PART 1 - SCOPE

This specification covers the classification, materials, proportioning of materials, equipment, mixing requirements, and testing for portland cement concrete to be used for construction of streets, bridges, and miscellaneous structures and facilities as defined in Division 2 – Site Construction of these Specifications. The classification requirements, forming, curing, measurement, and payment for specific uses of concrete are specified and defined in the appropriate sections of Division 2.

PART 2 – CONCRETE CLASSIFICATION

2.01 CONCRETE CLASSIFICATION

Portland cement concrete used for construction of the various items covered in Division 2 of these Specifications shall be classified by usage as follows:

A. Class A.

Class A concrete shall be used as specified for such items as concrete curb, curb and gutter, sidewalks, drainage and sewer structures other than box culverts, ditch paving, bridges (other than superstructure) and similar uses.

B. Class A S.

Class A S concrete shall be used for bridge superstructures and channel lining of ditches.

C. Class B.

Class B concrete shall be used for roadway base and pavement.

D. Class C.

Class C concrete shall be used as specified for such items as concrete cradles, encasements, embankment slope paving at bridge abutments, and other low strength applications.

E. Class P.

Class P concrete shall be used for cast-in-place box culverts and precast and precast-prestressed concrete structures or structural members. High-early-strength concrete shall be as specified in Specification Section 03050 Paragraph 6.05.

PART 3 – MATERIALS.

Materials used in the production of portland cement concrete of the various classifications specified herein shall meet the following requirements.

3.01 PORTLAND CEMENT.

Portland cement shall be Type I cement conforming to the requirements of AASHTO M 85, except that for high-early-strength concrete, Type III cement may be used.

3.02 FINE AGGREGATE.

A. Fine aggregate shall consist of natural sand, clean and free from any surface film or coating and graded from fine to coarse. Fine aggregate shall conform to the requirements of ASTM C 33 and the specifications included herein. The amount of deleterious substance shall not exceed the following percentage by weight:

Removed by decantation……	3 percent
Coal or lignite……	1 percent
Clay lumps……	1 percent

Other local deleterious substances (such as shale, alkali,

Mica, coated grains, soft and flaky particles)…… 1 percent

Total coal, clay lumps, shale, soft fragments and other local deleterious substances …….. 5 percent

B. All fine aggregate shall be free from amounts of organic impurities that would be detrimental to concrete strength and durability. Aggregate shall be subjected to the colorimetric test made in the field as follows:

Fill a 12 oz. graduated bottle to the 4 ½ oz. mark with the sand to be tested. Add a 3% solution of sodium hydroxide until the volume, after shaking, amounts to 7 ounces. Shake thoroughly and let stand for 24 hours. The sample shall then show a practically colorless solution, or at least, a solution not darker than straw color.

C. Fine aggregate shall be well graded from coarse to fine and, when tested by means of laboratory sieves, shall conform to the following requirements:

Passing	Percent
3/8 in. Sieve……	100
No. 4 Sieve……	95 to 100
No. 16 Sieve……..	50 to 90
No. 50 Sieve……..	10 to 30
No. 100 Sieve……	0 to 10
No. 200 Sieve……	0 to 3

Note: Not more than 45% should be retained between any two consecutive sieves.

D. Fine aggregate shall be of such quality that mortar composed one (1) part portland cement and three (3) parts fine aggregate, by weight when made into briquets or cylinders, shall show a tensile or compressive strength at seven (7) and twenty-eight (28) days at least equal to the strength of briquets or cylinders composed of one (1) part of the same cement and three (3) parts standard Ottawa sand by weight. The percentage of water used in making the test specimens of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand test specimens of standard consistency.

3.03 COARSE AGGREGATE.

A. Coarse aggregate for any class of portland cement concrete shall consist of crushed stone or crushed or uncrushed gravel unless otherwise specified.

B. Coarse aggregate for Class A, Class B, or Class C concrete shall be furnished in two sizes: Size No. 4 and Size No. 67 as shown hereinafter in Table 03050.1, Coarse Aggregate Gradation Table. The two sizes shall be manufactured, within the specified limits, to produce Size No. 467 when combined in the proper proportions at the batching plant. If the supplier provides a proper stockpile to prevent segregation, then a combined Size No. 467 can be used in lieu of blending Size No. 4 and Size No. 67.

