

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. Furnish, place, finish and cure cast-in-place concrete complete with all appurtenant work
- B. Additional Requirements Specified Elsewhere
  - 1. Section 01010: Summary of Work
  - 2. Section 01340: Shop Drawings, Product Data, and Samples
  - 3. Section 01400: Quality Control
- C. Related Requirements Specified Elsewhere
  - 1. Section 02200: Earthwork
  - 2. Section 03100: Concrete Formwork
  - 3. Section 03200: Concrete Reinforcement

##### 1.2 QUALITY ASSURANCE

- A. Reference Standards
  - 1. *American Concrete Institute Standards (ACI)*
    - a. ACI 214: Evaluation of Strength Test Results of Concrete
    - b. ACI 301: Specifications for Structural Concrete
    - c. ACI 302: Guide for Concrete Floor and Slab Construction
    - d. ACI 304: Guide for Measuring, Mixing, Transporting and Placing Concrete
    - e. ACI 305: Hot Weather Concreting
    - f. ACI 306: Cold Weather Concreting
    - g. ACI 315: Manual of Standard Practice for Detailing Reinforced Concrete Structures
    - h. ACI 318: Building Code Requirements for Structural Concrete
  - 2. *AASHTO Standard Specifications for Highway Bridges*
  - 3. Except as modified or supplemented herein, all concrete materials, placing, finishing, curing and other appurtenant work shall meet the requirements of the latest edition of the Reference Standards
  - 4. Pertinent portions of the Reference Standards are included herein; refer to the standards for detailed requirements
  - 5. Keep at least one copy of ACI Publication SP-15, *Field Reference Manual*, at the project site office at all times

## B. Source Quality Control

1. Test the proposed concrete mix for each size and gradation of aggregate and each consistency intended for use in the project
2. Aggregates
  - a. Sample and test according to ASTM C33
  - b. Determine bulk specific gravity in accordance with ASTM C127 and C128
3. Compression tests
  - a. Prepare two sets of compression test cylinders for each proposed concrete mix, three cylinders per set
  - b. Test one set of three cylinders at 7 days, the other at 28 days
  - c. Make, cure and store in accordance with ASTM C192
  - d. Test in accordance with ASTM C39
4. Slump test: ASTM C143
5. Total air content: ASTM C231
6. Initial set test
  - a. In accordance with ASTM C403
  - b. Test at 70°F and 90°F ambient
  - c. Test at 70°F on mix including specified plasticizing and air entraining admixtures
  - d. Test at 90°F on mix including specified retarding and air entraining admixtures

## 1.3 SUBMITTALS

### A. Shop Drawings and Product Data

1. Refer to Section 01340 - Shop Drawings, Product Data, and Samples
2. Supplement with additional information specified herein

### B. Test Reports

1. Submit reports of proposed concrete mix design and testing including
  - a. Slump on which design is based
  - b. Total water content (gallons) per cubic yard and proposed source
  - c. Brand, type, composition and quantity of cement
  - d. Source, type, gradation, deleterious substances and saturated surface dry specific gravity for coarse and fine aggregates
    - 1) Soundness (ASTM C88) of coarse aggregate
  - e. Ratio of fine to total aggregates
  - f. Surface dry weight of each aggregate per cubic yard
  - g. Brand, type, ASTM designation, active chemical ingredients and quantity of each admixture
  - h. Air content
  - i. Compressive strength based on 7-day and 28-day compression tests
  - j. Time of initial set
2. Submit reports of field quality control testing including results of tests required in Part 3 hereof

## 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

### A. Storage

1. Cement
  - a. Store in watertight enclosures
  - b. Protect against dampness, contamination and warehouse set
  - c. Do not use if caked or lumpy
2. Aggregate
  - a. Store to prevent segregation or contamination with other materials or other sizes of aggregate
  - b. Do not use bottom 6 inches of piles in contact with the ground
  - c. Use only one supply source for each aggregate stockpiled
3. Admixture
  - a. Store to prevent contamination, evaporation or damage
  - b. Protect liquid admixtures from freezing or harmful temperature ranges
  - c. Agitate emulsions prior to use
4. Rubber and plastic materials
  - a. Store in a cool place
  - b. Do not expose to direct sunlight

