

# Lessons Learned: Accelerated Bridge Construction

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# *Excellence in Transportation* *Every Trip. Every Mode. Every Dollar. Everyone.*

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We strive to make every trip taken in Delaware safe, reliable and convenient for people and commerce.

## **Every Mode**

We provide safe choices for travelers in Delaware to access roads, rails, buses, airways, waterways, bike trails, and walking paths.

## **Every Dollar**

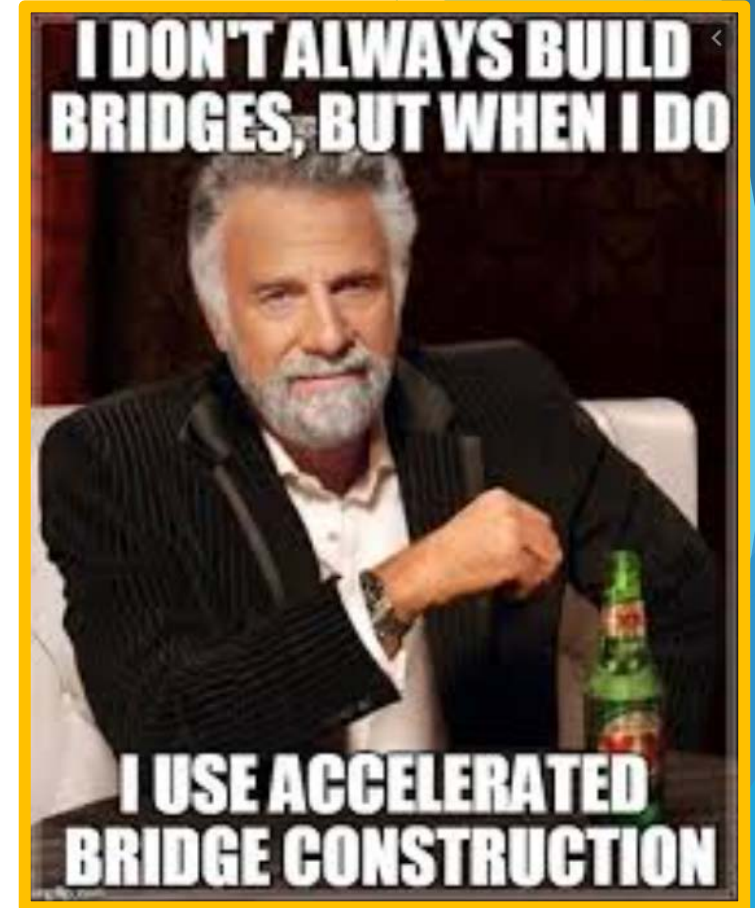
We seek the best value for every dollar spent for the benefit of all.

## **Everyone**

We engage and communicate with our customers and employees openly and respectfully as we deliver our services.

# Accelerated Bridge Construction (ABC) Overview

- ▶ 'Bridge construction that uses innovative planning, design, materials, and construction methods in a safe and cost-effective manner to reduce the onsite construction time...' - FHWA
- ▶ In Delaware: Typically use prefab/precast elements
  - ▶ Spoiler alert: bridge slides are coming!!
- ▶ Full closures... but less overall impact
- ▶ Safety
- ▶ Requires level of trust from everyone



