



UHPC in Iowa

Presented by:
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Overview

- UHPC / Ductal®
- Preliminary work
- Wapello Co Project
- Buchanan Bridge Project
- Future projects

A spiral-bound notebook with a brown cover and a white page. The spiral binding is on the left side. The text "UHPC / Ductal®" is printed in the center of the page.

UHPC / Ductal®

UHPC Development

- France in 1990's
- Industrial and Commercial Projects (France, Canada, United States)
- Pedestrian Bridges (Canada, Japan, Korea, France)
- Highway Bridges (France, Australia, United States)

Bridges

- Sherbrooke Bridge, Quebec, Canada
- Footbridge of Peace, Seoul, South Korea
- Sakata Mirai Footbridge, Sakata, Japan
- Two Highway Overpasses, Drome Region, France
- Shepherds Highway Bridge, Sydney, Australia
- Cat Point Highway Bridge, Virginia DOT

What is UHPC / Ductal®?

- High performance cement based material
- Finely graded, silica fumes (glass), cement, fine sand, water, superplasticizer, and fibers
- Metallic or organic fibers (2% by volume)
- Steel Fibers (0.008 inches x 0.5 inches)
- Largest aggregate (fine sand 0.024 inches)
- W/C ratio 0.15-0.20

Ductal®



Why UHPC?

- High compressive strength
- High durability
- Low permeability
- Fibers (removal mild reinforcement)
- After curing (stable, minimal creep and shrinkage)
- More efficient sections

Properties?

- Compressive strength = 18-33 ksi.
- Tensile strength = 1.1-1.6 ksi
- Flexural strength = 4-7 ksi.
- Final modulus of elasticity = 7,800 ksi
- Density (Steel Fibers) = 0.156 kips/ft³

Why Ductal® ?

- Available in the U.S.
- Testing by FHWA

A spiral-bound notebook with a brown cover and a white page. The spiral binding is on the left side. The text "Preliminary Work" is written in a black serif font in the center of the page.

Preliminary Work

A silver metal spiral binding is visible on the left side of the page, looping through a series of holes in the paper.

**VIDEO OF CYLINDER TEST
NO FIBERS**

A silver metal spiral binding is visible on the left side of the page, looping through a series of holes in the paper.

VIDEO OF FLEXURE TEST

Test Mixes at Iowa DOT Lab

(12-11-03, 1-26-04)

- Hands on DOT Materials Lab
- 1 cubic ft mix
- 3" x 6" cylinders
- 4" x 4" beam
- 2" x 2" cube

Test Mix Proportions

Test Mix Proportions	
Description	Quantity
Ductal Mix	137 lbs
Water	8.03 lbs
3000NS (Super Plasticizer)	850 g
Steel Fibers	9.7 lbs

Mixing UHPC



Test Cylinders



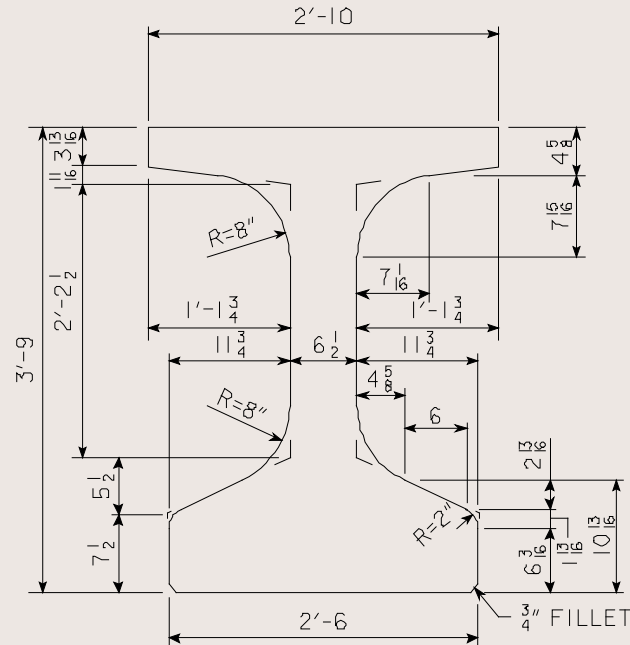
Results of Second Test Mix (95% Humidity)

2 inch cubes	Compressive Strength (psi)
1	29,930
2	27,540
3	30,610

Wapello Co Project

- Beam Design (Summer/Fall 2004)
- Test Beam (Cast Feb 2005)
- Bridge Beams (Cast June/July 2005)

