SPECIAL PROVISION
SPECIFICATION 934 – STRUCTURAL CONCRETE

934-1 DESCRIPTION

934-1.01 Scope

a. This work shall consist of furnishing, placing, finishing and curing Portland cement concrete for cast in place concrete, precast concrete and concrete mix designs in accordance with these specifications and in conformity with the lines, grades and dimensions shown on the plans or established by the Engineer. Concrete in bridge approach slabs is included in this work.

b. Portland cement concrete shall consist of a homogeneous mixture of Portland cement, mineral admixtures, slag cement or ground granulated blast-furnace slag, fine aggregate, coarse aggregate, water and chemical admixtures, if required, proportioned and mixed according to these specifications.

c. When the plans and other contract documents indicate that Portland cement concrete meeting the requirements of Special Provision 934 will be used in piles constructed under specification 615 and/or prestressed members constructed under specification 630; all references to specification 601 in specification 615 and/or 630 shall be interpreted as referring to Special Provision 934.

934-2 MATERIALS

934-2.01 The following materials shall meet the applicable requirements specified in the following specifications:

MATERIAL	SPECIFICATION
Portland cement ……	701-1
Ground Granulated Blast-Furnace Slag	AASHTO M302
Class F Fly Ash ……..	AASHTO M-295
Microsilica ……..	AASHTO M-307
Joint Fillers …….	705-1
Copper Water Stops or Flashing ……	705-5
Rubber and Neoprene Water Stops ……	705-6
Curing materials …….	711-1
Air-entraining Admixtures …….	711-2
Chemical Admixtures …….	711-3
Water ……..	712-1
Bearings and Expansion Plates, Bronze and Copper Alloy ……	715-7
Other Metallic Materials ……	715
Elastomeric Bearing ……...	717
Rubble Stone ……..	718-2

934-2.02 Fine Aggregate - Shall meet the requirements of Article 703-1 of Specification 703 - Aggregates, except that the grading shall conform to Grading A of Table 703-1 and that manufactured sand shall not be used as fine aggregate for all concrete that is to serve as the travel way to vehicular traffic. The same source of sand shall be used for all faces of a concrete structure exposed to view.

934-2.03 Coarse Aggregate - Shall meet the requirements specified in Article 703-2 - of Specification 703 Aggregates, except that the gradings in Table 703-2 are to be limited to those included in Table 934-1 of this specification. In addition, for concrete that is to serve as the travel way for vehicular traffic, such as concrete pavements, bridge decks and bridge approach slabs, the coarse aggregate shall have a minimum polishing value of 48 as determined by ASTM D 3319.

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934-2.04 Cementitious Materials and Mineral Admixtures Requirements -

a. **Portland Cement** - All Portland cement shall meet the requirements of this Section in addition to the requirements of Specification Section 701 - "Hydraulic Cement." Unless otherwise stated herein, the provisions of Specification Section 701 - "Hydraulic Cement" shall apply.

b. For Structural Concrete provide Portland cement meeting ASTM C 150 or blended Portland cement meeting ASTM C 595 and the following requirements:

Provide a cement that meets the requirements of ASTM C 150 for Type II or Type V or ASTM C 595, Type IP (MS) or Type IS (MS). As an alternative provide a combination of ASTM C 150 Type I cement and an ASTM C 618 Class F fly ash, an AASHTO M307 Microsilica and/or an ASTM C 989 Ground Granulated Blast-Furnace Slag having a sulfate expansion at 180 days of less than 0.10 percent when tested according to ASTM C 1012 using cementitious materials from the same sources as those proposed for use in the project.

c. For non-structural concrete such as concrete used for sidewalks, railings, curbs, wheel bumps, provide Portland cement that meets the requirements of ASTM C 150 or ASTM C 595.

d. The Contractor shall furnish mill certificates of compliance of the cement with the requirements of these specifications. Cement may also be accepted from pre-tested and approved bins. However, the Authority may sample and test the cement at any time, at its discretion and require additional mill certificates.

e. Cement shall be protected from rain and moisture by storing in suitable weatherproof bins or buildings. Any cement damaged by moisture or which fails to meet any of the specified requirements will be rejected and shall be removed from the work site.

f. Cement stored by the Contractor for a period longer than 60 days shall require the Engineer's approval before being used in the work. Stored cement shall meet the specification requirements at any time after storage when retesting is ordered by the Engineer.

g. Cement of different brands, types, or from different mills shall be stored separately.

h. **Cementitious Materials and Mineral Admixtures** - All mineral admixtures shall meet the requirements of this Section in addition to the requirements of Specification Section 711 - "Concrete Curing Materials and Admixtures." Unless otherwise stated herein, the provisions of Specification Section 711 - "Concrete Curing Materials and Admixtures" shall apply.

i. Microsilica can be used in concrete either as a cement replacement or as a cement addition on an equal weight basis. Recommended amounts of Microsilica are in the range of up to 10 percent of the total weight of the cementitious material. When fly ash is used, it shall be incorporated either as a cement replacement, as a mineral admixture added as a replacement of fine aggregate or a combination thereof. All fly ash shall be added on an equal weight basis of the material being replaced. Recommended amounts of fly ash are in the range of up to 40 percent added as a cement replacement and up to 20 percent added as a mineral admixture.

j. Ground Granulated Blast-Furnace Slag (GGBFS) for use as a cementitious material shall conform to the requirements of ASTM C 989, "Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars," Grade 100 or Grade 120. Ground Granulated Blast-Furnace Slag should be used as a Portland cement replacement on an equal weight basis. Recommended amounts of ground granulated blast-furnace slag are in the range of 25 to 65 percent added

as a cement replacement on an equal weight basis of the cement being replaced.

k. The pozzolan constituent of Type IP (MS) shall be in the range of 15 to 40 percent by weight of the Portland-pozzolan cementitious material.

l. Fly Ash for use with Portland cement shall conform to the requirements of ASTM C 618, Class F only. In addition, fly ash shall meet the following requirements:

1. Loss on Ignition is limited to a maximum of 2 percent.

2. Sulfur trioxide (SO_3) is limited to a maximum of 3 percent.

3. Available alkalis (expressed as Na_2O equivalent) is limited to a maximum of 1.5 percent.

4. The optional chemical requirements of ASTM C 618 Table 1A shall apply in all cases.

5. Fly Ash may not be substituted for Type IP blended cements.

6. Fly Ash may also be used as a replacement of fine aggregate if needed to achieve the performance requirements of the concrete. When used as a fine aggregate additive, it should not exceed 20 percent of the weight of the fine aggregate.

m. Ternary systems using Portland cement, Class F fly ash, slag and microsilica are permissible. The total amount of fly ash and silica fume shall meet the limits for fly ash used alone.

n. The Contractor shall submit notarized material certificate for the ground granulated blast-furnace slag and/or mineral admixtures proposed to be used in conformance with the General Provisions.

934-2.05 Classes of Concrete - Various classes of concrete are provided for in these specifications, based on their use and their specified compressive strength at 28 days, except as noted below. The various classes and their basic requirements are indicated in Table 934-1 and 934-2. Each class of concrete and its permeability level shall be used in that part of the structure as called for in the plans and other contract documents, or ordered by the Engineer.

Table 934-1
PORTLAND CEMENT CONCRETE MIXTURES

Class of Concrete	Specified Design Compressive Strength at 28 days (psi) *	Maximum Coarse Aggregate Size (square openings)	Permeability Maximum Charge Passed ** (Coulombs)	Minimum Cementitious Content *** (lb/cy)
I (Lean Concrete)	1,000	1” with 5% maximum passing No. 8	Not Applicable	-
II (Incidental)	2,200	1” with 5% max Passing No. 8	Not Applicable	300
III (General Use)	3,000	1” with 5% max Passing No. 8	See Table 934-2	500
III (Pavement Rehabilitation)	3,000 (See Note Below)	2” with 5% max Passing No. 8	See Table 934-2	600

IV (General Use)	4,000	1" with 5% max Passing No. 8	See Table 934-2	550
IV (Bridge Deck)	4,000	1" with 5% max Passing No. 8	See Table 934-2	600
V (Drilled Shaft)	5,000	1" with 5% max Passing No. 8	See Table 934-2	650
V (Prestressed Members)	5,000	1" with 5% max Passing No. 8	See Table 934-2	650
V (Pavement)	5,000	2" with 5% max Passing No. 8	See Table 934-2	650
V (General Use)	5,000	1" with 5% max Passing No. 8	See Table 934-2	650
VI	6,000	1" with 5% max Passing No. 8	See Table 934-2	650
VII	7,000	1" with 5% max Passing No. 8	See Table 934-2	650
VIII	8,000	1" with 5% max Passing No. 8	See Table 934-2	650
IX	9,000	1" with 5% max Passing No. 8	See Table 934-2	650
X	10,000	1" with 5% max Passing No. 8	See Table 934-2	650

Notes: 1- For Class III (Pavement Rehabilitation) the required compressive strength indicated in table 934-1 shall be interpreted so as to be attained at 5 days of age. Also, when using this class of concrete, steel reinforcement shall be installed as indicated in specification 503.

