

Every Day Counts – EDC-3
Ultra-High Performance Concrete Connections
for Prefabricated Bridge Elements
May 24, 2022

IMPLEMENTATION OF UHPC:
PROJECTS, FUTURE PLANS, AND
INTERACTIVE DISCUSSION

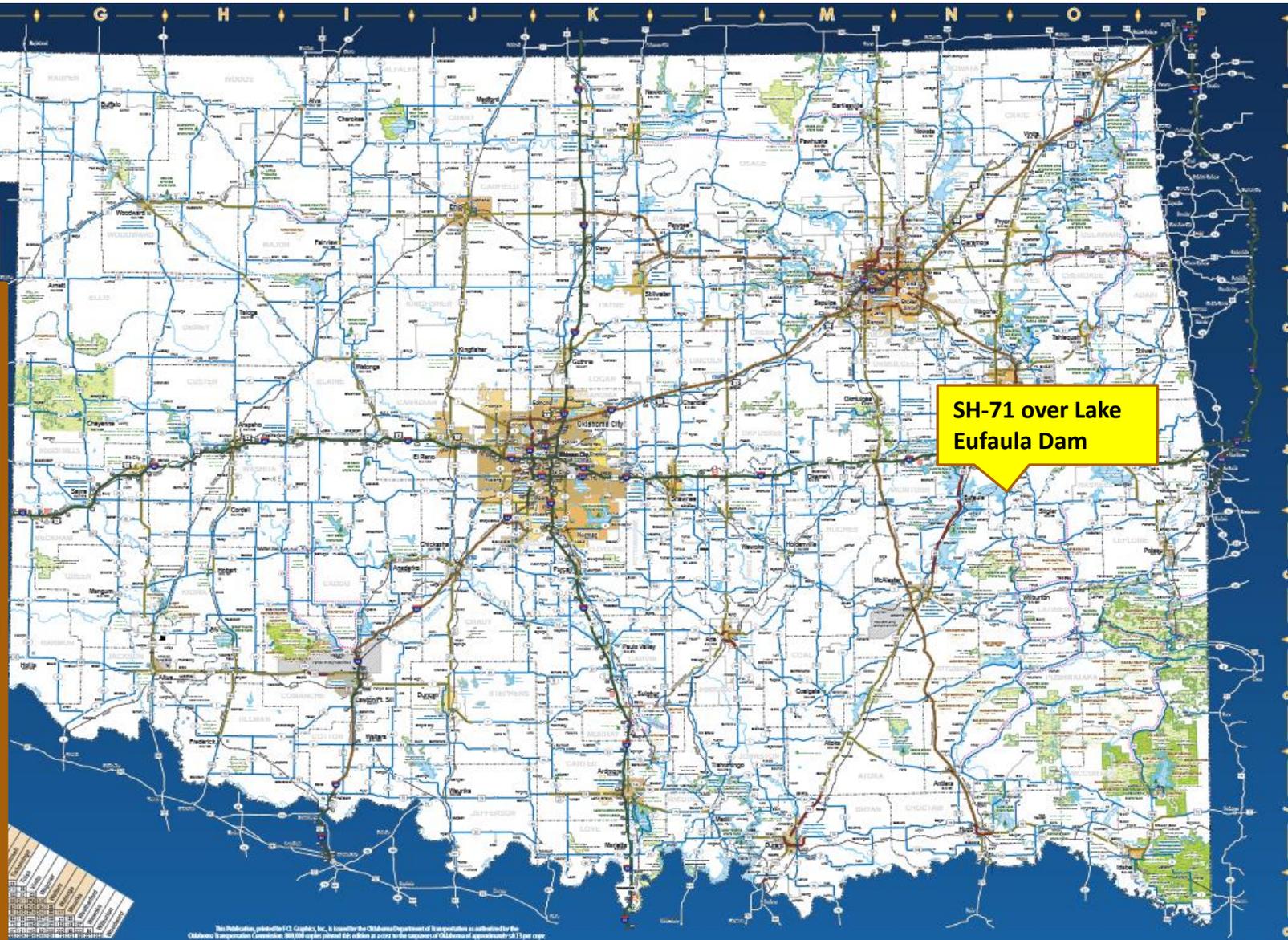


Project Location: SH-71 over Eufaula Dam East of Eufaula, OK



Oklahoma!

LEGEND	
Cities & Towns	Roadways
★ State Capital	— Adjoining State Highway
● County Seat	— Interstate / Free
● 100,000 and over	— Multilane / Controlled Access
○ 50,000 to 99,999	— Multilane / Turnpike
○ 10,000 to 49,999	— Other Multilane Highway



SH-71 over Lake Eufaula Dam



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The old bridge was showing signs of distress. The decision was made to replace.

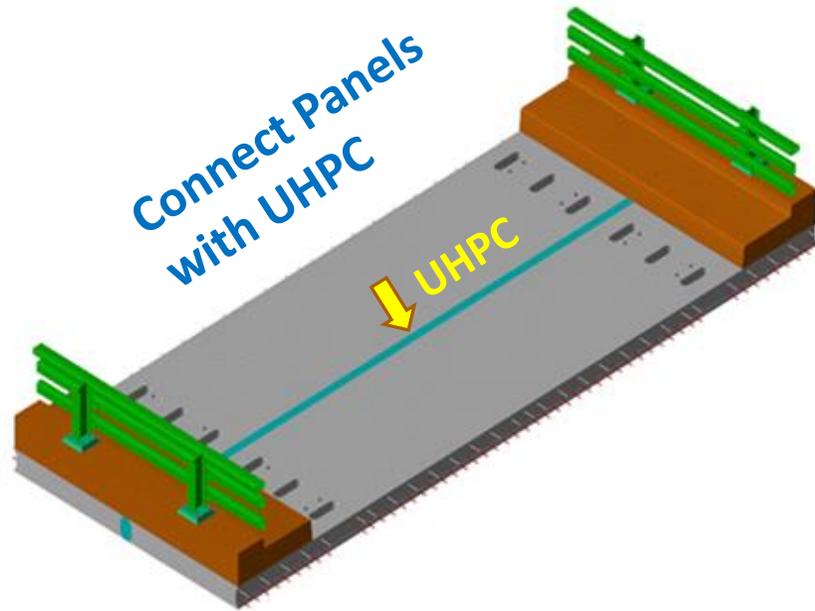
Note repairs by ODOT Maintenance – District 1



US Army Corps of Engineers
Tulsa District

North Canadian River
McIntosh County, Oklahoma

The Corps of Engineers Decided to replace the bridge and use UHPC to connect full depth precast deck elements for the bridge structure over Lake Eufaula Dam.



Presentation:

1. UHPC – Material Properties
2. Plan Drawings
3. Photos
4. Conclusion

- ▶ **Improved Long-Term Performance.** Field casting of UHPC connections between prefabricated components results in a strong connection that provides better long-term performance.



