SECTION M.03
PORTLAND CEMENT CONCRETE

M.03.01--General Composition of Concrete Mixes:

Portland cement concrete shall consist of an intimate mixture of portland cement, other approved cementitious material (when used), fine aggregate, coarse aggregate, water, and admixtures, if ordered or permitted by the Engineer, proportioned in accordance with the following requirements:

TYPE	28-day Minimum Compressive Strength	Water / Cement; or Water / Cement plus other approved Cementitious Material (by mass) Maximum	Minimum Cementitious Material Required (kg/m^3)
Pavement	25 MPa	0.49	365
Class "A"	21 MPa	0.53	365
Class "C"	21 MPa	0.53	390
Class "F"	28 MPa	0.44	390
Slope Paving	14 MPa	0.69	270

These proportions are based on the mass of the cementitious material and surface dry aggregates and on bulk specific gravity for fine and coarse aggregates.

At the option of the Contractor, other approved cementitious material may be used to replace a portion of the required portland cement in accordance with the requirements of Subarticle M.03.01-13.

When a Contractor proposes to use other approved cementitious material as a partial replacement for portland cement, he shall notify the Engineer, in writing, prior to the start of work, of the identity of the other approved cementitious material and the percentage of the required portland cement in the concrete mix which he proposes to replace with the other approved cementitious material.

The materials shall conform to the following requirements:

1--COARSE AGGREGATE: Coarse aggregate shall be broken stone, gravel, or reclaimed concrete aggregate defined as mortar-coated rock, consisting of clean durable fragments of uniform quality throughout. It shall be free from soft, disintegrated pieces, mud, dirt, organic or other injurious material and shall not contain more than one percent of dust by mass, as determined by the testing method used by the Laboratory. Reclaimed concrete aggregate shall not be used in prestressed concrete members.

Coarse aggregate of a size retained on a 28.6 mm square opening sieve shall not contain more than 8 percent of flat or elongated pieces, whose longest dimension exceeds five times their maximum thickness.

(a) Soundness: When tested with magnesium sulphate solution for soundness, using AASHTO Method T 104, coarse aggregate shall not have a loss of more than 10 percent at the end of five cycles.

(b) Loss on Abrasion: When tested by means of the Los Angeles Machine, using AASHTO Method T 96, coarse aggregate shall not have a loss of more than 40 percent.

(c) Grading:

For Pavement: The mix shall be designed utilizing a nominal maximum size of No. 4 aggregate.

For Class "A": The mix shall be designed utilizing a nominal maximum size of No. 4 aggregate.

For Class "B": The mix shall be designed utilizing a nominal maximum size of No. 4 aggregate.

For Class "C": The mix shall be designed utilizing a nominal maximum size of No. 6 aggregate.

For Class "F" : The mix shall be designed utilizing a nominal maximum size of No. 6 aggregate.

For Slope Pavement: The mix shall be designed utilizing a nominal maximum size of No. 4 aggregate.

Grading of the various stone sizes shall conform to the gradation table of Article M.01.01.

(d) Samples: Samples for tests of coarse aggregate will be taken from the bins at the quarry or from approved storage piles at the site of quarry or from approved storage piles at the batch plant.

(e) Chloride content: When reclaimed concrete aggregate is used, it shall be tested for chloride content prior to being mixed with virgin aggregate. The test used to determine chloride content shall be that outlined in the FHWA Report No. FHWA-RD-77-85. No aggregate will be accepted if the chloride content as determined from this test exceeds 0.3 kg/m^3.

2--FINE AGGREGATE: Fine aggregate shall be sand consisting of clean, hard, durable, uncoated particles of quartz or other rock, free from lumps of clay, soft or flaky material, loam, organic or other injurious material. In no case shall sand containing lumps of frozen material be used.

(a) Fine Material: Fine aggregate shall contain not more than 3 percent of material finer than 75 µm sieve, using AASHTO T 11.

