

402 – STRUCTURAL CONCRETE

SECTION 402

STRUCTURAL CONCRETE

402.1 DESCRIPTION

Provide the grades of concrete specified in the Contract Documents.
This specification is specific to Structural Concrete. See **SECTION 401** for general concrete requirements.

402.2 MATERIALS

Provide materials that comply with the applicable requirements.

General Concrete.....	SECTION 401
Aggregate.....	DIVISION 1100
Admixtures, and Plasticizers	DIVISION 1400
Cement, Fly Ash, Silica Fume, Slag Cement and Blended Supplemental Cementitious.....	DIVISION 2000
Water	DIVISION 2400

402.3 CONCRETE MIX DESIGN

a. General. Design structural concrete mixes as specified in the Contract Documents.

b. Concrete Mix Design. Two options are available for mix design procedures. Use the procedures outlined in **SECTION 401** or Appendix A to design structural concrete mixes. Mixes developed using Appendix A must meet permeability requirements of **TABLE 402-1**.

c. Concrete Strength Requirements. Design concrete to meet the strength requirements of **SECTION 401**.

d. Portland Cement, Blended Hydraulic Cement, and Individual and Blended Supplemental Cementitious Materials. Unless specified otherwise in the Contract Documents, select the type of portland cement, blended hydraulic cement and individual and blended supplemental cementitious materials according to **SECTION 401**.

e. Structural Concrete Specific Requirements. Design concrete to meet the following requirements:

- (1) Maximum water to cementitious ratio of 0.50 and a minimum cementitious content of 480 lbs per cubic yard.
- (2) Air entrain concrete with a target air content of 6.5 ± 1.5 percent.
- (3) Determine the air loss due to pumping operations once in the AM and once in the PM. Determine the difference between the air content from concrete sampled before the pump, and concrete sampled after pumping. Make adjustment to the mix to compensate for the pumping of the concrete.
- (4) Maximum air content is 10%. Take immediate steps to reduce the air content whenever the air content exceeds 8%.
- (5) Determine air content by KT-19 (Volumetric Method). A regularly calibrated KT-18 (Pressure Method) meter may be used for production with random verification by the Volumetric Method. See KT-19 for special requirements when using the Volumetric Method with high cementitious concretes or mixtures with midrange water reducers or plasticizers.
- (6) Concrete permeability requirements according to **TABLE 402-1**.
- (7) Use Quality Requirements for Structural Aggregates as listed in **SECTION 1102**, Aggregates For Concrete Not Placed on Grade.
- (8) Use gradation requirements for aggregates as listed in **SECTION 1102**, Aggregates For Concrete Not Placed on Grade.
- (9) Use MA-6 optimized gradation for Low Permeability Concrete for Bridge Overlays.

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(10) Perform 28-day Volume of Permeable Voids as per KT-73, 28-day Surface Resistivity as per KT-79, **or** 56-day Rapid Chloride Permeability as per AASHTO T-277 when required. Submit accelerated cure procedures for the Engineer’s approval. The field verification test procedure must be the same test procedure as the mix design approval test.

(11) To meet permeability requirements, the use of supplemental cementitious materials may be necessary. See **SECTION 401**.

(12) When used, add silica fume with other cementitious materials during batching procedures. If the silica fume cannot be added to the cementitious materials, add the loose silica fume to the bottom of the stationary drum that is wet, but has no standing water, before adding the dry materials. The Engineer may approve shreddable bags on a performance basis, only when a central batch mixing process is used. If so, add the bags to half of the mixing water and mix before adding cementitious materials, aggregate and remainder of water.

Mix silica fume modified concrete for a minimum of 100 mixing revolutions.

(13) ASTM C-1567 is required if supplementary cementitious materials (SCMs) are utilized. See **subsection 401.3d.(6)** for requirements. ASTM C 1567 is not necessary for concrete modified with only Silica Fume.