2- For laboratory reports purposes, the classes of concrete in arabic numerals showed in the reports shall be interpreted so as to be equal to the roman numerals indicated in the table above (Class I = Class 1,Class II = Class 2,Class III = Class 3, Class IV = Class 4, Class V = Class 5, Class VI = Class 6, Class VII = Class 7, Class VIII =Class 8, Class IX = Class 9 and Class X = Class 10).

* The compressive strength of the concrete at 28 days shall be determined using either 6 in. diam. x 12 in. or 4 in. diam. x 8 in. cylindrical specimens as long as the ratio of the maximum size of the coarse aggregate to the diameter of the cylinder test specimen does not exceed the value of 3.

* For concrete containing ground granulated blast-furnace slag, microsilica and/or fly ash, the compressive strength of the concrete at 28 days shall be determined using specimens moist cured at 73 +/- 3 deg.F until testing at 28 days. For special cases called for in the plans in which concrete strength at ages greater than 28 days can be specified, acceptance of the concrete could be based on the accelerated curing procedure used to determine the permeability of concrete as described below.

** Permeability will be the electrical conductance of the concrete as measured at 28 days according to AASHTO T-277. The permeability of the concrete at 28 days shall be determined using the following accelerated curing procedure: specimens will be moist cured at 73 +/- 3 deg.F for the initial 7 days after casting followed by curing in water at 105 +/- 3 deg.F for 21 days until testing at 28 days.

*** The Minimum Cementitious Content (lbs. /cu. yd.) refers to the total weight of Portland cement, ground granulated blast-furnace slag, microsilica and fly ash added to the concrete expressed in lbs./cu. yd.

Table 934-2

Permeability Level*	**Permeability Maximum Charge Passed (Coulombs)**
1	Not Applicable
2	1,500

*If no Permeability Level of concrete is indicated on the plans, a Permeability Level 2 shall be used in all

concrete mixes to be placed in the project.

a. Temperature of Fresh Concrete:

1. Maximum temperature of fresh concrete containing no set controlling admixtures shall not exceed 90 degrees F (32°C) at the time of placement.

2. Maximum temperature of fresh concrete mixes containing set controlling admixtures shall not exceed 95 degrees F (35°C) at the time of placement.

b. Provide concrete of a uniform color in all exposed concrete of any structure.

c. Whenever used, the corrosion inhibitor shall be dosed at the required application rate to achieve the required level of chloride protection as stated in Article 934-2.08-i-2.

d. Drying Shrinkage: The drying shrinkage of concrete shall not exceed 0.030 percent after 28 days of air storage following the initial 28 days curing period in accordance with ASTM C157, "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete" with the following modifications:

1. The initial curing period until the specimens have reached an age of 28 days, including the period in the molds, could be achieved either by storage in a moist cabinet or room in accordance with ASTM C511, or storage in lime saturated water at 73 +/- 3 deg.F.

2. Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C157 Section 7.4.

3. Certified test report shall be submitted before concrete is used.

934-2.06 Proportioning of Concrete -

a. The Contractor shall design the concrete mixes determining the proportions of Portland cement, mineral and chemical admixtures, coarse and fine aggregate, and water necessary to conform to these specifications and to obtain concrete having not less than the strength specified for each class in Table 934-1 and having a permeability level not greater than the specified in Table 934-2. The volumetric proportioning methods such as outlined in the American Concrete Institute (ACI) Standard 211.1, “Recommended Practice for Selecting Proportions for Normal Weight Concrete”, or other approved volumetric proportioning methods, shall be employed in the design of mixes. Separate mix designs shall be submitted for each mix to be used such as for travel way and otherwise, and whenever a change in fine or coarse aggregates is necessary. Further, the Contractor shall provide a notarized certificate of compliance with these specifications for all materials proposed to be used in the production of each concrete mix for the project. This certification shall provide information identifying the source of raw materials, manufacturing facility and supplier of each material. Any changes in the source of raw materials, manufacturing facilities and/or suppliers of any of the materials shall require that the contractor conduct trial mixes to verify that the performance of concrete meets all specification requirements and provide certified laboratory test results performed on the concrete trial mix to the Engineer prior to their use in the project.

b. The Contractor shall submit for the record, prior to the start of concreting operations, the proposed mix, including the aggregate gradings to be used, with certified laboratory reports on the tests performed on trial mixes, including permeability test at 28 days of water curing according to Table 934-1 and Table 934-2. In the event that the proportions of concrete mixture designed by the Contractor do not produce concrete of the specified strength and permeabilitylevel, the contractor shall adjust the mix accordingly in order to obtain the required strength and permeability, at no additional cost to the Authority,

and shall submit new certified test results.

c. Whenever the Contractor modifies the concrete mix, other than minor adjustment in the relative quantities of fine and coarse aggregates, he shall submit copy of the new mix design to the Engineer together with copies of test results of the new mix for approval before using the mix in the project.

d. In the event ready-mixed concrete from a commercial plant is used by the Contractor, such concrete and plant shall meet the requirements of AASHTO M-157 except as modified by these specifications and shall have been inspected and approved by the Authority for use on its projects within the last six months.

e. The concrete mix shall be of adequate fresh concrete properties to be placed, consolidated and finished without segregation or defects that will affect the performance of the concrete in service. The Contractor is responsible to ensure that the concrete mix proportions are adequate to meet the minimum standards of practice for the concrete's intended use.

934-2.07 Intentionally Omitted

934-2.08 Chemical Admixtures - All chemical admixtures shall meet the requirements of this Section in addition to the requirements of Specification Section 711 - "Concrete Curing Materials and Admixtures." Unless otherwise stated herein, the provisions of Specification Section 711 - "Concrete Curing Materials and Admixtures" shall apply. Use all admixtures in accordance with manufacturers' recommendations. All admixtures must be submitted to the Engineer prior to their use in the production of concrete.

a. Do not use admixtures which have not been incorporated and tested in accepted and approved mixes.

b. Contractor shall submit the manufacturer’s written certification of compliance with the specifications.

c. Use only admixtures that are compatible with each other, and that produce the desired concrete properties.

d. Water Reducing and Set Controlling Admixtures shall meet the requirements of ASTM C494.

e. Admixtures containing more than 0.05 percent chloride ions shall not be used in the concrete mix.

f. The use of calcium chloride as an admixture will not be permitted.

g. Anti-Washout Admixtures (AWA) may be used for placing concrete underwater provided all of the manufacturer's recommendations are followed. Testing shall be conducted on trial batches to ensure that concrete containing AWA meets the specifications.

h. Pigments for Integrally Colored Concrete - Concentrated color pigments containing no fillers, adulterants or admixtures that will affect characteristics or performance of concrete mix design, in accordance with ASTM C979. It shall be free of calcium chlorides and shall be coordinated with curing procedures as stated in Article 934-3.20.

i. Corrosion inhibitor: Calcium nitrite for the protection of reinforcing steel, prestressed strands, and accessories against chloride induced corrosion. Submit the following data and certification for the corrosion inhibitor:

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1. Test results and performance data for each of the Physical Requirements (Table 1) of ASTM C 494 or AASHTO M-194 for any type of admixture.

2. Concrete corrosion inhibitor supplier shall submit documentation, either in the form of literature or a letter from an authorized representative of the manufacturer, which documents that the chloride protection level meets or exceeds fifteen (15) lb/cy.

j. Water reducing, set retarding, or superplasticizers chemical admixtures may be used at the option of the Contractor but subject to approval by the Engineer. The Contractor shall designate in advance the particular types, trade names and manufacturer of admixtures that he proposes to use and only such admixtures as are approved by the Engineer shall be incorporated into the concrete.

k. Retarding admixtures may be used when the setting time of concrete must be retarded for proper placement. The quantity of admixture added to the mix shall be the minimum required for minimum retardation consistent with placing conditions. Retarding admixtures, when used, shall be added at the plant.

l. Use high range water reducing admixture in concrete mixtures incorporating microsilica.

m. Shrinkage Reducing Admixture: Shrinkage reducing admixtures may be used at the option of the Contractor but subject to approval by the Engineer. The Contractor shall designate in advance the particular type, trade name, manufacturer, and proposed dosage rate of the admixture that he proposes to use and only such admixture as approved by the Engineer shall be incorporated into the concrete. Contractor shall submit to the Engineer manufacturer's product data, recommendations for use and test results and performance data of the proposed admixture.

934-2.09 Sampling and Testing -

a. Compliance with the applicable requirements included in the above articles will be determined in accordance with the following AASHTO standards:

Sampling Fresh Concrete.....	T 141
Permeability …….....	T 277
Size of Aggregates …….….....	T 27
Making and Curing Concrete Test Specimens in the Field ……....	T 23
Compressive Strength of Cylindrical Concrete Specimens ……...	T 22
Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials ……....	T 260

b. Sampling frequency for compressive strength and permeability tests of concrete will be as follows:

(1) One set of six cylinders shall be obtained for each 25 cubic meters of concrete or fraction thereof placed each day for testing at 7 and 28 days. In addition to the stated above, two four inches in diameter cylinders shall be obtained for each 25 cubic meters of concrete or fraction thereof placed each day for permeability testing by AASHTO T-277.

