REVISION OF SECTIONS 601 AND 701
STRUCTURAL CONCRETE

Sections 601 and 701 of the Standard Specifications are hereby revised for this project as follows:

Delete subsection 601.02 and replace with the following:

601.02 Classification. The classes of concrete shown in Table 601-1 shall be used when specified in the Contract.

Table 601-1
CONCRETE TABLE

Concrete Class	Required Field Compressive Strength (psi)	Cementitious Content: Minimum or Range (lbs/yd^3)	Air Content: % Range (Total)	Water Cementitious Ratio: Maximum or Range
B	4500 at 28 days	N/A	5 - 8	0.45
BZ	4000 at 28 days	610	N/A	0.45
D	4500 at 28 days	615 to 660	5 – 8	0.44
DT	4500 at 28 days	700	5 – 8	0.44
E	4200 at 28 days	660	4 – 8	0.44
H	4500 at 56 days	580 to 640	5 – 8	0.38 - 0.42
HT	4500 at 56 days	580 to 640	5 – 8	0.38 - 0.42
P	4200 at 28 days	660	4 – 8	0.44
S35	5000 at 28 days	615 to 720	5 – 8	0.42
S40	5800 at 28 days	615 to 760	5 – 8	0.40
S50	7250 at 28 days	615 to 800	5 – 8	0.38

Class B concrete is an air entrained concrete for general use. Class D, H or P concrete may be substituted for Class B concrete. Additional requirements are: The coarse aggregate shall have a nominal maximum size of 1½ inches or smaller. Approved fly ash may be substituted for portland cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious.

Class BZ concrete is concrete for drilled piers. Additional requirements are: Entrained air is not required unless specified in the Contract. High range water reducers may be added to obtain desired slump and retardation. Slump shall be a minimum of 5 inches and a maximum of 8 inches. The concrete mix shall be made with AASHTO M 43 size No. 67, No. 7 or No. 8 coarse aggregate. Approved fly ash may be substituted for portland cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious.

Class D concrete is a dense medium strength structural concrete. Class H may be substituted for Class D concrete. Additional requirements are: An approved water reducing admixture shall be incorporated in the mix. The concrete mix shall be made with AASHTO M 43 sizes No. 57, No. 6 or No. 67 coarse aggregate. When placed in a bridge deck, the concrete mix shall consist of a minimum 55 percent AASHTO M 43 size No. 67 coarse aggregate by weight of total aggregate. Approved fly ash may be substituted for portland cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious.

Class DT concrete may be used for deck resurfacing and repairs. Class HT may be substituted for Class DT concrete. Additional requirements are: An approved water reducing admixture shall be incorporated in the mix. The concrete mix shall consist of a minimum 50 percent AASHTO M 43 size No. 7 or No. 8 coarse aggregate by weight of total aggregate. Approved fly ash may be substituted for portland cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious.

Class E concrete may be used for fast track pavements needing early strength in order to open a pavement to service soon after placement. Additional requirements are: Type III cement may be used The concrete mix shall consist of a minimum 55 percent AASHTO M 43 size No. 357 or No. 467 coarse aggregate by weight of total aggregate. If all transverse joints are doweled, the concrete mix shall consist of a minimum 55 percent AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 357, or No. 467 coarse aggregate by weight of total aggregate. The laboratory trial mix must produce an average 28 day flexural strength of a minimum 650 psi. Class E concrete

shall contain a minimum 10 percent to a maximum of 20 percent Class C, or a minimum 10 percent to a maximum 30 percent Class F fly ash by weight of total cementitious.

Class H concrete is used for bare concrete bridge decks that will not receive a waterproofing membrane. Additional requirements are: An approved water reducing admixture shall be incorporated in the mix. The concrete mix shall consist of a minimum of 55 percent AASHTO M 43 size No. 67 coarse aggregate by weight of total aggregate. Class H concrete shall contain cementitious materials in the following ranges: 450 to 500 pounds per cubic yard Type II portland cement, 90 to 125 pounds per cubic yard fly ash and 20 to 30 pounds per cubic yard silica fume. The total content of Type II portland cement, fly ash and silica fume shall be 580 to 640 pounds per cubic yard. The laboratory trial mix must not exceed permeability of 2000 coulombs at 56 days (ASTM C 1202) and must not exhibit a crack at or before 14 days in the cracking tendency test (AASHTO PP 34).

Class HT concrete is used as the top layer for bare concrete bridge decks that will not receive a waterproofing membrane. Additional requirements are: An approved water reducing admixture shall be incorporated in the mix. The concrete mix shall consist of a minimum of 50 percent AASHTO M 43 size No. 7 or No. 8 coarse aggregate by weight of total aggregate. Class HT concrete shall contain cementitious materials in the following ranges: 450 to 500 pounds per cubic yard Type II portland cement, 90 to 125 pounds per cubic yard fly ash and 20 to 30 pounds per cubic yard silica fume. The total content of Type II portland cement, fly ash and silica fume shall be 580 to 640 pounds per cubic yard. The laboratory trial mix must not exceed permeability of 2000 coulombs at 56 days (ASTM C 1202) and must not exhibit a crack at or before 14 days in the cracking tendency test (AASHTO PP 34).

