ITEM 499 CONCRETE—GENERAL

499.01 Description. This specification consists of proportioning and mixing portland cement concrete.

499.02 Materials. Furnish materials conforming to:

Portland cement	701.01, 701.02, 701.04[1]
	701.05 and 701.09[2]
Microsilica	701.10
Ground granulated blast furnace slag (GGBFS)	701.11
Fly ash	701.13
Fine aggregate[3]	703.02
Coarse aggregate	703.02, 703.13[4]
Air-entraining admixture	705.10
Chemical admixture for concrete[5]	705.12

[1] Use only 701.04 cement in all High Performance Class concrete.
[2] The Contractor may use 701.09, Type I(SM) only between April 1 to October 1 and when 705.10 air-entraining admixture is added at the mixer. Do not use Type I(SM) with Options 1 and 3 or with any Class HP concrete.
[3] 703.02 natural sand or sand manufactured from stone as specified in Item 703.02.A.3 is required in 255, 256, 451, 452, 526, and 511 deck slabs.
[4] Applies only to 305, 306, 451 and 452 concrete.
[5] Admixtures shall contain no more than 50 parts per million chloride ions by weight of cement.

For concrete, use water free from sewage, oil, acid, strong alkalis, organic matter, clay, and loam. Potable water is satisfactory for use in concrete.

499.03 Proportioning. Proportioning of the concrete mixtures contained in this section is based on a predetermined cement content. Except as otherwise provided below, the yield calculation determines if the specified weight of cement is contained in each cubic yard (cubic meter) of concrete. Ensure that the yield is within 1 percent of the theoretical yield in cubic feet (m^3) detailed in the mix design tables. Do not exceed the maximum specified water-cement (or water-cementitious) ratio.

A. Slump.

1. Classes C, F, and S Concrete. Maintain slump for Classes C, F, and S concrete within the nominal slump range in Table 499.03-1. If below the maximum water-cement ratio, then adjust the quantity of water to meet slump requirements. Do not use concrete with a slump greater than the maximum shown in Table 499.03-1. When the slump exceeds the nominal slump limit but is below the maximum limit, the

Contractor may use an occasional load of concrete in this condition, provided the mixture of succeeding loads is immediately adjusted to reduce the slump to within the nominal range. Conduct tests on the plastic concrete for pavement at the point of placement or at an Engineer-designated location.

TABLE 499.03-1 CONCRETE SLUMP

Type of Work	Nominal Slump inch (mm)[1]	Maximum Slump inch (mm)[2]
Concrete pavement (305, 306, 451, 452, 615)	1 to 3 (25 to 75)	4 (100)
Structural Concrete (511, 610, 622)	1 to 4 (25 to 100)	5 (125)
Class S, Superstructure concrete (511, 526)	2 to 4 (50 to 100)	4 (100)
Non-reinforced concrete (601, 602 603, 604, 608, 609, 622)	1 to 4 (25 to 100)	5 (125)
[1] This nominal slump may be increased to 6 inches (150 mm), provided the increase in slump is achieved by adding a chemical admixture conforming to the requirements of 705.12, Type F or G.		
[2] This maximum slump may be increased to 7 inches (180 mm), provided the increase in slump is achieved by adding a chemical admixture conforming to the requirements of 705.12, Type F or G.		

2. High Performance Concrete (Classes HP1, HP2, HP3, and HP4). Provide a maximum concrete slump of 8 inches (200 mm) at the placement site for all HP Classes. Conduct tests for structure concrete on concrete samples obtained from the point of placement in the forms.

B. Air Content. Ensure that the air content in all concrete at the point of placement is within the percentage range specified in the Concrete Tables.

C. Concrete Classes. Using the Concrete Tables, the Engineer will determine the weights of fine and coarse aggregate. The Concrete Table aggregate weights were calculated using the following Saturated Surface Dry (SSD) specific gravities: natural sand and gravel 2.62, limestone sand 2.68, limestone 2.65, and slag 2.30. The assumed specific gravities of portland cement, fly ash, ground granulated blast furnace slag and micro-silica are 3.15, 2.30, 2.90 and 2.20, respectively. For aggregates with specific gravities differing more than ±0.02 from these, the Engineer will adjust the table design weights as specified in 499.03.D.3.

