

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
- As noted on the plans

Plans requiring specialty concrete will be addressed in the special specifications.

The Contractor shall furnish concrete conforming to the requirements of these specifications without harmful segregation, bleeding, or incomplete consolidation. Portland cement concrete shall have proportioning of fine and coarse aggregates so as to not produce harshness in placing or honeycombing in the structure.

0301.0200 PRODUCTS

0301.0201 Materials.

(A) Portland Cement. Portland or Portland-Pozzolan cements are the 2 allowed materials in this Section. Portland cement shall conform to the requirements of ASTM C150 for Type II or Type III. Portland-Pozzolan cement shall conform to the requirements of ASTM C595 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.

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On-site mixing and proportioning will be allowed for Class C concrete only. The concrete materials shall be delivered, stored, and handled so as 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 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, and the mixing container shall be free from oil, acid, alkali, clay, silt, vegetable matter, 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 of deleterious materials, including soft or flaky particles, loam, caliche, ice, frost, organic matter, or clay lumps (not greater than 1.25 percent by weight).

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

**Table 0301-1
Size Distribution Requirements**

Sieve Size	Percent Passing (all classes)
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, crushed gravel, or other approved inert material of similar characteristics, free of clay and other deleterious substances in accordance with the requirements of AASHTO T 112 and T 113, and Arizona Test Method 201. 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

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Method 201, Section 12(3), except the amount of material passing the 200 sieve shall not exceed 1.0 percent.

(D) Admixtures. All materials other than the cement, water, and aggregates added just before or during mixing are considered admixtures. Admixtures will improve the concrete workability, accelerate its set, harden its surface, and increase its waterproof qualities. They shall be used in accordance with the manufacturer's recommendations and shall be added per Table 0301-3. Admixtures containing chlorides are not acceptable. Admixtures of any type are not to be used unless authorized by the Engineer or called out in the special specifications.

0301.0300 EXECUTION

0301.0301 Design Criteria. Portland cement concrete shall conform to the requirements specified in Table 0301-2 for each of the classes listed therein. Concrete classes shall be of 3 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:

**Table 0301-2
Concrete Class Requirements**

Type of Use	Class of Concrete
As specified on the plans	A (3,500 psi)
Footings, pipe supports, pump base, sidewalk replacement, FH blocking, walkways, or as noted on plans	B (3,000 psi)
Unauthorized excavations, thrust blocks, footings less than 1/3 cubic yard in volume and supporting less than 100 lbs. dead load	C (2,500 psi)

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 submitted per the Design Procedures below (Subsection 0301.0302). 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 smallest.

0301.0302 Design Procedures. At least 2 weeks before the appropriate concreting operation, the Contractor shall submit 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 1 mix design for each class of concrete may be submitted for approval provided specific items and locations of intended uses accompany the design. The Contractor shall substantiate each

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mix design by furnishing test data in addition to 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; coarse aggregate size number designation; source of aggregates; specific gravities of all ingredients; proposed slump; code number to identify the mix design; and intended use of each mix design shall be an integral part of each mix design.

See Table 0301-3 on the next page.

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**Table 0301-3
Concrete with Air Entrainment**

Class	Min. 28-Day Compressive Strength ⁽¹⁾ (psi)	Min. – Max. Hydraulic Cement Content ⁽²⁾ (pounds per cubic yard)	Max. Water/Cement Ratio	Slump Range (inches)
A	3,500	520 – 752	0.55	⁽⁴⁾
B	3,000 ⁽³⁾	520 – 752	0.55	⁽⁴⁾
C	2,500	520 – 752	0.55	⁽⁴⁾

NOTES:

⁽¹⁾ Testing for compressive strength of cylinders for all classes of concrete shall be in conformance with the requirements of Arizona Test Method 314.