Class P concrete is used in pavements. Additional requirements are: The concrete mix shall consist of a minimum 55 percent AASHTO M 43 size No. 357 or No. 467 coarse aggregate by weight of total aggregate. If all transverse joints are doweled, the concrete mix shall consist of a minimum 55 percent AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 357, or No. 467 coarse aggregate by weight of total aggregate. The laboratory trial mix must produce an average 28 day flexural strength of a minimum 650 psi. Class P concrete shall contain a minimum 10 percent to a maximum of 20 percent Class C, or a minimum 10 percent to a maximum 30 percent Class F fly ash by weight of total cementitious. Unless acceptance is based on flexural strength, the total weight of cementitious shall not be less than 660 pounds per cubic yard. If acceptance is based on flexural strength, the total weight of cementitious shall not be less than 520 pounds per cubic yard.

Class S35 concrete is a dense high strength structural concrete. Additional requirements are: An approved water reducing admixture shall be incorporated in the mix. The concrete mix shall be made with AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 7 or No. 8 coarse aggregate. When placed in a bridge deck, the concrete mix shall consist of a minimum 55 percent AASHTO M 43 size No. 67 coarse aggregate by weight of total aggregate. Approved fly ash may be substituted for portland cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious.

Class S40 concrete is a dense high strength structural concrete. Additional requirements are: An approved water reducing admixture shall be incorporated in the mix. The concrete mix shall be made with AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 7 or No. 8 coarse aggregate. When placed in a bridge deck, the concrete mix shall consist of a minimum 55 percent AASHTO M 43 size No. 67 coarse aggregate. Approved fly ash may be substituted for portland cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious.

Class S50 concrete is a dense high strength structural concrete. Additional requirements are: An approved water reducing admixture shall be incorporated in the mix. The concrete mix shall be made with AASHTO M 43 sizes No. 57, No. 6, No. 67, No. 7 or No. 8 coarse aggregate. When placed in a bridge deck, the concrete mix shall consist of a minimum 55 percent AASHTO M 43 size No. 67 coarse aggregate by weight of total aggregate. Approved fly ash may be substituted for portland cement up to a maximum of 20 percent Class C or 30 percent Class F by weight of total cementitious. The laboratory trial mix must not exhibit a crack at or before 14 days in the cracking tendency test (AASHTO PP 34).

Subsection 601.03 shall include the following:

Where blended hydraulic cement is used the substitution of fly ash for the blended hydraulic cement is not allowed.

Subsection 601.04 shall include the following:

601.04 Sulfate Resistance. The Contractor shall provide protection against sulfate attack on concrete structures by providing concrete structures manufactured with requirements according to Table 601-4. The exposure Class will be stated on the plans. A higher level of requirements may be used for a lower level of exposure.

If the Contractor can provide a test report that shows another class of exposure exists at a structure location, then the Engineer may accept a concrete mix for that location that meets the corresponding sulfate protection requirements in addition to other requirements shown in this section.

Table 601-4
REQUIREMENTS TO PROTECT AGAINST DAMAGE TO CONCRETE BY SULFATE ATTACK FROM EXTERNAL SOURCES OF SULFATE

Severity of potential exposure	Water-soluble sulfate (SO_4), percent, dry soil	Sulfate (SO_4) in water, ppm	Water cementitious ratio, maximum	Cementitious material requirements
Class 0	0.00 to 0.10	0 to 150	0.45	Class 0
Class 1	0.11 to 0.20	151 to 1500	0.45	Class 1
Class 2	0.21 to 2.00	1501 to 10,000	0.45	Class 2
Class 3	2.01 or greater	10,001 or greater	0.40	Class 3

Cementitious material requirements are as follows:

Class 0 requirements shall be one of the following:
(1) ASTM C 150 Type I, II or V
(2) ASTM C 595 Type IP
(3) ASTM C 1157 Type GU
(4) ASTM C 150 Type III cement if it is allowed, as in Class E concrete

Class 1 requirements for sulfate resistance shall be one of the following:
(1) ASTM C 150 Type II or V; Class C fly ash shall not be allowed in the concrete mix
(2) ASTM C 595 Type IP(MS)
(3) ASTM C 1157 Type MS
(4) When ASTM C 150 Type III cement is allowed, as in Class E concrete, it shall have no more than 8 percent C_3A. Class C fly ash shall not be allowed in the concrete mix

Class 2 requirements for sulfate resistance shall be one of the following:
(1) ASTM C 150 Type V with a minimum of a 20 percent substitution of Class F fly ash by weight
(2) ASTM C 150 Type II or III with no more than 0.040 percent expansion at 14 days when tested in accordance with ASTM C 452 with a minimum of a 20 percent substitution of Class F fly ash by weight
(3) ASTM C 1157 Type HS

(4) A blend of portland cement meeting ASTM C 150 Type II or III with a minimum of 20 percent Class F fly ash by weight, where the blend has less than 0.05 percent expansion at 6 months or 0.10 percent expansion at 12 months when tested according to ASTM C 1012.