### B. Delivery

1. Prepare a delivery ticket for each load of ready-mixed concrete
2. Ready-mix truck operator shall hand ticket to Engineer at the time of delivery
3. Ticket to include
  - a. Mix identification and quantity of concrete supplied
  - b. Amount of each material in batch
  - c. Outdoor temperature in the shade
  - d. Time at which cement was added
  - e. Structure and location in structure where unloaded
  - f. Quantity of water added at the site, time added and name of person authorizing supplemental water
  - g. Numerical sequence of the delivery

## PART 2 - PRODUCTS

### 2.1 MATERIALS

#### A. Concrete

1. Cementitious material
  - a. Portland, ASTM C150
  - b. Use consistent type and brand for exposed surfaces throughout
  - c. Type I/II or Type II with Class F fly ash
    - 1) 15% minimum and 20% maximum of the cementitious material will be class F fly ash
2. Fine aggregate
  - a. Clean, natural sand, ASTM C33
  - b. No manufactured or artificial sand
3. Coarse aggregate

- a. Crushed rock, natural gravel or other inert granular material
- b. ASTM C33 with the following limitations on coarse aggregate

<u>Item</u>	<u>Maximum % by Weight</u>
Soft particles	2.0
Chert as soft impurity	1.0
Total of above	2.0
Flat and elongated particles	15.0

- c. Pozzolan or other additives shall not be used to compensate for alkali reactivity
- d. Maximum size of coarse aggregate not more than the following
  - 1) 1/5 narrowest dimension between form sides
  - 2) 3/4 minimum clear spacing between reinforcing bars and form sides
  - 3) 1/3 depth of slabs
  - 4) No. 467 (1 1/2")
  - 5) No. 67 (3/4") for architectural concrete and concrete grout
- 4. Water
  - a. Fresh, clean, potable supply
  - b. Free from alkalis and other impurities except as permitted by ACI 301, Section 2.3, upon approval by Engineer
- 5. Admixtures
  - a. Use only as specified or as approved in writing by Engineer
  - b. Admixtures causing accelerated setting of cement shall not be used
  - c. Calcium chloride is not permitted
  - d. Air entraining agent: Conform to ASTM C260
  - e. Water reducing and retarding
    - 1) Conform to ASTM C494
    - 2) Use only with Engineer's approval

B. Accessories

- 1. Polyethylene film: PS 17, 6 mil
- 2. Membrane curing compound and floor sealer
  - a. FS TT-C-600, Type 1
  - b. Chlorinated rubber, minimum 18% solids
  - c. Protex "Triple Seal," Castle Chemical Corp. "Klearseal," Grace "Dekote" or equivalent
- 3. Waterstops
  - a. General use: Corps of Engineers Specification CRD C-572
    - 1) Flat-ribbed PVC, with center bulb type in keyed joints
      - a) Split section to accommodate embedded in formed concrete
    - 2) Size: 8", 6" where concrete section is less than 6"
  - b. Where indicated on the Drawings: Metal
    - 1) 12-gauge ungalvanized steel
    - 2) Clean and free of coatings which would weaken bond with concrete
    - 3) Size as indicated on Drawings
  - c. Expansion joint filler
    - 1) Bituminous type: ASTM 994
    - 2) Cork type: ASTM C1752, Type II or Type III
    - 3) Fiber type: ASTM D1751

