TECHNICAL SPECIFICATIONS FOR CONCRETE

1. Description

(a) This work shall consist of the construction of structures composed of portland cement concrete and steel reinforcement. They shall be constructed on prepared foundations at the locations indicated or directed, in conformity to the dimensions, lines, and grades shown on the Plans or as directed by the Engineer, and in accordance with these Specifications.

(b) Concrete structures shall be constructed of Class A Concrete, unless otherwise specified. The concrete shall be composed of a mixture of portland cement, aggregates, air-entraining agents, water and chemical additives when approved, combined and proportioned as specified.

(c) The work covered by this item shall consist of furnishing, erecting and removing concrete forms; furnishing, proportioning and mixing concrete ingredients; placing, curing and finishing plain and reinforced concrete masonry and all other work incidental thereto as required for the proper construction of the structures shown on the Plans or specified herein.

2. Materials

(a) Materials shall meet the requirements of Subsection 604.02 and 604.03 TDOTSS, January 1, 2015, and any Special Provisions which are dated prior to the advertisement of this Contract.

(b) Sampling and testing cement and aggregates shall be performed as specified below:

1) The Contractor shall determine the source, kind and quality of the cement, aggregates and admixtures to be used in the work well in advance of the time scheduled for starting the work and shall submit such information to the Engineer for approval before starting concrete operations.

2) The cost of testing cement, aggregates and admixtures shall be borne by the Contractor. Certified test reports and certificates shall be submitted in duplicate to the Engineer and to such other agencies or persons as he may designate. Reports or certificates indicating compliance of any shipment of cement, aggregate or admixtures shall be placed in the hands of the Engineer prior to use of such materials.

3) Where reputable cement and aggregate suppliers maintain regular recognized testing services, certified copies of such tests will be accepted by the Engineer. However, in any case of doubt as to the accuracy and/or adequacy of such tests, the Engineer may require that cement and aggregates be tested by a recognized commercial testing laboratory which has been selected by the Contractor and approved by the Engineer. The testing laboratory shall then test the cement and aggregates and prepare

written reports showing the results of such tests on each shipment. The laboratory shall also certify that the materials covered by the report comply in all respects with these Specifications. In general, cement and aggregates shall be tested at the mill but if untested shipments require sampling and testing after arrival at the site of the work, the Contractor shall be fully responsible for delays in the progress of the work due to delays in testing and reporting.

4) No cement or aggregate which fails to meet the requirements shall be incorporated into the work. In case of emergency, the Engineer may authorize the use of specific lots of cement which have satisfactorily passed the soundness test and the 7-day strength test only.

3. Classification and Proportioning of Concrete

Concrete shall be classified as shown in the proportioning table. Each class shall be manufactured by combining the several materials in the proportion specified. Proportioning shall be based on a predetermined cement content, water cement ratio and air content. The water cement ratio shall not exceed the maximum shown in the proportioning table. Below this limit , the quantity of water shall be adjusted to meet the slump requirement. Unless otherwise specified, the concrete shall contain 6 percent entrained air with a tolerance of plus or minus 1 percent. In no case shall the fine aggregate exceed 44 percent by volume calculation of the total aggregate.

CLASSIFICATION AND PROPORTIONING TABLE

Minimum 28 Day Compressive Strength (PSI)	Minimum Cement Per C.Y. (Sacks)	Maximum Water/Cement lb/lb	Air Content %
	CLASS A CONCRETE		
4,000	5.0	0.50	6 ± 1%
	CLASS F (LEAN CONCRETE)		
2,500	4.0	0.60	N/A

Fine Aggregate manufactured from limestone will not be permitted in concrete to be used as a riding surface in traffic lanes.

Cement replacement with fly ash in Portland Cement Concrete shall be in accordance with TDOTSS Subsection 604.03 or any subsequent Special Provision dated prior to advertisement of this Contract. In general, fly ash meeting all the requirements of 604.03 may be used as follows:

Case I

Where a concrete production facility has sufficient test records and experience to meet ACI 318-95, Section 4.3.1.1 or 4.3.1.2 and has significant experience in the use and testing of fly ash concrete, the concrete mixture may contain fly ash as shown in the following table.

Class of Fly Ash	Maximum Fly Ash Replacement, lb	Minimum Fly Ash Cement Substitution Ratios (by weight)
F	150	1.25 : 1
C	150	1 : 1

Case II

Where a concrete production facility can meet the requirements of ACI 318-95, Section 4.3.1.1 or 4.3.1.2, and has minimal experience in the use and testing of fly ash concrete, the concrete mixture may contain fly ash as shown in the following table.

Class of Fly Ash	Maximum Cement Replacement, (% by weight)	Minimum Fly Ash Cement Substitution Ratios (by weight)
F	15.0	1.25 : 1
C	15.0	1 : 1

Case III

Where a concrete production facility cannot meet the requirements of ACI 318-95, Section 4.3.1.1 or 4.3.1.2, no fly ash may be used. The mixture shall be proportioned according to the above proportioning table.

