



# I-74 Bridge Project

2017-2021





## I-74 Corridor Projects

- I-74 Main Span over Mississippi River
  - Lunda Construction (\$322M) (~100k Yards)
- I-74 WB Iowa Viaduct
  - Civil Constructors (\$30M) (~13k Yards)
- I-74 EB Iowa Viaduct
  - Civil Constructors (\$33M) (~10k Yards)
- Storm Sewer & Ramp D
  - Valley Construction (\$3M) (~500 Yards)
- I-74 Mainline to Middle Road
  - McCarthy Improvement (\$33M) (~20k Yards) \*Partially supplied by others
- I-74 Illinois Viaduct & Downtown Moline Improvements
  - Kramer North America (\$82M) (~40k Yards)
- I-74 Illinois Mainline Reconstruction
  - Walsh Construction (\$83M) (~80k Yards) \*Partially supplied by others
- 14<sup>th</sup> St Reconstruction
  - Langman Construction (\$2M) (~2k Yards) \*Supplied by others

## Prior Completed Projects

- I-74 & 53<sup>rd</sup> St Davenport Interchange (2012)
- Lincoln Road Bridge (2010)
- Downtown Bettendorf Reconstruction (2016) \*Done by others
- Moline River Drive Reconstruction (2015)



### Signature Project: I-74 Mississippi River Crossing



### Existing Crossing



### Existing Crossing



### Bridge Replacement Project

#### Existing Structures

- Twin Suspension Bridges
- Built 1935 & 1960
- 2 Lanes Each Direction
- 24' Deck Width (each)

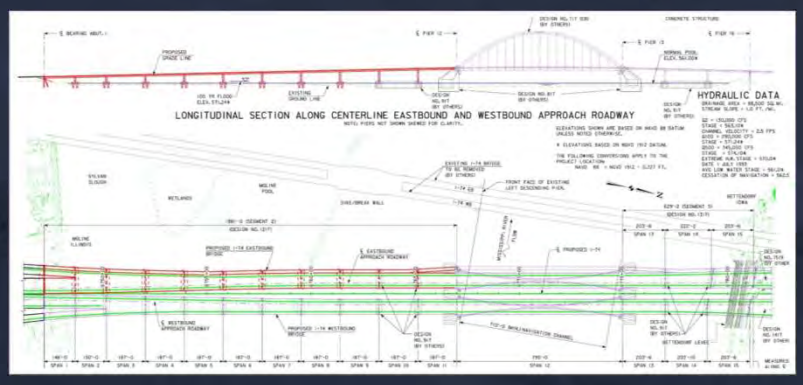


#### Replacement Structures

- Twin Arch Bridges
- Built 2020 & 2021
- 4 Lanes Each Direction
- 72' Deck Width (each)
- 14' Multi-use Trail



### Bridge Replacement Project



### Site Considerations – Access



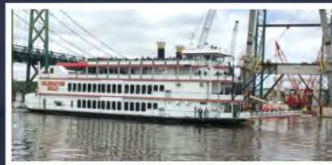
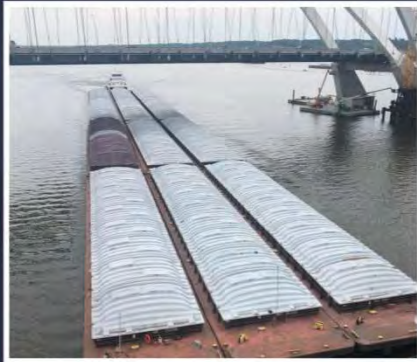
### Site Considerations – River Conditions (Ice)



### Site Considerations – River Conditions (Flood)



## Site Considerations – Commercial Navigation



## Site Considerations – Environmental

### 150181b.01 DESCRIPTION.

A. The work under this contract is located in an environmentally sensitive area within the Mississippi River (the River). This work has the potential to impact state and federally threatened and endangered mussels living in the River thus requiring areas in the river to be designated as Environmentally-Sensitive Areas (Restricted Access) [ES Areas]. No disturbances to the river bed no propulsion, no propellers or motorized vehicles will be allowed in ES Areas. The ES Areas are shown as red hatched areas in Figures 1 and 2.