(b) Organic Impurities: Fine aggregate subjected to the colorimetric test shall not produce a color darker than Gardner Color Standard No. 11, using AASHTO T21. If the fine aggregate fails to meet this requirement, the provisions of AASHTO M 6, Section 5.2, will govern.

(c) Gradation: Fine aggregate shall be uniformly graded from coarse to fine and shall meet the following gradation requirements.

SQUARE MESH SIEVES
TOTAL PERCENT PASSING BY MASS

9.5 mm	4.75 mm	2.36 mm	1.18 mm	600 µm	300 µm	150 µm
100	95-100	80-100	50-85	25-60	10-30	2-10

The above gradation represents the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified above. For the purpose of determining the degree of uniformity, a fineness modulus determination will be made upon representative samples from any source. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample will be rejected.

(d) Samples: Samples for tests of fine aggregate will be taken from approved storage piles at the site of the batch plant or from approved storage piles at the producing pit.

3--Cement: (a)
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Types I, II, and III portland cement shall conform to the requirements of AASHTO M85.

Type IS, portland blast-furnace slag cement and Type IP, portland-pozzolan cement shall conform to the requirements of AASHTO M240. The use of other approved cementitious material as a partial replacement for Type IS or Type IP cement will not be permitted.

Type III portland cement shall be used only when required by the special provisions or permitted or required by the Engineer.

(b) In addition the following requirements shall govern for all cements:

Cement having a temperature exceeding 71° C at the time of delivery to the mixer shall not be used in the concrete.

Ordering: Before starting work, the Contractor shall notify the Engineer, in writing, of the name of the manufacturer, mill, and the name of the brand of cement which he proposes to use on the work. Different brands of cement, or the same brand from different mills shall not be used on any project except with the approval of the Engineer.

All cement, except in lots of 200 bags or less, shall be shipped from bins approved by the Department.

Testing: All cement, except in lots of 200 bags or less, shall be sampled at the mill. All cements shall be tested by a laboratory whose methods and equipment are regularly inspected by the Cement and Concrete Reference Laboratory.

When a mill applies for permission to provide cement by certification, a copy of the last two (2) inspection reports by the Cement and Concrete Reference Laboratory shall be submitted for review by the Engineer. Reports of subsequent inspections shall also be submitted as received.

The mill shall provide the Bureau of Highways Laboratory with three (3) certified copies of tests of all cement which is being used by the CDOT for projects in Connecticut. The certified test report shall conform to Article 1.06.07.

4--Water: The water shall be reasonably clean, shall not be salty or brackish, and shall be free from oil, acid and injurious alkali or vegetable matter. The water shall be tested as prescribed by AASHTO Method T 26.

Water shall not be taken from shallow or muddy sources. In cases where sources of supply are relatively shallow, they shall be so enclosed as to exclude silt, mud, grass, etc.; and the water in the enclosure shall be maintained at a depth of not less than 610 mm under the intake of the suction pipe.

5--Transverse Joints for Concrete Pavement and Joint Filler for Concrete Curbing: These joints shall consist of corrosion resistant load transfer devices, poured joint seal and in addition, in the case of expansion joints, expansion joint filler conforming to the following requirements:

(a) The corrosion resistant load transfer device shall be coated steel or sleeved steel or be made of corrosion resistant material. The dimensions of any devices used shall be as shown on the plans, exclusive of any coating or sleeving. Core material of coated or sleeved metallic devices shall be steel meeting the requirements of AASHTO M 255 Grade 520, or steel having equal or better properties and approved by the Engineer. Nonmetallic devices shall meet the various strength requirements applicable to metallic devices as well as all other requirements stated herein.

All coated load transfer devices shall conform to the requirements of AASHTO M254. Uncoated or sleeved load transfer devices shall meet the applicable physical requirements of AASHTO M254. The use of field applied bond breakers will not be permitted.

The basis of acceptance for corrosion resistant load transfer devices shall be the submission by the Contractor of a minimum of two samples accompanied by certified test reports conforming to the requirements of Article 1.06.07 demonstrating that the load transfer device conforms to the requirements of AASHTO M254 for the type of device supplied.