If high early strength concrete is specified, the Contractor may use high early strength cement, additional cement, approved chemical admixtures, or a combination of these materials to achieve a split tensile strength of 450 pounds per square inch (3.1 MPa) in 3 days or less. If high early strength concrete is not specified, but is desirable to expedite the work, the Contractor may use these same materials at no additional cost to the City. Do not waive concrete curing periods specified for the item of work in which the concrete is used.

The concrete proportioning is based on developing a concrete compressive strength at 28 days of 4000 pounds per square inch (28.0 MPa) for Class C, 3000 pounds per square inch (21.0 MPa) for Class F and 4500 pounds per square inch (31.0 MPa) for Class S.

TABLE 499.03-2 CLASSES A, C, F, AND S CONCRETE (USING NO. 57 OR 67 SIZE COARSE AGGREGATE)

Quantities Per Cubic Yard (Cubic Meter) Provide concrete with an air content of 6 ± 2%					
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Water-Cement Ratio Maximum	Design Yield Cubic Feet (m3)
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)			
Class A (Using No. 57 or 67 Size)					
Gravel	1460(866)	1700(1009)	280(166)	1.04	27.02(1.00)
Limestone	1540(914)	1640(973)	280(166)	1.04	27.03(1.00)
Slag	1470(872)	1480(878)	280(166)	1.04	27.00(1.00)
Class C (Using No. 57 or 67 Size)					
Gravel	1150(682)	1720(1020)	600 (356)	0.50	27.04 (1.00)
Limestone	1270(753)	1610(955)	600 (356)	0.50	26.98 (1.00)
Slag	1330(789)	1340(795)	600 (356)	0.50	26.95 (1.00)
Class F (Using No. 57 or 67 Size)					
Gravel	1270 (753)	1810 (1074)	470 (279)	0.55	26.99 (1.00)
Limestone	1360 (807)	1750 (1038)	470 (279)	0.55	27.06 (1.00)
Slag	1390 (825)	1480 (878)	470 (279)	0.55	26.97 (1.00)
Class S (Using No. 57 or 67 Size)					
Gravel	1070(635)	1660(985)	715 (424)	0.44	27.00 (1.00)
Limestone	1240 (736)	1510 (896)	715 (424)	0.44	27.02 (1.00)
Slag	1235(733)	1320 (783)	715 (424)	0.44	27.02 (1.00)

Use Class C concrete using No. 57 or 67 size coarse aggregate for 305, 451 or 452 pavement and provide quantities per cubic yard (cubic meter) according to the above Concrete Table. Use Class F concrete using No. 57 or 67 size coarse aggregate for 306 pavement and provide quantities per cubic yard (cubic meter) according to the above Concrete Table. If No. 7, 78, or 8 size coarse aggregate allowed by 703.13 for 305, 306, 451 or 452 pavement is used, provide concrete according to Table 499.03-3.

TABLE 499.03-3 CLASSES A AND C CONCRETE (USING NO. 7, 78, OR 8 SIZE COARSE AGGREGATE)

Quantities Per Cubic Yard (Cubic Meter) Provide concrete with an air content of 8 ± 2%					
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Water-Cement Ratio Maximum	Design Yield Cubic Feet (m3)
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)			
Class A (Using No. 7, 78, or 8 Size)					
Gravel	1460(866)	1610(955)	280(166)	1.04	27.01(1.00)
Limestone	1530(908)	1560(926)	280(166)	1.04	27.02(1.00)
Class C (Using No. 7, 78, or 8 Size)					
Gravel	1320 (783)	1460 (866)	600 (356)	0.50	27.02 (1.00)
Limestone	1380 (819)	1410 (837)	600 (356)	0.50	26.99 (1.00)

Use Table 499.03-4 for High Performance (HP) Concrete Classes when specified and comply with the listed notes.

