

## SECTION 033000 – CAST-IN-PLACE CONCRETE

### Scope:

Contractor shall furnish all labor, equipment and materials to install complete cast-in-place concrete for footers, walls, slabs, roads, blocking, bedding, headwalls, driveways, sidewalks, curbs and other items as specified in this section and on the Drawings. Concrete of the respective classes for footers, walls, slabs, roads, bedding, blocking, headwalls, piers, and other miscellaneous structures shall be as called for in the work to which they pertain. Concrete blocking shall be installed per the Plans, however where ground conditions are questionable, the Owner reserves the right to exceed the Blocking Detail shown in the Plans. Additional concrete blocking will be paid for as a Unit Price Item.

### Submittals:

- A. Mix designs for all classes of concrete.
- B. Strength and slump test results.
- C. Certificates of compliance for cement, aggregates, and admixtures.

### Products:

#### **A. Base Materials:**

- (1) Cement: Cement shall be standard Portland Cement of American manufacture and satisfy the requirements of ASTM C 150 Type I as amended to date. Only one brand of commercial Portland cement shall be used in the exposed concrete of the structures on this project. Cement reclaimed by cleaning bags or from leaking containers shall not be used in this work. Each bag shall weigh approximately 94 pounds and contain one cubic foot.
- (2) Aggregate: Fine and coarse aggregate shall be clean, hard, durable, and uncoated particles and satisfy the requirements of ASTM C 33 as amended to date.
- (3) Water: Water shall be fresh, clean, and free from injurious amounts of oils, acids, alkalis, and organic materials. Water shall not contain more than 1,000 ppm of chlorides calculated as Cl, nor more than 1,000 ppm of sulfates calculated as SO<sub>4</sub>.
- (4) Admixtures: Admixtures shall not be used without prior written approval of Owner. Water reducing admixtures shall conform to ASTM C 494, Type A. Water reducing and water retarding admixtures shall conform to ASTM C 494, Type D. Non-corrosive, non-chloride accelerators shall conform to ASTM C 494, Type C. Air entraining admixtures shall conform to ASTM C 260. High range water reducers shall conform to ASTM C 494, Type F or G and be either Rheobuild 1000 and 716 (manufactured by Master Builders), Daracem 100 (manufactured by W.R. Grace), Sikamet 320 (manufactured by Sika Corporation) or Eucon 37 (manufactured by Euclid Chemical Company).
- (5) Vapor Barriers: Vapor barrier where specified in the plans shall be polyethylene sheeting, minimum 6 mil thickness, conforming to ASTM C 171.
- (6) Curing and Sealing Compounds: Curing compound shall only be used where approved in writing by Owner. Curing compound shall be acrylic based, conforming to ASTM C 309. Sealing compound shall be either Masterseal 340 (manufactured by Master Builders), Sikaguard 70 (manufactured by Sika Corporation), or Super Rez Seal (manufactured by Euclid Chemical Corporation).

- (7) Floor Hardener: Floor hardener shall be a siliceous aggregate; Master Builders' "Mastercron Aggregate", Devoe Paint Division of Celanese Coatings Company's "Hurundum", or equal. Floor hardener shall be used where shown on the plans.
- (8) Non-Shrink Grout: Nonshrink grout shall contain only premeasured, prepackaged materials supplied by the manufacturer. Water to be used for mixing Portland cement manufactured grout shall be potable. The grout shall show no shrinkage (0.0%) and a maximum of 4.0% expansion at any time before initial set when tested according to ASTM C 827. The grout shall show no shrinkage (0.0%) and a maximum of 0.2% expansion on the hardened state. All nonshrink cement-based grout shall show a minimum 28-day compressive strength of 5,000 psi at standard laboratory temperatures when tested according to ASTM C 109. Grout shall be Five Star Grout as manufactured by U. S. Grout Corporation, Sikagrout 212 by Sika Corporation, or equal.
- (9) Expansion Joint Material or Filler: Expansion joint material shall be self expanding corkboard meeting ASTM D 1752.

