NEW JERSEY STATE TRANSPORTATION INNOVATION COUNCIL

www.NJDOTtechtransfer.net/NJ-STIC

4TH Quarterly Meeting
December 14, 2022

WELCOME

Michael Russo

Assistant Commissioner

NJDOT Planning, Multimodal & Grant Administration


STIC
2022 Excellence Award


STIC
2022 Excellence Award
In recognition and appreciation,
the Federal Highway Administration Office of Transportation Workforce Development and Technology Deployment and the American Association of State Highway and Transportation Officials Innovation Initiative present the 2022 STIC Excellence Award to
New Jersey State Transportation Innovation Council
for making a significant impact toward fostering a strong culture of Innovation.
STIC Excellence Award
STIC Excellence Award


STIC
2022 Excellence Award

CIA TEAM

Organizational Support & Improvement

NJDOT – Kristal Walker

FHWA- Christopher Paige

EDC-7 Innovations (2023 - 2024)

Every Day Counts
Innovation for a Nation on the Move

For over 10 years the Federal Highway Administration's Every Day Counts program has rapidly deployed proven technologies and processes. EDC round 7 (2023-2024) highlights innovations to improve safety for all users, build a sustainable infrastructure for the future and grow an inclusive workforce.

NIGHTTIME VISIBILITY FOR SAFETY

The nighttime crash fatality rate is three times the daytime rate. Enhancing visibility along corridors, intersections, and pedestrian crossings can help reduce fatalities. This initiative promotes traffic control devices and properly designed lighting to improve safety for all users.

NEXT-GENERATION TIM: TECHNOLOGY FOR SAVING LIVES

Over six million crashes a year in the U.S. put responders and other vulnerable road users at risk. Next-Generation Traffic Incident Management programs promote emerging technologies such as emergency vehicle lighting and queue warning solutions. These and other tools can advance safety and operations to mitigate incident impacts.

INTEGRATING GHG ASSESSMENT AND REDUCTION TARGETS IN TRANSPORTATION PLANNING

Transportation is the largest emitter of greenhouse gases in the U.S. This initiative provides resources to help agencies quantify greenhouse gases and set goals to decrease motor vehicle, construction, and life-cycle emissions through planning and project development.

ENHANCING PERFORMANCE WITH INTERNALLY CURED CONCRETE (EPIC²)

Cracking in concrete is a limiting factor in achieving long-term concrete performance. Internal curing mitigates shrinkage cracking and has the potential to substantially extend the service life of concrete bridge decks and enhance the performance of pavements and repairs.

EPDs FOR SUSTAINABLE PROJECT DELIVERY

Construction materials such as concrete and asphalt have environmental impacts during their life cycle. Environmental product declarations, or EPDs, document those impacts. This tool helps States support procurement decisions and quantify embodied carbon reductions using life cycle assessments for sustainable pavements.

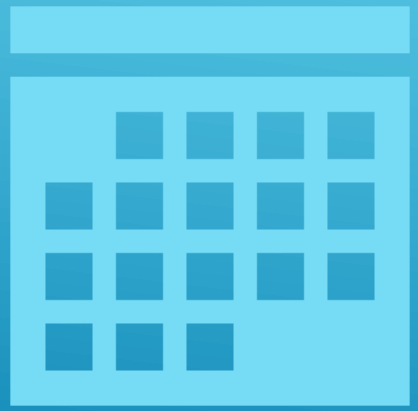
RETHINKING DBE IN DESIGN-BUILD

Many design-build contracts do not adequately provide opportunities for disadvantaged businesses. New practices are available to support the effective integration of program requirements to help small, disadvantaged businesses compete for design-build contracts.

STRATEGIC WORKFORCE DEVELOPMENT

The demand for highway workers is growing, and emerging technologies require new skills. This innovation helps stakeholders improve their ability to identify, train, and place highway construction workers. The focus will expand to rural and Tribal communities to increase career opportunities.

February 14-16, 2022
EDC-7 Virtual Summit



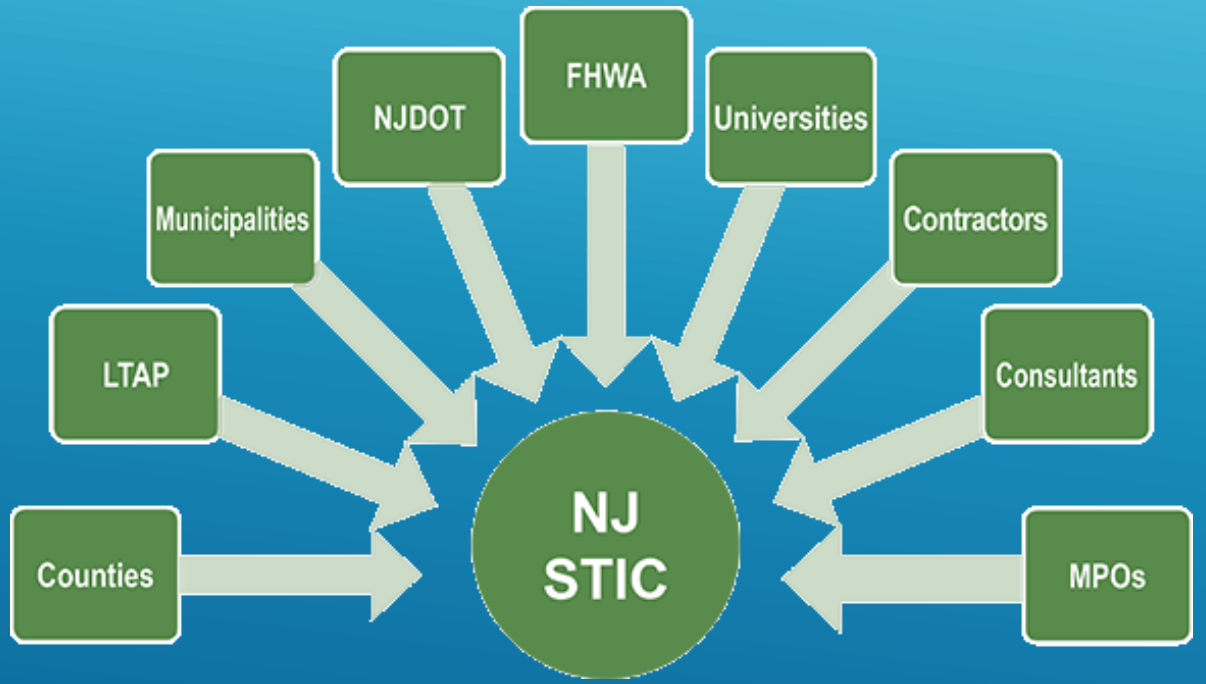
February 22, 2023
NJ EDC-7 Caucus

WELCOME
ATTENDEES & SPECIAL GUESTS

Feature Presentation:

NJDOT Structural Value Solutions Unit
"UHPC for Bridge Preservation"

Jess Mendenhall, Project Engineer
Samer Rabie, Principal Engineer



FHWA UPDATES

Helene Roberts, P.E.

Innovation Coordinator & Performance Manager

FHWA, NJ Division Office

EDC-7 INITIATIVES

- NIGHTIME VISIBILITY FOR SAFETY
- NEXT GENERATION TIM: TECHNOLOGY FOR SAVING LIVES
- INTEGRATING GHG ASSESSMENT AND REDUCTION TARGETS IN TRANSPORTATION PLANNING
- ENHANCING PERFORMANCE WITH INTERNALLY CURED CONCRETE (EPIC^2)
- EPDs FOR SUSTAINABLE PROJECT DELIVERY
- RETHINKING DBE IN DESIGN-BUILD
- STRATEGIC WORKFORCE DEVELOPMENT