## Bridge Replacement – Concrete Elements

### Substructure

- Abutments
- Drilled Shafts
- Approach Piers
- Arch Piers

### Superstructure

- Deck
- Overlay
- Barrier
- Trail



## Bridge Replacement – Plan Concrete Quantities

### Plan Quantities

- Abutments ≈ 550 CY
- Drilled Shafts ≈ 11,150 CY
- Approach Piers ≈ 25,400 CY
- Arch Piers ≈ 22,800 CY
- Deck, Trail, Overlay ≈ 19,150 CY
- Barrier ≈ 1,950 CY

### Incidental Quantities

- Footing Seals, Tub Seals

### As-placed Quantities

- Total ≈ 100,000 CY



## Concrete Elements – Abutments

### 2 Total $\approx$ 550 CY

- South (Illinois) bridge end only
- Concrete
  - Footing
  - Backwall
  - Slope Protection
  - Wings
  - Wall Face
- North (Iowa) bridge end ties to land viaduct, no north abutment.



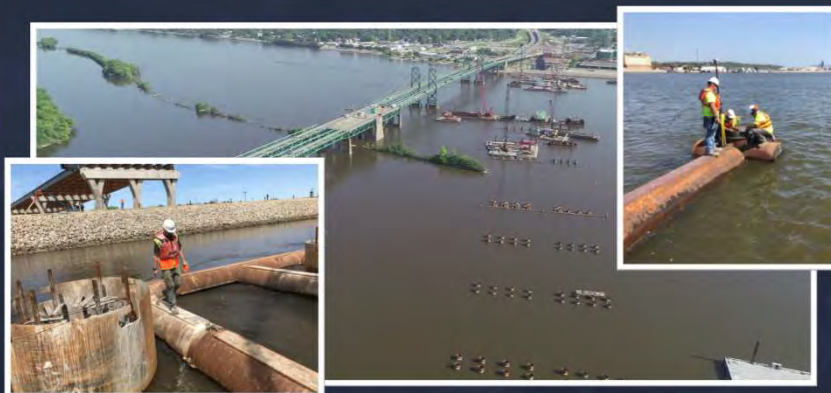
## Concrete Elements – Drilled Shafts

### 239 Total $\approx$ 11,150 CY

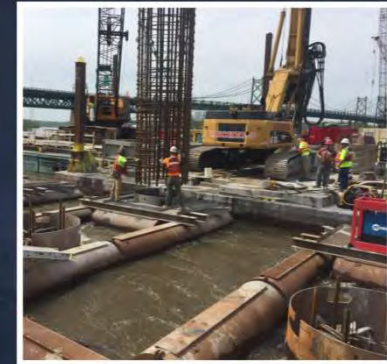
- 37 Arch Shafts
  - 10' Diameter
  - $\approx$  27.5' Length,  $\approx$  80 CY ea.
- 196 Approach Shafts (Water)
  - 7' Diameter
  - $\approx$  27.5' Length,  $\approx$  39 CY ea.
- 6 Approach Shafts (Land)
  - 9.5' Diameter
  - $\approx$  33' Length,  $\approx$  87 CY ea.



## Drilled Shafts – Layout



## Drilled Shafts - Construction



### Concrete Elements – Approach Piers

**26 Total ≈ 25,400 CY**

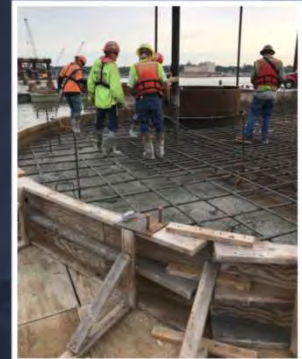
- Aesthetic "Reflection" Piers
- Footings
  - 42 @ ≈ 772 CY ea.
- Columns
  - 85 @ ≈ 42 CY ea.
- Caps
  - 27 @ ≈ 122 CY ea.