The Engineer reserves the right to reject any load transfer device which he deems unsatisfactory for use.

(b) The type of expansion joint filler shall be either preformed expansion joint filler or wood joint filler as indicated on the plans and shall conform to the following requirements:

(1) Preformed expansion joint filler shall be the bituminous cellular type and shall conform to the requirements of AASHTO M 213.

(2) Boards for wood joint filler shall be planed on two sides
and shall be either redwood, cypress or white pine.

Redwood and cypress boards shall be of sound heartwood. White pine boards shall be of sound sapwood.

Occasional small, sound knots and medium surface checks will be permitted provided the board is free of any defects that will impair its usefulness for the purpose intended. The joint filler may be composed of more than one length of board in the length of the joint, but no board of a length less than 1.9 m may be used; and the separate boards shall be held securely to form a straight joint. Boards composed of pieces that are jointed and glued shall be considered as one board.

Dimensions shall be as specified or shown on the plans; and tolerances of plus 4.2 mm thickness, plus 3.2 mm depth and plus 6.4 mm length will be permitted.

All wood joint filler boards shall be given a preservative treatment by brushing with a creosote oil conforming to AASHTO M 133. After treatment, the boards shall be stacked in piles, each layer separated from the next by spacers at least 6.4 mm thick; and the boards shall not be used until 24 hours after treatment.

Prior to concreting, all exposed surfaces of the wood filler shall be given a light brush coating of form oil.

Testing of board expansion joint filler shall be in accordance with pertinent sections of AASHTO T 42.

Preservative Treatment: All wood joint filler boards specified shall be given a preservative treatment by brushing with creosote oil conforming to AASHTO M 133. After treatment the boards shall be stacked in piles, each layer separated from the next by spacers at least 6.4 mm thick; and the boards shall not be used until 24 hours after treatment.

Oil Coating: Prior to concreting, all exposed surfaces of wood filler shall be given a light brush coating of form oil.

6--Longitudinal Joint Devices: The metal used in the fabrication of longitudinal joint devices shall conform to ASTM requirements for each type of metal used. The dimensions shall be as shown on the plans.

7--Expansion Joint Fillers for Structures:

(a) Preformed expansion joint filler for bridges shall conform to the requirements of AASHTO M 153, Type I and Type II.

(b) Premolded expansion joint filler for bridge bearings shall conform to the requirements of AASHTO M 33.

8--Joint Sealants:

(a) Joint Sealer for Pavement: The joint sealer for pavement shall be a rubber compound of the hot-poured type and shall conform to the requirements of AASHTO M 173 unless otherwise noted on the plans or in the special provisions.

(b) Joint Sealer for Structures: The joint sealer for structures shall be as noted on the plans or as required by the special provisions.

9--Admixtures: When data is required that an admixture shall perform the desired function without injurious effects upon the concrete, this data shall be in the form of a certified statement from a recognized laboratory. The certified statement shall contain evidence based upon tests pertinent to the admixture made in the recognized laboratory by the use of concreting materials and by methods that meet the requirements of current standards of AASHTO and ASTM. Tests

may be made upon samples taken from a quantity submitted by the Contractor for use on the project, or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied. A "recognized" laboratory is any cement and concrete laboratory approved by the Engineer and inspected regularly by the Cement and Concrete Reference Laboratory, sponsored by the ASTM and the NBS.

(a) Air-Entraining Admixtures: In the event an air entraining admixture is required, evidence based on tests made in a recognized laboratory shall be submitted to show that the material conforms to the requirements of AASHTO M 154 for 7 and 28 day compressive and flexural strengths and resistance to freezing and thawing. Tests for bleeding, bond strength and volume change will not be required.

An exception to the preceding requirement is the case of admixtures which are manufactured by neutralizing Vinsol resin with caustic soda (sodium hydroxide). When the Contractor proposes to use such an admixture, he shall submit to the Engineer a certification concerning the admixture in the following form:

This is to certify that the product (trade name) as manufactured and sold by the (company name) is an aqueous solution of Vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to Vinsol resin is one part of sodium hydroxide to (number) parts of Vinsol resin. The percentage of solids based on the residue resulting from evaporation and subsequent drying at 105° C is (number). No other additive or chemical agent is present in this solution.