(2) For Prestressed concrete classes, additional sets of 3 cylinders each will be obtained as required to determine when the load transfer can be made on prestressed units or the tensioning of the steel initiated on post-tensioned units. In addition to the stated above, two four inches in diameter

cylinders shall be obtained for each unit for permeability testing by AASHTO T-277.

(3) Additional sets of specimens will be made as needed to determine when forms may be removed or when a structure may be put into service or if the Engineer deems it necessary to determine the acceptability of concrete. All specimens tested to obtain an indication of the strength of the concrete in the structure for the purpose of proceeding with construction activities must be cured under conditions representative of those existing in the actual structure.

(4) The Contractor shall furnish at his expense all metal molds or single use plastic molds with manufacturer provided lids, conforming to AASHTO M 205 and T 23 that are necessary to comply with the required frequency of sampling. As a subsidiary obligation, when using single use plastic molds, the Contractor shall furnish stripping tools for removing the sample from the mold. Cardboard molds will not be accepted. The contractor shall supply four inches molds for permeability testing, as necessary, to comply with the required frequency of sampling.

(5) The concrete for the test specimens will not be measured for payment but shall be furnished by the Contractor without additional compensation.

c. Intentionally Omitted

d. For concrete intended for use on the travel way for vehicular travel, samples will be taken, at the Authority's discretion, of the fresh mix, the mortar will be washed out and the remaining aggregates will be tested for compliance with the requirements of Article 934-2 of this specification as to polishing value of the coarse aggregate.

934-2.10 Basis of Acceptance -

a. In general, the acceptability of the quality of the concrete delivered to or made at the job site will be based on aggregate tests and on the results of standard compressive strength and permeability tests of representative samples at 28 days as covered by these specifications. However, this does not relieve the responsibility of the Contractor for the concrete during placement, consolidation, finishing, curing and protection prior to final acceptance by the Authority.

b. Failure of the fine and coarse aggregate to meet the polishing value requirements may be cause of the rejection and removal of concrete for use on vehicular travel ways at no cost to the Authority.

c. Intentionally Omitted.

d. Intentionally Omitted.

e. The compressive strength of the quantity of concrete placed and represented by one set of cylinders shall be determined as the average of the three cylinders comprising the set. If any cylinder shows evidence of improper sampling, molding, handling, curing or testing, the test result of such defective cylinder shall be discarded and the compressive strength of the concrete represented shall be determined from the test results of the remaining cylinders. Low strength shall not be a basis for discarding a cylinder test result.

f. The compressive strength level of an individual class of concrete will be considered satisfactory if both of the following requirements are met:

(1) The moving average off all sets of three consecutive strength tests equals or exceeds the specified compressive strength. The following applies to the computation of the moving average:

(a) The first moving average value shall be computed by averaging the test results of the first three sets of cylinders. Subsequent moving average values shall be computed by dropping the test result of the first cylinder set in the previous average, adding the test results of the next cylinder set and computing a new average.

(b) The cylinder strength test values shall be entered into the moving average computations in the same chronological order that the concrete is delivered and sampled.

(c) Test values of cylinder sets representative of concrete that fails to meet the acceptance criteria and is rejected and removed will be eliminated from the moving average computation.

(2) No individual strength test (average of cylinders set) falls below the specified compressive strength by more than 500 psi if the specified compressive strength of the concrete is less than or equal to 5,000 psi or 10 percent of the specified compressive strength if the specified compressive strength is greater than 5,000 psi.

g. Should concrete used in the work fail to conform to the requirements in paragraph "f" above, the Contractor shall, at his expense, make corrective changes, subject to the approval of the Engineer, in the material mix proportions or in the concrete fabrication procedures, before placing additional concrete. In addition, such corrective changes shall be made when the compressive strength of concrete tested at 7 days consistently indicates that the concrete will not attain the specified compressive strength at 28 days.

h. When the moving average fails to meet the compressive strength requirement, the in-place concrete will be considered deficient but will be accepted, if the deficiency in the moving average does not exceed 300 psi and if no individual cylinders set is deficient by more than 500 psi for specified compressive strengths not exceeding 5,000 psi or 10 percent of the specified strength for specified compressive strengths over 5,000 psi, but payment for the concrete represented by the failing averages will be at a reduced unit price as specified in Article 934-5.05. When the moving average is deficient by more than 300 but not over 500 psi for specified compressive strengths not exceeding 5000 psi or 10 percent of the specified strength for specified compressive strengths over 5,000 psi and no individual cylinder set is deficient by more than 500 psi for specified compressive strengths not exceeding 5,000 psi or 10 percent of the specified strength for specified compressive strengths over 5,000 psi, the deficient concrete may be accepted, at the discretion of the Authority, subject to a satisfactory structural analysis at the Contractor's expense and to applicable unit price reduction as per Article 934-5.05.

i. All concrete represented by a cylinder set which shows a strength falling below the specified value by more than 500 psi for specified compressive strengths not exceeding 5,000 psi or 10 percent of the specified strength for specified compressive strengths over 5,000 psi will be considered deficient and will be rejected.

j. The Contractor may elect to drill core samples of the hardened concrete classified as deficient under paragraphs "h" and "i" above, at his expense but under the direction and supervision of the Engineer, to be tested at the Authority's laboratory. The following criteria shall govern the coring program:

(1) The obtaining and testing of drilled cores shall be in accordance with AASHTO T 24 and T 22. Moisture conditioning shall be in accordance with paragraph 6.3 of T 24.

(2) The cores shall be drilled no earlier than 28 days and no later than 56 days after the pouring of the concrete in question.

(3) A minimum of three cores shall be taken for each 25 cubic meters, or fraction

thereof, of concrete classified as deficient as a result of the cylinder tests. Cores shall be taken at random locations selected by the Engineer.

(4) The core strength shall be the average of all cores tested. The concrete represented by the core tests will be considered acceptable if the average of the cores is equal to at least 85 percent of the specified compressive strength and if no single core test is less than 75 percent of the specified compressive strength. If concrete represented by the cores fails to meet any of the above requirements will be considered rejected.

(5) Should the first set of cores show deficient strength, the contractor will have the option, at his expense, of obtaining one additional set of cores for further testing. These additional cores shall not be drilled no later than 56 days after the pouring of the concrete in question, shall not exceed the number drilled for the first set and shall be subjected to the criteria in paragraphs (1), (3) and (4) above. However, the results of all cores tested will be used in determining the average strength of the questioned concrete. If concrete represented by the cores fails to meet any of the above requirements will be considered rejected.

(6) The Contractor shall repair at his expense the core holes.

k. Concrete that fails both the cylinder and core strength tests acceptance criteria will be rejected and shall be removed and disposed of at the Contractor's expense. In some cases, the location of rejected concrete may be such as to require the removal, at the Contractor's expense, of otherwise satisfactory concrete. The removal shall be performed in such a manner as will not cause damage to the remaining concrete or to other units of the structure.

l. When the cylinder tests results indicate that the concrete mix meets the specified strength but the Authority has reasonable doubts as to the actual strength of the in-place concrete due to deficiencies in the placing, consolidation, curing or protection of the concrete, the Authority may order the Contractor to have cores drilled following the procedures specified in paragraph "j" above. If these cores meet the acceptance criteria specified in "j" above, the Authority will bear the cost of the drilling, testing and repair. However, if the cores fail, the Contractor shall bear the cost and the concrete represented by the failing cores will be subject to rejection and removal as determined by the Authority.

m. Intentionally Omitted

n. The permeability of the quantity of concrete placed and represented by one cylinder shall be determined as the average of two approximately 2 inch in height specimens taken at the top and bottom of the cylinder.

o. The permeability level of an individual class of concrete will be considered satisfactory if the average of the two approximately 2 inch in height specimens taken from the first cylinder is less than the value stated in table 934-2.

p. Should concrete used in the work fail to conform to the requirements in paragraph "o" above, the Contractor shall, at his expense, make corrective changes, subject to the approval of the Engineer, in the material mix proportions or in the concrete fabrication procedures, before placing additional concrete.

q. When the average of the two approximately 2 inch in height specimens taken at the top and bottom of the cylinder fails to meet the permeability requirement, the in-place concrete will be considered deficient but will be accepted, if the deficiency in the average does not exceed 1,000 Coulombs above the permeability level stated in the contract, but payment for the concrete represented by the failing averages will be at a reduced unit price as specified in Article 934-5.06. When the average of the two approximately 2 inch in height specimen taken at the top and bottom of the cylinder is greater than 1,000 Coulombs above the permeability level stated in the contract, the Authority may reject and require the removal and

replacement of any lot or unit. Said removal shall be performed in such a manner as will not cause damage to the remaining concrete or to other units of the structure. If the Authority allow the deficient lot to remain in place the applicable unit price reduction as per Article 934-5.06 will be applied. These deductions will be in addition to the deductions for compressive strength described in 934-5.05. The total deduction will never exceed 90% of the contract unit price.

r. When a lot fails the permeability requirements, the Contractor may request re-testing of the lot at 84 days after placement in the structure. The Contractor's request for retesting shall be submitted in writing to the Engineer prior to 77 days after placement of the concrete represented by the failing lot. Re-testing shall consist of taking two approximately 2 inch in height specimens from the top and bottom of the unused cylinder and averaging the two permeability results. The acceptance of the lot will be based upon the average of the retested cylinder and no further testing will be permitted. If the Contractor fails to submit a request for re-testing following the guidelines presented herein, the test specimens representing the failing lot will not be tested and will be discarded.

