Ultra-High Performance Concrete Connections for Pre-Fabricated Bridge Elements

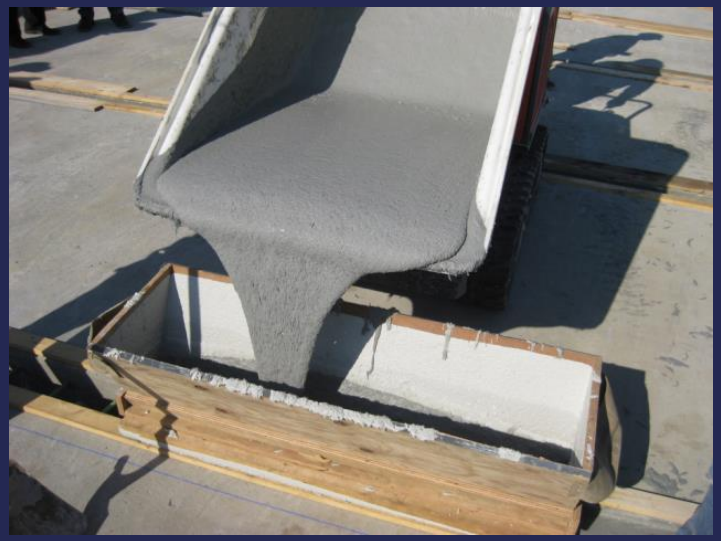
T.H.E. Conference

February 24, 2015

Dan Brydl, FHWA, Division Bridge Engineer

Outline

- History of UHPC
- National Experience with UHPC
- Definition
  - Properties
- Batching
- Placing
- Curing
- Testing
- Illinois' First Project
- Every Day Counts Initiative



History of UHPC

Concrete

High Performance Concrete

Self Consolidating Concrete

Ultra High Performance Concrete

Concrete

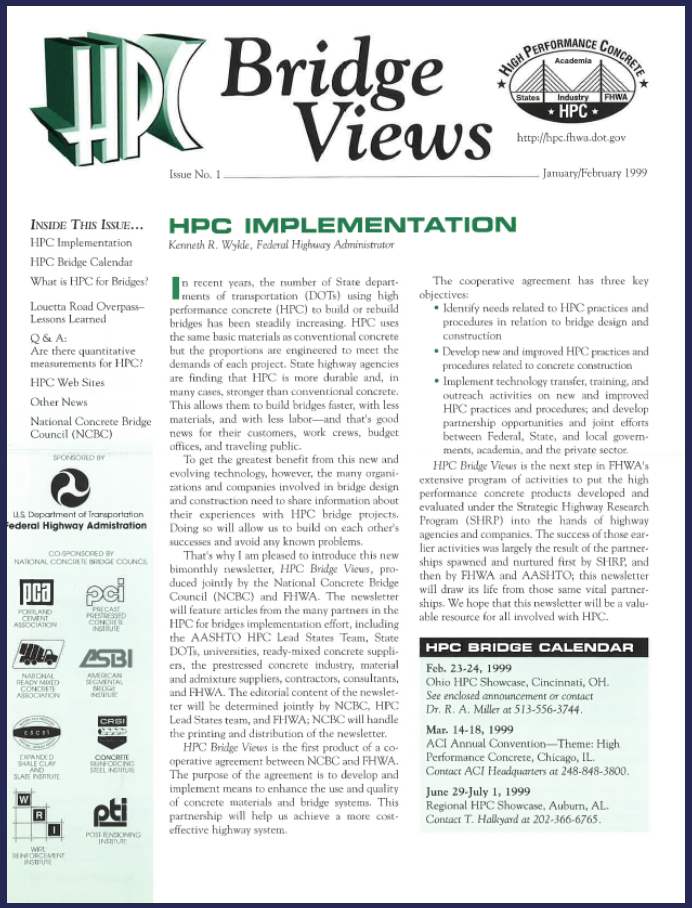
King Tut???

High Performance Concrete

- SHRP – Strategic Highway Research Program
  - 1988-1993
  - Catalog of Products
  - Superpave → Super Duper Pave
  - High Performance Concrete
    - Strength
    - Durability

HPC

- National Momentum started in 1996



HPC Bridge Views

http://hpc.fhwa.dot.gov

Issue No. 1 — January/February 1999

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Q & A: Are there quantitative measurements for HPC?
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National Concrete Bridge Council (NCBC)

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HPC IMPLEMENTATION

Kenneth R. Wykle, Federal Highway Administrator

In recent years, the number of State departments of transportation (DOTs) using high performance concrete (HPC) to build or rebuild bridges has been steadily increasing. HPC uses the same basic materials as conventional concrete but the proportions are engineered to meet the demands of each project. State highway agencies are finding that HPC is more durable and, in many cases, stronger than conventional concrete. This allows them to build bridges faster, with less materials, and with less labor—and that's good news for their customers, work crews, budget offices, and traveling public.

To get the greatest benefit from this new and evolving technology, however, the many organizations and companies involved in bridge design and construction need to share information about their experiences with HPC bridge projects. Doing so will allow us to build on each other's successes and avoid any known problems.

That's why I am pleased to introduce this new bimonthly newsletter, *HPC Bridge Views*, produced jointly by the National Concrete Bridge Council (NCBC) and FHWA. The newsletter will feature articles from the many partners in the HPC for bridges implementation effort, including the AASHTO HPC Lead States Team, State DOTs, universities, ready-mixed concrete suppliers, the prestressed concrete industry, material and admixture suppliers, contractors, consultants, and FHWA. The editorial content of the newsletter will be determined jointly by NCBC, HPC Lead States team, and FHWA; NCBC will handle the printing and distribution of the newsletter.

HPC Bridge Views is the first product of a cooperative agreement between NCBC and FHWA. The purpose of the agreement is to develop and implement means to enhance the use and quality of concrete materials and bridge systems. This partnership will help us achieve a more cost-effective highway system.

The cooperative agreement has three key objectives:

- Identify needs related to HPC practices and procedures in relation to bridge design and construction
- Develop new and improved HPC practices and procedures related to concrete construction
- Implement technology transfer, training, and outreach activities on new and improved HPC practices and procedures; and develop partnership opportunities and joint efforts between Federal, State, and local governments, academia, and the private sector.

HPC Bridge Views is the next step in FHWA's extensive program of activities to put the high performance concrete products developed and evaluated under the Strategic Highway Research Program (SHRP) into the hands of highway agencies and companies. The success of those earlier activities was largely the result of the partnerships spawned and nurtured first by SHRP, and then by FHWA and AASHTO; this newsletter will draw its life from those same vital partnerships. We hope that this newsletter will be a valuable resource for all involved with HPC.

HPC BRIDGE CALENDAR

Feb. 23-24, 1999
Ohio HPC Showcase, Cincinnati, OH.
See enclosed announcement or contact Dr. R. A. Miller at 513-556-3744.

Mar. 14-18, 1999
ACI Annual Convention—Theme: High Performance Concrete, Chicago, IL.
Contact ACI Headquarters at 248-848-3800.

June 29-July 1, 1999
Regional HPC Showcase, Auburn, AL.
Contact T. Halkyard at 202-366-6765.

HPC

- 1st Meeting with Illinois – 1998
- 33 HPC Decks in Illinois
  - 2000 and 2001
  - Conclusion: Crack too Much – Momentum Stopped
- ISTHA and Chicago of Chicago
  - Continue to utilize HPC (with success)

UHPC

- 1st work with this – 1980 in Denmark or France or somewhere like that?
- Just now gaining momentum in US
- 1st Bridge using UHPC – Iowa - 2006

UHPC Girders

Definition of UHPC

- Cementitious composite material composed of:
  - Optimized gradation of granular constituents
  - W/C Ratio < 0.25
  - High % of steel fibers
  - Compressive Strength > 21.7 ksi
  - Discontinuous pore structure that reduces liquid ingress
    - Enhanced durability

Key Components

- Silica Fume – 10% or more by wt. of cement
  - Illinois Microsilica Overlay uses 5.5%
- Crushed quartz, limestone or basalt (fine aggregates – no coarse stuff)
- Chemical Admixtures
  - Accelerators
  - Superplasticizers

Typical Composition of UHPC

Material	Amount	% by Weight
Portland Cement	1200 lb/yd^3	28.5
Silica Fume	390 lb/yd^3	9.3
Ground Quartz	355 lb/yd^3	8.5
Fine Sand	1720 lb/yd^3	41.0
Steel Fibers*	263 lb/yd^3	6.3
Superplasticizer	51 lb/yd^3	1.2
Water	218 lb/yd^3	5.2

* 290 ksi, 0.5” long, 0.008” diameter

UHPC Mix Design

Constituent	UHPC Proportion (lb/yd$^{3)}$	Normal Concrete (lb/yd^3)
Coarse Aggregate	---	1,739
Sand	1,719	1,429
Cement	1,197	600
Ground Quartz	354	---
Silica Fume	388	---
Water	236	300
Superplasticizer	22	---
Steel Fibers	270	---

Key Components

- Water - Temp of water is key
  - Use chilled water or ice
  - Cubed ice works better – helps in mixing
  - Note: All ice should be melted before addition of steel fibers

Iowa Research Finding

At ambient temperatures of 75.5°F, the temperature of freshly mixed UHPC reached 100°F and the flow characteristics were inadequate for placement and consolidation.

