

DIVISION 3 – CONCRETE
SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Cast-in-place concrete for foundations.
 2. Floors and slabs on grade.
 3. Control, expansion and contraction joint devices associated with concrete work, including joint sealants.
 4. Equipment pads and anchors, light pole bases, thrust blocks, manhole bases, pits and vaults.

1.02 REFERENCES

- A. American Concrete Institute (ACI)
1. ACI 301 – Structural Concrete for Buildings.
 2. ACI 302 – Guide for Concrete Floor and Slab Construction.
 3. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 4. ACI 305R – Hot Weather Concreting.
 5. ACI 306R – Cold Weather Concreting.
 6. ACI 308 – Standard Practice for Curing Concrete.
 7. ACI 318 – Building Code Requirements for Reinforced Concrete.
 8. ACI 350 – Concrete Sanitary The Authoritying Structures.
- B. American National Standards Institute
1. ANSI/ASTM D994 – Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 2. ANSI/ASTM D1190 – Concrete Joint Sealer, Hot-Poured Elastic Type.

3. ANSI/ASTM D1751 – Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
 4. ANSI/ASTM D1752 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- C. American Society for Testing and Materials
1. ASTM C33 – Concrete Aggregates.
 2. ASTM C94 – Ready-Mixed Concrete.
 3. ASTM C150 – Portland Cement.
 4. ASTM C260 – Air Entraining Admixtures for Concrete.
 5. ASTM C494 – Chemicals Admixtures for Concrete.

1.03 SUBMITTALS

- A. Submit in accordance with requirements of Section 01 33 00.
- B. Product Data: Submit manufacturer's product data with application and installation instructions for materials and items to be utilized.
- C. Mix Design: Submit mix design for each mix to be used. Design shall indicate admixtures proposed for use. Mix design shall be reviewed by the Authority prior to use.
- D. Samples: Submit samples of materials as requested by the Authority, including names, sources and descriptions.
- E. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design test as specified.
- F. Materials Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by the Authority. Material certificates shall be signed by supplier and Contractor certifying that each material item complies with, or exceeds, specified requirements.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301.
- B. Acquire aggregate from same source for all work.
- C. Conform to ACI 305R when concreting during hot weather.
- D. Conform to ACI 306R when concreting during cold weather.

- E. Use one brand of cement throughout project.
- F. Concrete Testing Service: Engage an independent testing laboratory acceptable to THE AUTHORITY to perform material evaluation tests and to design concrete mixes.

1.05 COORDINATION

- A. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.
- B. Contractor is solely responsible for coordination of the concrete pours with the items to be imbedded in the concrete.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I or Type II, Portland type. All wastewater structures shall be Type II, unless otherwise specified.
- B. Fine and Coarse Aggregates: ASTM C33. Do not use aggregate containing spalling causing deleterious substances.
- C. Water: Clean and not detrimental to concrete.

2.02 ADMIXTURES

- A. Use:
 - 1. In strict compliance with manufacturer's instructions, admixtures must be included in original concrete mix design reviewed by the Authority. No changes in mix design without prior approval of the Authority shall be permitted.
 - 2. Use of calcium chloride is prohibited.
- B. Air Entrainment:
 - 1. ASTM C 260, compatible with all other admixtures used.
 - 2. Use in exterior exposed concrete, additions in strict accordance with manufacturer's instructions for conditions anticipated for the concrete and aggregate size in mix.
- C. Water Reducing:
 - 1. ASTM C 494.

2. Type A – Use as required for placement and workability. Must contain less than 0.1% chloride ion.
3. Type F or Type G: Use in pumped concrete, architectural concrete, slabs in locations where chemicals are stored and concrete with water/cement ratios less than 0.5. Must contain less than 1% chloride ions.
4. Type E: Use in slabs placed at ambient temperatures below 50 degrees F. Must not contain any chloride ions.

2.03 ACCESSORIES

- A. Bonding Agent: Polyvinyl Acetate.
- B. Epoxy Adhesive: ASTM C881, Two component modified epoxy resin suitable for use on dry or damp surface.
- C. Non-Shrink Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.
- D. Moisture (Vapor) Barrier: Provide polyethylene sheet moisture barrier cover over prepared base material where indicated; minimum thickness 6 mils. Use only materials which are resistant to decay when tested in accordance with ASTM E 154.

