

## SECTION 0301

### PORTLAND CEMENT CONCRETE

#### 0301.0100 GENERAL

**0301.0101 Description of Work.** Except as otherwise noted in the special specifications, concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce a plastic, workable mixture in accordance with all requirements of these specifications and suitable to the specific conditions of placement.

Concrete called for in this section shall be for: footings, pipe supports, filling over excavations, floor slabs, pump supports, well heads, walkways, thrust blocks, conduit encasement or as noted on the plans. Plans requiring specialty concrete will be addressed in the special specifications.

The contractor shall furnish concrete which conforms to the requirements of these specifications without harmful segregation, bleeding, or incomplete consolidation. The Portland cement concrete shall have proportioning of fine and coarse aggregates such as to not produce harshness in placing nor honeycombing in the structure.

#### 0301.0200 PRODUCTS

##### 0301.0201 Materials.

**(A) Portland Cement.** Portland or Portland-pozzolan cements are the two allowed materials in this section. Portland cement shall conform to the requirements of ASTM C 150 for type II or type III. Portland-pozzolan cement shall conform to the requirements of ASTM C 595 for Type (MS).

Cement provided shall not contain more than 0.60 percent total alkali. The word alkali as used in these specifications shall be taken as the sum of sodium oxide and potassium oxide calculated as sodium oxide.

For Class C concrete only, on site mixing and proportioning will be allowed. The concrete materials shall be delivered, stored, and handled to prevent damage to the materials and the inclusion of foreign substances. Packaged materials shall be delivered and stored in original containers until ready for use. Material containers or materials showing evidence of water or other damage shall be rejected. The use of either sacked cement or bulk cement is permissible. The use of fractional bags of sacked cement shall not be permitted unless the contractor elects to weigh the cement into each batch.

**(B) Water.** Clean potable water shall be used the mixing container shall be free from oil, acid, alkali, clay, vegetable matter, silt or other harmful matter.

##### **(C) Aggregates.**

**(1) Fine Aggregate.** Fine aggregate shall be natural sand or other approved inert material with similar characteristics composed of clean, hard, strong, durable, uncoated particles. Fine aggregate shall be free from deleterious amounts of soft or flaky particles, loam, caliche, ice, frost, organic matter or clay lumps.

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The size distribution grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201:

<u>Sieve Size</u>	<u>% Passing all classes</u>
3/8 inch	100
No. 4	95-100
No. 16	45-80
No. 50	0-30
No. 100	0-10
No. 200	0-4

Fine aggregate shall have an average sand equivalent value of not less than 75 when tested in accordance with the requirements of AASHTO T 176.

**(2) Coarse Aggregate.** Coarse aggregate shall consist of crushed stone, gravel, or other approved inert material of similar characteristics, free of clay and other deleterious substances. The aggregate shall be washed.

The coarse aggregate gradation shall conform to the appropriate size designation of AASHTO M 43 when tested in accordance with the requirements of Arizona Test Method 201, Section 12 (3), except the amount of material passing the 200 sieve shall not exceed 1.0 percent.

### **(D) Admixtures.**

**(1) General.** All materials other than the cement, water, and aggregates that are added just before or during mixing are to be considered admixtures. The admixtures will improve the concrete workability, accelerate its set, harden its surface, and increase its waterproof qualities. Admixtures containing chlorides are not acceptable. Admixtures shall be used in accordance with the manufacturer's recommendations and shall be added separately to the concrete mix. Admixtures of any type are not to be used unless written authorization has been obtained from the Engineer or unless called for in the special specifications.

### **0301.0300 EXECUTION**

**0301.0301 Design Criteria.** Portland cement concrete shall conform to the requirements specified in Table 0301-1 for each of the classes listed therein. Concrete classes shall be of three classes, herein referred to as Classes A, B, and C. These classes of concrete shall have a minimum weight of 140 pounds per cubic foot. Concrete shall be provided by class for the corresponding use listed in the following table:

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**Table 0301-1**

<u>Type of Use</u>	<u>Class of Concrete</u>
As specified on the plans	A (3,500 psi)
Footings, Pipe Supports, Pump base, Sidewalk replacement, F.H. blocking, Walkways or as noted on the Plans	B (3,000 psi)
Unauthorized excavations, thrust blocks, footings less than 1/3 cu. yd. in volume and supporting less than 100 lbs dead load.	C (2,500 psi)

In no case shall concrete be placed which shows a slump outside the limits indicated in the table below. Classes A, B, and C concrete shall be made with Type II low alkali cement.