Key Components

- Steel Fibers
  - 2% by volume
  - May be straight or deformed
  - ½” long straight fibers are most common
  - Domestic Steel Issue

Guidance on Use of UHPC Connections

- **FHWA document HRT-14-084**
  - Design guidance
  - Construction guidance
  - Case Studies

TECHNOTE

Design and Construction of UHPC Field-Cast Connections

FHWA Publication No: FHWA-HRT-14-084

FHWA Contact: Ben Graybeal, HRDI-40, 202-493-3122, benjamin.graybeal@dot.gov

Introduction

Advancements in the science of concrete materials have led to the development of a new class of cementitious composites called ultra-high performance concrete (UHPC). UHPC exhibits mechanical and durability properties that make it an ideal candidate for use in developing new solutions to pressing concerns about highway infrastructure deterioration, repair, and replacement.[1,2] Field-cast UHPC details connecting prefabricated structural elements used for bridge construction have proven to be an application that has captured the attention of owners, specifiers, and contractors across the country. These connections can be simpler to construct and can provide more robust long-term performance than connections constructed through conventional methods.[3] This document provides guidance on the design and deployment of field-cast UHPC connections.

UHPC

UHPC is a fiber-reinforced, portland cement-based product with exceptional fresh and hardened properties. Through the appropriate combination of advancements in superplasticizers, dry constituent gradation, fiber reinforcements, and supplemental cementitious materials, UHPC is able to deliver performance that far exceeds conventional concrete. Developed in the late 20th century, this class of concrete has emerged as a capable replacement for conventional structural materials in a variety of applications.

Definition of UHPC

The Federal Highway Administration (FHWA) defines UHPC as follows:

UHPC is a cementitious composite material composed of an optimized gradation of granular constituents, a water-to-cementitious materials ratio less than 0.25, and a high percentage of discontinuous internal fiber reinforcement. The mechanical properties of UHPC include compressive strength greater than 21.7 ksi (150 MPa) and sustained post-cracking tensile strength greater than 0.72 ksi (5 MPa).[1] UHPC has a discontinuous pore structure that reduces liquid ingress, significantly enhancing durability compared to conventional concrete.[4]

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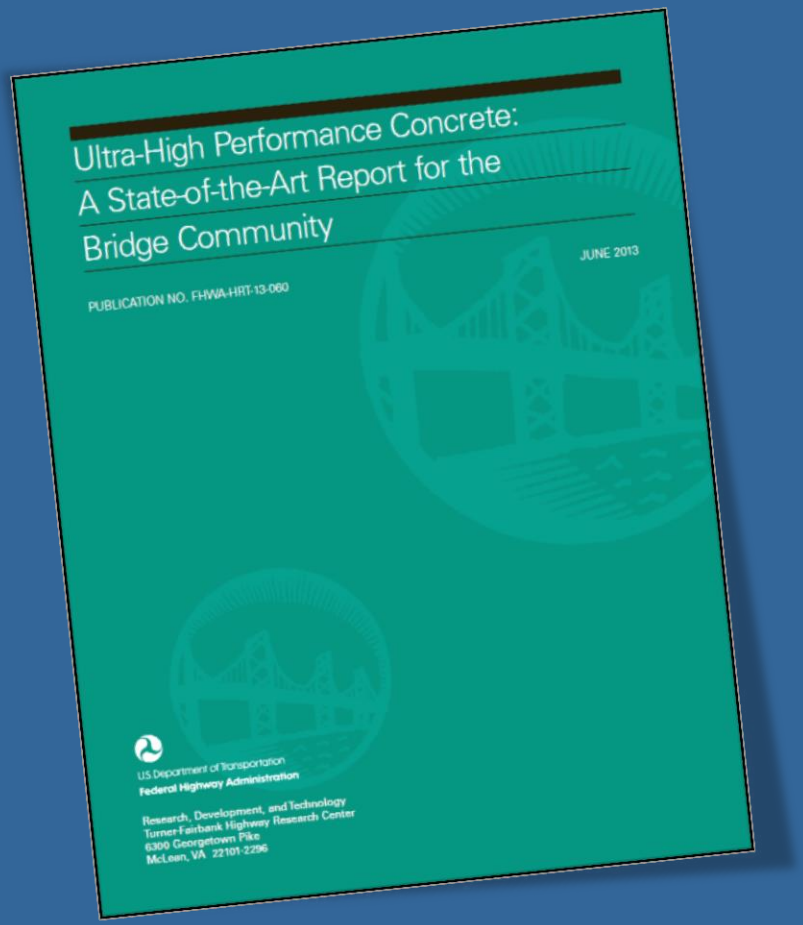
"The tensile behavior of UHPC may generally be defined as "strain-hardening," a broad term defining concretes in which the sustained post-cracking strength provided by the fiber reinforcement is greater than the cementitious matrix cracking strength. However, the definitional dependence on cementitious matrix cracking strength may inappropriately include or exclude some concretes that exhibit different pre-cracking and post-cracking strength levels. Note that the post-cracking tensile strength and strain capacity of UHPC is highly dependent on the type, quantity, dispersion, and orientation of the internal fiber reinforcement.

U.S. Department of Transportation
Federal Highway Administration
www.fhwa.dot.gov/research

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike, McLean, VA 22101-2296

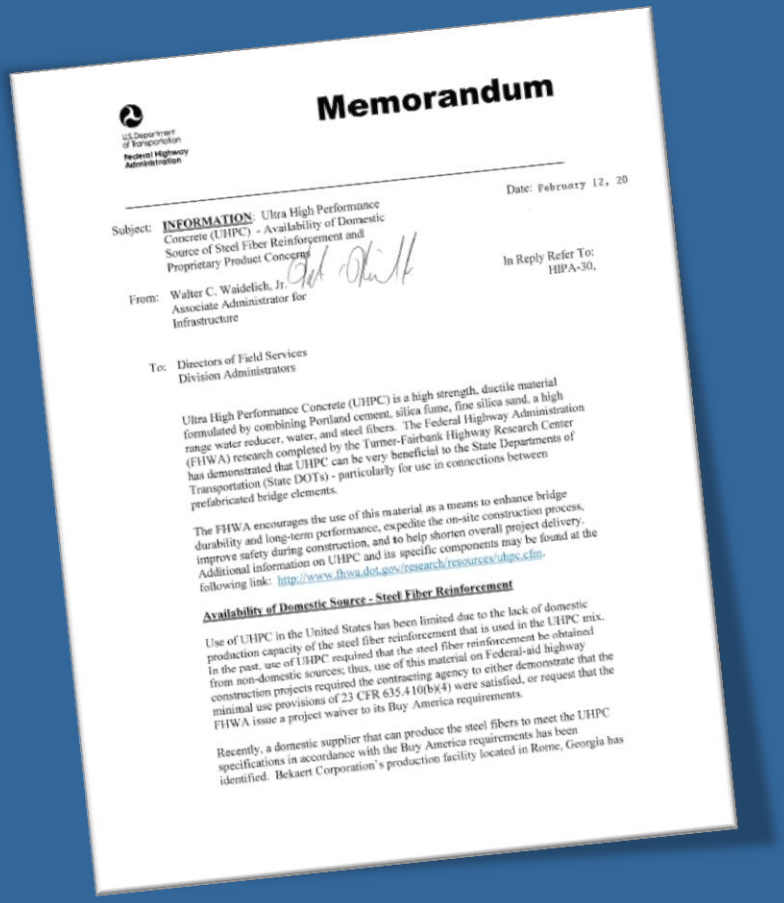
UHPC State-of-the-Art Report

- **FHWA HRT-13-060**
  - 300+ references
  - 600+ item bibliography
  - Materials, Performance, Design, Applications, Outlook
  - Web Search: ***UHPC State of the Art***



FHWA UHPC Memo – 12 Feb 2014

- Buy America re: Fibers
- Availability
- Proprietary Products
- Example Special Provision (NYSDOT)



U.S. Department of Transportation
Federal Highway Administration

Memorandum

U.S. Department of Transportation
Federal Highway Administration

Date: February 12, 20

Subject: **INFORMATION**: Ultra High Performance Concrete (UHPC) - Availability of Domestic Source of Steel Fiber Reinforcement and Proprietary Product Concerns

In Reply Refer To: HIPA-30,

From: Walter C. Waidelich, Jr.
Associate Administrator for Infrastructure

To: Directors of Field Services
Division Administrators

Ultra High Performance Concrete (UHPC) is a high strength, ductile material formulated by combining Portland cement, silica fume, fine silica sand, a high range water reducer, water, and steel fibers. The Federal Highway Administration (FHWA) research completed by the Turner-Fairbank Highway Research Center has demonstrated that UHPC can be very beneficial to the State Departments of Transportation (State DOTs) - particularly for use in connections between prefabricated bridge elements.

