NATIONAL CONCRETE CONSORTIUM

DENVER, CO, APRIL 2, 2019









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MASS CONCRETE, THE OHIO DOT PERSPECTIVE

Dan Miller, PE

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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./cy^3
    - 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

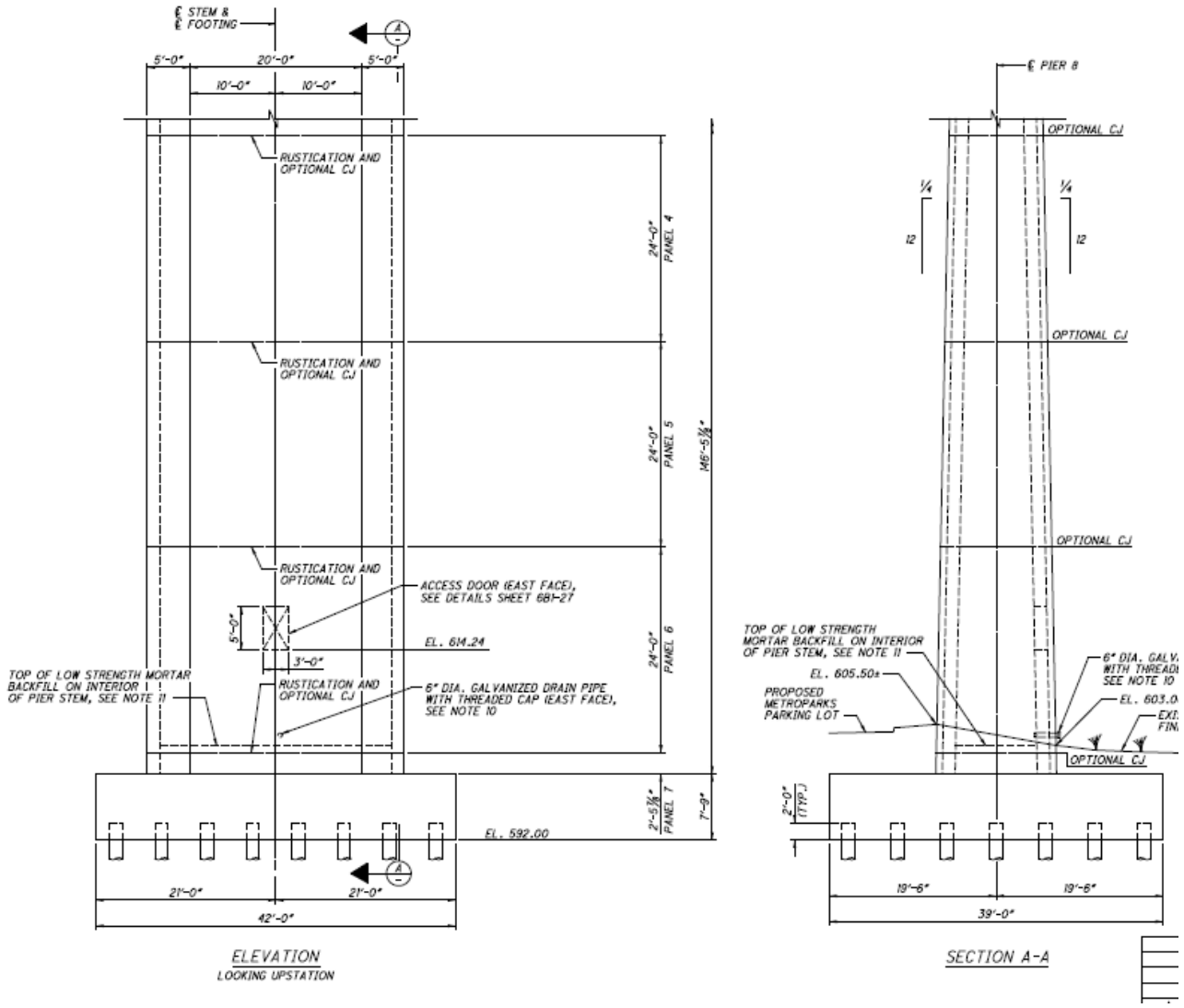
- TCP Requirements
  - Control temperature within the element for 28 days
    - Max allowable temp: 160 ºF (71 ºC)
    - Max differential temp: 36 ºF (20 ºC)
  - Procedures and controls at time of placement
  - Duration and Method of Curing
  - Method and equipment used for controlling ΔTs
  - Temperature sensor types and installation details
    - Monitor at hottest location
    - 2 outer faces/corners and top surface
  - Criteria for removal to control max ΔT