CURRENT STATE OF THE PRACTICE

Technical advancements and policy developments related to UHPC further support agency-owners who routinely make use of prefabricated bridge elements.

Domestic production of the steel fiber reinforcement used in UHPC began in 2013 and is expected to open the door to more agencies that are interested in using UHPC, but were previously hindered by Buy American provisions.

New York is leading the way, with more than two dozen bridges constructed using UHPC for prefabricated bridge elements. Other states that have used UHPC for bridge-related applications include Iowa, Oregon, Montana and New Jersey.

For additional information, please contact:

Benjamin Beerman
FHWA Resource Center
404-562-3930
Benjamin.Beerman@dot.gov

The presentation at the [EDC-3](#) meeting in St. Louis was given by [Benjamin Beerman](#).

Advantages of Ultra High Performance Concrete (UHPC)

- Compressive Strengths greater than 21,700 psi.
- Post-cracking tensile strength greater than 720 psi.
- Water-to-cementitious materials ratio less than 0.25
- UHPC has a discontinuous pore structure that reduces liquid ingress, significantly enhancing durability compared to conventional concrete.
- Makes short splices feasible.



Domestic production of this type of fiber is available for projects that must adhere to the **Buy America** provisions of Federal law.

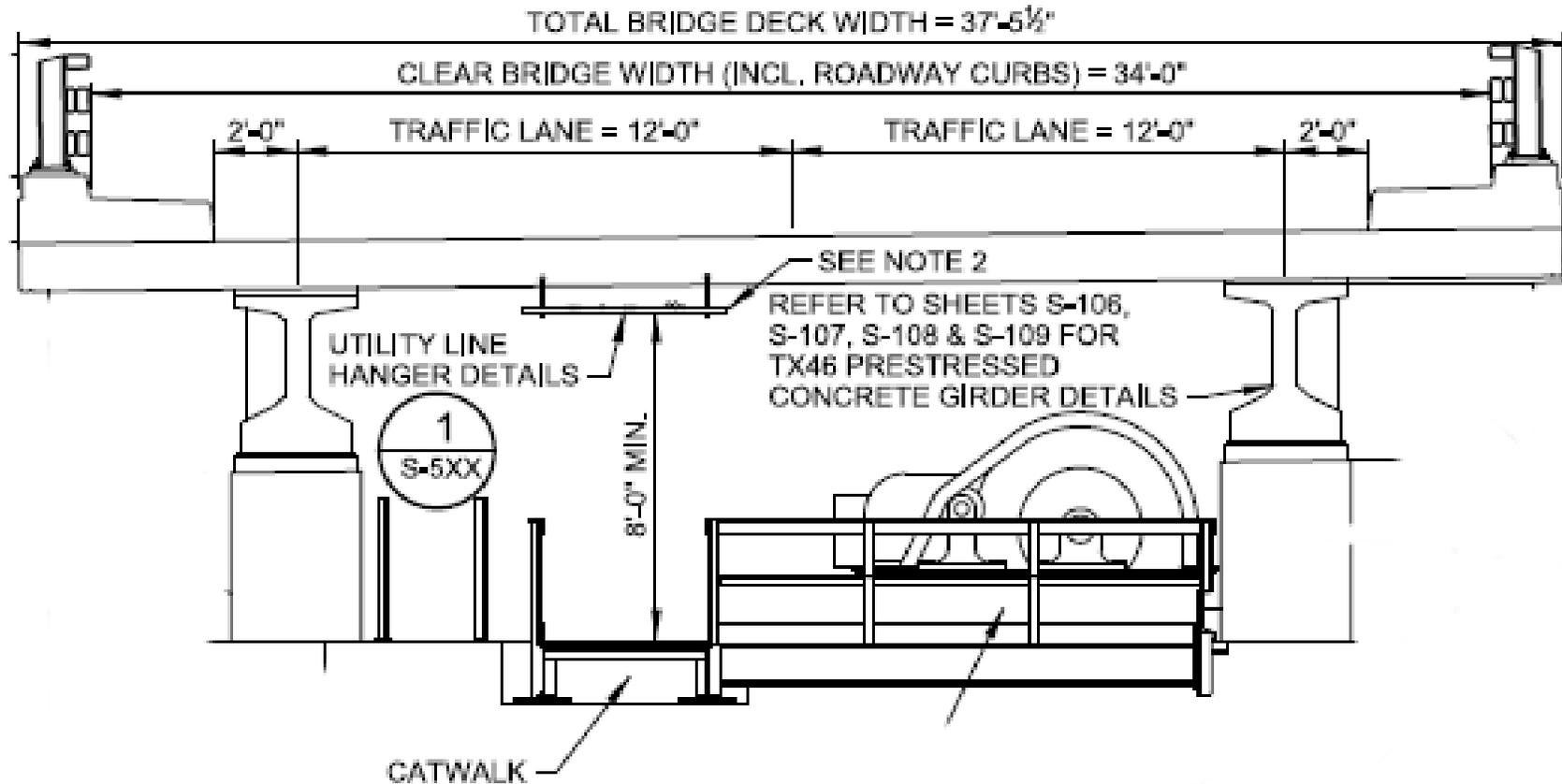
Key to UHPC is the Steel Fibers:

- Typical Length: 0.50 inches
- Typical Diameter: 0.008 inches.
- Tensile Strength 290 ksi.

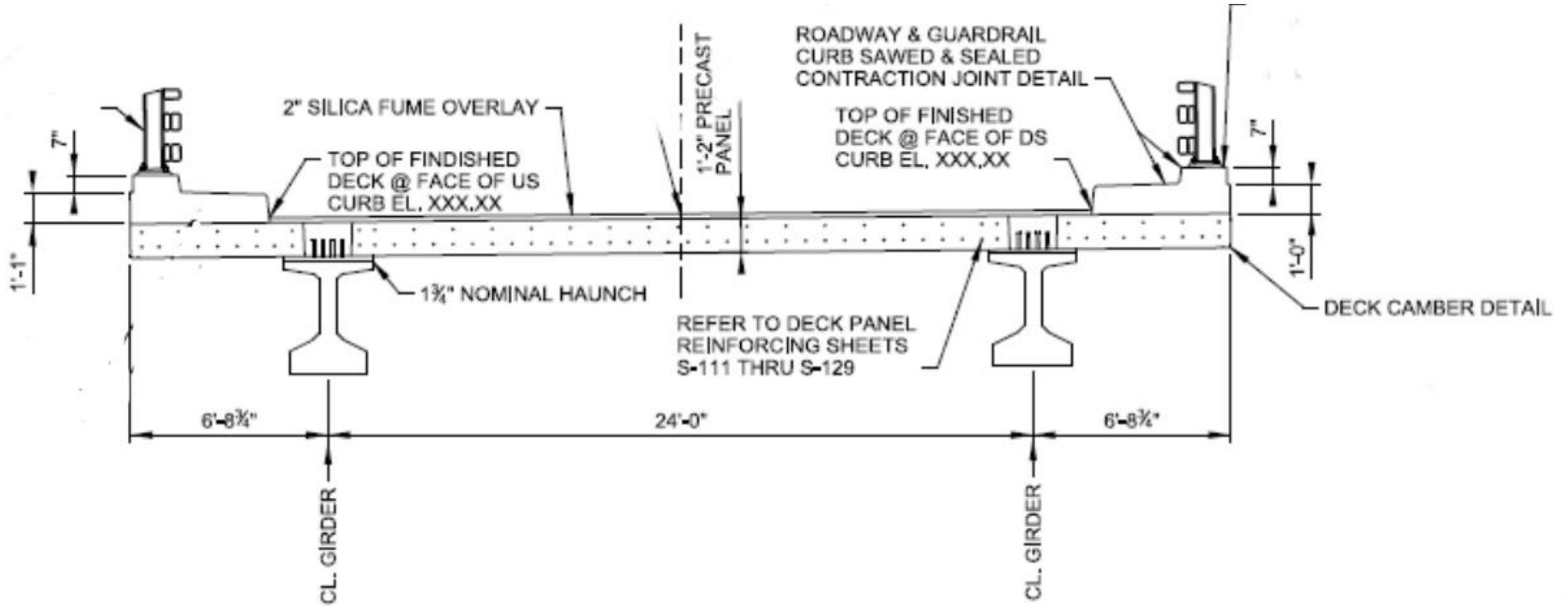
UHPC Disadvantages:

