S T A T E **O F** **T E N N E S S E E**
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Supplemental Specifications - Section 600

of the

Standard Specifications for Road and Bridge Construction

January 1, 2015

Subsection 602.17 (pg.459-477), 12-2-16; Entire Subsection: Replace all references to AASHTO M164 and AASHTO M253 with ASTM F3125, Grade A325 and A490,

Subsection 602.17 (pg. 459) 12-2-16; modify the following: "~~This Subsection covers the assembly of structural joints using AASHTO M 164 (ASTM A325) or ASTM A490~~ All high strength bolts, or equivalent fasteners, tightened to a high tension shall be coated with permitted coatings in accordance with ASTM F3125 for their respective grade. Use the bolts in holes conforming to 602.06, 602.07, and 602.08. All Grade A325 and A490 bolts, except Type 3 bolts used in weathering steel, shall be coated. Permitted coatings for Grade A325 and Grade A490 bolts are listed in ASTM F3125, Annex A1."

Subsection 602.17 (pg. 465–469), 12-2-16; Modify the following:

Table 602.17-1: Minimum Bolt Tension [1]

Bolt Diameter (inches)	Bolt Tension (pounds)	
	~~AASHTO M 164 Bolts~~ (Grade~~ASTM~~ A325)	Grade~~ASTM~~ A490 Bolts
½	12,000	15,000
5/8	19,000	24,000
¾	28,000	35,000
7/8	39,000	49,000
1	51,000	64,000
1-1/8	~~56~~64,000	80,000
1-1/4	81~~71~~,000	102,000
1-3/8	97~~85~~,000	121,000
1-1/2	118~~103~~,000	148,000

[1] Equal to 70% of the specified minimum tensile strength of bolts.

~~**Table 602.17-2: Snug Tension**~~

Bolt Diameter (inches)	Grade A325 Snug Tension (kips)	Grade A490 Snug Tension (kips)
½	1	1
5/8	2	2
¾	3	4
7/8	4	5
1	5	6
1-1/8	6	8
1-1/4	~~7~~8	10
1-3/8	10~~9~~	12
1-1/2	12~~10~~	15

Table 602.17-3: Minimum Installation Tension

Bolt Diameter (inches)	Grade A325 Tension (kips)	Grade A490 Tension (kips)
1/2	12	15
5/8	19	24
3/4	28	35
7/8	39	49
1	51	64
1-1/8	~~56~~64	80
1-1/4	81~~71~~	102
1-3/8	97~~85~~	121
1-1/2	118~~103~~	148

Table 602.17-4: Rotation from Snug Condition

Bolt Length (measured in Step 1)	Grade A325 Required Rotation	Grade A490 Required Rotation
Up to and including 4 diameters	2/3	2/3
Over 4 diameters, but not exceeding 8 diameters	1	5/6
Over 8 diameters to 12 diameters	1-1/6~~3~~	1

Table 602.17-5: Turn Test Tension

Bolt Diameter (inches)	Grade A325 Tension (kips)	Grade A490 Tension (kips)
1/2	14	17
5/8	22	28
3/4	32	40
7/8	45	56
1	59	74
1-1/8	6474	92
1-1/4	9482	117
1-3/8	11298	139
1-1/2	136118	170

Table 602.17-6

Bolt Length (measured in Step 1)	Required Rotation (All Grades)
Up to and including 4 diameters	1/3
Over 4 diameters, but not exceeding 8 diameters	1/2½
Over 8 diameters, but not exceeding 12 diameters	2/3

Table 602.17-7

Bolt Diameter (inches)	Grade A325 Torque (ft-lbs)	Grade A490 Torque (ft-lbs)
1/2	150	180
5/8	290	370
3/4	500	630
7/8	820	1020
1	1,230	1540
1-1/8	1,5001,730	2160
1-1/4	2,4502,410	3050
1-3/8	3,2102,810	3980
1-1/2	4,2503,690	5310

Table 602.17-8

Bolt Length (measured in Step 1)	Additional Required Rotation Grade A325	Additional Required Rotation Grade A490
Up to and including 4 diameters	1/32/3	¼
Over 4 diameters, but not exceeding 8 diameters	1/21	1/3
Over 8 diameters, but not exceeding 12 diameters	1 1/3	