In the event the Contractor desires to replace a portion of cement with fly ash, a mix design with fly ash as a partial cement replacement shall be submitted to the Engineer for review and approval together with the following minimum data as verified by an approved independent testing laboratory.

(a) Certified results of compressive strength tests at ages of 7, 14, and 28 days conducted in accordance with ASTM C-192

(b) Tests for slump, entrained air content, unit weight and yield conducted in accordance with ASTM C-192

(c) Copies of results of all tests performed by the fly ash producer within the previous 30 days on shipments to the concrete supplier showing:

1) Fineness (percent retained on No. 325 sieve)

2) L.O.I. (loss on ignition)

3) Specific Gravity

4) Soundness (Autoclave Expansion)

5) Moisture content

6) Pozzuolanic activity, 7 day cement (AASHTO M-295)

(d) A notarized certification from the fly ash producer stating that the fly ash meets the City of Knoxville and TDOTSS as amended by Special Provisions dated prior to the advertisement for this Contract.

In addition to the above, fly ash materials, proportioning of aggregates, cement water, air and admixtures shall be in accordance with Section 604.02 and 604.03 of TDOTSS, January 1, 2015, or Special Provisions dated prior to the date of advertisement of this Contract.

4. Equipment and Construction Requirements

Equipment and Construction shall meet the requirements of subsections 604.04 and 604.05 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

5. Falsework

All falsework used to support the forms and concrete for concrete structures shall be in accordance with TDOTSS, January 1, 2015, or any Special Provisions dated prior to the advertisement of this Contract.

6. Camber

Structures of any type or size shall be constructed to a permanent camber only when shown on the construction drawings. Sufficient camber shall be provided in the falsework and forms for each span to allow for the tightening of joints in the forms and supporting falsework.

7. Reinforcement

All reinforcement shall conform to Subsection 604.08 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

8. Drainage and Weep Holes

Drainage openings and weep holes shall meet the requirements as set forth on the construction drawings or as directed by the Engineer together with applicable and non-conflicting requirements of Subsection 604.09 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

9. Placing Pipes, Conduits, Anchors, Castings and Other Appurtenances

Placing of pipes, conduits, anchors, castings and other appurtenances shall be in accordance with details and notes on the construction drawings or as directed by the Engineer. Applicable and nonconflicting provisions of Subsection 604.10 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract shall govern in the absence of details on the Construction Drawings.

10. Handling, Measuring, and Batching Materials

The handling, measuring and batching of Portland Cement Concrete Materials shall be in accordance with Subsection 501.09 and 604.12 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

11. Limitations of Mixing

Conditions limiting the mixing of Structural Concrete shall be as prescribed in Subsection 501.11 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

12. Mixing Concrete

The requirements for mixing concrete shall be as prescribed in Subsections 501.10, 604.04, and 604.11 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of the Contract.

13. Consistency of Concrete (Slump)

The slump of the concrete shall be measured in accordance with AASHTO T-119 and unless otherwise permitted, shall meet the following requirement:

> Mass concrete and heavy, reinforced sections require a 2 inch slump with a tolerance of plus or minus one inch; girders, columns, slabs and thin sections require a slump of three inches with a tolerance of plus or minus one inch. Class "F" (lean concrete) may have a slump up to six inches depending upon its use and directions from the Engineer. The consistency of Class "A" concrete may be varied as directed by the Engineer to meet the requirements in different parts of the construction, provided however, that there shall be no increase in the ratio of water to cement, and the total amount of fine and coarse aggregate shall not be more than the amount designated by the Engineer. In general and unless otherwise directed, the slump of Class "A" concrete shall be 3 inches with a tolerance of plus or minus one inch.

14. Compressive Strength Tests of Concrete

The compressive strength of the various classes of concrete shall be as specified for minimum 28-day compressive strength in the Classification and Proportioning Table in Subsection 3 of this Specification. The verification and testing for compressive strength shall be in accordance with Subsection 604.15 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

15. Placing Concrete

The placing of concrete shall be in accordance with Subsection 604.16 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

16. Bonding Construction Joints

Bonding of Construction Joints shall be in accordance with good practice, workmanship and in accordance with the provisions of Subsection 604.17 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

17. Depositing Concrete Under Water

No concrete except for cofferdam seals shall be deposited under water without the written detailed instructions from the Engineer. Concrete deposited under water for Cofferdam seals or special cases shall be in accordance with Subsection 604.18 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the advertisement of this Contract.

18. Removal of Forms and Falsework

The removal of Forms and/or Falsework shall be in accordance with Subsection 604.19 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the advertisement of this Contract.

19. Defective Concrete

Any defective concrete discovered after placement and form removal shall be removed immediately and replaced. If the surface of the concrete is bulged, uneven, or shows honey-combing which cannot be repaired satisfactorily, the entire section shall be removed and replaced.

