curing blankets shall be left in place during the fourteen (14) day curing period and shall not be removed until after concrete for adjacent work has been placed. Should the curing blankets become torn or otherwise ineffective, the Contractor shall replace damaged sections. During the first three (3) days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The Contractor shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

### 3.09 PROTECTION:

- A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damage to finish surfaces.

Finished floor slabs in buildings and machine rooms shall be suitably protected from wear or damage from construction operations. The Contractor shall not use newly finished floors or buildings for machine assembly, fabrication, pipe fitting, curing or welding operations without covering the working area with plastic sheets and/or plywood. Any concrete found to be damaged or which may have been originally defective or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at the Contractor's expense.

- B. Immediately following the first frost in the fall, the Contractor shall be prepared to protect all concrete against freezing.

### 3.10 CURING IN COLD WEATHER:

- A. After the first frost, and until the mean daily temperature in the vicinity of the worksite falls below 40 degrees F. for more than one (1) day, the concrete shall be protected against freezing temperatures for not less than forty-eight (48) hours after it is placed. After the mean daily temperature in the vicinity of the worksite falls below 40 degrees F. for more than one (1) day, the concrete shall be maintained at a temperature not lower than 50 degrees F. for at least seventy-two (72) hours after it is placed.

Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F. over a (3) three day duration.

- B. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete

adjacent to the heaters are protected from drying and excessive carbon dioxide atmosphere by application of curing Method 2 or Method 3, as specified under Section 3.08, Paragraphs C and D herein.

**3.11 REPAIR OF DEFECTIVE CONCRETE:**

- A. No concrete repairs shall be made until after inspection and approval of the method of repair by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing extensive voids, holes, honeycombing or similar depression defects shall be completely removed and replaced. Concrete containing minor voids, holes, honeycombing or similar depression defects shall be repaired as specified herein. All concrete repairs and replacements shall be promptly executed by the Contractor at its own expense.
- B. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as shown on the Drawings and filled with construction joint sealant conforming to the requirements under Section 03290 entitled, "Joints In Concrete". This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill, which are not covered with a waterproofing membrane shall also have cracks repaired as specified herein.
- C. The repair of holes left by rock pockets, penetrations, tie rods or other reasons will require the use of non-shrink, non-metallic grout material.

END OF SECTION 03300

## SECTION 03315 - GROUTING MORTAR

### PART 1 - GENERAL

#### 1.01 THE REQUIREMENT:

- A. The Contractor shall furnish, place, finish and cure the following types of grouting mortars as called for herein and as shown in the Contract Documents
  - 1. Non-Shrink Grout: This type of grout shall be used wherever grout is shown or called for in the Contract Documents, unless another type is specifically referenced.
  - 2. Topping Grout: This type of grout shall be used for grouting clarifier bottoms.
  - 3. Epoxy Grout: This type of grout shall be used for anchor bolt or reinforcing steel embedment, repairs and resurfacing.

#### 1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Cast-In-Place Concrete. 03300

#### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS:

- A. Specifications, codes and standards is listed under Section 03300 entitled, "Cast-In-Place Concrete", and those additional commercial standards as follows:

CRD-C 621-85                      Corps of Engineers Specification for Non-Shrink Grout

ASTM C 109                      Standard Test Method for Compressive (Latest Edition)  
Strength of Hydraulic Cement Mortars (Using 2-inch or 50-  
mm Cube Specimens)

ASTM C-827-87                  Standard Test Method for Early Volume Change of Cementitious  
Mixtures

#### 1.04 CONTRACTOR SUBMITTALS:

- A. Non-Shrink Grout: Submit manufacturer's technical data, including compressive strength and expansion data at plastic, flowable, and fluid consistencies. Also submit manufacturer's applications manual containing instructions and recommendations for mixing, handling, placement and appropriate uses for each type of non-shrink grout used in the work.
- B. Topping Grout: Provide certified mix design including proportions and gradations of all materials and compressive strength test results from at least one (1) trial batch. Tests shall be performed by a certified testing laboratory. All costs for such mix design and trial batch tests shall be borne by the Contractor.
- C. Epoxy Grout: Submit manufacturer's technical data including strengths and application manual of instructions for mixing, handling and placing.

#### 1.05 QUALITY ASSURANCE:

- A. Mix design tests for topping grout shall be performed per the standards referenced herein.
- B. During the progress of construction the Engineer may have tests made of each type of grout used in the work to ensure compliance with the Contract Documents. These tests will be

made in accordance with the standards referenced herein. The test expense during construction, except for the mix design and trial batch tests, will be borne by the Owner. The costs of additional tests including non-destructive tests and core drilling needed to verify or investigate the quality of questionable work or material shall be borne by the Contractor.

- C. Grout for testing shall be supplied by the Contractor at no cost to the Owner.
- D. If any grout fails to meet the requirements of these specifications, immediate corrective action shall be taken for all subsequent batches. Grout already in place which fails to meet these requirements is subject to removal and replacement with all costs borne by the Contractor.
- E. Construction tolerances shall be as specified in Section 03300 entitled, "Cast-In-Place Concrete", except as modified herein and elsewhere in the Contract Documents.

## PART 2 - PRODUCTS

### 2.01 NON-SHRINK GROUT:

- A. Non-shrink grout shall be a prepackaged, inorganic, non-gas liberating, non-metallic, cement-based grout requiring only the addition of water. Manufacturers instructions shall be printed on each bag or other container in which the materials are packaged.
- B. Non-shrink grouts for use as herein specified shall conform to the Corps of Engineers specifications for Non-Shrink Grout, CRD-C621-85 and to these specifications. The grout shall have a 28-day compressive strength of 6,000 psi or greater.
- C. Non-shrink grouts shall be as manufactured by: Tremcrete Systems Incorporated, Woodland, California; Gifford-Hill & Company, Inc., Dallas, Texas; or approved equal.

### 2.02 TOPPING GROUT:

- A. Cement topping grout for clarifiers or channels shall be composed of one part cement, three parts sand, and the minimum amount of water necessary to obtain the desired consistency. The minimum compressive strength at 28-days shall be 4,000 psi.
- B. Cement grout materials shall be as specified in Section 03300 entitled, "Cast-In-Place Concrete".

### 2.03 EPOXY GROUT:

- A. Epoxy grout shall be a pourable, non-shrink, one-hundred percent (100%) solids system. The epoxy grout system shall have three components; resin, hardener, and specially blended aggregate, all premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. The chemical formulation of the epoxy grout shall be that recommended by the manufacturer for the particular application. Manufacturers instructions shall be printed on each container in which the materials are packaged.
- B. The mixed epoxy grout system shall have a minimum working life of 45 minutes at 75 degrees F. The epoxy grout shall develop a minimum compressive strength of 5,000 psi in 24-hours and 10,000 psi in 7-days.

2.04 CURING MATERIALS:

- A. Curing materials shall be as specified in Section 03300 entitled, "Cast-In-Place Concrete", for cement topping grout and as recommended by the manufacturer of non-shrink grouts.

PART 3 - EXECUTION

3.01 PLACING NON-SHRINK AND EPOXY GROUT:

- A. All forming, mixing, surface preparation, handling, placing and consolidated of non-shrink and epoxy grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. Curing shall be as specified herein.

END OF SECTION 03315

