

UHPC Repair of Steel Columns in Walnut Tunnel



THE WORLD'S GATHERING PLACE FOR ADVANCING CONCRETE



Michael McDonagh, PE, P.Eng.

Vice President, Engineering & Projects // Steelike, Inc

Michael has 24 years of experience designing bridges, working on projects in three continents around the globe. Since 2008, he became increasingly involved in projects using ultra-high-performance concrete (UHPC) and eventually helped the FHWA promote the material and write UHPC design guidance. In early 2021, he joined Steelike, Inc. to help spread awareness of the unique properties of Steelike® UHPC, expand the UHPC marketplace, and bring fresh innovation to UHPC construction.



Education: MS, Civil Engineering; BS, Civil Engineering/Structures

Registrations and Certifications:

PE – PA, NJ, NY, OH, IA, TX, WA

P.Eng. – AB



Joseph Sirignano, PE, VMA, CBSI

Vice President, Structural Group Manager //
Alfred Benesch & Company, Lehigh Valley Division

Joe has gained vast experience in structural design, condition inspection and rating analysis for various structures types over his 27-year career. He has played a key role in the rehabilitation of PennDOT steel bridge structures in the City of Philadelphia surrounding the 30th Street Station.

Joe served as Project Manager for the Walnut Tunnel design of rehabilitation where he incorporated the principles of Value Engineering with ABC techniques in Benesch's design approach.



Education: MS, Civil Engineering; BS, Civil Engineering/Structures

Registrations and Certifications:

PE – PA, NJ

PENNDOT Bridge Safety Inspector

SAVE Value Methodology Associate



- Project Overview
- UHPC Selection & Design Elements
- UHPC Construction
- Conclusions

