December 29, 2011

REVISION OF SECTION 601

CLASS H AND HT BRIDGE DECK CONCRETE

**NOTICE**

This is a standard special provision that revises or modifies CDOT’s *Standard Specifications for Road and Bridge Construction.* It has gone through a formal review and approval process and has been issued by CDOT’s Project Development Branch with formal instructions for its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by CDOT’s Standards and Specifications Unit. The instructions for use on CDOT construction projects appear below.

Other agencies which use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

**Instructions for use on CDOT construction projects:**

Use in projects having Class H or HT concrete.

Section 601 of the Standard Specifications is hereby revised for this project as follows:

In subsection 601.02 delete Class H and HT from Table 601-1 and replace with the following:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **H** | 4500 at 56 days | 500 to 640 | 5 – 8 | 0.42 – 0.44 |
| **HT** | 4500 at 56 days | 500 to 640 | 5 – 8 | 0.42 – 0.44 |

In subsection 601.02 delete Class H and HT and replace with the following:

Class H concrete is used for bare concrete bridge decks. Additional requirements are:

1. Type A or dual rated Type A and F chemical admixtures may be used.
2. Set retarding and accelerating admixtures shall not be used. These include Type B, C, D, E, and G chemical admixtures.
3. The concrete mix shall consist of a minimum of 55 percent sizes No. 57, No. 6, or No. 67 coarse aggregate by weight of total aggregate.
4. The permeability of the laboratory trial mix shall not exceed 2000 coulombs at 56 days when tested by ASTM C 1202
5. The cracking tendency of the laboratory trial mix shall not exhibit a crack before 15 days when tested by AASHTO T334.
6. Class H concrete shall contain a minimum of 20 percent pozzolan by weight of total cementitious material.
7. The sulfate exposure is Class 0 except when substituted for Class B or D concrete.

Class HT concrete is used for deck resurfacing and repairs on bare concrete bridge decks. Additional requirements are:

1. Type A or dual rated Type A and F chemical admixtures may be used.
2. Set retarding and accelerating admixtures shall not be used. These include Type B, C, D, E, and G chemical admixtures.
3. The concrete mix shall consist of a minimum of 50 percent size No. 7 or No. 8 coarse aggregate by weight of total aggregate.
4. The permeability of the laboratory trial mix shall not exceed 2000 coulombs at 56 days when tested by ASTM C 1202
5. The cracking tendency of the laboratory trial mix shall not exhibit a crack before 15 days when tested by AASHTO T334.
6. Class HT concrete shall contain a minimum of 20 percent pozzolan by weight of total cementitious material.
7. The sulfate exposure is Class 0

In subsection 601.05 delete the fifth paragraph and replace with the following:

Except for class BZ concrete, the maximum slump of the delivered concrete shall be the slump of the approved concrete mix design plus 1½ inch. Except for Class H and HT concrete, the laboratory trial mix shall produce an average compressive strength at least 115 percent of the required field compressive strength specified in Table 601-1. When entrained air is specified in the Contract for Class BZ concrete, an air entraining admixture may be added to an approved Class BZ mix design. A new trial mix will not be required.

In subsection 601.07 delete the second paragraph and (a) and replace with the following:

For Class H and HT concrete, adding water after the initial mixing shall not occur. All water shall be added at the plant. Slump adjustment shall be through the addition of an approved Type A or dual rated Type A and F water reducing admixture.

Silica fume, when used, shall be added to the mix during initial batching.

1. *Mixing General.* The concrete shall be deposited in place within 90 minutes after batching when concrete is delivered in truck mixers or agitating trucks, and within 60 minutes when delivered in non agitating trucks.

Except for Class H and HT concrete, the 90 minute time limit for mixer or agitating trucks may be extended to 120 minutes if:

* + 1. No water is added after 90 minutes.
		2. The concrete temperature prior to placement is less than 90 °F

Except for Class H and HT concrete, the 90 minute time limit for mixer or agitating trucks may be extended to 180 minutes if:

1. No water is added after 90 minutes.
2. The concrete temperature prior to placement is less than 90 °F.
3. The approved concrete mix contains a Type D water reducing and retarding chemical admixture.