934-3 CONSTRUCTION REQUIREMENTS

934-3.01 General - Portland cement concrete may be produced at the project site or may be supplied by a commercial plant as ready-mixed concrete.

934-3.02 Measuring and Batching - Measuring and batching of materials shall be done at a batching plant. The measuring equipment and batching plant, and the measuring and batching procedures followed shall be in accordance with the requirements of AASHTO M 157.

934-3.03 Mixing and Delivery - Concrete may be mixed at a central plant, in truck mixers or at the site as described in these specifications. The mixing and delivery of concrete shall be in accordance with the requirements of AASHTO M 157 as modified and supplemented by the following paragraphs of this article.

a. The Contractor shall supply concrete at a rate consistent with placement operations as determined by the Engineer. The intervals between deliveries of batches shall not be so great as to allow the concrete in place to harden partially.

b. The Engineer may order discontinuing the use of any type of concrete mixing or transporting units that fail to meet the specification requirements.

c. Volumetric batching and continuous mixing mobile equipment may be used if approved by the Engineer. In such case, the batching and mixing shall be in accordance with AASHTO M 241.

d. When an approved retardanting admixture is authorized, the 1-hour limitation between the introduction of the cement to the aggregates and discharge at the site may be increased by 30 minutes. This time limitation may be exceeded if the concrete is of such slump and workability that it can be placed and consolidated properly without the addition of water to the batch.

e. Concrete for bridge deck which is to be delivered at an ambient temperature above 85F shall be designed to include an approved retardanting admixture.

f. The entire contents of the mixer shall be removed from the drum before materials for another batch are placed therein. Upon cessation of mixing for a period exceeding one hour the mixer shall be thoroughly cleaned. The delivery unit shall also be completely emptied, cleaned and free from concrete and wash water before receiving the next load of concrete.

g. When a truck mixer or agitator is approved for mixing or delivery of concrete,

the addition of water shall be as per ASTM C94.

h. Certification of Batches - Before unloading at the site of delivery, the concrete supplier shall furnish to the Engineer delivery tickets containing the following information concerning the concrete in the truck. The tickets shall be issued to the truck operator at the proportioning plant for each load.

(1) Name and number of batch plant
(2) Serial number of ticket
(3) Date and truck number
(4) Name of Contractor
(5) Specific designation of job (name and location)
(6) Specific class of concrete in conformance with job specifications
(7) Volume of concrete (cubic yards)
(8) Batching tickets with a list of all the constituens and the amount of each one used for the mix (target and actual weights)
(9) For central mixed concrete, time when first mixing was completed at the central mix plant.
(10) For transit mixed concrete and truck-mixed concrete, time when the cement was introduced to the aggregates
(11) Name and quantity of admixtures, if any.
(12) Spaces to indicate time when discharge commenced and when completed.

The Authority may, at its discretion, inspect the weights at the batch plant. The Contractor shall provide all necessary facilities to assist the inspector in performing this task.

i. Intentionally Omitted.

j. Intentionally Omitted.

k. Delivery - The organization supplying concrete shall have sufficient plant capacity and transporting equipment to insure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing and finishing of the concrete. The methods of delivering and handling the concrete shall be such as will facilitate placing with the minimum of rehandling and without damage to the structure or the concrete.

l. Retempering - The concrete shall be mixed only in such quantities as are required for immediate use and any concrete which has developed initial set shall not be used. Retempering concrete by adding water or by other means will not be permitted.

934-3.04 Consistency -

a. Intentionally Omitted

b. Concrete shall be of such consistency and plasticity, and shall show the necessary cohesiveness to flow around reinforcing steel without segregation. Individual particles of the coarse aggregate when isolated shall show a coating of mortar containing its proportional amount of sand.

934-3.05 Falsework -

a. The Contractor shall be responsible for designing and constructing safe and adequate falsework which provides the necessary rigidity, supports the loads imposed, and produces in the finished structure the lines and grades indicated on the plans.

b. The Contractor shall furnish, upon request of the Engineer, detailed working drawings and design calculations of the falsework for bridges. The acceptance of such drawings and the falsework inspection by the Engineer will in no way relieve the Contractor of full responsibility for the adequacy and safety of the falsework.

c. Falsework which cannot be founded upon a solid footing shall be supported by falsework piling which shall be spaced, driven and removed in a manner approved by the Engineer. No additional compensation will be paid for the use and removal of falsework piling.

d. Falsework shall be set to give the finished structure the specified camber plus an allowance for shrinkage and settlement. The weight of the finishing screed for bridge decks and other construction loads and their effect on the required camber shall be considered by the Contractor in the design of the falsework.

e. Suitable screw jacks or hardwood wedges shall be incorporated into the falsework and adjusted to take up any settlement in the formwork either before or during the placing of concrete.

934-3.06 Forms -

a. Forms for all exposed concrete surfaces shall be made from one or more of the following materials:

(1) Faced with exterior type plywood
(1) Lumber dressed at least on one side and two edges
(2) Metal
(3) Plastic
(4) Fiberglass

b. All forms shall be well constructed, carefully aligned, substantial and firm, securely based and fastened together in final position. They shall be strong enough to prevent the plastic concrete from bulging the forms between supports and to withstand the action of mechanical vibrators. They shall be so constructed as to produce mortar-tight joints and smooth, even concrete surfaces.

c. Forms shall be designed to resist the pressure resulting from plastic concrete weighing 150 pounds per cubic foot, a live load allowance of 50 pound per square foot on horizontal surfaces, and other live loads incidental to the construction operations. Concrete misshapen by bulges or deformations caused by inadequate forms shall be removed or corrected as ordered by the Engineer at the Contractor's expense.

d. Forms shall be filleted and chamfered as shown on plans, and shall be given a bevel or draft in the case of all projections, such as girders and copings, to assure easy removal.

e. Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 2.5 centimeters from the face without injury to concrete. In case wire ties are permitted, suitable cones shall be provided. The cavities shall be filled with cement mortar and the surface left sound, smooth, even and uniform in color.

f. Where the bottom of the forms is inaccessible, the lower form boards shall be left loose or other provisions made so that extraneous material may be removed from the forms immediately before placing the concrete.

g. All forms shall be treated with an approved form coating prior to placing reinforcement and wood forms shall be saturated with water immediately before placing the concrete. The

form coating to be used can be of any acceptable commercial quality which permit the easy removal of the forms and will not discolor or stain the concrete.

h. The specifications for forms, as regards design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse and coating, also apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease or other foreign matter.

i. Stay-in-place metal forms will not be permitted unless specifically shown on the plans. In such case, the Contractor shall submit detailed shop drawings, samples, specifications and any other information complying with Specification 715.

j. All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be determined as specified in Article 934-3.13. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer will order the work stopped until the defects have been corrected.

k. Forms to be reused shall be maintained in good conditions as to tightness and surface smoothness at all times. Any warped or bulged lumber shall be resized before being used. Unsatisfactory forms shall not be used and shall be removed immediately from the site of the work.

934-3.07 Handling and Placing Concrete -

a. General - Concrete shall not be placed until the forms and reinforcing steel have been checked and approved by the Engineer.

(1) In preparation for the placing of concrete, all saw dust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces, serving temporarily to hold the forms in correct shape and alignments, bending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in concrete.

(2) Concrete shall be placed so as to avoid segregation of material and the displacement of reinforcement. All equipment used for conveying the concrete mix shall be capable of meeting this requirement and is subject to approval by the Engineer. In case any conveyance equipment results in an inferior quality of concrete, the Engineer may order discontinuance of its use and its substitution by a satisfactory method of placing. Concrete shall not come in contact with aluminum during conveyance and placing operations.

(3) Open troughs and chutes shall be of metal or metal lined, except aluminum. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement. All chutes and pipes shall be kept clean and free from coating or hardened concrete by thoroughly flushing with water after each run.

(4) Dropping concrete a distance of more than 1.5 meters or depositing a large quantity at any point and running or working it along the form shall not be permitted.

(5) Special care shall be taken to fill each part of the form by depositing concrete directly into the forms at or as near to its final position as possible, to work the coarser aggregates back from the face of the concrete and to force the concrete under and around the reinforcement without displacing the reinforcement. After the concrete has taken its initial set, care shall be exercised to avoid

jarring the forms or placing strain near the ends of reinforcement projecting out of the concrete.