- d. Curing materials
  - 1) Waterproof sheet: ASTM C171
  - 2) Liquid membrane: ASTM C309
- e. Joint sealers
  - 1) Horizontal application: Pecora "Urexpan NR-200" or equivalent
  - 2) Vertical application: Pecora "Dynatrol II" or equivalent
- f. Vapor barrier: Polyethylene coated reinforced paper or equivalent
- g. Weepholes: As detailed on Drawings
- 4. Fiber reinforcement
  - a. Refer to Section 03200
  - b. Use fiber reinforcement in shotcrete, all flatwork and equipment foundations
- 5. Architectural waterproof coating
  - a. General
    - 1) Use product of a single manufacturer
    - 2) Use coating compatible for placement on vertical substrate of concrete
    - 3) Provide tie coats where recommended by manufacturer
    - 4) Surface preparation: As recommended by the manufacturer
  - b. Product requirements
    - 1) Micro-porous
    - 2) Texture: Fine sand
    - 3) Waterproof: Federal Specification TT-C-00555 B, Par. 4.4.7.
    - 4) UV resistant
    - 5) Color
      - a) Match existing aerobic basin color – natural concrete grey
      - b) Submit color chart for selection by Owner
    - 6) Water-based acrylic emulsion
    - 7) Water vapor transmission: 13 perms per ASTM E96
  - c. Coverage and application
    - 1) 60-100 square feet per gallon depending on surface porosity and texture
    - 2) As recommended by the manufacturer
  - d. Design basis: Thoro System Products, Thorcoat
- 6. Bonding agent
  - a. High solids content, water dispersion of bonding polymers suitable for adhering pneumatically applied concrete to existing concrete
  - b. Design material: WR Meadows, Inc. Intralok

## 2.2 MIXES

- A. Design concrete mix within the limits specified
- B. Ready-Mixed Concrete
  - 1. Comply with ASTM C94
  - 2. Plant equipment and facilities shall conform to the "Checklist for Certification of Ready-Mixed Concrete Production Facilities" of the National Ready-Mixed Concrete Association
- C. Site-Mixed Concrete
  - 1. ACI 301, Section 7.2

#### D. Proportioning

1. Proportion ingredients to produce a well-graded mix of high density and maximum workability consistent with approved mix design and subject to the following
2. Strength: Minimum 28-day compressive strength
  - a. 3,000 psi for anchor blocks, thrust blocks and manhole bases
  - b. 3,750 psi for caissons
  - c. 4,500 psi for footings, foundation walls, slabs on grade and all other concrete
3. Entrained air: For structural concrete exposed to the weather and for sidewalks, curbs and gutters
  - a.  $6 \pm 1.0\%$  for  $\frac{3}{4}$ " coarse aggregate
  - b.  $6 \pm 1.0\%$  for 1" coarse aggregate
  - c.  $6 \pm 1.0\%$  for  $1\frac{1}{2}$ " coarse aggregate
  - d. Refer to Table 3.4.1 of ACI 301 for additional requirements
4. Entrained air: For concrete required to be watertight including concrete for all liquid-containing structures
  - a.  $6 \pm 1\%$  for  $\frac{3}{4}$ " and  $1\frac{1}{2}$ " coarse aggregate
5. Water cement ratio: Maximum
  - a. 0.42 for all liquid-containing structures
  - b. 0.48 for all other concrete unless otherwise required by ACI 301
6. Slump: Maintain the following limits
  - a. 1 inch minimum
  - b. 3 inches maximum for footings and substructure walls of liquid-containing structures
  - c. 5 to 7 inches for drilled caisson concrete
  - d. 4 inches maximum for all other concrete
7. Initial set
  - a.  $5\frac{1}{2}$  hours  $\pm 1$  hour after water and cement are added to the aggregates as determined by ASTM C403
8. Admixtures
  - a. Content, batching method and time of introduction in accordance with the manufacturer's recommendations for compliance with this Specification
9. Consistency
  - a. Suitable for placement conditions
  - b. Uniform slump
  - c. Aggregate floating uniformly throughout the concrete mass
  - d. Flow sluggishly when vibrated or spaded
10. Mixing: Minimum mixing time
  - a. Central-mixed concrete
    - 1) 1 minute for mixer capacities one cubic yard or less plus 15 seconds for each cubic yard or fraction thereof of additional capacity
  - b. Truck-mixed concrete
    - 1) 100 revolutions after the introduction of all ingredients
11. Tempering and control of mixing water
  - a. Mix concrete only in quantities for immediate use
  - b. Do not use concrete which has stiffened due to initial set or concrete which cannot be discharged within one and one-half hours or 300 revolutions of the mixer drum after the introduction of mixing water and cement