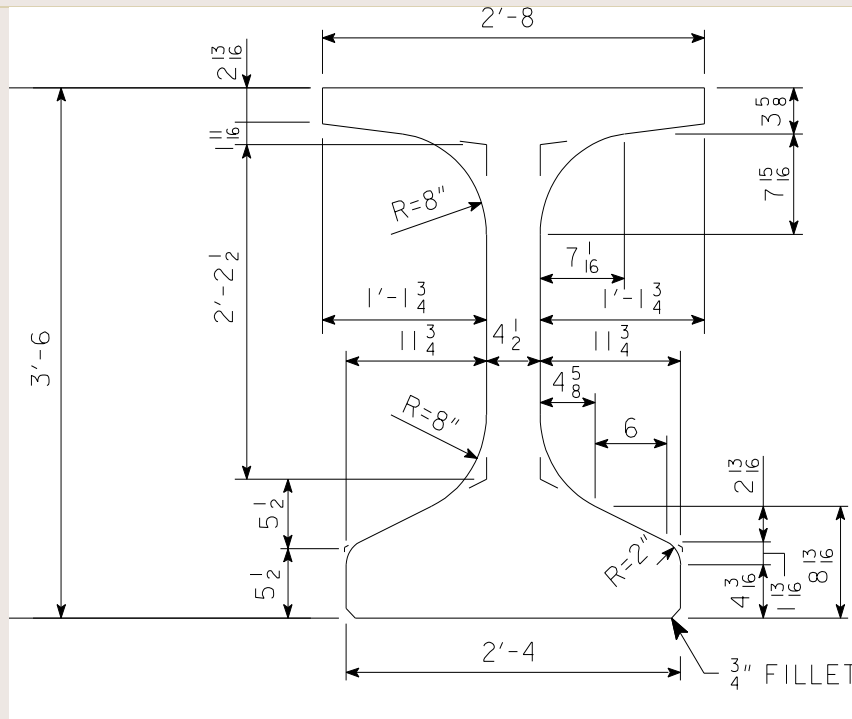
Iowa 45 in BTC



$$A = 691.8 \text{ in}^2, y_b = 20.74 \text{ in}, I = 178,971 \text{ in}^4$$

$$\text{UHPC } 19.8 \text{ yd}^3$$

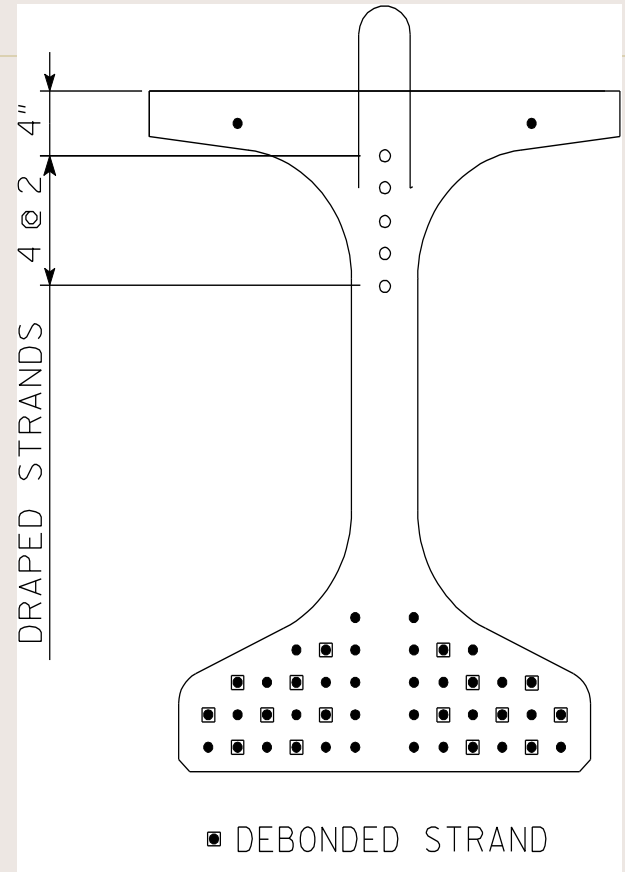
Summary of Section



Sec reduced 1" top, 2" bottom, 2" web

$$A = 512.3 \text{ in}^2, y_b = 18.72 \text{ in}, I = 123,654 \text{ in}^4$$

73.7 % ~ UHPC 14.6yd³



49 – 0.6" Dia. strands

5 draped, 16 debonded,
72.6% GUTS

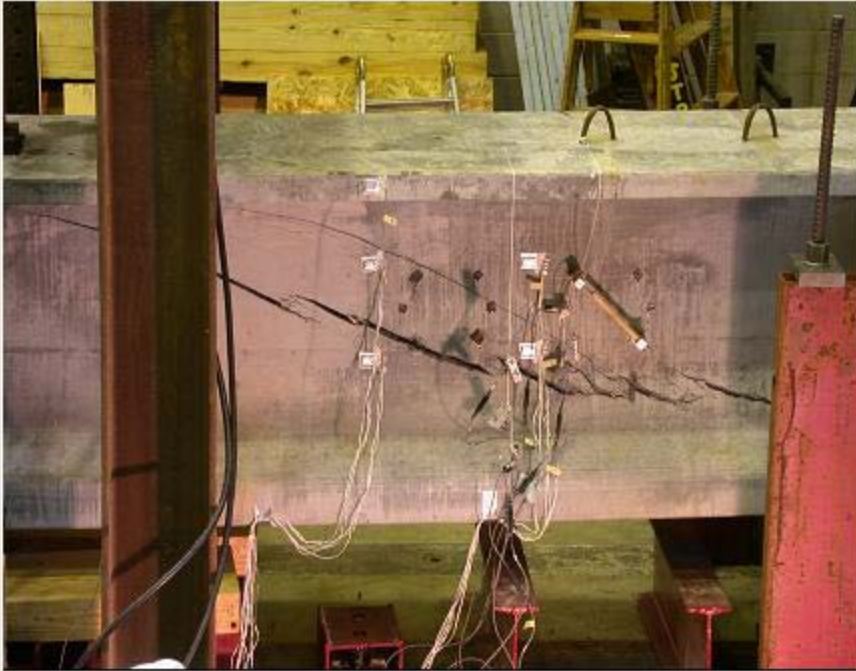
ISU Test Program

- Compression of Cubes
- Flexure of Prisms
- Large-Scale Beam (71 ft)
 - Flexure Test
 - Shear Test
 - Flexure-Shear Test
- Small-Scale Beams (Shear test)

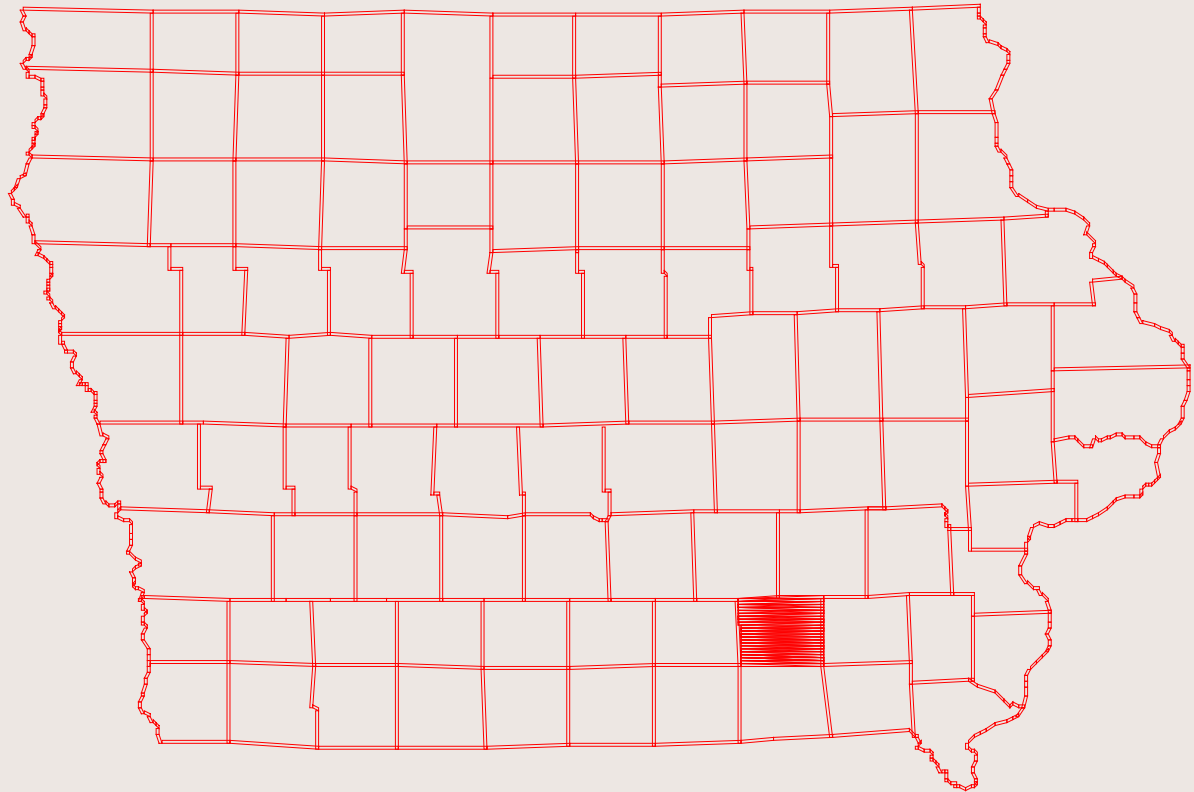
A spiral-bound notebook with a brown cover and a white page. The spiral binding is on the left side. The text "VIDEO OF SHEAR TEST" is centered on the page in a bold, black, serif font.