CUY-480-18.42 VALLEY VIEW

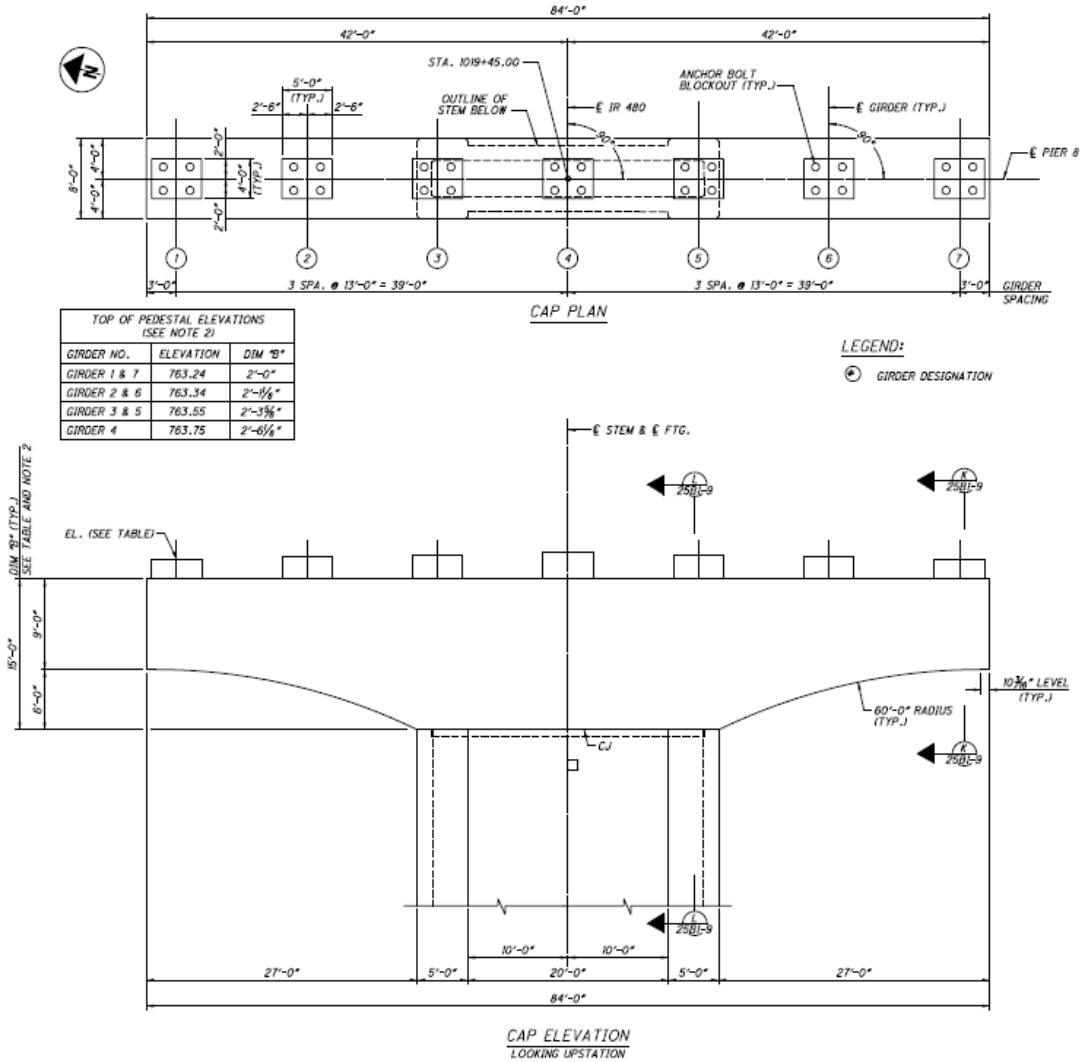
- New 7 girder bridge between 2 existing bridges
- Bridge length 4150 ft. 3% grade
- Adding capacity to I-480
- Twin Structures need new decks
  - Girders losing structural capacity
- Carries traffic over the Cuyahoga River
- Piers to be all Mass Concrete (QC 4)
  - Footer is on piles pad size 39’x42’
  - Bridge height approx. 212 ft.
  - Elevation difference of 50 feet (abutment to abutment)

CUY-480-18.42 PROJECT LOCATION

CUY-480-18.42 PIER

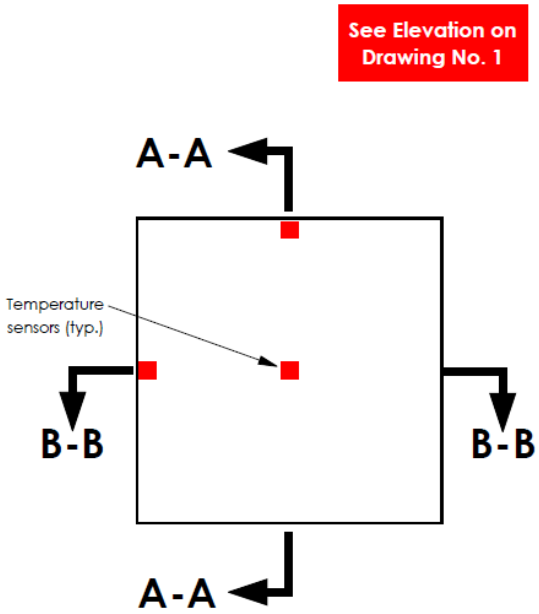


CUY-480-18.42 PIER CAP

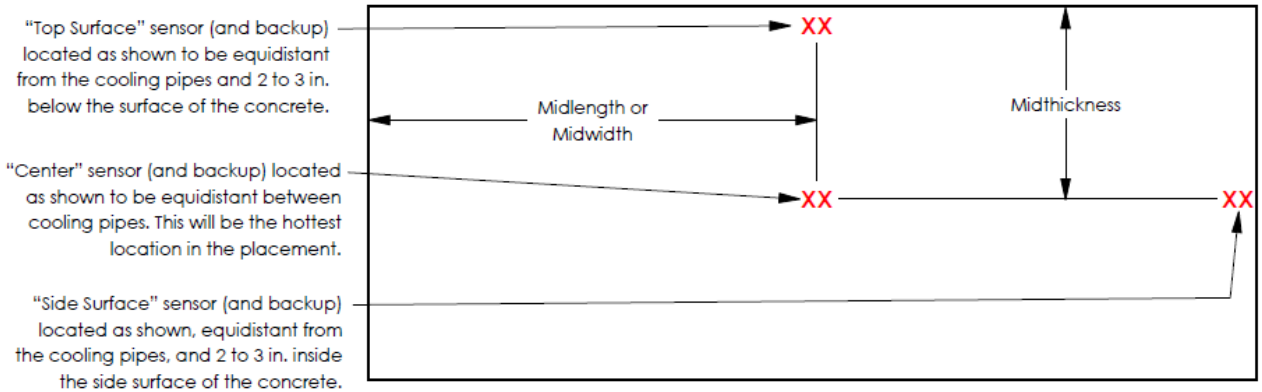


THERMAL CONTROL PLAN

- 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



Generalize plan view



Section B-B (also applies to Section A-A)