Class 3 requirements for sulfate resistance shall be one of the following:
(1) A blend of portland cement meeting ASTM C 150 Type II, III, or V with a minimum of a 20 percent substitution of Class F fly ash by weight , where the blend has less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012.
(2) ASTM C 1157 Type HS having less than 0.10 percent expansion at 18 months when tested according to ASTM C 1012.

When fly ash is used to enhance sulfate resistance, it shall be used in a proportion greater than or equal to the proportion tested in accordance to ASTM C1012 and it shall have a calcium oxide content no more than 2.0 percent greater than the fly ash tested according to ASTM 1012.

Delete subsection 601.05 and replace with the following:

601.05 Proportioning. The Contractor shall submit a Concrete Mix Design for each class of concrete being placed on the project. Concrete shall not be placed on the project before the Concrete Mix Design Report has been reviewed and approved by the Engineer. The Concrete Mix Design will be reviewed and approved following the procedures of CP 62. The Concrete Mix Design will not be approved when the laboratory trial mix data are the results from tests performed more than two years in the past or aggregate data are the results from tests performed more than two years in the past. The concrete mix design shall show the weights and sources of all ingredients including cement, pozzolan, aggregates, water, additives and the water cementitious ratio (w/c). When determining the w/c, cementitous (c) shall be the sum of the weight of the cement, the weight of the fly ash and the weight of silica fume.

The laboratory trial mix data shall include results of the following:

(1) AASHTO T 119 (ASTM C 143) Slump of Hydraulic Cement Concrete.
(2) AASHTO T 121 (ASTM C 138) Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete.
(3) AASHTO T 152 (ASTM C 231) Air Content of Freshly Mixed Concrete by the Pressure Method
(4) ASTM C 39 Compressive Strength of Cylindrical Concrete Specimens shall be performed with at least two specimens at 7 days and three specimens at 28 days. Three additional specimens tested at 56 days shall be required for Class H and HT concrete.
(5) Class H and HT concrete shall include a measurement of permeability by ASTM C 1202 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration. The concrete test specimens shall be two 2 inch thick disks sawed from the centers of two molded 4 inch diameter cylinders cured 56 days in accordance with ASTM C 192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
(6) Class H, HT and S50 concrete shall include a measurement of cracking by AASHTO PP 34 Standard Practice for Estimating the Cracking Tendency of Concrete. The ring shall be cured in an indoor room with the temperature maintained 65 to 75 °F and relative humidity not exceeding 40 percent.
(7) Class E and P concrete shall include AASHTO T 97 (ASTM C 78) Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading) performed with at least two specimens at seven days and four specimens at 28 days.

Prior to placement of Class E concrete, the Contractor shall provide the Engineer a report of maturity relationships in accordance with CP 69. The Contractor shall provide maturity meter and all necessary wire and connectors. The Contractor shall be responsible for the placement and maintenance of the maturity meter and wire. Placement shall be as directed by the Engineer.

Except for class BZ concrete, the maximum slump of the delivered concrete shall be the slump of the approved concrete mix design plus 1½ inch. Except for class H and HT concrete, the laboratory trial mix must produce an average 28 day compressive strength at least 115 percent of the required 28 day field compressive strength. The laboratory trial mix for Class H or HT concrete must produce an average 56 day compressive strength at least 115 percent of the required 56 day field compressive strength.

The laboratory trial mix shall have a relative yield of 0.99 to 1.02. When Portland Cement Concrete Pavement is paid with a volumetric pay quantity, the relative yield of the concrete produced on the project shall be 0.99 to 1.02.

If the relative yield of the produced concrete does not conform to this range for two consecutive yield determinations, concrete production shall cease and the Contractor shall present a plan to correct the relative yield to the Engineer.