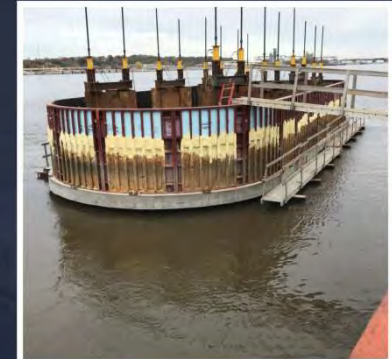
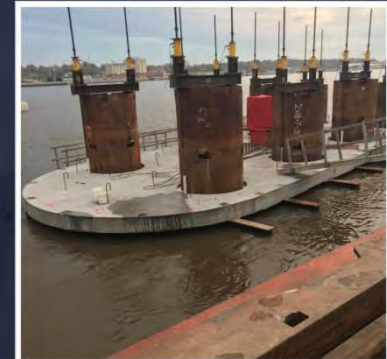
### Approach Piers – Layout



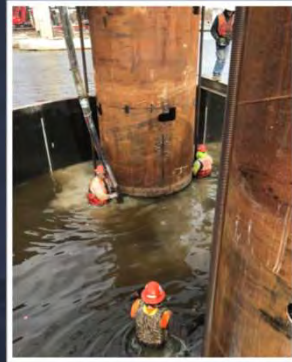
### Approach Piers – Tub Form



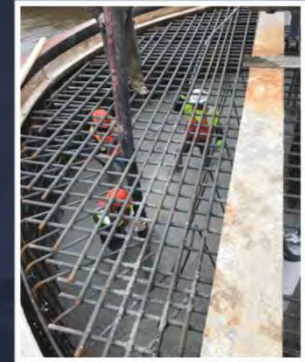
### Approach Piers – Tub Form



### Approach Piers – Submerge & Seal Forms



### Approach Piers – Footing Construction



### Approach Piers – Column Construction



### Approach Piers – Reflection Aesthetic

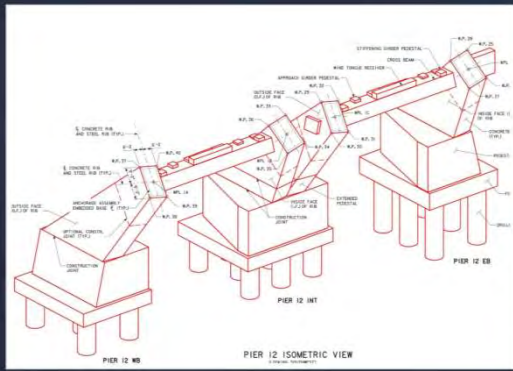




### Concrete Elements – Arch Piers

**6 Units ≈ 22,800 CY Total**

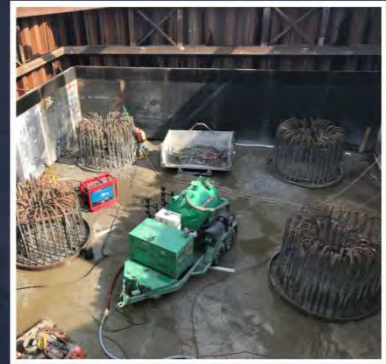
- Seal Slabs
  - 6 @ ≈ 922 CY
- Footings
  - 6 @ ≈ 1454 CY
- Pedestals
  - 2 @ ≈ 529 CY
- Extended Pedestals
  - 2 @ ≈ 529 CY
- Arch Ribs
  - 8 @ ≈ 907 CY
- Cross Beam (Post-Tensioned)
  - 2 @ ≈ 65 CY



### Arch Piers – Cofferdam



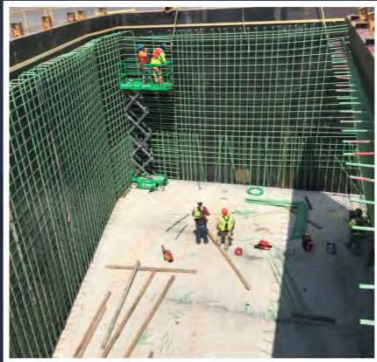
### Arch Piers – Seal Slab



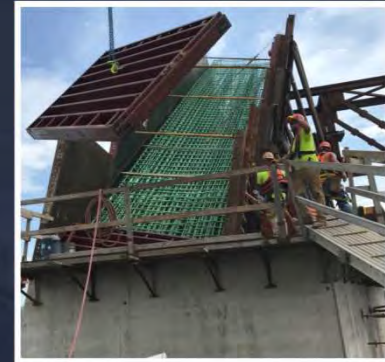
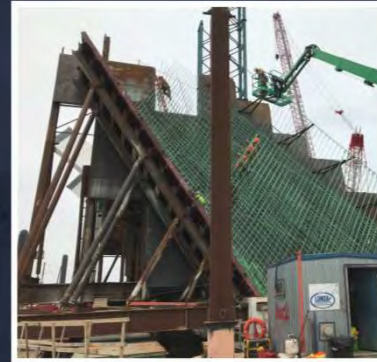
### Arch Piers – Footing