- Fibers must be handled carefully
- Fibers make mixing more difficult
- Forms must be water tight
- Must obtain 14 ksi to open to traffic
- Contractors not familiar with this material

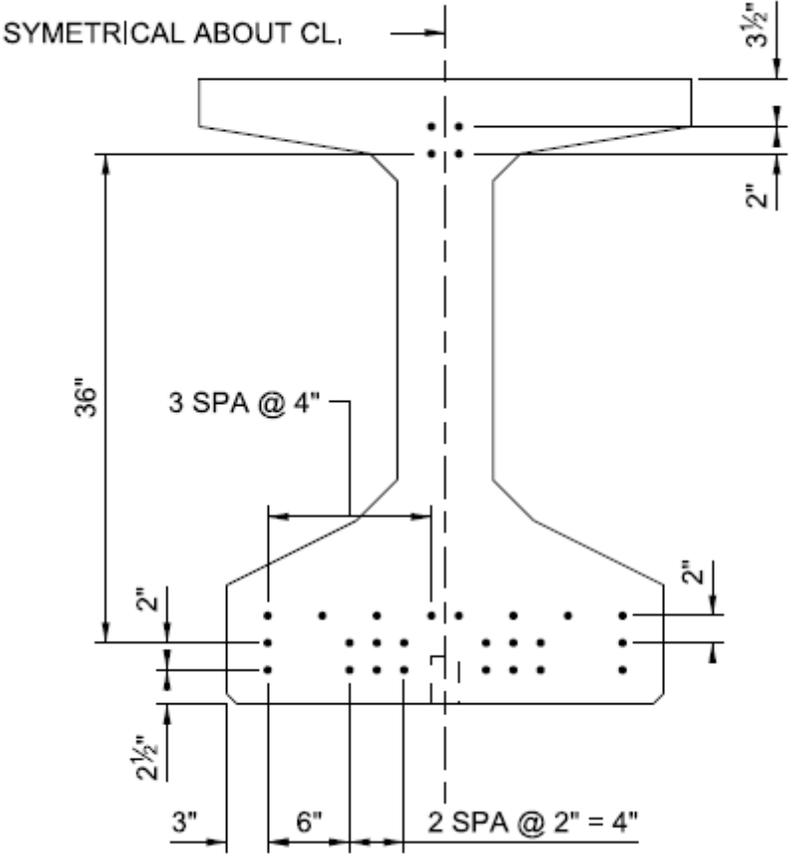
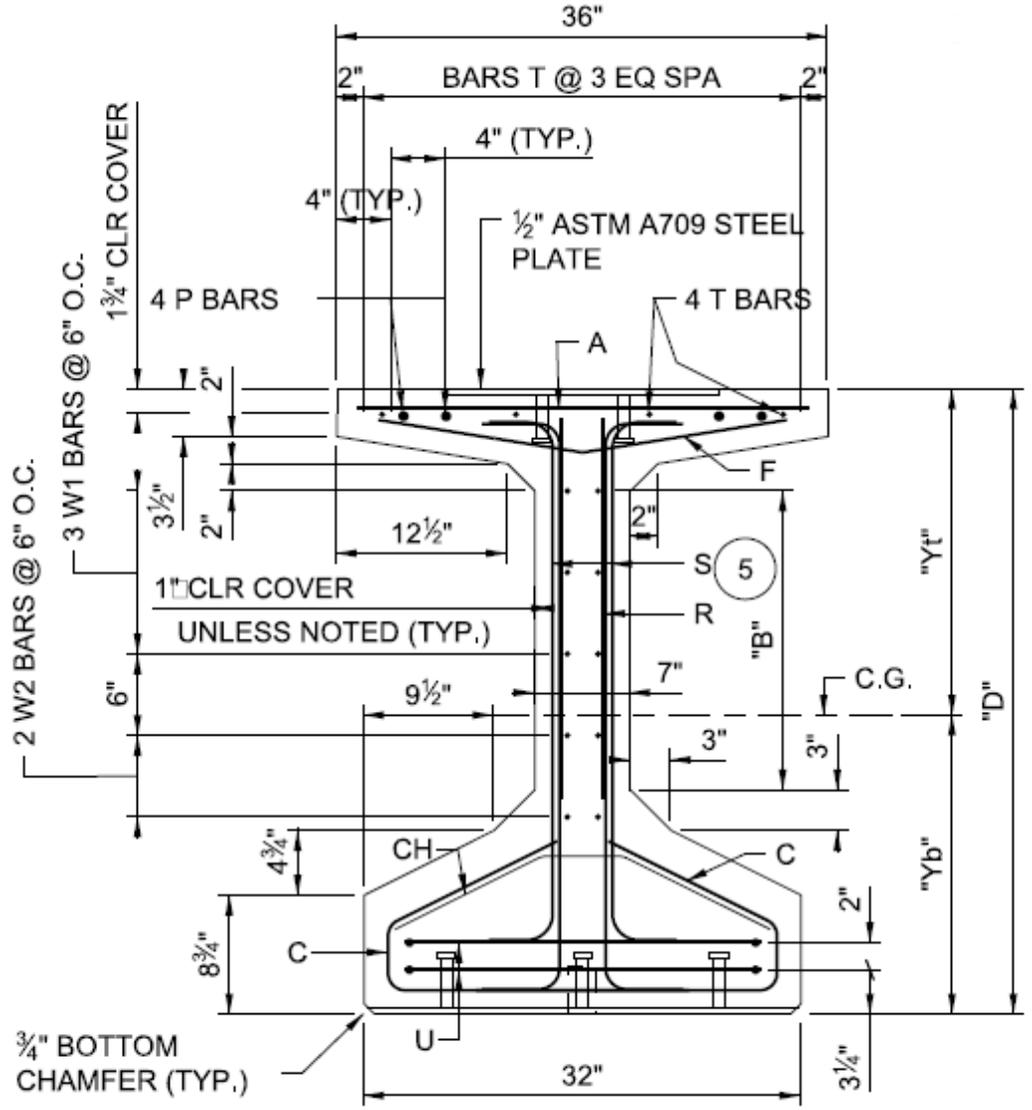
Note that equipment below the bridge structure required a two girder design – 28'-0" Clear Roadway.