CORE INNOVATION AREA REPORTS

CIA TEAM

SAFETY

NJDOT – Dan LiSanti

FHWA – Keith Skilton

CIA TEAM

INFRASTRUCTURE PRESERVATION

NJDOT – Shivani Patel

FHWA – Nunzio Merla

CIA TEAM

MOBILITY & OPERATIONS

NJDOT – Sal Cowan

FHWA – Ek Phomsavath

CIA TEAM

ORGANIZATIONAL SUPPORT & IMPROVEMENT

NJDOT – Kristal Walker

FHWA – Christopher Paige

CIA TEAM

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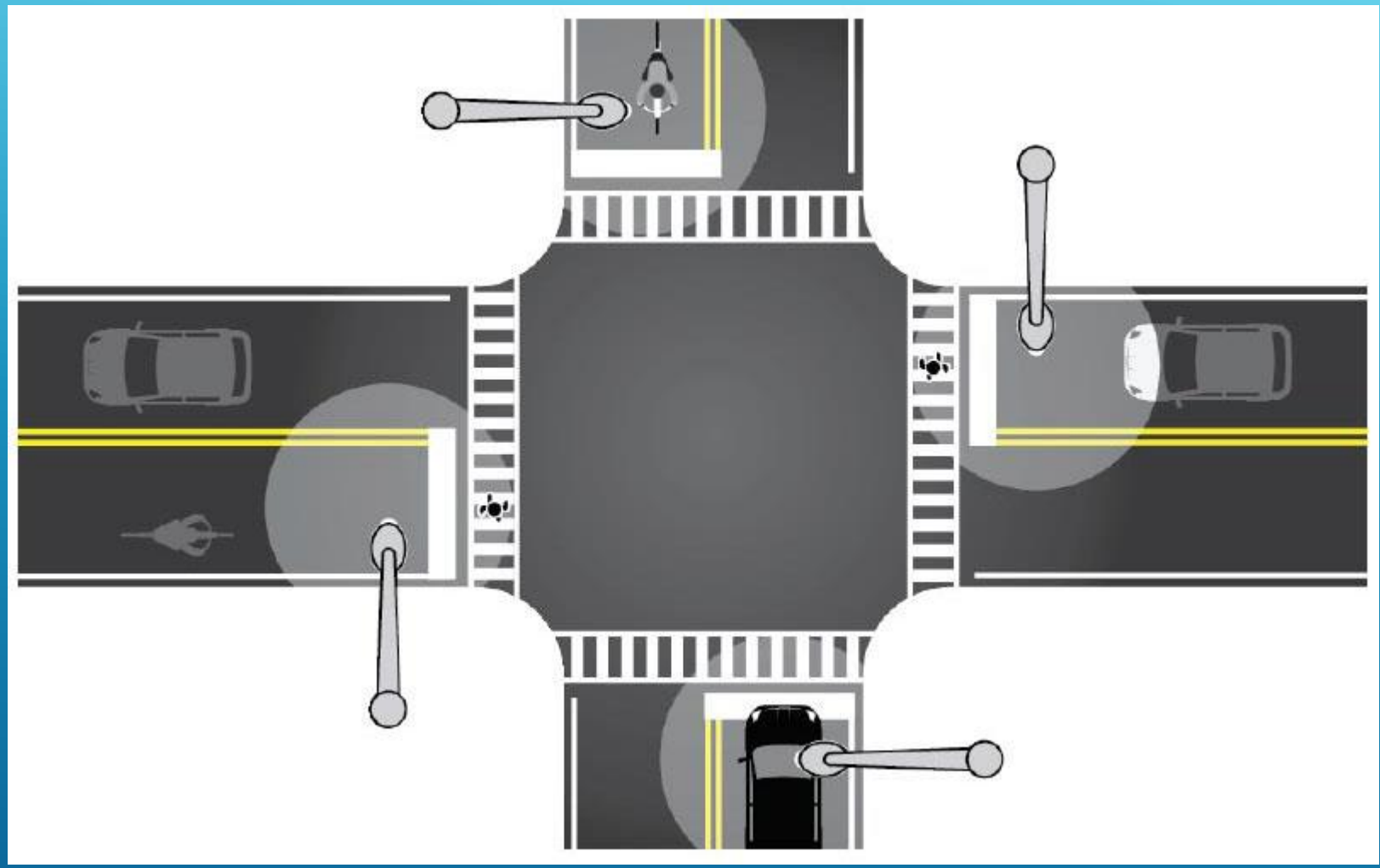
LIGHTING



Safety Benefits:

Lighting can reduce crashes up to:

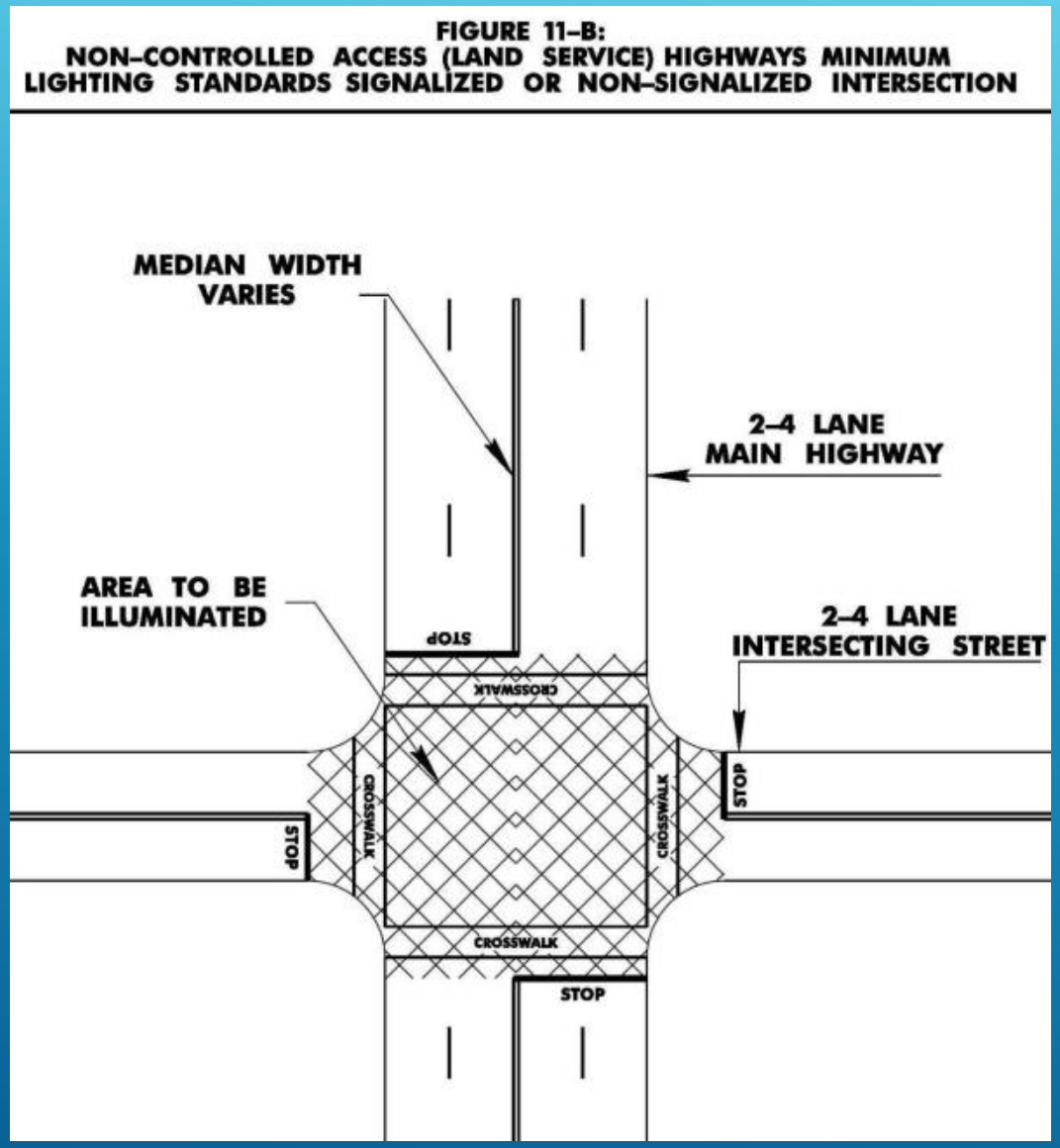
42%
for nighttime injury pedestrian crashes at intersections.[1]

33-38%
for nighttime crashes at rural and urban intersections.[1]

28%
for nighttime injury crashes on rural and urban highways.[1]

Source: FHWA

LIGHTING



Source: NJDOT

Source: OCNJ, Pinterest

LIGHTING

Source: FHWA

CIA TEAM

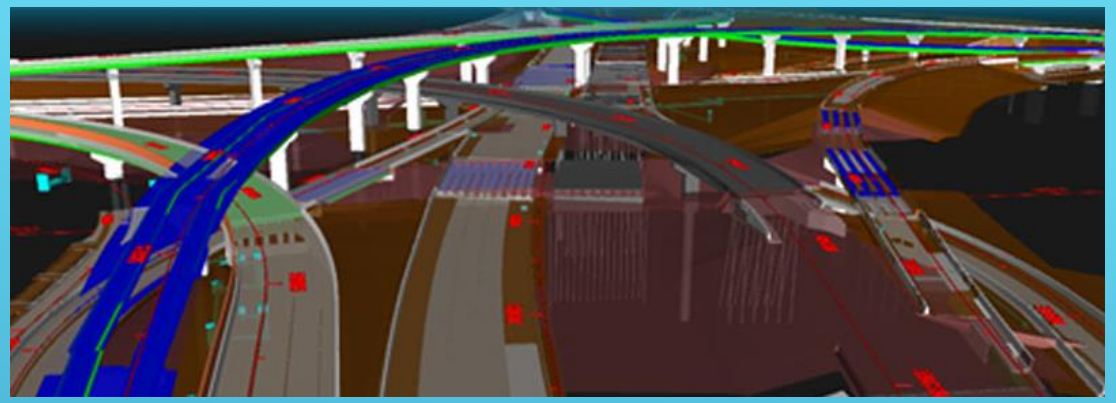
INFRASTRUCTURE PRESERVATION

NJDOT – Shivani Patel

FHWA – Nunzio Merla

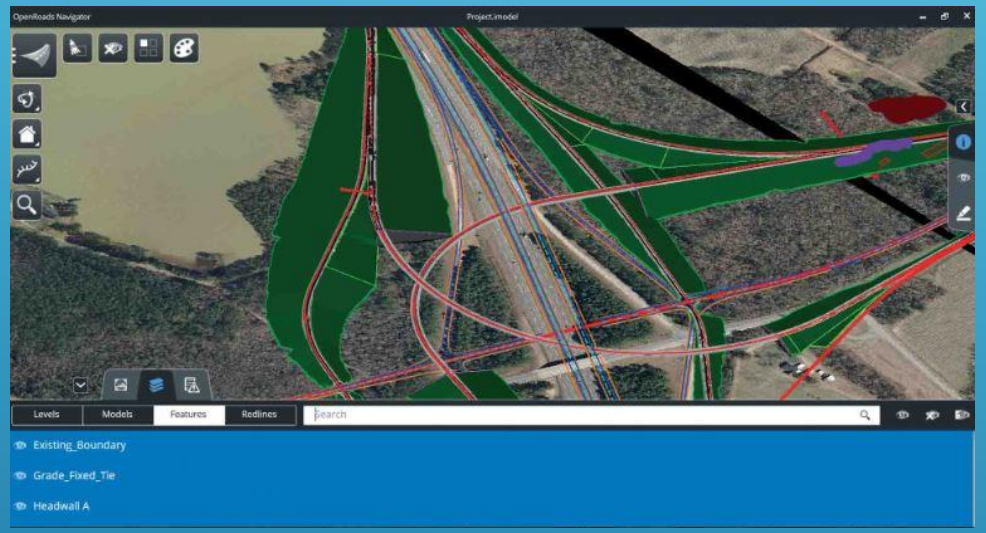
EDC – 6

DIGITAL AS-BUILTS



Purpose: *To explore the use of 3D models to build projects and update that digital information to reflect the project's as-built condition*