C. Coarse aggregate for Class AS concrete shall be Size No. 57. Only limestone coarse aggregate will be used for Class AS concrete; gravel coarse aggregate will not be permitted.

D. Coarse aggregate for Class P concrete shall be size No. 57 or Size No. 67 as may be specified or directed. Only limestone coarse aggregate shall be used for Class P concrete; gravel coarse aggregate will not be permitted.

E. Coarse aggregate for concrete curbing placed by machine extrusion methods shall be Size No. 57 or Size No. 67.

F. The coarse aggregates shall otherwise conform to the requirements of AASHTO M 80 and ASTM C 33 with the following exceptions and stipulations:

1. Deleterious Substances.
The amount of deleterious substances shall not exceed the following limits:

	Maximum Percent by Weight
a. Soft or nondurable fragments (fragments which are structurally weak such as shale, soft sandstone, limonite concretions, gypsum, weathered schist or cemented gravel) ……..	3.0
b. Coal and lignite ……	1.0
c. Clay lumps ……	0.25
d. Material passing the No. 200 sieve ……..	1.00
e. Thin or elongated pieces (length greater than 5 times average thickness)	10.00
f. Other local deleterious substances	1.00

Notes: 1. In the case of crushed aggregate, if all the material finer than the 200 mesh sieve consists of the dust of fracture essentially free of clay or shale, Item 4, Maximum Per Cent by Weight, may be increased to 1.5.

2. The sum of the percentages of Items No. a, b, c, d, and f shall not exceed 5.0.

3. When the coarse aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than nine.

4. Alternate freeze/thaw tests for soundness will not be performed.

5. The percentage of wear as determined by AASHTO T 96 shall not exceed 40.

COARSE AGGREGATE GRADATION TABLE
Table 03050.1

Size Number	Amounts Finer Than Each Lab. Sieve (Sq. Openings), % By Weight							
	2”	1-1/2”	1”	¾”	½”	3/8”	No. 4	No.8
4	100	90-100	20-55	0-15	----	0-5	----	----
467	100	95-100	----	35-70	----	10-30	0-5	----
57	----	100	95-100	----	25-60	----	0-10	0-5
67	----	----	100	90-100	----	20-55	0-10	0-5

3.04 WATER.

The water used in mixing concrete shall be clean, free from oil, acid, strong alkalis, organic or vegetable matter.

3.05 AIR-ENTRAINING ADMIXTURES.

A. Air-Entraining Admixtures shall conform to the requirements of AASHTO M 154, except that the tests for bleeding, bond strength and volume change will not be required.

B. The Owner will maintain a list of qualified products. The Contractor shall be required to furnish a material that appears on this list.

C. A product may become approved by furnishing test data from a recognized laboratory showing that the air-entraining admixture proposed for use conforms to the requirements of these Specifications. A recognized laboratory is defined as one of the following: A State Transportation Department Laboratory; a Federal Highway Administration Laboratory; or other laboratories which are approved by the Owner.

3.06 CHEMICAL ADDITIVES.

A. For portland cement concrete mixtures, these additives shall conform to the requirements of AASHTO M 194 covering the following five types:

1. Type A – Water reducing admixtures
2. Type B – Retarding admixtures
3. Type C – Accelerating admixtures
4. Type D – Water reducing and retarding admixtures
5. Type E – Water reducing and accelerating admixtures

B. Additionally, admixtures for increasing the flowable characteristics of concrete (super plasticizers) may be used, subject to the approval of the Owner for each class and intended use of the concrete. Such admixtures shall meet the applicable requirements of ASTM C 494. The use of a plasticizer shall not change the maximum water requirements for the approved design mix. When approved for use, the admixture shall be introduced into the mix in the manner and quantities recommended by the manufacturer.

C. Additives listed in items A through E above and super plasticizers may only be used with the written approval of the Owner. Before any admixture is approved, the manufacturer of the admixture or the Contractor shall furnish the owner documentary evidence that the material proposed for use has been tested in accordance with the methods of test specified in AASHTO M 194 (or ASTM C 494 for super plasticizers) and meets the requirements of the Specification. Documentary evidence for all additives shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. The Owner may require a notarized certification from the manufacturer of any additives used stating that the material is identical with that originally approved and has in no way been changed or altered. Even through additives have been approved by the Owner, the Contractor shall be responsible for the successful use of the additives. No reduction in the cement content of the concrete as designed without chemical additives will be made when additives are permitted.