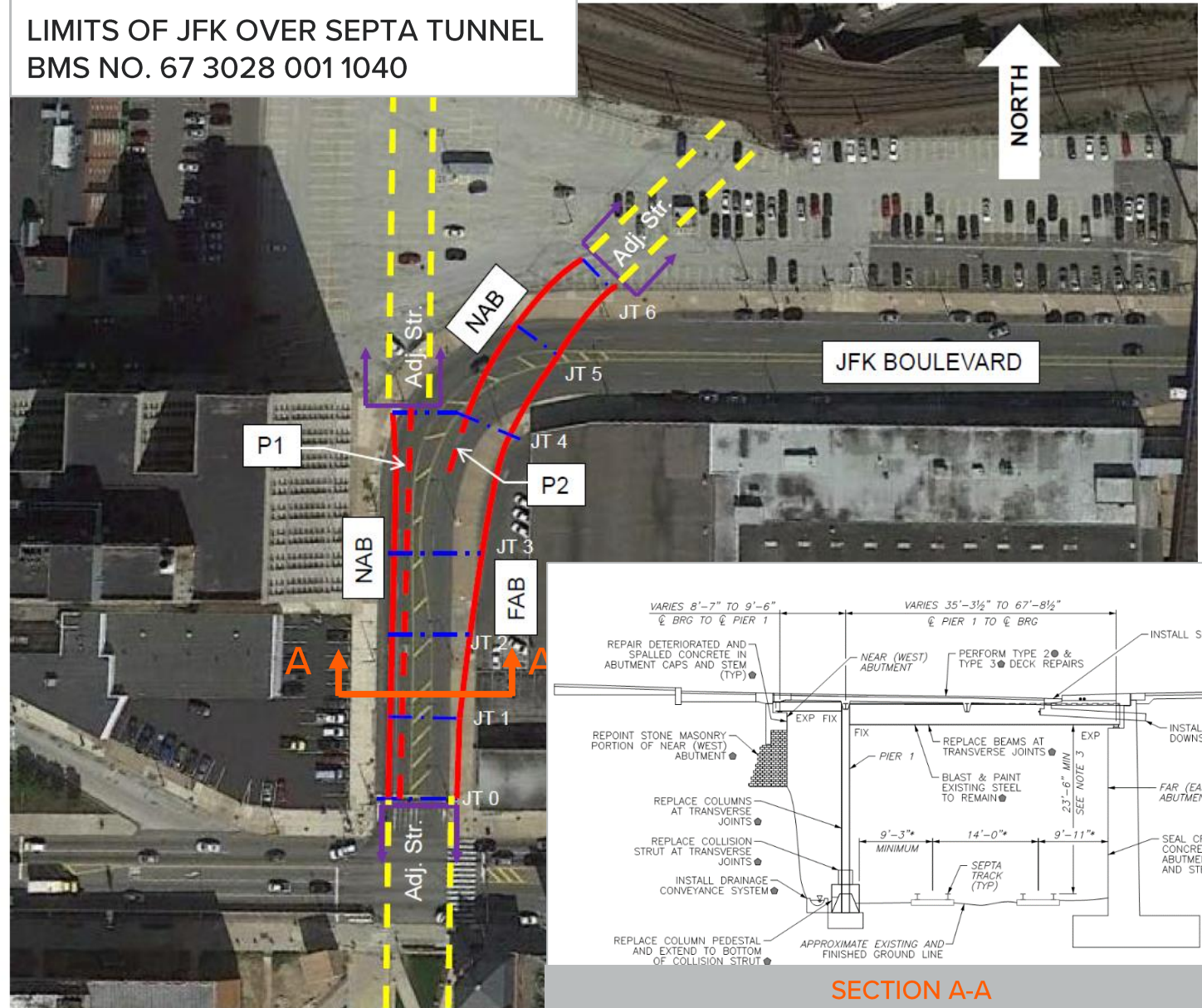
Agenda



SR 3028-SWB

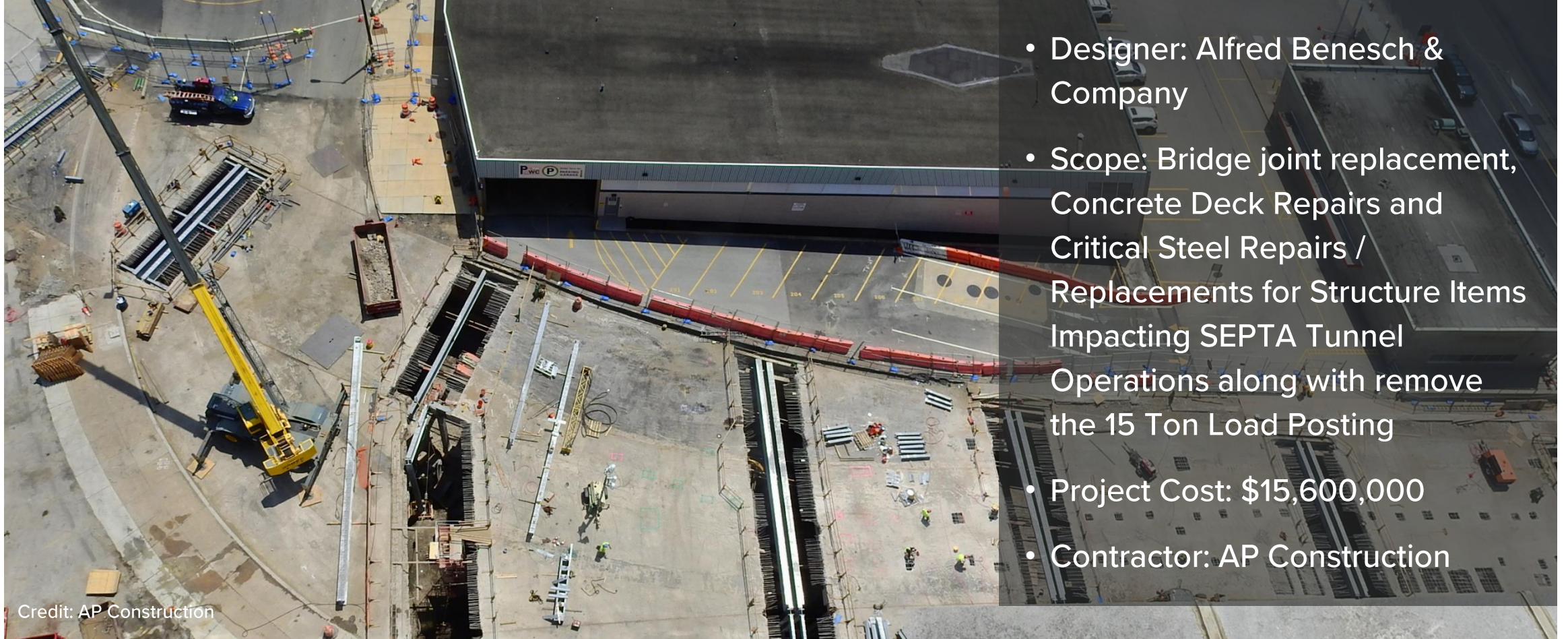
- Located: JFK Boulevard over SEPTA Walnut Tunnel near/West of 30th St Station
- Owner: Pennsylvania Department of Transportation (PennDOT)
- Year Built: 1955