CUY-480-18.42 FOOTING

CUY-480-18.42 PIER

CUY-480-18.42 PIER CAP

MOT-75-12.62 DAYTON

- 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

MOT-75-12.62 DETAILS

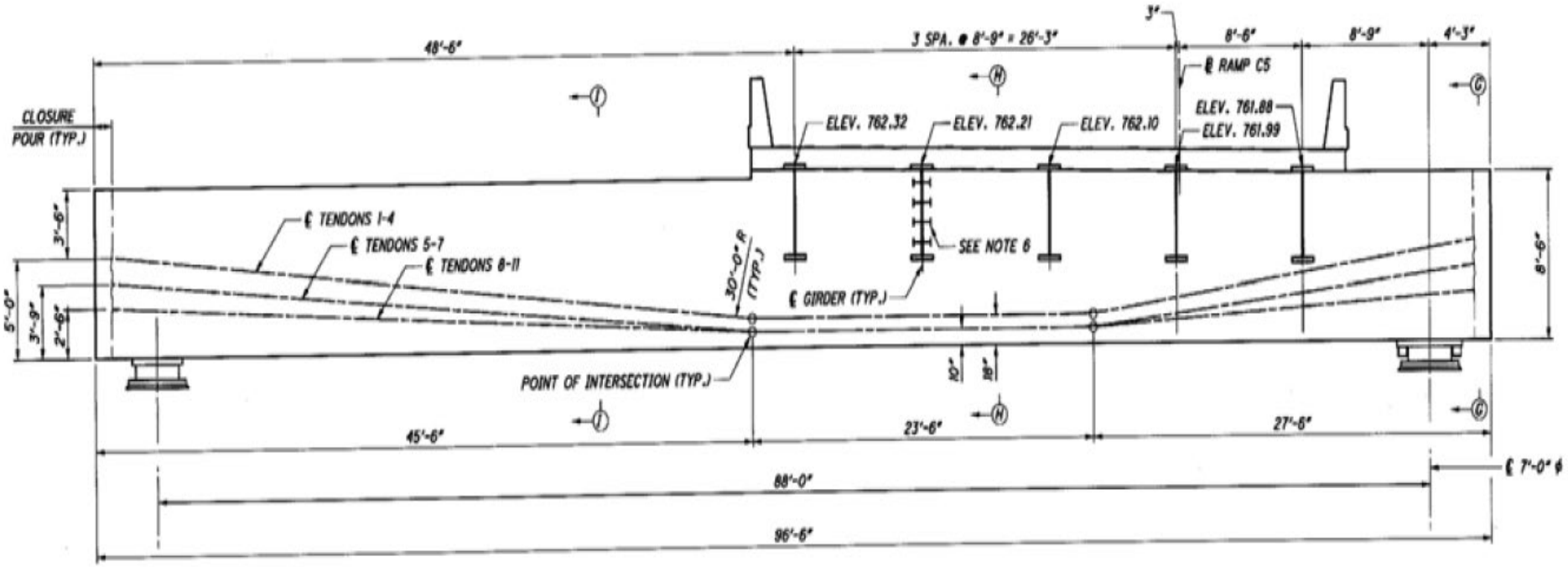


Figure 1 – Longitudinal Elevation of the Cap