D. Calcium chloride additives will not be permitted.

3.07 CURING MATERIALS.

Curing materials shall be as specified in the various Specification Sections of Division 2 and as specified below:

A. Water.
Water used in curing portland cement concrete shall be free from any substance which may be injurious to concrete when applied on the surface as a curing agent.

B. Burlap.
Burlap shall conform to AASHTO M 182, Class 3 or Class 4. If Class 1 or Class 2 burlap is permitted, at least two layers shall be use.

C. Liquid Membrane-Forming Compounds.
These compounds shall conform to AASHTO M 148. Where applied texture finish is specified, a Type 1-D, Class B, membrane which is compatible with the texture finish shall be used. Type 2 (white pigmented) membrane shall be used in all other applications, unless otherwise specified.

D. White Polyethylene Sheeting.
This material shall conform to AASHTO M 171.

3.08 FLY ASH.
Class C fly ash conforming to the requirements of ASTM C 618-84 may be used as a replacement for portland cement if approved in writing by the Owner. The maximum amount of cement being replaced by fly ash shall not exceed 15 percent. Before any fly ash will be approved for use, the Contractor shall furnish the Owner documentary evidence that the fly ash proposed for use has been tested in accordance with ASTM C 311-7 and meets the requirements of that specification. Documentary evidence shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. Even though the fly ash has been approved by the Owner, the Contractor shall be responsible for its successful use. When a specific air content has been required and fly ash is being used, the air content shall be tested on each truck load of concrete at the batch plant and the tested value shall be indicated on the ticket.

PART 4 – EQUIPMENT

4.01 GENERAL.
Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to the approval of the Owner. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans and Design Standards or as directed by the Owner.

4.02 BATCHING PLANT AND EQUIPMENT.

A. General.
The batching plant shall include bins, weighing hoppers, and scales. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The Contractor shall provide adequate means for cement cut off checks. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. The bulk cement storage bin or hopper shall be provided with adequate means for sampling the cement in storage.

B. Bins and Hoppers.
Bins with adequate separate compartments for fine aggregates, each size of coarse aggregate, and cement shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening shall be provided for removing an overload of any one of the several materials from the hopper. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments, both in bins and in hoppers, shall be ample to prevent spilling under any working conditions.

C. Scales.

1. The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within 0.5 percent throughout the range of use. The value of the minimum graduation on the scale for weighing cement shall not be greater than 5 pounds. The value of the minimum graduation on the scale for weighing amounts of aggregates up to 10,000 pounds or more shall be not greater than 10 pounds. The value of the minimum graduation of scales used in weighing amounts of aggregate 10,000 pounds or more shall be not greater than 0.1 per cent of the nominal capacity of the scales but shall not exceed 50 pounds. When beam type scales are used, provision, such as a "tell-tale" dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The "tell-tale" device on weighing beams shall indicate critical position clearly. Poises shall be designed so that they cannot be easily removed from the beam and can be held firmly in place. The weigh beams and "tell-tale" device shall be in full view of the operator while charging the hopper, and he shall have convenient access to all controls.

2. Scales shall be tested no less than once monthly by a certified scale testing company. Testing shall meet the requirements of applicable City ordinances and State law. The Contractor shall have available not less than 10 standard 50 pound weights meeting the requirements of the U.S. Bureau of Standards for calibrating and testing weighing equipment. The person dispensing weighed material shall certify that the amounts of materials used is in accordance with quantities shown on the delivery ticket.

D. Equipment For Structural Concrete.

1. The requirements for batching plants shall be as prescribed above, except that when approved by the Owner, the requirement for storage compartments in addition to weigh bins, for fine and coarse aggregates may be waived, provided the batching tolerances specified in Specification Section 03050 Paragraph 5.02.A are maintained.

2. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed. Tremies for placing seal concrete under water shall consist of a water tight tube 10 inches to 14 inches in diameter. It shall be constructed so that the bottom can be sealed and opened after it is in place and fully charged with concrete. It shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow.

4.03 MIXERS.

A. General.

1. Concrete may be mixed at a central point or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum, in terms of mixing and agitating capacity, and the speed of rotation of the mixing drum or blades for both mixing and agitation.

2. Mixers shall be capable of combining the aggregates, cement, additives when specified, and water into a thoroughly mixed and uniform mass within the specified mixing period. They shall have a minimum capacity sufficient to comply with minimum production requirements.