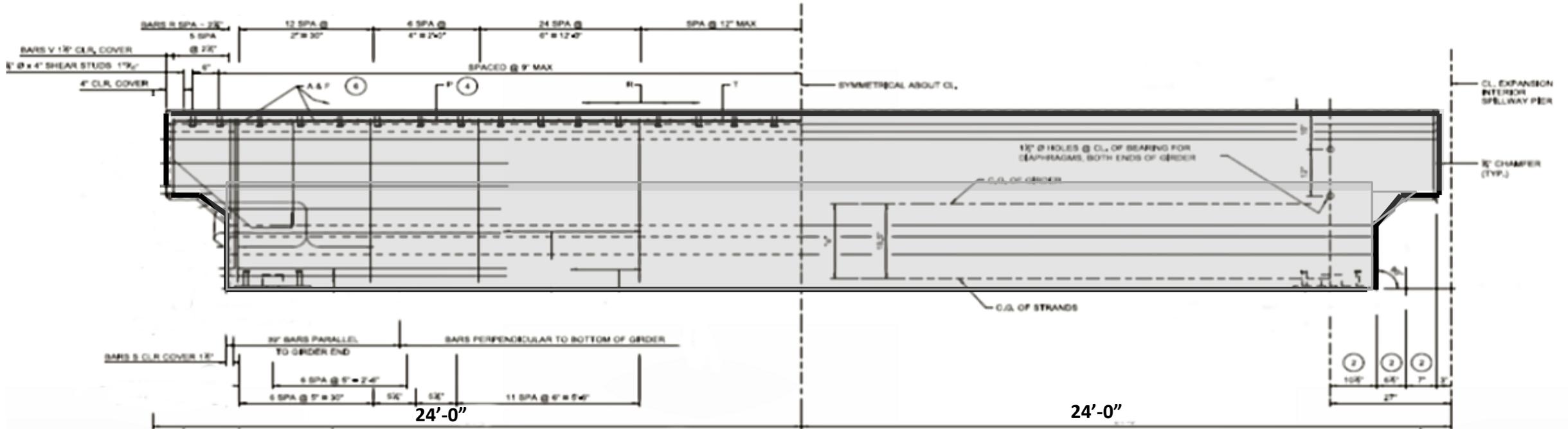
Typical Section 24'-0" Girder Spacing



TX46 (H=46")



PCB: 43'-6" c/c Bearing – Beam length 47'-6"



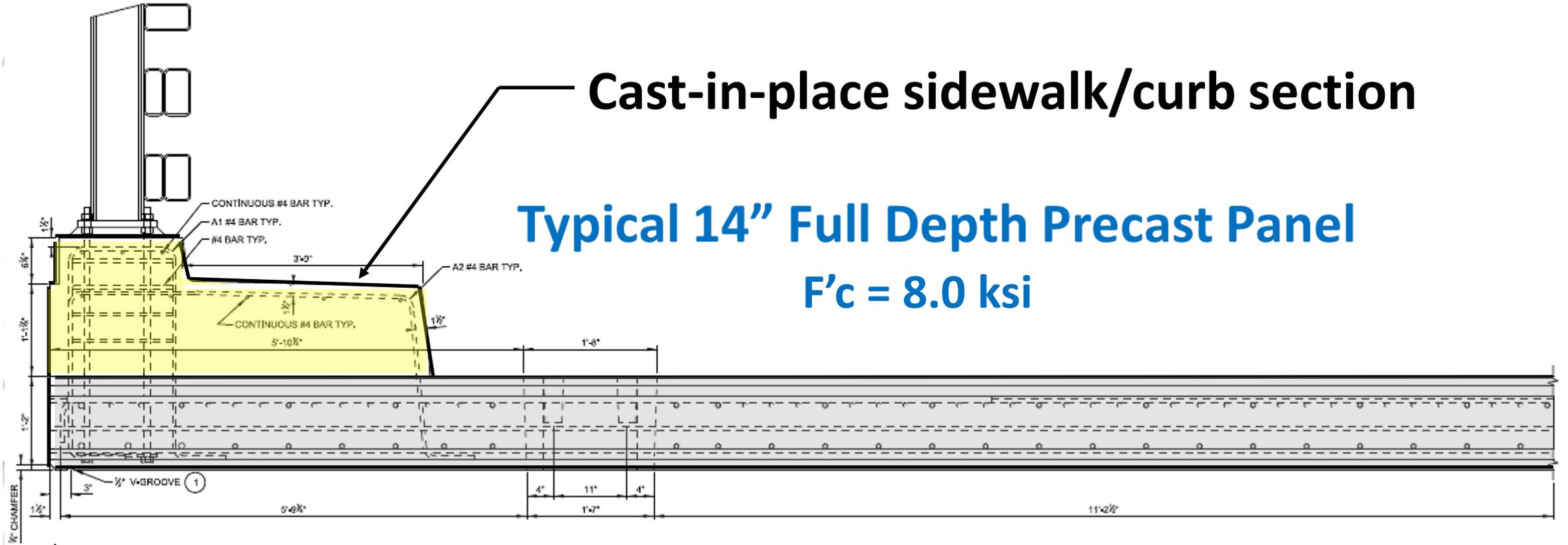
48'-0" Spans c/c Piers

GIRDER DIMENSIONS AND NON-COMPOSITE SECTION PROPERTIES									
GIRDER TYPE	"D"	"B"	"Yt"	"Yb"	"e"	AREA	"Ix"	"Iy"	WEIGHT
	(IN.)	(IN.)	(IN.)	(IN.)	(IN.)	(IN.) ²	(IN.) ⁴	(IN.) ⁴	(PLF)
TX46	46	22	25.90	20.10	19.50	761	198,089	46,478	819
T-SECTION	23	15.5	7.33	15.67	-	300	13,489	16,955	323

