August 7, 2013

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATION
DEPARTMENT OF ADMINISTRATION

DIVISION OF PURCHASES BID NO. 7484376

RHODE ISLAND DEPARTMENT OF TRANSPORTATION

RHODE ISLAND CONTRACT NO.2013-DF-084

FEDERAL-AID PROJECT NO. FAP Nos: STP-HRSY(001)

Hurricane Sandy Repairs to the Newport Cliff Walk (Rebid)

Bailey's Beach to Ruggles Avenue

CITY/TOWN OF Newport

COUNTY OF NEWPORT

NOTICE TO PROSPECTIVE BIDDERS

ADDENDUM NO. 3 Prospective bidders and all concerned are hereby notified of the following changes in the Plans, Specifications, Proposal and Distribution of Quantities for this contract. These changes shall be incorporated in the Plans, Specifications, Proposal and Distribution of Quantities, and shall become an integral part of the Contract Documents.

A. Contract Documents

1. Compilation of Approved Specifications, August 2013

   Insert Compilation of Approved Specifications, August 2013 attached to this Addendum No. 3. This document is part of the Standard Contract Documents."

for: David W. Fish
RI Department of Transportation
Chief Engineer

COMPILATION OF APPROVED SPECIFICATIONS

RHODE ISLAND DEPARTMENT OF TRANSPORTATION
STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

REVISIONS
SUPPLEMENTAL SPECIFICATIONS
SPECIAL PROVISIONS

SUPPLEMENT NO. 14

AUGUST 2013

Addendum No. 3

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Revise **Subsection 601.03; Portland Cement Concrete – Construction Methods,** of the RI Standard Specifications for Road and Bridge Construction as follows.

SECTION 601

PORTLAND CEMENT CONCRETE

- **Replace Subsection 601.03.4, page AC-34 of the January 2011 Specification Compilation with the following.**

601.03.4 Limitations for Mixing and Placement. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate artificial lighting system is operational and approved by the Engineer.

The Contractor, at all times during and immediately after placement, shall protect the concrete from adverse affects of rain.

When the air temperature is 40°F or less at the time and location of placement, or when there is a local forecast indicating that the temperature will be below 40°F during the 5 (cast in place masonry) or 14 (bridge deck) day curing period cold weather concreting, as defined herein and in **Subsection 601.03.5,** will apply. At least 24 hours prior to placement the Contractor shall submit for approval by the Engineer, a cold weather concreting and curing plan detailing the methods and equipment which will be used to assure that the concrete temperature does not fall below 50°F during the curing period after placement and shall be considered the protection period. Concrete mixing operations shall conform to **Subsection 601.03.5; Cold Weather Concrete**.

- **Replace Subsection 601.03.5(b), pages AC-34 and AC-35 of the January 2011 Specification Compilation with the following.**

601.03.5 Cold Weather Concrete.

a. Plant Procedures: When concreting is authorized by the Engineer during cold weather, the aggregates and/or water may be heated by either steam or dry heat prior to being placed in the mixer. 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 materials. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50°F and not more than 90°F at the time of placing it in the forms.

If the air temperature is 40°F or less at the time of placing concrete, the Engineer may require the water and the aggregates to be heated to not less than 70°F, nor more than 150°F, and be verifiable by a temperature measuring device. No frozen aggregates shall be used in the concrete.

Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire.

When aggregates are heated in bins, steam-coil or water-coil heating, or other methods which will not be detrimental to the aggregates, may be used. The use of live steam on or through binned aggregates will not be permitted without approval by the Engineer.

b. Concrete Placement Procedures. No concrete shall be placed on frozen subgrade. Sufficient heating devices of a type approved by the Engineer shall be installed under an enclosure or covering, capable of maintaining at all times and under all weather conditions during the protection period, a uniform concrete temperature of not less than 50°F. From days 8 to 14 of the concrete bridge deck curing period the minimum concrete temperature to be maintained shall not be less than 40°F. Heating devices shall be arranged to prevent overheating any areas of forms or concrete. Before any concrete is placed, the enclosure and heating apparatus shall be as nearly complete as the placing of the concrete will permit. The minimum temperature shall be continuously maintained around deposited concrete for the curing period of 5 days (cast in place masonry) or 14 days (bridge deck) immediately after concrete has been placed and then reduced gradually so the concrete will not be subjected to sudden change in temperature. When permitted by the Engineer, the heating period may be reduced when the concrete units involved will not be subjected to any appreciable bending stress from dead or live load until after seasonal conditions have permitted normal curing.

In general, a steam heating system may be used to supply heat during the protection period. Auxiliary devices such as stoves, covered salamanders with stacks or unit heaters shall be provided for use during the periods required for preheating the forms, reinforcing steel and previously placed concrete to 40°F minimum prior to placing the concrete, during placing of concrete, during the time required for the removal of forms and during the surface finishing operations.

When approved by the Engineer, heat for protection may be supplied by any method which will maintain the required concrete temperature of not less than 50°F. When methods other than live steam are used, provisions shall be made in the enclosure being heated to maintain a humid condition of sufficient vapor (minimum humidity of 100 percent) content to prevent the moisture in the concrete from being evaporated.

The Contractor shall provide adequate fire protection when heating is in progress and shall maintain watchmen or other attendants to keep heating units in continuous operation. The use of open fires will not be permitted.

When approved by the Engineer, concrete may be protected and cured by the use of insulating materials of sufficient thickness to properly maintain the concrete at the specified minimum temperature. The insulating materials and methods of application shall meet with the approval of the Engineer. In general, the insulating material used on vertical forms shall consist of blankets having a durable liner on the side exposed to the weather. The liners shall be asphalt-bonded to both sides of the insulating mat. The insulation material shall be applied tightly against the wood form with the nailing flanges extending out from the blanket so they can be stapled or battened to the sides of the horizontal or vertical studs, spaced as required. The top of all piers, abutments and like concrete shall be covered with the insulating blanket, tightly secured to prevent loss of heat. Areas around protruding reinforcing which cannot be protected with the insulation blankets shall be first covered with sufficient straw or hay to prevent loss of heat from the concrete. In addition to the above, tarpaulins shall be used as an overall cover on top of such concrete. Failure to attain satisfactory control and results with insulation materials will be cause for rejection.

The Contractor will keep a daily permanent record of the concrete surface temperatures throughout the curing period with the use of a 24-hour temperature recording device (disc or other approved type). The Engineer will retain these records.

During freezing weather, all keyways, anchor bolt holes or other depressions in exposed horizontal concrete surfaces shall be sealed against the admission of water, and any damage to the concrete due to the freezing of water in such depressions shall be repaired if practicable, or the concrete shall be replaced by the Contractor at his expense and as directed by the Engineer.

Although permission may be granted to mix and place concrete under the conditions described above, the Contractor is not relieved of any responsibility for obtaining satisfactory results. Unsatisfactory concrete placed under such conditions shall be removed and replaced at the Contractor's expense.