### Arch Piers – Pedestal



### Arch Piers – Rib



### Arch Piers



### Concrete Elements – Deck

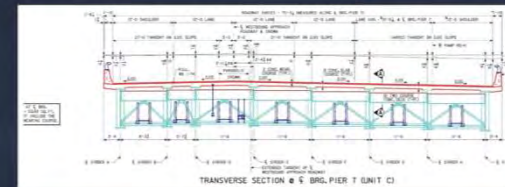
#### Westbound

- 4 lanes @ 12'
- 2 shoulders @ 12'
- 72' nominal roadway width

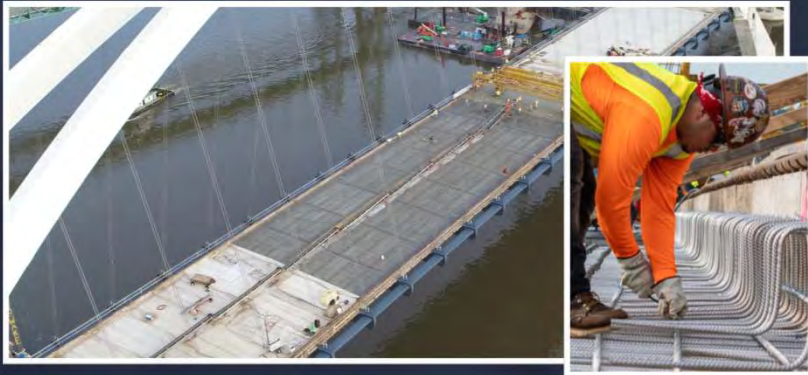
#### Eastbound

- 4 lanes @ 12'
- 2 shoulders @ 12'
- 72' nominal roadway width

**100% Stainless Reinforcing**



## Deck



## Deck



## Concrete Elements – Overlay

### 2-course deck, by design

- Plan requirement for full length
- 8" base + 2" overlay
- Sacrificial/Replaceable wearing surface

### 1-course deck, by request

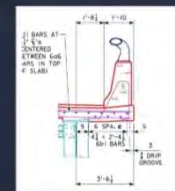
- Contractor request, approved for partial length
- 10" single course
- Wearing surface can be removed by grinding



## Concrete Elements - Barrier Rail

### 14,650 LF ≈ 1,950 CY

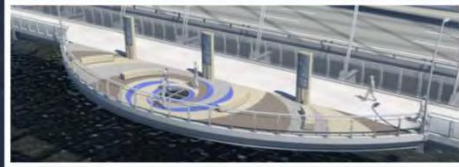
- Combined shape, concrete & steel
- Concrete base, safety shape
- Steel tube upper rail



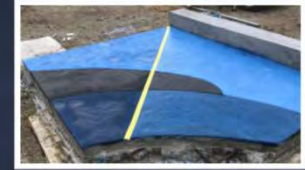
### Concrete Elements - Trail

#### 14' Multi-Use Trail

- Rare for Interstate Bridge
- Connects to Robust Community Trail System & Riverwalk
- Bettendorf, IA to Moline, IL
- Pedestrian Overlook
- See-Thru Glass Oculus
- Identity Elements & Aesthetic Treatments