The FHWA encourages the use of this material as a means to enhance bridge durability and long-term performance, expedite the on-site construction process, improve safety during construction, and to help shorten overall project delivery. Additional information on UHPC and its specific components may be found at the following link: http://www.fhwa.dot.gov/research/resources/uhpc.cfm.

Availability of Domestic Source - Steel Fiber Reinforcement

Use of UHPC in the United States has been limited due to the lack of domestic production capacity of the steel fiber reinforcement that is used in the UHPC mix. In the past, use of UHPC required that the steel fiber reinforcement be obtained from non-domestic sources; thus, use of this material on Federal-aid highway construction projects required the contracting agency to either demonstrate that the minimal use provisions of 23 CFR 635.410(b)(4) were satisfied, or request that the FHWA issue a project waiver to its Buy America requirements.

Recently, a domestic supplier that can produce the steel fibers to meet the UHPC specifications in accordance with the Buy America requirements has been identified. Bekaert Corporation's production facility located in Rome, Georgia has

U.S. Department of Transportation
Federal Highway Administration

Memorandum

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Date: February 12, 2014

From: Walter C. Waidelich, Jr.
Associate Administrator for Infrastructure

In Reply Refer To:
HIPA-30,

To: Directors of Field Services
Division Administrators

Buy America Requirements

- Two Issues Limited Usage To Date
  - Availability of Domestic Source of Steel Fibers
  - Proprietary Product Concerns

Buy American Requirements

- Bekaert Corporation
  - Rome, Georgia
  - New Domestic Source
  - No more problem ???

Sole Source Issue

- Ductal® - Lafarge Corporation

- BCV®
- BSI®
- CRC®
- Densit®
- Cor-Tuf®
- Several States developing non-proprietary mix designs

MONTANA MDT DEPARTMENT OF TRANSPORTATION

RESEARCH PROGRAMS USE ONLY
RESEARCH TOPIC STATEMENT NO:
DATE OF RECEIPT:

RESEARCH PROGRAMS

RESEARCH TOPIC STATEMENT

I. TITLE (required):

Feasibility of Non-Proprietary Ultra-High Performance Concrete (UHPC) for Use in Highway Bridges in Montana.

II. TOPIC STATEMENT (required):

The objective of the proposed project is to design and test non-proprietary UHPC mixes to determine whether UHPC is a viable option for Montana.

III. BACKGROUND STATEMENT (required):

Ultra-high performance concrete became commercially available in the U.S. in 2000. Since then, UHPC has been actively promoted by the Federal Highway Administration. UHPC has mostly been used in the U.S. for

National Usage

- 9 States have UHPC bridges in service
- About 45 bridges total – built or being built right now
- New York is leader by far
- 20 other states seriously considering usage right now

Name	Year
Mars Hill Bridge, Wapello County, IA	2006
Route 624 over Cat Point Creek, Richmond County, VA	2008
Jakway Park Bridge, Buchanan County, IA	2008
State Route 31 over Canandaigua Outlet, Lyons, NY	2009
State Route 23 over Otego Creek, Oneonta, NY	2009
Little Cedar Creek, Wapello County, IA	2011
Fingerboard Road Bridge over Staten Island Expressway, NY	2011-2012
State Route 248 over Bennett Creek, NY	2011
U.S. Route 30 over Burnt River and UPRR bridge, OR	2011
U.S. Route 6 over Keg Creek, Pottawatomie County, IA	2011
Ramapo River Bridge, Sloatsburg, NY	2011
State Route 42 Bridges (2) near Lexington, NY	2012
State Route 31 over Putnam Brook near Weedsport, NY	2012
I-690 Bridges (2) over Peat Street near Syracuse, NY	2012
I-690 Bridges (2) over Crouse Avenue near Syracuse, NY	2012
I-481 Bridge over Kirkville Road near Syracuse, NY	2012
Windham Bridge over BNSF Railroad on U.S. Route 87 near Moccasin, MT	2012
State Route 12 over Spring Brook near Greene, NY	2013
State Route 10 over Webster Brook near Dehli, NY	2013
State Route 38 over Wilson Creek near Newark, NY	2013
State Route 962G over U.S. Route 17 in Owego, NY	2013
State Route 907W over U. S. Route 1 in Pelham, NY	2013
State Route 2 Bridges (2) over SR9 in Colonie, NY	2013
I-81 Bridges (2) over E Castle St in Syracuse, NY	2013
I-81 Bridges (2) over E Calthrop Ave in Syracuse, NY	2013
I-84 Bridges (2) over Dingle Road in Southeast, NY	2013
I-690 Westbound over Onandaga Creek in Syracuse, NY	2013
I-690 over N. Salina Street in Syracuse, NY	2013
SR1004 over Cove Creek in Everett, PA	2013
Northampton St. over Manhan River in Easthampton, MA	2013
Sollars Road over Lees Creek in Washington Court House, OH	2014
SR0288 over Wampum Run in Wampum, PA	2014
I-81 Bridges (2) over Preble Road in Preble, NY	2014
US Route 6 over D&RGW Railroad in Spanish Fork, UT	2014

Bridges in Service in the U.S.

Summary – Bridges in Service

- New York – 22
- Iowa – 4
- Pennsylvania – 2
- Virginia -1
- Oregon – 1
- Montana – 1
- Massachusetts – 1
- Ohio – 1
- Utah - 1

Largest UHPC Application

- New Jersey Pulaski Skyway

Pulaski Skyway

- 4 lanes
- 3.5 miles long
- 118 spans
- $400 million rehab
- 1 million sq.ft. of deck replacement in 2 yrs
  - 10,000 sq.ft. replaced per week
- Panels: Light weight concrete and stainless steel reinforcement

Pulaski Skyway

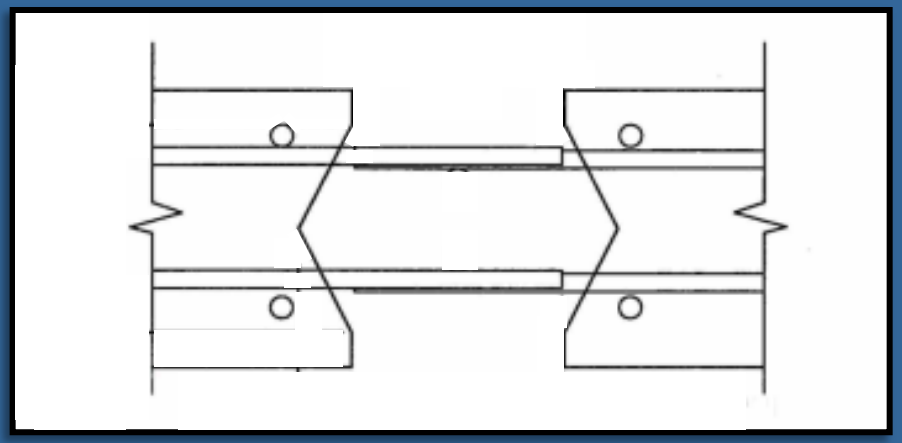
- Spec req'd full scale mock-up of the panel assembly prior to production
  - Very necessary and recommended
  - Contractor not used to fluidity of UHPC compared to normal concretes/grouts
  - Multiple forms failed and material leaked out