Add new **Section 607, MASS CONCRETE** to the RI Standard Specifications for Road and Bridge Construction

SECTION 607

MASS CONCRETE

607.01 DESCRIPTION. This specification covers the requirements for concrete used in mass concrete elements. Concrete proportioned for mass concrete applications shall conform to the applicable requirements of **PARTS 600** and **800** of these specifications, together with the additional provisions set forth below.

607.01.1 DEFINITIONS. Mass Concrete is defined as any elements so specified on the Plans and any other concrete placement where the ratio of the total surface area to the volume of the element equals or exceeds 0.6 and has a minimum dimension of 3 feet in any of the three planes.

Requirements for mass concrete construction include laboratory testing, thermal modeling, temperature monitoring, and providing concrete temperature control before, during, and after placement. All testing shall be performed at a laboratory with recognized accreditations for performing the necessary tests, with the provision that no exception is taken by the Engineer with the Contractor's choice of laboratory.

The peak temperature is defined as the average of the values measured at any given time by the two temperature sensors placed at the location of the highest temperature as determined by the thermal model for the structural element. The highest acceptable peak temperature is 155°F.

The differential temperature is defined as the value measured at any given time by the temperature sensor in any given location (or the average, if two sensors placed in the location) in the structural element and the peak temperature as defined above. The highest acceptable differential temperature until the completion of temperature control is 35°F.

The performance-based differential temperature is defined as a limit that changes as the concrete gains strength, determined as a function of the established maturity curve for the mix. The benefit of this method is a potential acceleration of the production schedule over the use of a fixed limit. This option may be considered by the Engineer, with the proper submission of an implementation plan for the process as described herein, after the contractor has demonstrated good control of the concrete mix during batching, placement and curing.

607.02 MATERIALS AND EQUIPMENT.

607.02.1. CONCRETE. The applicable material requirements of **Section 808** and **Section 601**. Unless specified in the contract documents, calcium nitrite based corrosion inhibitor shall not be allowed in Mass Concrete mixtures. Any proposed mixture adjustment that meets the requirement in Section 601 for a new approval of the mix design will also require a new approval of the mass concrete temperature control plans per this specification.

607.2.2 TEMPERATURE AND MATURITY RECORDING. Primary temperature measuring loggers shall be designed specifically for determining the maturity of concrete in accordance with ASTM C1074. They shall operate in the range of 0°F to 212°F to an accuracy of +/- 1°F and internally record the time and temperature at a minimum of 1 hour intervals for a minimum of 90 days. Each logger shall

have a unique serial number and shall upon download of the information using the compatible reader or other appropriate data connection, produce a secure (unalterable) Windows PC-readable file that identifies the logger by its serial number and the start date. Software shall be provided to develop maturity curves to predict strength and display the temperature versus time data for any or all of the loggers in a given placement.

The data leads shall be sized to reach from the logger's installed location to an accessible site where a handheld reader can be employed. A data cable that can connect the loggers to a notebook computer or other standard mobile device will be considered equivalent to a handheld reader, providing a Windows PC-readable file can be created that can be transferred to a Windows PC. The Contractor shall provide a reader and any necessary software for the exclusive use of the Engineer. The reader and software provided for the Engineer shall become the property of the State at the completion of the project.

The loggers selected by the Contractor shall have the capability to use battery operated Wireless Remote Boxes for the downloading of data. The transmission range of the system shall be sufficient to provide a reliable connection to both the Contractor's and Engineer's field offices. A Windows PC-Compatible Wireless System Radio Base Station shall be provided and capable of downloading the data file as described above. The Wireless System Radio Base Station shall be maintained by the Contractor for monitoring the mass concrete placement. An additional Wireless System Radio Base Station shall also be provided for the Engineer's field office. The additional device and any associated software provided for the Engineer shall become the property of the State at the completion of the project.

The requirement for a wireless communications system may be waived by the Engineer, if the Engineer determines that access to the placement does not warrant it.

The Contractor shall provide the Engineer recording equipment that will allow intermediate downloading of measurements to a computer without restarting the logger. The recording equipment provided for the Engineer shall become the property of the State at the completion of the project. An automatic temperature monitoring system shall be provided with email, phone, or text message alarm capability to notify the Contractor when temperature control limits are about to be exceeded.

The Contractor must submit technical literature on the complete maturity logger system, including the loggers, handheld reader, wireless system, software and any other components to the Engineer for approval at least 60 days prior to the first mass concrete placement. This shall include manufacturer contact information for the responsible technical representative and product performance history showing at least one year of successful use of the complete system on a minimum of three projects with mass concrete placements comparable to those within the scope of this project. Contact information shall be provided for the project owners. No mass concrete placements shall proceed until approval of the maturity logger system has been given in writing by the Engineer.

607.03 SUBMITTALS.

607.03.1 Mass Concrete Temperature Control Plans. As part of the submittals, the Contractor shall submit a "Mass Concrete General Temperature Control Plan" for approval at least 60 days prior to the first mass concrete placement and shall be stamped by a Rhode Island Registered Professional Engineer. This shall show the general procedures proposed for temperature control. A "Mass Concrete Specific Temperature Control Plan" shall be prepared for each unique placement and shall be based on the general plan. Each specific temperature control plan shall provide guidance for the Contractor, developed based on a concrete hydration temperature model, to indicate when the peak and differential temperatures might exceed the specification limits. The guidance shall provide specific concrete placement temperature

restrictions based on anticipated ambient temperatures and other environmental factors, passive and active cooling, and insulation practices that could produce peak or differential temperatures that require remedial action. Guidance shall also be provided on appropriate remedial actions to be taken when concrete temperatures approach specification limits. At a minimum, these guidelines shall take effect when the concrete peak temperature reaches 3°F below the specification limit of 155°F and when the differential temperature reaches 2°F below the specification limit of 35°F or the temperature value at the specified maturity, for the variable differential limit, (if approved). Each specific plan shall be submitted for approval at least 30 days prior to the placement and shall be stamped by a Rhode Island Registered Professional Engineer. Any costs related to the development of Mass Concrete Temperature Control Plans shall be considered incidental to the project.

Approval of any Mass Concrete Temperature Control Plan by the Engineer will not relieve the Contractor of his responsibility to maintain concrete temperatures within specification limits.

A. General Mass Concrete Temperature Control Plan. The General Mass Concrete Temperature Control Plan shall include the following:

1. Concrete mixture proportions, indicating aggregate sources and physical properties, cementitious material sources, and admixture product names and doses for each concrete mixture. The Class MC concrete mixture design and prequalification test results shall be submitted for approval separately.

2. Anticipated mass concrete placement schedule, including proposed concrete mixture adjustments for the full range of conditions that may occur during placement and curing operations.

3. Concrete temperature rise for each mixture shall be tested directly in an adiabatic concrete calorimeter cast from laboratory trial batches using the same material sources and proportions as intended for use on the project.

4. Concrete compressive strength development in standard moist curing environment (73.5 ± 3.5 deg F) at 3, 7, 14, 28, and 56 days for each mixture, based on the average of three 6" x 12" cylinders for each age. Cylinders shall be cured and tested per AASHTO T-22. Cast a temperature sensor in the center of two additional cylinders and cure these cylinders alongside those used for compressive strength. Record the average temperatures of the cylinders hourly. Report the compressive strength and maturity for each specimen at each test age and the average values.