Cast-in-place sidewalk/curb section

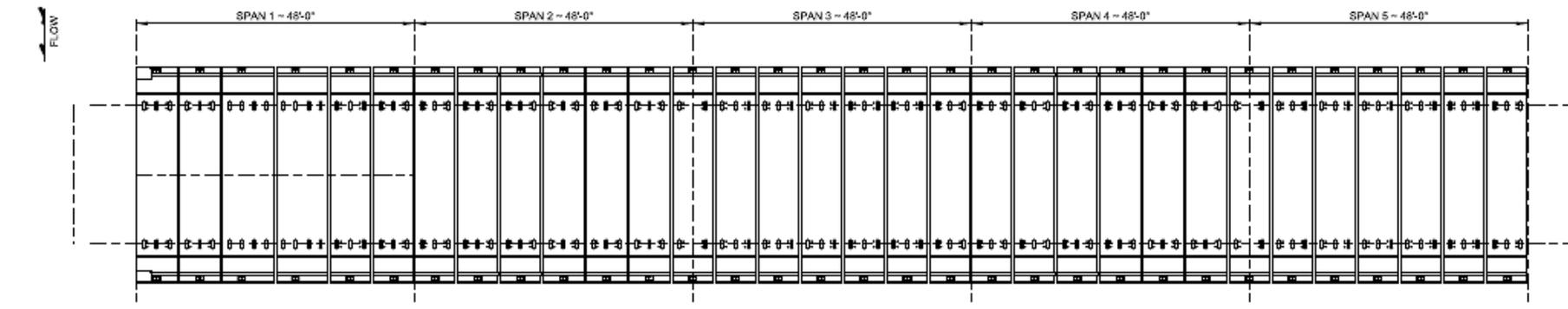
Typical 14" Full Depth Precast Panel

$F'_c = 8.0$ ksi



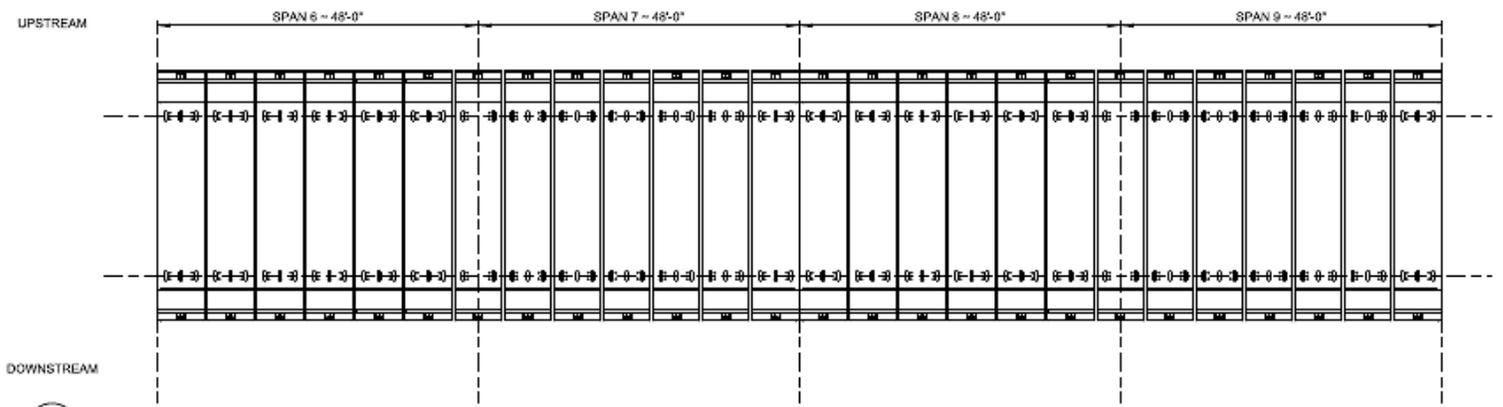
Total Panel width 36'-5 1/2"

Precast Panel shown in Gray



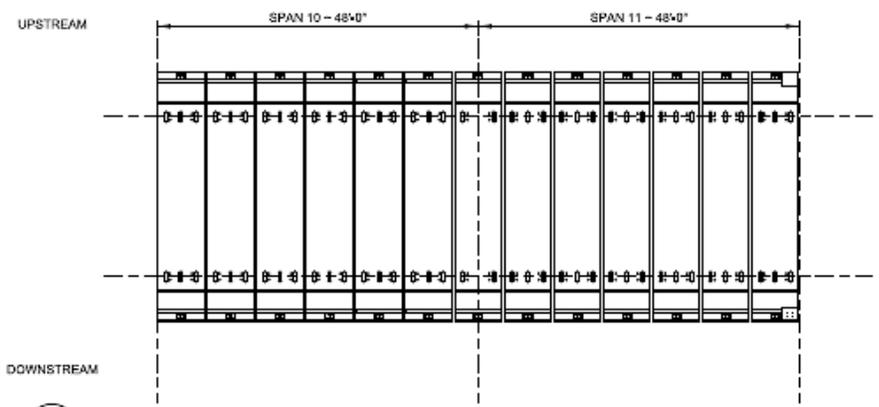
DOWNSTREAM

A NEW DECK PANEL DESIGNATION SPANS 1 THROUGH 5
8-110



UPSTREAM

B NEW DECK PANEL DESIGNATION SPANS 6 THROUGH 9
8-110



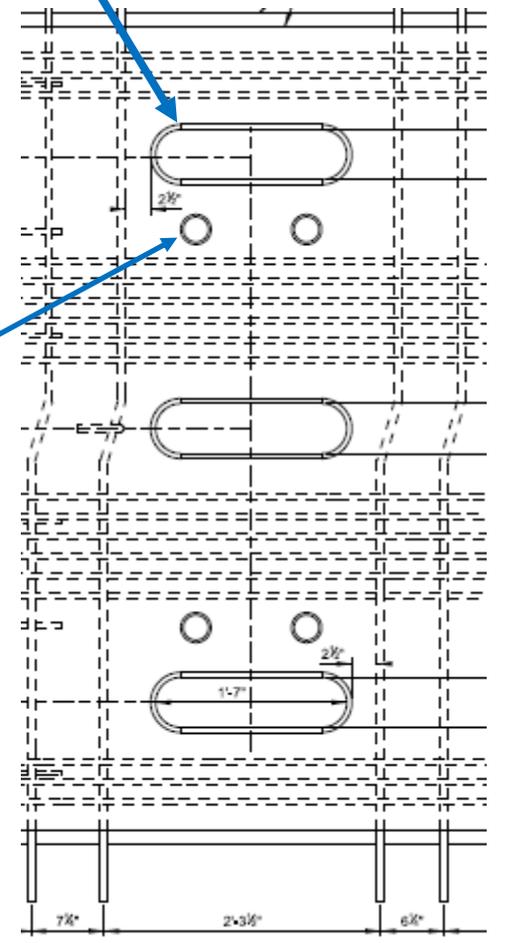
DOWNSTREAM

C NEW DECK PANEL DESIGNATION SPANS 10 THROUGH 11
8-110

Full Width Precast Panels. Fill openings with UHPC.

Openings for Studs

Holes for Leveling bolts





Gantry Crane runs on track shown below.