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit to the Engineer a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to, or at any time during construction, the Engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. When so tested, 7-day compressive strength of concrete made with the cement and aggregates in the proportions to be used in the work, and containing and admixture under test in an amount sufficient to produce from 4 to 6 percent entrained air in the plastic concrete, shall be not less than 85 percent of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixture.

The percentage reduction in strength shall be calculated from the average strength of at least 5 standard 150 mm by 300 mm cylinders of each class of concrete.

Specimens will be made and cured in the laboratory in accordance with the requirements of AASHTO T 126 and will be tested in accordance with the requirements of AASHTO T 22. The percentage of entrained air will be determined in accordance with the requirements of AASHTO T 152.

(b) Retarder Admixtures: The admixtures may be in liquid or powder form, and of one of the following types:

(1) A calcium, sodium, potassium or ammonium salt of lignosulfonic acid.

(2) A hydroxylated carboxylic acid or its salt.

(3) A carbohydrate.

Mix Requirements: The properties of retarded concrete prepared with the admixture under test shall be compared with those of a reference concrete prepared without the admixture. The cement, water and aggregates for both concretes shall be drawn from common sources or stockpiles and the mixes shall have the following composition:

Cement Content, bags per cubic meter	.....	7.9 ± 0.1
Air Content, % (reference concrete)	.....	5.5 ± 0.5
Air Content, % (retarded concrete)	.....	6.0 ± 1.0

Slump, mm	.....	66 ± 12
Fine aggregate, by soil volume of total aggregate, %	.....	36 to 41

An approved air-entraining admixture shall be used if necessary to obtain the required air content.

A sufficient amount of retarding admixture shall be used to cause an increase of 50 to 60 percent in setting time over the setting time of the reference mix. The setting time for both mixes shall be determined by ASTM C 403 using a pressure of 3.45 MPa at a temperature of 23 °± 2° C for the concretes and ambient air.

Required Properties of Retarder: When added to concrete in powder or liquid form, in the manner prescribed by it's manufacturer or marketer and in sufficient amount to retard the setting time 50 to 60 percent, the retarding admixture shall cause the concrete to have the following properties in comparison with those of the reference concrete.

When the test and reference concrete have equal cement content and equal slump, the water content shall be decreased at least 5 percent; the air content of the retarded concrete with or without an air-entraining admixture, shall not exceed 7 percent; and the compressive strength at ages of 3, 7 and 28 days shall be increased at least 10 percent.

Performance Requirements: When a Contractor proposes to use a previously approved retarding admixture, he shall submit a certificate stating that the admixture is identical in composition with the sample that was used for the acceptance tests. If the admixture varies in concentration from the acceptance sample, a certificate will be required stating that the product is essentially the same for chemical constituents as the approved admixture and that no other admixture or chemical has been added. Either prior to or at any time during construction, the Engineer may require the selected admixture to be retested. When retested, the 3- and 7-day compressive strengths or 7-day flexural strength of the concrete shall meet the requirements stated above.

(c) All other admixtures, when specified, shall meet the requirements set forth in the special provisions or on the plans.

10--Curing Materials: (a) Cotton Mats : Cotton mats for curing concrete shall conform to the following:

The mats shall consist of a filling material of cotton "bat" or "bats" covered with unsized cloth and tufted or stitched to maintain the shape and stability of the unit under job conditions of handling.

The covering of the mats shall be one of the following:

(1) Cotton cloth covering shall have a mass of not less than 215 g/m^2 and shall have an average of not less than 32 threads in warp and not less than 28 threads in filling, having a minimum average breaking strength (grab method) of 270 N in the warp and 270 N in the filling. The mass of the cotton cloth covering shall not fall below the specified mass by more than 5 percent. The raw material used in the manufacture of the cotton cloth shall be raw cotton, cotton comber waste, cotton card strip waste, or combination thereof. The other physical characteristics of the cloth shall be equal to those in such material for industrial purposes.