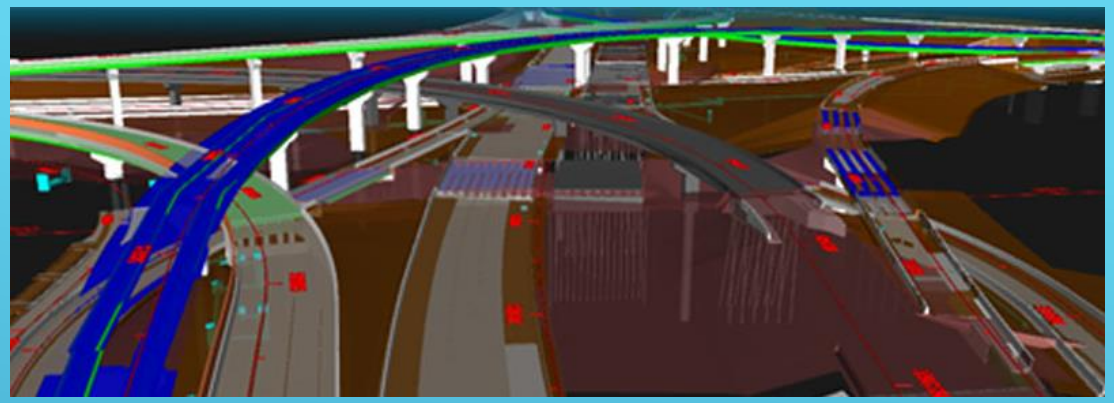
Status:



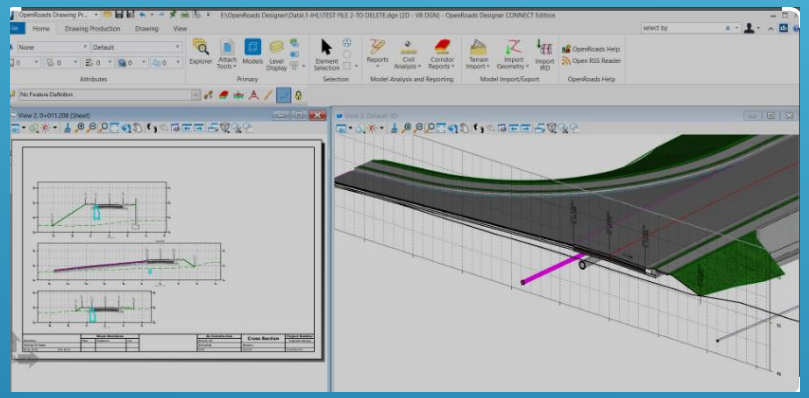
- Prioritizing CADD development
- Participated in a webinar focusing on the importance of digital twins

EDC – 6

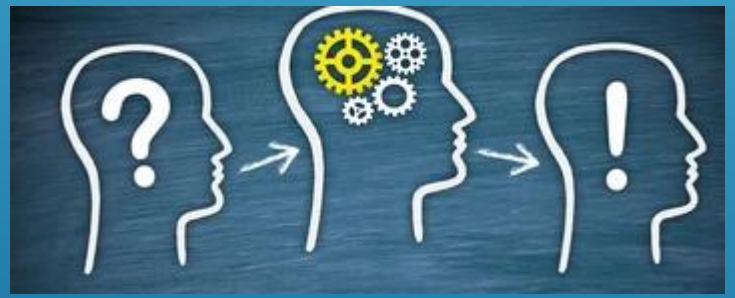
DIGITAL AS-BUILTS



Lessons Learned & Accomplishments



- Emphasized the prioritization of CADD development



- Need for staff availability and expertise

EDC – 6

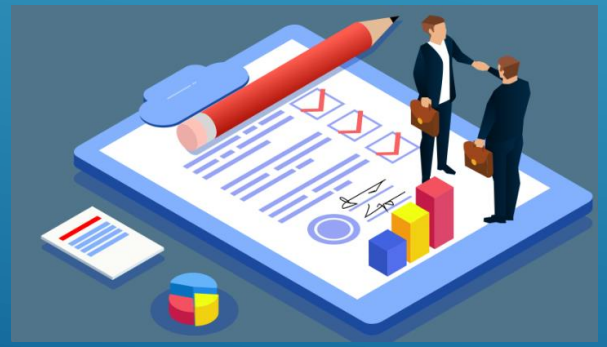
E-TICKETING

Purpose: *Provide stakeholders with an electronic means to produce, transmit, and track and verify materials deliveries*

Status:

- Submitted the System Architecture Review (SAR)

- Next steps: completing the procurement process, selecting a vendor and learning the system



EDC – 6

E-TICKETING

Lessons Learned & Accomplishments

- Logical SAR is in progress
- Required paperwork is time-consuming

EDC – 6

TARGETED OVERLAY PAVEMENT SOLUTIONS (TOPS)

Purpose: *To develop and install overlays that provide long-life performance under a wide range of traffic, environmental, & existing pavement conditions*

Status:

- NJDOT's first HiMA project (Rt.42 Pavement Preservation) is in construction
- Skid testing was conducted on six projects

EDC – 6

TARGETED OVERLAY PAVEMENT SOLUTIONS (TOPS)

Lessons Learned & Accomplishments

- Project including HiMA is now in construction (South State Inc.)
- Acquired new skid testing equipment in 2022
- Rutgers University will perform companion testing

EDC – 6

UHPC FOR BRIDGE PRESERVATION AND REPAIR

Purpose: *To explore the use of UHPC for Bridge Preservation and Repair*

Status:

- Established baseline of UHPC overlay bond condition

- Presented at the 2022 International ABC Conference
- Seeking funding to extend UHPC overlay monitoring program up to 2026

EDC – 6

UHPC FOR BRIDGE PRESERVATION AND REPAIR

Lessons Learned & Accomplishments

- Completed two UHPC overlay projects
- NJDOT's first UHPC link-slab application project is in construction

- Material and labor for UHPC is costly
- Industry experience in UHPC applications is limited

CIA TEAM

Organizational Support & Improvement

NJDOT – Kristal Walker

FHWA- Christopher Paige

Kristal Walker – NJDOT
Christopher Paige – FHWA-NJ

NJSTIC CIA Team
Organizational Support & Improvement

CIA TEAM

MOBILITY & OPS

NJDOT – Sal Cowan

FHWA – Ek Phomsavath

EDC-6: Next-Generation TIM: Integrating Technology, Data, and Training

NJDOT collaborating with NJSP

- Computer-Aided Dispatch (CAD) integration project
- CAD integration into traffic operations centers to improve incident response and quicker clearance.

"Development" Stage

- Maintain the existing team
- NJ State Police CAD system (Motorola FLEX) being re-evaluated
- Access/deployment for DOT to be reevaluated once system issues resolved

EDC-6: Crowdsourcing for Advancing Operations

Regional Capstone Peer Exchange: Eastern States (Raleigh, NC; November 1st – 3rd)

- Crowdsource innovation conclusion
- States DOT presentations
- Discuss experiences, lessons learned, best practices, and future plans

***Drivewyze Notifications* "Institutionalized"**

Real time notifications to commercial vehicles travelling on 647 miles of NJ roads. Operational since January 2022

Extra Credit : *In 2023, NJDOT will coordinate with NJIT to deploy HAAS Alert technology on Safety Service Patrol vehicles, replacing the previous iCone program.*

BREAK &
TRANSPORTATION TRIVIA

Go to www.menti.com
Use code 7464 4198

Feature Presentation

UHPC for Bridge Preservation

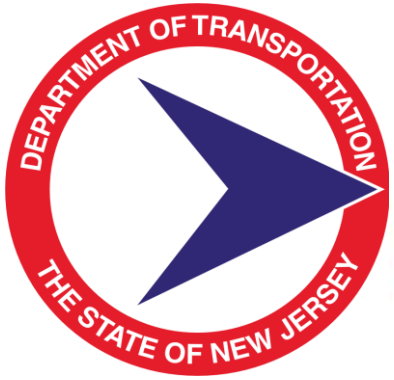
Jess Mendenhall, Project Engineer

Samer Rabie, Principal Engineer

Design, Construction, and Evaluation of UHPC Bridge Deck Overlays for NJDOT

Samer Rabie - New Jersey Department of Transportation

Jess Mendenhall, P.E. - New Jersey Department of Transportation



Introduction

- Pilot project to install and evaluate Ultra-High-Performance Concrete (UHPC) bridge deck overlays.
- Focus on use as a strategy for preserving existing bridge decks.