- c. Water may be added to concrete arriving at the site only if neither the maximum slump nor the maximum water cement ratio is exceeded
- d. Provide additional cement if required by the addition of water to maintain water-cement ratio within specified limits
- e. Obtain Engineer's approval prior to adding water or cement
- f. Incorporate any added water or cement by additional mixing equal to half the total mixing required

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. Inspection

1. Assure that excavations and formwork are completed and that dirt, mud, encrusted concrete, debris and excess water are removed
2. Check that reinforcement is secure in place
3. Verify that expansion joint material, anchors, waterstop and other embedded items are secure in position
4. Verify that all required tests for pipes under slabs have been completed

#### B. Preparation

1. Notify Engineer not less than 24 hours in advance of the times and places at which Contractor intends to place concrete
2. Designate the limits of each placement and obtain Engineer's approval of the entire installation prior to proceeding
  - a. Place all concrete within limits of pour in one continuous operation
3. Prepare slab subgrades in accordance with ACI 302, Chapter 4. Moisten the subgrade prior to concrete placement but do not cause soft or muddy spots on the subgrade
4. Remove any hardened concrete and foreign material from the inner surface of conveying equipment
5. Bonding to hardened concrete
  - a. Place new concrete on rough, clean, damp faces of existing concrete
  - b. Remove surface mortar to expose aggregate
  - c. Clean hardened concrete of all foreign substances including curing compound, wash with clean water and keep saturated for 24 hours preceding placement of fresh concrete

#### C. Embedments

1. Accurately position and securely anchor to forms all anchor bolts, castings, steel shapes and other materials to be embedded in concrete
2. Embedments shall be clean when installed
3. Remove concrete splatter from surfaces not in contact with concrete

#### D. Installation

1. Conveying concrete

- a. Convey concrete from mixer to final position as rapidly as practicable without segregation or loss of material
  - b. Use only metal or metal-lined chutes with maximum length 20 feet, maximum slope 1 vertical to 2 horizontal, and minimum slope 1 vertical to 3 horizontal
  - c. Provide a hopper at the end of long belt conveyors and chutes not meeting the above requirements
  - d. Conveying by pumping methods shall conform to ACI 304
    - 1) Maximum loss of slump: 2 inches
    - 2) Adjust air content of batched concrete to compensate for air losses in transit and through pumping equipment
    - 3) Do not use pipe made of aluminum or aluminum alloy to convey concrete
  - e. Place concrete in final position without moving laterally in forms more than 5 feet
2. Placing concrete
- a. Deposit concrete in a continuous operation until the section is completed
  - b. Place concrete in approximately horizontal layers
    - 1) 18 inches maximum thickness for liquid-containing structures
    - 2) 24 inches maximum thickness for all other structures
  - c. Regulate rate of placement so concrete remains plastic and flows into position
    - 1) Fill form at rate not less than 2 feet per hour
    - 2) Place subsequent layer while preceding layer is still plastic
  - d. Maximum height of concrete free fall: 4 feet
  - e. Use an elephant trunk or tremie for placing concrete through a reinforcing cage
  - f. Do not allow concrete to fall on reinforcement or other objects that would cause segregation
  - g. Do not place concrete in supported elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of two hours
  - h. Top finish concrete when thoroughly settled
  - i. Overfill the forms for walls whose tops will be exposed to weathering and screed off the excess after the concrete has settled
3. Consolidation
- a. Thoroughly consolidate concrete during and immediately after placement
  - b. Work concrete around all reinforcements and embedments and into corners of forms
  - c. Use mechanical vibrating, rodding or spading for consolidation
  - d. Conform to ACI 309, "Guide for Consolidation of Concrete"
  - e. Do not use vibrators to transport concrete in forms
  - f. Minimum vibrator speed: 8,000 rpm
  - g. Vertically insert vibrators at points 18 inches apart to a depth sufficient to penetrate 6 inches into the preceding layer
    - 1) Vibrate each location for a length of time to obtain adequate consolidation (generally 5 to 15 seconds)
4. Concreting under water
- a. Permitted only with Engineer's approval