5. Calculate and report the concrete strength development-maturity equation for each mixture from the standard cured strength results as described in ASTM C 1074 "Estimating Concrete Strength by the Maturity Method".

6. Demonstration Mock-up(s) shall be performed at least 120 days prior to the first scheduled Mass Concrete Placement. The Contractor shall cast at least one mock-up to verify that the concrete thermal properties and temperature control procedures required for the Mass Concrete General Temperature Control Plan are adequate to meet the specification limits. The mock-up(s) shall use the same concrete mixture proportions and materials, form materials, curing materials, and monitoring devices defined in the General Temperature Control Plan, and shall use the same batching and placing operation as intended for the project. The mock-up shall be a cube or other element measuring 4 ft or more in the least dimension. Temperature monitoring of the mock-up

shall be as specified in the General Mass Concrete Temperature Control Plan and shall continue for at least seven (7) days. As a minimum, the demonstration mock-up shall be insulated with R-20 insulation on all sides. If various insulation, cooling, or curing options are proposed, a separate demonstration mock-up cube shall be cast and instrumented for each option. The engineer responsible for the design of the temperature control plan shall be present at the placement for each mock-up.

Sensor placement:

a. Two sensors shall be located At the center of the mock-up. The average of these two shall be used.

b. Two sensors shall be located within one inch from the top surface located directly above the center of mass sensors. The average of these two shall be used.

c. Two sensors shall be located within one inch from the center of a vertical face. The average of these two shall be used.

d. Two sensors shall be located in an upper corner of the cube. The average of these two shall be used.

e. One sensor shall be used to record the ambient temperature. This sensor shall be placed at approximately ten (10) feet from the placement, in a shaded area.

Note: A 5°F or greater variation between adjacent sensors pairs, or erratic variations or outright failure of a sensor shall be brought to the attention of the Engineer immediately upon discovery of the problem. At the time of the notification, the Contactor shall provide the Engineer with a course of corrective action for approval. If the approved corrective action requires that the data from one sensor in a pair no longer be used, the other functioning sensor shall be used solely for the peak and maximum differential temperature measurements.

From the concrete batched for the mock-up, the Contractor shall have tests conducted for air content (AASHTO T152), placement temperature (ASTM C1064, unit weight (AASHTO T121) and fabricate cylinders (per AASHTO T23) from the same concrete by an ACI Certified Concrete Field Technician Level I. The cylinders shall be tested for compression strength by an AASHTO Accredited independent concrete testing laboratory (AASHTO T22) at 3,7, 14, 28, and 56 days. The Contractor shall coordinate the mock-up with the Engineer, and shall provide the State at least one week advance notice of the casting date. The Engineer shall be provided the opportunity to witness the placement and functioning of temperature recording sensors prior to casting, and may perform concrete property tests on companion samples selected by the Engineer.

If a mix design has been approved for mass concrete placement prior to the scheduled first placement for this project and the test conforms to these standards, the Engineer may waive the requirement of items 607.03.1 (A)(1) through 607.03.1 (A)(1)(6). However, any requirements for testing/analysis added after the aforementioned mix design was approved shall still be performed, with the exception that mix designs previously approved using data derived from semi-adiabatic testing will not require re-testing per the above requirements. If the approved mix design has already had a mock-up performed previously and the criteria matches that for the applicable temperature control plan, the Engineer may accept the results of the previous mock-up instead of running a new one.

A letter report documenting the concrete properties and temperatures developed in the mock-up compared against the thermal analysis contained in the General Mass Concrete General Temperature Control Plan models shall be submitted as part of the General Temperature Control Plan. Any revisions/corrections required to the General Mass Concrete Temperature Control Plan for differing ambient conditions shall be outlined in the letter report. Strength results may be submitted separately.

If the project involves four or less unique mass concrete placement designs, the Engineer may waive the requirement for a General Mass Concrete Temperature Control Plan. If waived, the Specific Mass Concrete Temperature Control Plans shall meet all of the requirements listed above.

B. Specific Mass Concrete Temperature Control Plans. Each Specific Concrete Temperature Control Plan shall include the following:

1. Form and form liner R-value and anticipated time of form removal.

2. Insulating material(s) R-value and anticipated periods of use

3. Curing procedure and duration

4. Thermal modeling analysis for typical placement scenarios shall be provided. The analysis shall incorporate, but not be limited to: A range of anticipated ambient placement temperatures, anticipated water temperatures for active cooling, effects of water temperature for placements in water, effects of convection cooling in locations where high winds may be a factor, anticipated concrete placement temperatures, assumed R-values for concrete forms and insulation, and shall calculate maximum core and surface temperatures vs. time after placement. The impact of planned construction activities, such as form removal, shall be included in the analysis. Concrete strength at form removal shall be estimated from the maturity relationship using the lowest calculated maturity value shown by the sensors placed within the concrete.

5. Drawings identifying temperature monitoring locations for each placement, and product data for all sensors and recording instrumentation shall be provided. With the exception of the ambient sensor, the sensors shall be installed in pairs for the redundancy. The minimum number of automated temperature monitoring locations shall be nine (9) per element for placements less than 500 yd^3, and seventeen (17) for placements 500 yd^3 or larger. Minimum sensor locations are noted below. Each of the sensors in a pair shall be placed in separate locations, no less than 6" and no more than 18" apart: The relative locations shall be as shown for the mock-ups.

    a. Two sensors shall be placed in the geometric center of the placement. This location shall be based on the isocurves developed for the model, with the approval of the Engineer. The average of the two will be used to determine the peak temperature at any given time and to measure the maximum temperature differential in the placement based on the difference between the peak temperature and each sensor location at any given time. The average of the two sensors shall be used.

    b. Two sensors shall be placed at the location as determined by isocurves developed for the model that shows the point where the lowest temperature is predicted during temperature control. The average of the two sensors shall be used.

    c. Two sensors shall be located within one inch from the top surface located directly above the center of mass sensors. This location may be adjusted, based on the isocurves

developed for the model, with the approval of the Engineer. The average of the two sensors shall be used.

d. Two sensors shall be located within one inch from the center of vertical formed surfaces at mid-height. This location may be adjusted, based on the isocurves developed for the model, with the approval of the Engineer. The average of the two sensors shall be used.

e. One sensor shall be used to record the ambient temperature. This sensor shall be placed at approximately ten (10) feet from the placement, in a shaded area.

f. The Contractor shall also provide up to four (4) additional sensor pairs to be located at the discretion of the Engineer.

g. Use similar sensor distribution for placements greater than 500 yd^3.

Note: A 5°F or greater variation between adjacent sensors pairs, or erratic variations or outright failure of a sensor shall be brought to the attention of the Engineer immediately upon discovery of the problem. At the time of the notification, the Contactor shall provide the Engineer with a course of corrective action for approval. If the approved corrective action requires that the data from one sensor in a pair no longer be used, the other functioning sensor shall be used solely for the peak and maximum differential temperature measurements.

Following a mass concrete pour, the Engineer may require the Contractor to perform thermal modeling analysis of the placement using actual concrete and ambient temperatures to evaluate the effects of construction practices such as, but not limited to, form removal or curing. If required, this shall be performed at no additional cost to the State.