3. Mixers shall be equipped with an approved device for accurately measuring water within a range of error of not more than one percent. The amount of water used in each batch shall be shown by an indicator which is accurately calibrated and easily read.

4. Central plant mixers shall be equipped with an approved batch meter and timing device which will automatically lock the discharge lever during the full time of mixing and release it at the end of the mixing period. This device shall be equipped with a bell or other suitable warning device that will give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, providing the Contractor furnishes a satisfactory means of determining the mixing time.

B. Mixers At Site Of Construction.
Mixers at the site of construction will not be permitted, unless permitted by the Owner.

C. Truck Mixers And Truck Agitators.
Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall meet all the applicable requirements under Paragraph A above, and in addition, the manufacturer's plate shall indicate the various uses for which the equipment is designed, the gross volume of the drum, and the minimum and maximum speed of rotation of the drum or blades for charging, mixing and agitating. Trucks equipped for mixing shall be equipped with an approved device for recording the number of revolutions of the drum or blades. Mixers or agitators used to mix and transport paving concrete shall be of the hydraulic drum lift type or other especially designed types which will discharge low slump concrete (1 – 2 ½ inch) at a satisfactory rate without segregation.

D. Nonagitator Trucks.
Bodies of nonagitator hauling equipment for concrete shall be smooth, mortar tight, metal containers, and shall be capable of discharging the concrete at a satisfactorily controlled rate without segregation. Covers shall be provided when needed for protection of the concrete. Nonagitator trucks may be used only with approval of the Owner.

E. Admixture Induction.
A satisfactory method and equipment for setting the dosage for admixtures must be furnished and if admixtures other than air entraining agents are used, they shall be added in the manner and in the dosage recommended by the manufacturer.

F. Vibrators.
Vibrators shall be of an approved type and design, and shall operate under load at the rate as recommended by the manufacturer and approved by the Owner. For concrete structures, all concrete to be vibrated shall be compacted by means of approved high frequency internal vibrators or other approved types of vibrators immediately after being deposited in the forms. At least two vibrators in good operating condition and tow sources of power shall be available at the site where more than 25 cubic yards of concrete are to be poured. The use of external vibrators for compacting concrete will be permitted where the concrete is inaccessible for adequate compaction, provided the forms are sufficiently rigid to prevent displacement or damage from external vibration and approved by the Owner. For concrete pavement, the frequency of surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand operated or attached to spreader or finishing machines, are used adjacent to forms, they shall have a frequency not less than 7,000 impulses per minute. For prestressed concrete, all concrete shall be thoroughly compacted with approved high frequency vibrators operating at a minimum of 7,000 vibrations per minute.

PART 5 – HANDLING, BATCHING AND MIXING

5.01 STOCKPILING AGGREGATES.

A. Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the ground shall be firm and smooth and well drained. A cover of at least three inches of aggregate shall

be maintained in order to avoid the inclusion of soil or foreign material. The stockpiles shall be built in layers not exceeding four feet in height, and each layer shall be completely in place before the next layer is started so as to prevent segregation. The material shall be deposited in such manner as to prevent coning, except in the case of aggregate composed essentially of material finer than the No. 4 sieve and base material.

B. Dumping, casting or pushing over sides of stockpiles will be prohibited, except in the case of aggregate for base material and fine aggregate materials.

C. Unless otherwise authorized, aggregates from different sources, different gradings or differing in specific gravity by more than 0.03 shall not be stockpiled together. Stockpiles of different types or sizes of aggregates shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.

D. When it is necessary to operate trucks or other equipment on a stockpile in the process of building the stockpiles, it shall be done in a manner approved by the Owner. Any method of stockpiling aggregate which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated, and failure of such samples to meet all grading requirements for the aggregate shall be considered cause for discontinuance of such stockpiling procedure.

E. Stockpiles shall be maintained in a saturated surface dry condition to the extent possible.

5.02 HANDLING, MEASURING AND BATCHING MATERIAL.

A. General.

1. The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the Work.

2. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to maintain a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Owner. The Owner may require sprinkling of aggregate that has dried to the extent that it absorbs mixing water.