### Trail – Construction Progress & Mockups



### Trail – Pedestrian Elevator



### I-74 Mississippi River Crossing



## I-74 Mississippi River Crossing



## Challenges



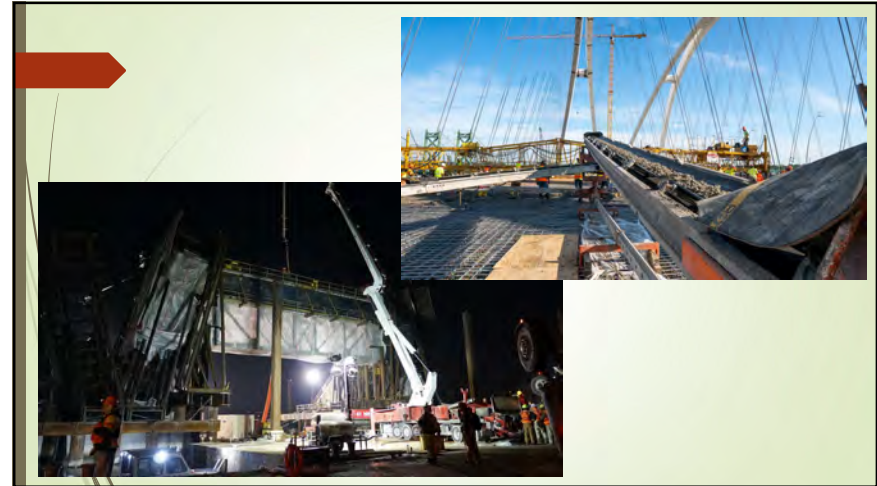
## Barging

- Up to two hours on the water before placement
- Increased truck demand
- Safety Concerns
- Driver Concerns
- River Levels
- Insurance

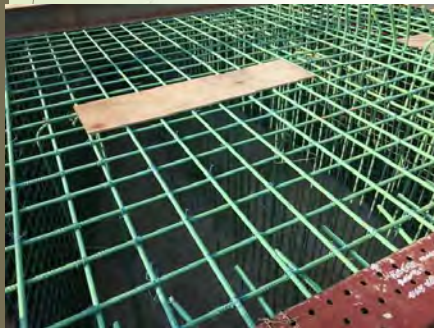


## Pumping/Conveying

- Correlations required for Slump/Spread/Air on many pours
- First load of SCC
- Often, large slump or air loss through the pump
- Inconsistencies based on boom angle
- Double or Triple Pumping



## Mass Concrete



## Mass Concrete Specifications

- Concrete with a least dimension of 4' or greater.
- Thermal Control Plan for concrete with a least dimension of 6.5' or greater
- 70 degree max concrete temp, Mass Concrete Plan governs, however.
- Internal curing temperature not to exceed 160 degrees.
- Temperature differential between interior of section and outside surface not to exceed:
  - 20 degrees over the first 24 hours
  - 30 degrees between 24-48 hours
  - 40 degrees between 48-72 hours
  - 50 degrees after 72 hours
- No cooling tubes used (contractor choice)
- 70% GGBFS Slag mixes utilized to reduce heat generation during curing process.
  - Adiabatic Heat Testing to determine best SCM options
- Initial concrete temp lowered using liquid nitrogen & chilled water.

## Liquid Nitrogen

- 2017/2018 – Direct addition of nitrogen to the rear of the mixer truck
  - Lots of Supply Issues
  - Time Consuming
  - Cracking mixer drums
  - Visibility Issues
  - Cost Effective
  - Significant air content growth on SCC mixes
- 2019-2021 – Addition of nitrogen to aggregates on the charge belt of the plant
  - Less total cooling capacity
  - Freezing gates on the plant
  - Destroying the belt on the plant
  - Visibility Issues
  - Much Quicker
  - Much Safer

## Liquid Nitrogen Direct Injection



## Liquid Nitrogen Belt Addition





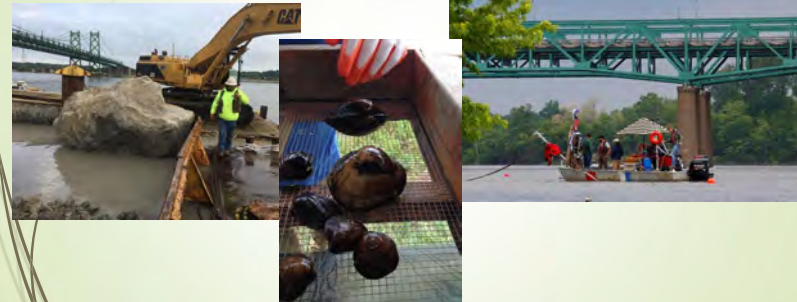
## Specification Issues

- Air content in Drilled Shafts under the River
- Mass Concrete Requirements on C-Mixes
- Mass Concrete & SCC Dissonance
- Slump Requirements on Bridge Decks
- Simultaneous Multiple DOT Specs
  - IL & IA Approved Materials, Different Mix Designs, Different Specifications.