MOT-75-12.62 DETAILS

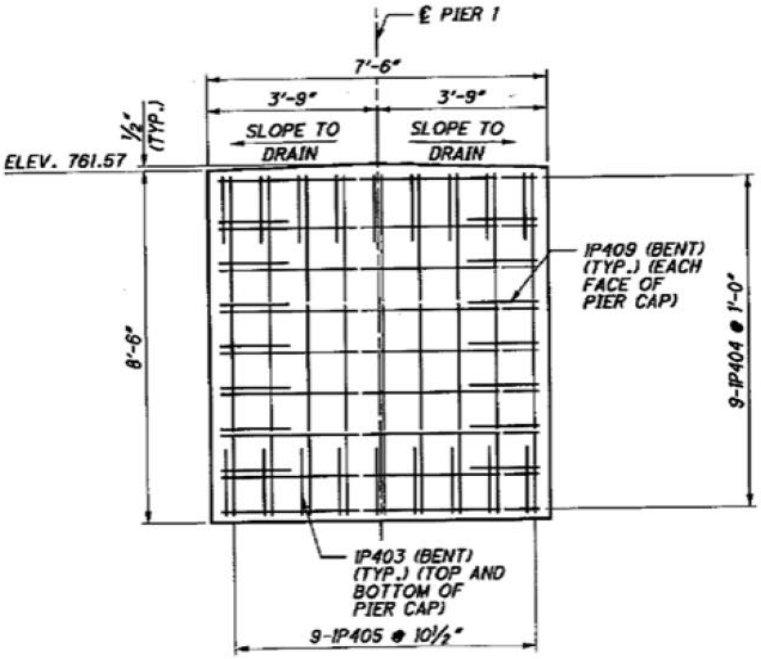


Figure 2 – General Cross-Section of the Cap

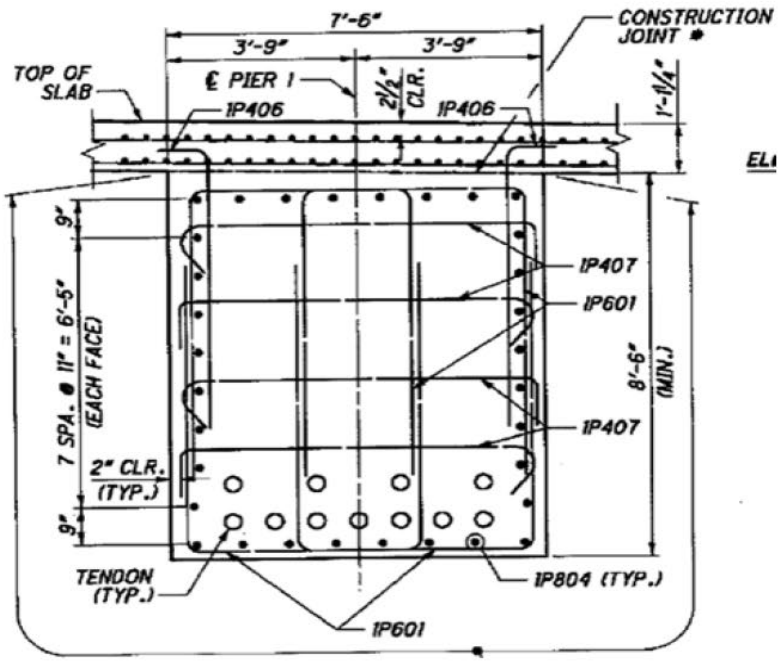


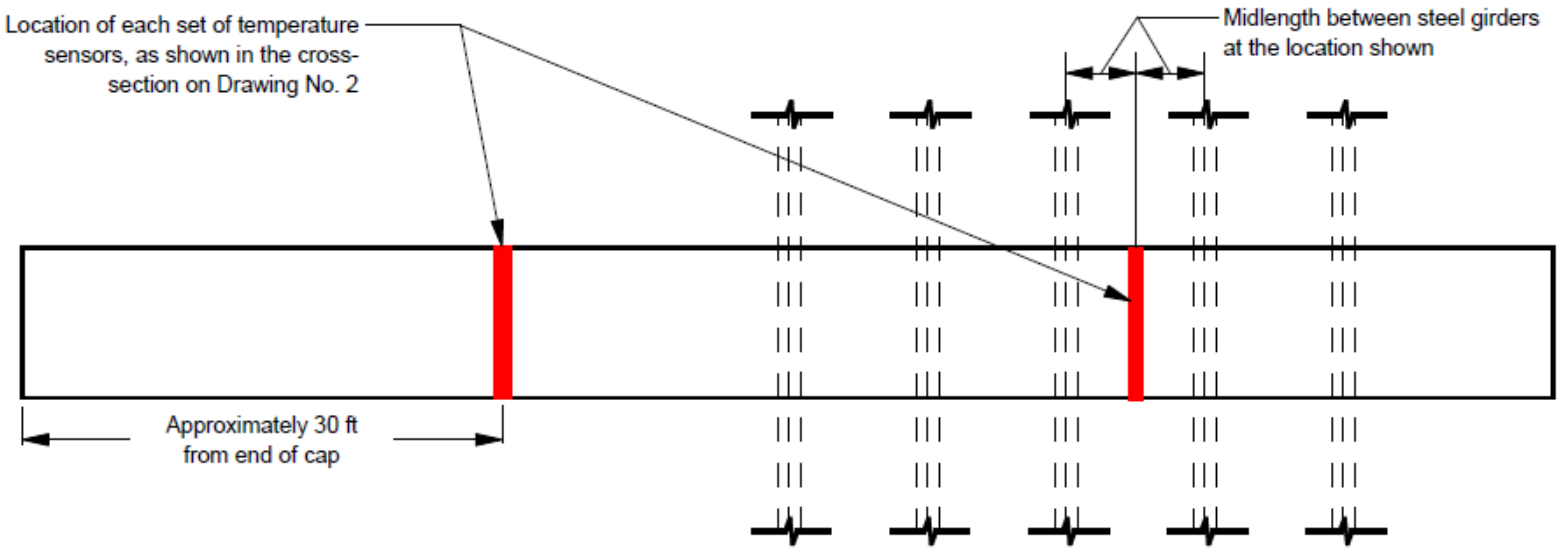
Figure 3 – Cross-Section of the Cap Below the Roadway Deck

