

SECTION 32 13 13.01
CONCRETE (Plain and Reinforced Cement Concrete)

PART 1 GENERAL**1.1 DESCRIPTION**

- A. The work of this section includes, but is not limited to:
1. Construction of cast-in-place plain and reinforced cement concrete structures
 2. Concrete curbs and sidewalks
 3. Trench restoration of concrete roadways and driveways.
 4. Testing of cast-in-place concrete for curbs, sidewalks and utility related structures
- B. Related Work Specified Elsewhere:
1. Concrete (Cement concrete curb and sidewalk): Section 32 13 13.00
 2. Concrete (Trench Paving and Restoration): Section 32 13 13.02
 3. Concrete (Cement concrete for utility construction): Section 32 13 13.03
- C. Definitions:
1. Exposed construction - Permanently exposed to view.
 2. Concrete - Normal weight concrete for which density is not a controlling attribute, made with aggregates of the types covered by ASTM C33, and having unit weights in the range of 135 to 160 lb. per cubic foot.
 3. f'c - The design compressive strength of the hardened concrete at an age of 28-days.
- D. Applicable Standard Details: NONE
- E. Work shall conform to all requirements of ACI 301-05, published by the American Concrete Institute, Farmington Hill, Michigan, except as modified by these Contract Documents.

1.2 QUALITY ASSURANCE

- A. Reference Standards:
1. American Concrete Institute (ACI):

ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete.
ACI 315	Details and Detailing of Concrete Reinforcement.
ACI 318	Building Code Requirements for Structural Concrete.
 2. American Society for Testing and Materials (ASTM):

A185	Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
A615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C33	Standard Specification for Concrete Aggregates
C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C94	Standard Specification for Ready-Mixed Concrete
C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
C150	Standard Specification for Portland Cement
C171	Standard Specification for Sheet Materials for Curing Concrete

- C172 Standard Practice for Sampling Freshly Mixed Concrete
 - C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
 - C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - C260 Standard Specification for Air-Entraining Admixtures for Concrete
 - C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - C494 Standard Specification for Chemical Admixtures for Concrete
 - D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³)
 - D994 Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
 - D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
 - D1752 Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
 - E329 Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
3. National Ready-Mixed Concrete Association, 900 Spring Street, Silver Spring, MD 20910: Check list for certification of ready-mixed concrete production facilities.
- B. Testing Agencies:
1. Testing services shall be performed by an independent testing agency acceptable to the ENGINEER at the CONTRACTORS's expense.
 2. All testing agencies shall meet the requirements of ASTM E329.

1.3 SUBMITTALS

- A. Submit manufacturer's or supplier's certification for the following materials verifying compliance with these Specifications:
1. Portland cement
 2. Coarse and fine aggregates
 3. Any specified concrete admixtures
 4. Reinforcing steel
 5. Joint forming and filling materials
 6. Form coating materials
 7. Concrete curing compounds
- B. Submit concrete mix designs, including strength test records, for review and approval.
- C. Submit certified results of compressive strength cylinder tests.
- D. Submit copies of concrete batch slips.

PART 2 PRODUCTS

2.1 CONCRETE

- A. Cement - Unless otherwise specified, Portland cement shall be Type I cement conforming to ASTM C150.

- B. Aggregates - Aggregates for normal weight concrete shall meet the requirements of ASTM C33.
- C. Water - Mixing water for concrete shall be clean, potable water meeting the requirements of ASTM C94.
- D. Admixtures - Concrete admixtures, when required and/or approved for use by the ENGINEER, shall conform to the following Specifications:
 - 1. Air-entraining admixtures - ASTM C260.
 - 2. Water-reducing, retarding and accelerating admixtures - ASTM C494.

2.2 REINFORCEMENT

- A. Reinforcing Bars - All reinforcing bars shall be deformed, except spirals, which may be plain bars. Reinforcing bars shall be Grade 60, plain carbon-steel conforming to the requirements of ASTM A615, including supplementary requirements on Contract Drawings.
- B. Welded Wire Reinforcement - Welded wire reinforcement shall be fabricated from smooth or deformed wire of the size and spacing required on the Contract Drawings and shall conform to the requirements of ASTM A185, except welded intersections shall be spaced not farther apart than 12 inches in the direction of the principal reinforcement.

PART 3 EXECUTION

3.1 PROPORTIONING

- A. General - Concrete for all parts of the work shall be of the specified quality and capable of being placed without excessive segregation. When hardened, concrete shall develop all characteristics required by these Specifications and the Contract Documents.
- B. Strength - Unless otherwise specified, the minimum 28-day compressive strength of the concrete, f'c, shall be 3000 psi.
- C. Durability - All concrete which will be subjected to potentially destructive exposure, including freezing and thawing, weather, and/or deicer chemicals, shall be air-entrained and shall conform to the air content limits in ACI 301 moderate exposure.

3.2 REINFORCEMENT

- A. Welding - Welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.
- B. Fabricate and place all reinforcing in accordance with ACI 117.