# What is prefab and precast again?

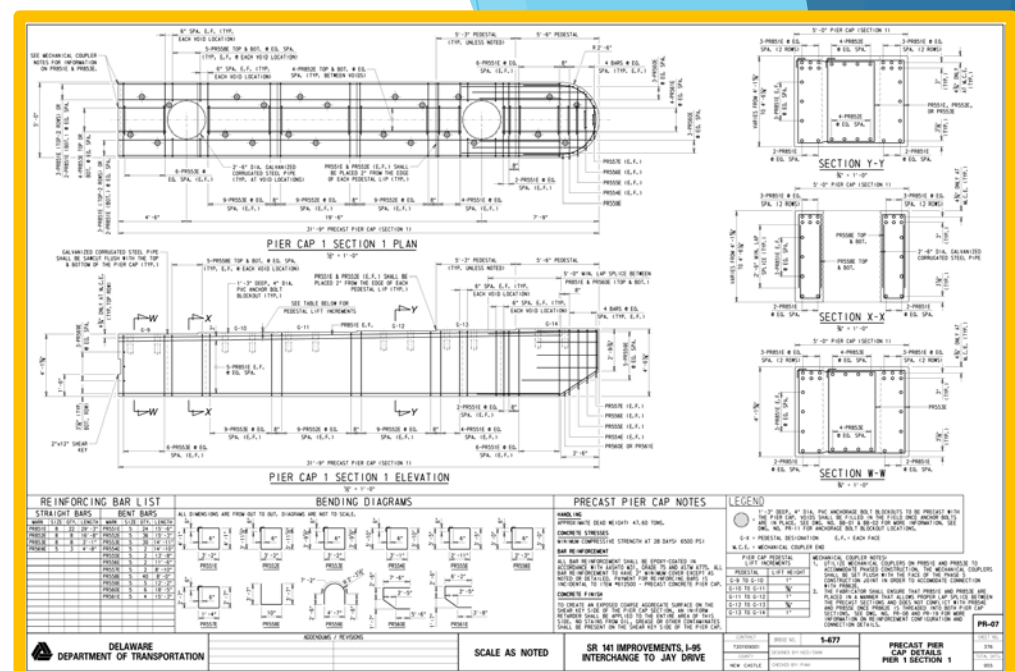
- ▶ Fabrication of elements off-site or in an area that would not cause traffic impacts
- ▶ Shifts time away from the construction site
  - ▶ For precast concrete: formwork, placing reinforcement, pouring, finishing, and... curing
  - ▶ Can happen without impacting traffic

▶ Is it really that easy?



# ABC - Design stage

- ▶ Is what we're proposing realistic?
  - ▶ Coordinate with others!
- ▶ Greater detail in design plans
  - ▶ Little room for error
  - ▶ Elements must fit together
  - ▶ QA/QC
- ▶ Comes back to trust



# Communication

- ▶ Unforeseen challenges in fabrication will arise
- ▶ Example: Bridge 1-676/1-677 beam camber
  - ▶ How will you respond?
  - ▶ Focus on the goal and a quality product
    - ▶ Not who is at fault and who is going to pay
  - ▶ Sense of urgency in responses/calculations
  - ▶ Communicate amongst the entire project team!
- ▶ Lessons learned can be a success



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# Planning is Key

- ▶ "If you fail to plan, you plan to fail." - Benjamin Franklin
- ▶ Case Study 1: Bridge 2-050A
  - ▶ Cost of abutments...\$80,000
  - ▶ Not the only issue...this is a custom-made piece and the road is closed!
- ▶ Plan every move
  - ▶ Including material delivery and lifting and handling
- ▶ Do less...
- ▶ Quick comparison to 1-438
  - ▶ Abutments completed in ~1 hour





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# Planning is Key

- ▶ Case Study 2: Bridge 1-251
  - ▶ Fabricator delivered panels to the contractor's yard where they were stacked for storage
  - ▶ Contractor shipped panels to the site, stacked on the north side of the bridge
  - ▶ Crane set up on north and south side of bridge for panel installation
  - ▶ Contractor shipped half the panels to the south side of the site and restacked before placement
- ▶ Think ahead...way ahead
  - ▶ It may be means and methods but...
    - ▶ Open the conversation
    - ▶ Interact and offer experiences
- ▶ **Disclaimer:** Great project team in place here and the project was a success! M&R monitored that panels were stacked correctly