LIMITS OF JFK OVER SEPTA TUNNEL
BMS NO. 67 3028 001 1040



SR 3028-SWB

JFK Boulevard over SEPTA // Philadelphia, PA



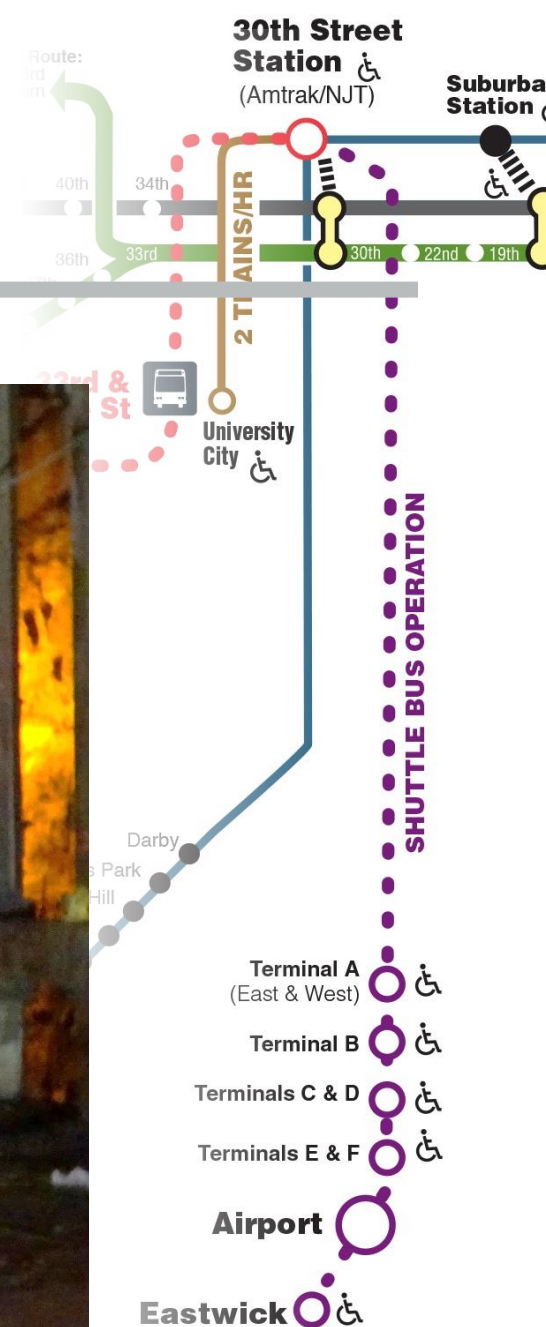
- Designer: Alfred Benesch & Company
- Scope: Bridge joint replacement, Concrete Deck Repairs and Critical Steel Repairs / Replacements for Structure Items Impacting SEPTA Tunnel Operations along with remove the 15 Ton Load Posting
- Project Cost: \$15,600,000
- Contractor: AP Construction

Credit: AP Construction



Design Drivers for use of ABC Techniques

- SEPTA Regional Rail Airport Line Operates 7 days a week 5 am to 12 midnight
- Trains from Airport to 30th St Station every half hour
- 3 week planned outage with substitute bussing on City Streets by SEPTA, actual 7 weeks during COVID shutdown

