UHPC Bridge Overlay

Presented By Logan Wells

Typical Iowa DOT overlay

- 1970's Iowa DOT
- Low Permeability
- More Durable
- Low Slump
- Stiffer and more difficult to place

UHPC Overlay

Possible Benefits	Possible Difficulties
Lower Permeability	Unfamiliar
Fiber Crack Control	Composite Action/Bond
Strengthening	Cost
Durability	Mixing
	Material Flows – Placing and Finishing
	Grinding and Grooving

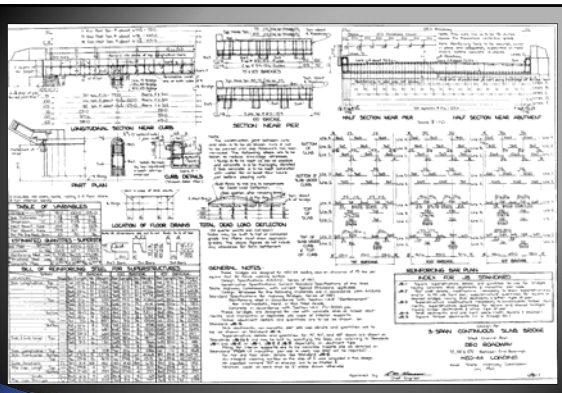
Mud Creek Objectives

- Evaluate constructability on superelevation
- Test UHPC overlay durability as a maintenance application.
- Predict bridge strength improvements (Can HL-93 Loading be accommodated?)
- Research building block

The Original Bridge

- Built in 1967
- 3 span Continuous Concrete Slab Bridge
- 0° Skew
- 5% Superelevation
- Located 2.25 miles West of Brandon on Laporte road over Mud Creek

Location

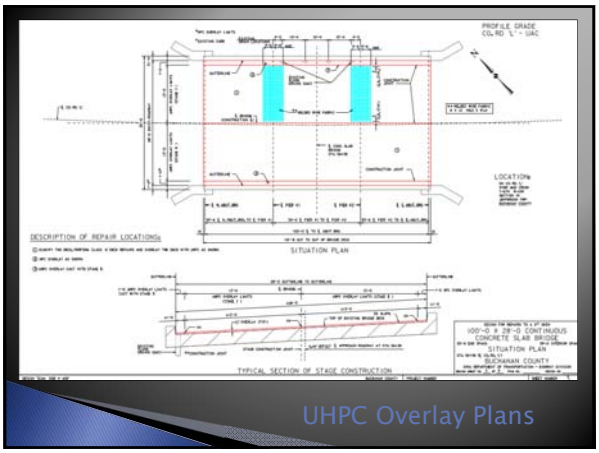


Original Bridge Plans

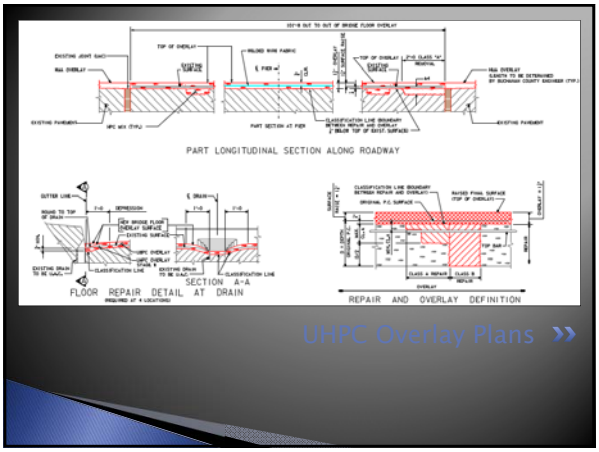
Original Bridge Characteristics			
Dimensions		**Properties**	
Roadway Width (ft)	28	Concrete Compressive Strength (ksi)	3
Out to Out Width (ft)	30	Rebar Grade (ksi)	40
Original Concrete Thickness (ft)	1.47	Concrete Modulus of Elasticity (ksi)	3300
Total Length Length (ft)	100	Steel Modulus of Elasticity (ksi)	29000
Exterior Span Length (ft)	30.5		
Interior Span Length (ft)	39		

Repair and Overlay Description

- Repair patches use standard HPC
- UHPC mix provided by Lafarge North America
- Welded wire fabric (6x12-W8.5xW1.4) only placed over piers in one lane
- Mockup for testing by Iowa State
- Class A removal west abutment (Typical)
- No Class A removal on east abutment



UHPC Overlay Plans



UHPC Overlay Plans

Bridge Overlay Characteristics			
Dimensions		Properties	
Grinding depth (in)	0.25	UHPC Compressive Strength (ksi)	20
Overlay Thickness (in)	1.5	UHPC Tensile Strength (ksi)	0.9
Surface Raise (in)	1.25	UHPC Modulus of Elasticity (ksi)	8000
		WWF Strength (ksi)	65
		WWF Modulus of Elasticity (ksi)	29000

Negative Moment Capacity

Increase amount of material available to resist tension

- UHPC
  - Cracking & Strain Limit
  - Tensile Strength
  - Concrete Interface
- Welded Wire
  - Over Piers
  - WWF engaged?
  - Substantial Crack Control?
- 31% increase

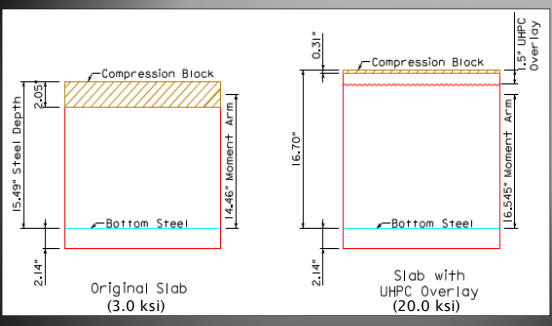
Figure 4. Graph. Tensile stress-strain response of UHPC[17]

Graybeal, B., Perry, B., And Royce, M., "UHPC Ultra-High Performance Concrete," NHI Innovations Webinar, November 18, 2010. Available at https://connectdot.connectsolutions.com/n124083201011 [Cited May 5, 2016]

Positive Moment Capacity

Increase moment arm for positive moment capacity

- Smaller compression block due to higher compressive strength
- Greater depth of Steel
- 16% increase



Slab Positive Moment Arm

Can HL-93 Load be Carried?

- Yes!
- …and No.

Cut Off Requirement Issues

- Less strict requirements in past
- Negative Moment manageable
- Positive Moments require different methods
- Iowa DOT rating policy under old codes

Moving Forward

- Is a 1.5 inch thickness appropriate?
- How can we be certain the mesh is engaged?
- Can HL-93 loading be proven?
- Can a economic and durable shear interface be achieved?
- Is the UHPC overlay viable with staged construction and associated traffic vibrations?

Questions?