VIDEO OF SHEAR TEST

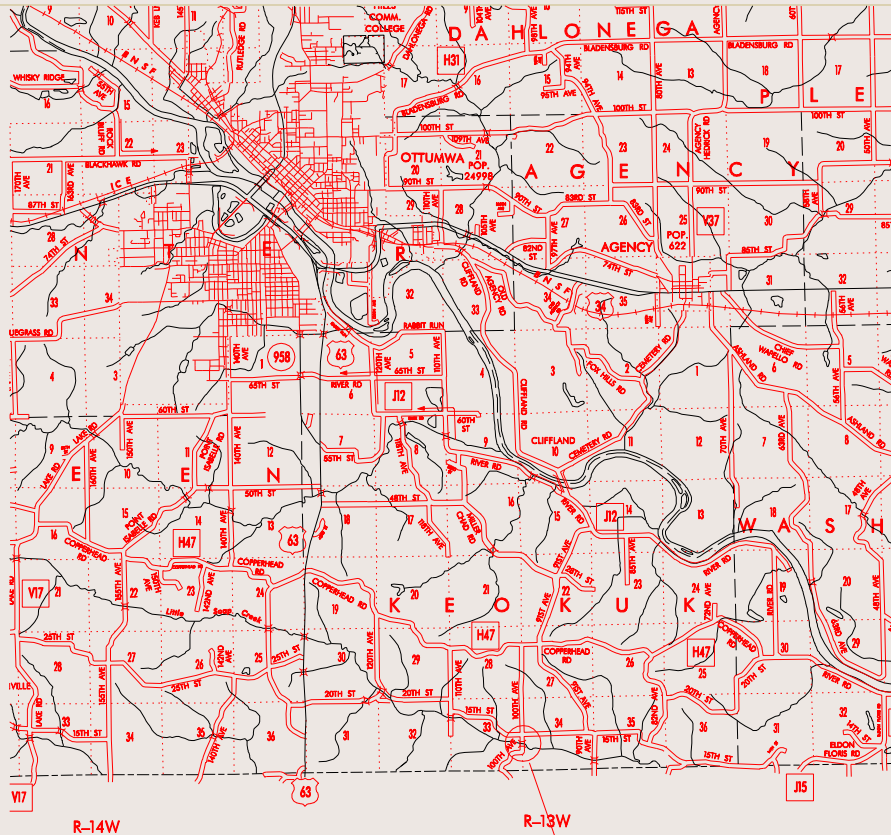
Shear Test Cracking



Project Location, Wapello Co., Iowa



Project Location

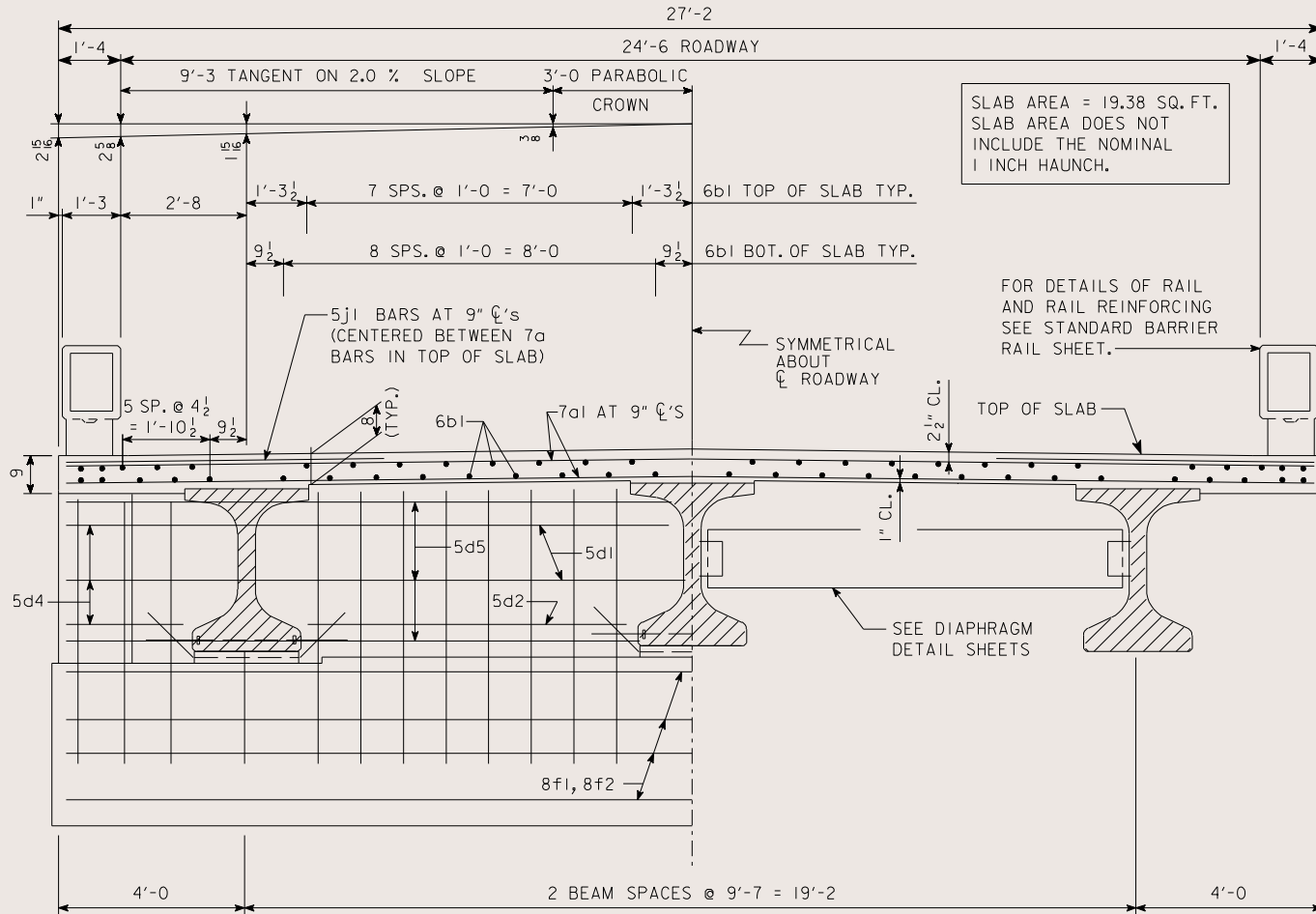


Project Location

Bridge Description

- 110 ft single span
- 3 beam cross section
- Modified Iowa bulb-tee
- Integral abutments
- 8 inch cast-in-place deck
- Open style concrete rail.

Wapello Co. Bridge



110' Girder Casting



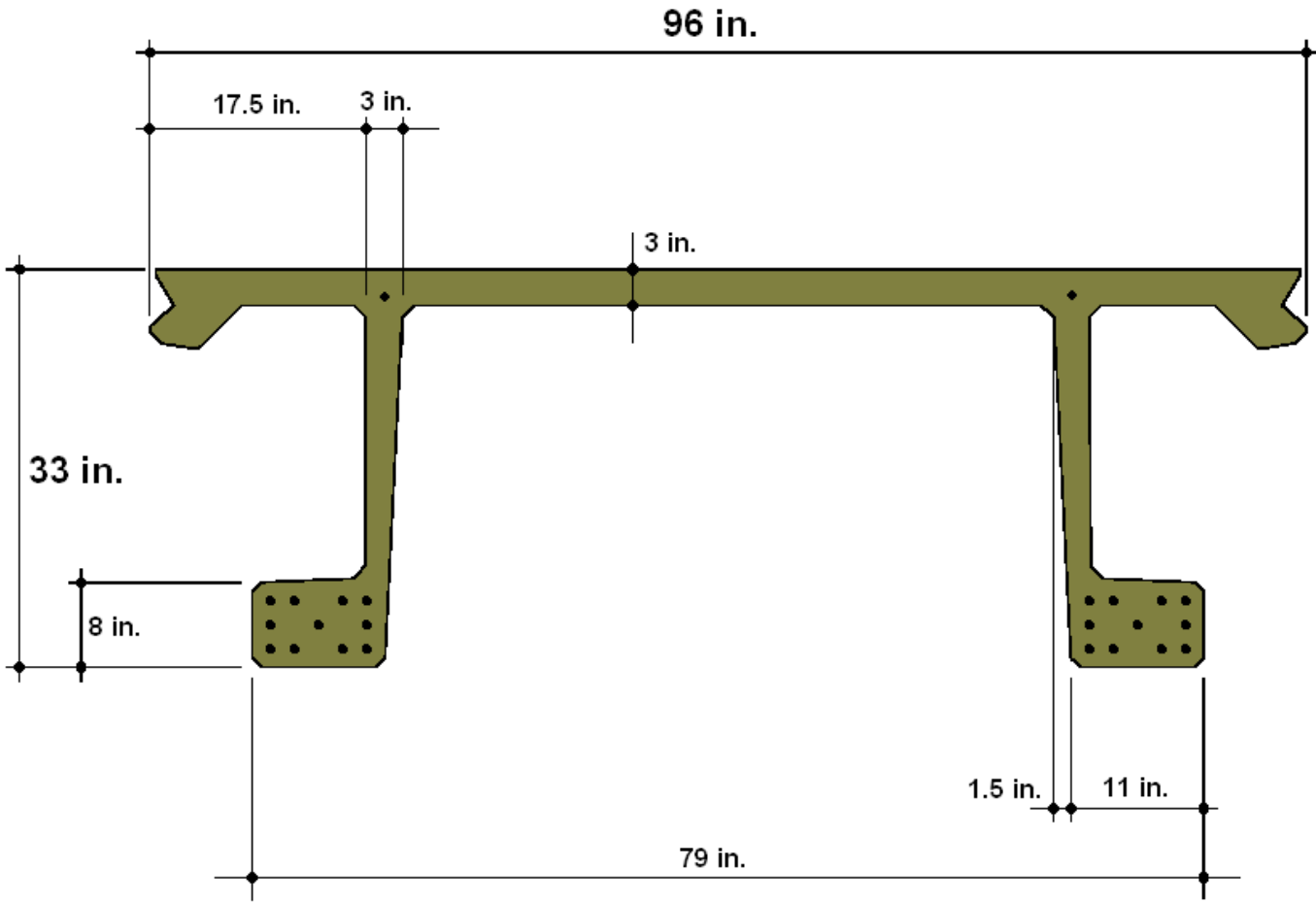
Completed Structure



Initial Pi-Girder

- Developed by MIT/FHWA
- Optimized section
- No Mild Steel
- Integral Deck
- Tested by FHWA