**B. Concrete Materials:** Mixing shall be at a central plant unless prior approval is given by the Owner for mixing on the job site. The classes and use of concrete shall be as follows:

- (1) Class "A" Concrete: Class "A" concrete shall have a 28-day compressive strength of not less than 4,000 psi, and shall be used for reinforced concrete work, and for unreinforced footings, sidewalks, curbs, and driveways not thicker than 8-inches. The slump shall be between 3 and 5 inches. The maximum water to cement ratio will be 0.45. Concrete shall have an air content of between 4 and 7 percent.
- (2) Class "B" Concrete: Class "B" concrete shall have a 28-day compressive strength of not less than 3,000 psi, and shall be used for blocking, gravity type walls, and for unreinforced footings and slabs thicker than 8-inches. The slump shall be between 3 and 5 inches. The maximum water to cement ratio will be 0.56. Concrete shall have an air content of between 4 and 7 percent.
- (3) Class "C" Concrete: Class "C" Concrete shall have a 28-day compressive strength of not less than 1,500 psi, and shall be used for concrete subfoundations, pipe encasement, and concrete backfill where required.

**Implementation:**

- A. Mix Design:** Design mix for each classification of concrete to be used in the work shall be prepared and tested by the independent, commercial, testing laboratory selected by the Contractor and approved by the Engineer for the testing of materials. The design mix shall be prepared using samples of cement, slag cement, fly ash (if required), admixture, (if required), and the aggregates to be used in the work. Not fewer than four (4) cylinders shall be made from the design mix for each classification of concrete; two (2) shall be tested at 7 days, and two (2) shall be tested at 28 days. Cylinders shall be made and tested in accordance with ASTM C 31 and C 39. If an existing design mix that was recently prepared using the same source of proposed materials is demonstrated to conform to this Specification, the Engineer may approve its use in the work.
- B. Plant Mixing:** Mixing, if accomplished at a central mix plant, shall be accomplished by a plant which has had its layout, equipment, and trucks reviewed by the Engineer. Concrete shall be mixed (and transported to the job site) in accordance with the requirements of ASTM C 94, as amended to date. Loading tickets and batch mix tickets for Class "A" concrete shall

be initialed by the laboratory representative and shall bear the time of loading; tickets shall be handed to the inspector when the trucks arrive at the job site, and before load is discharged.

- C. Conveying:** Concrete shall be conveyed from mixer to place of final placement by methods which will prevent separation or loss of material. Runway supports shall not bear upon reinforcing steel or fresh concrete. All conveying equipment shall be thoroughly cleaned before each run of concrete is begun.
- D. Delivery and Protection of Materials:** Contractor shall deliver ready-mixed concrete in compliance with requirements of ASTM C 94.
- E. Inspection Prior to Placing:** Inspect the area to receive concrete for any deficiencies that would prevent proper placing of concrete. Do not proceed with placing until such deficiencies are corrected. The Owner shall be provided with 48 hours notice before any concrete is placed. Concrete formwork, reinforcing steel, embeds, inserts, mechanical, electrical and any other miscellaneous items required for the concrete pour shall be inspected by the Owner prior to placement. The forms shall be verified to be clean and the surfaces ready to receive concrete by the Owner.
- F. Placing Concrete:** Before concrete is placed, the depth and character of the foundations, the adequacy of forms and falsework, and the placing of steel and appurtenant work shall be inspected, and must be approved by the Owner; that approval, however, shall not relieve the Contractor from the responsibility to produce the finished work. Preparation for placing concrete, and the handling and placing of concrete, shall be as follows:
- (1) Preparation: Accumulated water and debris shall be removed from excavations, and from form work into which concrete is to be placed; flow of water into those places shall be diverted into side drains or sumps, and be removed without disturbing newly-placed concrete. Forms, unless lined, shall be thoroughly wetted with water before concrete is placed so as to tighten joints and prevent leakage of the mix. Runways for buggies and wheelbarrows, if used, shall not be supported by form work. Concrete shall be conveyed in a method which will not disturb forms.
  - (2) Placing in Daylight Hours: Concrete shall be placed in daylight; placing of concrete in a portion of the work shall not be started if that portion of the work cannot be completed during daylight, unless otherwise specifically approved by the Owner. That approval will not be given unless an adequate lighting system is provided, and that system is approved by the Owner.
  - (3) Placing in Cold Weather: Concrete shall not be placed when the atmospheric temperature is below 35 degrees Fahrenheit. If, after placing concrete, the atmospheric temperature becomes lower than 35 degrees Fahrenheit, the Contractor shall enclose, heat, and protect the concrete in a manner which will keep the air surrounding the fresh concrete at a temperature above 45 degrees Fahrenheit for a period of 5 days after concrete is placed. The Contractor shall assume all risk connected with the cool-weather placing and protecting of concrete and, should that concrete be unsatisfactory, it shall be rejected.
  - (4) Placing in Hot Weather: When the ambient temperature is 90 degrees Fahrenheit or above, special precautions shall be taken during mixing, placing, and curing. Concrete shall be protected in accordance with ACI 305R as modified in these Specifications. In no case should the temperature of the concrete, when placed, be above 90<sup>0</sup> F. When the ambient temperature is expected to exceed 100 degrees Fahrenheit, placement of concrete should not occur within 12 hours of the expected hot weather. When the ambient temperature exceeds 75 degrees Fahrenheit, forms and reinforcing steel shall be thoroughly wetted prior to placement of concrete.