- b. Deposit concrete by an approved method in such a manner that the fresh concrete enters the mass of previously placed concrete from within and displaces the water with minimum disturbance to the concrete
- 5. Environmental requirements
  - a. Do not place concrete during rain, sleet or snow unless adequate protection is provided and the Engineer's approval is obtained
  - b. Do not allow rainwater to increase the mixing water or damage the surface finish
- 6. Cold weather concreting
  - a. Conform to ACI 306R, "Cold Weather Concreting," except as modified herein
  - b. Temperature of concrete when placed shall not be less than the following

Outdoor Temperature at Placement °F	Minimum Concrete Temperature °F with Sections with Least Dimension	
	Under 12"	12" and Over
30 to 45	60	50
0 to 30	65	55
Below 0	70	60

- c. When placed, heated concrete shall not be warmer than 80°F
- d. Prior to placing concrete, all ice, snow and surface and subsurface frost shall be removed, and the temperature of the surfaces to be in contact with the new concrete shall be raised to the temperature specified above for placing
- e. Protect concrete from freezing during the specified curing period
  - 1) Do not allow concrete to cool suddenly
  - 2) If freezing temperatures are expected during the curing period, maintain the concrete temperature at or above 50°F for 5 days or 70°F for three days
- f. Heated enclosures
  - 1) Strong and windproof to ensure adequate protection of corners, edges and thin sections
  - 2) Do not permit heating units to locally heat or dry the concrete
  - 3) Do not use combustion heaters during the first 24 hours unless the concrete is protected from exposure to exhaust gases which contain carbon dioxide
- 7. Hot weather concreting
  - a. Conform to ACI 305, "Recommended Practice for Hot Weather Concreting," except as modified herein
  - b. At air temperature of 90°F or above keep concrete as cool as possible during placement and curing
    - 1) Cool forms and reinforcing to a maximum of 90°F by spraying with water prior to placing concrete
    - 2) Do not use concrete that has reached temperatures in excess of 90°F
  - c. Temperature of the concrete when placed shall not exceed 70°F unless otherwise approved by Engineer. Engineer's approval will be based on paragraphs d and e below
  - d. Prevent plastic shrinkage cracking due to rapid evaporation of moisture
  - e. Do not place concrete when evaporation rate (actual or anticipated) equals or exceeds 0.20 pounds per square foot per hour as determined by Figure 2.1.5 of ACI 305

- f. Set-retarding and water-reducing admixtures may be used to offset the accelerating effects of high temperatures and low humidities with the approval of the Engineer
- 8. Placing sequence
  - a. Construct slabs on grade as a system of independent slabs formed by construction joints
    - 1) As shown on the Drawings or
    - 2) If not shown, divide slab into approximate squares not exceeding 625 square feet in area
    - 3) Place slabs in a checkerboard fashion with a minimum time of 24 hours between placements

#### E. Construction and Control Joints

- 1. Locations
  - a. As indicated on the Drawings
  - b. Obtain Engineer's approval for location of construction joints not shown on Drawings
  - c. At walls
    - 1) Maximum spacing of 1.7 times wall height, unless shown or noted otherwise on the Drawings
  - d. Slabs
    - 1) 35 feet maximum spacing
  - e. Install construction joints in slabs perpendicular to the planes of their surfaces
  - f. Obtain bond at construction joints by
    - 1) Cleaning and roughening concrete surface and removing laitance, then wetting the surface and applying neat cement grout prior to placing concrete or
    - 2) The use of an approved adhesive
- 2. Watertight joints
  - a. Provide watertight joints with continuous flat-ribbed PVC waterstop in the following locations
    - 1) Locations where shown on the Drawings
    - 2) All locations where construction joints occur in tankage below exterior grade
  - b. Continuous through the length of the construction joint
  - c. Maintain in proper position until surrounding concrete is placed and consolidated
  - d. Butt-splice PVC waterstop with an electric welding iron in accordance with manufacturer's printed instructions