⁽²⁾ A supplementary cementitious material (fly ash, natural pozzolan, or silica fume) may be used at the option of the Contractor only when Portland cement is used. The use of a supplementary cementitious material is not allowed for replacement of cement when Portland-Pozzolan cement [Type IP (MS)] is used. A maximum of 25 percent of the required weight of Portland cement may be replaced with fly ash or natural pozzolan. A maximum of 10 percent of the required weight of Portland cement may be replaced with silica fume, or a maximum of 10 percent silica fume may be added to the required weight of Portland cement. When supplementary cementitious material is used as a replacement for Portland cement, the replacement shall be made on a 1.0 pound to 1.0 pound basis. If performance enhancement of the concrete—such as mitigating an alkali silica reaction or increasing sulfate resistance—is necessary, additional quantities of fly ash or natural pozzolan may be incorporated into the concrete without a corresponding Portland cement replacement, if approved by the Engineer.

⁽²⁾ The hydraulic cement content shall be as shown unless otherwise specified.

⁽²⁾ Concrete to be placed under water (tremie concrete) shall conform to the requirements for the class and strength required, except the minimum hydraulic cement content shall be increased by 50 pounds per cubic yard of concrete.

⁽³⁾ Unless otherwise shown on the project plans.

⁽⁴⁾ The proposed slump shall be chosen by the Contractor. Concrete at the proposed slump shall be sufficiently workable to allow proper placement without harmful segregation, bleeding, or incomplete consolidation.

Water reducing admixtures may be used at the option of the Contractor provided the concrete meets the minimum 28-day compressive strength requirements detailed above (Table 0301-3).

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No changes in the approved mix designs or code numbers shall be made by the Contractor except with Engineer approval. 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 his/her responsibility for the results obtained from using such 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/she shall submit 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. Mobile mixing will be allowed for Class C concrete. Mobile mixing will be allowed for Class A and Class B concrete only with written authorization from the Engineer.

(C) Weather Limitations.

(1) General. Under rainy conditions, placement 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 3 days.

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(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 placing concrete when the ambient air temperature exceeds 90 degrees F.

(3) Cold Weather Concreting. The temperature of the mixed concrete immediately before placement 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 used 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 immediately after finishing of the fresh concrete has been completed. No traffic, hauling, storing of material, or other work shall be allowed on any concrete surface during the required curing periods.

Placed concrete should be protected so as to minimize loss of moisture from exposed surfaces for a period of 7 days when using normal Portland cement, and 3 days when using high early-strength cement. 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 24 hours minimum after placement of concrete. Other forms supporting concrete and shoring shall remain in place as follows:

**Table 0301-4
Required Curing Time**

Type of Form	Minimum Curing Time
Sides of footings	24 hours
Vertical sides of beams, girders, and similar members	48 hours
Slabs, beams, and girders	10 days, and until concrete strength reaches 85% of the specified strength
Wall bracing	Until concrete strength of the slab literally supporting the wall reaches 85% of the specified strength

Immediately after the forms are removed, the concrete's surface shall be carefully examined and any irregularities in the surface shall be repaired. Concrete surfaces

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exhibiting honeycombing with fissures larger than 1 inch in diameter and covering an area greater than 1 square yard may require removal in lieu of repairs; this decision shall be at the Engineer's discretion.

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 the Engineer's rejection of in-place concrete.

(E) Acceptance Sampling and Testing.

(1) General. Rejection of concrete may occur based on noncompliance with this specification. If the failed concrete mixture has already been placed, the Engineer may require its removal or—at his/her discretion—allow it to remain in place subject to acceptance by compressive strength.

Rejection of concrete will also occur due to insufficient compressive strength. Concrete compressive strength requirements consist of:

- (a) The specified strength the concrete shall attain before various loads or stresses are applied
- (b) A minimum strength at 28 days

Acceptance for placed concrete meeting mixture requirements is deemed a "quality control test". The Engineer's representative shall determine the need for, and frequency of, such a test. 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 less than 20 cubic yards, testing will be conducted at the Engineer's discretion. 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

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.

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A strength test will consist of either the average strength of 2 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/her own expense—can submit evidence indicating to the Engineer that the concrete's strength and quality is such that it should be considered acceptable.

(4) Scheduling. It is the Contractor's responsibility to schedule required testing per specifications, contract, plans, and special provisions. All required testing must be coordinated by the Contractor; failure to schedule required tests may result in rejected work at the Contractor's sole expense.