Table 602.17-9: DTI Requirements for A325 Bolts

Bolt Diameter (inches)	Verification Tension (kips)	Maximum Verification Refusals	DTI Spaces	Minimum Installation Refusals
1/2	13	1	4	2
5/8	20	1	4	2
3/4	29	2	5	3
7/8	41	2	5	3
1	54	2	6	3
1-1/8	6759	2	6	3
1-1/4	8575	3	7	4
1-3/8	10289	3	7	4
1-1/2	124108	3	8	4

Table 602.17-11

Bolt Diameter (inches)	Bolt Tension (kips)	
	AASHTO M 164 Bolts (ASTM A325)	ASTM A490 Bolts
1/2	13	N/A16
5/8	20	N/A25
3/4	29	37
7/8	41	51
1	54	67
1-1/8	6759	84
1-1/4	8575	107
1-3/8	10289	127
1-1/2	124108	N/A155

Table 602.17-12

Bolt Diameter (inches)	Number of Spaces	
	~~AASHTO M 164~~ Bolts (Grade~~ASTM~~ A325)	~~ASTM~~ Grade A490 Bolts
1/2	4	N/A
5/8	4	N/A
3/4	5	6
7/8	5	6
1	6	7
1-1/8	6	7
1-1/4	7	8
1-3/8	7	8
1-1/2	8	N/A

Subsection 602.19 (pg. 478), 6-27-16; add the following as the 2nd paragraph: "All welders shall be qualified in accordance with the AASHTO/AWS D1.5, Bridge Welding Code, current edition. Welders shall be certified for each weld process and position which they will be using."

Subsection 602.39 (pg.488), 6-27-16; revise the title as follows: "CONSTRUCTION REQUIREMENTS ~~–~~ – ERECTION – REMOVAL"

Subsection 602.42 (pg.489), 6-27-16; revise as follows: "All contractors and subcontractors directly engaged in the erection or removal of structural steel, precast prestressed or mild steel reinforced concrete bridge beams or girders over active highway traffic lanes, on any route, railroad or any stream deemed navigable to commercial or pleasure water craft, shall submit an erection or removal plan prepared and stamped by a Professional Engineer licensed in the State of Tennessee. Include the following in these~~is~~ plans: the sequences of erection or removal, the generalized location of all pick points, and the plan to adequately stabilize the structure throughout the erection or removal process. Submit this plan to the Engineer at least 30 days before starting erection. At each stopping point in the erection or removal sequence, have a competent contractor's representative inspect the beams to ensure adequate stability.

Do not begin any erection or removal work without the Engineer's approval. The Engineer's approval does not relieve the Contractor of the responsibility for the safety of its method or equipment or from carrying out the work in accordance with the Plans and Specifications."

Subsection 604.02 (pg. 519), 11-16-15; C. 2nd paragraph, 1st sentence:
"Prior to construction, s~~S~~ubmit for approval shop drawings of the proposed precast ~~box section~~ structure and design calculations for ~~any details which deviate from the standard box culvert drawings.approval before construction.~~"

Subsection 604.03 (pg. 522 and 523), 5-18-15; 2. Mix Design Submittal; Replace the first sentence of the last paragraph on page 522 with the following:

"Instead of the above mix design submittal, ~~the Contractor may submit for approval~~ an existing design may be submitted for approval~~ed by the Department~~ provided the design has been used on a state funded project within the last six (6) months.~~within the current calendar year.~~"

Subsection 604.03 (pg. 519-522), 11-16-15; A. Classification and Proportioning and Quality Assurance, modify the following:

"1a. Design and Production Parameters. Proportion the concrete based on a pre-determined minimum cement content, and a water-cement ratio that does not exceed the maximum shown in **Table 604.03-1**. Below this limit, adjust the quantity of water to meet the slump requirements. The fine aggregate shall not exceed 44% by volume calculation of the total aggregate, with the exception of slip formed Class A concrete incorporated into parapets and median barriers.

For slip formed parapet and median barriers exclusively, the percentages of fine and coarse aggregate in an approved concrete mix design may be adjusted plus or minus 2%, such that the….