3. The fine aggregate and each size of coarse aggregate shall be separately weighed into the hopper or hoppers in the respective amounts set by the Contractor and approved by the Owner. Cement shall be measured by the sack or weight. Separate scales and hoppers shall be used for weighing the cement. The scales shall be equipped with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Ninety-four pounds of bulk cement shall be considered one sack. Batches involving fractional sacks will not be allowed except when bulk cement is used.

4. Batching plants equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type may be used.

5. Batching shall be so conducted as to result in the required weights of each material being within a tolerance of 1.0 percent for cement and 1.5 percent for aggregates.

6. Water may be measured either by volume or by weight. The accuracy of measuring the

water shall be within a range of error of not over 1.0 percent. Unless otherwise permitted, calibrated tanks for measuring water shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

7. The use of chemical additives shall be as prescribed under Paragraph 3.06 of this Specification and they shall be added to the mix using the methods and at the time and in the manner recommended by the manufacturer of the additive, subject to approval by the Owner.

8. Unless specifically provided in the contract, the furnishing and use of approved additives or admixtures and the other precautions necessary to provide satisfactory concrete and concrete products shall be considered subsidiary to the furnishing and placement of the concrete and any and all additional costs related thereto and risks resulting there from shall be borne by the Contractor.

9. Different types of cement shall not be mixed, nor shall they be used alternately. Where it is necessary for the color of the concrete to be uniform, only those cements which will produce similar color in concrete may be used alternately. The Owner shall designate which cements may be used alternately.

10. Air entraining agents shall be added to the mix by an approved procedure and by the use of an approved dispenser to assure an accurate proportioning of the agent.

11. All admixtures shall be measured with an accuracy of plus or minus 3.0 percent.

B. Limitations On Concrete Operations.

1. Mixing of concrete shall be discontinued in time to allow finishing to be completed in daylight hours, unless an adequate and approved artificial lighting system is provided and operated.

2. When concrete is being placed during hot weather, appropriate measures shall be taken to reduce the hazards of increased rate of cement hydration and high concrete temperatures. The temperature of the concrete at point of discharge shall not exceed 90^0 F. The Owner may require any or all, but not limited to, the following precautions to reduce the temperature of the concrete:

a. Sprinkle coarse aggregate stockpiles in a manner so as to distribute the water evenly and to prevent a variation of moisture within the stockpile.

b. Use crushed or chipped ice as a portion of the mixing water, or use water cooled by refrigeration or other means. If ice is used, it shall be substituted on a pound for pound basis for water and completely melted before the concrete is discharged from the mixer.

c. The Contractor may employ other means which he may have at his disposal if approved by the Owner. In order to minimize the number and extent of precautions as indicated during the production and use of concrete during hot weather, the Contractor may use approved chemical admixtures for set-retarding purposes, with the Owner's approval. However, the use of such approved set-retarding admixtures shall not relieve the Contractor of the necessity for other precautions deemed necessary to minimize variability of the physical characteristics, strength, and other requirements of the green concrete.

d. Unless authorized in writing by the Owner, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40^0F (if the temperature is expected to reach 35^0F or below), and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35^0F.

e. When concreting at temperatures above 35^0F, the aggregates or water shall be heated or cooled if necessary prior to being placed in the mixer so that the temperature of the resultant mixture will be not less than 50^0F nor more than 90^0F at the time of placement. If heating is required, the apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the concrete.

f. When concreting is authorized at temperatures 35^0F or less, the Owner will require the water or the aggregates or both to be heated to not less than 70^0F nor more than 150^0F. The temperature of the mixed, heated concrete shall be not less than 50^0F nor more than 100^0F at the time of placement. No concrete shall be placed on frozen grade nor shall frozen aggregates be used in the concrete.

g. When it is expected that the ambient temperature will drop below 35^0F, the Contractor shall provide sufficient canvas and framework, other types of housing, or to enclose and protect the concrete in such a way that the air surrounding the fresh concrete can be maintained at a temperature of not less than 45^0F and the temperature of the concrete shall not exceed 80^0F. The above conditions shall be maintained for a period of 120 hours after the concrete is placed. The Contractor shall be responsible for the quality of concrete placed during cold weather, and any concrete injured by frost action or freezing shall be removed and replaced at the Contractor's expense. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before the Owner's permission is granted to begin placement.