Initial Pi-Girder



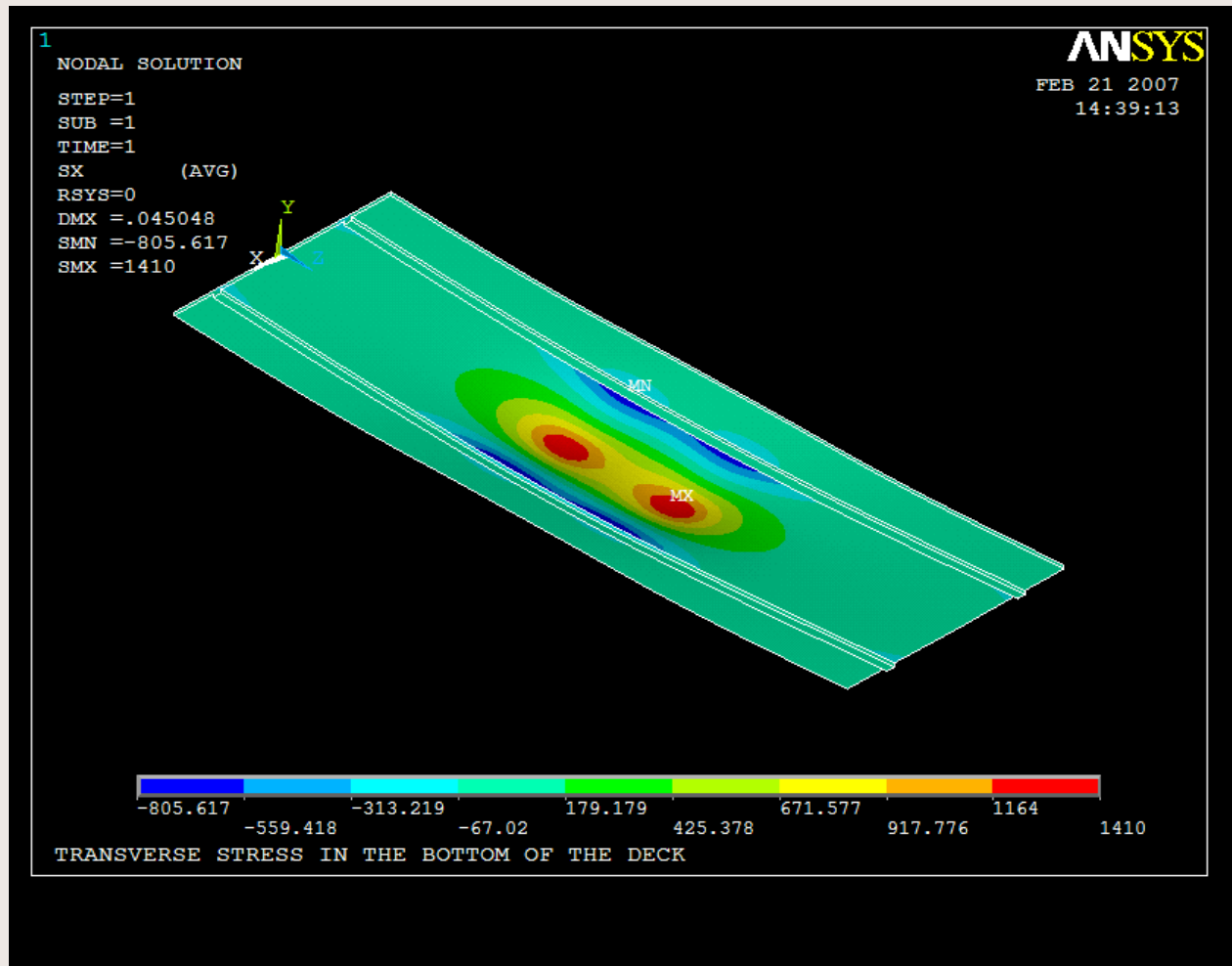
Testing Results by FHWA

- Optimized section
- Longitudinal capacity okay
- Low service capacity transverse in deck
- Low live load distribution between girders

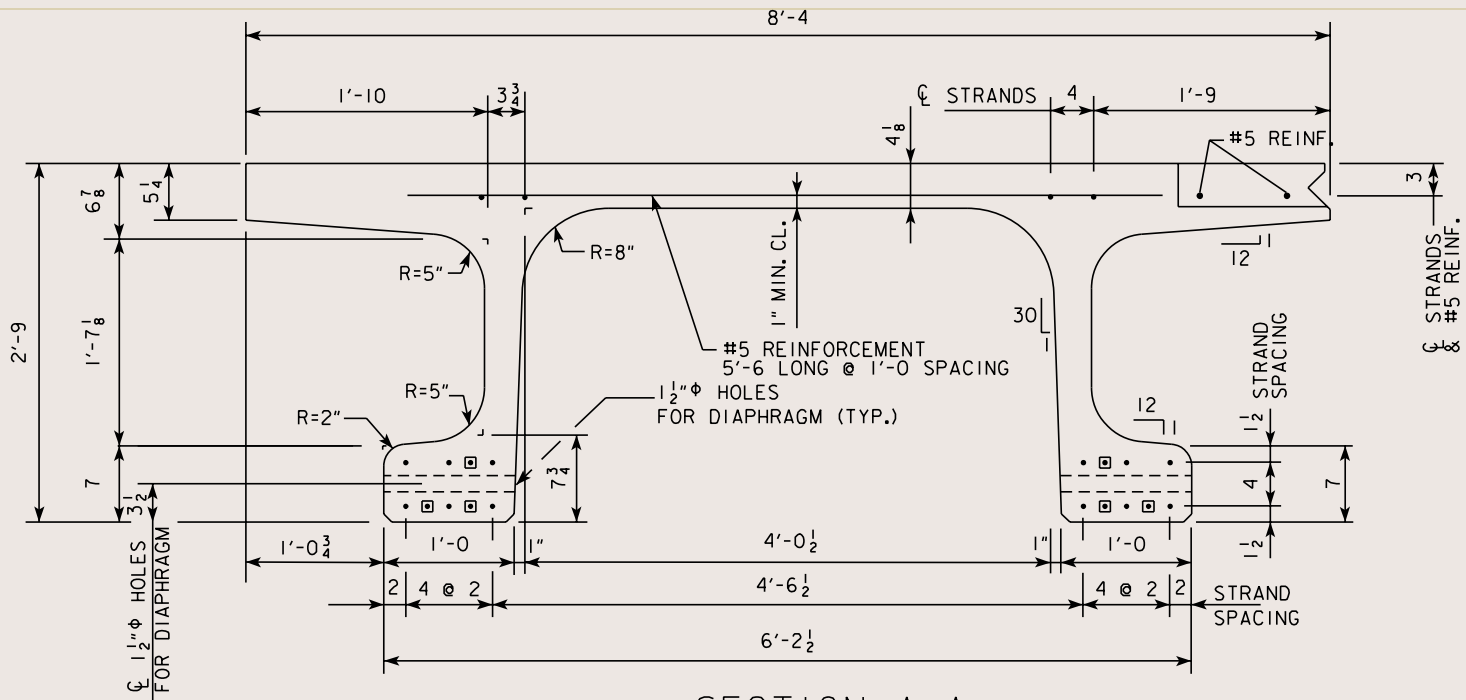
Finite Element Analysis

- Revised section analyzed by ISU and FHWA
- Analyzed girder unit and complete bridge
- Load combinations 16 kip single and 12.5 kip tandem wheel loads with impact.