3.3 EMBEDDED ITEMS

- A. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.
- B. All CONTRACTORS whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.
- C. Placing Embedded Items - Expansion joint material, water stops, and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

3.4 PRODUCTION OF CONCRETE

- A. Production Method - All concrete shall be ready-mixed concrete, batched, mixed and transported in accordance with ASTM C94. Plant equipment and facilities shall conform to "Certification of Ready-

Mixed Concrete Production Facilities (Checklist with Instructions)" of the National Ready-Mixed Concrete Association.

- B. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Discharge of the concrete shall be completed within 1-1/2 hours, or before the truck drum has revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. Truck batch slips must include time of batching, total drum revolutions upon arrival at site, and quantity of water (in gallons) per cubic yard available to be added to attain the maximum design water-cement ratio.

3.5 PLACING

- A. Preparation Before Placing:
1. Hardened concrete and foreign materials shall be removed from the inner surfaces of the conveying equipment.
 2. Formwork shall be completed; snow, ice and water shall be removed; reinforcement shall be secured in place; expansion joint material, anchors, and other embedded items shall be positioned; and the entire preparation shall be accepted.
 3. Concrete shall not be placed on frozen ground.
- B. Conveying:
1. Concrete shall be handled from the mixer to the place of final deposit, as rapidly as practicable, by methods which will prevent segregation or loss of ingredients and in a manner which will assure that the required quality of the concrete is maintained. Do not use aluminum pipes or chutes.
 2. Conveying equipment shall be of a size and design such that detectable settling of concrete shall not occur before adjacent concrete is placed. Conveying equipment shall be cleaned at the end of each operation or work day.
 - a. Truck mixers, agitators and non-agitating units and their manner of operation shall conform to the applicable requirements of ASTM C94.
 - b. Belt conveyors shall be horizontal or at a slope which will not cause excessive segregation or loss of ingredients. Concrete shall be protected against undue drying or rise in temperature. An acceptable arrangement shall be used at the discharge end to prevent segregation. Mortar shall not be allowed to adhere to the return length of the belt. Long runs shall be discharged into a hopper or through a baffle.
 - c. Chutes shall be metal or metal-lined and shall have a slope not exceeding 1' vertical to 2' horizontal and not less than 1' vertical to 3' horizontal. Chutes more than 20 ft. long and chutes not meeting the slope requirements may be used provided they discharge into a hopper before distribution.
 - d. Pumping or pneumatic conveying equipment shall be capable of pumping the specified mix with adequate pumping capacity. Pneumatic placement shall be controlled so that segregation is not apparent in the discharged concrete. The loss of slump in pumping or pneumatic conveying equipment shall not exceed 2 in. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy.

C. Depositing:

1. General - Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as indicated on the Contract Drawings. Placing shall be carried on at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened or has been contaminated by foreign materials shall not be deposited.
2. Segregation - Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to any procedure which will cause segregation.
3. Consolidation - All concrete shall be consolidated by vibration so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honey-combing, pitting, or planes of weakness. Internal vibrators used shall be the largest size and the most powerful that can be properly used in the work. They shall be operated by competent workmen. Use of vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at points approximately 18 in. apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not sufficient to cause segregation, generally from 5 to 15 seconds. A spare vibrator shall be kept on the job site during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented if necessary by spading to work the coarse aggregate back from the formed surface.

D. Protection:

1. Unless adequate protection is provided, concrete shall not be placed during rain, sleet or snow.
2. Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.
3. The temperature of the concrete, as placed, shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 90°F. When the temperature of the steel is greater than 120°F, steel forms and reinforcement shall be sprayed with water just prior to placing the concrete.

3.6 FINISHING OF FORMED SURFACES

- A. If the finish is not designated on the Contract Drawings, the following finishes shall be used as applicable:
1. Rough form finish - For all concrete surfaces not permanently exposed. Tie holes and defects shall be patched and fins over 1/4" in heights rubbed off.
 2. Smooth rubbed finish - For all concrete surfaces permanently exposed. Apply on newly hardened concrete within one day following form removal. Surfaces shall be wetted and rubbed until uniform color and texture are produced.

3.7 SLABS

- A. General - Concrete for slabs shall be as specified in Paragraph 3.01.
- B. Preparation of Subgrade for Slabs on Ground:
 - 1. The subgrade shall be well drained and of adequate and uniform load-bearing capacity. The minimum in-place density of the subgrade soils shall be not less than 95% of its maximum dry weight density at its optimum moisture content, plus or minus 2%, as determined by ASTM D698.
 - 2. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing, it shall be raised and maintained above 50°F long enough to remove all frost from the subgrade.
 - 3. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall not be standing water on the sub-grade nor any muddy or soft spots when the concrete is placed.
- C. Finishes
 - 1. Floated finish - After the concrete has been placed, consolidated, struck off, and leveled, the concrete shall not be worked further until ready for floating. Floating with a hand float or with a bladed power trowel equipped with float shoes, or with a powered disc float shall begin when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after the first floating, planeness of surface shall be checked with a 10-ft. straightedge applied at not less than two different angles. All high spots shall be cut down and all low spots filled and the slab shall then be refloated immediately to a uniform sandy texture.
 - 2. Broom or belt finish - Immediately after the concrete has received a float finish, it shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface.
 - 3. Unspecified Finish - When type of finish is not specified on the Contract Drawings, use broom finish.