TABLE 499.03-4 CLASS HP CONCRETE

Quantities Per Cubic Yard (Cubic Meter) for High Performance (HP) Concrete Mixes Aggregates Weights (SSD)
Provide 8-inch (200 mm) maximum slump concrete at placement site for all Class HP concrete mixes[1] Provide concrete with an air content of 7 ± 2%

Class HP1 (Fly Ash)

Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	Fly Ash [3] lb (kg)		Water-CM Ratio Maximum [4]	Design Yield Cubic Feet (m^3)
Gravel	1310(777)	1470(872)	530 (314)	170 (101)		0.38	27.04 (1.00)
Limestone	1310(777)	1480(878)	530 (314)	170 (101)		0.38	27.00 (1.00)
Slag	1310(777)	1290(765)	530 (314)	170 (101)		0.38	27.03 (1.00)

Class HP2 (GGBF Slag)

Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	GGBF Slag lb (kg)		Water-CM Ratio Maximum [4]	Design Yield Cubic Feet (m^3)
Gravel	1330(789)	1480 (878)	490 (291)	210 (125)		0.38	26.99 (1.00)
Limestone	1335 (792)	1495 (887)	490 (291)	210 (125)		0.38	27.01 (1.00)
Slag	1335 (792)	1295 (768)	490 (291)	210 (125)		0.38	27.00 (1.00)

Class HP3 (Fly Ash + Microsilica)

Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	Fly Ash[3] lb (kg)	Micro-silica lb (kg)	Water- CM Ratio Maximum [4]	Design Yield Cubic Feet (m^3)
Gravel	1340(795)	1460(866)	480 (285)	150 (89)	30 (18)	0.40	27.01 (1.00)
Limestone	1350(801)	1480(878)	480 (285)	150 (89)	30 (18)	0.40	27.03 (1.00)
Slag	1340(795)	1290(765)	480 (285)	150 (89)	30 (18)	0.40	27.01 (1.00)

Class HP4 (GGBF Slag + Microsilica)

Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	GGBF Slag lb (kg)	Micro-silica lb (kg)	Water-CM Ratio Maximum [4]	Design Yield Cubic Feet (m^3)
Gravel	1370 (813)	1475 (875)	440 (261)	190 (113)	30 (18)	0.40	27.03 (1.00)
Limestone	1370 (813)	1490 (884)	440 (261)	190 (113)	30 (18)	0.40	27.02 (1.00)
Slag	1370 (813)	1290 (765)	440 (261)	190 (113)	30 (18)	0.40	27.00 (1.00)

[1] Use a high range water reducer, conforming to 705.12, Type F or G and approved by the Laboratory, to achieve the desired slump at the specified water cement ratio. The probability of higher than normal dosage rates of the Types F and G admixtures is likely. The need for chemical admixtures or aggregates or both, different from the Contractor's normal sources is a distinct possibility. Add a Type A or D chemical admixture, conforming to 705.12 to the concrete at the plant. Add the majority of the water reducer at the plant.

[2] Use 701.04 cement only for Class HP concrete mixes.

[3] Use only Class C fly ash meeting 701.13 in HP concrete mixes.

[4] Calculate the water-cement ratio based upon the total cementitious material. Cementitious material includes portland cement, fly ash, GGBF slag and microsilica (solids). GGBF = ground granulated blast furnace slag; CM = cementitious material.

1. Adjust the proportions of coarse and fine aggregate to provide the maximum amount of coarse aggregate possible and still provide a workable and finishable mix. The Contractor may modify the mixes shown by adjusting the coarse and fine aggregates up to 100 pounds (50 kg) each, unless otherwise approved by the Engineer.

2. Provide the coarse aggregate with a moisture content above the saturated surface dry (SSD) condition immediately prior to batching. Maintain the cement content and ensure that the maximum water cement ratio is not exceeded.

3. Remove all wash water by reversing each truck drum at the plant immediately prior to reloading.

4. Add and mix a Type F or G admixture according to the manufacturer's recommendations. Furnish a volumetric dispenser for the Type F or G admixture or ensure that there is a gage on each truck-mounted Type F or G admixture dispensing tank. If Type F or G admixture is added at the job site, mix the load for a minimum of 5 minutes at mixing speed.