MOT-75-12.62 REINFORCEMENT AND DUCTS

MOT-75-12.62 INSULATION ON BEAMS

MOT-75-12.62 DETAILS

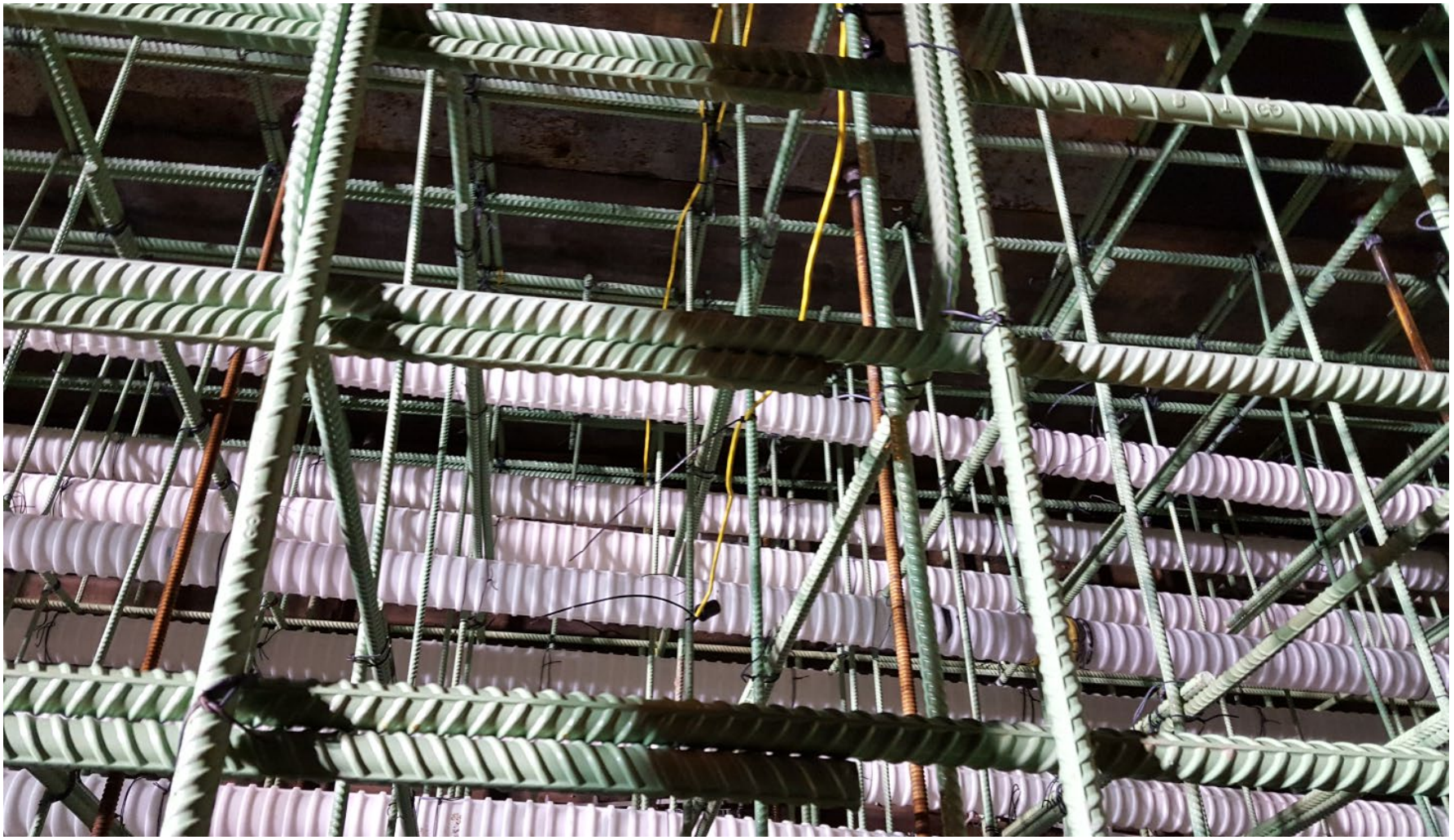
MOT-75-12.62 SENSOR LOCATION



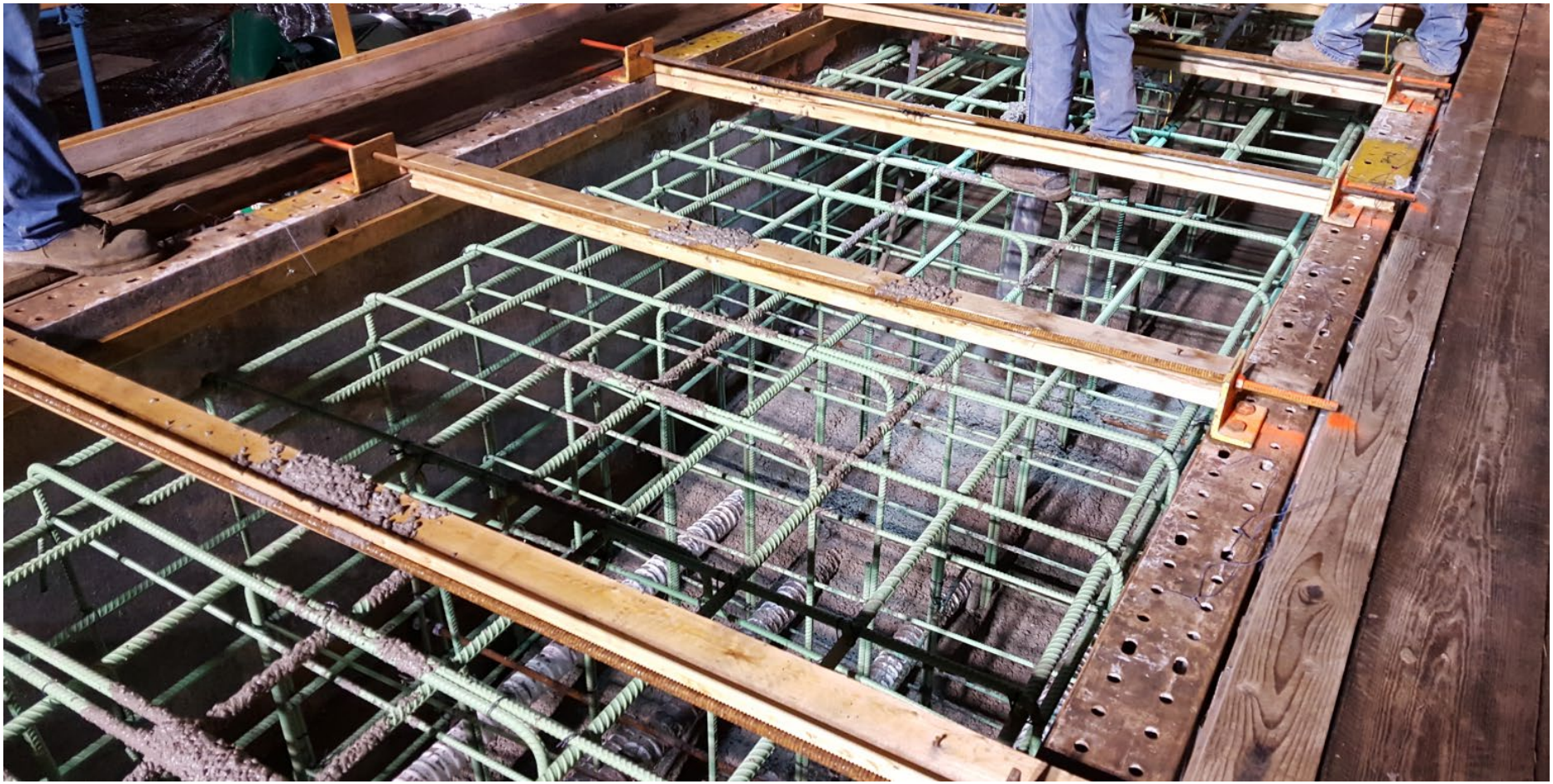
See Cross-Section on Drawing No. 2