## Coordination

- Some Contractors very flexible, organized and cooperative.
- Others not so much.
- Sometimes 3 Bridge Deck pours in a day.
- Multiple pours with multiple contractors on multiple projects nearly every day.
  - Driver & Quality Control Staffing Issues
- Major impact on existing customer base.
- Logistics for multiple day pours, overnight pours, etc.
- DOT paperwork was often confusing and overwhelming due to the multitude of individual contractors and projects.

## Construction Process Excavation & Mussel Relocation





## Drilled Shafts



## Drilled Shaft Mix Design & Specifications

- Mix Design: D-57-C15
- 709lbs Cementitious
- 15% Fly Ash
- No Mass Concrete Requirements
- 4500psi Specified Strength... Avg Strength ~6500psi
- .45 w/c Ratio Limit
- 9" Slump Target
- 3/8" Nominal Max Agg Size
- 5.5% -8.5% Air 🙄
- Recover (hydration stabilizer) up to 6oz/hwt for long pours

## Seal Slabs



## Seal Slab Mix Design & Specification

- Mix Design: X-4-C15
- 709lbs Cementitious
- 15% Fly Ash
- No Mass Concrete Requirements
- 3500psi Specified Strength
- 6" Slump Target
- 3/4" Nominal Max Agg Size
- No Air requirement
- 100-600cy placements

## Footings



## Footing Mix Design & Specifications

- Mix Design: C-3WR-S70
- 571lbs Cementitious (Much too high)
- Began Project with 50% GGBFS, adjusted to 70% early on
- Mass Concrete Specifications Applied
- 3500psi Specified Strength.. Avg Strength ~5500psi
- .45 w/c ratio limit
- Target Slump 6"
- 3/4" Nominal Max Agg Size
- 5.5%-8.5% Air
- Max 65 Degree Concrete Temperature
- 600-1000cy Pour sizes

## Pedestals



## Pedestal Mix Design & Specifications

- Mix Design: C-3WR-S70
- 571lbs Cementitious
- 70% GGBFS
- Mass Concrete Specifications Applied
- 3500psi Specified Strength.. Avg Strength ~5500psi
- .45 w/c ratio limit
- Target Slump 6"
- 3/4" Nominal Max Agg Size
- 5.5%-8.5% Air
- Max 55 Degree Concrete Temperature
- 1200-2500cy Pour sizes

## Architectural Columns



## Column Mix Design & Specifications

- Mix Design: SCC-675
- Started with 725lbs cementitious, adjusted to 675lbs cementitious
- Started with 10% Ash & 40% GGBFS, adjusted to 70% GGBFS
- Mass Concrete Specifications Applied
- 5000psi Specified Strength... 9000-12000psi strengths
- .42 w/c ratio limit.. Normally placed .35-.37
- 25-27" Spread
- 5.5%-8.5% Air
- VSI not to exceed 1
- J-Ring test within 2", Static Segregation limit 15%
- Max 60 degree concrete temperature
- Optimized aggregate proportioning



## SCC



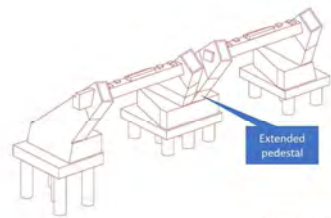
## Pier Caps



## Pier Cap Mix Design & Specifications

- Mix Design: HPC-S-S50
- 624lbs Cementitious
- 50% GGBFS
- Mass Concrete Specifications Applied
- 4500psi Specified Strength.. Avg Strength ~6500psi
- .45 w/c ratio limit
- Target Slump 6-8"
- 3/4" Nominal Max Agg Size
- 5.5%-9.5% Air
- Max 60 Degree Concrete Temperature