Aggregate data shall include the results of the following:

(1) AASHTO T 11 (ASTM C 117) Materials Finer Than 75 um (No. 200) Sieve in Mineral Aggregates by Washing.
(2) AASHTO T 19 (ASTM C 29) Unit Weight and Voids in Aggregate.
(3) AASHTO T 21 (ASTM C 40) Organic Impurities in Fine Aggregate for Concrete.
(4) AASHTO T 27 (ASTM C 136) Sieve Analysis of Fine and Coarse Aggregates.
(5) AASHTO T 84 (ASTM C 128) Specific Gravity and Absorption of Fine Aggregate.
(6) AASHTO T 85 (ASTM C 127) Specific Gravity and Absorption of Coarse Aggregate.
(7) AASHTO T 96 (ASTM C 131) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
(8) AASHTO T 104 (ASTM C 88) Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
(9) AASHTO T 176 (ASTM D 2419) Plastic Fines in Graded Aggregates and Soils by use of the Sand Equivalent Test
(10) ASTM C 535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
(11) CP-L 4201 Determining the Potential Alkali Reactivity of Aggregates (Accelerated Mortar-Bar Method). When an aggregate source is known to be reactive, CP-L 4202 results may be submitted in lieu of CP-L 4201 results.

Any aggregate tested by CP-L 4201 with an expansion of 0.10 percent or more, or that is known to be reactive, shall not be used unless mitigative measures are included in the mix design. Mitigative measures shall be tested using CP-L 4202 and exhibit an expansion less than 0.10 percent by one of the following methods:

(1) Combined Aggregates. The mix design sources of aggregates, cement and mitigative measures shall be tested. The proportions of aggregates and mitigative measures shall be those used in the mix design.

(2) Individual Aggregates. Each source and size of individual aggregates shall be tested. The source of cement and mitigative measures shall be those used in the mix design. The highest level of mitigative measures for any individual aggregate shall be the minimum used in the mix design.

The Concrete Mix Design Report shall include Certified Test Reports showing that the cement, fly ash and silica fume admixture meet the specification requirements and supporting this statement with actual test results. The certification for silica fume shall state the solids content if the silica fume admixture is furnished as slurry.

Where the Contractor's use of fly ash results in any delay, necessary changes in admixture quantities or source, or unsatisfactory work, the cost of such delays, changes or corrective actions shall be borne by the Contractor.

The Contractor shall submit a new Concrete Mix Design Report meeting the above requirements when a change occurs in the source, type, or proportions of cement, fly ash, silica fume or aggregate. When a change occurs in the source of approved admixtures, the Contractor shall submit a letter stamped by the Concrete Mix Design Engineer approving the changes to the existing mix design. The change will be approved by the Engineer prior to use.

The use of approved accelerating, retarding or hydration stabilizing admixtures to existing mix designs will be permitted at the discretion of the Engineer when documentation includes the following:

(1) Manufacturers recommended dosage of the admixture

(2) A letter stamped by the Concrete Mix Design Engineer approving the changes to the existing mix design.

Unless otherwise permitted by the Engineer, the product of only one type of portland cement from one source of any one brand shall be used in a concrete mix design.

Review and approval of the Concrete Mix Design by the Engineer does not constitute acceptance of the concrete. Acceptance will be based solely on the test results of concrete placed on the project.

Subsection 601.12 (j), third paragraph, shall include the following:

When concrete is to be placed on or adjacent to hardened concrete surfaces, the surface shall be saturated surface dry. Saturated surface dry concrete has no water on its surface. The pores of the concrete beneath the surface are moist.

Delete subsection 701.01 and replace with the following:

701.01 Hydraulic Cement. Hydraulic cement shall conform to the requirements of the following specifications for the type specified or permitted:

Portland Cement	ASTM C 150
Blended Hydraulic Cement	ASTM C 595
Hydraulic Cement	ASTM C 1157

In addition to the standard chemical requirements for portland cement in ASTM C 150, the maximum percent of equivalent alkalis ($Na_2O + 0.658\ K_2O$) shall not exceed 0.90 percent.

All concrete, including precast, prestressed and pipe shall be constructed with one of the following hydraulic cements unless permitted otherwise.

ASTM C 150 Type I
ASTM C 150 Type II
ASTM C 150 Type V
ASTM C 595 Type IP consisting of no less than 70 percent portland cement,
ASTM C 595 Type IP(MS) consisting of no less than 70 percent portland cement,
ASTM C 1157 Type GU,
ASTM C 1157 Type MS
ASTM C 1157 Type HS consisting of no less than 20 percent Class F fly ash by weight

Cement shall be from a preapproved source listed on the Department's Approved Products List. The cement intended for use on the project shall have been tested and accepted prior to its use. Certified Test Reports showing that the cement meets the specification requirements and supporting this statement with actual test results shall be submitted to the Engineer prior to the tested material being incorporated into the project.

The cement shall be subject to sampling and testing by the Department. Test results that do not meet the physical and chemical requirements may result in the suspension of the use of the cement until the corrections necessary have been taken to insure that the material meets the specifications.

The Contractor shall provide suitable means for storing and protecting the cement against dampness. Cement which, for an reason, has become partially set or which contains lumps of caked cement shall not be used.

Cement salvaged from discarded or used bags shall not be used.