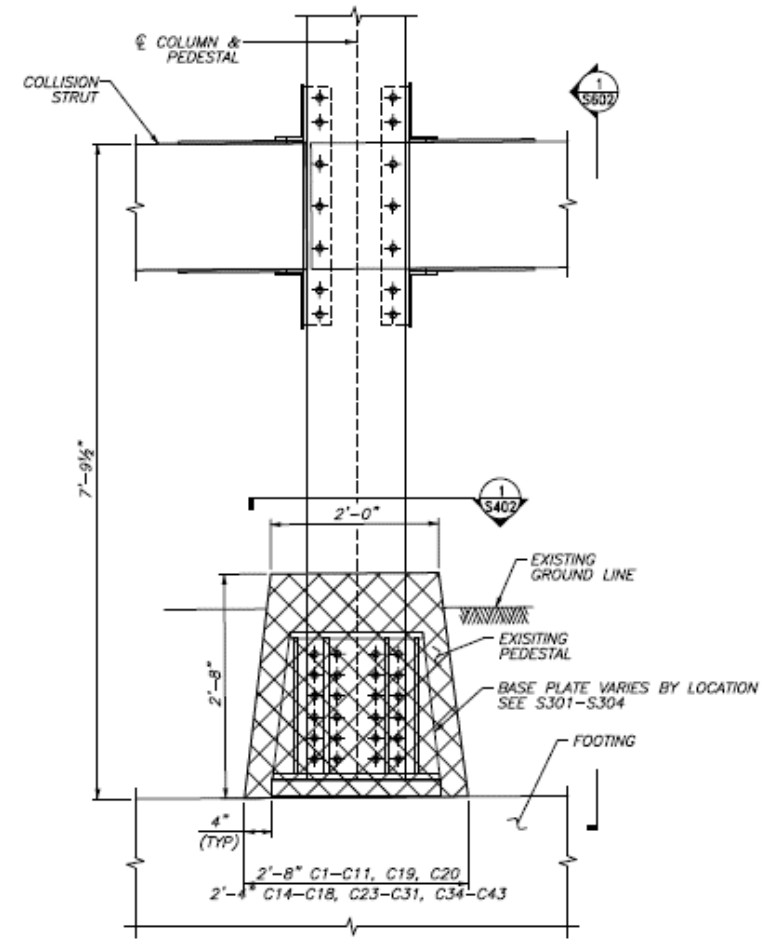


Column Repairs with UHPC Encasement

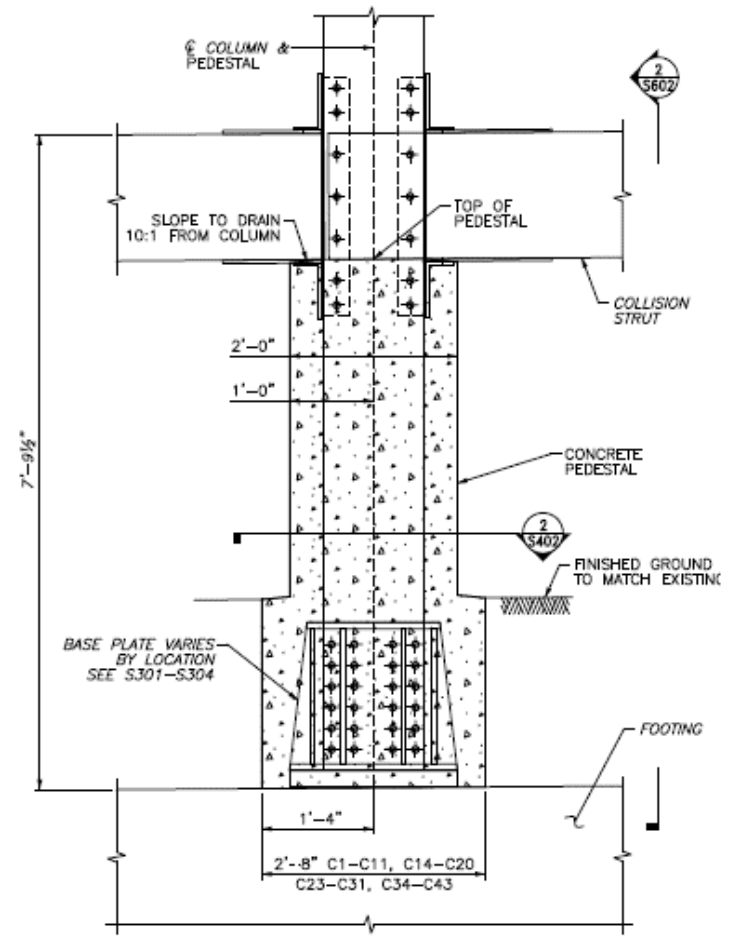
- Utilized PennDOT Standard Special Provision for UHPC with additional criteria
- Minimum Compressive Strength of 12 ksi in 12 hours using accelerated heat curing
- Provides additional compressive and buckling resistance to steel column
- Protects against future corrosion of column bases in tunnel environment