5. The Engineer will reject concrete loads, if during placement of any concrete, cement or microsilica balling is observed. Revise the mixing process and/or loading sequence to prevent further balling.

6. If slump loss occurs before placement of the concrete, the concrete may be "replasticized" with the admixture to restore plasticity. The Engineer will recheck the slump range and air content to ensure conformance to the specifications. If after "replasticizing" the components of the load are segregated, the City will reject the load. Completely discharge the concrete from each delivery truck within 90 minutes after combining the water and the cementitious material.

7. Perform sufficient advance testing to ensure conformance with this specification before placing the concrete.

8. Sampling and testing for air content and slump will be measured at the point of placement in the forms.

9. Prior to placing Class HP concrete mixes, obtain and present to the Engineer a written statement from the manufacturers of the chemical admixtures to be used in the concrete verifying the compatibility of the combination of materials and the sequence in which they are combined. The manufacturers will further designate a technical representative from its company or the ready-mix concrete supplier to be in charge of the dispensing of the admixture products. The technical representatives will act in an advisory capacity and will report to the Contractor and the Engineer any operations and procedures which are considered by the representative as being detrimental to the integrity of the placement. The manufacturer's technical representative will be present during concrete placement unless waived by the Engineer.

10. Class HP Concrete Blended Cement Options conforming to City Supplement 1086 may be used as alternate mix designs.

D. Concrete Mix Adjustments. At any time during the concrete placement, the Engineer may vary the relative weights of fine and coarse aggregate from the relative weights determined from Table 499.03-1 through Table 499.03-4 in order to ensure a workable mix within the slump range and to control the yield. However, do not change

the total weight of aggregate per cubic yard (cubic meter) except, as allowed by the following conditions.

1. Correct SSD aggregate weights described above to compensate for moisture contained in the aggregates at the time of use.

2. If it is impossible to prepare concrete of the proper consistency without exceeding the specified maximum water/cement ratio, use a water-reducing admixture conforming to 705.12 or increase the cement content. Adjust the absolute volume of the aggregates if the cement content is increased. The City will not provide additional compensation for the admixture or additional cement required by this adjustment.

3. If, during the work, the specific gravity of an aggregate changes more than ±0.02 from those specified in 499.03.C, adjust the design weight to conform to the new specific gravity.

4. Make unit weight determinations in order to calculate and maintain the yield according to ASTM C 138. Based on these determinations, adjust the batch weights when necessary. Maintain the specified cement content within a tolerance of ±1 percent and do not exceed the maximum water-cement ratio.

5. Adjust the amount of water added at the mixer based on the moisture contained in the aggregate and the moisture that the aggregates will absorb.

6. Use an approved set-retarding admixture conforming to 705.12, Type B or D when the concrete temperature exceeds a nominal temperature of 75 °F (24 °C).

499.04 Proportioning Options for Portland Cement Concrete. The Contractor may substitute one of the following options for each respective class of concrete given in Table 499.03-2 and Table 499.03-3. Use the same air content specified in Table 499.03-2 and Table 499.03-3. Comply with slump requirements of Table 499.03-1.

Submit requests to use any of the following optional mix designs to the Engineer for approval before use. The SSD weights specified in Table 499.04-1 through Table 499.04-3 were calculated using the specific gravities in 499.03.C. Make adjustments to the mix design when specific gravities differ by more than ±0.02. Make other adjustments allowed in 499.03.D and approved by the Engineer.

Do not use option mixes in concrete mixes designed or intended to obtain high early strength.

The following option mixes only apply to Classes C, S, and F concrete mixes.

A. Proportioning Option 1. Reduce the cement content 15 percent by weight and substitute and equivalent weight of fly ash conforming to 701.13. Base the water-cementitious materials (water-cm) ratio on the combined weight of cement and fly ash. Meet the concrete mix design requirements of Table 499.04-1 for Option 1.