(6) Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

(a) The vibration shall be internal unless special authorization of other method is given by the engineer.

(b) Vibrators shall be of a type and design approved by the Engineer. They shall be capable of transmitting vibrations to the concrete at frequencies of not less than 6,000 impulses per minute. The Contractor shall have available at the job site a copy of the manufacturer's literature on the vibrators, showing that they comply with the above requirements.

(c) Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visible effective.

(d) The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms. Extra vibrators shall be on hand for emergency use and for use when other vibrators are being serviced. All vibrators shall be in satisfactory working conditions.

(e) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into corners and angles of the forms but with care not to cause segregation.

(f) Vibration shall be applied at the point of deposit and in the areas of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete but shall not be continued at any one point to the extent that localized areas of grout or segregation of aggregates are created.

(g) Vibration shall not be applied directly or through the reinforcement to the sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation and vibrators shall not be used to push or distribute concrete laterally in the forms. The vibrating element shall be inserted in the concrete mass a sufficient depth to vibrate the bottom of each layer effectively, in as nearly a vertical position as practicable. It shall be withdrawn completely from the concrete before being advanced to the next point of application.

(h) To secure even and dense surfaces free from aggregate pockets or honeycombing, vibration shall be supplemented by such spading as is necessary to insure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with vibrators while the concrete is plastic.

(i) External vibration methods will be permitted by the Engineer when satisfactory results are demonstrated.

(j) The provisions of this paragraph shall apply to pre-cast piling; concrete cribbing and other precast members except that if approved by the Engineer, the manufacturer's methods of vibration may be used.

(7) When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible on exposed faces,

the top surface of the concrete adjacent to the forms shall be smoothed and leveled whenever concreting is discontinued. Where a "feather edge" might be produced at a construction joint, as in the sloped top surface of a wing-preceding layer, it shall produce an edge thickness of not less than 15 centimeters in the succeeding layer. Work shall not be discontinued within 45 centimeters of the top of any face, unless provision has been made for a coping less than 45 centimeters thick, in which case, if permitted by the Engineer, the construction joint may be made at the under side of the coping.

(8) Immediately following the discontinuance of placing concrete, all accumulation of mortar splashed upon the reinforcing steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddle into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete, while cleaning the reinforcing steel.

(9) The Contractor shall protect the concrete from the adverse effect of rain at all times during and immediately after placement. He shall have available adequate covering material to protect the exposed surfaces of unhardened concrete.

(10) Fogging and Interim Curing. From the time of initial strike off of the concrete until finishing is completed and required curing is in place, the unformed surfaces of slab concrete in bridge decks and top slabs of direct traffic culverts shall be fogged at all times. Fogging equipment shall be capable of applying water in a fine mist, not a spray. The fog shall be produced using equipment which pumps water or water and air under high pressure through a suitable atomizing nozzle. The equipment shall be hand operated and sufficiently portable for use in the direction of any prevailing wind. It shall be adaptable for intermittent use as directed by the Engineer to prevent excessive wetting of the concrete surface. Fogging shall also be used as a means of interim curing for preventing drying of the concrete surface between the time final finish is completed and curing is in place.

b. Intentionally omitted -

c. Girder, Slabs and Columns -

(1) For simple spans, concrete shall be deposited by beginning at the center of the span and working from the center toward the ends unless otherwise directed by the Engineer. Concrete in girders shall be deposited uniformly for the full length of the girder.

(2) Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided for in the contract documents.

(3) The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified, in which case special shear anchorage shall be provided to ensure monolithic action between girder and floor.

(4) Concrete in T-beam or deck girder spans may be placed in one continuous operation or may be placed in two separate operations, each of which shall be continuous; first to the top of the girder stems, and second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical, and shall be secured by means of suitable shear keys on the top of the girder stem. The size and location of these keys shall be as shown on the plans. The period between the girder stem pour and the slab pour shall be at least 24 hours. Before the second pour, the Contractor shall check the falsework for shrinkage and settlement and shall tighten wedges or screws to insure minimum deflections of stems when slab is poured.

(5) Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least 12 hours before the caps are placed unless otherwise shown on the plans.

(6) Unless otherwise permitted by the Engineer, no concrete shall be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least 14 days, unless otherwise permitted by the Engineer.

934-3.08 Adverse Hot Weather Conditions -

a. Concrete shall be properly protected from adverse hot weather conditions before, during and after placement. The initial concrete placement temperature shall not exceed the values set in Article 934-2.05-c. All necessary precautions shall be taken to see that the concrete is promptly placed on arrival at the job and immediately vibrated after placement. The concrete shall be protected from excessive drying during finishing and curing operations which shall be performed without delay as soon as the concrete is ready for them. The Contractor shall provide, at no cost to the Authority, the necessary equipment to perform relative humidity, - wind speed, air temperature and concrete temperature testing. Said equipment shall be calibrated at least once a year.

b. When the corrosion inhibitor calcium nitrate is used in a hot weather concrete mix, use a water reducing retarding admixture (Type D) and a high range water reducing admixture (Type F), and place the concrete in the early morning or at night.

c. Concrete shall not be placed in bridge decks and other exposed slabs when any combination of air temperature, relative humidity, concrete temperature and wind speed is expected to result in an evaporation rate in excess of 0.2 pound per square foot per hour. Table 934-3 may be used as a guide to determine wind speeds and relative humidity combination at which evaporation rates in excess of 0.2 lb/ft2/hr, at an ambient temperature of 90F, may be expected.

d. The Engineer may authorize, at his discretion, the placing of concrete in bridge ***decks*** and other exposed slabs at concrete temperatures in excess of the critical values if the Contractor submits for approval acceptable procedures which will effectively reduce the evaporation rate throughout the placement area to less than 0.2 1b/ft^2/hr. In no case shall the concrete temperature exceed values stated elsewhere in this specification**.** Such procedures shall include one or more of the following:

(1) Shading and cooling aggregates and other components at the batching plant.

(2) Dampening subgrade and forms.

(3) Erecting windbreaks to effectively reduce the wind speeds throughout the placement area.

(4) Placing concrete at the lowest possible temperature by reducing the time between mixing and placing.

(5) Fog spraying throughout the placement area to effectively increase the relative humidity.

(6) Placing concrete at lower ambient temperature such as early morning, late afternoon or at night.

e. Water reducing and retarding admixtures may be used to offset the undesirable effects of placing concrete at high temperatures provided the design mix requirements for the specified strength are met.

SPECIAL PROVISION
SPECIFICATION 934 – STRUCTURAL CONCRETE

Table 934-3
TYPICAL CRITICAL CONCRETE TEMPERATURES FOR VARIOUS WIND SPEEDS AND RELATIVE HUMIDITIES (1)

Concrete Temperature (°F)	Relative Humidity % at 10 mph	Relative Humidity % At 15 mph	Relative Humidity % at 20 mph	Relative Humidity % at 25 mph
95	65	80	85	90
90	45	60	70	75
85	30	45	55	60
80	20	35	40	45
75	10	20	30	35

(1) Maximum concrete temperatures at an ambient temperature of 90°F for different wind speeds and relative humidities to limit the rate of evaporation to about 0.2 lb/ft^2/hr.

(2) Required relative humidities in excess of 100%.

934-3.09 Intentionally omitted

934-3.09 Mass Concrete -

A monolithic concrete placement having a least dimension greater than five (5) feet shall be considered a mass concrete placement subject to the requirements of this section. For mass concrete placements the Contractor shall develop a plan to assure that the concrete in-place (a) will not achieve an internal temperature in excess of 160 deg. F during the first 36 hours after placement and (b) will not be subjected to a temperature differential between the central core of the placement and the exposed concrete surface in excess of 35 deg.F during the heat dissipation period.

A detailed plan, along with an analysis of the associated heat generation and dissipation (heat flow analysis) shall be submitted to the Engineer for approval. No concrete shall be placed until this plan is approved.

This plan may include a combination of the following:

1. Selection of concrete ingredients to minimize heat of hydration.
2. Using ice or cooling the concrete ingredients.
3. Controlling the rate of concrete placement.
4. Using insulation to control the heat loss.
5. Using supplemental heat to control the heat loss.
6. Using mineral admixtures and/or ground granulated blast-furnace slag.
7. Controlling the temperature of the fresh concrete at placement to within a limit which had been shown through testing not to result in an internal concrete temperature in excess of the 160 deg.F limit. Testing shall consist of monitoring the internal concrete temperature of a mass of concrete having a least dimension of five

(5) feet and cast using the proposed materials and concrete mix design for the job.

The Contractor shall furnish and install two (2) sets of approved temperature recording devices at locations designated by the Engineer. The devices shall be acurate to within +/- 2 deg.F within the range of 32 deg.F to 212 deg.F and shall be used to simultaneously measure the temperature of the concrete at the core and at the surface of the mass of concrete in place.