## F. Expansion and Contraction Joints

1. Contraction joints
  - a. Provide as indicated on the Drawings
  - b. Seal accessible edges
  - c. Waterstop embedment equal on each side of joint
2. Expansion material
  - a. Provide as indicated on the Drawings
  - b. Firmly bond to previously poured joint. Face with a suitable adhesive
  - c. Pour new concrete directly against joint filler
  - d. Seal accessible edges
3. Do not extend reinforcement continuously through the joint
4. Where "bond break" or "isolation" joint is indicated, form joint with 30-lb. asphalt-saturated felt extending full depth of joint or approved metal keyed joint

## G. Finishing Unformed Surfaces

1. Do not finish buried or permanently submerged concrete not forming an integral part of a structure except as required to attain surface elevations, contours and freedom from laitance
2. Screed and initial float finish followed by additional floating and troweling as required, all other surfaces
3. Screeding
  - a. Screed concrete surfaces to the proper elevation and contours with all aggregates completely embedded in mortar
  - b. Surface free of irregularities of height or depth more than 3/16" measured from a 10-foot straightedge
4. Floating
  - a. Float finish screeded surfaces as soon as the concrete has stiffened sufficiently for working
  - b. Remove and replace with mortar any coarse aggregate which is disturbed by the float or which causes a surface irregularity
  - c. Initial floating to produce a surface of uniform texture and appearance with no unnecessary working of the surface
  - d. Follow initial floating with a second floating at the time of initial set
  - e. Second floating to produce a finish of uniform texture
  - f. Except as otherwise specified, the second float finish is the final finish
  - g. Use hand floats or mechanical compactor floats
5. Scratched finish
  - a. Use for surfaces to receive grout applications
  - b. Roughen surface with stiff brushes or rakes after initial floating but before final set
6. Broom or belt finish
  - a. Use for sidewalks, ramps, curbs, gutters and driveways
  - b. After completion of second floating draw a broom or burlap belt transverse across the surface
    - 1) Right angles to direction of normal traffic
7. Unless specified to be beveled, edge all exposed edges of floated surfaces with a tool having a 1/2" corner radius

## H. Curing

1. Protect concrete from moisture loss for at least seven days after placement except that the time period for curing by saturation for concrete being protected from low temperature shall be one day less than the duration of low temperature protection
2. Cure concrete by methods which will keep concrete surfaces adequately wet during curing
3. Maintain concrete within 50°F to 70°F temperature range during curing
4. Optional curing methods
  - a. Water curing
    - 1) Begin water saturation as quickly as possible after initial set
    - 2) Regulate water application to provide complete surface coverage with a minimum of runoff
    - 3) Interrupt the application of water to walls for grout cleaning only over the area being cleaned at the time and do not permit the surface to become dry during such interruption
  - b. Membrane curing
    - 1) Membrane curing compound may be used in lieu of water curing on concrete which will not be covered later with mortar or concrete
    - 2) Spray-apply membrane curing compound of not more than 300 sq. ft./gallon
    - 3) Cover unformed surfaces within 30 minutes of final finishing
    - 4) If forms are removed before the end of the curing period, immediately apply curing compound to the formed surfaces before they dry out
    - 5) Protect curing compound against abrasion during the curing period
    - 6) Do not use compounds which would discolor the surface
  - c. Film curing
    - 1) Polyethylene sheeting may be used in lieu of water curing on concrete which will be covered later with mortar or additional concrete or will otherwise be covered or hidden from view
    - 2) Begin film curing as quickly after initial set of the concrete as possible
    - 3) Completely cover the surfaces with polyethylene sheeting
    - 4) Overlap the sheeting edges for sealing and anchorage
    - 5) Seal joints between sheets
    - 6) Promptly repair tears, holes or other damage
    - 7) Anchor covering continuously at edges and on the surfaces as required to prevent billowing
  - d. Submit list of all intended curing methods for approval, including description of materials

#### I. Repairing Defective Concrete

1. Repair defects in formed concrete surfaces within 24 hours
2. Replace defective concrete within 48 hours
3. Cut out and remove to sound concrete honeycombed or otherwise defective concrete
4. Cut edges square to avoid feathering
5. Comply with ACI 301
6. Perform repair work so as not to interfere with thorough curing of adjacent concrete
7. Adequately cure repair work