Procedures for achieving temperature restrictions including contingencies for severe weather events shall be provided. Procedures may incorporate either active (cooling pipes) or passive control methods (insulation, tenting, venting, etc.) or both. The Temperature Control Plan shall show the expected duration of all temperature control measures for each model condition model provided.

If cooling pipes are proposed, submit detailed description of the system describing the layout and size of pipes, anticipated coolant flow rate, temperature of the raw coolant source, pump size, flow and recirculation control equipment, instrumentation, coolant temperature control procedure, and contingency plans.

607.03.2 Performance-Based Variable Temperature Differential Limit. After the Contractor has established, to the satisfaction of the Engineer, that proper control can be maintained of the concrete mix properties, including curing temperatures, the Contractor shall have the option of submitting a plan to use a performance-based criteria for a variable differential limit, based on the concrete strength as determined by the maturity at any given time. This will supersede the 35 degree F limit. Failure to maintain proper temperature control under this plan will result in reversion to the 35 degree F limit for subsequent placements until such time that the Contractor demonstrates to the Engineer that causes for the loss of control have been identified and corrected. Temperature control will be considered to have failed if one of the following conditions occurs:

- The differential exceeds the variable value by more than 3 degrees F at any time during the first 40 hours after placement.
- The differential exceeds the variable value by more than 5 degrees F at any time after the first 40

hours after placement during temperature control.

- The differential exceeds the variable value by 2 degrees F or more for any period of 8 hours or more at any time during temperature control.
- Cracking of the placement determined to be the result of thermal issues will also be considered to be failure of the temperature control and will result in reversion to the 35 degree F limit, as well as triggering the provisions specified in 607.05.4.

Plan Submission Requirements. The Contractor's written implementation plan shall include complete back-up data such as, but not limited to, listing of all assumptions used in the analysis, published reference documents, coefficient of the thermal expansion for the mix being placed, tensile strength development versus maturity equations for the mix being placed, elastic modulus versus maturity equations for the mix being placed, example implementation of the method using a predicted thermal gradient analysis and complete test data justifying the prediction equations for the proposed mixture. Each placement shall also include a specific plan with an assumed restraint factor, consideration of the placement geometry and other factors that can affect the differential limit. The other factors shall include, but not be limited to, anticipated concrete placement temperature, ambient temperatures, cooling water temperature (if active cooling is used), convection effects from wind and design elements of the temperature control plan.

For acceptable demonstration of the submission of an implementation plan, the Contractor may use a mass concrete pour defined and conducted using the 35 degree F differential limit. The gradients predicted in the thermal model for the performance-based temperature limit shall match the actual temperatures to the satisfaction of the Engineer. It shall have as a minimum a set of at least eleven temperature/maturity sensors. Locate sensors as follows:

1. At the location of the maximum temperature, at least one sensor shall be placed as defined in 607.03.1 (B) (1) (a)
2. Near the formed surface, at least one sensor shall be placed as defined in 607.03.1 (B) (1) (b)
3. Near the top surface\, at least one sensor shall be placed as defined in 607.03.1 (B) (1) (c)
4. A minimum of two equally spaced between the location of the maximum temperature and top surface sensor in an approximate straight line configuration
5. A minimum of two equally spaced between the location of the maximum temperature and formed surface sensor in an approximate straight line configuration
6. At the location of the minimum temperature, at least one sensor shall be placed as defined in 607.03.1 (B) (1) (d)
7. A minimum of two equally spaced between the location of the maximum temperature and the location of the minimum temperature, in an approximate straight line configuration
8. One sensor should be used to record the ambient temperature remote from the placement , as defined in 607.03.1 (B) (1) (e)

For items 1, 2, 3 and 6, the sensors may be the same as those used for the actual temperature control of the placement as specified in 607.03.1B. While redundant sensors are not required, failure at any of the required locations without a backup will invalidate the results.

The performance-based temperature limit plan shall be submitted for approval at least 30 days prior to the first placement for which it is proposed to be used and shall be stamped by a Rhode Island Registered Professional Engineer. Should the plan be approved by the Engineer, this will become the standard sensor distribution for as long as this plan is in effect and shall be used to verify the accuracy of the performance-based temperature limit plan thermal model for each placement. The plan shall show a relationship between the maturity and the appropriate maximum acceptable temperature differential that will prevent cracking of the concrete. The relationship shall be shown in tabular form, at intervals of one

(1) degree F for the first forty (40) hours after placement and two (2) degrees F for more than forty (40) hours after placement. to a minimum of fourteen (14) days. The maturity value used to determine the appropriate differential at any given time shall be the lowest measured within the placement.

607.04 CONSTRUCTION METHODS. Applicable construction requirements for **SECTION 808 CAST-IN-PLACE STRUCTURE CONCRETE MASONRY** and **SECTION 601 PORTLAND CEMENT CONCRETE** shall apply, with the following additions:

607.05 TEMPERATURE CONTROL REQUIREMENTS.

607.05.1 Temperature Control. Mass concrete temperature control shall be monitored by maturity loggers cast into the concrete, as described in 607.03.1. Use of low heat concrete mixtures, pre-cooling of the concrete, insulated curing blankets, insulated forms, cooling pipes, and other measures may be necessary to satisfy the temperature control requirements.

The Contractor shall notify the Engineer immediately when temperature control limits are exceeded.

Complete concrete temperature records for each placement including the secure files generated by the automated temperature sensors shall be provided to the Engineer. The Engineer shall be provided unobstructed access to temperature sensors at any time to verify compliance with temperature control criteria.

a. When forms are placed in water, the forms and insulation shall be waterproof or otherwise protected against water absorption. The required combined form and insulation R-Value shall be determined through thermal analysis prior to placement using forecasted temperatures to meet the requirements to maintain the maximum peak and differential temperatures within the limits defined in tis specification.

b. The temperature of the concrete at placement must not exceed 65 degrees for cold weather placements, nor 85 degrees F for hot weather placements, unless active temperature control precautions are employed. All active temperature control piping shall be non-metallic and shall be filled with a non-shrink grout on the RIDOT Approved Products List upon completion of cooling operations. The temperature of the concrete at placement shall be within the acceptable range of values shown in the temperature control plan for the structural element.

c. Temperature sensors shall be maturity loggers as described in 607.02.2. The logger will be programmed with the appropriate datum temperature. .

d. Wiring for loggers that must be cast into the concrete shall be secured to reinforcing or otherwise protected to prevent damage during concrete placement. The method of protection of the wires cast into the concrete shall be approved by the Engineer and shall use methods satisfactory to the Engineer. Wiring for loggers shall be clearly labeled to identify the location within the form at both ends before being placed into the form. Ambient temperature sensors shall be located no closer than 10 feet from the Mass Concrete Placement and shall be placed as to provide an accurate measurement of the environmental condition. Wire runs outside of concrete shall be encased in conduit where necessary to prevent damage during subsequent construction operations.