934-3.10 Pumping Concrete -

a. Placement of concrete by pumping will be permitted only if specified in the contract documents or if authorized by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. Equipment having components of aluminum and magnesium alloy in contact with the concrete shall not be permitted.

b. Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

c. An admixture to aid in pumping the concrete may be used provided it has no deleterious effect on the concrete and subject to previous approval by the Engineer.

934-3.11 Construction Joints -

a. Construction joints shall be shear key type and shall be made only where shown on the plans or in the pouring schedule, unless otherwise approved by the Engineer. If not detailed on the plans, or in the case of emergency, construction joints shall be placed as directed by the Engineer. Joints shall be perpendicular to the principal lines of stress and, in general, shall be located at points of minimum shear. Necessary dowels, load transfer bars and bonding devices shall be placed as shown on the plans or directed by the Engineer.

b. Before depositing new concrete on or against concrete which has hardened, the forms shall be retightened. The surface of the hardened concrete shall be roughened in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. It shall be thoroughly cleaned of foreign matter and laitance, and saturated with water. To insure an excess of mortar at the juncture of the hardened and the newly deposited concrete, the cleaned and saturated surface, including vertical and inclined surfaces, shall first be thoroughly covered with a thin coating of mortar or neat cement grout against which the new concrete shall be placed before the mortar or grout has attained its initial set.

c. The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints which are exposed to view shall be carefully finished true to line and elevation. At horizontal construction joints, gage strips 4 centimeters thick shall be placed inside the forms along all exposed faces to give the joints straight lines.

934-3.12 Expansion Joints -

a. All expansion joints shall be located and constructed according to the details shown on the plans.

b. Open joints shall be placed at the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans. Concrete

corners shall be chamfered 2.5 centimeters or as shown on the plans.

c. Filled expansion joints shall be constructed similar to open joints. When premolded types are specified, the filler shall be placed correct position as the concrete on one side of the joints is placed. When the form is removed, the concrete on the other side shall be placed. Water stops shall be carefully placed as shown on the plans. When during construction, an opening of 0.3 cm. or more appears in any joint over which traffic will occur; the opening shall be completely filled with hot tar or asphalt as directed by the Engineer.

d. Premolded expansion joint fillers shall be used where called for on the plans or as authorized by the Engineer. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise authorized by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape by stapling or other positive fastening satisfactory to the Engineer.

e. The plates, angles or other structural shapes for steel joints shall be accurately shaped at the shop to conform to the section of the concrete floor. The fabrication and painting shall conform to the requirements of the specifications covering those items. When called for in the contract documents the material shall be galvanized in accordance with specification 715 in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.

f. Water stops shall be furnished and placed as provided on the plans. They shall be spliced, welded, or soldered, to form continuous watertight joints.

934-3.13 Anchor Bolts and Bearing Devices -

a. All necessary anchor bolts in piers, abutments or pedestals shall be accurately set either in the concrete as it is being placed or in holes formed while the concrete is being placed, or in holes drilled after the concrete has set. Preformed holes and drilled holes shall be at least 2.5 cm. in diameter larger than the bolts used. Bolts set in holes shall be permanently fixed with a non-shrink grout completely filling the holes.

b. Bearing plates, rockers and other expansion devices shall be constructed according to details shown on the plans. Unless set in plastic concrete or as otherwise specified, they shall be set in grout to insure uniform beating.

c. The anchor bolts, rockers or other expansion devices shall be set to conform to the temperature at the time of erection.

d. When called for in the contract documents these materials shall be galvanized in lieu of painting.

934-3.14 Removal of Falsework and Forms -

a. Falsework and forms shall not be removed without the consent of the Engineer; however, the Engineer's consent shall not relieve the Contractor of responsibility for the safety of the work. Forms may only be removed if the temperature differential between the concrete within the forms and the ambient is less than or equal to 8 degrees F. Provisions shall be made to monitor the internal temperature of the concrete within the forms through the use of thermocouples or similar techniques.

b. When concrete strength tests are used for controlling the removal of forms and

supports, such removal shall not begin until the concrete has attained the percentage of the design strength specified in the contract documents. Concrete strength tests used for this purpose may include, in addition to test cylinders, Penetration Resistance of Hardened Concrete (ASTM C 803), Rebound Number of Hardened Concrete (ASTM C 803) and Pullout Strength or Hardened Concrete (ASTM C 900), subject to approval by the Engineer.

c. If falsework and forms removal is not controlled by cylinder tests, the falsework and forms for the various parts of the structure shall not normally be removed before the time indicated below has elapsed after placing the concrete, unless otherwise specified in the contract documents or authorized by the Engineer. The exact number of days shall be determined by the Engineer and will be dependent on the class of concrete, curing conditions and other factors.

(1)	Mass piers except pier caps, mass abutments, columns and wall faces (not supporting loads)	1 day
(2)	Traffic railing and median barriers ……..	1 day
(3)	Pier caps continuously supported …….	7 days
(4)	Slabs supported on stringers or prestressed concrete girders ……..	7 days
(5)	Box girders, continuous slabs, box culvert top slabs, centering under girders, beams and arches …….	14 days

d. Items (3), (4) and (5) above apply to falsework and forms supporting the full load of the concrete. Side forms and forms not supporting and loads may be removed after 12 hours to facilitate the finishing of exposed faces.

e. The above periods may be reduced as directed by the Engineer when early strength concrete is used.

f. Methods of form removal likely to cause overstressing of the concrete shall not be used. Supports shall be removed in such manner as to permit the concrete to uniformly and gradually take the stress due to its own weight.

g. Centers shall be gradually and uniformly lowered in such manner as to avoid injurious stresses in any part of the structure. In arch structures of two or more spans, the sequence of striking centers shall be specified or approved by the Engineer.

934-3.15 Depositing Concrete under Water -

a. Concrete, except for cofferdam seals, shall not be deposited under water except with the approval of the Engineer and under his immediate supervision. The method of placing concrete under water shall be as hereinafter described.

b. Concrete deposited under water shall be of the Class Specified with 10 per cent excess cement. No extra payment will be allowed for the excess cement used. To prevent segregation, the concrete shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom dump bucket or other approved method, and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit. Pumping shall be discontinued while depositing foundation concrete if it results in a flow of water inside the forms. The Contractor may submit for consideration the use of an appropriate additive to reduce the need for the excess cement.

c. Care shall be exercised to prevent the formation of laitance. Concrete shall not be deposited until any laitance which may have formed on concrete previously placed has been removed. The use of aluminum pipes for depositing concrete will not be allowed.

d. For parts of structures under water, concrete seals shall be placed continuously from start to finish. As many tremies or dump buckets shall be provided and used as needed to insure that the work progresses without interruption until completed. The surface of the concrete shall be kept as nearly horizontal as practicable at all times. To ensure thorough bonding, each succeeding layer of a seal shall be placed before the preceding layer has taken initial set.

e. A tremie shall consist of a tube having a diameter of not less than 25 centimeters and constructed in sections having flanged couplings fitted with gaskets. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the concrete placement and so as to permit rapid lowering when necessary to retard or stop the concrete placement. The discharge end shall be closed at the start of work so as to prevent water entering the tube and shall be entirely sealed at all times; the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it submerged in the deposited concrete. The flow shall be continuous until the work is completed.

f. In depositing concrete by a bottom dump bucket, the top of the bucket shall be open. The bottom doors shall open freely downward and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete. The mound of concrete shall be maintained between 10 and 20 centimeters.

g. Dewatering may proceed when the concrete seal is sufficiently hard and strong. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, chipping, or other means which will not injure the surface of the concrete.

h. Tremie concrete used for bridge foundations shall be cored at the Contractor's expense for testing for compressive strength and for quality of the concrete. Coring shall be as specified in Article 934-2.10 j.

934-3.16 Intentionally omitted

934-3.17 Additional Requirements -

a. Intentionally omitted

b. Corrosion Protection of Reinforcement - The maximum water soluble chloride ion concentration in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed 0.06% by weight of cement in prestressed concrete and 0.15% by weight in all other concretes. Tests shall be performed to determine watersoluble chloride ion content following procedures conforming to ASTM C 1218. Test report shall be submitted before concrete is used.

c. Reinforcing steel shall normally be epoxy coated reinforcing steel conforming to the requirements of Specification 709-3 with a minimum clear distance from the face of the concrete to the nearest face of the reinforcement of 75 mm with exception of 50 mm at bottom of slabs.

d Epoxy coated reinforcing bars shall conform to ASTM A775. Repair damaged areas with patching material conforming to ASTM A 775 and in accordance with the material manufacturer's recommendations. Repair all coating damage due to shipping, handling, and placing. The

maximum amount of repaired damages shall not exceed 2 percent of the surface area in each linear meter of each bar. Fading of the coating color will not be cause for rejection of epoxy-coated reinforcing bars.

e. When epoxy-coated reinforcing bars are cut in the field, coat the ends of the bars with the same material used for repair of coating damage.

f. The concrete shall be thoroughly compacted and stone pockets shall be avoided. No construction joints shall be formed and no form ties shall be used between levels of extreme low water and extreme high water as determined by the Engineer. Between these levels sea water shall not come in direct contract with the concrete for a period of not less than 30 days. The original surface, as the concrete comes from the forms, shall be left undisturbed.