(2) Burlap or jute covering shall have a mass of not less than 230 g/m^2 and shall have not less than 8 threads per 25 mm of warp and not less than 8 threads per 25 mm of filling. It shall be the grade known commercially as "firsts" and shall be free from avoidable imperfections in manufacture and from defects or blemishes affecting the serviceability. A tolerance in mass of minus 5 percent will be permitted.

The filling material for the mats shall be a cotton bat, or bats, made of raw cotton, cotton waste, cotton linters, or combinations thereof, and shall have a mass of not less than 410 g/m^2. The mats shall not contain any materials such as dyes, sugar, etc., that may be injurious to the concrete. The batting used shall not be lower in quality than a batting made of U.S. Standard Grade No. 3 Linters.

The cotton thread for tufting shall be not less than 4-cord number 12's. The thread used for all sewing or stitching shall be at least equivalent in size and strength to standard 3-cord, number 30 cotton thread.

The mats shall have a filler 1.8 m in width and shall have a flap 150 mm or more in width, consisting of an extension of two thicknesses of the covering material, extending along one longitudinal edge of the mat. The length of the mats shall be 765 mm greater than the width of pavement slab to be cured. The length or width of the mats shall be not less than that specified by more than 2 percent.

The covering material for each surface of the mat shall consist of two widths of cloth joined by a lapped seam or by a seam formed by superimposing the two widths and uniting them by one row of stitches. If the seam is of the latter type, the edges shall be on the inside of the finished mat. The cotton filling material in the form of a bat or bats shall be held in place between the coverings by sewing or tufting all around the periphery of the mat within 25 mm of each of the four edges of the filler, and by sewing or quilting longitudinally at intervals not greater than 100 mm, or by tufting at intervals, both longitudinally and transversely, not greater than 75 mm. The sewing or tufting shall be sufficiently loose to permit substantially all of the surface of the mat to come in contact with a flat surface when in use, but not so loose as to permit the filling material to shift. The flap shall be constructed by sewing the upper and lower covering together longitudinally within 25 mm of the outer edge of the flap. Along the edge of the mat opposite the flap, the filling material shall be within 25 mm of the edges of the covering material, and the covering material shall be sewn together so as to enclose the filling material. The ends of the mats shall be finished by running an additional seam (i.e., a seam in addition to the seam holding the filling material in place) across the mats. This seam shall not be closer to the seam holding the filling material in place than 6.4 mm and not closer to the end of either covering than 12.5 mm, unless the ends of the mat are finished with an overlying or whip stitch or in a manner which will not leave a raw edge. All longitudinal sewing or quilting shall average at least three stitches per 25 mm and shall have not less than five stitches in any 50 mm. All other sewing shall average six stitches per 25 mm and shall have not less than nine stitches in any 50 mm.

(b) Waterproof Paper: Waterproof paper shall conform to the requirements of AASHTO M 171 and in addition shall not be less than 6.1 m in length and shall be of sufficient width to cover completely the surface of the pavement.

(c) Liquid Membrane-Forming Compound: Liquid membrane-forming compound shall conform to the requirements of AASHTO M 148 Type 2, Class B, or shall be a water-soluble linseed oil-based compound conforming to the requirements of AASHTO M 148, Type 2.

(d) White Polyethylene Sheeting (Film): White polyethylene sheeting (film) shall conform to the requirements of AASHTO M 171.

11--Protective Compound Material: This material shall be listed on the approved list of the CDOT for the specified use.

12--Non-shrink, Non-staining Grout:

(a) Bagged, pre-mixed formulations of non-shrink grout shall meet the requirements of ASTM C 1107, Grade B. The grout must be mixed with potable water for use. The grout shall be mixed to a flowable consistency as determined by ASTM C 230. All bagged material shall be clearly marked with the manufacturer's name, date of production, batch number, and written instructions for proper mixing, placement and curing of the product.