Pulaski Skyway Lessons Learned

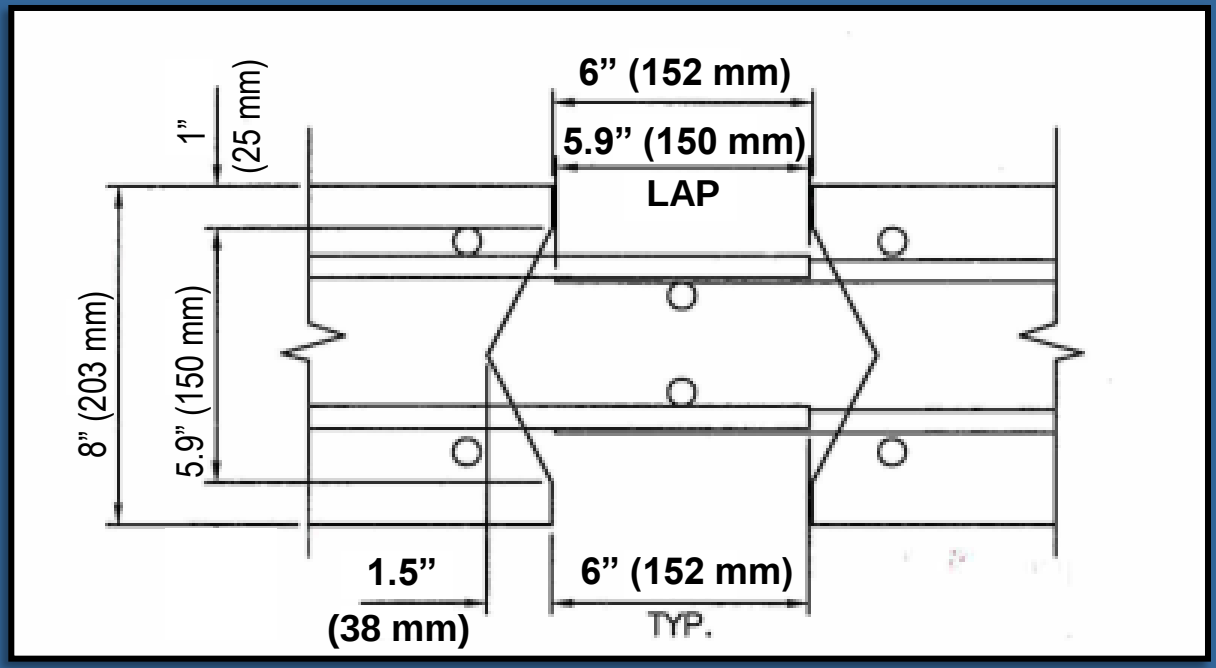
- Do a practice run – easy to screw up in field
- Reduce congestion in joints
  - Minimize reinforcement
- Keep the design simple and “cookie cutter” if possible

Field-Cast "Splice" Connections

- Simple Lap-Splice Cxn
- Smaller Grout Volumes
- Shortened Bar Lengths
- Emulates Monolithic Component

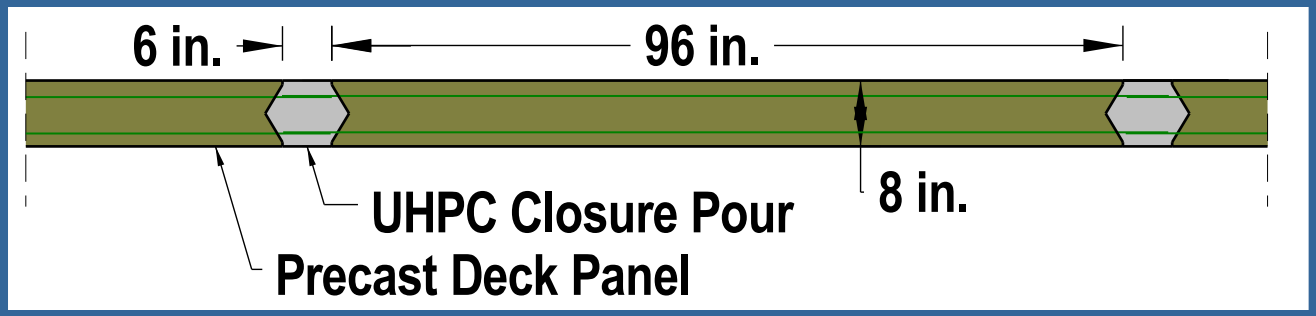


SLAB/PLATE/DECK CONNECTIONS W/ UHPC



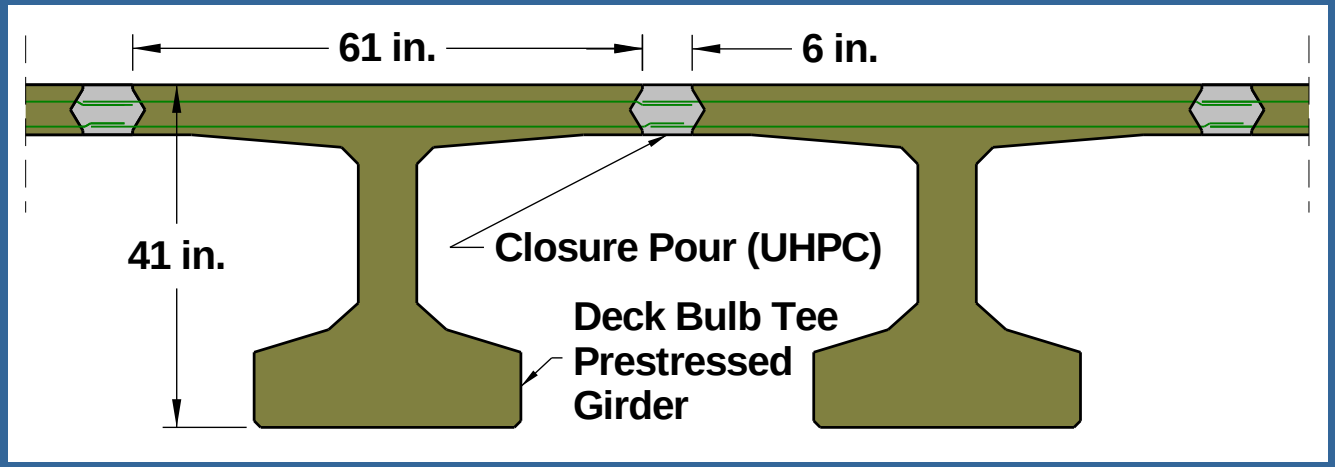
Field-Cast, Non-Contact Lap Splice Connection