2.04 JOINT DEVICES AND FILLER MATERIALS

- A. Joint Filler:
 1. ASTM D1751; Asphalt impregnated fiberboard or felt, ¼ inch thick; tongue and groove profile, exterior use only.
 2. ASTM D1752; Premolded sponge rubber fully compressible with recovery rate of minimum 95 percent.
- B. Construction Joint Devices: Integral galvanized steel; 3/8 inch thick, formed to tongue and groove profile, with removable top strip exposing sealant trough, knockout holes spaced at 6 inches, ribbed steel spikes with tongue to fit top screed edge.
- C. Expansion and Contraction Joint Devices: ASTM B221; resilient neoprene filler strip with a Shore A hardness of 35 to permit plus or minus 25 percent joint movement with full recovery; vinyl cover plate, of longest manufactured length at each location, recess mounted.
- D. Sealant: ASTM C309, acrylic copolymer, high solids curing and sealing compound.

2.05 CONCRETE MIX

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method is used, use an independent testing facility acceptable to the Authority for preparing and reporting proposed mix designs. Determine standard deviation and required average compressive strength for each class of concrete to be utilized and provide supporting documentation that mix designs meet the indicated criteria.
- B. Submit written reports to the Authority of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by the Authority.
- C. Design Mixes: Provide normal weight concrete with the following properties, as indicated on applicable details:
 - 1. 5,000 psi 28-day compressive strength. (Type II Cement).
 - 2. 4,000 psi 28-day compressive strength. (Type II Cement).
 - 3. 3,000 psi 28-day compressive strength. (Type II Cement).
- D. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
 - 1. Reinforced foundation systems and treatment tanks – Not less than 1 inch or more than 4 inches.
 - 2. Concrete with high range water reducing admixtures – Not more than 8 inches.
 - 3. Ramps and sloping surfaces – Not more than 4 inches.
 - 4. Slabs and floors - Not less than 1 inch and not more than 3 inches.
 - 5. Miscellaneous Concrete – Not less than 1 inch and not more than 4 inches.
- E. Water-Cement Ratio: The maximum permissible water-cement ratio will be as follows:
 - 1. 5,000 psi concrete – maximum water/cement = 0.40
 - 2. 4,000 psi concrete – maximum water/cement = 0.45
 - 3. 3,000 psi concrete – maximum water/cement = 0.50
- F. Minimum Cement Content: The minimum cement content utilized for the concrete mix design shall be as follows:
 - 1. 5,000 psi concrete – 715 pounds per cubic yard.
 - 2. 4,000 psi concrete – 611 pounds per cubic yard.

3. 3,000 psi concrete – 564 pounds per cubic yard.

- G. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Changes in mix design must have prior approval of the Authority and be at no additional cost to the Authority. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Authority before use in the Work.

- H. Use accelerating admixtures in cold weather only when approved by the Authority. Use of admixtures will not relax cold weather placement requirements.

- I. Use set retarding admixtures during hot weather only when approved by the Authority.

- J. Add air entraining agent to normal weight concrete mix for work exposed to exterior. Design the mix to have air content of 6 ± 1.5 percent.

2.06 READY MIX CONCRETE

- A. Comply with requirements of ASTM C94, with the following exceptions:
 1. Water can be added to batch for material with insufficient slump only with agreement of the Authority. The Contractor is solely responsible for amount of water added and resulting strength of concrete. If concrete strength does not conform to 28 day compressive strength requirements, it shall be removed and replaced at no cost to the Authority.
 2. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified by ASTM C94 may be required.
 3. When air temperature is between 85° F and 90°F, reduce mixing and delivery time from 90 to 75 minutes, and when air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that subsurface and field conditions are acceptable and ready to receive work.

- B. Verify requirements for concrete cover over reinforcement.