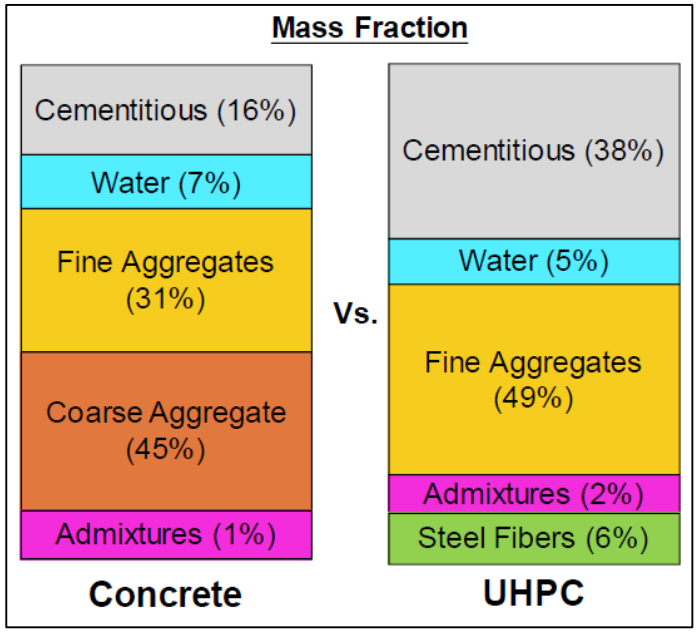
<u>Project Overview:</u>

- 4 bridges
- 48,000 SF total deck area
- 2 Construction contracts (North/South)

UHPC

- Cementitious composite
- Optimized gradation
- Steel Fibers
- Superior mechanical & durability properties
- Self-leveling vs semi-thixotropic mixes

Image Source: FHWA



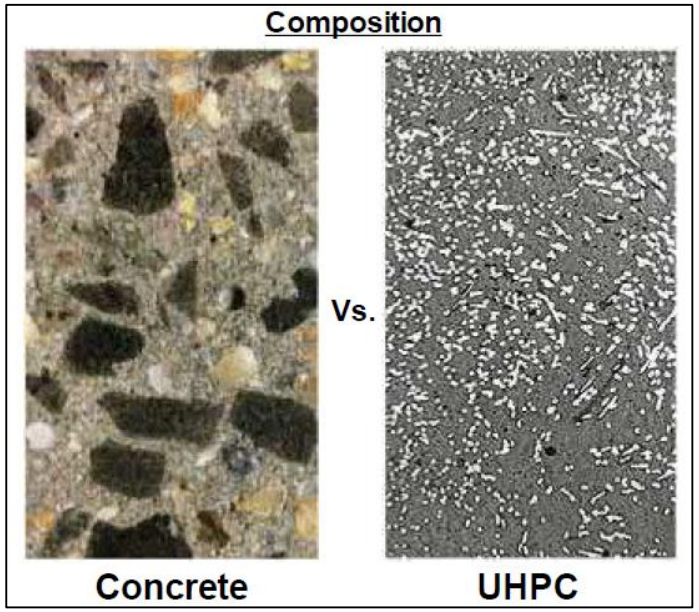


Image Source: FHWA

Program Background

- Past use of overlays for rehabilitation and new decks
- Preservation vs. Reconstruction

<u>UHPC Overlay Advantages</u>:

- Mechanical and durability properties
- Service life, potential life cycle cost savings

<u>UHPC Overlay Disadvantages:</u>

- Cost $ (project avg. cost $30-$45/SF, overlay only)
- Contractor experience with use as an overlay
- Workability of overlay mix

Conventional Overlay (40 years service)

Preservation vs. Reconstruction

- Deck Preservation (UHPC Overlay) vs Deck Reconstruction/Replacement
- Consider remaining service life of primary structural components (deck, superstructure, substructure)
- Consider Life Cycle Cost Analysis (LCCA)

Preservation vs. Reconstruction

LCCA Details:

- Example Bridge:
  - Year Constructed: 1990
  - Footprint: 8000 SF
  - Single Span, Multi-Girder

- **Alternative 1**: UHPC overlay now (w/ super. & sub. Rehab.)

- **Alternative 2**: Do nothing, replace deck in 10 years (w/ super. & sub. rehab.)

- Assumptions:
  - Overall fair condition (Deck/Super/Sub)
  - Assume superstructure or substructure repairs for either alternative to increase remaining component service life
  - Assume 40-year service life of UHPC overlay
  - Structural Cost Only
  - Consider major routine maintenance/rehabilitation

Preservation vs. Reconstruction

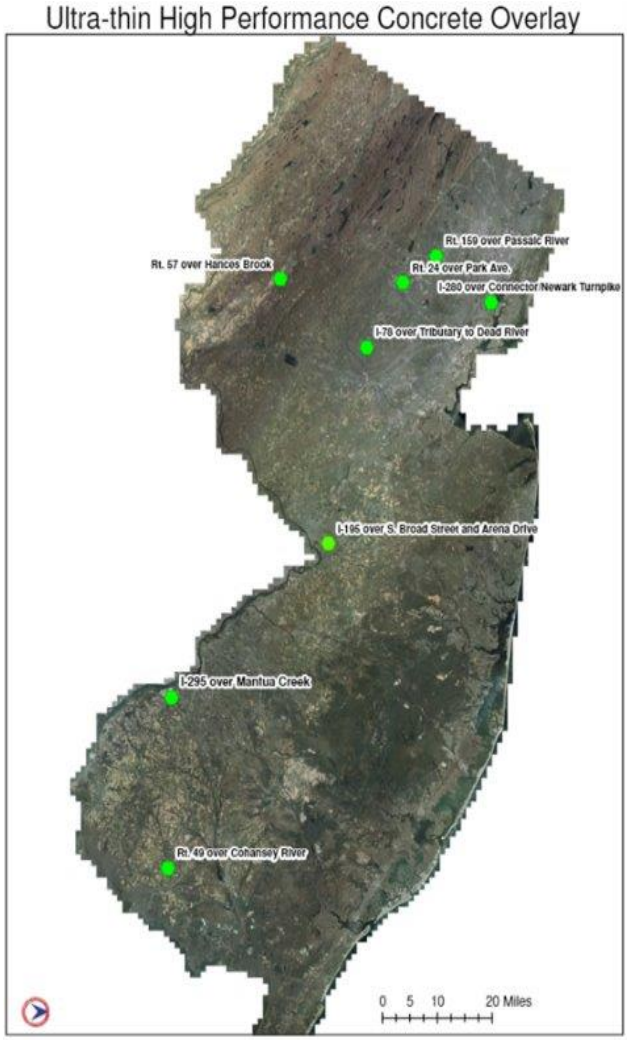
- Initial Construction Cost:
  - UHPC Overlay (deck work only): $480,000
  - Deck Replacement (deck work only): $1,100,000

- Life Cycle Cost (100-year):
  - **Alt. 1:** UHPC Overlay (now): $7.3M
  - **Alt. 2:** Deck Replacement (in 10 years): $7.7M

Bridge Selection

Bridge Selection

- 8 structures fully evaluated and tested
- 4 structures advanced into design and construction
- Considerations:
  - Component condition ratings
  - Deck chloride content
  - Existing overlay depths
  - Need for superstructure and substructure repairs
- Elimination:
  - Chlorides
  - Traffic impacts
  - Load ratings



Bridge Selection

Structure	Structure Type	Deck Area (SF)	Deck Age (yr)
I-295/US 130 NB over Mantua Creek	Steel Multi-Girder	20300	33
NJ 57 over Hances Brook	Prestressed Adjacent Slab	850	<10
I-280 WB over Newark Turnpike (CR 508)	Steel Multi-Girder	15200	40
NJ 159 WB over Passaic River	Prestressed I-Beam	11500	<10

- Deck slab ages: 10 - 40 years
- Deck slab areas: 800 - 20,000 SF
- All bridges existing asphalt overlay
- Deck/Super/Sub Condition - Good or Better

Existing Conditions & Testing

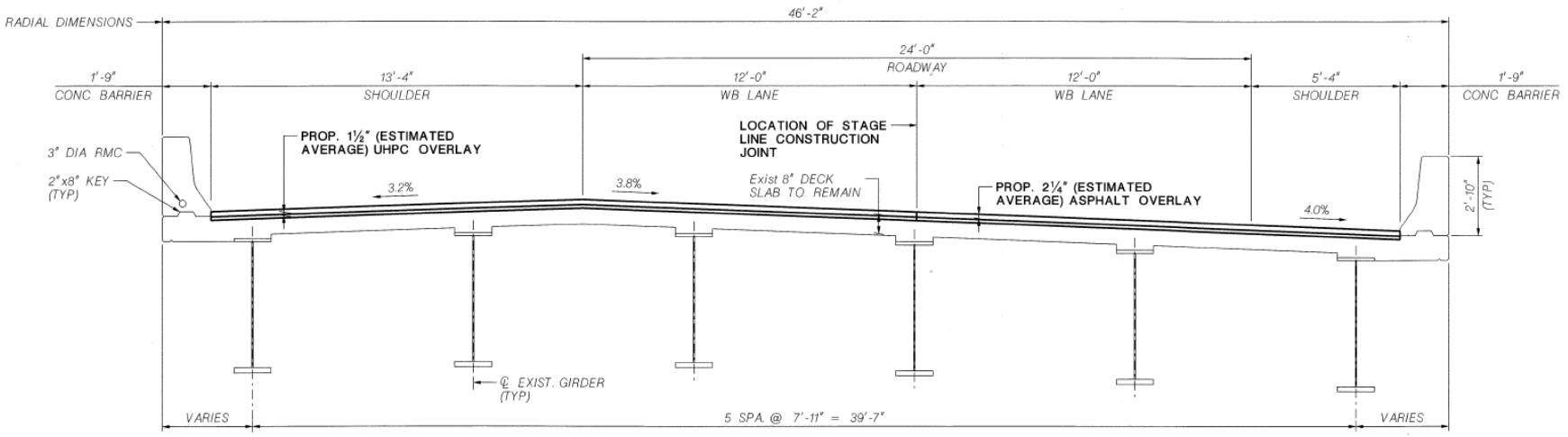
- Core samples were taken at each bridge:
  - Existing overlay thickness
  - Chloride content

- Chloride content:
  - Contamination of deck concrete to remain
  - Baseline data for future testing

- Ground penetrating radar (GPR):
  - Estimate area of deck spall repairs
  - Confirm overall condition of the deck.