Field-Cast "Splice" Connections



Precast Deck Panels and Slabs

Deck Bulb Tee Girders



UHPC Composite Connection

Steel Girder Connection

Concrete Girder Connection

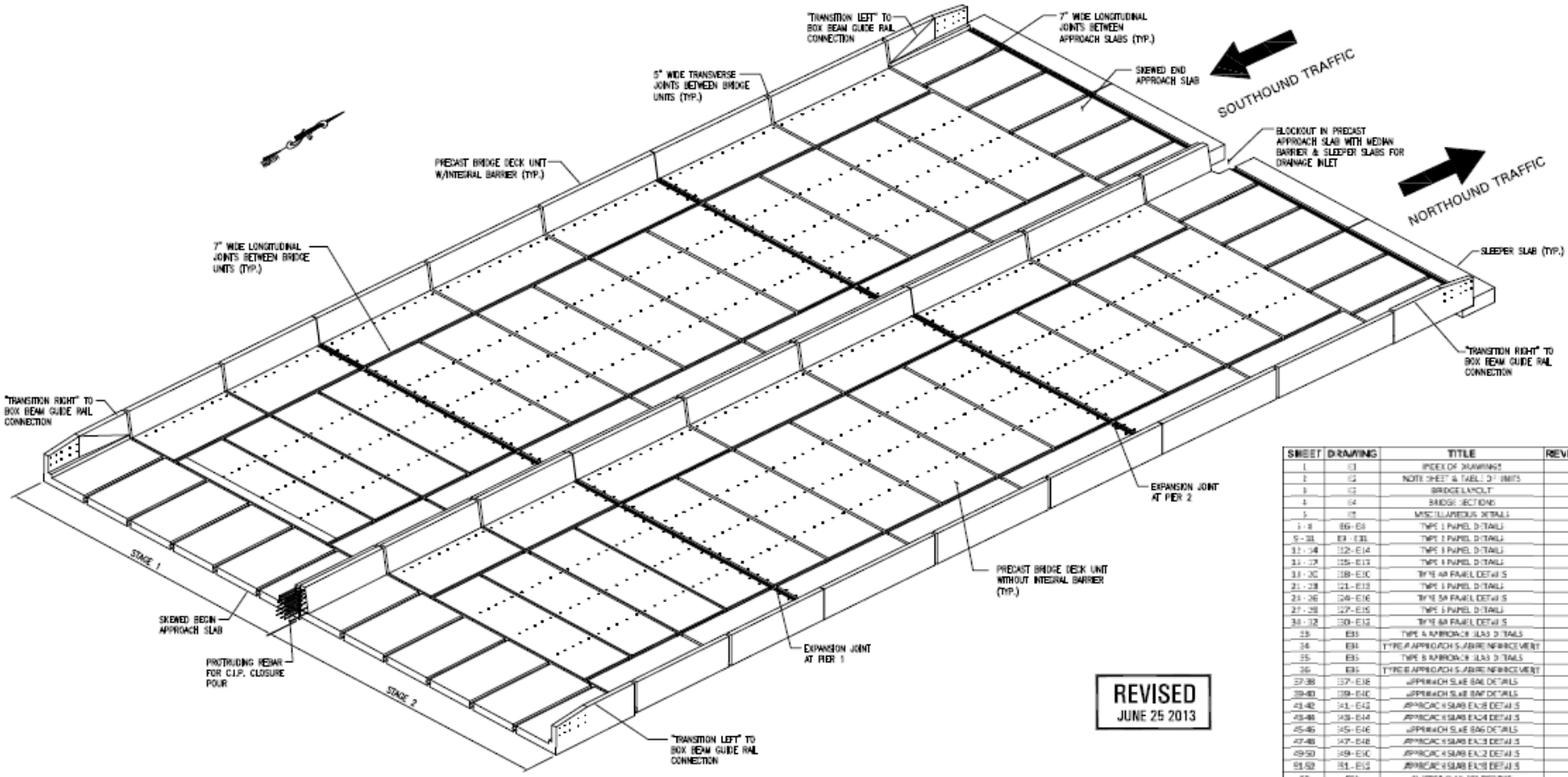
PBES Innovation

I-81 in Syracuse NY — August 2013

Acknowledgements:

NY Accelerated Bridge Program
NYSDOT
Fort Miller Group, Inc.
Slate Hill Constructors, Inc.
Economy Paving Company, Inc.

I-81 OVER EAST CALTHROP AVENUE



REVISED
JUNE 25 2013

SHEET	DRAWING	TITLE	REVISION
1	G1	INDEX OF DRAWINGS	
2	G2	NOTE SHEET & PARTIAL PLAN LIMITS	
3	G3	BRIDGE LAYOUT	
4	G4	BRIDGE SECTIONS	
5	G5	MISCELLANEOUS DETAILS	
6 - 8	B6-B8	TYPE 1 PANEL DETAILS	
9 - 10	B9 - B10	TYPE 1 PANEL DETAILS	
11 - 12	B11 - B12	TYPE 1 PANEL DETAILS	
13 - 14	B13 - B14	TYPE 1 PANEL DETAILS	
15 - 16	B15 - B16	TYPE 1 PANEL DETAILS	
17 - 18	B17 - B18	TYPE 1A PANEL DETAILS	
19 - 20	B19 - B20	TYPE 1A PANEL DETAILS	
21 - 22	B21 - B22	TYPE 1 PANEL DETAILS	
23 - 24	B23 - B24	TYPE 1A PANEL DETAILS	
25 - 26	B25 - B26	TYPE 1A PANEL DETAILS	
27 - 28	B27 - B28	TYPE 1 PANEL DETAILS	
29 - 30	B29 - B30	TYPE 1A PANEL DETAILS	
31	B31	TYPE A APPROACH SLAB & TAILS	
32	B32	TYPE A APPROACH SLAB REINFORCEMENT	
33	B33	TYPE B APPROACH SLAB & TAILS	
34	B34	TYPE B APPROACH SLAB REINFORCEMENT	
35 - 36	B35	TYPE B APPROACH SLAB REINFORCEMENT	
37-38	B37-B38	APPROACH SLAB BAR DETAILS	
39-40	B39-B40	APPROACH SLAB BAR DETAILS	
41-42	A1 - B42	APPROACH SLAB BAR DETAILS	
43-44	A3 - B44	APPROACH SLAB BAR DETAILS	
45-46	A5 - B46	APPROACH SLAB BAR DETAILS	
47-48	A7 - B48	APPROACH SLAB BAR DETAILS	
49-50	A9 - B50	APPROACH SLAB BAR DETAILS	
51-52	B51 - B52	APPROACH SLAB BAR DETAILS	
53	B53	SLEEPER SLAB DETAILS	
54	B54	SLEEPER SLAB DETAILS	
55	B55	SLEEPER SLAB DETAILS	
56	B56	SLEEPER SLAB DETAILS	
57	B57	HAND LINE & WIRE STORAGE DETAILS	

APPROVED
Michael B. Twiss, P.E.
For Deputy Chief Engineer Structures
Reviewed By: MBT

Michael Twiss
APPROVED for Deputy Chief Engineer Structures
2013.07.01 18:34:51 -04'00'

FED. ROAD REG. NO.	STATE	CONTRACT NO.	SHEET NO.	TOTAL SHEETS
	N.Y.	D262027		

P.I.N. #: 5ABP.03 B.I.N. #: 1031529
ACCELERATED BRIDGE PROGRAM—PHASE 1A, CONTRACT 3
INTERSTATE 81 OVER EAST CALTHROP AVENUE
CITY OF SYRACUSE
ONONDAGA COUNTY

THE FORT MILLER Co., Inc.
P.O. BOX 98
SCHUYLERVILLE, NY 12871
(518) 695-5000
(518) 695-4970 FAX
www.fortmiller.com

NO.	DATE	BY	DESCRIPTION
1	6/25/13	VCE	ADDED BULKHEAD TO NORTH SIDE MEDIAN

REVISIONS

I-81 OVER EAST CALTHROP AVENUE
CITY OF SYRACUSE

BRIDGE SECTION

ENGINEER: NYSDOT

CONTRACTOR: SLATE HILL CONSTRUCTORS, INC.
8573 HERMAN ROAD
WARNERS, NEW YORK 13164

DRAWN BY:	DATE:	CHK'D BY:	SHEET:	SCALE:	P.M. JOB No.	DWG.
VCE	5/3/13	PJR	1	NONE	13716	B1


OVERSIZE LOAD


Deck-to-Deck Connection


Deck-Barrier Components

Testing of UHPC

Air Content

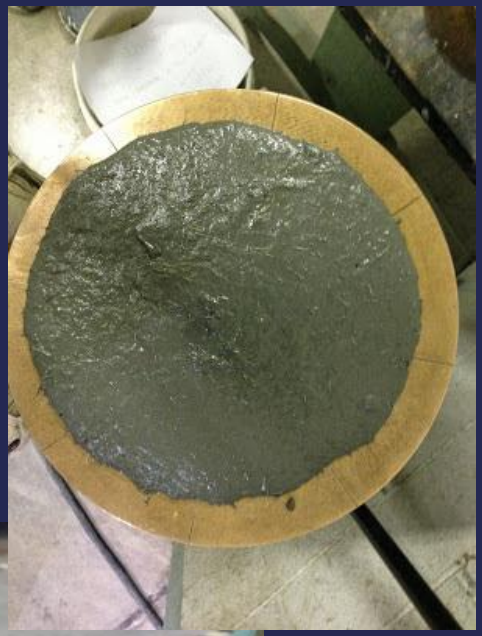
- None Required
- No Testing

- UHPC is so impermeable that water cannot get in to cause problems with freeze/thaw

Slump

Flow Testing of UHPC

7” to 10”



Compressive Strength

Compressive Strength

- 3” by 6” cylinder is most common
- Can use 4” diameter cylinders
  - Depends on Machine Capacity
- Acceptable Alternative: Cubes
  - 2” to 4” cubes
  - 2” most common

Compressive Strength

- Typical Spec:
  - 4 Sets of Test Samples each day of placement
    - One set is 3 cylinders
- Test at:
  - 4 Days
  - 14 Days
  - 28 Days

Helpful Hints

- Very Important : for strengths > 15 ksi
  - Requires grinding of ends of cylinders
    - flat and parallel
  - Usually requires a fixed-end grinder
    - Some Labs have this, many don't
  - If you don't grind ends properly, you'll see a much lower strength

What's a Fixed-End Grinder?

Alternative

Cubes

- Eliminates need for grinding
- Molds must be kept very still
- Sides must be parallel
- Cheap Plastic molds don’t work well

New York Spec to Check for Leaking Joints

https://www.dot.ny.gov/main/business-center/engineering/specifications/english-spec-repository/ - Windows Internet Explorer

https://www.dot.ny.gov/main/business-center/engineering/specifications/english-spec-repository/section550.pdf

File Edit Go To Favorites Help

Favorites Home Federal Highway A...

https://www.dot.ny.gov/main/business-center/e...