Column Repairs with UHPC Encasement



3 EXISTING COLUMN PEDESTAL REMOVAL
 S402 SCALE: 1"=1'-0"
 6 0 6 12 INCHES

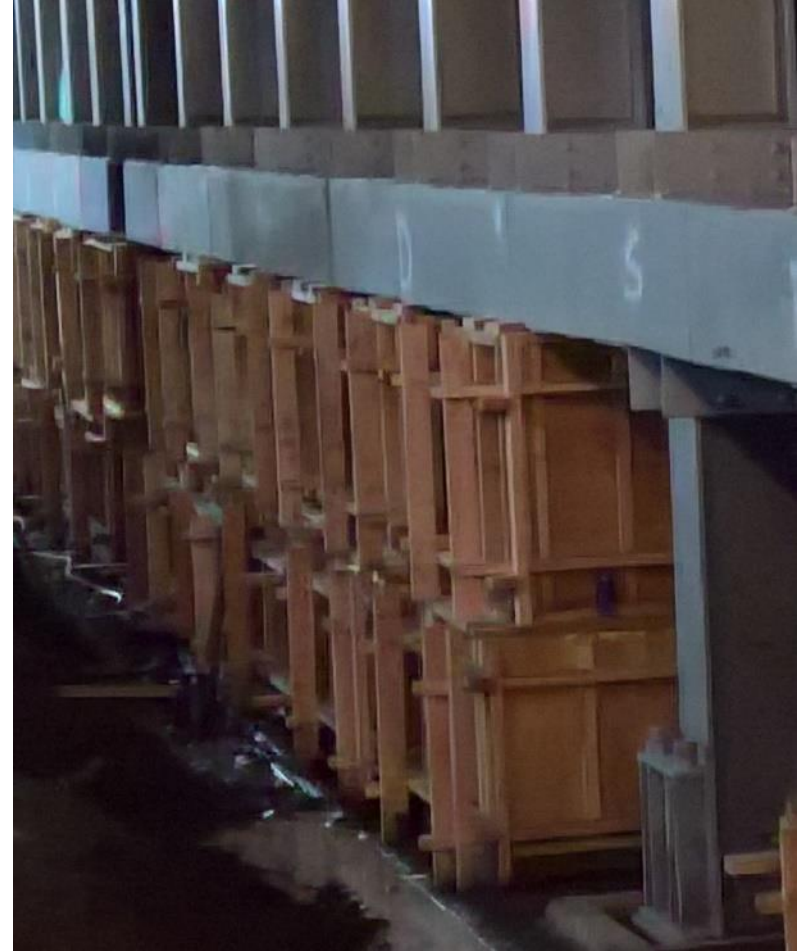


4 PROPOSED COLUMN PEDESTAL REPAIR
 S402 SCALE: 1"=1'-0"
 6 0 6 12 INCHES

UHPC Construction - Formwork



UHPC Construction - Formwork



UHPC Construction – Mixing



UHPC Construction – Mixing



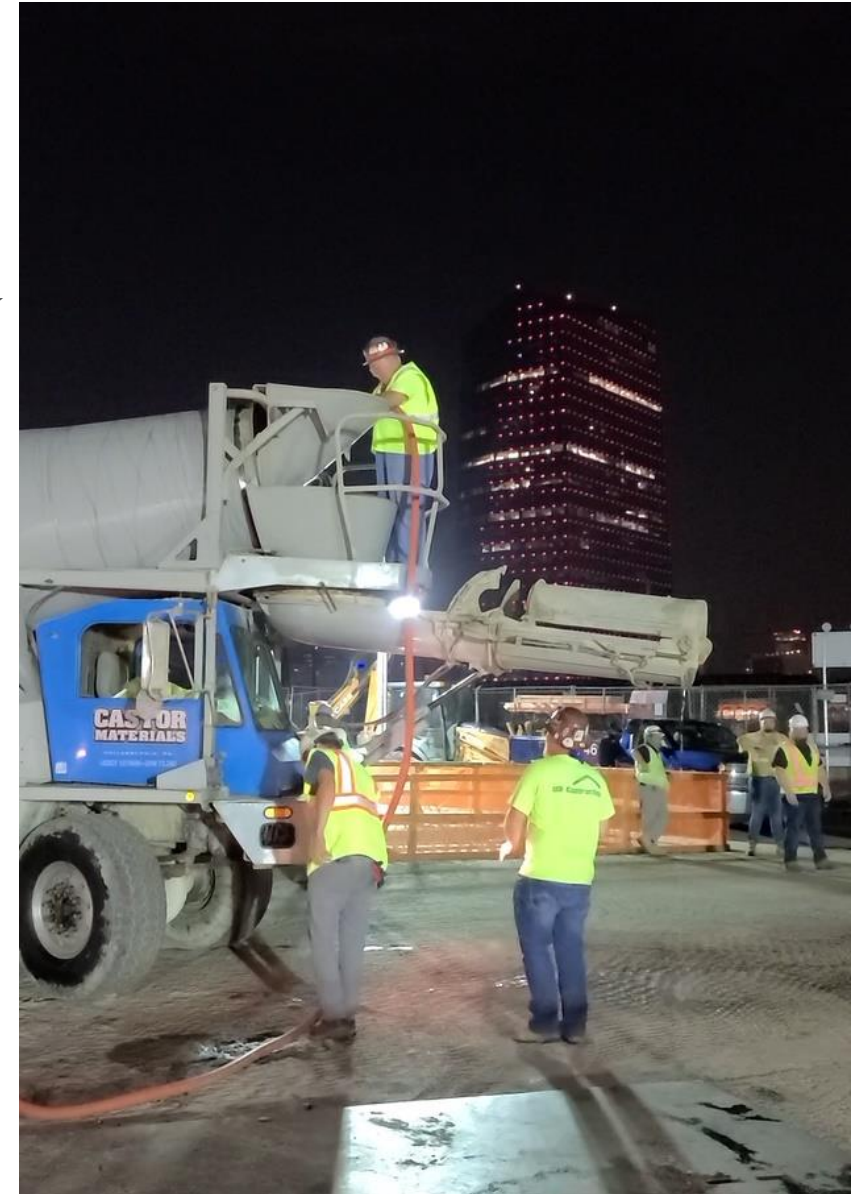
UHPC Construction – Mixing



UHPC Construction – Mixing

Advantages to Mixing in Ready-Mix Truck

- Large batch sizes – 6 CY per batch
 - Up to 7 CY possible
- Unique properties of Steelike UHPC facilitate low-energy mixing, which reduces heat buildup and allows the mix to stay alive for 1.5 hours or more



