Lessons Learned: Accelerated Bridge Construction

Scott Walls, P.E., M.C.E.
Nicholas Dean, P.E., M.C.E.
Every Trip
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
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
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
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...
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...
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
The ABC's of Construction Tolerances

- Tolerances Become Tighter
  - Precast elements don't allow for as much "play" in construction
  - Smaller joints/connections
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: 8¾" with ¼" sacrificial surface to be grind
    - Tolerance: ±¼"
  - Fabricated Panels
    - End-to-end: 8¾" at one end and 9½" 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
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
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
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, DelDOT 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
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!