934-3.18 Concrete Exposed to Alkali Soils or Alkali Water - Where concrete may be exposed to the action of alkaline waters or soils, concrete of the Specified class will be used, and special care shall be taken to place it in accordance with the placing specifications included herein. Whenever possible, placing shall be continuous until completion of the section or until the concrete is at least 45 cm. above ground or water level. Alkaline waters or soils shall be kept from contact with the concrete during placement and for a period of at least 72 hours thereafter.

934-3.19 Finishing Concrete Surfaces -

a. General

(1) Concrete surface finishes, except for bridge decks, sidewalks, and concrete pavements, shall be classified as follows:

Class 1 …… Ordinary Finish
Class 2 …… Rubbed Finish
Class 3 ……Float Finish

(2) All concrete, except bridge decks, sidewalks and concrete pavements, shall be given Class 1, Ordinary Finish, and in addition, such other type of finish as specified in the plans or special provisions. If not otherwise specified, the following surfaces shall be given a Class 2, Rubbed Finish.

(a) The exposed faces of piers, abutments, wing walls and retaining walls. The surface finish on piers and abutments shall be limited to all exposed surfaces below bridge seats to 30 cm. below low water elevation, or 60 cm. below finished ground line when such ground line is above the water surface. Wing walls shall be finished from the top to 60 cm. below the finished slope lines on the outside face, and shall be finished on top and for a depth of 30 cm. below the top on the back sides.

(b) The outside faces of fascia girders, beams, slabs, columns, brackets, curbs, headwalls, railings, arch wings, spandrel walls and parapets.

(3) The bottoms of deck slabs, bottoms of beams and girders, sides of interior beams and girders, backwalls above bridge seats and the underside of copings require only a Class 1 finish.

(4) Unless otherwise specified, concrete floors of minor structures shall be given a Class 3, Float Finish.

(5) Finish for sidewalks shall be in accordance with Specification 608.

(6) Bridge decks shall be finished in accordance with Article 934-3.19 e. of this specification.

b. Class 1 - Ordinary Finish

(1) Immediately following the removal of forms, all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges and other defects shall be thoroughly cleaned, saturated with water, and shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished. Mortar used in pointing shall be not more than one hour old. The mortar patches shall be cured as specified under Curing Concrete. All construction and expansion joints in the completed work shall be left carefully tooled and free of mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

(2) The resulting surfaces shall be true and uniform. All surfaces which cannot be repaired to the satisfaction of the Engineer shall be rubbed as specified for Class 2, Rubbed Finish.

c. Class 2 - Rubbed Finish

(1) After removal of forms the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before wetting down to allow the mortar used in the pointing of holes and defects to thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the proportions used in the concrete being finished. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids filled and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place at this time.

(2) After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

d. Class 3 - Float Finish. The finish for horizontal surfaces, except for bridge decks, concrete pavements and sidewalks, shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be thoroughly worked and floated with a suitable floating tool. Before the finish has set, the surface cement film shall be removed with a fine brush in order to have a fine grained, smooth but sanded texture.

e. Finishing bridge deck and other concrete surfaces intended to be used as traveled way.

(1) General -

(a) Unless otherwise specified, machine finishing shall be used on all bridge decks with the exception of small irregular areas.

(b) Screed Supports shall be accurately set and of substantial construction so that the finished roadway surface will conform to the profile and transverse sections shown on the plan. Screed supports shall be placed and adjusted to properly allow for the deflection of forms, falsework and structural supporting members which will occur during the placement of concrete.

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(c) The bridge deck surface shall be uniformly smooth, dense and even. Variation in the pavement surface in excess of 7 mm above or below the elevations required by the plans, or pavement surface irregularities of more than 3 mm in 3 meters will not be accepted. The 3 meter straight edge shall be furnished by the Contractor and maintained in good condition at the paving site at all times.

(d) Surface irregularities in excess of the above stated limits shall be corrected as the Engineer may direct or approve. Surface irregularities shall be filled, while the pavement concrete is still plastic, with concrete of the same consistency, as specified for the paving operation. Excess thin mortar and laitance accumulating ahead of the finishing screeds or lutes shall be removed and not used in filling depressions.

(2) Machine Finishing

(a) Machine finishing shall be accomplished with power driven transverse finishing machines. The specific method and equipment that the Contractor proposes to use shall be subject to the approval of the Engineer. Approval of the method and equipment will not relieve the Contractor of full responsibility for obtaining the required finished surface.

(b) Finishing machines shall be equipped with adjustable strike-off and finishing screeds, the bottom surface of which shall be adjusted to produce the required contour of the finished surface. Machine shall be kept true adjustment. Machines out of adjustment shall not be used until proper adjustments have been approved by the Engineer.

(c) Just prior to beginning concreting operation, the finishing machine shall be operated over the full length of the bridge segment to be paved. This test run shall be made with the screed adjusted to its finishing position. While operating the finishing machine in this test the screed rails shall be checked for deflection and proper adjustment, the cover on slab reinforcement measured and the controlling dimensions of slab reinforcement and forms checked. All necessary corrections shall be made before concreting is begun.

(d) After the concrete has been placed, spread and consolidated to provide a uniformly dense structural slab, the surface shall be struck of immediately by the passage of the finishing machine. The finishing machine shall carry sufficient concrete in front of the screed to fill low places. This operation shall be repeated as may be necessary to produce a uniformly consolidated dense smooth surface of the required contour. The first passages of the finishing machine shall provide a concrete surface slightly above grade so that after settlement, if any, and the disappearance of excess water from the surface, a final passage or passages of the finishing machine will result in a uniform surface at the required grade and contour over its entire area.

(3) Hand Finishing - Hand finishing, where permitted, shall be performed in such a manner as to produce the same wearing surface quality and uniformity as that produced by machine finishing. Finishing screeds shall be 25 centimeters or more in width and the contacting surfaces shall be steel. Hand operated screeds shall be used in such a manner as to duplicate the action of a transverse finishing machine. Hand finishing shall be performed in the same sequence and manner as machine finishing unless otherwise directed by the Engineer.

(4) Final Finish - Following the straightedging and after all excess moisture has disappeared, but before the application of curing compound, the concrete deck surface shall be given a grooved texture with a set of spring steel tines. The grooves shall be perpendicular to the centerline of the concrete deck. Down pressure on the concrete surface shall be maintained at all times during texturing so as to obtain uniform texturing. The spring steel tines of the grooving device shall be rectangular in cross section, approximately 0.32 cm. (1/8”) wide and placed on 1.9 cm. (3/4”) centers. The tines shall be of sufficient length, thickness and resilience to form grooves approximately 0.48 cm. (3/16”)

deep in the fresh concrete surface. Final texture shall be uniform in appearance with substantially all grooves having a depth of 0.48 cm (3/16") +/- 0.16 cm. (1/16"). Grooving will be terminated a distance of 2.5 cm. on either side of transverse contraction or construction joints. The tine head may be operated by hand or mechanically. In any case, the tines shall be operated with their longitudinal axis at an approximate angle of 45 degrees to the concrete surface to eliminate dragging of mortar by the tines. The tines shall be kept free of hardened concrete particles.

934-3.20 Curing of Concrete -

a. General -

(1) The Contractor shall inform the Engineer of the methods proposed for curing; shall provide the proper equipment and material in adequate amounts; and shall have the proposed methods, equipment and material approved prior to placing concrete. Inadequate curing and/or facilities shall be cause for the Engineer to delay all concrete placements on the job until remedial action is taken.

(2) All-newly placed concrete, except for concrete decks**,** shall be cured in accordance with one of the methods described below. Unless the contract documents require a specific method, the Contractor may use either method at his discretion. Curing shall be initiated immediately after placing and finishing. Curing shall be done so that moisture is always present and shall be an integral part of the concreting operations. Improperly cured concrete will be considered defective and the Engineer will stop all the Contractor's concrete placing operations until proper curing procedures are put into effect.

(3) Concrete surfaces which call for a Class 2, Rubbed Finish, shall be kept moist before and during the rubbing, and the wet curing shall be initiated immediately following the first rub while the concrete is still moist.

(4) Curing of all concrete surfaces to be exposed to traffic must be by the water method for at least 7 days, followed by an immediate application of an approved membrane curing compound at the termination of the wet method curing period. Initial 7 day curing of concrete surfaces exposed to traffic may not be by the curing compound method.

b. Water Method -

(1) This method includes supplying additional moisture to the concrete by sprinkling or fogging. All surfaces other than slabs shall be kept wet for at least 7 days and shall be protected from the sun by using coverings such as burlap, which retain the additional water supplied. Surfaces requiring a Class 2, Rubbed Finish, may have the cover temporarily removed while finishing but the cover shall be restored as soon as the finishing is completed.

(2) In concrete slabs, continuous fogging shall be applied immediately after finishing and until covering with wet burlap, cotton mats or other suitable moisture retaining material that shall be kept thoroughly wet for at least seven days.