Generalized Plan View Showing Temperature Sensor Locations in the Cap

MOT-75-12.62 SENSOR LOCATION



MOT-75-12.62



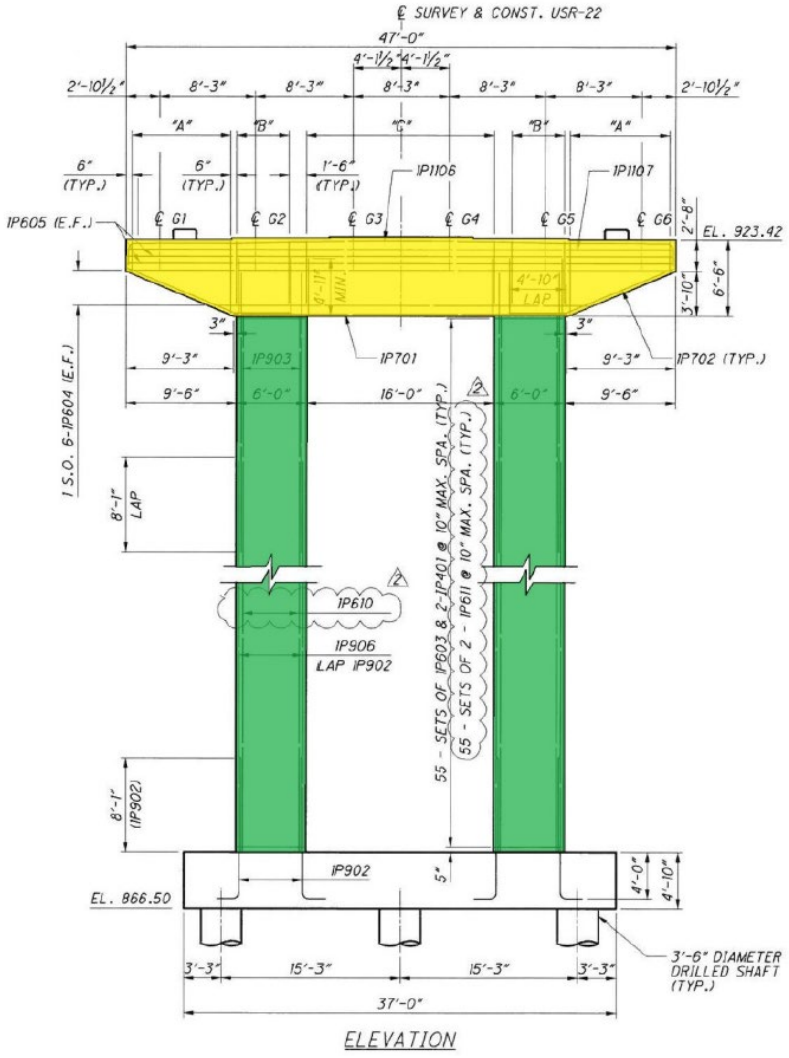
MOT-75-12.62

MOT-75-12.62

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’