e. The Contractor shall not perform installation and verification checks for operation of any loggers

unless the Engineer is present. The Contractor shall provide as-built versions of the temperature control plans showing the location of the loggers as identified by the unique serial numbers. Upon completion of monitoring all visible wires shall be removed from the concrete and any conduit penetrations filled with a non-shrink grout on the RIDOT Approved Product List.

f. Each logger will be programmed with notes identifying the placement and relative location within the placement. Loggers shall be secured into position and function shall be verified at least one day prior to concrete placement. Temperature recording for each placement shall start no less than 2 hours prior to the initial concrete placement. The Contractor shall provide the Engineer safe access to the locations where readings will be taken, to observe the initialization of the loggers and record relevant information. This information shall include each logger serial number, location in the placement and start time. Access shall also be provided as needed for subsequent readings, as required by the Engineer.

g. Each logger for each placement shall be connected to the Wireless Remote Boxes purchased by the Contractor. The Contractor shall provide as many Wireless Remote Boxes as necessary to monitor all loggers simultaneously. The Contractor shall be aware that a sufficient quantity of Wireless Remote Boxes must be on hand to monitor all of the loggers for all of the placements being actively monitored at any given time during the project. The Contractor shall also maintain two (2) spare Remote Boxes or 10% of the total on hand, whichever is larger, in operating condition at all times.

h. The Contractor shall maintain the wireless system in operating condition, including maintaining any batteries at sufficient charge and protecting the units from damage due to the environment and other factors. This shall be done to insure that the Remote Boxes are capable of retrieving and transmitting data on a daily basis for the duration of the specified monitoring period for the concrete placement.

i. The Contractor shall have at the Contractor's field office a Wireless System Radio Base Station compatible with the Wireless Remote Boxes and an equivalent model provided to the Engineer, as described in 607.02.2. Both Wireless System Radio Base Stations shall be configured to access all of the active Wireless Remote Boxes at any given time without reconfiguration of any component. Upon setup of each Wireless Remote Box and prior to placement of the concrete, the Contractor shall test the remote operation of the system to verify that it works properly and that all loggers that are to be connected to the Wireless Remote Box can be accessed. The Contractor may, at his discretion, have a handheld reader for the loggers. However, this shall not be used, except to configure the loggers initially or to collect data in the event of a problem with a Wireless Remote Box. Any such problem shall be corrected within 24 hours, unless permission is granted by the Engineer for a longer delay. Upon connection/reconnection of a Wireless Remote Box, the operation shall be tested as described above.

j. Automated temperature measurements shall be downloaded within one hour of the start of each calendar day during which any element of temperature control is in place. Secure data files from each logger shall be provided to the Engineer on a daily basis.

k. The peak concrete temperature at any location within the mass shall not exceed 155 degrees F at any point in time. Failure to maintain a maximum peak concrete temperature less than or equal to 155 degrees will be cause for rejection of the concrete placement by the Engineer.

l. The temperature differential calculated as the difference between the mean of the peak temperature and any concrete surface sensor temperature shall not exceed 35 degrees F or the value of the variable limit (if approved) at any point in time. Failure to control the maximum concrete temperature differential less than or equal to the specified limit may be cause for rejection of the concrete placement by the Engineer. Malfunctioning sensors, as determined by the Engineer, shall be excluded from the differential calculation.

m. The placement shall be completely protected from exposure to precipitation to prevent cooling of the surface. Such protection shall be maintained until temperature control is no longer required.

n. Forms shall remain in place until the estimated strength of the concrete surface exceeds 2500 psi based on the lowest indicated maturity from the data loggers and until the differential between the mean center temperature and ambient temperature is less than 30 degrees F and decreasing. Ambient temperatures must be rising at the time of form removal. Forms shall not be removed prior to meeting all other requirements listed elsewhere in the Contract Documents.

o. Tenting, erecting windbreaks, covering with plastic or curing blankets or other means may be necessary to protect the concrete surface from rapid cooling after form removal. Any and all such measures shall be at no additional cost to the State.

p. Concrete surfaces shall be protected when the temperature differential between the peak temperature and ambient temperature is greater than 30 degrees F.

q. Mass concrete temperature control procedures shall remain in effect until the temperature differential between the mean center temperature and the 3-day mean ambient low temperature is less than 35 degrees F.

r. Mass concrete elements exposed to seawater, brackish water or freshwater shall have reached at least 28 days compressive strength as indicated by the approved Maturity Curve and shall have a core temperature-to-water temperature differential less than 35 degrees F prior to exposure.

s. Verbal approval shall be obtained from the Engineer before removing temperature control.

607.05.2 Curing. Curing requirements of SECTION 601.03.8 and SECTION 808.03.09 shall apply, except as follows:

Mass concrete placements shall be continuously moist cured for at least 14 days and until the 28 day compressive strength as indicated by the approved Maturity Curve is achieved. Maintaining moisture on the top surface with forms in place shall be considered adequate moist curing. If strength and thermal control are achieved prior to 14 days, forms may be removed but moist curing must be continued.

Water used for curing shall be fresh water and shall not contain any salts or other components harmful to concrete. The temperature of any water used for moist curing of mass concrete shall be controlled to within 30 degrees F of the mean concrete center temperature.

607.05.3 Temperature Control Failure. Failure to meet the temperature control requirements of this specification will be cause for rejection of the concrete. Subsequent mass concrete placements shall be immediately halted. The Contractor shall investigate the events that produced the failure, and shall submit a written report to the Engineer. The investigation shall include a thorough examination of the concrete

placement, the reasons for non-compliance with these requirements and shall document the width and extent of all visible cracks (if any), after cleaning the surface to fully expose them. Surface crack intensity will be measured after monitoring shows the maximum internal temperature has dropped to within 10°F of the outer concrete temperature The investigation shall be conducted by a licensed Rhode Island Professional Engineer, and shall present crack repair options for approval by the Engineer in accordance with **Subsection 607.05.05**.

The Contractor shall remove all equipment and materials from the mass concrete element and clean the surface for the Engineer to verify the Contractor's measurements of the crack intensity. The Contractor shall provide safe access for the Engineer's inspection, at no additional cost to the State.

At the discretion of the Engineer, repair or removal and replacement of the rejected placement may be required of the Contractor. If required, repair, or removal and replacement of the rejected placement shall be performed at no additional cost to the State.

At the discretion of the Engineer, the Contractor shall be required to submit a revised Mass Concrete General Temperature Control Plan to address any deficiencies identified by the investigation, at no additional cost to the State.

Subsequent mass concrete placements shall not resume without written approval by the Engineer.

There shall be no claims for additional payment by the Contractor nor will there be an extension of the project Completion Dates for any corrective actions required as a result of the rejected concrete and subsequent corrective measures to address any deficiencies identified by the investigation.

607.05.4 Crack Repairs. Cracking determined to be due to thermal issues shall be repaired by methods submitted to the Engineer. Determination of when cracking is caused by thermal issues will be solely by the Engineer. No repairs shall begin until the Engineer has approved the repair plan.

In case of thermal cracking, the Contractor shall suspend further work on members of similar size and configuration, submit a written explanation of the thermal cracking and additional steps to be taken to eliminate future thermal cracking, and submit proposed modifications in writing to the Engineer for review. Concrete placement may not resume until the Engineer approves the proposed modifications.