(3) Coverings which cause unsightly discoloration or staining of the concrete shall not be used. Any method which results in the concrete being alternately wet and dry will be considered improper curing procedure.

c. Membrane Curing Compound -

(1) This method shall consist of preventing moisture loss from the concrete by the use of a membrane forming, white pigmented, curing compound, approved by the Engineer, which will retard the loss of water during the early hardening period and which will, because of its white pigment,

reduce temperature rise in the concrete exposed to the sun's radiation.

(2) All surfaces shall be given the required surface finish prior to application of the curing compound. During the finishing period, the concrete shall be protected by the water method of curing.

(3) The curing compound shall be applied by power-operated atomizing spray equipment to obtain a uniform coating. The surface shall be sprayed in one direction and then followed within 30 minutes with a second application sprayed at right angles to the first one.

(4) The rate of application of curing compound will be as prescribed by the Engineer with a minimum spreading rate per application of one gallon of liquid coating for each 15 square meters of concrete surface. The coat shall be applied immediately after stripping of forms and acceptance of the concrete finish. If the surface is dry, the concrete shall be thoroughly wetted with water and the curing compound applied just as the surface film of water disappears. During curing operations, any unsprayed surface shall be kept wet with water.

(5) The coating shall be protected against marring for a period of at least 7 days after application. Any coating marred or otherwise disturbed shall be given an additional coating. Should the surface coating be subjected continuously to injury, the Engineer will require that the water curing method be applied at once and continuously until the membrane curing compound can be reapplied over the affected areas.

(6) The curing compound shall be thoroughly mixed within an hour before use. It shall be of such character that the film will harden within 30 minutes after application.

(7) If the use of a curing compound results in a streaked or blotchy appearance, the method shall be stopped and water curing applied until the cause of the defective appearance is corrected.

(8) Any curing compound adhering to a surface to which new concrete is to be bonded shall be completely removed by sand blasting, powered steel brush or grinder, or other approved means.

(9) If the contractor cannot obtain a uniform curing compound membrane throughout the entire surface by means of spraying equipment, then the membrane shall be applied by brush or roller.

(10) All exposed reinforcing steel shall be covered before curing compound is applied. Any curing compound adhering to a surface to which new concrete is to be bonded shall be completely removed by approved means.

(11) The liquid membrane-forming compound shall be delivered in the manufacturer's original, clean, sealed containers. No liquid membrane-curing compound shall be accepted in containers other than manufacturer's original.

934-4 METHOD OF MEASUREMENT

934-4.21 Structural concrete of each class and permeability level included in the contract will be measured by the cubic meter in accordance with the dimensions shown on the plans or ordered by the Engineer. The measurement will not include concrete used in the construction of cofferdams or falsework. No deductions in volume will be made for the volume of reinforcing steel, drainage holes, weep holes, timber bumpers, pipes and conduits less than 30 cm. in diameter, or pile heads embedded in the concrete.

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934-4.22 Concrete in reinforced bridge approach slabs and concrete pedestals for lighting standards on structures will be measured for payment under structural concrete of the class and permeability level specified in accordance with the dimensions shown on the plans or ordered by the Engineer.

934-4.23 The volume obtained as stated above will not include any concrete require under any other item of work included under other specifications, when such other item provides that payment for the same includes payment for any concrete which forms part of it.

934-4.24 Reinforcing steel and other contract items which are included in the completed and accepted structure will be measured for payment in the manner prescribed in their respective specifications.

934-5 BASIS OF PAYMENT

934-5.01 The completed and accepted quantities of each class and permeability level of structural concrete will be paid for at the contract unit price per cubic meter except as specified in Article 934-5.05 below. Such prices and payment shall constitute full compensation for furnishing, placing, finishing and curing the concrete and for all materials, equipment, tools, labor and incidentals necessary to complete each item as required by the plans and specifications.

934-5.02 The unit prices include full compensation for furnishing and placing all subsidiary items necessary to complete the structure such as joint fillers, flashing, metal drains, expansion joints, bearings and miscellaneous materials called for in the contract documents unless they constitute or are specifically covered by other pay items included in the contract.

934-5.03 No separate pay allowance will be made for any increased cement content, for any admixtures, nor for any finishing of any description for concrete surfaces indicated on the plans or required by the specifications.

934-5.04 No additional payment will be made for any concrete over dimensions stipulated in the contract documents or for strength in excess of that specified. No payment will be made for the removal and disposal of any concrete found deficient and not accepted.

934-5.05 Concrete found deficient in strength but which is accepted by the Authority under the provision of Article 934-2.10 of this specification will be paid for at a reduced unit price.

a. The reduction in unit price will be computed in accordance with the following formula: $R = 0.05D$

Where,

R = Percentage reduction in unit price of the concrete.
D = Deficiency in psi of the moving average value from the Specified strength.

b. The price reduction will be applied to all the volume of concrete represented by the three cylinder sets in a moving average subject to the following:

(1) No price will be applied when the deficiency "D" in the moving average does not exceed 100 psi.

(2) The price reduction will be applied to any given volume of concrete only once. It will be applied on the basis of the value of the first deficient moving average of which it is a component.

(3) When the Contractor opts for drilling and testing cores as per paragraph 934-2.10 j. in lieu of accepting unit price reductions based on the cylinder tests, and the core strength values fail

to meet the acceptance criteria specified in paragraph 934-2.10 j. (4), the core strength values will be divided by 0.85 and if the resulting values are below the required concrete strength by more than 500 psi the concrete represented by the core strength will be rejected. If the core strength values divided by 0.85 are not below the required concrete strength by more than 500 psi, the resulting values will be substituted in the moving average computations (and will be subjected to the strength acceptance criteria specified for the moving averages) for computing the deficiency "D" and the applicable price reductions.

(4) The cylinder sets values and the core values of concrete which is classified as deficient, is rejected and ordered removed, as per paragraph 934-2.10 k. will be omitted from the moving average and price reduction computations.

934-5.06 When the permeability of the concrete used in any type of structure described in this contract exceeds the permeability level indicated in the contract the unit price of the concrete or other pay items will be reduced in the amount of $0.10 per coulomb per cubic meters in excess of the permeability level indicated in the contract. The Authority may reject and require the removal and replacement of any lot which exceeds 1,000 coulombs above the permeability level indicated in the contract. Deductions for failure to meet the permeability requirements of article 934-5.06 shall be applied to all concretes requiring to meet a limit for permeability under these specifications including, but not limited to prestressed structural concrete members, AASHTO beams of all types, bridge decks, and to pretensioned cylinder piles and test piles. The unit price for the prestressed beams and pretensioned piles and test piles shall be deducted in the amount computed above based upon the total cubic meters of concrete incorporated in the structural member. These deductions will be in addition to the deductions for compressive strength described in 934-5.05. The total deduction will never exceed 90 percent of the contract unit price.

When the permeability of the concrete used in any type of structure described in this contract is less than the permeability level indicated in the contract, the Contractor shall receive a permeability credit in the amount of $0.10 per coulomb per cubic meters less than the permeability level indicated in the contract. Credits for exceeding the permeability requirements of this specification shall be applied to all concretes requiring to meet a limit for permeability under these specifications including, but not limited to, prestressed structural concrete members, AASHTO beams of all types, bridge decks, and to pretensioned cylinder piles and test piles. Permeability credits may only be used to offset any deductions resulting from concrete that failed to meet permeability level indicated in the contract.

The Authority may omit permeability testing in any lot at its discretion. If permeability testing is omitted, the lot will be considered to have acceptable permeability.

When a lot fails the permeability requirements, the Contractor may request re-testing of the lot at 84 days after placement in the structure. The Contractor request for re-testing shall be submitted in writing to the Engineer prior to 77 days after placement of the concrete represented by the failing lot. Re-testing shall consist of taking two approximately 2 inch in height specimens from the top and bottom of the unused cylinder and averaging the two permeability results. The acceptance of the lot will be based upon the average of the retested cylinder and no further testing will be permitted. If the Contractor fails to submit a request for re-testing following the guidelines presented herein, the test specimens representing the failing lot will not be tested and will be discarded.

934-5.07 Payment will be made under:

Pay Item	**Pay Unit**
Class II (Incidental)–(1 or 2)* Concrete …….	Cubic Meter
Class III (General Use)–(1 or 2)* Concrete ……..……	Cubic Meter
Class IV (General Use)–(1 or 2)* Concrete ……	Cubic Meter
Class IV (Bridge Deck)-(1 or 2)* Concrete …….	Cubic Meter
Class V (General Use)-(1 or 2) * Concrete ……..	Cubic Meter

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Class VI – (1 or 2)* Concrete…….……	Cubic Meter
Class VII – (1 or 2)* Concrete …….	Cubic Meter
Class VIII – (1 or 2)* Concrete …….	Cubic Meter
Class IX –(1 or 2)* Concrete ……..	Cubic Meter
Class X – (1 or 2)* Concrete ……	Cubic Meter

* The number 1 or 2 included in the pay items indicates the permeability level included in the contract.