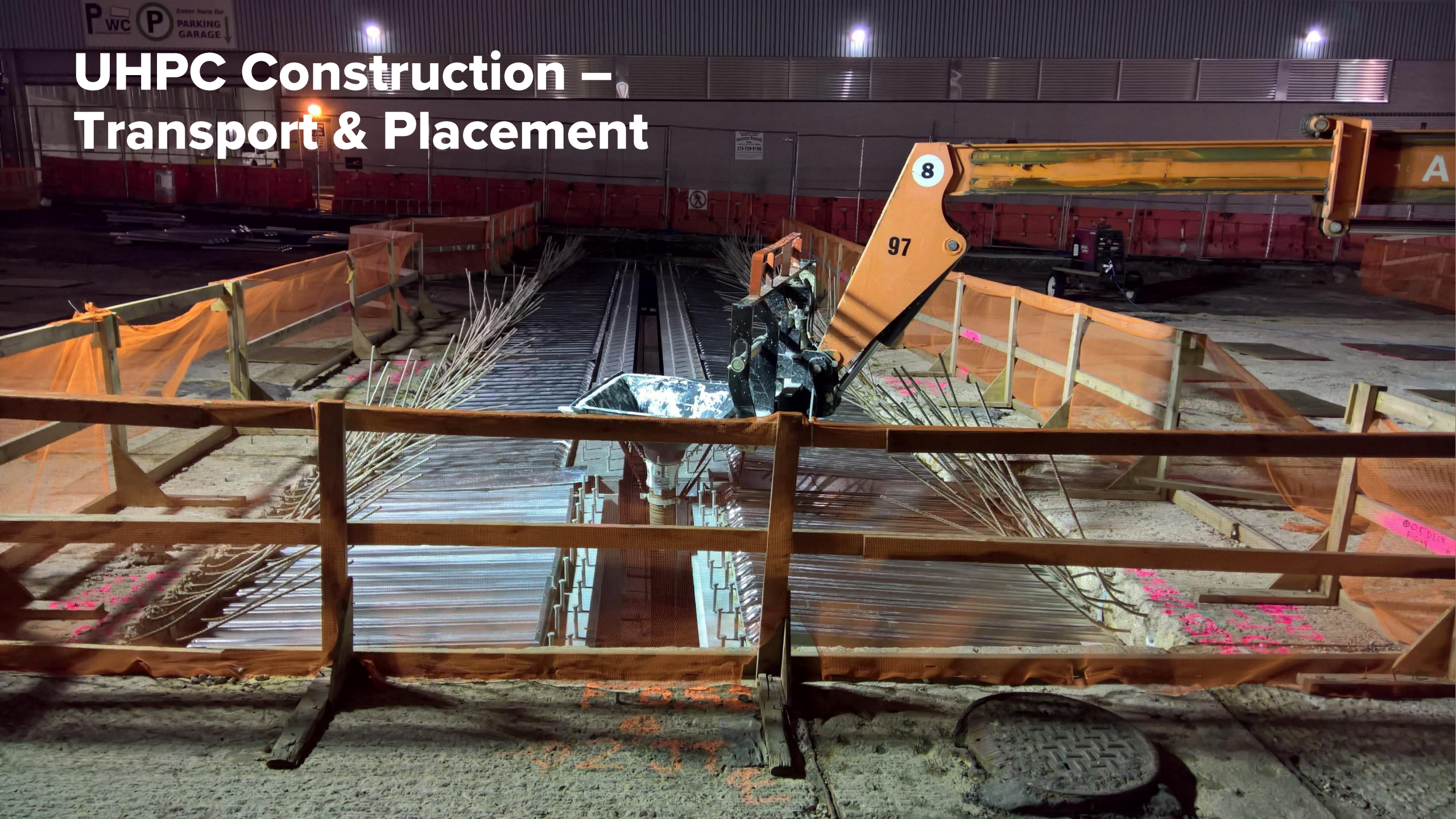
UHPC Construction – Transport & Placement