TABLE 499.04-1 OPTION 1 CONCRETE (CEMENT AND FLY ASH)

Quantities Per Cubic Yard (Cubic Meter)						
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Fly Ash lb (kg)	Water-CM Ratio Maximum	Design Yield Cubic Feet (m^3)
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)				
Class C Option 1 (Using No. 57 or 67 Size)						
Gravel	1140 (676)	1700 (1009)	510 (303)	90 (53)	0.50	27.02 (1.00)
Limestone	1260 (748)	1595 (946)	510 (303)	90 (53)	0.50	27.00 (1.00)
Slag	1320 (783)	1330 (789)	510 (303)	90 (53)	0.50	26.99 (1.00)
Class F Option 1 (Using No. 57 or 67 Size)						
Gravel	1260 (748)	1800 (1068)	400 (237)	70 (42)	0.55	27.00 (1.00)
Limestone	1350 (801)	1730 (1026)	400 (237)	70 (42)	0.55	27.00 (1.00)
Slag	1380 (819)	1475 (875)	400 (237)	70 (42)	0.55	27.00 (1.00)
Class S Option 1 (Using No. 57 or 67 Size)						
Gravel	1060 (629)	1640 (973)	608 (361)	107 (63)	0.44	27.02 (1.00)
Limestone	1230 (730)	1490 (884)	608 (361)	107 (63)	0.44	27.03 (1.00)
Slag	1220 (724)	1300 (771)	608 (361)	107 (63)	0.44	27.02 (1.00)
Class C Option 1 (Using No. 7, 78, or 8 Size) per 703.13 [2]						
Gravel	1310 (777)	1440 (854)	510 (303)	90 (53)	0.50	27.01 (1.00)
Limestone	1350 (801)	1410 (837)	510 (303)	90 (53)	0.50	26.97 (1.00)

[1] CM = cementitious material.
[2] 8% +/- 2% entrained air content

B. Proportioning Option 2. If an approved water-reducing admixture conforming to 705.12, Type A or D is used at the manufacturer's recommended dosage, reduce the cement content of the Standard Class C, F, or S concrete mixes by 50 pounds per cubic yard (30 kg/m^3), and substitute an equivalent volume of aggregate.

Meet the concrete mix design requirements of Table 499.04-2 for Option 2.

TABLE 499.04-2 OPTION 2 CONCRETE (CEMENT REDUCTION OF 50 LB W/ 705.12, TYPE A OR D)

Quantities Per Cubic Yard (Cubic Meter)					
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Water-Cement Ratio Maximum	Design Yield Cubic Feet (m^3)
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)			
Class C Option 2 (Using No. 57 or 67 Size)					
Gravel	1190 (706)	1780 (1056)	550 (326)	0.50	26.99 (1.00)
Limestone	1320 (783)	1670 (991)	550 (326)	0.50	27.00 (1.00)
Slag	1385 (822)	1395 (828)	550 (326)	0.50	27.02 (1.00)
Class F Option 2 (Using No. 57 or 67 Size)					
Gravel	1315 (780)	1880 (1115)	420 (249)	0.55	27.00 (1.00)
Limestone	1410 (837)	1810 (1074)	420 (249)	0.55	27.03 (1.00)
Slag	1440 (854)	1540 (914)	420 (249)	0.55	27.00 (1.00)
Class S Option 2 (Using No. 57 or 67 Size)					
Gravel	1120 (664)	1710 (1015)	665 (395)	0.44	27.00 (1.00)
Limestone	1290 (765)	1560 (926)	665 (395)	0.44	27.02 (1.00)
Slag	1270 (753)	1370 (813)	665(395)	0.44	27.01 (1.00)
Class C Option 2 (Using No. 7, 78, or 8 Size) per 703.13 [1]					
Gravel	1370 (813)	1510 (896)	550 (326)	0.50	27.01 (1.00)
Limestone	1420 (842)	1480 (878)	550 (326)	0.50	27.00 (1.00)
[1] 8% +/- 2% entrained air content					

C. Proportioning Option 3. Use Option 3 **only** for Items 305,306, 451 and 452. Reduce the cement content of standard Class C, F, or S concrete mixes by 50 pounds per cubic yard (30 kg/m^3) and use an approved water-reducing admixture conforming to 705.12, Type A or D at the manufacturer's recommended dosage. Substitute an equivalent volume of aggregate for the cement reduction. The remaining cement content is proportioned, by weight, of a minimum of 75 percent 701.04 or 701.01 portland cement and a maximum of 25 percent ground granulated blast furnace slag (GGBFS), conforming to 701.11. Base the water-cementitious (water-cm) ratio on the combined weight of the cement and the GGBFS.

