SPECIFICATION REQUIREMENTS

- ODOT CMS 511.04.A
  - Concrete Components with min. dimension of...
    - 5 ft. or greater (columns, pier caps, piers, etc.)
    - 7 ft. or greater (drilled shafts)
  - When bid item requires QC/QA
    - Contractor Supplies QC Plan for testing
  - When bid item does not require QC/QA
    - Department tests once every 50 yd$^3$
  - Mix design is developed prior to beginning Work
    - Thermal Control Plan (TCP) Developed
CONCRETE MIX

- QC 4 Mix Design Requirements
  - Designed based on ACI 301, Section 4 (+1200 psi overdesign)
  - **Permeability:** 2000 Coulombs or As Per Plan at 28 days
    - AASHTO T277 with modified cure (7d at 73 ºF, 21d at 100 ºF)
  - **Cementitious Contents:** 470 lbs./cy³
    - Max. ash and slag content may increase to 50%
    - Does not allow Type III cement or accelerators
  - **Strength:** 4000 psi or As Per Plan (28 or 56 days)
  - **Aggregates:** Well Graded
TCP REQUIREMENTS

TCP Requirements

- Control temperature within the element for 28 days
  - Max allowable temp: 160 °F (71 °C)
  - Max differential temp: 36 °F (20 °C)
- Procedures and controls at time of placement
- Duration and Method of Curing
- Method and equipment used for controlling $\Delta T$s
- Temperature sensor types and installation details
  - Monitor at hottest location
  - 2 outer faces/corners and top surface
- Criteria for removal to control max $\Delta T$
New 7 girder bridge between 2 existing bridges

Bridge length 4150 ft. 3% grade

Adding capacity to I-480

Twin Structures need new decks
  - Girders losing structural capacity

Carries traffic over the Cuyahoga River

Piers to be all Mass Concrete (QC 4)
  - Footer is on piles pad size 39’ x 42’
  - Bridge height approx. 212 ft.
  - Elevation difference of 50 feet (abutment to abutment)
THERMAL CONTROL PLAN

- Determined no cooling tubes required
- R-2.5 Insulation outside
- R-5 Insulation inside
- Temperature Sensors installed
  - Middle of placement
  - Outer Edges on 2 sides
Unique Project
  - Largest VECP change order in ODOT History

Straddle bent with beams in concrete
  - Post-tensioned as well

Redesign of I-75 through downtown Dayton

Straddle bent required QC 4 Mass Concrete

Required “on the fly” Spec change
MOT-75-12.62 MIX DESIGN USED

- QC 4 Concrete Used
  - Strength requirement of 8,000 psi (up from standard 4,000 psi)
  - Supplementary Cementitious Material Requirements Changed
- New Amounts
  - 40% Cement
  - 30% Slag
  - 30% Fly Ash
  - Also used 250 lb. of ice per yard during production
- Reason for change
  - TCP testing showed that a 50/50 mix would not meet temp. requirements
  - Included the use of R5 Insulation
Figure 1 – Longitudinal Elevation of the Cap
Figure 2 – General Cross-Section of the Cap

Figure 3 – Cross-Section of the Cap Below the Roadway Deck
Location of each set of temperature sensors, as shown in the cross-section on Drawing No. 2.

Midlength between steel girders at the location shown.

Generically Plan View Showing Temperature Sensor Locations in the Cap.

Approximately 30 ft from end of cap.

See Cross-Section on Drawing No. 2.
FAI-SR22-23.89 RUSHVILLE

- Bridge over RR/Creek
- Cap and Columns
  - Both used Mass Concrete
- 520 foot long bridge
- 2- 6’x6’x45.5’ Columns per pier
- Cap dimensions of 6’x6.75’x47’
FAI-SR22-23.89 TCP

- Analysis found cooling tubes beneficial
  - No tubes: Initial concrete temp. of 71 °F
  - With tubes: Initial concrete temp. of 86 °F

- Cooling tubes selected and used
  - R-5 Insulation also used to insulate concrete

- Water used in cooling tubes sourced from river nearby

- Temperature sensors placed mid-height
See Notes on Drawing No. 5

Location of the temperature sensors as shown in the plan views.

Generalized Elevation Showing Temperature Sensor Locations in the Columns (the Locations Shown are Identical Whether or Not Cooling Pipes are Installed)

"2nd Side Surface" temperature sensor (primary and backup) located 2 to 3 in. inside the side surface of the concrete, and horizontally aligned with the "Center" temperature sensor.

"Side Surface" temperature sensor (primary and backup) located 2 to 3 in. inside the side surface of the concrete, and horizontally aligned with the "Center" temperature sensor.

"Center" temperature sensor (primary and backup) located as shown to be at the plan center of the column. This will be the hottest location in the column.

Plan View Showing Temperature Sensor Locations in the Columns when Cooling Pipes are Not Installed

"2nd Side Surface" temperature sensor (primary and backup) located 2 to 3 in. inside the side surface of the concrete, and horizontally aligned with the "Center" temperature sensor but equidistant between the cooling pipes.

"Side Surface" temperature sensor (primary and backup) located 2 to 3 in. inside the side surface of the concrete, and horizontally aligned with the "Center" temperature sensor but equidistant between the cooling pipes.

"Center" temperature sensor (primary and backup) located as shown and equidistant between the cooling pipes. This will be the hottest location in the column.

Plan View Showing Temperature Sensor Locations in the Columns when the 2x2 ft Cooling Pipe Layout is Installed

Drawing No. 6 - Temperature Monitoring System Layout in the Columns (Not to Scale)
FAI-SR22-23.89 COOLING DETAIL (CAP)

Longitudinal Elevation Showing Temperature Sensor Locations in the Cap
(the Locations Shown are Identical Whether or Not Cooling Pipes are Installed)

Cross-Section Showing Temperature Sensor Locations in the Cap when Cooling Pipes are Not Installed

Cross-Section Showing Temperature Sensor Locations in the Cap when the 2x2.25 ft Cooling Pipe Layout is Installed

Drawing No. 7 - Temperature Monitoring System Layout in the Cap (Not to Scale)
FAI-SR22-23.89 RUSHVILLE
CONCLUSIONS/PERSPECTIVE

- Beneficial for large elements
  - 5 feet seems to work for minimum length

- Caution with Thermal Control Plans
  - Contractors’ responsibility
  - District reviews
  - Concerns on what to look for and how to track

- Monitor contractor in the field for compliance

- Make sure elements are not submerged during curing