The coarse aggregate size designation for Class A and Class B concrete shall be chosen by the contractor and approved by the Engineer and shall conform to the size designation, the maximum size of coarse aggregate shall not be larger than 1/5 of the narrowest dimension between sides of adjacent forms, or 2/3 of the minimum clear spacing between reinforcing bars, or 1/3 the depth of the slab, whichever is least.

**0301.0302 Design Procedures.** At least two weeks prior to the appropriate concreting operation, the contractor shall furnish to the Engineer a mix design for each class of concrete for review and approval. Class C concrete does not require mix design approval. More than one mix design for each class of concrete may be submitted for approval provided specific items and locations of intended uses accompany the mix design. The contractor shall substantiate each mix design by furnishing test data and providing all details of the mixtures proposed for use. Mix designs from previous or concurrent projects may be submitted for approval.

The complete, solid volume mix designs, submitted for approval, shall include all weights and volumes of all ingredients. The brand, type, and source of cement and admixtures, the coarse aggregate size number designation, source of aggregates, the specific gravities of all ingredients, the proposed slump, code number to identify the mix design, and the intended use of each mix design shall be an integral part of each mix design.

<b>Table A</b>				
<b>CONCRETE WITH AIR ENTRAINMENT</b>				
Class	Compressive Strength at 28-days (psi)	Max. Net Water to Cement Ratio by Wt.	Min. Cement Per Yard of Concrete (Pounds)	Consistency Range in Slump (inches)
A	3,500	0.53	564	2 to 4**
B	3,000	0.53	500	2 to 4**
C	2,500	0.71	423	3 to 6

\*\* NOTE: Slump for slabs, decks, walks, and beams shall be not more than 3-1/2 inches.

In no case shall concrete be placed which shows a slump outside the limits indicated in the table.

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No changes in the approved mix designs or code numbers shall be made by the contractor except with the approval of the Engineer. A new mix design shall be submitted for approval any time the contractor requests a change in each approved mix design. In no case shall the approval of a mix design relieve the contractor of the responsibility for the results obtained by the use of such approved mix design.

### **0301.0303 Concrete Production.**

**(A) General.** For Class A and Class B concrete, the contractor shall furnish an invoice for each batch of concrete. The minimum information to be shown on each invoice shall be the batch weights or mix design code number, date, time batched, truck identification or number, name and location of the project, and the volume of concrete. An authorized representative of the contractor shall be responsible for each invoice and shall sign each invoice accepting the contractor's responsibility for the concrete as the concrete is being placed. He shall furnish the invoice to the Engineer's representative at the time of placement.

#### **(B) Mixing.**

**(1) General.** All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement. Class A and Class B concrete are to be batched at a central plant and mixed by truck en-route to the job destination. Class C concrete will be allowed to either be mixed on-site by a mobile mixer or trucked to the site similar to Class A and Class B.

**(2) Mixing in Truck Mixers.** Classes of concrete requiring mixing in trucks shall complete discharge from the truck within 90 minutes from the time batched. Any additional mixing water and required mixing revolutions shall be documented on the batching invoice prior to placement.

**(3) Mixing in Mobile Mixers.** Concrete mixing in mobile mixers shall only be allowed for class C concrete and in accordance with the requirements of AASHTO M 241.

#### **(C) Weather Limitations.**

**(1) General.** Under rainy conditions, placing of concrete shall be stopped before the quantity of surface water is sufficient to cause a flow or wash of the concrete surface or have a detrimental effect on the finished concrete and acceptance parameters.

The contractor shall provide adequate insulation or heat, or both, to protect the concrete after placement. This protection shall be to the extent required to maintain a concrete surface temperature above 50 degrees F for a period of three days.