FEA



Final Section New detail



SECTION A-A

BOTTOM STRAND DEBONDING	
SYMBOL	DEBONDED LENGTH FROM EACH END OF BEAM
□	3'-0

$A = 860.8 \text{ in}^2$
 $y_b = 22.5 \text{ in}$
 $I = 105,730 \text{ in}^4$
 $w_t/f_t = 0.932 \text{ k/ft}$

SECTION PROPERTIES

Summary Project

- Bridge Project let in June 17, 2008
- Casting completed September 2008
 - 2-25 ft test girders for FHWA
 - 3-51 ft bridge girders
- Construction started September 2008
- Girders placed October 16, 2008
- Pockets grouted October 21, 2008
- End spans cast October 30, 2008
- Load Test Week of November 17, 2008
- 3/8 in. chip seal Spring 2009

Girder Casting

- Cast by Lafarge, Winnipeg, Manitoba, Canada
- 11.3 cu. yd. per beam
- Premixed bags of Ductal
- Mixed in two redi-mix truck
- Water added as ice cubes
- Total mixing time ~ 6-7 hours





DANGER

STAY AWAY FROM THIS AREA
WHEN OPERATING
DO NOT TOUCH THE
MACHINE





A spiral-bound notebook with a brown cover and a white page. The spiral binding is on the left side. The text is centered on the page.

VIDEO OF PI GIRDER CASTING









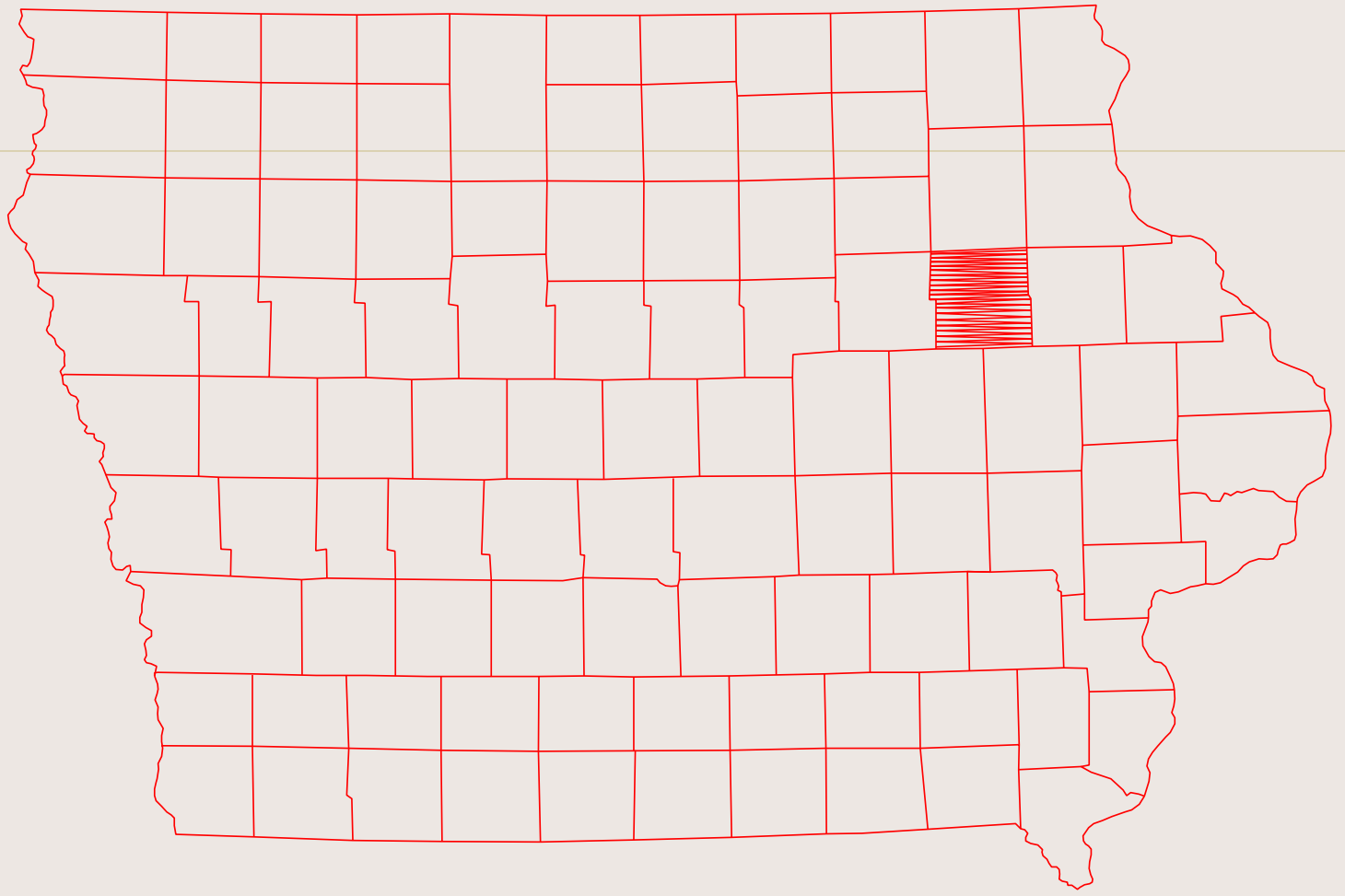
Post-casting

- Initial set to break forms (25-30 hrs)
- Strand release (40 hrs)
- Steam cure (48 hrs at 195 degree F)