In subsection 601.15 delete (b) and (c) and replace with the following:

1. *Test Slab*. At least fourteen working days prior to initial placement of Class H, Class HT or Class S50 concrete on or in a deck, the Contractor shall place, finish and cure a test slab according to the project specifications, using the same personnel, methods and equipment (including the concrete pump, if used) that will be used on the bridge deck. The test slab shall be the same width as the bridge deck. When the bridge deck width is greater than 40 feet, the Contractor may reduce the test slab width to a minimum of 40 feet. The test slab shall have a length of at least 30 feet and shall have a thickness a minimum of the bridge deck thickness. Placement of Class H, HT or S50 Concrete in the deck shall not occur until approval is given by the Engineer. Approval to place concrete on the deck will be based on satisfactory placement, consolidation, finishing and curing of the test slab and cores, and will be given or denied within two working days of receiving the cores from the Contractor.

A minimum of one day after construction of the test slab, the Contractor shall core four full-depth 4 inch diameter cores, one from each quadrant of the test slab, and submit them to the Engineer for visual inspection of degree of consolidation. . If an additional test slab is deemed necessary by the Engineer, it will be placed at the Contractor’s expense.

Additional test slabs shall be placed as necessary to verify changes in design or procedures at the Contractor’s expense.

Test slabs that are placed as acceptable work in segments of concrete pavement, or as approach slabs, or other locations acceptable to the Engineer, will be paid for as the pay item for that element of the Contract.

1. *Placing*. Concrete shall be placed in accordance with the requirements of subsection 601.12 except for the following:

Concrete shall be placed in such manner as to require as little handling as possible and at sufficient depth to provide adequate material for screeding and finishing operations. The concrete shall be discharged as near its final location as practicable. The pattern of placement shall be such that lateral flow will be minimized. Concrete shall be placed against the leading edge of fresh concrete where practicable.

For Class H, HT and S50 Concrete maintain environmental conditions on the entire bridge deck so the evaporation rate is less than 0.2 pounds per square foot per hour. The temperature of Class H, HT and S50 Concrete immediately before placement shall be a minimum of 55°F and a maximum of 70°F. This may require placing the deck at night, in the early morning or on another day. The evaporation rate (as determined in the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2) is a function of air temperature, concrete temperature, wind speed and relative humidity. The effects of any fogging required by the Engineer will not be considered in the estimation of the evaporation rate.

Just prior to and at least once every hour during placement of the Class H, HT and S50 Concrete and until the water cure method is applied, the Contractor will measure, record and report to the Engineer the air temperature, concrete temperature, wind speed, and relative humidity on the bridge deck. The Contractor will take and report to the Engineer the air temperature, wind, and relative humidity measurements approximately 12 inches above the surface of the deck. With this information, the Engineer will determine the evaporation rate.

When the evaporation rate is equal to or above 0.2 pounds per square foot per hour, take actions (such as cooling the concrete, installing wind breaks, sun screens, etc.) to create and maintain an evaporation rate less than 0.2 pounds per square foot per hour on the entire bridge deck.

Fogging using hand-held equipment may be required by the Engineer during unanticipated delays in the placing, finishing or curing operations. If fogging is required by the Engineer, the Contractor shall not allow water to drip, flow or puddle on the concrete surface during fogging, placement of absorptive material, or at any time before the concrete has achieved final set.

Longitudinal joints for a Class HT concrete overlay will be allowed only at the locations of lane lines and must be approved by the Engineer.

If placing Class H, HT and S50 Concrete is delayed and the concrete has taken its initial set, stop the placement, saw the nearest construction joint approved by the Engineer, and remove all concrete beyond the construction joint.

Transverse joints may be utilized when the Engineer determines that the work is not progressing in a satisfactory manner, or when required by change in weather conditions. The Engineer may approve transverse joint locations to accommodate phased overlay construction.

Delete subsection 601.16 and replace with the following:

**601.16 Curing Concrete Bridge Decks.** Except for Class H and HT concrete, the minimum curing period shall be 120 hours. For Class H and HT concrete the minimum curing period shall be 168 hours.

The concrete surface shall be kept moist at all times by fogging with an approved atomizing nozzle or applying a monomolecular film coating to retard evaporation until the curing material is in place.