607.06 METHOD OF MEASUREMENT. "Mass Concrete" will not be measured for payment.

607.07 BASIS OF PAYMENT. No separate payment will be made for this item. Compliance with the above requirements shall be considered incidental to placement of mass concrete. Costs for this item shall be included in the bid prices of the appropriate items as listed in the Proposal.

Revise **Subsection 814.03; Placement of Concrete Bridge Decks – Construction Methods,** of the RI Standard Specifications for Road and Bridge Construction as follows.

SECTION 814

PLACEMENT OF CONCRETE BRIDGE DECKS

- **Replace the fourth paragraph of Subsection 814.03. 8(b) with the following.**

All concrete shall be kept continuously moist and protected against any drying for a minimum period of 14 consecutive days after placement of concrete. The burlap covers shall be kept moist for the entire 14 day curing period, and under no circumstances shall the concrete be allowed to be exposed to an alternating wet and dry condition.

- **Replace the first paragraph of Subsection 814.03.8(c), page AC-61 of the January 2011 Compilation of Approved Specifications with the following.**

814.03.8 Curing.

c. Falling Temperatures. The Contractor shall provide suitable measures to maintain the concrete surface temperature between 50°F and 85°F which shall be monitored by a continuously recording thermometer. The minimum 50°F temperature requirement shall be continuously maintained around the forms and deposited concrete for 7 days after concrete placement and above 40°F for the remaining 7 days of the curing period.

- **Replace Subsection 814.03.9(a), Bridge Decks with Exposed Concrete Surfaces with the following.**

814.03.9 Final Finish. Unless otherwise shown on the Plans, the final finish required shall be as follows:

a. Bridge Decks with Exposed Concrete Surfaces. The final concrete surface shall consist of diamond grinding and texturing Portland cement concrete bridge decks longitudinally to establish proper riding characteristics to the deck surface. The diamond grinding shall be take place prior to the installation of asphaltic expansion joint systems.

1. Equipment. The equipment shall be suitable and appropriate for the task at hand and shall be approved by the Engineer. The equipment shall possess a positive means of removing the diamond grinding residue from the deck surface leaving the surface in a clean, near dry condition.

2. Surface Preparation – Disposal of Construction debris. Prior to the start of work the Contractor shall submit to the Engineer, a debris handling and management plan indicating quantities of residue that are expected to be generated; locations for temporary storage for drying or settling of fines, if necessary, and the location acquired or designated for disposal of residue debris.

The contractor shall be responsible for both the proper management of and legal disposal of all debris from the diamond grinding operations. All costs associated with said management and legal disposal such as tipping fees, disposal permits or applications for permits shall be considered as incidental to the concrete work and will not be paid for separately.

3. Construction Methods. The entire bridge deck area shall receive the diamond grinding. No spot diamond grinding will be allowed. Diamond grinding shall be accomplished in a manner that establishes proper riding characteristics to the deck surface while providing positive lateral drainage by maintaining a constant cross-slope between diamond grinding extremities in each lane. The operation shall result in a bridge deck that conforms to the typical cross-section and the requirements specified for the final surface finish.

The diamond grinding process shall produce a pavement surface that is true to grade with the ground area consisting of a longitudinal corduroy-type texture. The grooves shall be between 0.10 and 0.15 inches wide. The land area between the grooves shall be between 0.065 and 0.125 inches. The peaks of the ridges shall be approximately 2/32 inch higher than the grooves with 53 to 57 evenly spaced grooves per foot. Adjusting the blade spacing may be necessary to achieve the specified texture. The tolerance for the above dimensions is 1/64 of an inch.

Immediately after diamond grinding, the pavement shall be left in a washed and clean condition, free of all residue and slurry. Residue shall not be permitted to flow across lanes used by the traveling public or into gutters or drainage facilities.

4. Quality Assurance [JOB-SPECIFIC SPECIFICATION ONLY]

(a.) Quality Control (QC). Prior to the beginning of diamond grinding operations, the Contractor shall submit a Quality Control Plan to the Engineer for approval. The Contractors QC plan shall describe and outline to the method and frequency of testing that the contractor intends to exercise during the production stage of the diamond grinding operations.

The plan shall include checks of the diamond ground surfaces to be taken behind the diamond grinding operations at regular intervals throughout the process using a standard commercial tire tread gauge, micrometer, or other approved instrument. The location of the measurements shall vary at regular measurement intervals. Readings shall be made to the nearest 0.063 (2/32) inch. If two consecutive readings fall outside the specified limits, adjustments shall be made by the Contractor to bring the diamond grinding operations back into compliance. The tolerance for the above dimensions is 1/32 of an inch.

The Contractor shall regularly inspect the ground surface during the course of the work to determine whether raveling, spalling, faults or cracking are occurring. Particular attention shall be required at transverse and longitudinal joints. If raveling, spalling, faults or cracking are occurring the Contractor shall stop operations at no cost to the Department and take immediate steps to resolve the problem to the satisfaction of the Engineer.

The Contractor shall perform Quality Control in accordance with the methods and frequency described in its approved Quality Control Plan. QC testing shall be performed for the full duration of the work and over the full area of the project. Failure to comply with the QC plan will result in:

- Suspension in progress payments
- $2,000.00 penalty per occurrence

(b.) Acceptance. Depth measurements of the diamond ground surface texture will be conducted on a daily basis by the Department. Each day the acceptance testing will be conducted at a minimum of five randomly selected locations. Acceptance testing will be conducted using one or more of the following methods:

1. Groove Depth Measurements;

2. Sand patch texture Depth Measurements (ASTM E965)
3. CT Meter Texture Depth Measurement (ASTM E2157)

At each selected location, the minimum number of measurement (5 for Groove Depth Method and 3 for Sand patch and CT Methods) will be taken. Under each of the methods the average of the measurements will be determined. If the Average Depth of the average MTD (mean texture depth) of the Sand Patch of CT methods is outside the specified depth limits, two additional measurement will be conducted in the vicinity to ascertain non-compliance (i.e., consistently too shallow or too deep). Area that does not meet the specified minimum groove depth or specified MTD will be subject to corrective action by the Contractor. Area that exceed the specified maximum groove depth or specified maximum MTD will be subject to a price adjustment of a 1% reduction of the concrete cost for that area of diamond grinding performed that day.

• **Replace Subsection 814.03.10 with the following.**

814.03.10 Application of External Loads. No construction work (including placement of sidewalk, curbing, railing, bituminous pavement, concrete overlays, grooving, etc.), shall be allowed on the newly placed bridge deck until concrete has cured for a minimum of 14 days and has attained the minimum required 28-day compressive strength. No heavy equipment or traffic of any description will be permitted on the concrete deck until authorized by the Engineer.

Revise **Subsection 820.02; Concrete Surface Treatment Protective Coating – Materials,** page` 8-120 of the RI Standard Specifications for Road and Bridge Construction as follows.

SECTION 820

CONCRETE SURFACE TREATMENT PROTECTIVE COATING

820.02 MATERIALS. Concrete protective sealers shall conform to the requirements of **Subsection M.12.03** of these Specifications.