Attention shall be given to coordinating the dispatching of trucks with the rate of placement to avoid delays in delivery. When elapsed time from batching to placement is so long as to result in significant increases in mixing water demand, or in slump loss, mixing in the trucks should be delayed until only sufficient time remains to accomplish mixing before the concrete is placed. On truck arrival at the job site, addition of water shall not be allowed other than that required to adjust to the specified slump. The forms and reinforcing should be cooled to a temperature of not more than 90<sup>0</sup> F by spraying with fog nozzles. Admixtures for retardation shall conform to ASTM C 494-71, Type B or Type D. The concrete shall be cured with water.

- (5) Time to Place: Centrally mixed concrete shall be discharged into forms within one hour of the time that water is added to the mixture. Contractor shall furnish delivery tickets for each load of concrete delivered under these Specifications. Delivery ticket shall indicate class and strength, size of coarse aggregate, water per cubic yard, slump, quantities of all admixtures, date and time of departure from batching plant and time of placement.
- (6) Transporting From Mixer: Concrete shall be transported from the mixer to the point of deposit by a pump, a crane-handled bottom-dump concrete bucket, with concrete buggies, or with wheelbarrows. In the event the quality of the concrete as it reaches the form, and the method and placing thereof, in the opinion of the Owner, is not satisfactory, the Contractor shall change his method of operation so as to place concrete in a manner suitable to the Owner.
- (7) Care In Placing: Concrete shall be placed in a manner which will prevent the possibility of segregating aggregates, displacing reinforcing, and coating and splattering the reinforcing steel which is in place. Troughs, pipes, hoppers, chutes, and canvas tremies shall be arranged and used in a manner which will ensure that the concrete is placed in the manner specified. The placing of concrete within form work shall be regulated in manner which will ensure that the pressure within the form work caused thereby shall not exceed the design pressure of the form work. Concrete shall be placed in continuous horizontal layers, the thickness of which, in general, shall not exceed 12 inches. When placing concrete, each batch and each layer shall be placed following the preceding batch or layer so closely that there will be no "cold joints" in the work. Care shall be used to fill each part of the forms; concrete shall be deposited to as near the final position as possible. After the concrete has taken its initial set, care should be used to avoid jarring the form work, and placing strain and vibration on the ends of projecting reinforcing bars. If concrete must be dropped more than five (5) feet, it shall be deposited through a tremie.
  - a. Compacting Concrete: Concrete, when placed, shall be compacted with mechanical, internal-vibrating equipment supplemented with hand-spading with a slicing rod. Vibrating shall not be used to transport concrete within forms. Vibrating equipment shall maintain an impulse rate of not less than 5,000 impulses per minute, when submerged in concrete. Not fewer than one (1) spare vibrator shall be maintained on the jobsite as a relief. The duration of vibration shall be limited to that time necessary to satisfactorily consolidate the concrete without causing objectionable segregation. The vibrator shall not be inserted into lower layers which have begun to set.
  - b. Thin Section Work: Thin section work shall be thoroughly worked with a steel rod; faces shall be shaped and mortar flushed to the surface of the form. Small diameter holes shall be drilled in form work beneath large wall

sleeves and inserts to prevent the entrapment of air beneath those sleeves and inserts when concrete is placed.