Except for when Class H & HT Concrete is used; Concrete bridge decks, including bridge curbs and bridge sidewalks shall be cured as follows:

1. Decks placed from May 1 to September 30 shall be cured by the membrane forming curing compound method followed by the water cure method as follows:
	1. Membrane Forming Curing Compound Method*.* A volatile organic content (VOC) compliant curing compound conforming to ASTM C 309, Type 2 shall be uniformly applied to the surface of the deck, curbs and sidewalks at the rate of 1 gallon per 100 square feet. The curing compound shall be applied as a fine spray using power operated spraying equipment. The power operated spraying equipment shall be equipped with an operational pressure gage and a means of controlling the pressure. Before and during application the curing compound shall be kept thoroughly mixed by recirculation or a tank agitator. The application shall be within 20 feet of the deck finishing operation. When the finishing operation is discontinued, all finished concrete shall be coated with curing compound within ½ hour. The curing compound shall be thoroughly mixed within one hour before use.
	2. Water Cure Method. The water cure method shall be applied as soon as it can be without marring the surface. The surface of the concrete, including bridge curbs and bridge sidewalks, shall be entirely covered with wet burlap and polyethylene sheeting. Prior to being placed, the burlap shall be thoroughly saturated with water. The wet burlap and polyethylene sheeting shall extend at least twice the thickness of the bridge deck beyond the edges of the slab and shall be weighted to remain in contact with the surface. The wet burlap and polyethylene sheeting shall remain in contact and be kept wet for the entire curing period.
2. Decks placed between November 1 and March 31 shall be cured by application of a membrane forming curing compound followed by the blanket method as follows:
	1. Membrane Forming Curing Compound Method. This method shall be applied in accordance with subsection 601.16(a)1 above.
	2. Blanket Method. Curing blankets with a minimum R-Value of 0.5 shall be placed on the deck as soon as they can be without marring the surface. Blankets shall be loosely laid (not stretched) and adjacent edges suitably overlapped with continuous weights along the lapped joints. The blankets shall remain in place for a minimum of five days after placement.
3. Decks placed in April or October may be cured in accordance with either subsection 601.16(a) or 601.16(b) above.
4. For decks above an elevation of 8,000 feet above mean sea level, the Engineer may modify the time of year requirements for the cure methods defined in subsection 601.16(a) and 601.16(b) above.
5. Class H, Class HT and Class S50 concrete shall be cured as follows:

Water Cure Method. The water cure method shall be applied as soon as it can be without marring the surface. The surface of the concrete, including bridge curbs and bridge sidewalks, shall be entirely covered with wet burlap and polyethylene sheeting. Prior to being placed, the burlap shall be thoroughly saturated with water. The wet burlap and polyethelene sheeting shall extend at least twice the thickness of the bridge deck beyond the edges of the slab and shall be weighted to remain in contact with the surface. The wet burlap and polyethylene sheeting shall remain in contact and be kept wet for the entire curing period

1. When the ambient temperature is expected to fall below 40 °F during the curing period, the Contractor shall maintain the internal concrete temperature above 50 °F during the curing period. The Contractor shall provide suitable measures such as straw, additional burlap, or other suitable blanketing materials, and/or housing and artificial heat to maintain the concrete temperatures between 50ºF and 75ºF as measured on the upper and lower surfaces of the concrete. Enclose the area underneath the deck and heat so that the temperature of the surrounding air is as close as possible to the temperature of the concrete and between 50ºF and 75ºF. When artificial heating is used to maintain the concrete, provide adequate ventilation to limit exposure to carbon dioxide. Maintain wet burlap and polyethylene cover during the curing period. Heating may be stopped after the first 72 hours if the time of curing is lengthened to account for periods when the ambient air temperature is below 40ºF. For every day the ambient air temperature is below 40ºF, an additional day of curing with a minimum ambient air temperature of 50ºF will be required. After completion of the required curing period, remove the curing and protection so that the temperature of the concrete during the first 24 hours does not fall more than 25°F.

Internal concrete temperature shall be determined by using thermocouples. Thermocouple wire, connectors, and hand held thermometer will be supplied by the Contractor. The Contractor shall install the thermocouples at locations designated by the Engineer.

During the curing period, the Contractor shall monitor the enclosure at intervals acceptable to the Engineer. The Contractor shall monitor concrete temperature, and the structural integrity of the enclosure. Artificial heat sources shall not be placed in such a manner as to endanger formwork or expose any area of concrete to drying due to excessive temperatures.

If the internal concrete temperature at any location in the bridge deck concrete falls below 32 °F during the first 24 hours of the curing period, the Engineer may direct the Contractor to core the areas in question at the locations indicated by the Engineer. The Engineer will take immediate possession of the cores. The Engineer will submit the cores to a petrographer for examination in accordance with ASTM C 856. Concrete damaged by frost, as determined by the petrographer, shall be removed and replaced at the Contractor's expense. All costs associated with coring, transmittal of cores, and petrographic examination shall be borne by the Contractor regardless of the outcome of the petrographic examination.