ITEM 91555.08 M - FOOTING CONCRETE, CLASS HP, USING THE CONCRETE MATURITY METHOD
ITEM 91555.09 M - CONCRETE FOR STRUCTURES, CLASS HP, USING THE CONCRETE MATURITY METHOD

DESCRIPTION :

Construct portland cement concrete (PCC) substructures as detailed in the contract documents. Substructures include footings, abutment stems, backwalls, pier columns, pier plinths, pier cap beams, pedestals and wingwalls and retaining walls. Section 555 applies with the exception of Sections 555-3.09 and Table 555-4, which are amended as follows:

Use the concrete maturity method to estimate the in-place concrete strength. The time required before removal of the forms and loading of the substructure will be determined based on the estimated in-place concrete strength.

EQUIPMENT:

Use a Concrete Maturity Meter and thermocouples that can:

- Provide a maturity value based on the Equivalent Age or Temperature Time Method as detailed in ASTM 1074-98.
- Continuously log and store maturity data.
- Accurate to within +/- 1° C when the meter is calibrated as per the manufacturer's instructions.
- Take readings every half hour for the first 48 hours and every hour after that at a minimum.
- Print data and/or download it into a spreadsheet.

METHODOLOGY:

The procedure for utilizing the concrete maturity method to determine in-place concrete strengths includes three steps: development of the strength-maturity relationship, monitoring the maturity of the concrete placement, and regular validation of the strength maturity relationship. Any changes in the mix design, its components, or proportions will require that a new strength-maturity relationship be developed.

The strength-maturity relationship can be developed prior to or during construction. No substructure will be exempt from the requirements of Section 555 Table 555-4 until a maturity value corresponding 21MPa is established. A minimum of 7 days data and a cylinder strength in excess 21Mpa is required for the strength-maturity relationship to be accepted. Continue data collection for the strength-maturity relationship after acceptance of the maturity value for a total of 28 days.

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A pre-placement meeting is required with the Engineer, inspection staff and the contractor, before developing the strength-maturity relationship. The contractor will provide details on using the concrete maturity method. Information includes, but is not limited to, detailed procedure, equipment list, and persons responsible for testing.

CONSTRUCTION DETAILS:

Strength-Maturity Relationship:
Prior to developing the strength-maturity relationship, and at least once per year, the contractor will calibrate the maturity meter as per the manufacturer's instructions. The contractor will provide certification of calibration.

Develop the strength-maturity relationship with a maturity meter that utilizes either the Temperature Time Factor or Equivalent Age Methods as follows:

1. Cast a minimum of 20 cylinders using the procedure outlined in Materials Method 9.2. Make the cylinders from a minimum batch size of 3 m^3. Additional specimens are recommended in case some cylinders are defective. Have the cylinders cast by an ACI Certified Concrete Field Testing Technician, Grade I or higher.
2. Perform all other tests on the concrete as required by the Standard Specifications and record the data.
3. Embed one thermocouple into the fresh concrete of each of two cylinders. Take care to insure that the thermocouples are within 50 to 100mm of any surface and that the thermocouple wires are accessible outside the cylinder. The two specimens with the thermocouples are to be tested last.
4. Attach the maturity meter and activate the thermocouple immediately. Continuously read and store the data. Do not disconnect the meter unless the thermocouple has the capability of continuously recording data without an attached meter.
5. Moist cure the cylinders as per Materials Method 9.2
6. Perform compression tests at 1, 3, 5, 7, 14, and 28 days. Test three cylinders at each interval. Calculate the average compressive strength of the three cylinders. Record the individual and average compressive strengths. Record the individual and average maturity values at the time of each test.
   a. If a cylinder is obviously defective, discard it.
   b. If an individual cylinder is not within +/- 10% of the average value, discard the results and recalculate the average value.
   c. If two or more of the three cylinder are defective, evaluate a new batch unless additional cylinders are available.

7. Plot the average strengths versus the maturity value at each time interval. Draw a best-fit curve through the data points.
8. Sign and certify the strength-maturity. Provide copies of the curve and supporting data to the Engineer in Charge, the Regional Materials Engineer and the Director, Materials Bureau.

Estimation of In-Place Strength:

1. For each day of concrete placement and for each individual element install a minimum of two thermocouples. The thermocouples shall be within 50 to 100 mm of any concrete surface. The thermocouple wiring may be connected to reinforcing steel, but probe endings may not be in direct contact with the steel. Consider structural or exposure conditions when placing thermocouples. The Engineer-in-Charge or Director, Materials Bureau may direct the location and time of installation of the thermocouples.
2. As soon as possible after placement of the concrete, install the thermocouples and attach and activate the meter.
3. Curing shall be maintained as per Section 555 of the standard specifications.
4. When the maturity value of both thermocouples reaches the value corresponding to the strengths listed below, the forms may be removed and the substructure may be loaded.

Action	**Strength Requirement**
Stripping Forms	15 MPa
Loading Element	17 MPa *

* If element loading is to be immediate, for example placing a pre-cast unit or steel girders, contact DCES for strength requirements.

5. Record and save the maturity data from the meter. Disconnect the meter and clip all wires flush with the concrete surface.

A continuous read thermocouple or thermistor with a data logger can be used to estimate in place strength. The methodology outlined in ASTM Specification C 1074-98 will be used. The maturity function used to estimate strength will be calculated with the same formula that is used by the maturity meter that established the initial strength maturity relationship. Copies of the calculations will be provided to the engineer.

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Validation of the Strength-Maturity Relationship:
For each substructure element and at least once per day of placement, perform validation tests by casting 3 cylinders. Equip one of the cylinders with a thermocouple. Test the cylinders as close as possible to the maturity value corresponding to 21 MPa. Record the maturity value immediately prior to testing.

If the average value of compressive strength of each pair of cylinders is within 5% of the estimated value, the strength-maturity relationship will be validated. If the average cylinder value is more than 5% below the estimated value, the strength maturity relationship will need to be re-established. If the average difference between the estimated and measured strengths is more than 5% above the estimated value, the relationship may require re-establishment.

The Department may perform additional testing for research purposes. Casting and testing in addition to that required in this spec will be performed by NYSDOT personnel.

In case of loss of required data, or non verification of the strength-maturity relationship, the loading of the substructure will be as defined in Table 555-4 of Section 555 of the Standard Specifications.

METHOD OF MEASUREMENT:

The Engineer will use Section 555-4, Method of Measurement.

BASIS OF PAYMENT:

Include all materials, equipment, and labor necessary to complete the work, including the equipment needed to use the concrete maturity method, in the unit bid price. Refer to Section 555-5 Basis of Payment, for details.