G. Concrete Placement and Finishing. After the jo... shall be placed in accordance with the contract plans. The concrete shall be finished in accordance with 557-3.07 - Finishing Integral Wearing Surfaces on Superstructure Slabs.

H. Watertight Integrity Test At least five work days after the joint system has been fully installed the Contractor shall test the entire (full length) joint system for watertight integrity employing a method satisfactory to the Engineer. The entire joint system shall be covered with water, either ponded or flowing, for a minimum duration of 15 minutes. The concrete surfaces under the joint shall be inspected, during this 15 minute period and also for a minimum of 45 minutes after the supply of water has stopped, for any evidence of dripping water or moisture. Water tightness shall be interpreted to be no free dripping water on any surface on the underside of the joint. Patches of moisture shall not be cause for non-acceptance.

Should the joint system exhibit evidence of water le... shall locate the place(s) of leakage and take all... shall be done at the Contractor's expense. ... subject to the same conditions and conse...

567-3.02 Armored Joint System with Compre...

A. Delivery. The joint system shall be delivered to the work site ready for installation in accordance with the requirements of 567-2.02B1.

Five working days after

15 minute period and also for a minimum of 45 minutes after

Done

Unknown Zone | Protected Mode: On

1:05 PM
2/13/2015

Half Time Entertainment

Questions to Ponder

If you throw a cat out of the car window, does it become kitty litter?

Questions to Ponder

Why do we say something is out of whack?
What is a whack?

Questions to Ponder

You can be overwhelmed and underwhelmed, but why can't you be simply whelmed?

Questions to Ponder

What do people in China call their good plates?

Questions to Ponder

Do Roman paramedics refer to IVs as "Fours"?

Questions to Ponder

If a bunch of cats jump on top of each other, is it still called a dog pile?

Questions to Ponder

When French people swear, do they say "pardon my English?"

Batching of UHPC

Batching

- Can Be Mixed by:
  - Small Portable Mixers *
  - Batch Plant Mixers
  - Ready-Mix Trucks
- The higher the energy of the mixer, the faster the mixing occurs
  - Mixing is critical path, so pay attention !!!

Batching

- Ready Mix Truck
  - Long Duration Mixing
  - Maybe 30-40 minutes per load
- Most Common
  - Onsite Portable – 13 cubic feet per batch
  - Each batch 10-15 minutes
  - Deployed in pairs, so new ½ yd load every 5-7 minutes

Batching Warning

- During Mixing UHPC is thicker than conventional concrete
- Too big of a batch can bend mixer arms or burn out motor, etc.
- Fibers will ball up if you put them in too fast or if you put in too many
  - 2% is normal
  - 130 lbs per 1/2 yard batch

Shot Clock After Batching

- Can be workable up to an hour or more
- Very dependent on air temperature, concrete temperature, wind, sun
- Need to keep agitating the mix if you want it to be workable for a longer duration
- If left exposed to adverse weather conditions:
  - Surface dehydration – very little water to start with
  - “Elephant Skin” forms on surface with still fluid UHPC underneath


Need Batch Plant Close to Pour Area


Iowa Project
Need 6-7 guys for batching
15-20 minutes per batch
ZIEGLER CAT
POWER FOR
ZIEGLER POWER SYSTEMS
uctal


Ductal
POWER FOR RENT

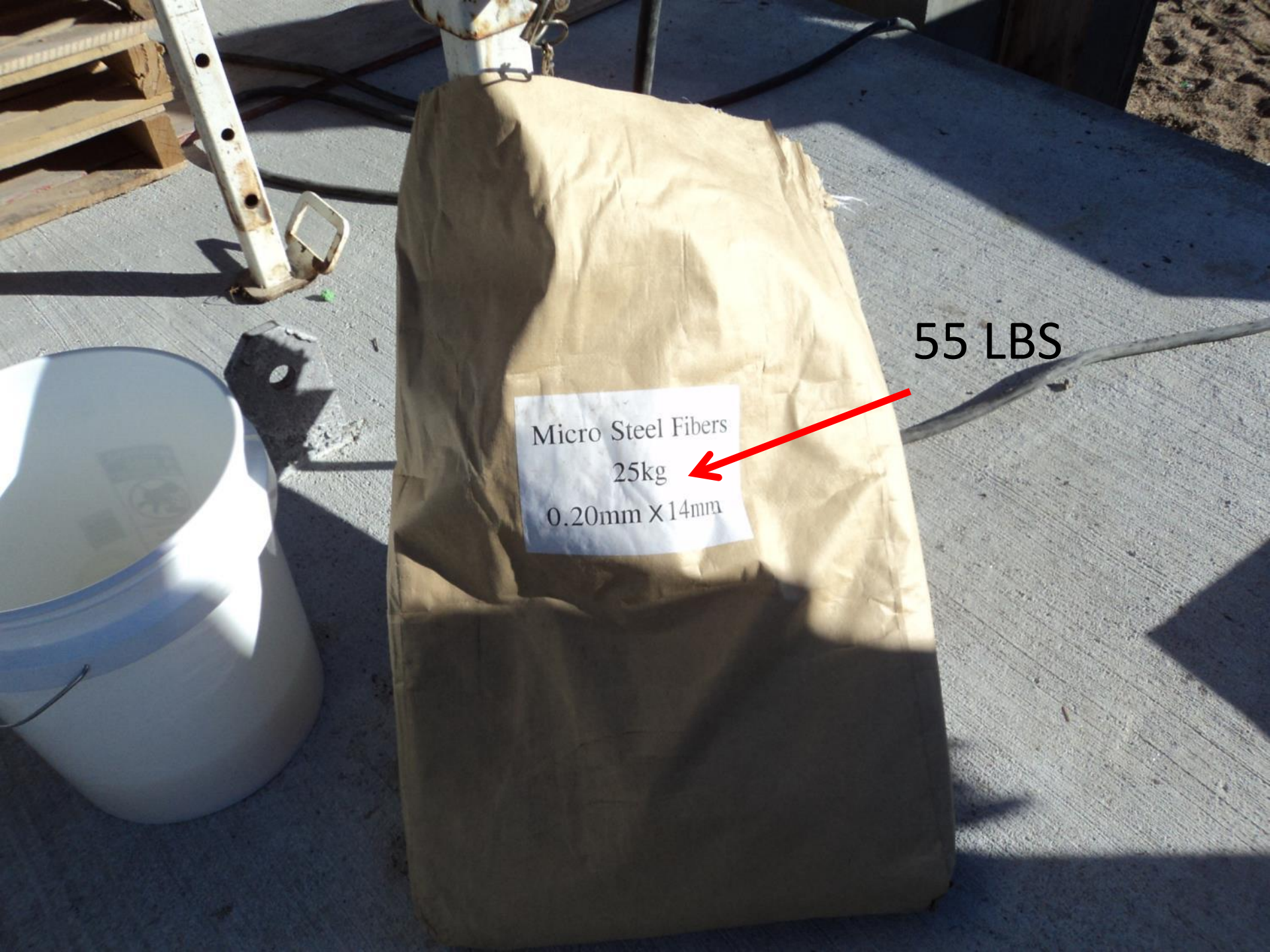

ZIEGLER CAT
CANYCOM

Nebraska Project


Ductal


Micro Steel Fibers
25kg


LAFARGE
Ductal
premix grey / mélange gris
DANGER
CORROSIVE / CORROSIF
50 lbs / 23 kg


55 LBS
Micro Steel Fibers
25kg
0.20mm X14mm


Ductal
Ductal
RYAN


SIMON
CONTRACTORS
DANGER


SIMON
CONTRACTORS
Company
DANGER
PINCH POINT


Ductal
RYAN
NDOR


CHRYSO
LAFARGE
NORTH AMERICA
CHRYSO® Fluid Premia 150
CAM11848 20414296
ASTM C-494 Type A and F, High Range Water Reducer
SAFETY INSTRUCTIONS: Read Before Use
CAUTION! MAY CAUSE IRRITATION
Irritant. Sensitizer. - May cause respiratory, skin and eye irritation
1 0 0
Precautionary Measures:
Avoid contact with eyes, skin and clothing
Wash thoroughly after handling
Avoid breathing vapors
Use with adequate ventilation
DISCHARGE AND DISPOSAL:
According to EPA(40CFR 261.3) waste of this product is not defined as hazardous. Dispose of waste in accordance with all applicable local, state and federal regulations. In case of spill, collect liquid or solidify liquid with an inert, noncombustible material and remove for disposal
For additional information, refer to MSDS
In case of emergency, call CHEMTREC 1-800-424-9300
FOR INDUSTRIAL USE ONLY.
KEEP OUT OF CHILDREN'S REACH.