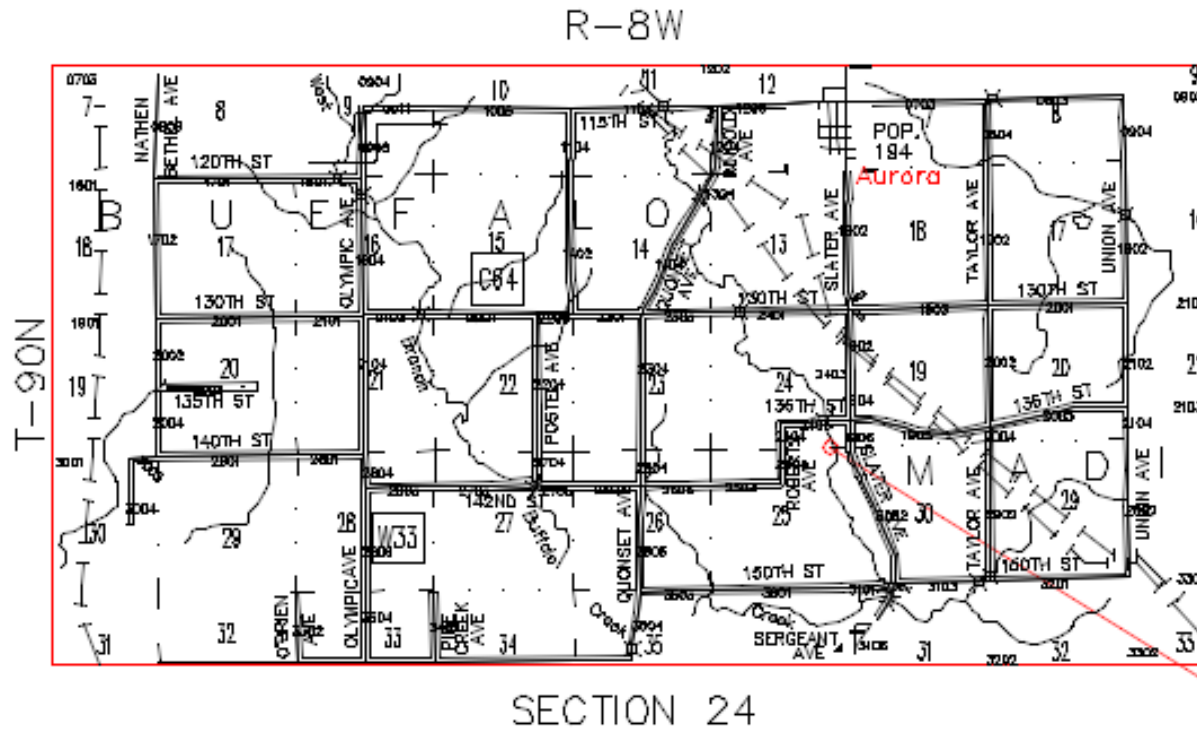




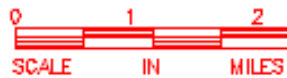




Bridge Location



APPROX. SCALE.