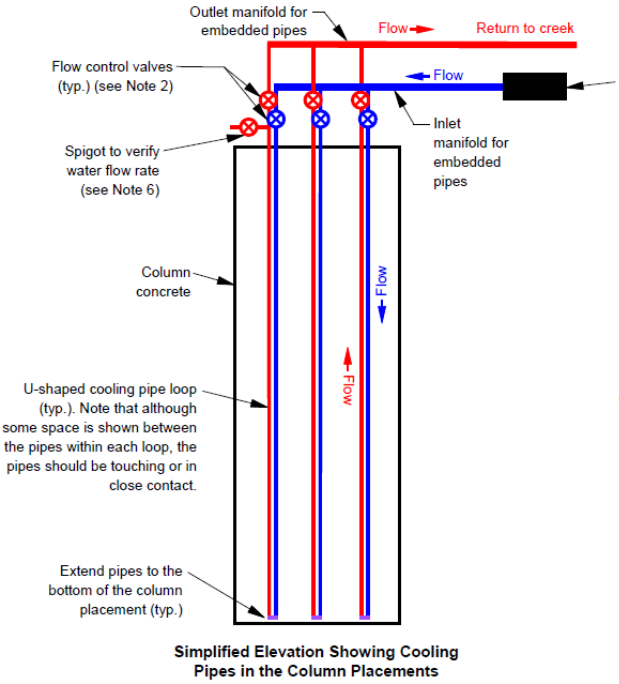
FAI-SR22-23.89 DETAIL



FAI-SR22-23.89 TCP

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

FAI-SR22-23.89 COOLING TUBE DETAIL

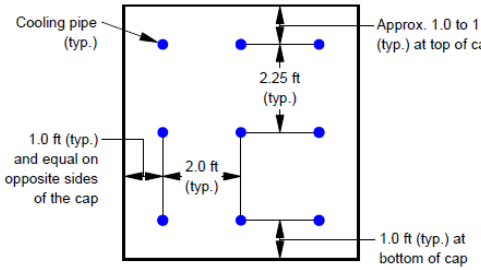


Simplified Elevation Showing Cooling Pipes in the Column Placements

Drawing No. 1 - Layout of the Cooling Pipe System

See Plan View on Drawing No. 2

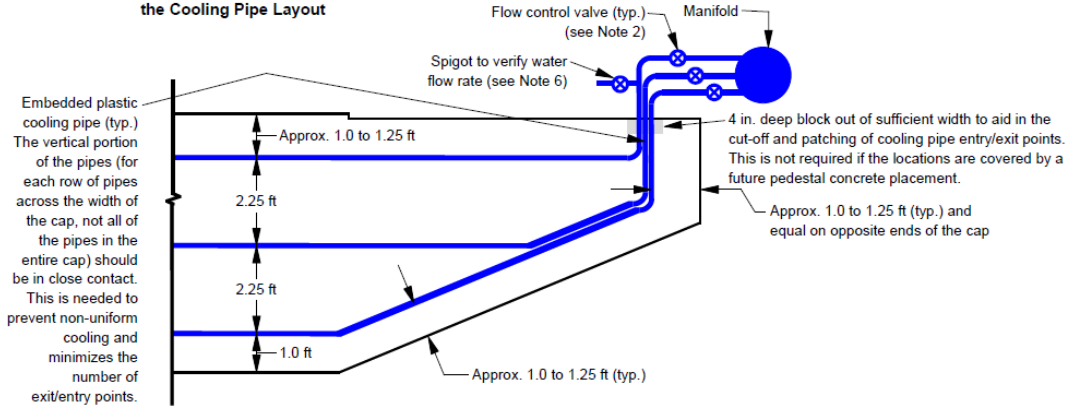
See Notes on Drawing No. 5



Cross-Section of the Cap Placement (at the Midlength of the Cap) Showing the Cooling Pipe Layout

See Plan View on Drawing No. 3

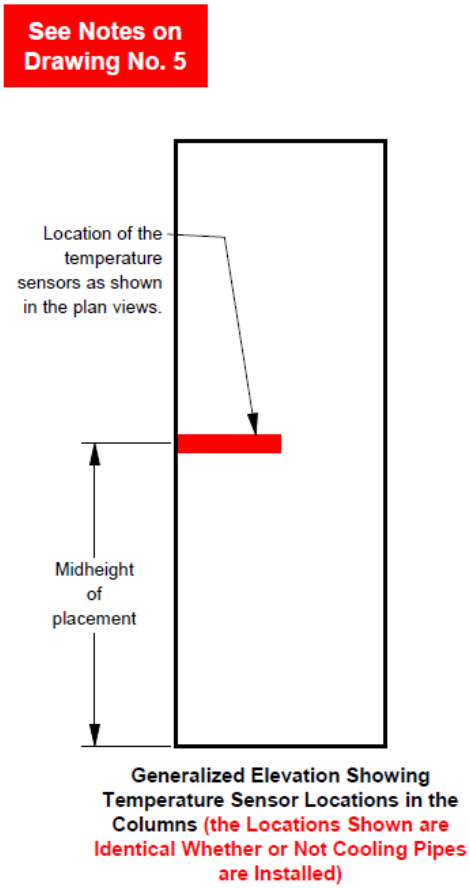
See Notes on Drawing No. 5



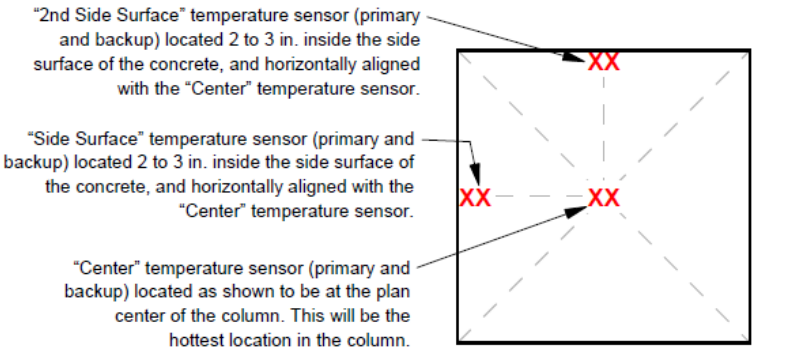
Partial Generalized Longitudinal Elevation of the Cap Placement Showing the 2x2.25 ft Cooling Pipe Layout

Drawing No. 4 - Details of the Cooling Pipe Layout in the Cap (Not to Scale)

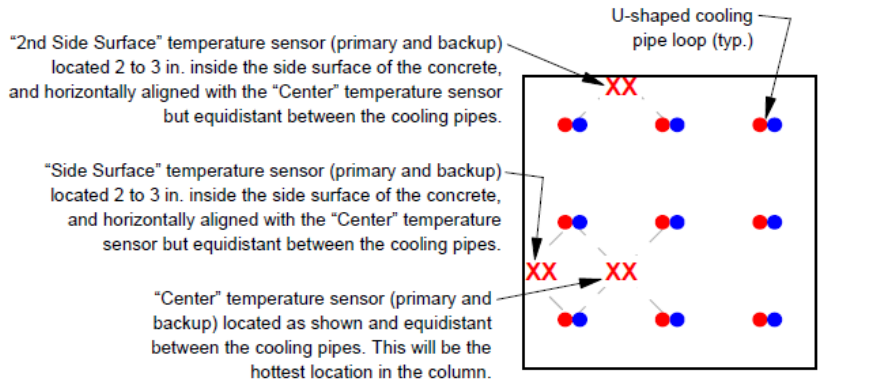
FAI-SR22-23.89 COOLING DETAIL (COLUMN)