UHPC Construction – Transport & Placement

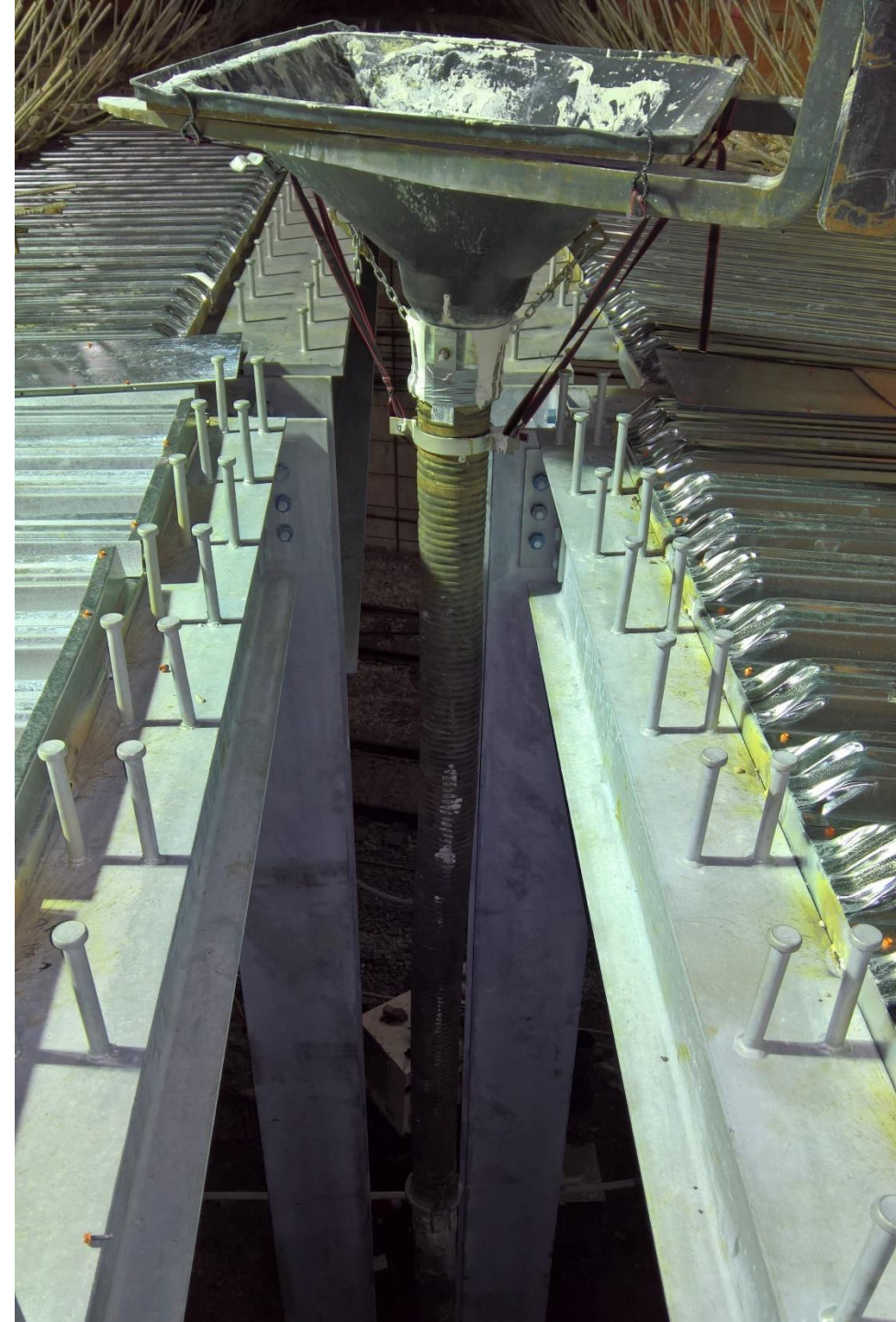


UHPC Construction – Transport & Placement



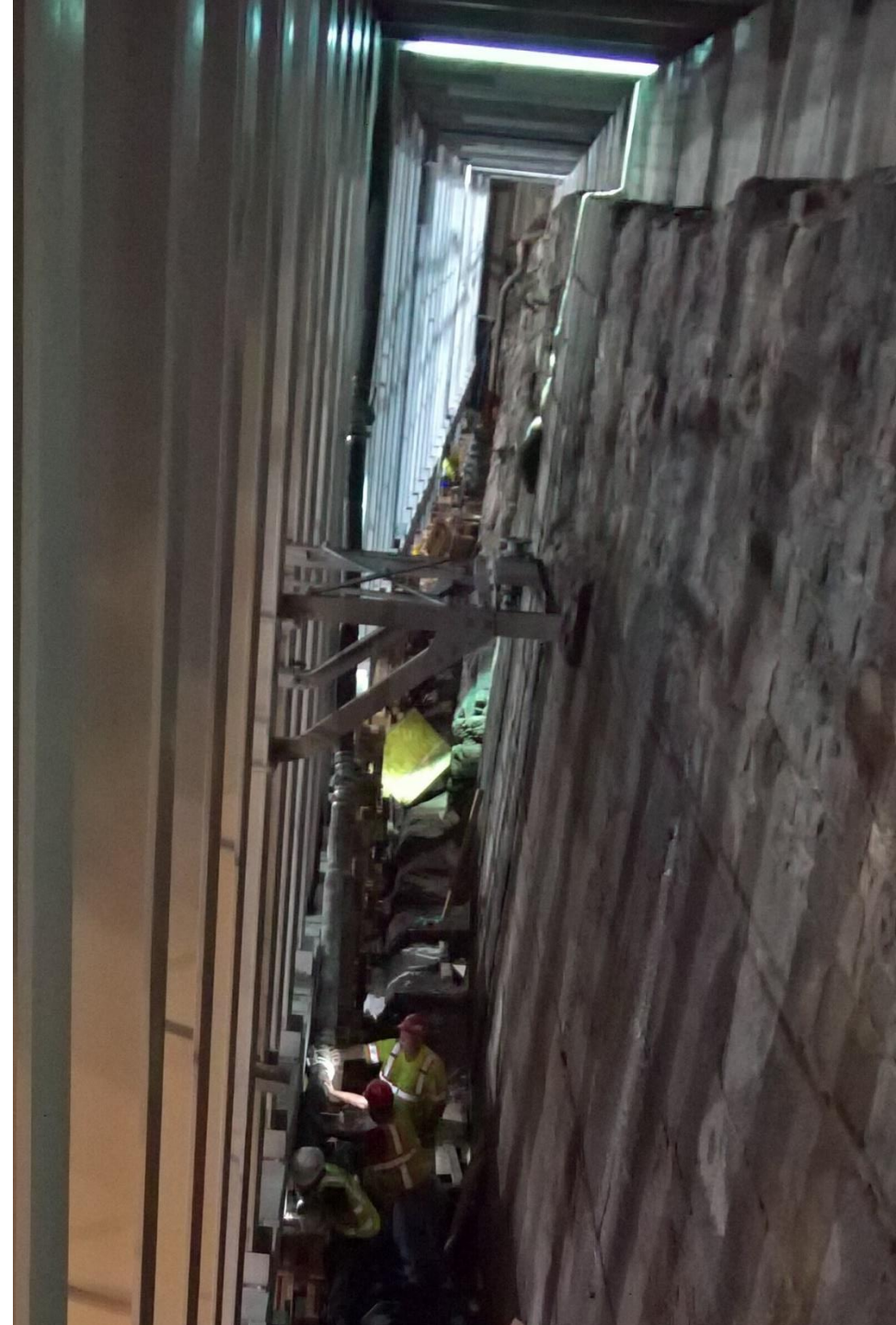
UHPC Construction – Transport & Placement

- 6-inch tremie line
- 4-inch reducer at lower end
- Repairs were 30 feet below the deck
- Tremie line was up to 70-feet long



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UHPC Construction – Transport & Placement