**(2) Hot weather Concreting.** The temperature of the concrete mixture immediately before placement shall not exceed 90 degrees F. Forms, subgrade, and reinforcing steel shall be sprinkled with cool water just prior to placement of concrete when the ambient air temperature exceeds 90 degrees F.

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**(3) Cold Weather Concreting.** The temperature of the mixed concrete immediately before placing shall not be less than 50 degrees F. Concrete operations shall be discontinued when the ambient air temperature falls below 40 degrees F. Artificial heating may be utilized to maintain a concrete surface temperature of not less than 50 degrees F for a period of 72 hours after placement. When artificial heating is used, the heating units shall not locally heat or dry the surface of the concrete.

### **(D) Curing Concrete.**

**(1) Curing Cast-In-Place Concrete.** All cast-in-place concrete shall be cured beginning immediately after completion of finishing of the fresh concrete. No traffic, hauling, storing of material or other work shall be allowed on any concrete surface during the required curing periods.

The placed concrete should be protected so as to minimize the loss of moisture from exposed surfaces for a period of seven days when normal Portland cement is used and three days when the cement is of high early strength. The contractor shall employ the proper method to control moisture loss in the concrete during the curing period.

Required curing time for vertical forms is to be a minimum of 24 hours after the concrete is placed. Other forms supporting concrete and shoring shall remain in place as follows:

Sides of footings	24 hours (minimum)
Vertical sides of beams, girders, and similar members	48 hours (minimum)
Slabs, beams, and girders –	10 days (minimum) and until concrete strength reaches 85 percent of the specified strength
Wall bracing –	Until concrete strength of the slab literally supporting the wall reaches 85 percent of the specified strength

Immediately after forms are removed, the surface of the concrete shall be carefully examined, and any irregularities in the surface shall be repaired. Concrete surfaces exhibiting honey-combing with fissures larger than one inch in diameter and covering a greater area than one square yard may require concrete removal in lieu of repairs; at the discretion of the Engineer.

The early removal of forms should be avoided; the forms should be allowed to remain for as long a period as is practicable. Concrete placed in thin sections in hot weather requires an increased period of protection. Freezing of the concrete before it has cured should not be allowed to occur; this condition will warrant rejection of in-place concrete by the Engineer.

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### **(E) Acceptance Sampling And Testing**

**(1) General.** Rejection of concrete may occur based on noncompliance with this specification. The engineer at his discretion may allow the failed concrete mixture, already placed, to remain in place subject to acceptance by compressive strength or may require its removal.

Rejection of concrete will also occur due to insufficient compressive strength. Concrete compressive strength requirements consist of the specified strength which the concrete shall attain before various loads or stresses are applied and a minimum strength at 28 days.

Acceptance for placed concrete which meets mixture requirements is deemed a “quality control test”. The engineer’s representative shall determine the need for such a test and the frequency. Acceptance for placed concrete is subject to rejection by the engineer. Placed concrete allowed to remain is deemed a “compliance test”. Both tests require a testing laboratory to perform a 28 day compressive strength test.

**(2) Sampling and Testing for Cast-In-Place Concrete.** A “quality control test” sample for a strength test consisting of a minimum of 4 cylinders, 2 of which will be considered “hold” cylinders, will be taken at random, for each 50 cubic yards of placed concrete on a daily basis. For daily pours of less than 20 cubic yards testing will be conducted at the discretion of the engineer. The engineer will determine the quantity of concrete represented by each sample of concrete for a strength test. “Compliance test” samples shall be obtained in the same manner and number as samples for the above, “quality control test.”

Samples of concrete for test specimens will be taken in accordance with requirements of AASHTO T 141. All test cylinders will be fabricated in accordance with the requirements of AASHTO T 23. Testing for compressive strength will be in accordance with the requirements of AASHTO T 22.

A strength test will consist of the average strength of two cylinders or 95 percent of the higher strength cylinder, whichever is greater.

**(3) Acceptance for Compressive Strength.** Concrete represented by a strength test of at least 100 percent of the required 28-day compressive strength will be acceptable for cast-in-place concrete. All concrete failing to meet this requirement will be rejected unless the contractor, at his own expense, can submit evidence that will indicate to the Engineer that the strength and quality of the concrete is such that the concrete should be considered acceptable.