## J. Finishing Formed Surfaces

1. Rough form finish
  - a. All surfaces not exposed to view, such as surfaces in contact with earth backfill
  - b. Repair defects and patch tie holes
  - c. Remove fins exceeding ¼" in height
2. Smooth form finish
  - a. All exposed surfaces not generally subject to view including interior surfaces of manhole structures and storm sewer catch basins
  - b. Use form facing to produce a smooth, hard uniform surface
  - c. Keep the number of seams to a minimum
  - d. Repair and patch all defects and tie holes
  - e. Remove all fins
3. Grout-cleaned finish
  - a. All concrete surfaces exposed to view
  - b. Grout clean surfaces to produce a smooth, uniform surface free of marks, voids, surface glaze and cement dust
  - c. ACI 301, Section 5
  - d. Complete operations for smooth form finish
  - e. Wet surface and apply grout mix of one part portland cement and one and one-half parts fine sand
    - 1) Substitute white portland cement for gray as required to match surrounding concrete
  - f. Rub surface with cork float or stone to fill air bubbles and holes
  - g. Remove excess grout by rubbing with a rubber float, sack or other means
  - h. Do not begin cleaning until all contiguous surfaces are completed and accessible
  - i. Grout-cleaned finish may be constructed with architectural waterproof coating
    - 1) Thorocoat, fine sand finish
4. Use power grinder where necessary to remove projections and fins and to provide a flush surface
5. Tie holes
  - a. Clean, wet and fill with patching mortar
  - b. Finish flush to match texture of adjacent concrete

## 3.2 FIELD QUALITY CONTROL

### A. Perform Field Quality Control Testing

1. Refer to Section 01400 - Quality Control for responsibilities
2. Tests by qualified personnel
3. Make tests in presence of Engineer
4. Contractor shall provide equipment, supplies and services of one or more employees as required by the testing laboratory
5. Test frequencies specified are minimum; perform additional tests as required by the job conditions

### B. Aggregate Gradation: Sample and test in accordance with ASTM D75 and C136

1. Fine aggregates: Each 100 tons
2. Coarse aggregates: Each 200 tons

#### C. Concrete Tests

1. Conduct the following minimum tests in accordance with the requirements of ACI 301, Section 1 and the specified ASTM requirements
2. Slump
  - a. ASTM C143
  - b. Conduct test for each compression test sample and whenever consistency of concrete appears to vary
3. Air content
  - a. ASTM C231
  - b. Conduct test for one of first three batches mixed each day and for each compression test sample
4. Compression tests
  - a. Mold and cure four cylinders for each sample
  - b. Make, cure, store and deliver samples in accordance with ASTM C31
  - c. Mark or tag each set of test cylinders with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content and the slump
  - d. Cylinder testing
    - 1) One cylinder of each set at 7 days for information
    - 2) One cylinder of each set at 28 days for acceptance
    - 3) Reserve remaining two cylinders from each set for possible testing as directed by the Engineer
    - 4) Test in accordance with ASTM C39
    - 5) Engineer will evaluate in accordance with ACI 214, 301 and 318
  - e. Collect the following minimum number of samples per class of concrete for each day's placing
    - 1) 20 cubic yards or less: One sample
    - 2) 20 - 50 cubic yards: Two samples
    - 3) 50 cubic yards or more: Two samples plus one sample for each additional 100 cubic yards or portion thereof

#### D. Acceptance of Concrete

1. The strength level of concrete will be considered satisfactory so long as the average of all sets of three consecutive strength test results equals or exceeds the specified 28-day strength and no individual strength test result falls below the specified strength by more than 500 psi
2. Upon failure of the test cylinder results the Engineer may require the Contractor, at the Contractor's expense, to obtain and test at least three 2" diameter core samples from the area in question
  - a. ASTM C42
  - b. Concrete will be considered adequate if the average of the three cores is at least 85% of, and if no single core is less than 75% of, the specified 28-day strength

3. Upon failure of core test results the Engineer may require the Contractor, at the Contractor's expense, to perform load tests as specified in ACI 301, Section 1.7
4. Fill all core holes as specified for repairing defective concrete

END OF SECTION