3.05 MIXING CONCRETE.

A. General.

1. The concrete may be mixed in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity, and shall comply with the applicable requirements of Paragraph 4.03 of this Specification Section. Mixers shall be cleaned at suitable intervals. Equipment having components made of aluminum or magnesium alloys which would have contact with plastic concrete during mixing, transporting or pumping of portland cement concrete, shall not be used.

2. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. Mixing time shall be measured from the time all materials except water are in the drum. The flow of water shall be uniform, and all water shall be in the drum buy the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the flow of materials into the drum.

3. When mixed in a central mixing plant, the mixing time shall not be less than 60 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers shall be included in the mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

4. The mixer shall be operated at the drum speed recommended by the manufacturer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. Mixers for central mix plants shall not be operated at a capacity greater than the manufacturer's guaranteed mixing capacity.

5. Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators or nonagitating trucks having special bodies. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the Work shall not exceed 30 minutes when the concrete is hauled in nonagitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators. When high early strength concrete is used, agitator trucks only

shall be used and the concrete shall be deposited in place at the site of the Work within 30 minutes from the time water is added to the mix, regardless of the method of transportation, unless otherwise approved by the Owner.

6. Truck mixers and truck agitators used to transport concrete from a central mixing plant and truck mixers used to mix concrete in transit from a central batching plant shall meet all applicable requirements of Paragraph 4.03 of the Specification Section, and in addition, the mixing speed and agitating speed shall be those recommended by the manufacturer of the mixer and the total revolutions at mixing speed shall not be less than 70 nor more than 100. Truck mixers and truck agitators shall be operated within the capacity recommended by the manufacturer.

7. Retempering concrete by adding water or by other means will not be permitted. Concrete that is not within the specified slump limits at time of placement shall not be used. Admixtures for increasing the workability or for accelerating the set will be used only when provided for in the Contract, or permitted by the Owner. The addition of admixtures to the mix shall be in accordance with the provisions of Paragraph 5.02.A of this Specification Section.

8. Tests for air content shall be made on samples of fresh concrete when and as directed. The air content shall be that specified under Part 6 of this Specification Section and shall be determined in accordance with AASHTO T 152, T 196 or T 199.

B. Ready Mixed Concrete.

1. Ready mixed concrete shall fully comply with ASTM C 94 for Ready Mixed Concrete and to the requirements of these Specifications. Ready mixed concrete shall be discharged from the mixer within 1 hour after the introduction of water, provided the air temperature or the concrete temperature does not exceed 70^0F. When the air temperature or concrete temperature exceeds 70^0F, the elapsed time between the addition of water to the mix and discharge shall not exceed 30 minutes. The 30 minute time limit for temperatures exceeding 70^0F may be extended to 1 hour, provided an approved admixture is used. The admixture shall be a water reducing and retarding agent meeting the requirements of Paragraph 3.06, Type D of this Specification Section and shall be used in accordance with the provisions of Paragraph 5.02.A of this Specification Section. The ready-mix plant furnishing the concrete shall have been inspected and approved for use as provided for in Part 4 of this Specification Section.

2. The delivery ticket accompanying each load of concrete shall show the class and quantity of concrete, the quantity of cement, aggregates, water, and additive used in the batch, and the time of batching. Materials used in the concrete shall be tested and approved.

PART 6 – MIX DESIGN AND PROPORTIONING

6.01 GENERAL.

A. A Concrete Classification Table, Table 03050.2 is provided hereinafter to indicate to the Contractor the five classes of concrete to be use. The table contains certain criteria to be met in the design of job mixes for the different classifications of concrete. Data included are the minimum 28 day compressive strength of the concrete (14 day strength for Class B concrete), the range of slum allowed, the minimum cement content of the concrete, and the maximum water allowed. The Contractor shall be responsible for design of the concrete mix to be used for each classification of concrete within the limits of Table 03050.2, and for providing concrete to the City in accordance with the approved design mixes.

B. Unless otherwise specified in the Contract Documents all concrete shall contain an air entraining admixture. The concrete shall contain between 5 percent and 8 percent entrained air. Other admixtures may be used if specifically approved by the Owner. The use of calcium chloride will not be allowed.

C. The Owner may specify differing compressive strengths for the several classifications by notation on the Plans or in the Special Provisions, and those values shall govern over the values of these Specifications.