1b. Self-Consolidating Concrete (SCC) Design and Production Parameters. Proportion the concrete based on a pre-determined minimum cement content, and a water-cement ratio that does not exceed the maximum shown in **Table 604.03-4**. The fine aggregate shall not exceed 50% by volume calculation of the total aggregate volume. Maximum size of coarse aggregate shall not exceed a No. 67 stone. The Contractor may elect to use SCC as an alternate/option in replacement of Class A concrete.

Document mixture adjustments in the field book and daily concrete report. Ensure that the adjusted mix complies with all of the performance criteria specified in **Table 604.03-4**.

Table 604.03-4: Composition of Self-Consolidating Concrete

Class of Concrete	Min 28-Day Compressive Strength (psi)	Min Cement Content (pound per cubic yard)	Maximum Water/Cement Ratio (pound/pound)	Air Content % (Design + production tolerance)	Slump Flow (inches)
SCC (2,3,4,5)	3,000(1)	564	0.45	6 + 1	25 + 4

(1) Or as shown on the Plans or approved shop drawings.

(2) Acceptance range for the T50 test in accordance with ASTM C1611 shall be between 2-7 seconds.

(3) Passing ability in accordance with ASTM C1621 shall be less than 2 inches for acceptance.

(4) Visual Stability Index (VSI) shall not exceed 1.0 as per ASTM C1611 for acceptance.

(5) Static segregation as measured by ASTM C 1610 shall not exceed 20%.

Include chemical admixtures in the self-consolidating concrete mixture as specified in Table **604.03-5** based on the ambient air temperature and expected weather conditions. Approved viscosity modifying admixtures (VMA) may be used as part of the chemical admixtures if they are shown in the approved mixture design.

Table 604.03-5: Use of Chemical Admixtures

Class of Concrete	Temperature less than 85 °F and falling	Temperature 85 °F or greater and rising

SCC	Type A or F Type S (Viscosity Modifying)	Type D or G or A and B Type S (Viscosity Modifying)

Dosage rates for any admixtures incorporated into the concrete shall be stated during the mix design submittal process. All admixtures shall be compatible and from the same manufacturer.

2.Mix Design Submittal. Submit the proposed concrete design to the Engineer for approval. Develop the design using saturated surface dry aggregate weights and trial batches meeting the requirements of these Specifications….

As a minimum, include the following information in the proposed concrete design submittal:

1. Source of all aggregates
2. Brand and type of cement
3. Source and class of fly ash (if used)
4. Source and grade of ground granulated blast furnace slag (if used)
5. Specific gravity of cement
6. Specific gravity of the fly ash (if used)
7. Specific gravity of the ground granulated blast furnace slag (if used)
8. Admixtures (if used)
9. Gradations of aggregates
10. Specific gravity of aggregates (saturated surface dry)
11. Air content (if air entrainment is used)
12. Percentage of fine aggregate of the total aggregate (by volume)
13. Slump
14. Weight per cubic yard
15. Yield
16. Temperature of plastic concrete
17. Water/cement ratio (pound/pound)
18. 7-day compressive strength (minimum of three 4-inch x 8-inch cylinders)
19. 14-day compressive strength (minimum of three 4-inch x 8-inch cylinders)
20. 28-day compressive strength (minimum of three 4-inch x 8-inch cylinders)
21. Weight of each material required to produce a cubic yard of concrete

In addition to the above mentioned items, for self-consolidating concrete include as a minimum the following information in the proposed SCC design submittal:

22. Slump flow, VSI, and T50, in accordance with ASTM C1611, shall be required in place of the slump test.
23. Passing ability in accordance with ASTM C1621.
24. Static segregation in accordance with ASTM C1610.
25. 7-day compressive strength (minimum of three 4-inch x 8-inch cylinders), in accordance with ASTM C1758.
26. 14-day compressive strength (minimum of three 4-inch x 8-inch cylinders), in accordance with ASTM C1758.
27. 28-day compressive strength (minimum of three 4-inch x 8-inch cylinders), in accordance with ASTM C1758.