Notes on Connection Details

Keep it Simple

Notes on Connection Details

Lots of Rebar
Equals
Lots of Labor

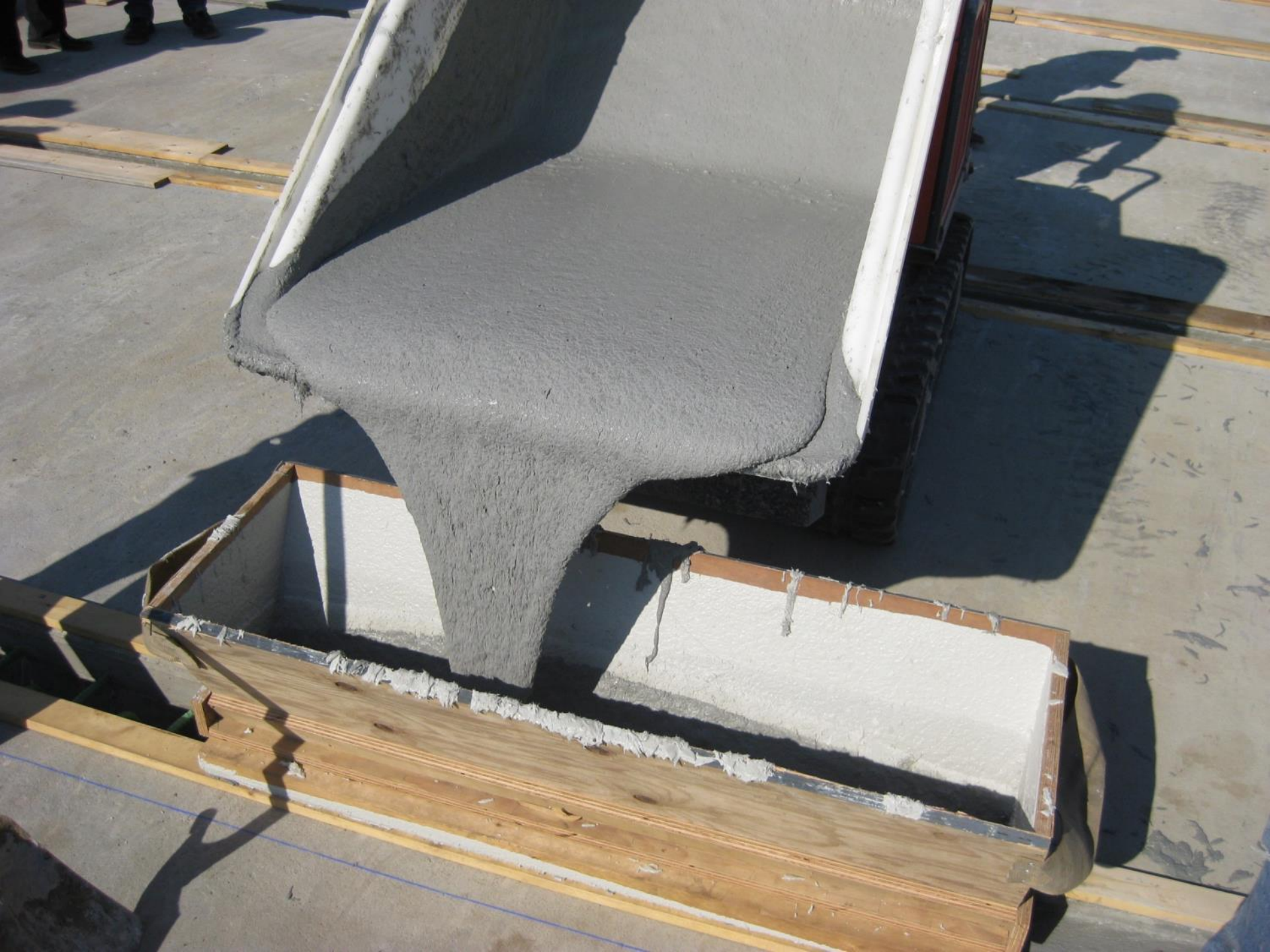

Epoxy Coating Damage

Steel Congestion – Try to Avoid


Non-contact rebar lap splice

UHPC Placement


Joint Dams




JoyofBlending.com


NDOR

Narrow Joints - Trough


Wider Joints May Not Need Troughs


Several Troughs Necessary with Several Buggies

Need for Tight Forms

Warning: DO NOT VIBRATE - Steel Fibers will Settle


Leak in Forms


2 more joint leaks on
East Abutment end

Parapet Closure Pour

Nebraska Placement Method

Chimney and Cover Method


ACE


NDOR


TRUPER


ACE

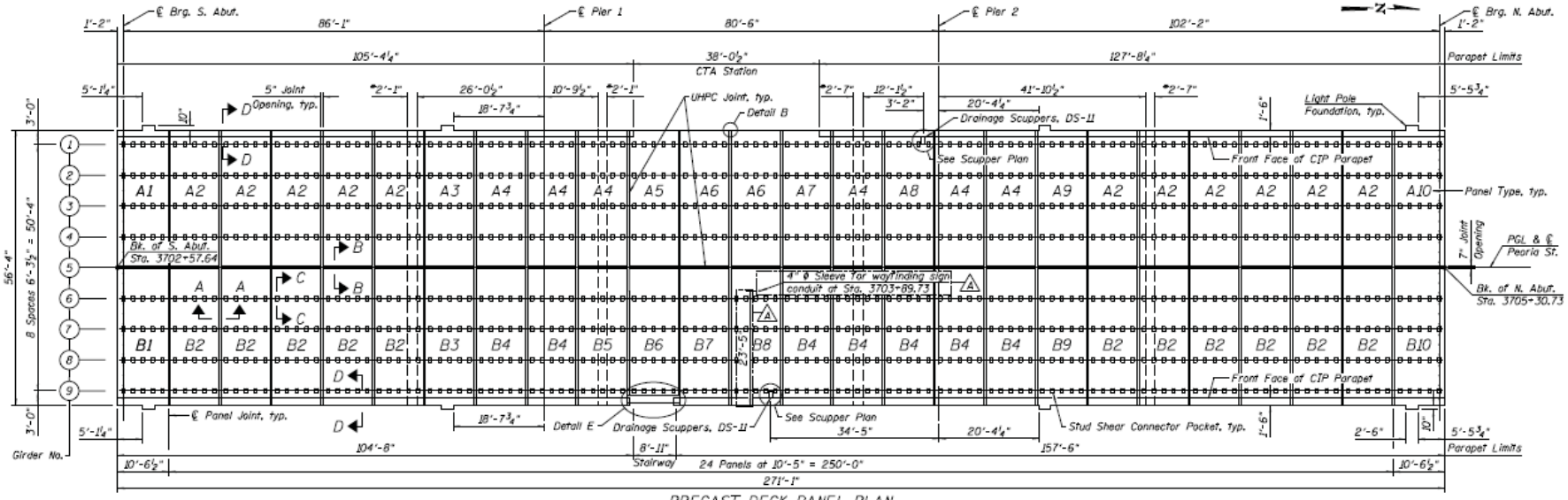

ACE


Aesthetics Concern?
After 5 yrs in service

My New Favorite Porto Potty Name

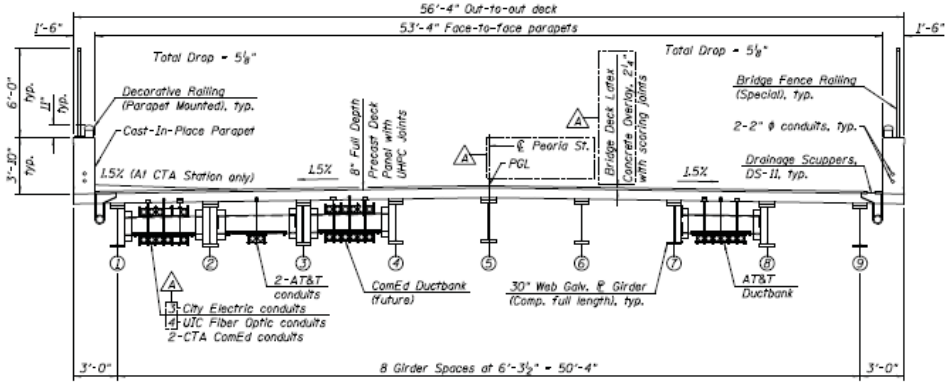
Illinois's First UHPC Project

- Peoria Street Bridge at the Circle Interchange
  - Downtown Chicago
- Contract: 60W29
- Structure Number: 016-1708
- Letting: 02/28/2014



PRECAST DECK PANEL PLAN

* Do not place stud shear connectors within this region (field splice).