UHPC Construction – Transport and Placement

More Advantages to Mixing in Ready-Mix Truck

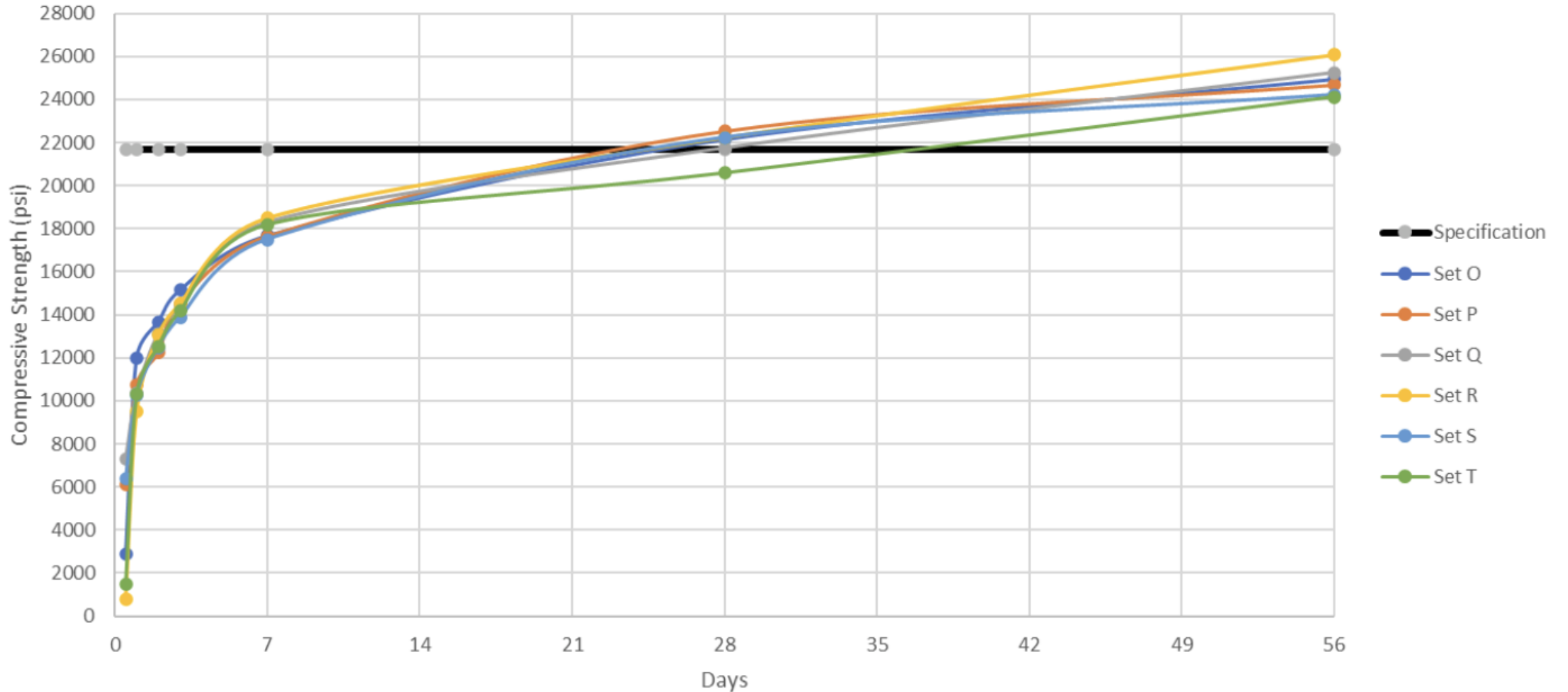
- UHPC was mixed above the tunnel and away from the construction area.
- Ready-mix truck drove right up to openings in deck and discharged directly into the tremie line.
- This avoided causing congestion in the construction area, saved time, and reduced waste versus using buggies to move UHPC from stationary mixers.

UHPC Construction – Transport and Placement

Even More Advantages to Mixing in Ready-Mix Truck

- Each column repair required 1.5 CY of UHPC. Large batch sizes were able to provide a continuous flow of UHPC to fill 4 column repair forms per batch.
- 50 total column repairs (75 CY) were filled with 13 batches (vs. 58 or 116)
- Contractor stopped discharge mid-batch due to form leaks – Steelite kept the UHPC remaining in the truck alive for more than 2.5 hours in >80°F (<27°C) temperatures.

UHPC Construction – Strength Gain



Credit: Pennoni Associates

Completed Repairs



Completed Repairs



Conclusions

- PennDOT championed the first project using UHPC for steel column repair in North America.
- Due to site constraints for delivery of material, the use of UHPC for encasement of steel columns facilitated rapid placement over a regional rail facility.
- UHPC provides long lasting protection against future corrosion due to its low permeability.
- Steelike[®] UHPC flowed easily through the contractor's 6-inch tremie line with 4-inch reducer, allowing all UHPC mixing and discharge to take place outside the tunnel.
- Mixing Steelike[®] UHPC in standard ready-mix trucks provided the contractor numerous advantages that helped accelerate the UHPC placement and reduced waste.
- The unique properties of Steelike[®] UHPC provided the contractor lots of time flexibility when formwork problems arose without having to waste any UHPC in hot weather.



THANK YOU



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aci CONCRETE CONVENTION