Self-consolidating concrete (Classes SCC and P-SCC) shall be verified prior to placement either at the ready mix facility or prestressed plant. The submitted mix design shall be reviewed by Headquarters Materials and Tests for specification compliance. The concrete producer shall then perform a trial batch verification of the submitted mix design in the presence of Regional Materials and Tests. The trial batch will ensure that all batch quantities and target admixture dosage rates are acceptable and meet TDOT specification prior to full mix design approval. If using a previously approved SCC design additional verification of the trial batch is not required. All quantities and identified admixture target dosage rates shall meet the tolerances specified in **501.09**.

Subsection 604.03 (pg. 522), 12-2-16; Mix Design Submittal, modify the following:

"18. 7-day compressive strength (minimum of two~~three~~ 4-inch x 8-inch cylinders)
19. 14-day compressive strength (minimum of two~~three~~ 4-inch x 8-inch cylinders)
20. 28-day compressive strength (minimum of two~~three~~ 4-inch x 8-inch cylinders)"

Subsection 604.14 (pg. 542), 11-16-15; Consistency of Concrete, modify the following: **"**The slump of the concrete when measured according to AASHTO T 119 shall meet 604.03 - **1A**. The slump flow of self-consolidating concrete when measured according to ASTM C1611 shall meet **604.03 1B**."~~.~~

Subsection 604.15 (pg. 542-543), 11-16-15; B. Concrete Acceptance Cylinders, modify the following:

"~~Make and cure test specimens according to AASHTO T 23, unless otherwise specified or directed by the Engineer.~~ The Department will test the specimens for compressive strength according to AASHTO T 22. Provide the necessary concrete for making test specimens and adequate curing and storage facilities at no additional cost to the Department.

~~Deliver all acceptance cylinders for testing 28 day strength for conformance with **604.03** to the Central Lab in Nashville, or deliver to the regional lab or other agreed upon pick up point if arrangements are made in advance with the Regional Materials Engineer.~~ Concrete cylinders submitted for testing beyond 28 days shall comply with the strength requirements specified in Table 604.15-1.

Table 604.15-1: Strength Requirements

Class of Concrete	Compressive Strength (psi) at:		
	Less than 31 days	31 to 42 days	43 days to 56 days
A, S, CP, SCC	3,000	3,300	3,500
D, L	4,000	4,400	4,600
X	Plans Requirement (Req)	Req. + Req. * (10%)	Req. + Req. * (15%)

If the acceptance cylinders fail to meet the specified strengths, the Contractor may drill core samples from the hardened concrete as verification of concrete strength instead of using the concrete cylinders. The Contractor must provide QC data from companion cylinders that meet or exceed the required strength, and TDOT Materials and Test shall perform a nondestructive test using a Swiss Hammer on the concrete to prove required strength is achieved ~~under the observance of a Materials and Tests Representative~~. If the above mentioned requirements are met, the Contractor may then elect to drill a maximum of three core samples per set of cylinders from the hardened concrete. The Contractor shall obtain the cores in accordance with the Department's Standard Operating Procedure 4-2, and bear all costs of obtaining the cores and repairing the core holes."

Subsection 604.27 (pg. 560), 11-16-15; Rideability of New or Resurfaced Bridge Decks and Roadway Approaches, A. General, modify the following:
"On all highway sections with a posted~~design~~ speed greater than 40 miles per hour, the following rideability provisions shall apply to new or resurfaced bridge decks and roadway approaches, ~~except that testing with the Rainhart Profilograph or high speed road profiling equipment need not be performed on bridges with approaches posted for a lower speed due to roadway alignment.~~"

Subsection 606.04.B.1(b) (pg. 578), 6-27-16; modify the following: "(b) Except as provided in paragraph 2(b) below, develop an energy per blow in foot-pounds~~ of~~ not less than 250~~30~~ multiplied by R, where R is the required minimum bearing resistance of the pile in tons."

Subsection 606.07.A. (pg. 581), 6-27-16; revise the following: "Construct cast-in-place concrete piles of the design shown on the Plans and that consist of concrete cast in drilled holes or in steel shells or pipes driven to the required bearing. Use Class A concrete meeting **604**, or use Class X concrete, as required by design, meeting **604**. Provide and place suitable casing when required to prevent caving of the hole before concrete is placed.