Concrete having a 28-day strength of less than the minimum specified in Subsection 3 of this Specification, shall be removed and disposed of by the Contractor, at his expense, unless specifically authorized in writing by the Engineer to remain in place. The removal shall be in such a manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

The Engineer may at his discretion, allow concrete which fails to meet the strength specified to remain in place, provided the durability is good, but the payment for such concrete will be made at a reduced price to compensate the City of Knoxville for the loss of strength. The bid price for concrete failing to meet the specified strength, yet considered to be structurally adequate to remain in place shall be adjusted downward in accordance with the following formulas:

$$A.P. = B.P. \frac{fc}{S.S.}$$

where A.P. = Adjusted Price
B.P. = Contract Bid Price
fc = Actual 28-day Compressive Strength of Affected Concrete
S.S. = Minimum Specified Strength

20. Finishing Concrete Surfaces

Unless otherwise detailed on the Construction Drawing or authorized by the Engineer, the Finishing of Concrete Surfaces shall be in accordance with Subsection 604.21 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

21. Finishing Slab Surfaces for Pavements or Bases

The finishing of bridge floors, or top slabs of structures serving as finished pavements or bases shall be in accordance with Subsection 604.22 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this Contract.

22. Curing Concrete

All concrete surfaces, except those surfaces protected by forms that remain in place 7 days or longer as required under the provisions of Subsection 18 of this Specification, shall be cured as specified herein. All curing materials shall meet the requirements of Section 913 TDOTSS, January 1, 2015, or any Special Provisions dated prior to the date of advertisement of this

Contract. Curing shall begin as soon as the Concrete has hardened sufficiently to withstand surface damage to unformed surfaces and immediately after form removal from formed surfaces. Only white-pigmented curing compound shall be used.

When the temperature is expected to fall below 35 degrees F, the concrete shall be protected in accordance with the provisions of Subsection 24 of this Specification.

The "Water Method" of curing with burlap will be required for all bridge decks.

(a) Water Method

All concrete slabs shall be covered immediately with material suitable for use with the water cure and kept thoroughly wet for at least 120 hours from the beginning of the initial curing period. All surfaces other than slabs shall be protected from the sun and shall be kept wet for a period of at least 72 hours from the beginning of the curing period. Curbs, walls, handrails and other surfaces requiring a class II finish may have the covering temporarily removed for finishing, but the covering shall be restored as soon as possible.

(b) Membrane-Forming Compound Method

All surfaces shall be given the required surface finish prior to the application of the curing compound. Prior to the application of the curing compound, the surface shall be kept moist.

The rate of application of curing compound shall be as recommended by the manufacturer, but shall not be less than one gallon for 150 square feet of concrete surface. The curing compound shall be applied under pressure, immediately after acceptance of the concrete finish. Hand sprays shall only be used in areas that are inaccessible to pressure equipment. 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. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment or dye uniformly dispersed throughout the vehicle. If the application of the compound results in a streaked or blotchy appearance, the method shall be stopped and water curing as described herein above, applied until the cause of the defective appearance is corrected. The coating shall be protected against marring for a period of five days from the date of application. Any coating marred or otherwise disturbed within the five day period shall be replaced at once.

23. Protection of Concrete in Cold Weather

After the concrete has been placed, if it is expected that the ambient temperature will drop below 35 degrees F, the contractor shall provide sufficient canvas and framework, or other types of housing, to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be maintained at a temperature of not less than 45 degrees F, and the surface temperature of the concrete shall not exceed 80 degrees F. The above conditions shall be maintained for a period of 120 hours after the concrete is placed. The Contractor shall furnish a maximum/minimum thermometer to the Engineer for the purpose of temperature documentation.

24. Painting Metals

The painting of metals shall meet the requirements of Section 604.25 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the advertisement of this Contract.

25. Waterproofing and Waterstops

Waterproofing where indicated on the Plans or directed by the Engineer shall be in accordance with Section 605 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to the advertisement of this Contract.

Waterstops, as specified, shall be installed in accordance with the details on the Plans and in conformity with Section 604.26 of TDOTSS, January 1, 2015, or any Special Provisions dated prior to advertisement of this Contract.

26. Loading and Opening to Traffic

No traffic, heavy equipment, storage of materials, or other loading on a structure or any part thereof until after all forms and falsework have been removed and 10 calendar days have elapsed from the date of removal of forms, falsework and supports is permitted under the provisions of Subsection 19 of this Specification.

27. Method of Measurement

(a) Concrete for concrete structures, unless otherwise stipulated, will be measured for payment by the cubic yard. Computation of the quantities will be based on the dimensions shown on the plans or ordered in writing by the Engineer. Where concrete masonry for which specific dimensions are not given on the Plans is ordered by the Engineer, the volume shall be determined by the Engineer from field measurements.

(b) No deductions will be made in concrete volumes for drainage openings 6 inches in diameter or less, individual cavities or embedded pieces less than 1 cubic foot, or for reinforcement.

28. Basis of Payment

(a) Payment will be made for Structural Concrete and Reinforced Structural Concrete as specified on the Bid Schedule at the Contract unit price per cubic yard.

(b) The volumes allowed for payment shall include only the items of concrete placed in accordance with the Plans and Specifications and accepted by the Engineer.

Payment shall be full compensation for all labor, materials including steel reinforcement where specified, equipment, tools, plant services and all other expenses incidental to the structural concrete work.