- (8) **Continuous Placement:** The placement of concrete within units of the work between construction joints, once begun, shall continue without interruption so that the unit will be monolithic in construction.
  - (9) **Dense Compact Structure:** Concrete shall be placed and compacted in a manner which will form a dense, compact, impervious structure having smooth faces on exposed surfaces. Sections of concrete work found to be porous, plastered, and otherwise defective, in the opinion of the Owner, shall be removed and replaced in-whole, or in part, as directed by the Owner, at no cost to the Owner.
- G. Testing:** Slump tests shall be made in accordance with ASTM C 143, air content shall be measured in accordance with ASTM C 173 or C 231, and test cylinders shall be made in accordance with ASTM C 31 all prior to placement of the concrete at the work site.
- (1) **Concrete Cylinders:** A representative of an independent testing lab shall be on site to make test cylinders for concrete, slump test, air entrainment, and concrete temperature, all of which shall be included on the report for the cylinder broken, along with the truck number and date of test. Concrete cylinders for testing purposes shall be made in accordance with the procedure described in ASTM C 31, as amended to date. Compression tests shall be made at the age of 7 days and 28 days by the testing laboratory in accordance with the procedure described in ASTM C 39, as amended to date, and as required by the Owner. After beginning work, the number of tests shall be not less than one for each type of concrete for each pour. Each test shall consist of at least 4 specimens; two (2) shall be for field control and two (2) for laboratory control. Slump tests of concrete shall be made in the field by the testing lab representative for each pour with an accurately made sheet iron test cone, and in accordance with the procedure described in ASTM C 143, as amended to date.
  - (2) Test reports shall show all data including exact pour location, ambient temperature, pour date and time, truck number, date cylinder was broken, age of cylinder, compressive strength of tested cylinder, slump test results, and air content. Provide one copy of the test results to the Contractor and one copy to the Owner.
  - (3) Samples for strength tests of each class of concrete placed shall be taken not less than once a day, nor less than once for each 100 cubic yards of concrete placed, nor less than once for each 5,000 square feet of surface area of slabs or walls.
  - (4) Each class of concrete shall be tested with at least five strength tests.
  - (5) For each set of cylinders, the average of tests of two cylinders at 28 days shall be considered one strength test under the definition of these Specifications. At the Owner or Contractor's option, one cylinder may be broken at 7 days as an aid in evaluating the concrete. The last cylinder will be held in reserve and tested and used in the average for the strength test if either of the two tests performed at 28-days are below the required 28-day strength of the concrete. The pour will be rejected if any of the compression tests are 500 psi less than the required compressive strength.
  - (6) Test for unit weight of the concrete when first load of each class of concrete is delivered and thereafter at the discretion of the Owner.

(7) The Contractor will maintain a temperature and placing record each day during concreting operations. The location, quantity, starting and stopping time and temperature shall be recorded for each concrete pour and submitted to the Owner.

**H. Protection:** Protect freshly placed concrete from damage or injury due to water, falling objects, persons or anything that may mar or injure finish surface on concrete. Only light use of slabs will be permitted for the first 14 days after placing of concrete.

**I. Curing:** Curing shall conform to ACI 308 except as modified in this specification. All finished slabs on grade shall be maintained in a moist condition for at least seven successive days when temperatures are 50 degrees Fahrenheit or above. When ambient temperatures fall below 50 degrees Fahrenheit, the curing period shall be extended to 14 days. Concrete shall be kept moist by any of the following methods or a combination of these methods:

- (1) Ponding or Immersion: Continually immerse concrete in water throughout the curing period. Water shall not be more than 20 degrees Fahrenheit less than temperature of concrete.
- (2) Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period.
- (3) Pervious Sheeting: Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6-inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.
- (4) Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting through the curing period. Lay sheeting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting as necessary. Inspect surface of concrete daily for wetness. Surface shall be kept continuously wet during the curing period.