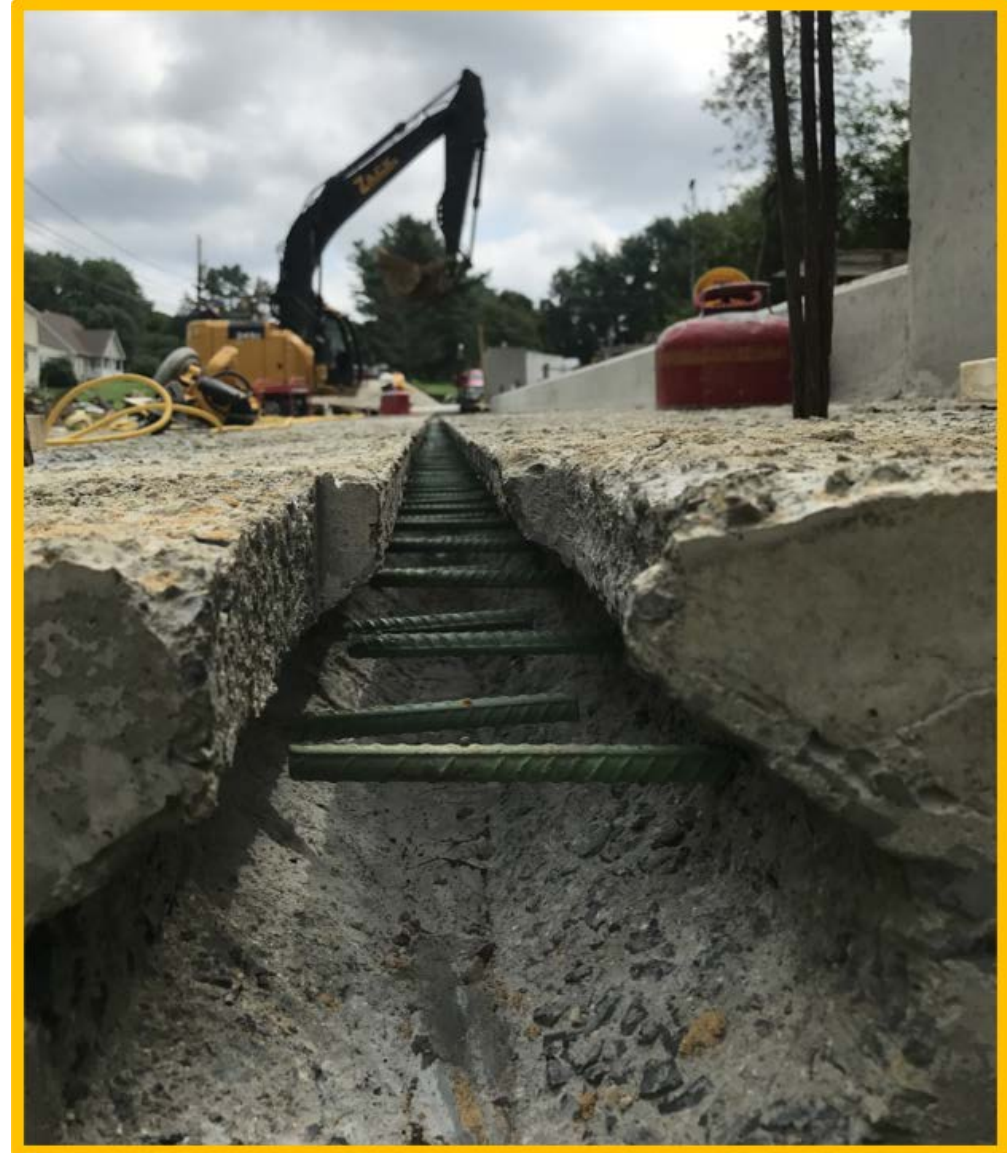
# The ABC's of Construction Tolerances

- ▶ Tolerances Become Tighter
  - ▶ Precast elements don't allow for as much "play" in construction
  - ▶ Smaller joints/connections



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# The ABC's of Construction Tolerances

- ▶ Differential camber
  - ▶ Major issue with precast superstructure elements
    - ▶ Additional attention during camber design
  - ▶ Use of grinding and overlays as a buffer for achieving proper roadway profile



# The ABC's of Construction Tolerances

- ▶ ABC examples where tolerance issues reared their ugly heads
  - ▶ Precast deck panels:
    - ▶ BR 1-717 on I-95
    - ▶ BR 1-680 on SR 141
    - ▶ BR 1-251 on Harmony Road
  - ▶ Proposed Panels
    - ▶ Thickness:  $8\frac{3}{4}$ " with  $\frac{1}{4}$ " sacrificial surface to be grind
    - ▶ Tolerance:  $\pm\frac{1}{4}$ "
  - ▶ Fabricated Panels
    - ▶ End-to-end:  $8\frac{3}{4}$ " at one end and  $9\frac{1}{2}$ " at the other for some panels
    - ▶ Panel-to-panel: 1" difference between some panels
    - ▶ Estimated 80% of panels on BR 1-717 and BR 1-680 were out of tolerance (per Kevin Lindell)



