Section 701. PORTLAND CEMENT CONCRETE FOR STRUCTURES

701.01. Description. This work consists of producing and furnishing concrete proportioned for the grades of concrete required.

The term “sack” refers to a 94-pound sack of cement.

701.02. Materials. Provide materials in accordance with the following:

Cement	901
Slag Cement	901
Fly Ash	901
Coarse Aggregate 6A, 6AA,17A	902
Fine Aggregate 2NS, 2SS	902
Concrete Admixtures	903
Water	911

Provide coarse aggregate in accordance with Table 701-1A and Table 701-1B for the specified concrete grade.

Provide stone sand 2SS only for structure concrete not exposed to vehicular traffic.

Do not use concrete accelerators that contain calcium chloride in concrete for bridges or concrete with embedded aluminum or galvanized steel.

701.03. General Requirements.

A. **Structural Concrete Mixtures.** Provide concrete mixtures in accordance with:

1. Batch plant equipment, certification, and certification waiver requirements of subsection 601.03.A, subsection 601.03.B, and subsection 601.03.C, respectively;
2. Materials handling requirements of subsection 601.03.D;
3. Concrete mixing requirements of subsection 601.03.E; and
4. Concrete temperature requirement of subsection 601.03.F.1.

B. **Concrete Quality Control.** Provide concrete Quality Control (QC) in accordance with section 604 and the contract. Unless otherwise specified in the contract, provide concrete structure mixtures in accordance with Table 701-1A and Table 701-1B. Use supplemental cementitious materials as specified in the contract.

C. **Air Content of Structural Concrete.** Do not use de-foaming (air-detraining) admixtures. Furnish concrete containing 5.0 to 8.0 percent entrained air, except as follows:

1. Provide an entrained air content of 5.5 to 8.5 percent for concrete containing Type F or Type G admixtures;
2. Air content less than 5.5 percent for concrete that lies in the finished work at least 3 feet below the surface of the ground or entirely under water will not be cause for rejection; and
3. The Engineer will allow non-air-entrained concrete for concrete placed in steel shell piles not subject to freezing.

Use the Department's modification of ASTM C 231 or ASTM C 173 to determine the air content of freshly mixed concrete. Take samples according to MTM 207.

Use the volumetric method, ASTM C 173 to determine the air content of freshly mixed concrete containing highly porous coarse aggregate. Take samples according to MTM 207.

If the proportion of air entraining admixture used is adjusted, record the new quantity on the first delivery ticket following the adjustment.

If concrete having low air content arrives at the project site in truck mixers, additional air-entraining admixture may be added at the site, with additional mixing as necessary, until adjustments at the batching plant are made.

D. **Work Progress Specimens for Structure.** Ensure that the strength of structure concrete meets the requirements of subsection 104.11.B for opening to construction traffic or vehicular traffic, removing shoring or forms, or similar operations. Test work progress specimens in accordance with subsection 601.03.H.

701.04. Measurement and Payment. The cost of producing and furnishing structure concrete mixtures is included in the unit prices for other relevant pay items.

Table 701-1A
Concrete Structure Mixtures by Slump

Concrete Grade (e, h)	Section Number Reference (i)	Cement content per cubic yard (b, c)		Slump (in)			
					Type MR, F, or G Admixtures (g)		
		lb	sack	Type A, D or no Admixture	Before Admixture	After Admixture (Type MR)	After Admixture (Type F or G)
D (a)	706, 711, 712	658 (d)	7.0	0 – 3	0 – 3	0 – 6	0 – 7
S1	705	611	6.5	3 – 5	0 – 3	3 – 6	3 – 7
T	705, 706	611	6.5	3 – 7	0 – 4	3 – 7	3 – 8
S2 (a)	401, 705, 706, 712, 713, 801, 802, 803, 810	564	6.0	0 – 3	0 – 3	0 – 6	0 – 7
		526 (d)	5.6				
S3	402, 403, 803, 804, 806	517	5.5	0 – 3	0 – 3	0 – 6	0 – 7
		489 (d)	5.2				

Note: See Table 701-1B below for table notes.

Table 701-1B
Concrete Structure Mixtures by Strength of Concrete

Concrete Grade (e, h)	Section Number Reference (i)	Cement content per cubic yard (b, c)		Minimum Strength of Concrete (f)					
				Flexural, (psi)			Compressive, (psi)		
		lb	sack	7 day	14 day	28 day	7 day	14 day	28 day
D (a)	706, 711, 712	658 (d)	7.0	625	700	725	3,200	4,000	4,500
S1	705	611	6.5	600	650	700	3,000	3,500	4,000
T	705, 706	611	6.5	550	600	650	2,600	3,000	3,500
S2 (a)	401, 705, 706, 712, 713, 801, 802, 803, 810	564	6.0	550	600	650	2,600	3,000	3,500
		526 (d)	5.6						
S3	402, 403, 803, 804, 806	517	5.5	500	550	600	2,200	2,600	3,000
		489 (d)	5.2						

Notes for Table 701-1A and Table 701-1B:

a. Unless otherwise required, use Coarse Aggregate 6AA or 17A for exposed structural concrete in bridges, retaining walls, and pump stations.

b. If the local average minimum temperature for the next 10 consecutive days after concrete placement is forecast to be below 40 °F, submit a revised quality control plan for the Engineer's approval prior to cold weather concrete placement. The revised plan must detail changes in materials, concrete batching and mixing processes, construction methods, curing, and protection of the in situ concrete to ensure that the quality characteristics of the hardened concrete are not compromised by the cold weather. The restriction does not apply to Grade S1 concrete in foundation piling below ground level or Grade T concrete in tremie construction.

c. Type III cement is not permitted.

d. Use admixture quantities specified by the Qualified Products Lists to reduce mixing water. Admixture use is required for Grade D, Grade S2, and Grade S3, concrete with a reduced cement content. Use a water-reducing retarding admixture at the required dosage for Grade D concrete to provide the setting retardation required. When the maximum air temperature is not forecast to exceed 60 °F for the day, the Contractor may use a water-reducing admixture or a water-reducing retarding admixture. Ensure Grade D concrete in concrete diaphragms contains a water-reducing admixture, or a water-reducing retarding admixture. For night casting, the Contractor may use a water-reducing admixture in lieu of water-reducing retarding admixture, provided that the concrete can be placed and finished prior to initial set.

e. The mix design basis for bulk volume (dry, loose) of coarse aggregate per unit volume of concrete is 68% for Grade S1, and 70% for Grade D, Grade S2, Grade T, and Grade S3 Footnote e does not apply to mix designs containing Engineer-approved, optimized aggregate gradations.

f. The Contractor may use flexural strength to determine form removal. Use compressive strength for acceptance in other situations.

g. MR = Mid-range.

h. The Engineer will allow the use of an optimized aggregate gradation meeting the requirements of MTM 130.

i. Section Number Reference

401	Culverts	402	Storm Sewers
403	Drainage Structures	705	Foundation Piling
706	Structural Concrete Construction	711	Bridge Railings
712	Bridge Rehabilitation-Concrete	713	Bridge Rehabilitation-Steel
801	Concrete Driveways	802	Concrete Curb, Gutter and Dividers
803	Concrete Sidewalk, Sidewalk Ramps, and Steps	804	Concrete Barriers and Glare Screens
806	Bicycle Paths	810	Permanent Traffic Signs and Supports