- C. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.02 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
- B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- C. Notify the Authority a minimum of 24 hours prior to commencement of each significant pour. The Authority shall define "significant pour" based on the Contractor's work plan.
- D. Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other trades to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
- E. Install vapor barrier under interior slabs on grade. Lap joints minimum 6 inches and seal watertight by sealant applied between overlapping edges and ends.
- F. Repair vapor barrier damaged during placement of concrete reinforcing. Repair with vapor barrier materials; lap over damaged areas minimum 6 inches and seal watertight.
- G. Separate slabs on grade from vertical surfaces with isolation joint material.
- H. Place joint filler in floor slab pattern. Set top to required elevations. Secure to resist movement by wet concrete.
- I. Extend joint filler from bottom of slab to within ¼ inch of finished slab surface.
- J. Install joint devices in accordance with manufacturer's instructions.
- K. Install construction joint devices in coordination with floor slab pattern. Set top to required elevations. Secure to resist movement by wet concrete.
- L. Install joint device anchors. Maintain correct position to allow joint cover to be flush with finished surfaces.
- M. Install joint covers in longest practical length, when adjacent construction activity is complete.

3.03 JOINTS

- A. Construction Joints:
 - 1. Locate and install to not impair strength and appearance of structure. Locations to be reviewed by the Authority.
 - 2. Place perpendicular to main reinforcement. Continue reinforcement across construction joints.
- B. Isolation Joints (Slabs on Grade):

1. Construct isolation joints in slabs on grade as indicated on Drawings and at points of contact between slab and vertical surfaces, such as foundation walls, column pedestals, and grade beams.
- C. Contraction (Control) Joints (Slabs on Grade):
1. Location: Construct joints to form panel of patterns. Use inserts $\frac{1}{4}$ inch wide by $\frac{1}{4}$ of slab depth unless otherwise indicated.
 2. Form joints by inserting a premolded hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured, remove inserts and clean groove of loose debris.
 3. With the Authority's written approval, contraction joints may be formed by saw cuts within 24 hours after slab finishing. Do not dislodge aggregate. Use $\frac{3}{16}$ inch blade, cut $\frac{1}{4}$ depth of slab thickness.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301, ACI 304, ACI 305, ACI 306 and ACI 318.
- B. Ensure reinforcement, inserts, embedded parts, and formed expansion and contraction joints are not disturbed during concrete placement.
- C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken for each structural pour.
- D. Place concrete continuously between predetermined expansion, control, and construction joints.
- E. Do not interrupt successive placement; do not permit cold joints to occur.
- F. Maintain concrete at joints in walls continuously wet for 12 hours prior to pour. Place minimum 3 inches of grout above joint.
- G. Concrete Placement in Forms:
 1. Deposit concrete into forms continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.
 2. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

3. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.
4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

H. Concrete Placement in Slabs:

1. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
4. Provide surface within ¼ inch in 10 feet in any direction.
5. Place floor slabs in pattern.

I. Cold Weather Placement:

1. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as specified.
2. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat water and aggregate before mixing to obtain a concrete mixture temperature of not less than 50°F and not more than 80°F at point of placement.
3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
4. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless chemical accelerators were accepted in mix designs.

J. Hot Weather Placement:

1. When hot weather conditions exist that would impair quality and strength of concrete, place concrete in compliance with ACI 305 and as specified.

2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing.
 3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete
- K. Special Testing:
1. If the Authority determines that any concrete placement has not been completed in accordance with ACI and these specifications, the Contractor shall be responsible for testing to verify compressive strength and other characteristics of the concrete.

3.05 CONCRETE FINISHING

- A. Provide all formed concrete surfaces to be left exposed to view with smooth rubbed finish. Rub surfaces within 24 hours of form removal. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout.
- B. Provide all formed concrete surfaces not left exposed to view, including interior tank walls from 1 foot below normal water level, with a form finish. Form finish is texture imparted by form facing materials with tie holes and defective areas repaired and patched, and fins and other projections exceeding ¼ inch rubbed down or chipped off and repaired.
- C. At tops of walls, horizontal offsets and surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent uniformed surfaces, unless otherwise indicated or directed by the Authority.
- D. Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated.
 1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units.
 2. Check and level surface plane to a tolerance not exceeding ¼ inch in 10 feet. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
- E. Apply trowel finish to all monolithic slab surfaces. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a

ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8 inch in 10 feet.