## Arch Ribs



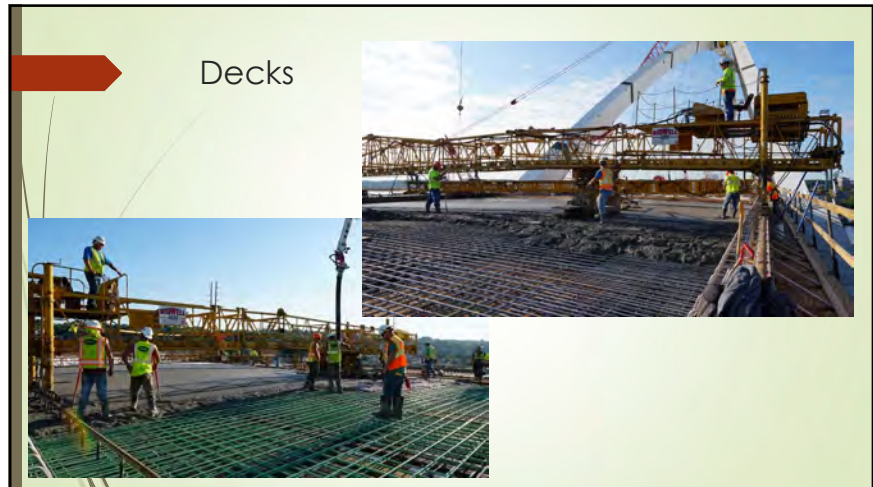
## Arch Rib Mix Design & Specifications

- Mix Design: SCC-675
- 675lbs cementitious
- 70% GGBFS
- Mass Concrete Specifications Applied
- 7500psi Specified Strength... 9000-12000psi strengths
- .42 w/c ratio limit.. Normally placed .35-.37
- 25-27" Spread
- 5.5%-8.5% Air
- VSI not to exceed 1
- J-Ring test within 2", Static Segregation limit 15%
- Max 55 degree concrete temperature
- 350-850cy Pour Sizes
- Optimized aggregate proportioning
- A combination of the toughest requirements for SCC, mass, barging, cooling & pour sizes

## Arches



## Decks



## Bridge Deck Mix Design & Specifications

- Mix Design: HPC-D-C15-S30
- 624lbs Cementitious
- 15% Fly Ash, 30% GGBFS
- Evaporation Rate Specifications Applied... .1 to start, .15 limit
- 575psi flexural strength requirement... avg strengths >700psi
- .42 w/c ratio limit
- Maximum Slump 5"
- 3/4" Nominal Max Agg Size
- 5.5%-8.5% Air
- Recover from 1oz/hwt to 12oz/hwt
- Maximum concrete temperature determined by evap. rate & set times
- 100-900cy Placements

## Barrier Rail



## Barrier Rail Mix Design & Specifications

- Mix Design: BR-C15-S20
- 603lbs Cementitious
- 15% Fly Ash, 20% GGBFS
- 4500psi Strength Requirement
- .40 w/c ratio limit
- Maximum Slump 1.5"
- Optimized aggregate proportioning
- 5.5%-8.5% Air
- Fibers for slump control

## Paving



## Paving

- Mix Design: QMC
- 560lb Cementitious
- 15% Ash 20% Slag
- 575 Flexural Strength Req.
- .45 w/c ratio limit
- Maximum 4" Slump
- Optimized 3-Aggregate Proportioning
- 6-10% Air in front of Paver
- Mostly done in Dump Trucks
- Up to 1600cy placements

## Bridge Deck Overlay

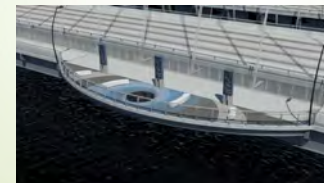


## Bridge Deck Overlay

- Mix Design: HPC-O-C15-S25
- 709lbs Cementitious
- 15% Fly Ash, 25% GGBFS
- Evaporation Rate Specifications Applied... .1 to start, .15 limit
- 575psi Flexural Strength Requirement
- .42 w/c Ratio Limit
- Maximum Slump 5"
- Special 1/2" Bridge Deck Chip
- 5.5%-8.5% Air
- Maximum Concrete Temperature Determined by Evap. Rate & Set Times

## Decorative Concrete

- Mix Design: HPC-O
- No Ash Mix
- Special 1/2" Bridge Deck Chips
- 3 Integral Colors" Black, Blue 1, Blue 2
- White Portland used with Blue 2
- \$1400-\$2800/yard for the blue color



Hahn Ready Mix Total Yards Delivered

44 Mix Designs

212,152.25 cy to 15 Contractors

Questions?



Visit [i74riverbridge.com](http://i74riverbridge.com) for more pictures and information