Meet the concrete mix design requirements of Table 499.04-3 for Option 3.

TABLE 499.04-3 OPTION 3
(CEMENT REDUCTION AND USE OF GGBFS)

Quantities Per Cubic Yard (Cubic Meter)						
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	GGBF Slag lb (kg)	Water-CM Ratio Maximum	Design Yield Cubic Feet (m^3)
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)				
Class C Option 3 (Using No. 57 or 67 Size)						
Gravel	1185 (703)	1775 (1053)	412 (224)	138 (82)	0.50	26.99 (1.00)
Limestone	1310 (777)	1670 (991)	412 (224)	138 (82)	0.50	27.00 (1.00)
Slag	1385 (822)	1385 (822)	412 (224)	138 (82)	0.50	27.01 (1.00)
Class F Option 3 (Using No. 57 or 67 Size)						
Gravel	1320 (783)	1870 (1109)	315 (187)	105 (62)	0.55	27.02 (1.00)
Limestone	1400 (831)	1810 (1074)	315 (187)	105 (62)	0.55	27.01 (1.00)
Slag	1440 (854)	1535 (911)	315 (187)	105 (62)	0.55	27.01 (1.00)
Class S Option 3 (Using No. 57 or 67 Size)						
Gravel	1105 (656)	1715 (1017)	499 (295)	166 (99)	0.44	27.02 (1.00)
Limestone	1280 (759)	1555 (923)	499 (295)	166 (99)	0.44	27.00 (1.00)
Slag	1270 (753)	1360 (807)	499 (295)	166 (99))	0.44	27.02 (1.00)
Class C Option 3 (Using No. 7, 78, or 8 Size) per 703.13 [2]						
Gravel	1370 (813)	1500 (890)	412 (224)	138 (82)	0.50	26.98 (1.00)
Limestone	1410 (837)	1480 (878)	412 (224)	138 (82)	0.50	27.00 (1.00)

[1] Use only 701.04 or 701.01 cement with this option.
[2] 8% +/- 2% entrained air content
GGBF = ground granulated blast furnace slag;
CM = cementitious material.

Restrict the use of coarse aggregate in portland cement concrete pavements according to 703.13.

Use compatible admixtures in the concrete mixture, and dispense admixtures according to manufacturer's recommendations.

If portland cement with fly ash as an additive is used as described under Option 1 or if ground granulated blast furnace slag is used under Option 3, only use the mix designs between April 1 and October 15 unless otherwise authorized by the Director. Do not schedule the use of mix designs utilizing fly ash or ground granulated blast furnace slag for the time period before April 1 or after October 15. These date restrictions do not apply to Class HP concrete mixes. If Option 1 is used and the nominal concrete temperature exceeds 75 °F (24 °C), use an approved set-retarding admixture conforming to 705.12, Type B or D. If Option 2 or 3 is used and the nominal concrete temperature exceeds 75 °F (24 °C), use an approved water-reducing, set-retarding admixture conforming to 705.12, Type D. Unless otherwise authorized by the Engineer, use only one source of fly ash or GGBFS in any one structure. Store bulk fly ash and GGBFS in waterproof bins.

499.05 Additional Classes of Concrete for Rigid Replacement. Proportion the concrete materials to conform to the requirements of each class of full depth rigid pavement removal and rigid replacement concrete specified. Use any one of the following coarse aggregate sizes: No. 57, 6, 67, 7, 78, or 8. Use an entrained air content

of 8 ± 2 percent with No. 7, 78, or 8 size coarse aggregate. Otherwise, use an entrained air content of 6 ± 2 percent.

The Engineer will base approval of the concrete mix design on submitted proportions and the requirements of this item.