820.02.1 Film Forming Sealers. Concrete surface protective sealers applied to concrete median barriers shall be of the film forming sealer type and conform to the requirements of **Subsection M.12.03** of these Specifications.

Remove **Section 918; Rural Mailboxes Postmaster Approved,** page AC11-35 of the May 2011 Specification Compilation and replace it with the following.

SECTION 918

RURAL MAIL BOXES POSTMASTER APPROVED

918.01 DESCRIPTION. This work consists of replacing existing rural mail boxes with new 2-door mail boxes when said existing mail boxes do not conform to the specifications of the U.S. Postal Service and/or local requirements, all in accordance with these Specifications.

918.02 MATERIALS. New rural mail boxes shall conform to the standards established by the U.S. Postal Service for materials, coatings, and paint. The doors of the new mail boxes must have embossed thereon the following inscriptions: "U.S. MAIL," and "APPROVED BY THE POSTMASTER GENERAL." Identification in the form of a house, apartment or box number, clearly visible to the mail carrier's approach and consistent with USPS Standards, shall be provided.

918.03 CONSTRUCTION METHODS. Mounting of new rural mail boxes on posts shall conform to the requirements of **Subsection 917.03.2, Para. c; Mounting of Mail Boxes**, of these Specifications.

918.04 METHOD OF MEASUREMENT. "Rural Mail Boxes" of the various types indicated on the Plans will be measured by the number of such boxes actually installed in accordance with the Plans and/or as directed by the Engineer.

918.05 BASIS OF PAYMENT. The accepted quantities of "Rural Mail Boxes" of the various types indicated on the Plans will be paid for at their respective contract unit prices per each such box as listed in the Proposal. The prices so-stated constitute full and complete compensation for all labor, materials and equipment including removal of existing rural mail boxes, hardware and other incidentals required to finish the work, complete and accepted by the Engineer.

Replace **Subsection M.01.09; Gradation of Aggregates**, page M-4 of the RI Standard Specifications for Road and Bridge Construction with the following:

M.01.09

GRADATION OF AGGREGATES

M.01.09 GRADATION OF AGGREGATES. Aggregates for use in base and subbase courses and other applications shall conform to the gradation requirements indicated in the following Table I.

Table I

Gradation - Percent Passing

Sieve Size	I Gravel Borrow Ia Bank Run Proc Sand/ Gravel	I Gravel Borrow Ib Reclaimed Processed Material	II Crushed Stone or Crushed Gravel	III Keystone	IV Pervious Fill	V Filter Stone	VI Cover Stone
3"	60-100	100			100		
2¼"							
2"			100				
1½"		70-100	90-100				
1¼"							
1"			30-55	100		100	
3/4"		50-85	0-25	90-100		70-85	100
½"	50-85		0-10	20-55		10-40	90-100
3/8"	45-80			0-20		0-20	30-60
#4	40-75	30-55		0-5	30-100	0-5	0-15
#8							0-5
#40	0-45						
#50		8-25					
#100			0-1				
#200	0-10	2-10			0-8		

Remove **Subsection M.15.06.1; Light Standards,** pages AC-161 and AC-162 of the January 2011Specification of Approved Compilations in its entirety and replace with the following:

M.15.06.1

LIGHT STANDARDS

M.15.06 LIGHT STANDARDS AND FOUNDATIONS.

M.15.06.1 Light Standards. Poles are to be designed for a basic wind speed of 130 miles per hour with 1.14 gust factor with loading in accordance with the latest revision of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

All non-rounded luminaries and high level lighting structures, as defined in the latest revision of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals on Interstate Highways or limited access type facilities must comply with fatigue Category I requirements, including galloping, vortex shedding (if applicable), natural wind gusts, and truck induced gusts. The truck induced loading shall be based on 65 mph velocity.

All non-rounded luminaries and high level lighting structures on all other roadways must comply with fatigue Category II requirements, including galloping, vortex shedding (if applicable), natural winds gusts, and truck induced gusts. The truck induced loading shall be based on 30 mph velocity.

Lighting structures that have a taper of 0.14 inch per foot or greater are not susceptible to vortex shedding.

Structural components and their connections shall be designed to resist the worst-case fatigue loading, upon evaluation of all applicable cases acting separately.

The design of anchor bolts shall result in a ductile steel failure prior to any sudden brittle failure of the concrete.

The breakaway support couplings shall meet the requirements of the latest revision of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

Design and fabrication of aluminum lighting standards for the support of high pressure sodium luminaires shall be similar and compatible in design and appearance with lighting standards installed on various sections of Interstate highways in the State of Rhode Island, except as otherwise noted or indicated on the Plans. The nominal luminaire mounting heights shall be 30 and 40 feet.

Each shaft shall be tempered by a cold working process from a seamless extruded tube of 6063-T6 or 6005-T5 wrought-aluminum alloy. The davit arm shall taper from 6 inches at the base to 4 inches at the tip.

A 2-inch diameter slip fitter, 9 inches long, shall be provided at the end of each davit arm.

All arms shall be curved on an approved radius through an angle within 3 degrees of the horizontal. Twin davit lighting standards shall be provided with approved type field joints. The bottom of the bases shall be coated with bituminous paint after assembly.

The base shall be of 356-T4 permanent mold cast aluminum alloy. The base shall be approximately 12 inches square at the bottom with a height of 3½-inches. Welding shall be performed by the inert gas shielding arc method, and welds shall be free from cracks and porosity. The base shall be capable of withstanding a load of 18,500 foot-pounds. The base shall have slotted anchor bolt holes to allow mounting on 11-inch or 12-inch bolt circles. Bases shall be provided with cast aluminum bolt covers.

The aluminum after fabrication shall have a minimum yield of 25,000 pounds per square inch. The shaft shall be capable of withstanding 1,500-pound horizontal load 18 inches down from the top without fracture or apparent permanent deformation after the load has been released. The base shall be capable of withstanding the maximum allowable bending moment of the shaft.

When the arm is welded to the shaft, the arm shall withstand a vertical load of 100 pounds and a horizontal load of 50 pounds applied at the end of the arm without fracture or permanent deformation after the load has been removed.

Remove **Section T.06; Conduit**, pages AC-138 to AC-140 of the January 2011 Compilation of Approved Specifications in its entirety and replace with the following:

SECTION T.06

CONDUIT

T.06.01 DESCRIPTION. This work consists of furnishing and installing rigid steel conduit, polyvinyl chloride (PVC) plastic conduit, and fiberglass conduit of the size specified, including the necessary fittings, at the locations indicated on the Plans or as directed by the Engineer, all in accordance with these Specifications.

T.06.02 MATERIALS. Conduit and fittings shall conform to **Subsection M.15.04** of these Specifications.

T.06.03 CONSTRUCTION METHODS. All work shall be performed strictly in accordance with the requirements of the National Electrical Code, latest Edition.