**J. Patching:** As determined by the Owner, any concrete out of alignment or level or that has a defective surface or has defects which reduce structural capacity, shall be considered as not conforming to the Drawings and Specifications and shall be rejected at the Owner's discretion. No corrective action shall be taken on any concrete surface regardless of the defect without the permission of the Owner. Unless the Owner grants permission to patch defective concrete, remove and replace rejected concrete so that it conforms to the Drawings and Specifications. The location of the cut lines and the extent of removal will be specified by the Owner. If the Owner allows patching of defective concrete, it shall be done in accordance with the following:

- (1) Permission to patch rejected concrete shall not be a waiver of the Owner's right to request replacement of rejected concrete if the patching does not in the opinion of the Owner result in concrete meeting the requirements of the Drawings and Specifications.
- (2) Patching shall not be started until curing is complete.
- (3) Defective areas shall be cleaned out to a depth of at least 1-inch or to sound concrete whichever occurs first. Edges must be clean and perpendicular to the surface of the concrete. Feathered edges will not be permitted. The surface must be cleaned with

high pressure air delivered at a minimum of 100 psi. The area to be patched and an area of at least 12 inches around the patch will be dampened. A bonding grout shall be prepared using a mix of approximately one part cement to one part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surfaces.

- (4) The patching mixture shall be made of the same materials and of the same portions of cement and sand used for the original concrete, except that the coarse aggregate shall be omitted. The mortar shall consist of not more than one part cement to two and on-half parts sand by damp, loose volume. Mortar used in patches shall match surrounding concrete. Test patches will be necessary to confirm that the mortar matches. Only enough water to provide for handling and placing shall be used.
- (5) After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface, allowing for initial shrinkage. After approximately one hour finishing tools matching the surrounding concrete shall be used for final finishing. The patched area shall be kept damp for seven days.

**K. Finishing:** Once any required patching is complete, concrete shall be finished.

- (1) Smooth Form Finish shall be used on all concrete surfaces exposed to view in the completed work. Remove all burrs and form marks and smooth out lines of indentations.
- (2) Rough Form Finish shall be used on locations that will not be exposed to view and shall be produced by filling all tie holes and honeycomb and in other respects leaving the surface as formed. All concrete surfaces that will be covered by earth or compost and which shall not be visible in the completed structure, shall be finished with a rough form finish.
- (3) Steel Troweled Finish shall be applied to the surface of all slabs. Concrete shall be placed, consolidated, struck-off and leveled to the proper elevation and grade. After the surface has stiffened sufficiently to permit the operation and the water sheen has disappeared, the surface shall be wood or magnesium floated, by hand or power floated, at least twice, to a uniform sandy texture. Floors shall be leveled such that depressions between high spots do not exceed 1/4-inch under a 10 foot straightedge except where drains occur, in which case the floors shall be pitched to the drains as indicated on the drawings. After the concrete has received a wood float finish, it shall be troweled at least twice to a smooth dense finish. The drying of the surface moisture before floating or troweling shall not be hastened by treatment of the concrete with dry sand or cement. The first troweling shall be done by a power trowel and shall produce a smooth surface relatively free of defects. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by hand troweling operations. The finished surface shall be free of any trowel marks or other imperfections; shall be uniform in texture and appearance, and shall be in true plane within the tolerance specified. Any deviation from this condition which remains after the troweling is completed shall be corrected by grinding.
- (4) Broom Finish shall be applied to all exterior sidewalks, walkways, steps, landings and platforms. The surface shall be given a floated finish as specified above and then finished with a flexible bristle broom or burlap belt drawn across the surface.

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Surface must be hardened sufficiently to retain scoring or ridges. Scores or ridges shall be transverse to traffic or at right angles to the slope of the slab.

- (5) After finishing has been complete as detailed above, all concrete slabs, sidewalks, walkways, steps, and landings shall be treated with the appropriate curing and sealing compound as specified.

- L. Payment:** Payment for concrete work, making and testing of concrete cylinders, and placing concrete shall be paid for under the items to which it pertains.

**END OF SECTION**