A. Class FS. This class is a fast-setting portland cement concrete for accelerated setting and strength development. Use a minimum cement content of 900 pounds per cubic yard (534 kg/m^3) and a maximum water-cement ratio of 0.40. Do not open the rigid replacement to traffic until test cylinders have a split tensile strength of 250 pounds per square inch (1.7 MPa), as tested per ASTM C496.

Use an admixture conforming to 705.12, Type B or D, according to manufacturer's recommendations to keep the concrete plastic until the surface can be textured.

Just before placement, add and mix calcium chloride with each batch of concrete. If using calcium chloride with 94 to 97 percent purity, add 1.6 percent by weight of the cement. If using calcium chloride with 70 to 80 percent purity, add 2.0 percent by weight of the cement. When using a calcium chloride and water solution, consider the water as part of the concrete mixing water and make appropriate adjustments for its inclusion in the total concrete mixture.

Use any other approved accelerating admixture at the dosage rate per cubic yard (cubic meter) recommended by the manufacturer, provided the accelerating mixture produces the required strength.

Immediately after applying the curing compound, cover the replacement concrete with polyethylene sheeting and with building board according to ASTM C 208. Wrap the building board in black polyethylene sheeting, place the building board tight against the surrounding concrete, and weigh down the board to protect the fresh concrete from the weather.

B. Class MS. This class is a moderate-setting portland cement concrete for accelerated strength development. Use a minimum cement content of 800 pounds per cubic yard (475 kg/m^3) and a maximum water-cement ratio of 0.43. Do not open the rigid replacement to traffic until test cylinders have attained a split tensile strength of 250 pounds per square inch (1.7 MPa), as tested per ASTM C496.

499.06 Equipment. Provide batching and mixing equipment meeting the following requirements:

A. Batching Plants. Operate each plant so that aggregate materials are not segregated and there is no intermingling of the materials before batching. Use weighing mechanisms that allow a visible means of checking weights and produce a printed record. Use dispensing mechanisms for water and admixtures that allow a visible means of checking quantities and produce a printed record.

Use cement and aggregate weighing mechanisms that are accurate to within ±0.5 percent of the correct weight. Ensure that devices for weighing or metering water are accurate to ±1.0 percent throughout the range used.

Maintain a certification from a Sealer of Weights and Measures or a scale servicing company attesting to the accuracy of the weighing and metering devices. Have this service performed within a 12-month period before use of the plant. A

Certificate of Performance issued by the National Ready Mixed Concrete Association may be used instead of the Sealer of Weights and Measures or a scale servicing company.

Maintain the services of a scale servicing company or ten standard test weights to reach a capacity of 500 pounds (227 kg) for testing the weighing devices at the batch plant. The Ohio Department of Agriculture will seal all device-testing weights every 3 years.

The Engineer will test weighing and dispensing devices as often as deemed necessary to ensure continued accuracy.

B. Mixers. Provide mixers and agitators conforming to AASHTO M 157, Sections 10, 11.2, 11.5, and 11.6, except that the City will allow mechanical counters.

For bodies of non-agitating concrete hauling equipment, provide smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactory controlled rate without segregation. Provide covers when required by the Engineer. The Engineer will allow trucks having dump bodies with rounded corners and no internal ribs or projections for non-agitating hauling.

499.07 Handling, Measuring, and Batching Materials. Do not stockpile aggregates from different sources or different gradations together. The Engineer may direct reworking or cleaning, or may reject aggregates that have become segregated or mixed with earth or foreign material. Maintain coarse aggregate with a uniform moisture content.

Separately weigh the amounts of fine aggregate and coarse aggregate, as determined by the Engineer and outlined in 499.03. Use a separate weighing device for cementitious materials.

Conduct batching such that the weight of cement is within a tolerance of ±1.0 of the weight required and the weight of each aggregate batched is within ±2.0 percent of the weight required. Measure water by weight or volume to within a tolerance of ±1.0 percent of the required amount. Dispense admixtures to within a tolerance of ±3.0 percent of the required amount.

The Engineer will approve methods and equipment used to add admixtures into the batch. Add air-entraining admixture at the time of batching.