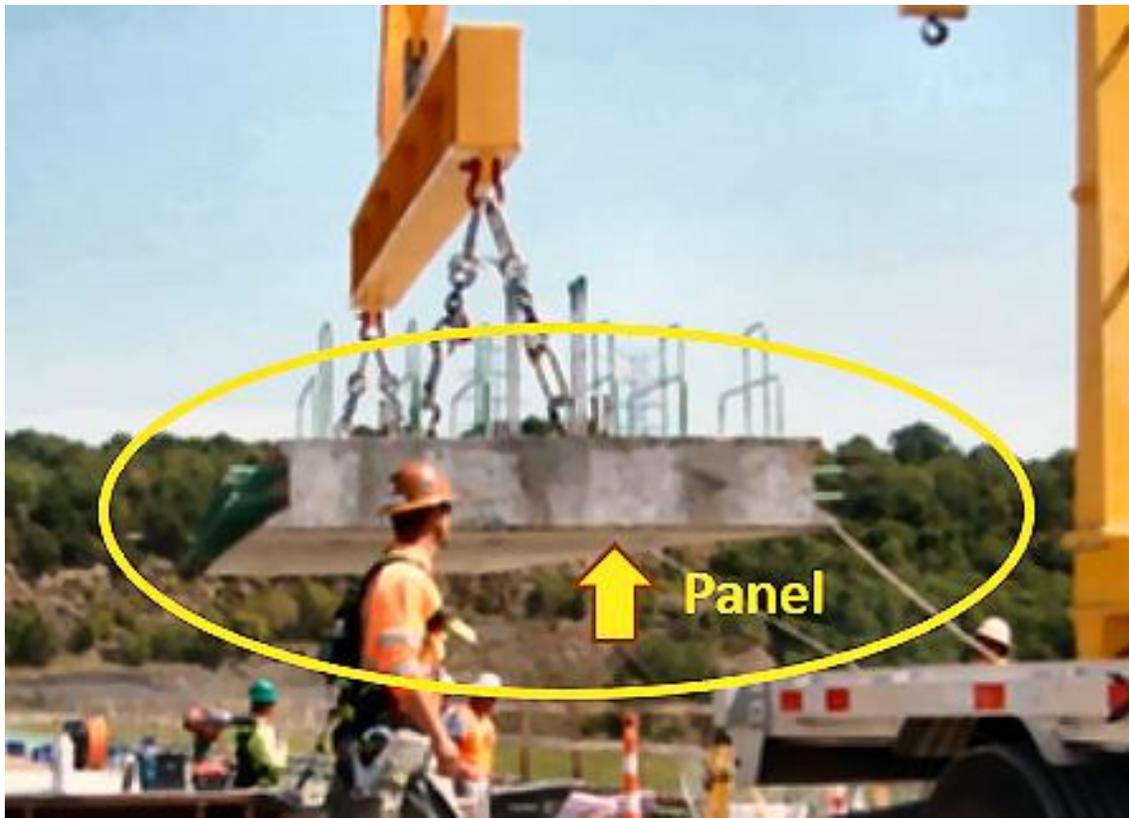
**Gantry Crane
Used to place panels**



Gantry Running on Track

Support for Gantry





Precast panel being swung into position using gantry crane.

Panels in place on beams



Contractor: Mobley out of Arkansas



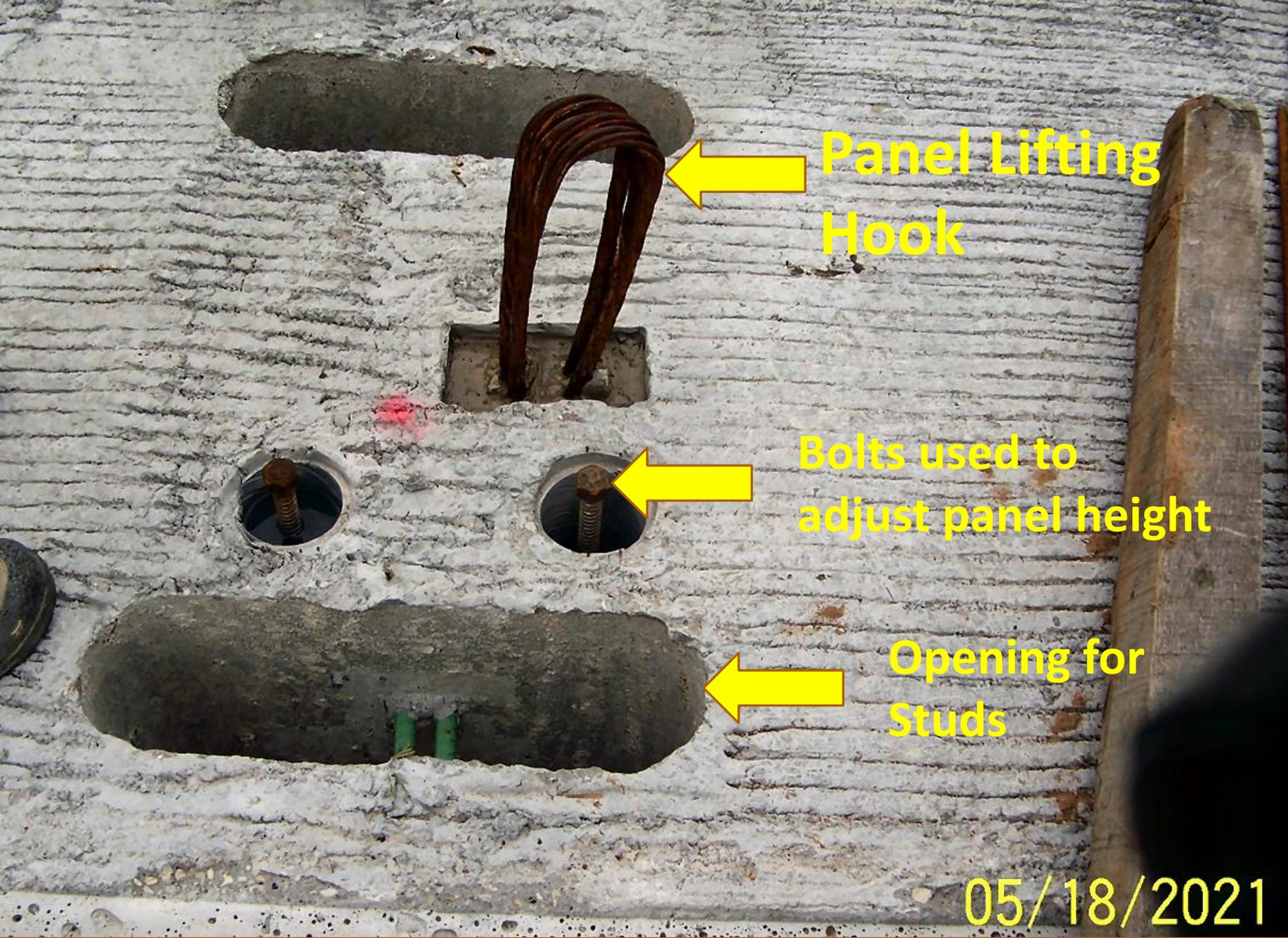
Looking down on the prestress beam note steel plate on the top of the beam. Studs will be welded to the steel plate.