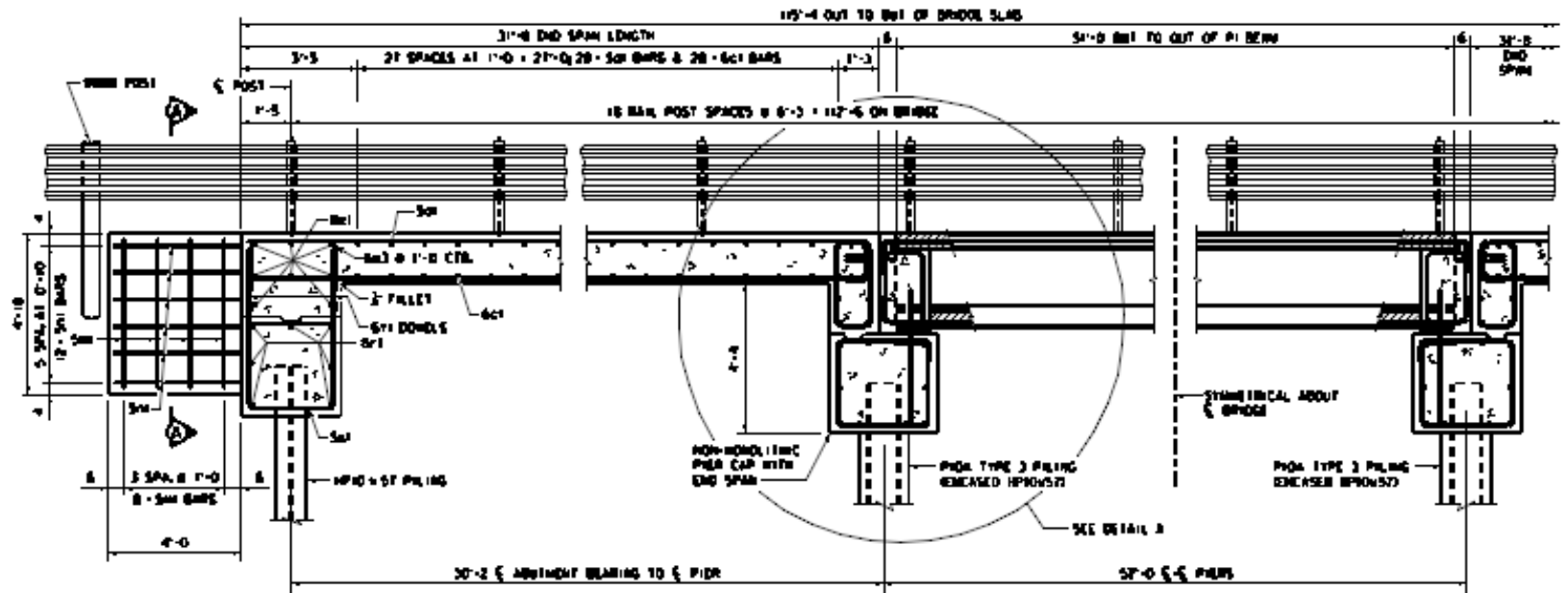


Bridge Location

Bridge Description

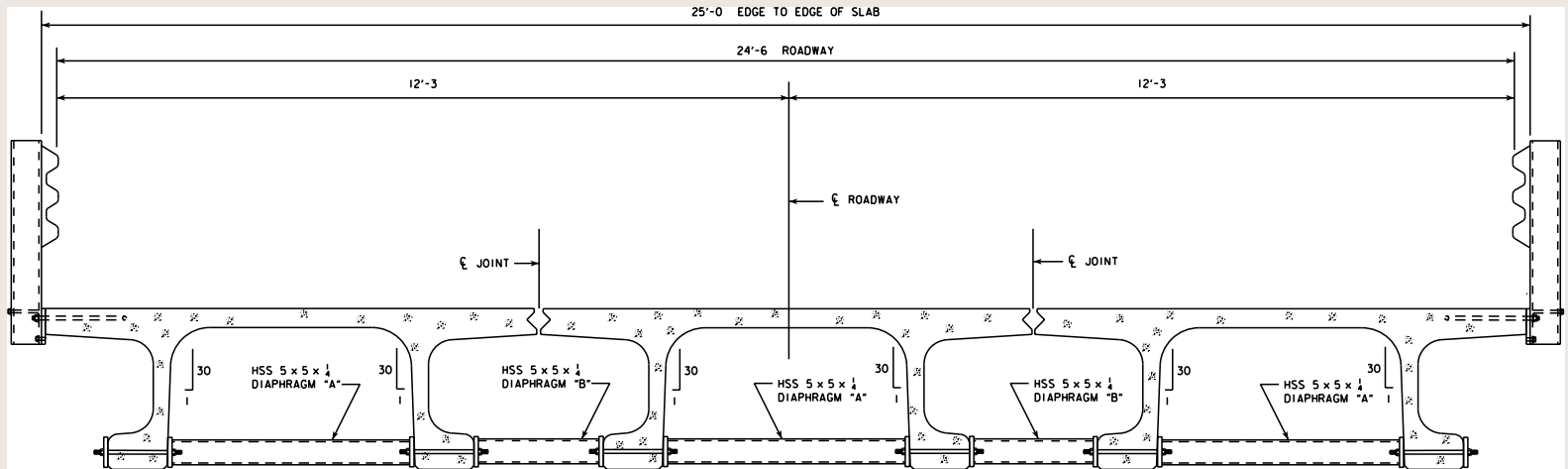
- 24'-6 x 112'-4
- 3 simple spans (32'-2, 52'-0, 30'-2)
- Integral Abuts and Pile Bents (HP10x57)
- End spans 18 in, CIP concrete slab
- Center span 3 PI girders
- Girders connected, grouted dowel pockets, steel diaphragms
- Thrie beam bridge railing

Longitudinal View



PART LONGITUDINAL SECTION NEAR GUTTER LINE

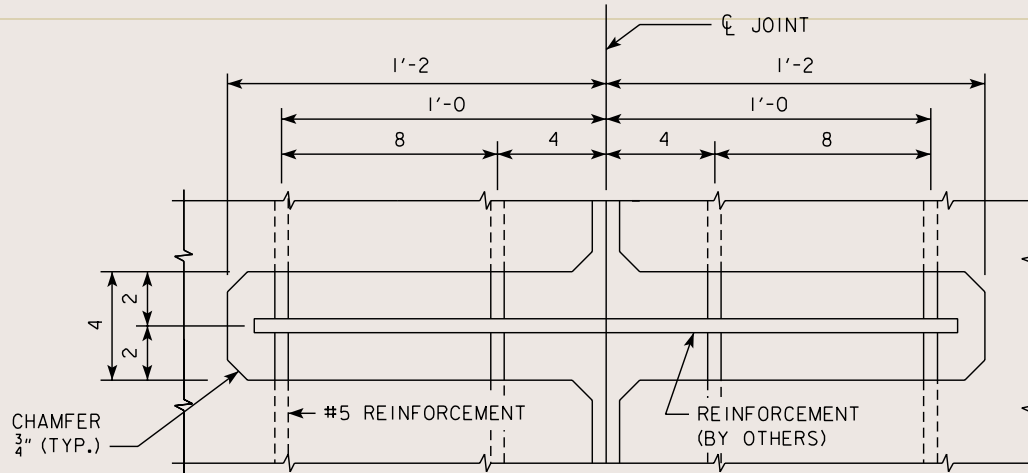
PI Cross-Section