499.08 Batch Plant Tickets. Furnish a concrete batch plant ticket to the Engineer for each load of concrete delivered for use on the project. Use handwritten, computer generated, or a combination of computer generated and handwritten batch tickets. At a minimum, include the information listed in Table 499.08-1 on each ticket:

TABLE 499.08-1 EVERY BATCH TICKET

Name of ready-mix batch plant	
Batch plant No.	
Batch plant location	
Serial number of ticket	
Date	
Truck number	
Class of concrete	
JMF Number	
Time the load was batched	
Size of batch	yd^3 (m^3)
Actual weights of cementitious material:	
Cement	lb (kg)
Fly ash	lb (kg)
Ground granulated blast furnace slag	lb (kg)
Microsilica	lb (kg)
Other	lb (kg)
Actual weights of aggregates:	
Coarse	lb (kg)
Fine	lb (kg)
Other	lb (kg)
Actual weight of water	lb (kg)
Actual volume of admixtures:	
Air-entrainer	fl oz (mL)
Superplasticizer	fl oz (mL)
Water-reducer	fl oz (mL)
Retarder	fl oz (mL)
Other	fl oz (mL)
Aggregate moisture contents:	
Coarse aggregate	%
Fine aggregate	%
Water-cement ratio, leaving the plant	

Provide the information in Table 499.08-2 with batch tickets for each day's first load of concrete and for each JMF. Include Table 499.08-2 information on the batch ticket or furnish the information on a separate computer-generated or handwritten form attached to the batch ticket.

If during the concrete manufacturing process any of the information listed in Table 499.08-2 changes, resubmit Table 499.08-2 information with the first batch ticket supplied with the changed concrete.

TABLE 499.08-2 FIRST TICKET EACH DAY, EACH JMF

Cementitious Materials:	Source:	Grade or Type:
Cement		
Fly ash		
Ground granulated blast furnace slag		
Microsilica		
Other		
Admixtures:	Brand:	Type:
Air-entrainer		
Retarder		
Superplasticizer		
Water-reducer		
Other		

The provided concrete batch ticket information is according to ASTM C 94/C 94M, Section 13.

The Engineer may require supporting data to validate the basis for furnished aggregate moisture contents.

Include the cost for generating and supplying the information of this section and the concrete batch tickets in the individual concrete items.

499.09 Mixing Concrete. Use a central mix plant or in truck mixers to mix the concrete.

When using a central mix plant, mix the concrete for not less than 60 seconds. Begin the mixing time when all materials are in the drum and end the mixing time when discharge begins. Include transfer time in multiple drum mixers in the mixing time. Remove the contents of an individual mixer drum before a succeeding batch is emptied into the drum.

When concrete is mixed using a truck mixer for complete mixing, mix each batch of concrete at the rotation rate designated on the mixer as mixing speed for not less than 70 revolutions of the drum. Transport mixed concrete from the central mixers in truck mixers, truck agitators, or trucks having non-agitating bodies. Within 60 minutes after cement and water are combined, deliver and completely discharge concrete. If an approved set-retarding (705.12, Type B) or water-reducing and set-retarding (705.12, Type D or G) admixture is used at no expense to the City, complete discharge within 90 minutes after combining the water and the cement.

When concrete is delivered in transit mixers and before discharging any of a batch, the Engineer may allow adding water within the specified water-cement ratio limits. Perform sufficient mixing, a minimum of 30 revolutions at mixing speed, to adjust the slump and to regenerate the specified air content throughout the batch. Adding water will not extend the above 60 and 90-minute time limitations.

When approved by the Engineer, the Contractor may use approved admixtures (705.12, Type F or G) for retempering the load to adjust the slump after the start of

discharge. Mix for a minimum of 30 revolutions at mixing speed after addition of the admixture.

Use admixtures containing no more than 50 parts per million chloride by weight of cement only when specified in the Contract Documents or with the Engineer's written permission.

Perform split tension testing in accordance with ASTM C496.

Until discharged in the work, ensure that the temperature of all concrete does not exceed 90 °F (32 °C).