Mock-up Bridge
Photo Provided by OU

UHPC Placement shown was for the Mock-up bridge. Night pours were required for the UHPC placement on the actual bridge due to the temperatures during the hot summer days.

Lessons learned on the Mock-up bridge greatly reduced the problems encountered on the actual bridge placement.

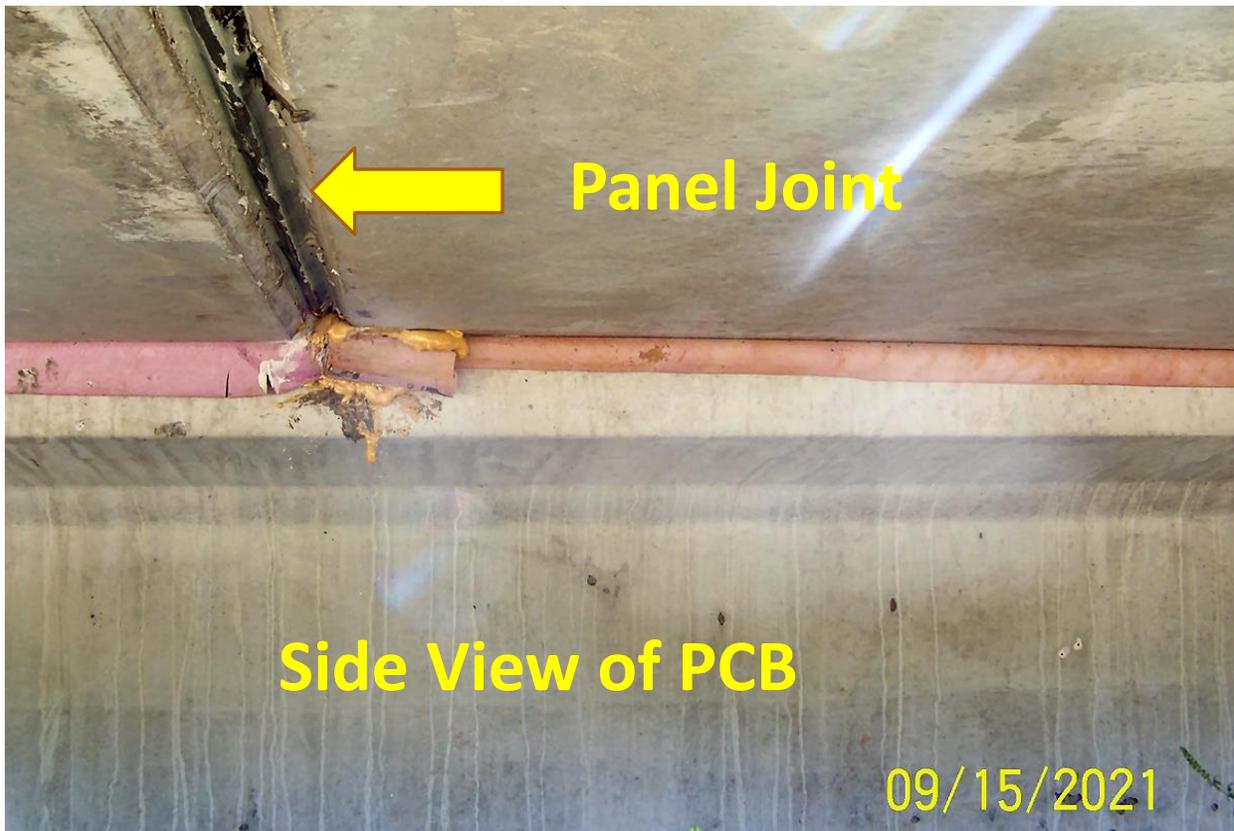


Panel Lifting
Hook

Bolts used to
adjust panel height

Opening for
Studs

05/18/2021



**Mockup Bridge –
Looking up from the
bottom of the panels.**

Note – Joints do **NOT Leak.
UHPC makes for **very durable**
construction.**

Actual Bridge



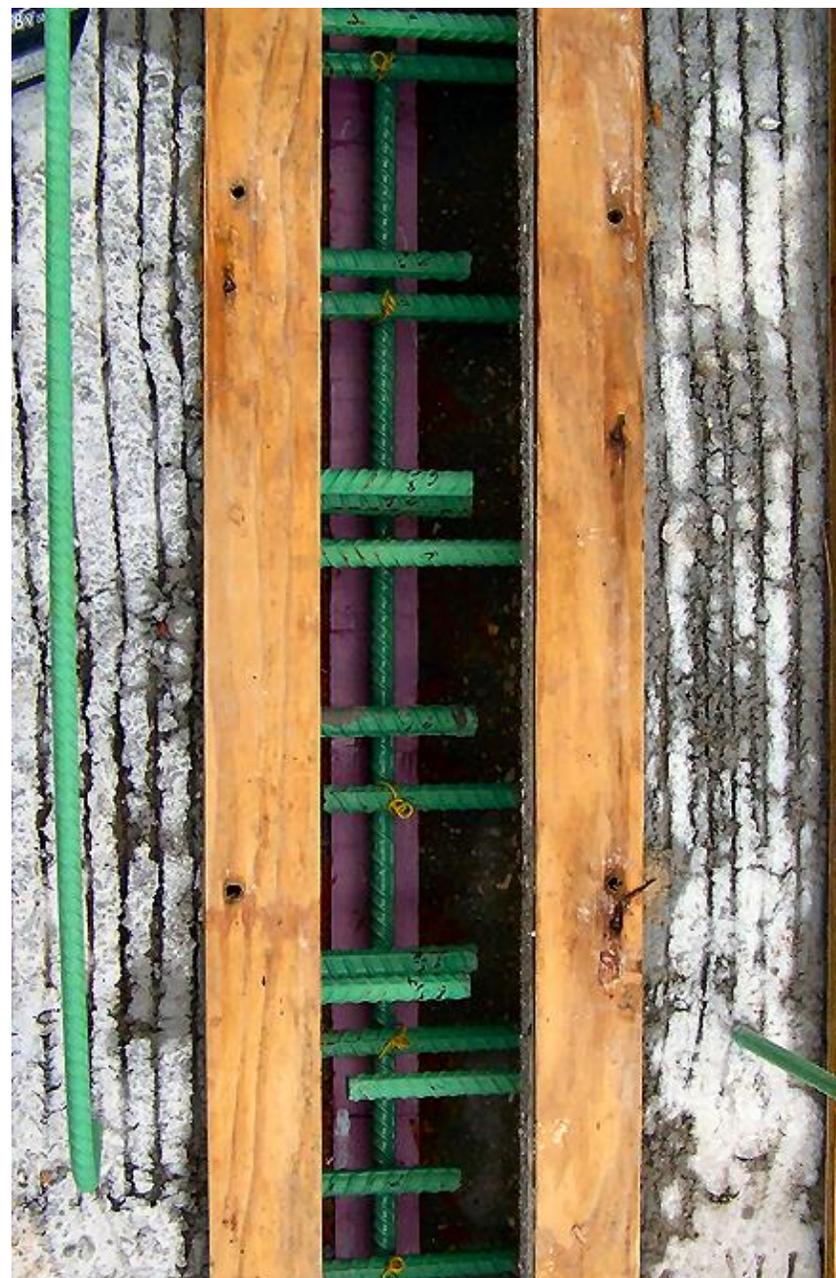
Side View of PCB



Foam placement to seal joints form UHPC placement. Joints formwork was tested for watertightness by filling joints with water in advance of the UHPC placement.