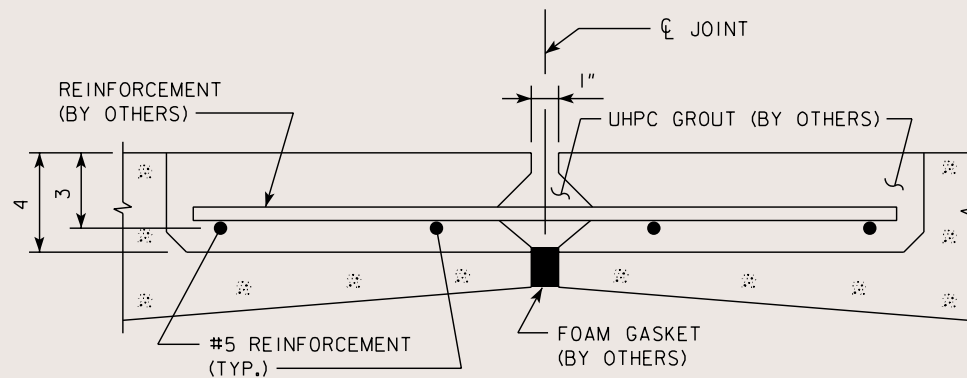




Girder Connection Detail



PLAN VIEW SHOWING DOWEL POCKETS



TYPICAL LONGITUDINAL SECTION
THRU JOINT DETAIL AT POCKET LOCATIONS









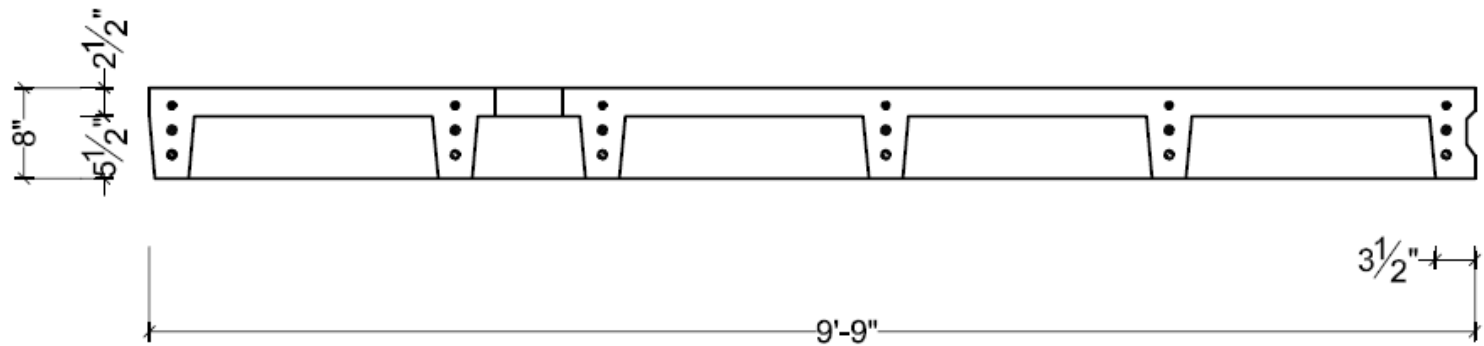




Future Work

- UHPC Precast Deck with Wapello Co.
- ISU research on used of UHPC piles

WAFFLE SLAB TEST PANELS IN PROGRESS



SIDE VIEW



09/15/2009 08:48



09/15/2009 10:57





09/15/2009 11:10

Acknowledgments

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