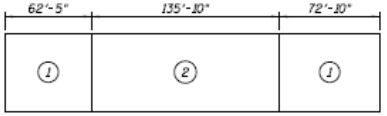


CROSS SECTION

(Looking North)

SUGGESTED CONSTRUCTION SEQUENCE

1. Erect steel girders.
2. Cast abutment diaphragms.
3. Clean surfaces of deck panel shear keys and stud shear connector pockets.
4. Install drainage scuppers.
5. Preset leveling bolts to anticipated height.
6. Erect precast concrete deck panels according to the erection sequence for Stage 1.
7. Adjust leveling devices on deck panels to bring panels to grade.
8. All leveling bolts shall be torqued to approximately the same value (20 percent maximum deviation).
9. Form and cast transverse and longitudinal UHPC joints for Stage 1.
10. Repeat steps 6-9 according to the erection sequence for Stage 2.
11. Install stud shear connectors in all blockouts.
12. Form fillets between the top of the girders and the bottom of the deck panels.
13. Grout all fillets and stud shear connector pockets with a flowable, non-shrink grout.
14. Cast Concrete Superstructure slab at CTA stairway.
15. Cast parapets.
16. Place latex concrete overlay.



PANEL ERECTION SEQUENCE

Precast Concrete Deck Panel Notes:

Contractor shall field verify all dimensions and horizontal locations prior to ordering materials to verify fit-up of new deck panels.

The panel layout and dimensions provided are suggested. Final panel layout and dimensions shall be shown on the panel shop drawings.

All panel dimensions provided on the superstructure plans are plan dimensions. The fabrication dimensions on the panel shop drawings shall account for the profile and slope of the proposed bridge deck.

Contractor shall be responsible for exercising care in lifting, handling, storing, and transportation of the precast slab panels to prevent cracking or damage. Panels shall be lifted by devices as designed by the contractor and approved by the Engineer.

UHPC shall reach a strength of 14.5 ksi before live loads or deck overlay can be applied to the bridge.

Contractor shall apply set retarder to inside of side bulkheads and to stud pocket blockouts on the day prior to a pour to avoid interference with form setup. After form stripping, set retarder shall be thoroughly cleaned off keyways (and stud pockets) using a water blast to create the desired exposed aggregate finish.

BILL OF MATERIAL

Item	Unit	Total
Precast Concrete Deck Panels	Sq. Ft.	15,272

Notes:

See Sheet 16 of 55 for Sections A-A, B-B, C-C, D-D, Detail B and Scupper Plan.

See Sheet 23 of 55 for Detail E.

See Sheet 20 of 55 for Bill of Material.

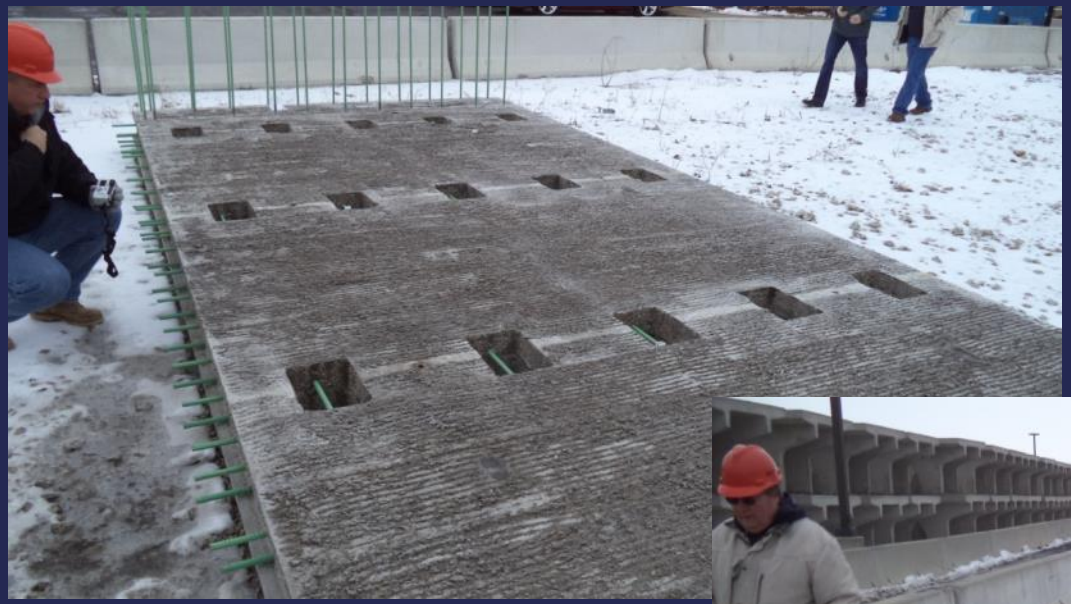
See Sheet 21 of 55 for parapet reinforcement.

Type and location of precast inserts for utility hangers shall be coordinated with the utility companies. Cost included in Precast Concrete Deck Panels.

See Lighting Plans for parapet conduit sleeve locations.

See Roadway Plans for scoring joint details.

A *Location of the 4" ϕ sleeve for the wayfinding sign conduit shall be confirmed with the University of Illinois at Chicago prior to fabrication of the deck panels.*




01 23 2015


01 23 2015

Illinois' First UHPC Project

- Status
  - Maybe about 40 of 52 panels are fabricated
  - Currently scheduled to be delivered to project in late March
- UHPC work not expected until May/June

Every Day Counts Initiative (EDC 3)

EDC-3 Innovations (2015-2016)

EDC-3 Overview Video


3D Engineered Models


e-Construction


eNEPA and IQED


GRS-IBS


Railroad Coordination


Regional Models of


Road Diets


Smarter Work Zones


Stakeholder Partn ing


Ultra-High Performance Concrete Connections


Data- riven Safety nalysis

Illinois DOT / FHWA EDC3 Deployment Team

- Dan Brydl – Co-Chair
- Gary Kowalski – IDOT Bridge Office – Co-Chair

- Other Team Members: TBD

STIC Incentive Funding

- Up to $100,000 per State per fiscal year

- Peer Exchanges
- Scanning Tours
- Computer Software
- Equipment
- Not for research, but for deployment of ready-to-go technologies

FHWA "Accelerated Innovation Deployment" (AID) Demonstration program

- Rolling Grant Applications
- No annual call for candidates
- Team assembles and evaluates as candidates come in
- States apply directly to grants.gov
- Up to $1,000,000
- $36 million total program - ongoing until funds run out
- $13.371 million distributed to 20 projects to date

IDOT Funding

- $4 million to be applied to ABC/PBES
- Just need suitable candidates

FHWA UHPC Website

- https://www.fhwa.dot.gov/research/resources/uhpc/
- Web Search: *UHPC FHWA*
- *Overview, Research Projects, Bridges, Publications*

UHPC Resources

Design and Construction of Field-Cast UHPC Connections (HRT-14-084)

UHPC State-of-the-Art (HRT-13-060)

UHPC Memo (Feb 12, 2014)

Deployment Activities

- Webinars
- Workshops
- Conferences
- Peer Exchanges
- Project Showcases

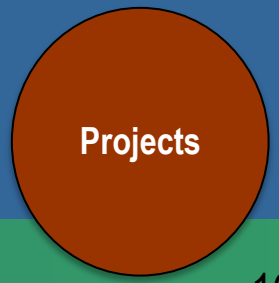
- Online technical assistance service
- Online shared project review service

Activities

DRAFT

National Deployment Goals

- 100 UHPC/PBE projects under design/construction
- 25 UHPC/PBE projects mobility impact < 3 weeks
- 25 State DOTs to be fully implemented
- 50 Projects in the National UHPC Project Exchange



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National Deployment Goals

- State - *fully implemented*
  - Adopt *UHPC Specification* and/or *UHPC Design Criteria* as part of your BDM
  - 2-4 projects: constructed or under design
  - 1 project: mobility impact < 3 weeks
  - 2 projects: National UHPC Project Exchange

Projects

Summary

- Promising Technology
- Price is high right now
- No concerns about Buy America or Sole Source anymore
  - Many States using non-proprietary performance-based specs requiring qualification testing

Summary

- Practical Considerations
  - For non-overlay decks, overfill joints by ¼”, then grind
  - Pre-wet panels to SSD – CRITICAL
  - Leak proof forms are essential – highly flowable
  - Communication between UHPC supplier and contractor is key


Questions ????