# The ABC's of Construction Tolerances

- ▶ How did this happen?
  - ▶ Design was sound
  - ▶ Fabrication Issue
    - ▶ Could forms have warped?
    - ▶ Were they cast on unlevel surface?
- ▶ Effect
  - ▶ UHPC closure pour formwork becomes more difficult
    - ▶ More prone to leaking
    - ▶ Forming takes more time
  - ▶ Reflective cracking through overlay (BR 1-680)
    - ▶ Improper grinding technique created shear stresses
- ▶ Solutions:
  - ▶ Use of overlay to create proper profile
  - ▶ NYDOT started designing panels with an additional 1" of concrete to be ground down





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# Ultra High Performance Concrete (UHPC)

- ▶ Facilitates use of precast elements
  - ▶ Turns weak point into a strength
  - ▶ Allows for:
    - ▶ Smaller Connections
    - ▶ Shorter Development Lengths
- ▶ Versatile Material
  - ▶ New Construction & Rehabilitations
  - ▶ Connections
  - ▶ Overlays
  - ▶ Precast Members?



# There is no "I" in UHPC

- ▶ Put your ego aside
- ▶ Not your traditional concrete
  - ▶ ~5x stronger
  - ▶ Steel fibers vs Traditional Aggregate
  - ▶ Flowable
- ▶ Utilize the experience of others
  - ▶ FHWA & Other State DOT's
  - ▶ M&R, DeIDOT Bridge Design, Construction



# Planning is the Mother of Success...in UHPC Pours

- ▶ Development of Specifications
  - ▶ Continuously Developing
  - ▶ Prescriptive vs. Non-prescriptive
  - ▶ Input from Multiple Parties
- ▶ UHPC Pour Plan
  - ▶ Submitted by Contractor
  - ▶ Approved by Engineer
  - ▶ Vet out Potential Problems
- ▶ Pre-Pour Meeting
  - ▶ Bring Together All Parties: Design, Construction, & Contractor
  - ▶ Final Walk-through of Approved Plan

**An hour of planning can  
save you 10 hours of doing.**

Dale Carnegie



@donhornsby

# UHPC Pour Planning by the Contractor

- ▶ Adequate personnel?
  - ▶ Mixing, transporting, Top-forming, etc.
- ▶ How many mixers?
  - ▶ Plan for one to fail
  - ▶ Timing with alternating mixers
- ▶ Where to stage the mixers?
  - ▶ Distance from mixer to pour location
  - ▶ How to transport UHPC
- ▶ Pour Sequence
  - ▶ Bulkhead locations
  - ▶ MOT: Pouring over traffic
- ▶ Pour Technique
  - ▶ Buckets vs. Troughs



# Formwork Makes the Dream Work

- ▶ Slow = Smooth...Smooth = Fast
  - ▶ Take extra time to ensure formwork is sound
  - ▶ Spending extra time on formwork ultimately saves time & money
  - ▶ Built in bulkheads limit losses
- ▶ Losing 1 Large Batch of UHPC Equates to:
  - ▶ ~1 Hour of time lost
    - ▶ Does not include time to repair leaking joint & clean up UHPC spill
  - ▶ ~\$6,667 in wasted material
- ▶ Successful Techniques



# Summary

- ▶ Change the mindset
  - ▶ See change as an opportunity, not a threat
- ▶ Cut construction time, not corners
  - ▶ Specifications still need to be met
  - ▶ Environmental restrictions still apply
  - ▶ Extended Hours/Night work
    - ▶ Noise Ordinance Waiver
    - ▶ Noise Survey
- ▶ Learn from others' mistakes and improve on their details
- ▶ COMMUNICATION & PLANNING are the keys to success!