Design – UHPC Overlay

- Environmental constraints limited the design to match existing elevations.
- Thin UHPC Overlay:
  - UHPC Overlays can be a minimum of 1” .
  - Average of 1.5” was specified to account for construction tolerances.
- Structures with existing overlay > 3” were designed for a 1.5” UHPC Overlay with an Asphalt topping
- NJ-159 bridge was designed with 2.75” UHPC Overlay, no asphalt topping



PROPOSED TYPICAL SECTION

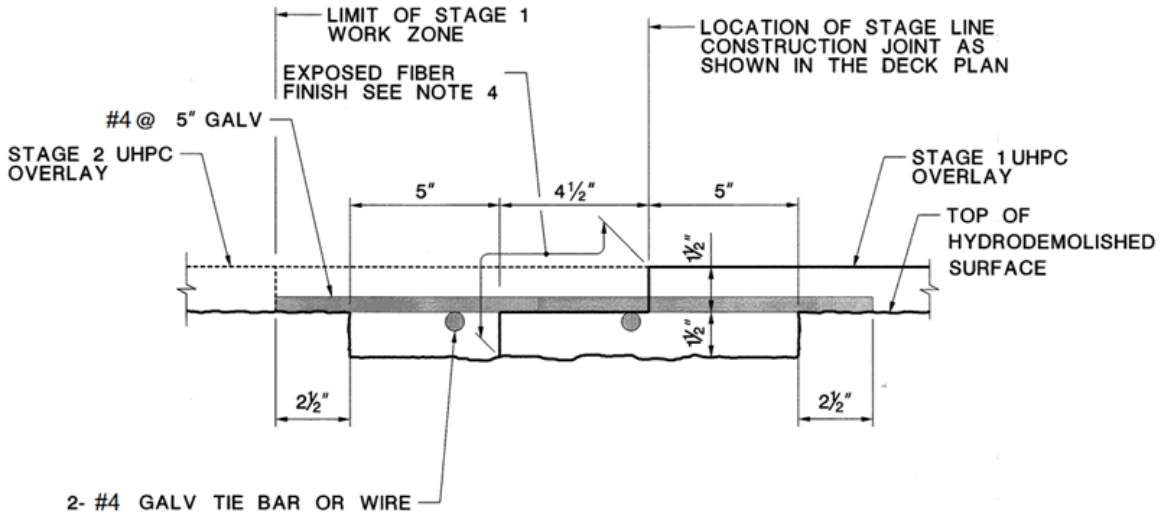
Design – Hydrodemolition

- Hydrodemolition is the preferred removal method for UHPC Overlays.
- Roughened surface with no microfractures creates ideal bonding surface with UHPC.
- The design called for 0.5” removal of the top surface of the deck

Hydrodemolished Surface – Typical

Design – Construction Joint

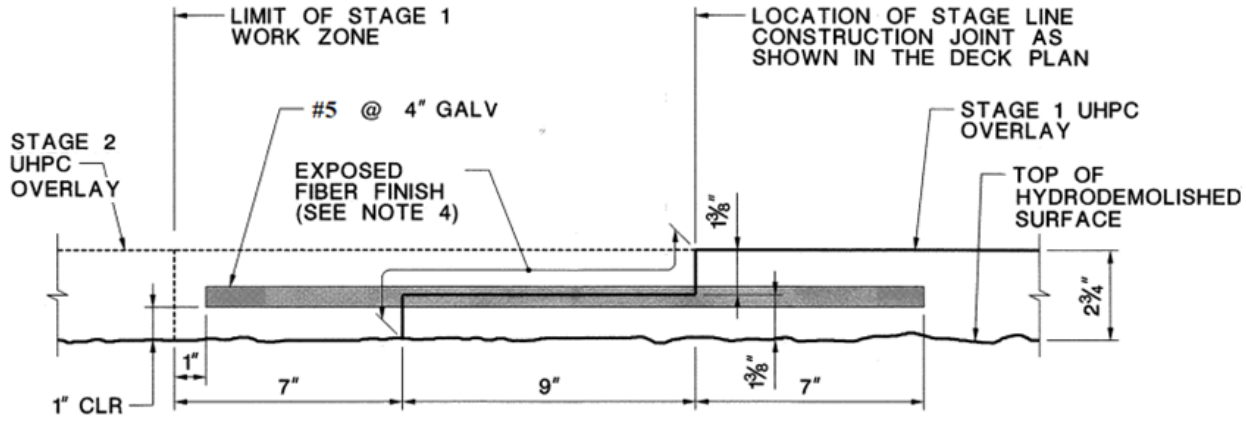
Construction Joint – 1.5” UHPC Overlay



UHPC OVERLAY CONSTRUCTION JOINT DETAIL

NTS

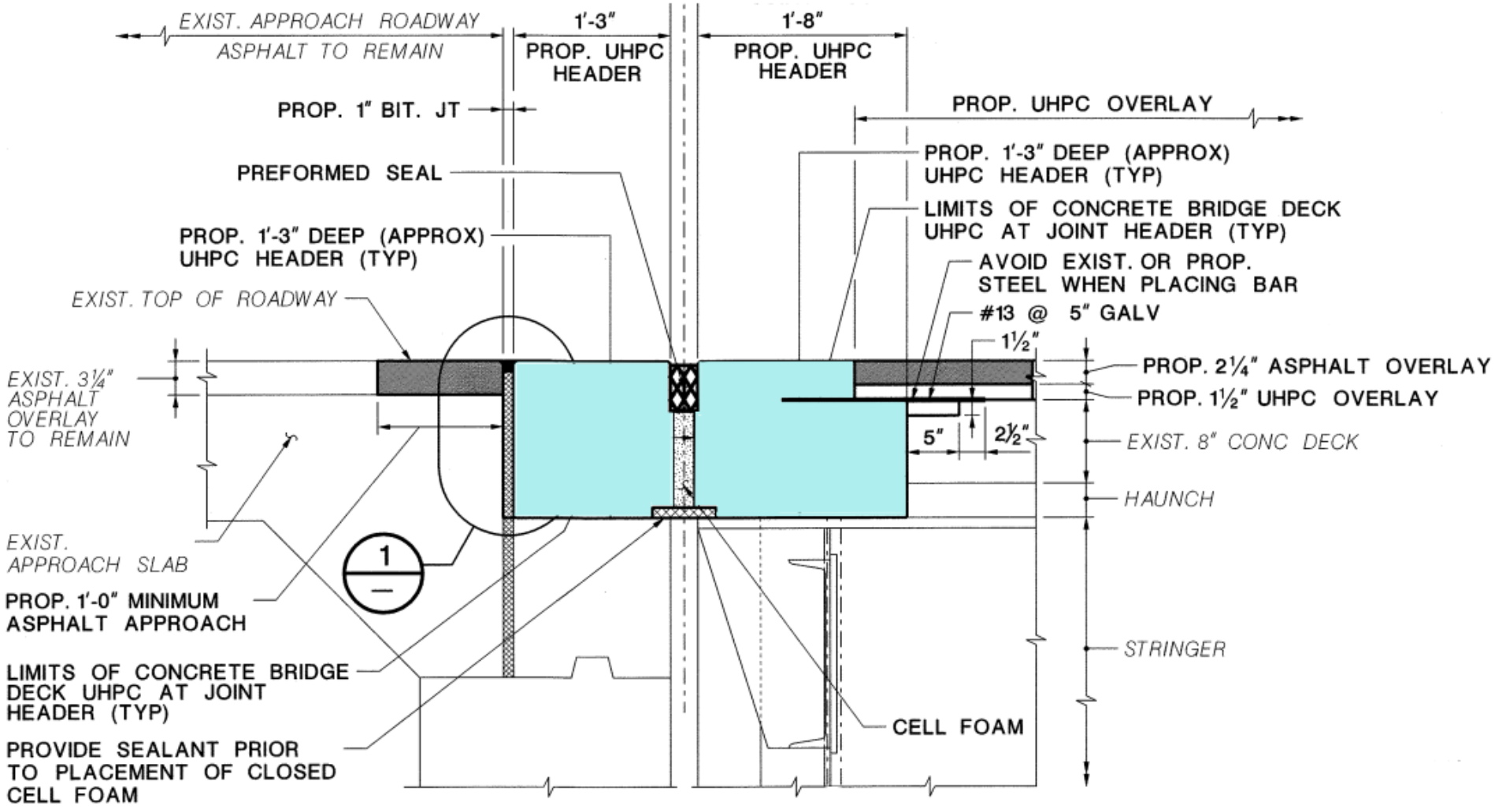
Construction Joints – 2.75” UHPC Overlay



UHPC OVERLAY CONSTRUCTION JOINT DETAIL

NTS

Design – Headers (Deck Joints)



Material Testing

- Performance Specifications
- Verification Testing
- Acceptance Testing
- Fresh Properties
- Both contractors choose to use proprietary UHPC mixes