TABLE 402-1: REQUIREMENTS FOR STRUCTURAL CONCRETE

	Volume of Permeable Voids, maximum	Surface Resistivity, minimum	Rapid Chloride Permeability, maximum	ASTM C-1567 Accelerated Mortar Bar Expansion
Use Low Permeability Concrete (LPC) for Bridge Overlays	9.5%	27.0 kΩ-cm	1000 Coulombs	0.10% @ 16 days
Use Moderate Permeability Concrete (MPC) for specified Full Depth Bridge Decks.	11.0%	13.0 kΩ-cm	2000 Coulombs	0.10% @ 16 days
Use Standard Permeability Concrete (SPC) for all other structural concrete not specified as Low or Moderate Permeability.	12.0%	9.0 kΩ-cm	3000 Coulombs	0.10% @ 16 days

f. Slump.

(1) Designate a slump for each concrete mix design that is required for satisfactory placement of the concrete application. Reject concrete with a slump that limits the workability or placement of the concrete.

(2) If the designated slump is 3 inches or less, the tolerance is ±3/4 inch, or limited by the maximum allowable slump for the individual type of construction.

(3) If the designated slump is greater than 3 inches the tolerance is ±25% of the designated slump.

(4) For drilled shafts the target slump just prior to being pumped into the drilled shaft is 9 inches. If the slump is less than 8 inches, redose the concrete with admixtures as permitted in **subsection 401.3i**.

(5) Do not designate a slump in excess of 5 inches for all other structural concrete.

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APPENDIX A – NON-MANDATORY INFORMATION

GENERAL CONCRETE FOR STRUCTURES AND SILICA FUME MODIFIED CONCRETE

CONCRETE FOR STRUCTURES

Design concrete for structures according to **TABLE 402-A1** meeting the applicable requirements for Volume of Permeable Voids, Surface Resistivity or Rapid Chloride Permeability as required in **TABLE 402-1**.

TABLE 402-A1: CONCRETE FOR STRUCTURES		
Grade of Concrete	lb. of Cementitious per yd of Concrete, minimum	lb. of Water per lb. of Cementitious, maximum
Grade 6.0(**)(**)(**)(**): MA Gradation	700	0.35
Grade 5.0(**)(**)(**)(**): MA Gradation	602	0.35
Grade 4.5(**)(**)(**)(**): MA Gradation	602	0.40
Grade 4.0(**)(**)(**)(**): MA Gradation	602	0.44
Grade 3.5 and 3.0(**): MA Gradation	564	0.46
Grade 2.5(**): MA Gradation	526	0.50

Structural Concrete (*) (**) (**)(**)(**)(**)

*Grade as specified in the Contract Documents

Air Entrained meeting **subsection 402.3e.

***Aggregate as specified in **DIVISION 1100**.

****MPC (Moderate Permeability Concrete)

Air entrained concrete with a target air of 6.5 ± 1.5 percent.

Maximum water to cementitious ratio of 0.50 and a minimum cementitious content of 480 lbs per cubic yard. Maximum limit of lb. of water per lb. of cementitious material includes free water in aggregates, but excludes water of absorption of the aggregates.

SILICA FUME MODIFIED CONCRETE

When silica fume is selected for use in structural concrete, meet the mix design and production requirements in **TABLE 402-A2**.

Use MA-6 Aggregate Gradation for Bridge Overlay concrete.

TABLE 402-A2: SILICA FUME BRIDGE OVERLAY CONCRETE CRITERIA	
lbs. of Cement per cu. yd. maximum	595
lbs. of Silica Fume per cu. yd., maximum	30
lbs. of water per lbs. of (Cement + Silica Fume), maximum	0.40
Percent of Air by Volume	6.5±1.5
Maximum 28 day Permeable Voids KT-73	9.50%
or Minimum 28 day Surface Resistivity KT-79	27.0 kΩ-cm
or Maximum 56 day Rapid Chloride Permeability T-277	1000 coulombs