CONCRETE CLASSIFICATION TABLE

Table 03050.2

Class Of Concrete	Minimum 28-Day Compressive Strength (psi)	Slump In Inches	Min. Cement Factor-Sacks/CY **(3)**		Min. Cement Factor-#/CY **(3)**		Net Water Max. Gals./CY **(3)**		Net Water Max-#/CY **(3)**	
			Gravel Course Aggregate	Limestone Course Aggregate	Gravel Course Aggregate	Limestone Course Aggregate	Gravel Course Aggregate	Limestone Course Aggregate	Gravel Course Aggregate	Limestone Course Aggregate
A	3,000	3-5	6.0	5.5	564	517	36	33	300	275
AS	4,000	3-5	**(2)**	6.2	**(2)**	583	**(2)**	37.2	**(2)**	310
B	3,500 **(1)**	1-2 ½	6.2	5.8	583	545	34.1	31.9	284	266
C	2,500	2-4	5.0	4.5	470	423	34	30.6	283	255
P	5,000	1-3	**(2)**	7.0	**(2)**	658	**(2)**	35.0	**(2)**	292

(1) Minimum compressive strength @ 14 days. Minimum flexural strength @ 14 days of 550 psi per AASHTO T 22.
(2) Gravel Coarse Aggregate no permitted.
(3) Tabulated valves are for Type I cement conforming to the requirements of AASHTO M 85 only.

6.02 MIX DESIGN.

Prior to mixing any concrete for the project, the Contractor shall submit his proposed design mix and reports of tests for each classification of concrete to the Owner for approval. The design mix shall be submitted on a form that indicates the supplier and type of the concrete and materials to be used as well as the amounts of materials per cubic yard for at least the following items and units (based upon saturated surface dry aggregate):

A. Cement-Pounds
B. Coarse Aggregate-Pounds
C. Fine Aggregate-Pounds
D. Air Entraining Admixture – Ounces
E. Other Admixtures (if allowed) – Ounces
F. Water – Pounds
G. Fly Ash (if allowed) – Pounds

6.03 PROPORTIONING.

A. Each class of concrete shall be manufactured by combining the several materials prescribed in the design mix in the proportions necessary to obtain the specified compressive strength for each class. Proportioning shall be based upon the specified cement content, and the amount of water for each class of concrete shall not exceed the quantity shown in Table 03050.2. Below this limit, the quantity of water shall be adjusted to meet the slump requirements. Aggregate weights shown in the Contractor's mix design(s) shall be based on saturated surface dry aggregate; batch weights shall be corrected to compensate for surface moisture on the aggregate in order to determine the amount of water to be added at the mixer.

B. In addition to the requirements specified herein and on Table 03050.2, portland cement concrete for pavement, Class B, (Specification Section 02750) shall have a flexural strength at 14 days of not less than 550 pounds per square inch when tested in accordance with AASHTO T 22.

6.04 CHANGES IN MIX.

A. When approved by the Owner, the ration of coarse and fine aggregate may be adjusted in order to assure better workability or to accommodate placement by pumping. However, in no case shall the fine aggregate exceed 44 percent of the total aggregate.

B. If during the progress of the Work, the specific gravity of one or both of the aggregates change more than plus or minus 0.03 from those shown on the concrete design, the design weights shall be adjusted by a design change to conform to the new specific gravity.

6.05 HIGH-EARLY-STRENGTH CONCRETE.

A. High-early-strength concrete may be required in the Plans and Specifications or substituted at the request of the Contractor, subject to the approval of the Owner. When high-early-strength cement concrete is authorized, it shall conform to the requirements of Table 03050.2 except that the 28 day strength (or 14 day strength for Class B concrete) shall be obtained in 7 days. The use of Type I or Type III cement for high-early-strength concrete in lieu of using Type III cement. When type I cement is used, the concrete shall have a minimum of 7.6 sacks (714 pounds) of cement per cubic yard of concrete. If admixtures are used to obtain high-early-strength concrete, such admixtures may only be used if previously approved by the Tennessee Department of Transportation for similar uses of the concrete and if specifically approved for the project by the Owner.

B. The gradation of fine and coarse aggregates shall be the same as that approved for the concrete for which the high-early-strength concrete is substituted. All materials entering into the high-early-strength concrete shall be of the same kind and class as the materials entering into the other part or parts of the facility constructed of the class of concrete for which high-early-strength is being substituted.

C. No additional compensation will be made if the Contractor elects to substitute high-early-strength concrete for any class of concrete. The unit price for the class for which the substitution is made shall be full compensation for the concrete.