3.8 CURING AND PROTECTION

- A. General - Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete.
- B. Preservation of Moisture:
 - 1. For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing:
 - a. Application of acceptable moisture-retaining covering as approved by the ENGINEER.
 - b. Application of a curing compound conforming to ASTM C309 - The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be bonded unless it is proven that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.
 - 2. Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured.

3. Curing shall be continued for at least 7 days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the strength, f'c. Moisture retention measures may also be terminated when the temperature of the concrete is maintained at least at 50°F for the same length of time that laboratory-cured cylinders, representative of the concrete in-place, require to achieve 85 percent of f'c.
- C. Temperature, Wind, and Humidity:
 1. Cold weather - When the mean daily outdoor temperature is less than 40°F, the temperature of the concrete shall be maintained between 50° and 70°F for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hrs. unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.
 2. Hot weather - When necessary, provisions for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.
 3. Rate of temperature change - Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5°F in any 1-hr. or 50°F in any 24-hr. period.
- D. Protection from mechanical injury - During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials or methods, by application of curing procedures, and by rain or running water.

3.9 TESTING

- A. General - Concrete materials and operations will be tested and inspected as the work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the ENGINEER for final acceptance.
- B. Testing Services - The following testing services shall be performed by the designated testing agency.
 1. Conduct strength tests of the concrete during construction, in accordance with the following procedures:
 - a. Secure composite samples, in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement.
 - b. Mold and cure four (4) specimens from each sample, in accordance with ASTM C31. Any deviations from the requirements of this Standard shall be recorded in the test report.
 - c. Test specimens in accordance with ASTM C39. Two specimens shall be tested at 28-days for acceptance and two shall be tested at 7-days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test

- result. Should both specimens in a test show any of the above defects, the entire test shall be discarded.
- d. Make at least one strength test for each 50 cu. yd., or fraction thereof, of each mixture design of concrete placed in any 1 day.
 2. Determine slump of the concrete sample for each strength test and whenever consistency of concrete appears to vary, using ASTM C143.
 3. Determine air content of the concrete sample for each strength test, in accordance with either ASTM C231, ASTM C173, or ASTM C138.
 4. Determine temperature of the concrete sample for each strength test.
- C. Additional Services When Required - The following services shall be performed by the testing agency, when required by the ENGINEER, at the CONTRACTOR's expense:
1. Inspect concrete batching, mixing and delivery operations to the extent deemed necessary by the ENGINEER.
 2. Sample concrete at point of placement and perform required tests.
 3. Review the manufacturer's report for each shipment of cement and reinforcing steel and conduct laboratory tests or spot checks of the materials, as received, for compliance with specifications.
 4. Mold four specimens from each sample (in addition to those required in Section 32 13 13.01, Paragraph 3.09.B.1.b), in accordance with ASTM C31 and field cure in or on the structure providing the same method of cure for the specimens as that which the structure receives.
- D. Other Services As Needed - The following services shall be performed by the testing agency at the CONTRACTOR's expense:
1. Additional testing and inspection required because of changes in materials or proportions requested by the CONTRACTOR.
 2. Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements.
- E. Duties and Authorities of Designated Testing Agency:
1. Representatives of the agency shall inspect, sample and test the materials and the production of concrete, as required by the ENGINEER. When it appears that any material furnished or work performed by the CONTRACTOR fails to fulfill specification requirements, the testing agency shall report such deficiency to the ENGINEER and the CONTRACTOR.
 2. The agency shall report all test and inspection results to the ENGINEER and CONTRACTOR immediately after they are performed. All test reports shall include the exact location in the work at which the batch represented by a test was deposited. Reports of strength tests shall include detailed information on storage and curing of specimens prior to testing.
 3. The testing agency and its representatives are not authorized to revoke, alter, relax, enlarge or release any requirement of the Contract Documents, nor to approve or accept any portion of the work.
- F. Responsibilities and Duties of CONTRACTOR:
1. The CONTRACTOR shall provide the necessary testing services for the following:
 - a. Qualification of proposed materials and the establishment of mixture designs.
 - b. Other testing services needed or required by the CONTRACTOR.
 2. The use of testing services shall in no way relieve the CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
 3. The CONTRACTOR shall submit to the ENGINEER the concrete materials and the concrete mix designs proposed for use with a written request for acceptance. This submittal shall include the

results of all testing performed to qualify the materials and to establish the mix designs. No concrete shall be placed in the work until the CONTRACTOR has received such acceptance in writing.

4. To facilitate testing and inspection, the CONTRACTOR shall:
 - a. Furnish any necessary labor to assist the testing agency in obtaining and handling samples at the project or other sources of materials.
 - b. Advise the testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.
 - c. Provide and maintain for the sole use of the testing agency adequate facilities for safe storage and proper curing of concrete test specimens on the project site for the first 24-hrs. as required by ASTM C31.

END OF SECTION