T.06.03.1 Rigid Steel Conduit. Conduit shall be installed as shown on the Plans or as directed by the Engineer. Bends which are not smooth or which show any evidence of flattening or destruction of the protective coating will not be accepted. All joints requiring rethreading shall be made with a zinc-based, cold galvanized, spray-applied compound as approved by the Engineer, applied to the male threads. Oils shall be removed from the threads prior to applying the galvanizing compound. All threaded couplings shall be tightened until the ends of the conduit are brought together to form a good electrical connection.

A nylon pulling rope shall be installed in all conduits which do not carry conductors under the contract. Such pull rope shall be for subsequent use to facilitate pulling of cables. Cost of this pull rope shall be considered incidental in the price of the conduit involved.

Conduit bends and elbows made in the field shall have a radius of not less than twelve (12) times the inside diameter of the conduit, and all such bends shall be made without crimping, heating, denting or otherwise damaging the conduit.

Conduit ends at handholes shall be supplied with insulated bonding bushings with threaded ends. All conduits shall be bonded to the ground rod within the handhole using #6 bare ground wire.

a. Conduit Underground. Conduit underground shall refer to all conduit placed underground in non-paved areas or in paved areas where the pavement will be replaced as part of the project under other contract items. All conduit shall be grounded in accordance with the National Electrical Code, latest Edition. Ends that have bonding clamps shall be filled with sealing compound to prevent the entrance of moisture, except at handholes. All ground lugs shall be copper, bronze or brass. Underground conduit shall be placed at a minimum depth of 24 inches under vehicular travel areas and 18 inches under non-vehicular travel areas.

Conduits shall be placed on a 6-inch sand bed. Conduits within roadways shall be backfilled with Class 1 controlled low-strength material (CLSM) to the bottom of the gravel subbase. Yellow warning tape shall be placed 1 foot below finished grade.

When two or more conduits are placed in the same trench, conduit spacers shall be used. Spacers shall be placed at 6-foot intervals or as directed by the Engineer.

If the condition of the bottom of the trench is in any way unsatisfactory, as determined by the Engineer, the Engineer may require the Contractor to excavate additional material and replace it with Class B bedding to provide a firm bearing for the conduit. The backfill shall be compacted in layers not more than 6 inches in depth.

After the trench is backfilled the Contractor shall, in the presence of the Engineer, test the installation by pushing or pulling a mandrel, not less than 1/4-inch less than the inside diameter of the conduit, through the entire length of the conduit. Any debris, including stones and dirt, shall be removed. All damaged conduit shall be removed and replaced at the Contractor's expense.

b. Conduit Under Existing Pavement. Conduit under existing pavement shall refer to all conduit placed under existing paved areas where removal of the pavement is required only for the placement of conduit and the pavement is to be restored as part of this item. Conduit under existing pavement shall be placed in accordance with all applicable requirements of **Para. a** of this Subsection. - The excavation shall be patched in accordance with the Plans regardless of the method of excavation. When conduit is placed in existing paved sidewalks, the sidewalk shall be replaced in accordance with **Subsection T.01.03.11** of these Specifications.

c. Conduit Overhead. All conduit above grade shall be securely attached using clamps and/or hangers at intervals not exceeding 5 feet or as directed. All clamps and hangers shall be galvanized. A weatherhead shall be installed on all risers.

d. Conduit In or On Structure. Conduit to be embedded in concrete structures shall be rigidly supported in the concrete form by methods and materials which will not cause injury to the zinc coating of the conduit.

Conduit installations on bridges and other structures shall be provided with expansion fittings at all structure expansion joints. The expansion joint fittings shall be installed as shown on the Plans and meet the requirements of **Subsection M.15.04.3** of these Specifications.

T.06.03.2 PVC Plastic Conduit. PVC plastic conduit shall be installed as shown on the Plans and in conformity with the requirements previously specified in **Subsection T.06.03.1** except those referring specifically to rigid steel conduit.

PVC plastic conduit shall be installed with bell ends on the inside of each handhole.

T.06.03.3 Fiberglass Conduit. Fiberglass conduit shall be installed as shown on the Plans and in conformity with the requirements previously specified in **Subsection T.06.03.1** except those referring specifically to rigid steel conduit.

T.06.04 METHOD OF MEASUREMENT. "Rigid Steel Conduit," "PVC Plastic Conduit", and "Fiberglass Conduit" will be measured by the number of linear feet actually installed of the type or types indicated on the Plans and/or as directed by the Engineer, with no deduction for fittings and couplings.

T.06.05 BASIS OF PAYMENT.

T.06.05.1 Conduit Underground. The accepted quantities of "Rigid Steel Conduit -Underground" and "PVC Plastic Conduit - Underground" will be paid for at their respective contract unit prices per linear

foot for the type or types as listed in the Proposal. The prices so-stated constitute full and complete compensation for furnishing all materials, equipment, tools, and labor including fittings, couplings, saw cutting pavements, excavation and backfill, Class B bedding, temporary patch, restoration of existing ground surfaces including all materials necessary for such restoration, testing, and all other incidentals necessary to satisfactorily finish the work, complete in place and accepted by the Engineer.

T.06.05.2 Conduit Under Existing Pavement. The accepted quantities of "Rigid Steel Conduit - Under Existing Pavement" and "PVC Plastic Conduit - Under Existing Pavement" will be paid for at their respective contract unit prices per linear foot for the type or types as listed in the Proposal. The prices so-stated constitute full and complete compensation for furnishing all materials, equipment, tools, and labor including fittings, couplings, saw cutting, excavation and backfill, Class B bedding, restoration of existing pavements and sidewalks including all materials necessary for such restoration, testing, and all other incidentals required to finish the work, complete in place and accepted by the Engineer.

T.06.05.3 Conduit Overhead. The accepted quantities of "Rigid Steel Conduit - Overhead" and "PVC Plastic Conduit - Overhead" will be paid for at their respective contract unit prices per linear foot for the type or types as listed in the Proposal. The prices so-stated constitute full and complete compensation for furnishing all materials, equipment, tools and labor, including fittings, couplings, clamps and hangers, weatherhead, and all other incidentals required to finish the work, complete in place and accepted by the Engineer.

T.06.05.4 Rigid Steel or PVC Plastic Conduit In Structure. The accepted quantities of rigid steel or PVC plastic conduit in structure will be paid for at their respective contract unit prices per linear foot for the various types as listed in the Proposal. The prices so-stated constitute full and complete compensation for furnishing all materials, equipment, tools and labor, including fittings, couplings, and all other incidentals necessary to satisfactorily finish the work, complete in place and accepted by the Engineer.

T.06.05.5 Fiberglass Conduit On Structure. The accepted quantities of "Fiberglass Conduit On Structure" will be paid for at the contract unit prices per linear foot of conduit as listed in the Proposal. The price so-stated constitutes full and complete compensation for furnishing all materials, equipment, tools and labor, including fittings, hangers and support systems, expansion fittings, and all other incidentals necessary to satisfactorily finish the work, complete in place and accepted by the Engineer.

T.06.05.6 Expansion Couplings. The accepted quantities of expansion couplings of various types will be paid for at the contract unit price per each as listed in the Proposal. The price so-stated constitutes full and complete compensation for furnishing all materials, equipment, tools and labor, and all other incidentals necessary to satisfactorily finish the work, complete in place and accepted by the Engineer.