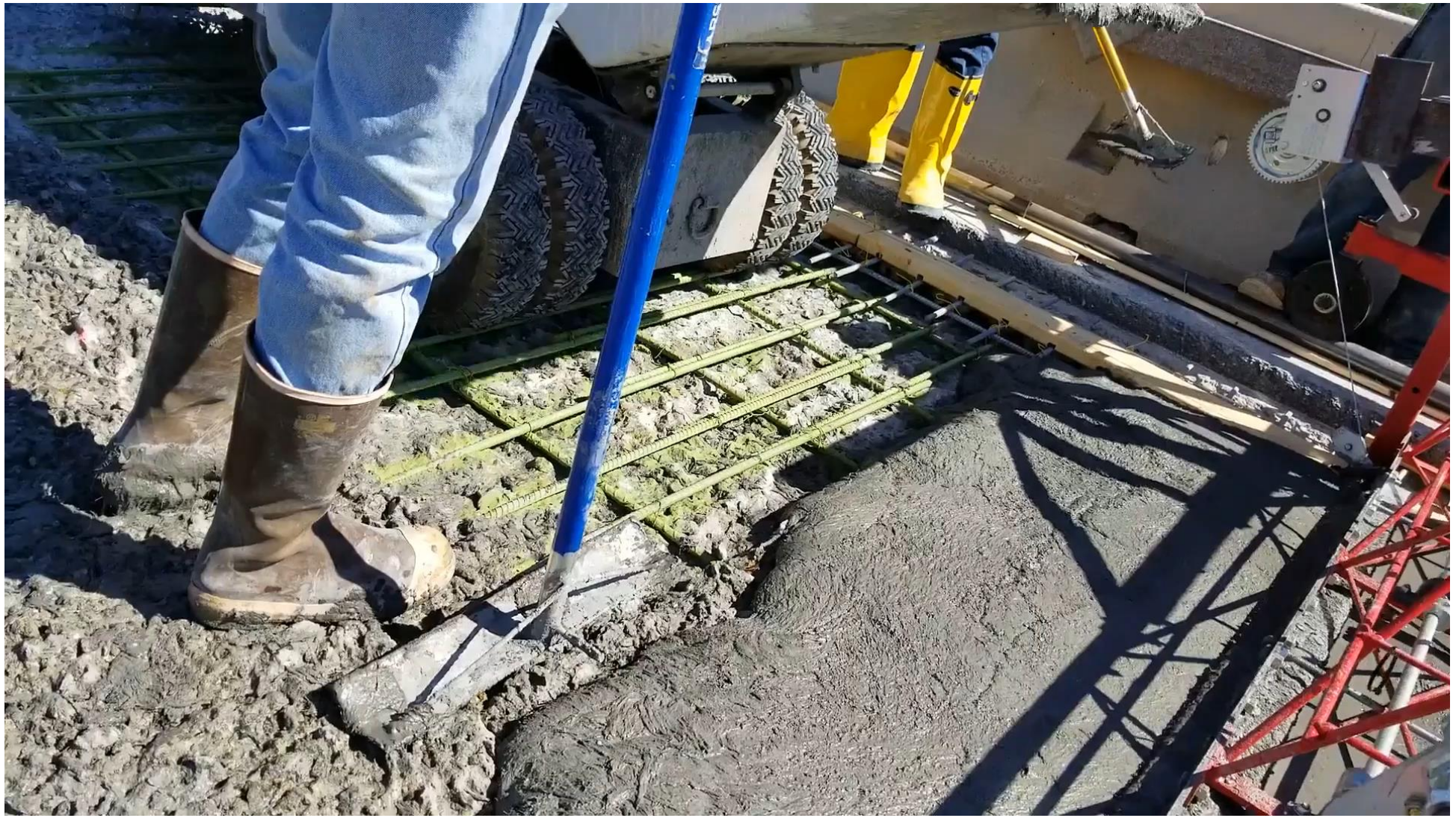
UHPC Material Properties		
Description	**Test Method**	**Acceptance Criteria**
Compressive Strength	C39 as modified by ASTM C 1856	-18,000 psi at 28- day moist cure
Direct Tension 1st Cracking Strength	AASHTO T 397	fcr > 1,000 psi
Direct Tension Post-Cracking Hardening Ratio	AASHTO T 397	Fp/fcr ≥ 1.25
Bond Strength	ASTM C 1583, Bonded to an Exposed Aggregate Concrete Surface	100% failure in substrate concrete with concrete compressive strength ≥ 4ksi, or > 400 psi
Modulus of Elasticity	C469 as modified by ASTM C 1856	≥ 6,500 ksi
Long-Term Shrinkage	C157, initial reading after set, as modified by ASTM C 1856	≤ 800 micro-strain
Rapid Chloride Ion Penetrability	AASHTO T277/ASTM C1202	≤ 250 coulombs (w/o steel fibers)
Scaling Resistance	ASTM C672	≤ 3
Freeze-Thaw Resistance	C666A, 600 cycles, as modified by ASTM C1856	Relative Dynamic Modulus of Elasticity > 95%
Alkali-Silica Reaction	ASTM C1567	Innocuous

UHPC Overlay Mockup Tests : Per the contract documents, contractors were required to successfully place a 4’x12’x3” deep rectangular test slab of UHPC with a grade of 8% in the longitudinal direction.

Construction – Hydrodemolition

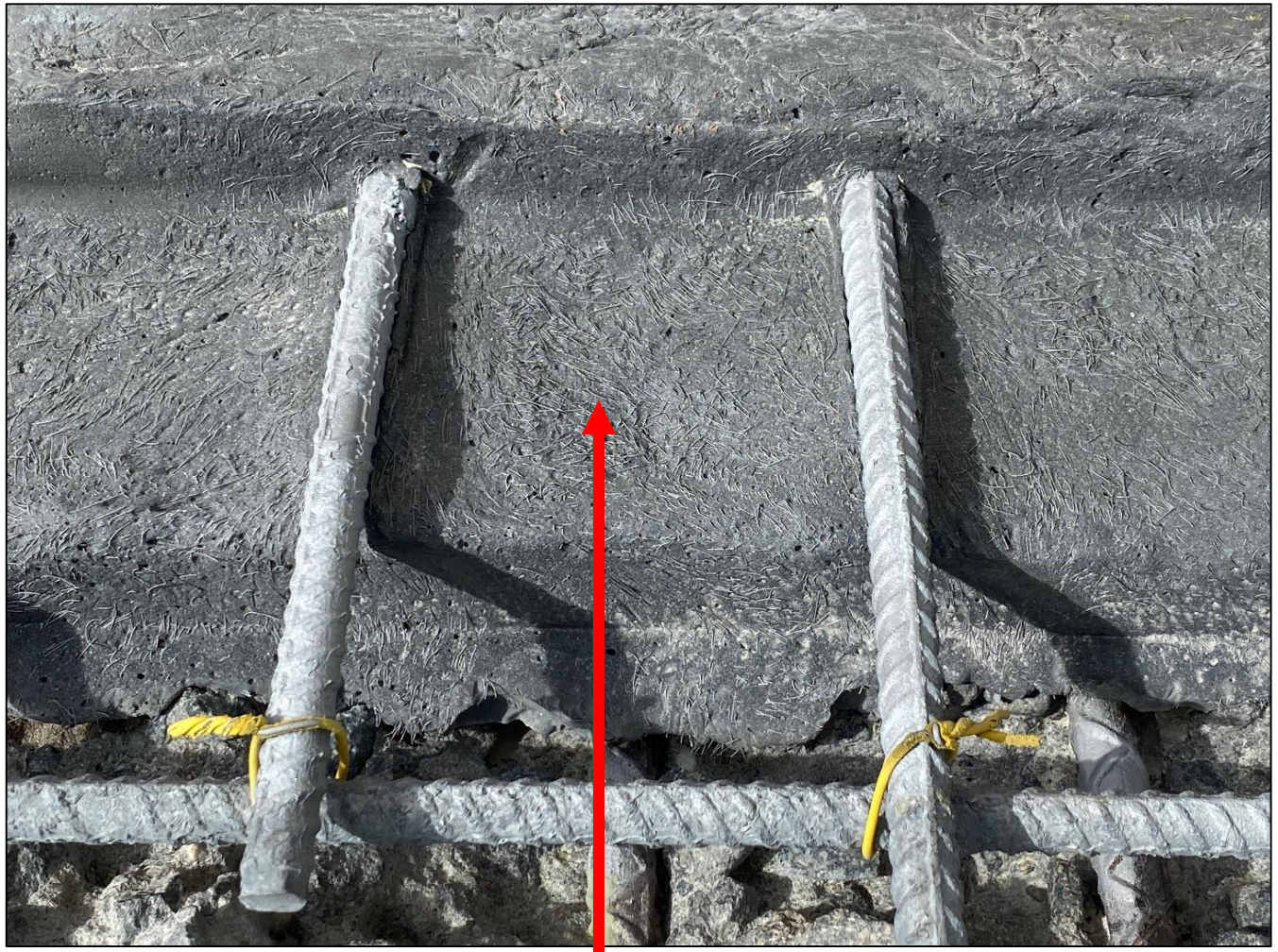
Construction – UHPC Placement

Construction – UHPC Placement



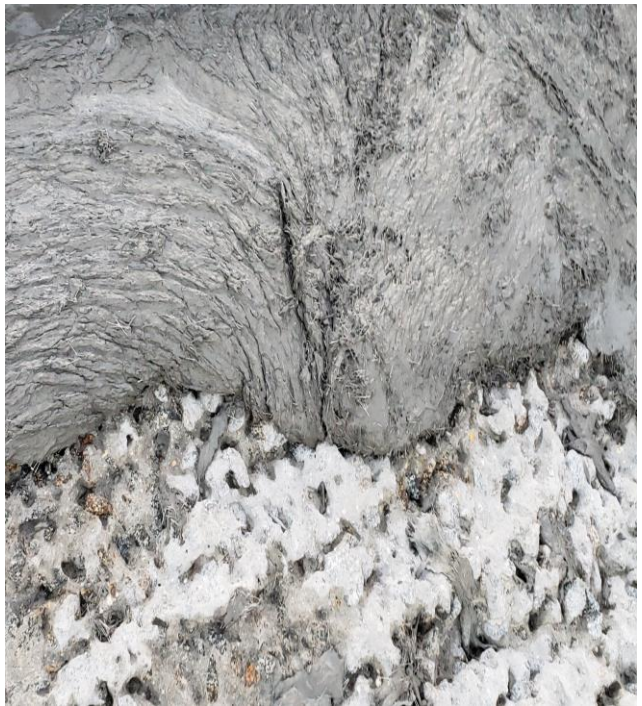
Construction – Construction Joint

Exposed Fiber



Step

Construction – Curing/Finishing



Lessons Learned

- If an overlay on top of the UHPC is required, consider BDWSC, curing materials must be removed.
- GPR to determine concrete cover, overlay thickness and reinforcement locations.
- Construction surveys for each interim stage.
- Specify watertight forms, top forms, minimum of ¼” to ½” overfill, and surface grinding.