Subsection 613.02 (pg. 633), 6-27-16; add the following:
"Brick Paving Units .....912.05"

Subsection 615.09 (pg. 644), 11-16-15; Proportioning and Mixing of Concrete, modify the following:

Table 615.09-1: Composition of Prestress Concrete Classes

Class of Concrete	Minimum 28-Day Compressive Strength (psi)	Minimum Pounds Cement per Cubic Yard	Maximum Water/Cement Ratio (pound/pound)	Air Content %	Slump or Slump Flow (inches)
P	5,000 (1)	658	0.45	0-8 (2)	2 ± 1 (3)
P-SCC (4)	5,000 (1)	658	0.45	0-6 (2)	25 + 4

(1) Or as shown on the Plans or approved shop drawings.

(2) Air entraining is optional with the Contractor, unless otherwise shown on the Plans or shop drawings.

(3) Not to exceed 3 inches before the addition of high range admixtures, and not to exceed 10 inches after the addition of high range admixtures. If water-cement ratio is equal to or less than 0.35 then the maximum slump is 10 inches. If the water-cement ratio is 0.36 – 0.45, the maximum slump is 8 inches.

(4) Maximum coarse aggregate size of a No. 67 stone.

Comply with all applicable provisions of **604.03** except as modified herein.

Submit a concrete design to the Department for review and approval. In addition to the proportions, identify in the design submittal the source or brand of all materials and the type of cement to be used. The Contractor may use Type I or Type III cement, unless otherwise specified. Do not use calcium chloride. Use a retardant admixture when the ambient temperature is 75 °F or higher.

The slump of the concrete shall be 2 inches with a tolerance of ±1 inch at the time of placement. When an approved superplasticizer is to be used, the slump of the concrete shall be the same as above

before the superplasticizer is added to the mix. After the addition of the superplasticizer, the slump may be increased to a maximum of 8 inches at the time of placement.

The slump flow of self-consolidating concrete shall be determined and within the design and production tolerances stated in **Table 615.09-1**. Include chemical admixtures in the self-consolidating concrete mixture as specified in **Table 604.03-5** based on the ambient air temperature and expected weather conditions. Approved viscosity modifying admixtures (VMA) may be used as part of the chemical admixtures if they are shown in the approved mixture design.

Handle, measure, and batch materials; mix concrete; and comply with the limitations of mixing as specified in **501.09**, **501.10**, and **501.11**, respectively.

Make concrete test specimens for Class P and Class P-SCC, in accordance with AASHTO T 23 and ASTM C1758 respectively, to determine the adequacy of the concrete design and the minimum time at which the stress may be applied to the concrete. Cure the test specimens used to determine the time at which stress may be applied in the same manner and under the same conditions as the bridge members. The initial curing of specimens to determine the design strength of the concrete shall be as specified above with additional curing water, as provided in AASHTO…

Subsection 615.17 (pg. 652), 5-18-15; Table 615.17-1: Manufacturing Tolerances in Standard Sections, Replace the following:

Table 615.17-1: Manufacturing Tolerances in Standard Sections

Description	Tolerance	
	I-Sections	**Box Sections**
Nominal Depth	± 1/2 inch	± 1/2 inch
Nominal Width	± 1/2 inch	± 1/2 inch
Nominal Length	Computed Elastic Shortening ±1/2 inch	Computed Elastic Shortening ±1/2 inch
Variation in Straightness, inches	1/4 inch x (Total Length in feet)/10	1/4 inch x (Total Length in feet)/10
Variation in Camber, inches	Beams in any 1 span not more than: 1/8 inch x (Total Length in feet)/10	Beams in any 1 span not more than: 1/8 inch x (Total Length in feet)/10
Location of Voids	---------	Length ± ~~1~~ 1/2 in Wall Thickness ± 1/2 in
Bearing	Full Bearing - Full Width of Beam	Full Bearing on at Least 2/3 of Width of Beam
Tendon Placement	± 1/2 inch	± 1/2 inch
Reinforcing Steel Placement	± 1/2 inch	± 1/2 inch
Reinforcing Steel Concrete Cover	± 1/2 inch	± 1/2 inch
Reinforcing Steel Splice Lengths	Minus 1-1/2 inches	Minus 1-1/2 inches

Subsection 622.03 (pg. 686) 12-2-16; Add the following at the beginning of the section: "Same-as designs shall not be submitted for Shotcrete."