Joint Opening prior to placing the UHPC – note the non-contact splice bars.



Note foam in bottom of joint to keep UHPC from leaking out.



Ductal® JS1000 - sacks premixed in pre-weighed supersacks of 2400 lbs. Steel fibers 2% by volume, and a high range water reducing admixture (HRWR). +/-25% of the required mixing water was added as ice since the ambient temperature that day was in excess of 80 °F.

Mixing UHPC - Each batch was approximately 0.66 yd³ in volume.



Steel Fibers were added last.

Ice was required to control temperatures



Problems:

- **Steel Fiber blocked UHPC from going down into the mixer due to the small openings in the grates.**
- **Fix – Manually stir fibers.**
- **Increased time for mixing slowed down the placement process which decreased the workability of the material already in the joints.**
- **Quality was maintained by measuring flow and temperature Measurements were made by the UHPC manufacturer's representative after each batch.**



Placing UHPC to connect precast panels.

**UHPC Flowing down the joint.
It runs like molasses.**



Note prior to placement of UHPC, surfaces must be “Surface Saturated Dry”. This can be a challenge on a hot windy day.



UHPC Flowing under panel and into openings for studs.





Hand pump sprayer was identified as a better alternative to the water hose sprayer to keep surfaces SSD.



UHPC must be top formed to prevent it from running out on the bridge deck.



Forms must be water tight, otherwise UHPC will run out and it is very expensive.

Contractor must have a plan in place to seal leaks. All forms must be tested with water for leaks **prior** to placement of UHPC.



The leak issues were resolved by the contractor applying additional spray foam and formwork bracing

Photos provided by OU



Drainage 1% slope
towards upstream
side

Precast Elements
Jointed with
UHPC

04/05/2022



**Roughened
Surface for
Future Silica
Fume Overlay**

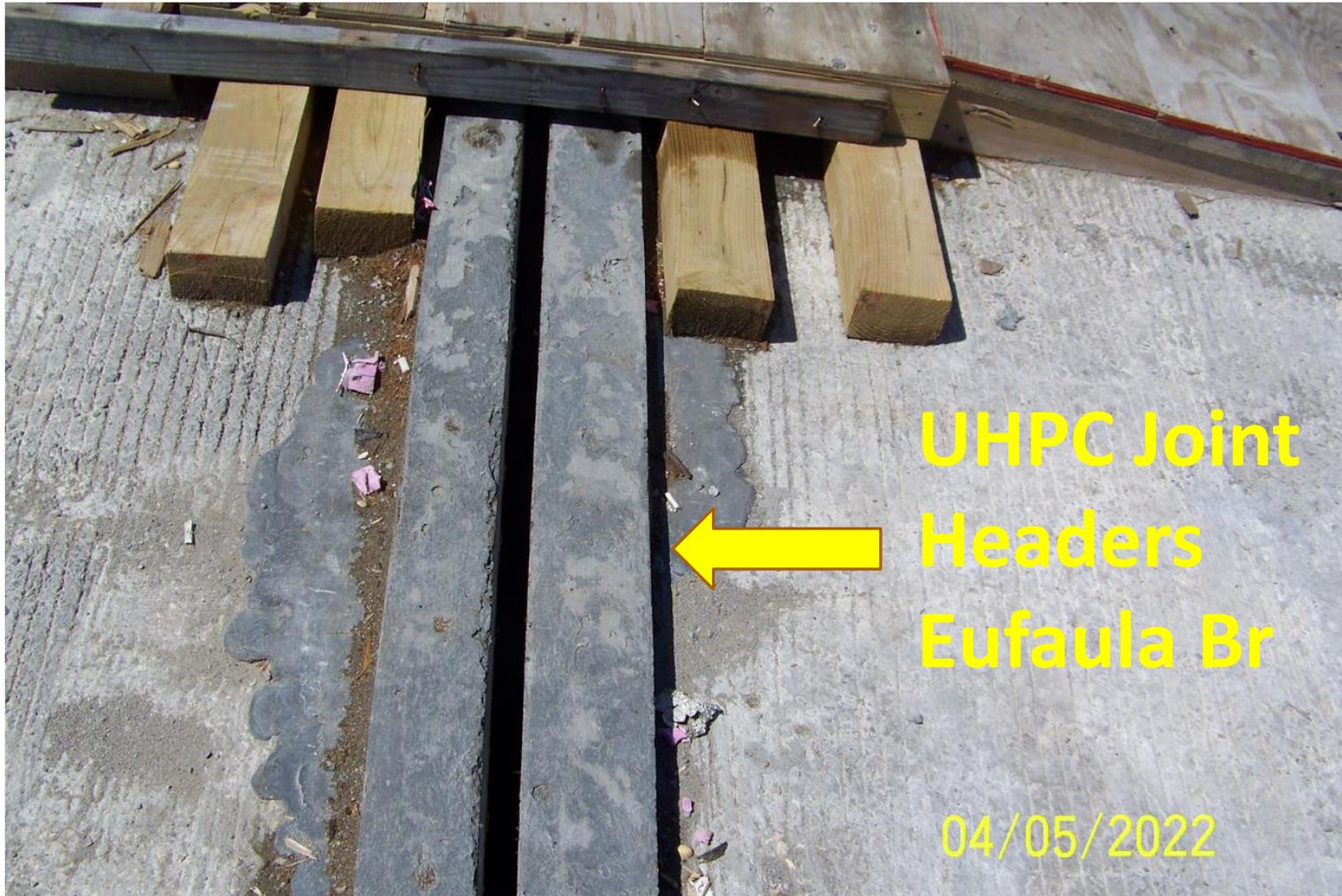
04/05/2022



UHPC Joint after Form Removal. Cores taken from the mock-up joints indicated excellent bond between the UHPC and the deck panel concrete.



My understanding is that a walk behind concrete grinder was used to grind the UHPC. UHPC is formed and poured $\frac{1}{4}$ " high. The reason we overpour $\frac{1}{4}$ " is to expose air pockets and other anomalies occurring during placement. Grinding removes these imperfections leaving a smooth surface.



Conclusion:
UHPC has been specified for several future ODOT projects. Expect to see more and more UHPC in the years to come.

**Use UHPC for Expansion Joint Headers
EDC-3 and beyond!**



OKLAHOMA
Transportation

wpeters@odot.org