PART 7 – TESTING

7.01 TEST SAMPLES.

The Owner shall provide for all test cylinders. All samples shall be cast, cured and tested by the City at its expense. The Contractor will be required to assist the Owner in securing necessary materials for casting the required number of cylinders. Testing ages will be 7 days and 28 days unless otherwise determined by the Owner. Laboratory cylinders shall be used to determine the quality of concrete produced. The number of cylinders to be cast daily for any quantity of concrete and laboratory tested, shall be specified by the Owner. With prior consent of the Owner, the Contractor may prepare field cylinders. These cylinders may be used as a gauge for early safe removal of forms where the Contractor requests earlier removal than set out in the Specifications.

7.02 CEMENT TESTING.

All cement used in the Work shall be pre-tested before use. Cement may be used upon completion of a satisfactory 3 day physical test made in accordance with current ASTM Specifications. Cement shall be tested by an approved commercial testing laboratory at the Contractor's expense.

7.03 CORE SAMPLES.

A. If the Owner's testing of cylinders indicates compressive strength less than required in Table 03050.2 for the class of concrete specified, the Contractor may, at his option, elect to drill core samples from the actual concrete placed. If the Contractor elects to drill (or is instructed by the Owner to drill) core samples from the hardened concrete, the costs of obtaining the cores and of repairing the core holes with nonshrinking grout shall be borne by the Contractor.

B. The cores shall be drilled as directed by the Owner, at the same approximate locations from which the test cylinder concrete was obtained. The locations of the drilled cores shall be selected so that the remaining structure will not be impaired or sustain permanent damage after the holes are repaired by the Contractor. The drilled samples shall be tested for compressive strength by the Owner, and the equivalent 28 day strength of the concrete placed and represented by the drilled core samples shall be determined. The Owner shall use the test results of the drilled cores to determine the acceptability of the concrete.

7.04 METHODS OF SAMPLING AND TESTING.

A. Test cylinders cast to determine acceptability for minimum AASHTO strength requirements shall be made and cured in accordance with AASHTO T 23 and tested in accordance with AASHTO T 22. Test cylinders cast to determine when a precast unit or a structure may be put into service or to determine when a tensioning load may be transferred shall be cured by methods identical to those used in curing the concrete member, and tested in accordance with AASHTO T 22.

B. Drilled core samples shall be taken and tested in accordance with AASHTO T 24. Due to possible fracturing effect of the coring operation, drilled core samples having a compressive strength of 85 per cent or more of specified strength will be considered acceptable.

C. Slump shall be determined in accordance with AASHTO T 119 on the job site during each placement.

D. The amount of air entrained shall be determined by pressure or volumetric meters of approved design and in accordance with AASHTO Method T 152 or AASHTO Method T 196, except that AASHTO Method T 199 may be used after the accuracy of the Chace Air Indicator has been determined by comparison tests.

7.05 CONCRETE FAILING TO MEET STRENGTH REQUIREMENTS.

A. Concrete which has been mixed and placed in accordance with these Specifications, and which fails to meet the minimum 28 day strength requirements shall be removed and disposed of by the Contractor, at his expense, unless specifically authorized by the Owner, in writing, to remain in place. The removal shall be in such manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

B. The Owner may, at his discretion, allow concrete which fails to meet the minimum strength requirement to remain in place. Payment for this concrete will be at a reduced price, to compensate the Owner for loss of durability. The amount of the reduction shall be determined by the Owner and shall be based on the particular circumstances.

PART 8 – MISCELLANEOUS

8.01 CONCRETE MIXED AND/OR BATCHED OFF PROJECT SITE.

Concrete may be mixed and/or batched off the immediate project site, subject to specific approval of the Owner and under the direct supervision of the Contractor. A delivery ticket (certified by the batch plant) showing mix, quantity of cement, quantity of fine and coarse aggregate, moisture content, total water and gallons per cubic yard of concrete shall be furnished to the Owner with each delivery of concrete and the Contractor shall show to the satisfaction of the Owner that the plant is so located and equipped as to produce and deliver concrete fully meeting the specification requirements.

8.02 MEASUREMENT AND PAYMENT.

The methods of measurement and payment for concrete shall be as specified in Divisions 2 and 3 of these Specifications for each particular item constructed by the Contractor.

END OF SECTION 03050