Lessons Learned

- To replace deck joints use conventional HPC with UHPC at the surface.
- Self-consolidating UHPC is preferred for the full-depth UHPC header placement to ensure consolidation.
- Partial depth UHPC headers will be recommended with staging limitations.

Lessons Learned

- Surface defects were addressed before asphalt paving.
- UHPC slurry with no fibers was placed in air voids.
- Define proper repair methods in the contract documents for aesthetic or structural anomalies.

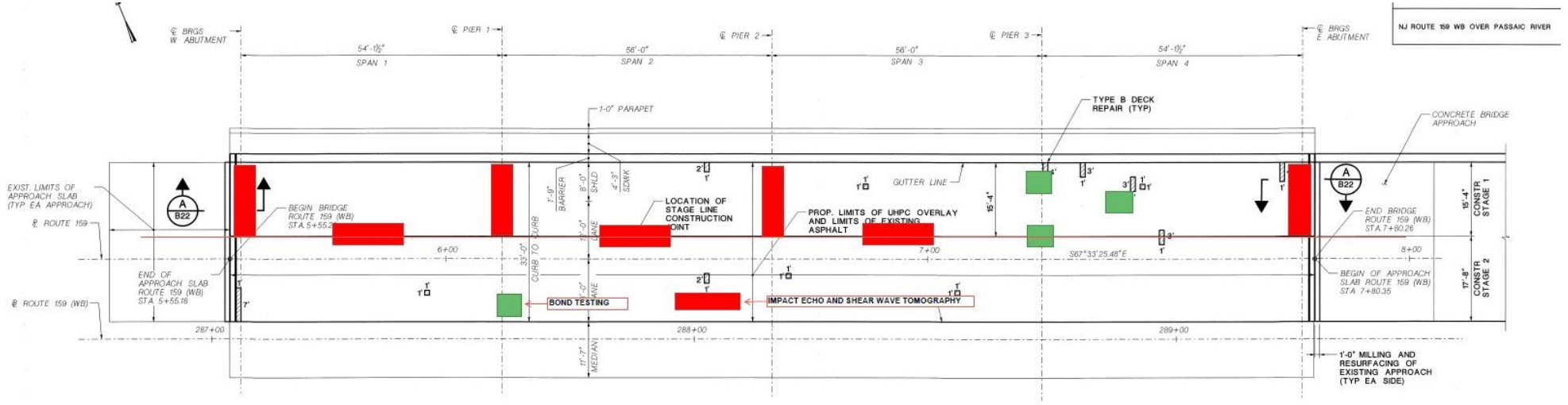
Evaluation

- Two Bridges selected for annual Evaluations :
  - I-295 NB & US 130 NB over Mantua Creek in Gloucester County
    - (UHPC with Asphalt Topping)
  - NJ 159 WB over Passaic River in Morris County
    - (UHPC diamond grinding)
- Objective is to ensure the bond is intact between UHPC and the existing concrete.
- Initial survey to establish baseline conditions followed by periodic monitoring over succeeding years.

Evaluation

Testing Program :

- Non destructive testing (NDT)
  - Impact Echo (IE) : depth and location of potential debonding or voids.
  - Ultrasonic shear wave tomography (MIRA) : 3D representation to identify the location and orientation of embedded features.
- Physical Sampling and Lab Testing
  - Pull-off testing (ASTM C1583)
    Bond Strength and Failure Mode
  - Chloride profile (ASTM C1152)
    0.5 ” and ~ 1.0 ” below the UHPC Overlay
- Testing Plan:

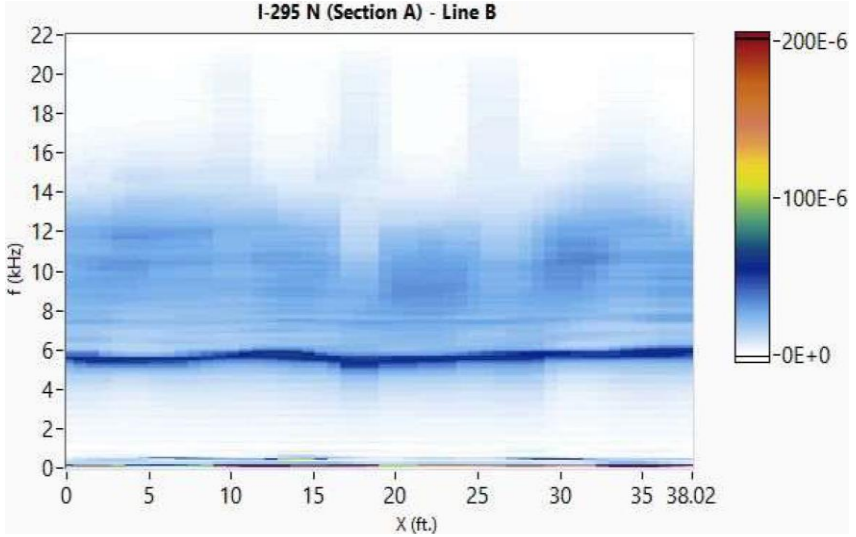


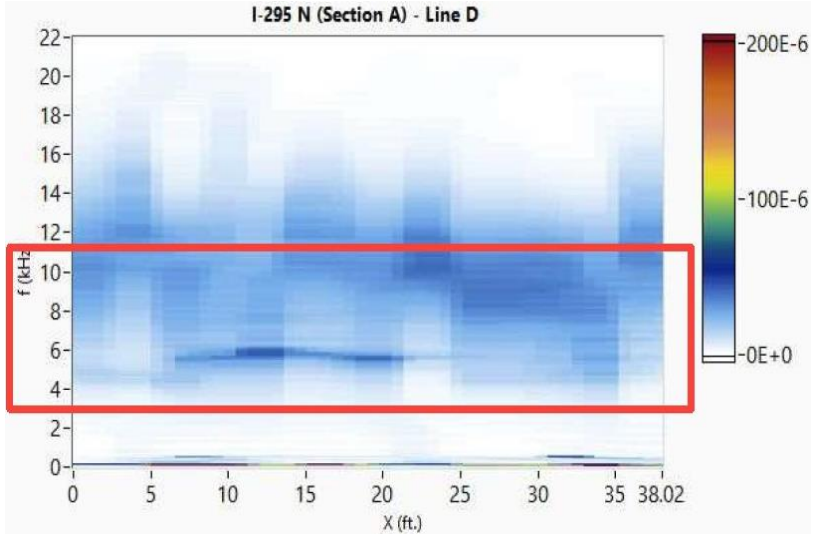
Evaluation

IMPACT ECHO

Impact echo is a commonly used NDE method for evaluating concrete and reinforced concrete elements for discontinuities, delamination, and thickness verification.

ASTM C1383-15 “Standard Test Method for Measuring the P-Wave Speed and the Thickness of Concrete Plates Using the Impact-Echo Method”