- F. Apply non-slip broom finish to exterior concrete platforms, steps and ramps, and elsewhere as indicated. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with the Authority before application.
- G. Finish concrete floor surfaces not receiving other surface finish materials in accordance with ACI 301.
- H. Wood float surfaces which will receive quarry tile with full bed setting system.
- I. Steel trowel surfaces which will receive resilient flooring.
- J. Steel trowel surfaces which are scheduled to be exposed, except those to receive broom finish.
- K. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1/8 inch per foot.

3.06 PROTECTION AND CURING

- A. Protection:
 - 1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
 - 2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3.07 FIELD QUALITY CONTROL

- A. Field testing to be performed in accordance with ACI 301.
- B. Tests of cement and aggregates may be requested by the Authority to ensure conformance with specified requirements.
- C. Fresh concrete sampling shall be in accordance with ASTM C172, with the exception of slump test which shall comply with ASTM C94.
 - 1. Slump: ASTM C143; one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.
 - 2. Air Content: ASTM C173, volumetric method for normal weight concrete; ASTM C231 pressure method for normal weight concrete; one test for each set of compressive strength test specimens.

3. Concrete Temperature: Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens made.
 4. Compressive Test Specimen: ASTM C31; one set of 6 standard cylinders for each compressive strength test, unless otherwise directed by THE AUTHORITY. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
 5. Compressive Strength Tests:
 - a. ASTM C39; one set for each 100 cu. yds. or fraction thereof, of each concrete class placed in any one day or for each 5,000 sq. ft. of surface area placed; 2 specimens tested at 7 days, 3 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 - b. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 6. When total quantity of a given class of concrete is less than 50 cu. yds., strength test may be waived by the Authority if, in its judgement, adequate evidence of satisfactory strength is provided.
 7. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 8. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
 9. If required by the Authority, one additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.
- D. Field test results will be reported in writing to the Authority and the Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- E. Independent testing laboratory will make additional tests as directed by the Authority of in place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure. Independent testing laboratory may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods acceptable to the Authority. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.
- F. Concrete Basin Testing:

1. The Contractor is required to provide impermeable, watertight concrete and joints in structures and divider walls designed to hold water or other solution.
2. Should honeycomb, cracks and/or such imperfections develop in such structures, they shall be fully and completely repaired at the Contractor's expense in a manner satisfactory to the Authority as soon as possible after they are discovered.
3. Concrete work or joints with such imperfections which, in the opinion of the Authority, cannot be successfully repaired shall be removed and replaced with satisfactory work at Contractor's expense.
4. When the concrete work in structures and divider walls designed to hold water or other solutions has attained sufficient strength and all visible honeycomb, cracks or other such imperfections have been repaired, the Contractor shall fill each basin, tank, or compartment with water to within one (1) ft of the top of the structure. If the water level in the basin, tank or compartment being tested falls more than ½ inch in 24 hours, the cause of the leakage shall be determined and repaired and the basin retested.
5. All visible leaks shall also be repaired even though the test for watertightness has been met.
6. All repair work required as a result of the tests for watertightness shall be the Contractor's expense.

3.08 PATCHING

- A. Allow the Authority to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify the Authority upon discovery.
- C. Patch imperfections in accordance with ACI 301 to the satisfaction of the Authority.

3.09 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the Authority.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon direction of the Authority for each discrete area.

3.10 FLOTATION PROTECTION

- A. The Contractor shall be solely responsible for the protection of any new concrete structures against flotation due to high groundwater conditions encountered during construction.
- B. The Contractor shall be responsible to undertake any additional work needed, to include pressure release valves, placement of additional concrete, backfilling and/or dewatering operations to assure flotation does not occur during the construction period at no cost to the Authority.
- C. If flotation does occur, the damaged concrete shall be removed and replaced to the satisfaction of the Authority at the Contractor's expense.

3.11 SCHEDULE

- A. Concrete cradles, encasements, and thrust blocks: 3,000 psi 28-day compressive strength.
- B. Strip footings for building foundations; foundations for stairs, bollards and other miscellaneous work: 3,000 psi 28-day compressive strength.

END OF SECTION