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



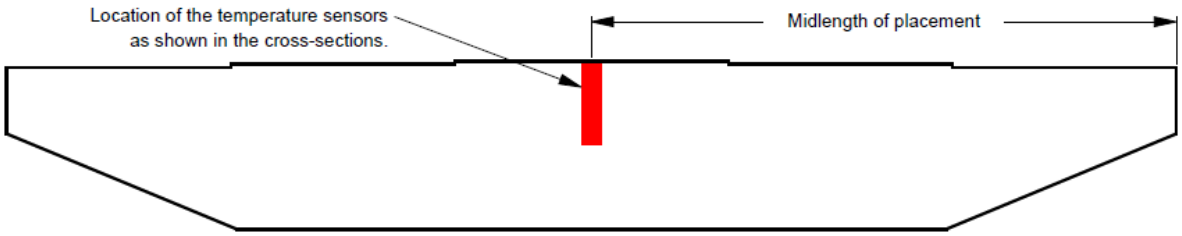
Plan View Showing Temperature Sensor Locations in the Columns when Cooling Pipes are Not Installed



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

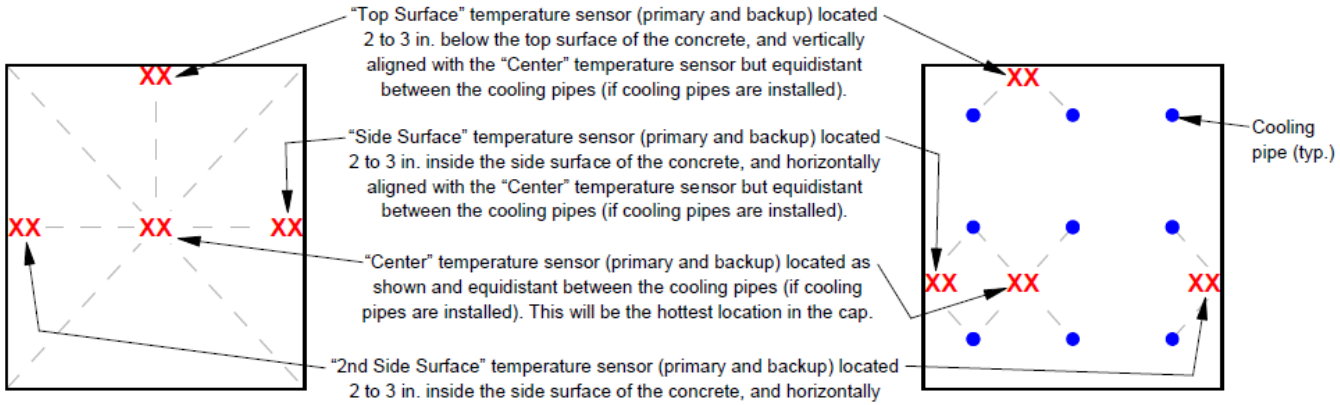
Drawing No. 6 - Temperature Monitoring System Layout in the Columns (Not to Scale)

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)

See Notes on Drawing No. 5



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)

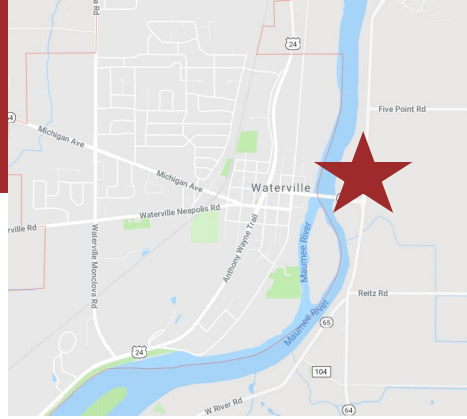
FAI-SR22-23.89 RUSHVILLE

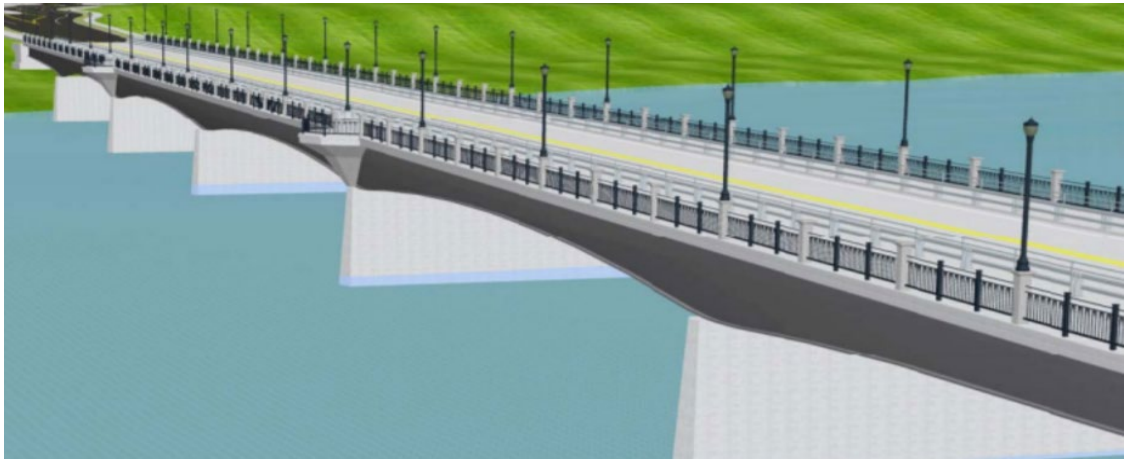
FAI-SR22-23.89 RUSHVILLE

FAI-SR22-23.89 RUSHVILLE

FAI-SR22-23.89 RUSHVILLE

LUC-SR64-12.03 WATERVILLE





LUC-SR64-12.03 WATERVILLE

LUC-SR64-12.03 WATERVILLE

LUC-SR64-12.03 WATERVILLE

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

QUESTIONS

Last updated 4/8/2019