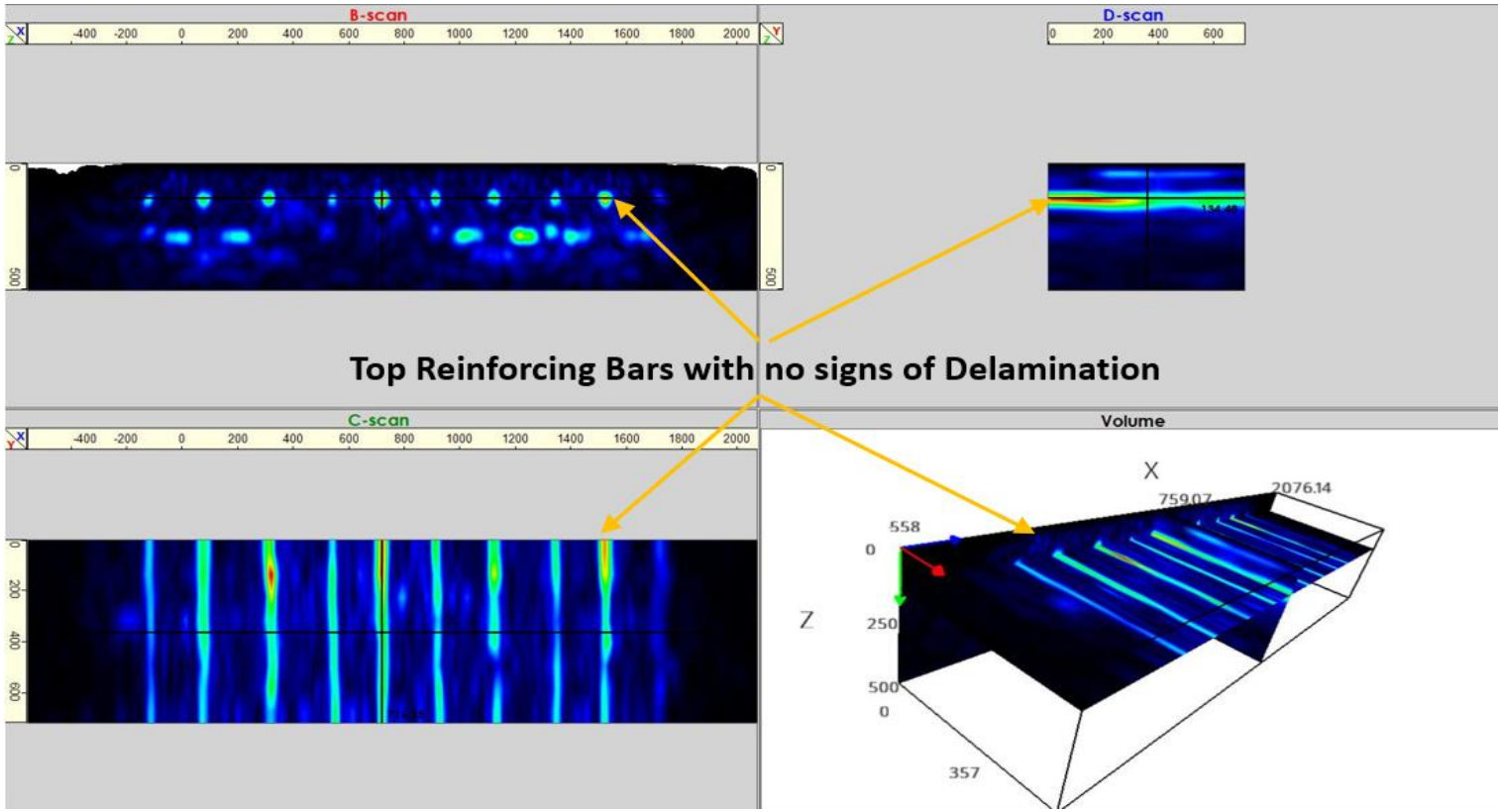


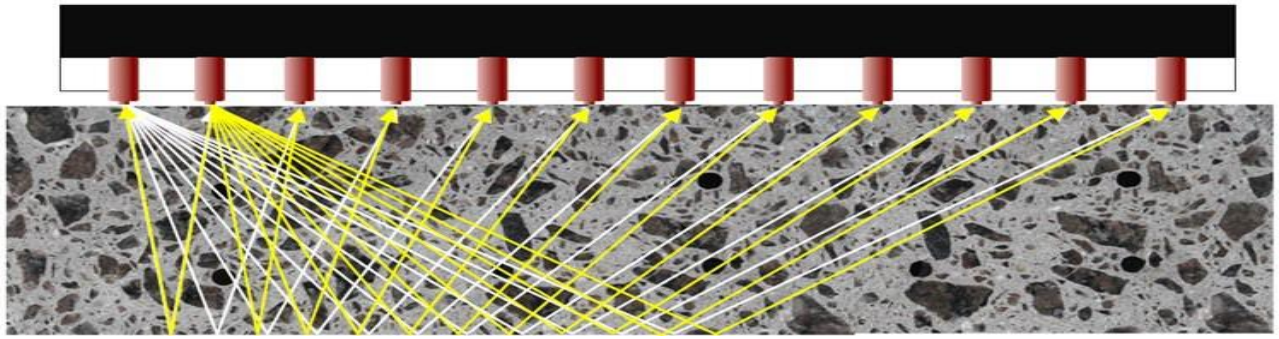


Evaluation

ULTRASONIC TOMOGRAPHY

Analysis of the signal times and angles of incidence between transducers allows for the construction of a 3-D representation of embedded features (tomograph).





Evaluation

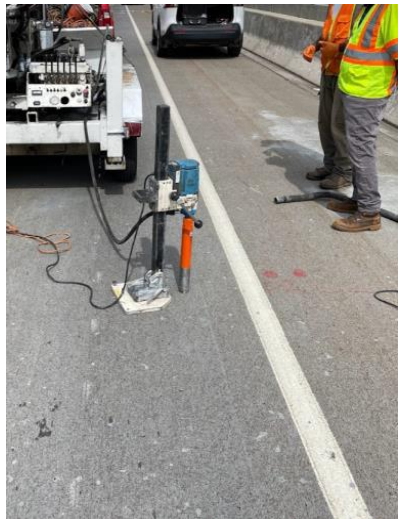
Pull-off Testing (ASTM C1583)

Bond Strength and Failure Mode

Location #	Bond Strength (PSI)	Failure Mode
P 11	184.7	c
P 12	376.7	a
P 13	200.9	a

Chloride Profile (ASTM C1152)

Within and below UHPC Overlay



Core Number	Depth (inches)	
	0.5” (Within UHPC)	1.0“ (Below UHPC)
	Chloride at Depth (PCY)	
C1	0.807	0.603
C2	3.221	0.519
C3	0.460	0.452
C4	0.464	0.44

Conclusions

- The ultrasonic tomography and impact echo testing indicated that the bond between UHPC and concrete substrate is sound.
- Bond strength test data demonstrates that the desired bond was achieved between UHPC and the substrate concrete.
- Chloride content is also within expectations.
- The baseline testing was successful, with no significant defects encountered
- Future monitoring at the same locations as well as different from the baseline to allow to maximize testing area.
- NJDOT is considering installing UHPC overlays on newly constructed decks as well as decks with lower condition ratings for future projects.
- A deeper overlay (with deeper existing deck removal) will be regarded as a viable alternative for structures that need a major deck rehabilitation.
- Incorporating UHPC for several applications in the new design manual, including P&R.

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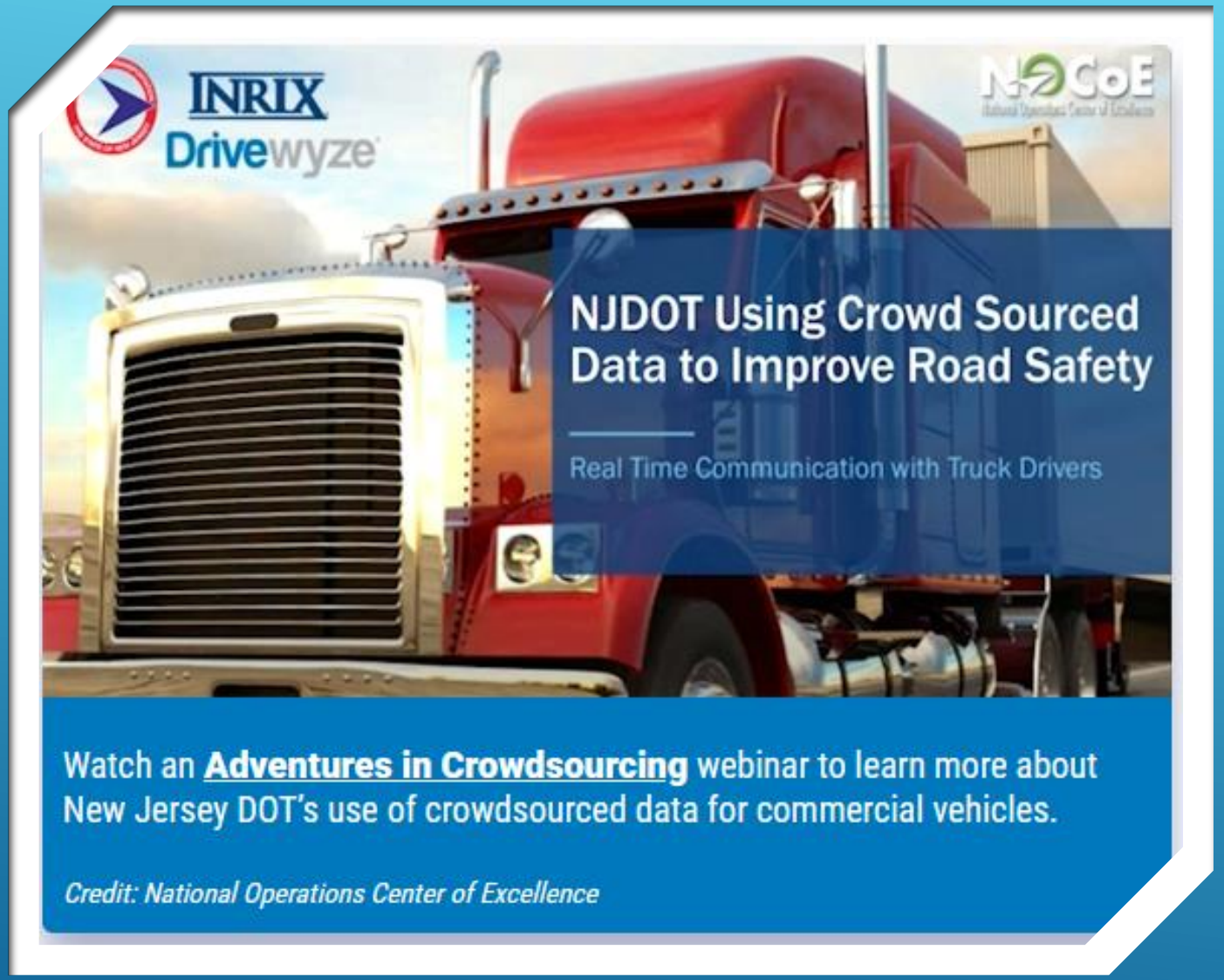
  - Andy Foden

REMINDERS & ANNOUNCEMENTS



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