(b) The Contractor may formulate and design a grout mix for use on the project in lieu of using a pre-bagged product. The Contractor must obtain prior written approval of the Engineer for any such proposed mix design. Any such mix design shall include the proportions of hydraulic cement, potable water, fine aggregates, expansive agent, and any other necessary additive or admixture. This material shall meet all of the same chemical and physical requirements as must the pre-bagged grout, in accordance with ASTM C 1107, Grade B.

13--Other Cementitious Material:

(a) Fly Ash

1. Fly ash may be used to replace up to a maximum of 15 percent of the required portland cement. The fly ash shall be substituted on a mass basis, with a minimum of 0.45 kg of fly ash for 0.45 kg of portland cement.

2. Fly ash to be used as a replacement for portland cement in portland cement concrete shall meet the requirements of AASHTO M295, either Class C or Class F, including the uniformity requirements of Table 2A. Loss on Ignition for either class of fly ash shall not exceed 4.0%.

3 Ordering: Before starting work, the Contractor shall notify the Engineer, in writing, of the class, the name and location of the producing plant and the name and location of the bulk storage facilities, if different from the producing plant, for the fly ash he proposes to use in the work. Different classes of fly ash or the same class from different producing plants, shall not be used on any project without the written express approval of the Engineer.

Fly ash shall be obtained from an approved source and shall be supplied from silos or bulk storage facilities, whose contents have been approved by the Department.

4 Testing: Fly ash shall be sampled and tested in accordance with the procedures and methods prescribed in ASTM C311.

The producer or supplier of the fly ash shall provide the Department with three copies of certified test reports from an approved laboratory for all fly ash supplied to the Department. The certified test reports shall conform to Article 1.06.07. An approved laboratory shall be defined as a laboratory whose cement and concrete testing equipment and methods are regularly inspected by the Cement and Concrete Reference Laboratory.

Approval of the laboratory will be contingent on review by the Department of the last two inspection reports by the CCRL, which are to be submitted by the laboratory.

5 Storage: The fly ash shall be stored at the producing plant or at the supplier's terminal in approved weather-tight silos or bulk storage facilities. All silos or storage facilities shall be completely empty and clear before the fly ash is deposited therein.

Fly ash remaining in bulk storage for a period greater than one year after approval shall be resampled and tested prior to shipment or use. Fly ash which has been in bulk storage for a period exceeding two years from the time of original manufacture, shall not be used on Department work.

14--Anchoring Cement: The premixed anchoring cement shall be non-metallic, concrete gray in color and packaged in bags. The mix shall consist of hydraulic cement, fine aggregate, expansive admixtures and water conforming to the following requirements:

1. The anchoring cement shall have a minimum 24 hour compressive strength of 18 MPa, when tested in accordance with ASTM C 109.

2. The water content of the anchoring cement shall be as recommended by the manufacturer. Water shall conform to the requirements of Article M.03.01-4. The potable water shall not contain chlorides or nitrates.

Portland cement shall be Type I, II, or III cement conforming to the requirements of Article M.03.01-3.

Fine aggregate shall conform to the requirements of Article M.03.01-2.

The Contractor shall provide a Certified Test Report and Materials Certificate for the premixed anchoring cement in conformance with Article 1.06.07. The Contractor shall also provide, when requested by the Engineer, samples of the premixed anchoring cement for testing and approval.

15--Chemical Anchors: The chemical anchor material shall be epoxy or polyester polymer resin. It shall contain no metals or products that promote corrosion of steel. The Contractor shall supply the Engineer with a Certified Test Report and Materials Certificate for the chemical anchor material in conformance with Article 1.06.07. The Contractor shall also provide, when requested by the Engineer, samples of the chemical anchors for testing and approval. Chemical anchor material shall be listed on the approved list of the CDOT and approved by the Engineer for the specified use.

M.03.02--Penetrating Sealer Protective Compound:

The penetrating sealer protective compound shall be a clear penetrating sealer which will protect the concrete against salt intrusion and is approved by the Engineer as indicated by being listed on the approved list of the CDOT for the specified use.