# Accelerated Bridge Construction at SR141/I-95

Kevin Lindell and Scott Walls, DelDOT Bridge
March 14, 2023

# Excellence in Transportation

## Every Trip. Every Mode. Every Dollar. Everyone.

### 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.

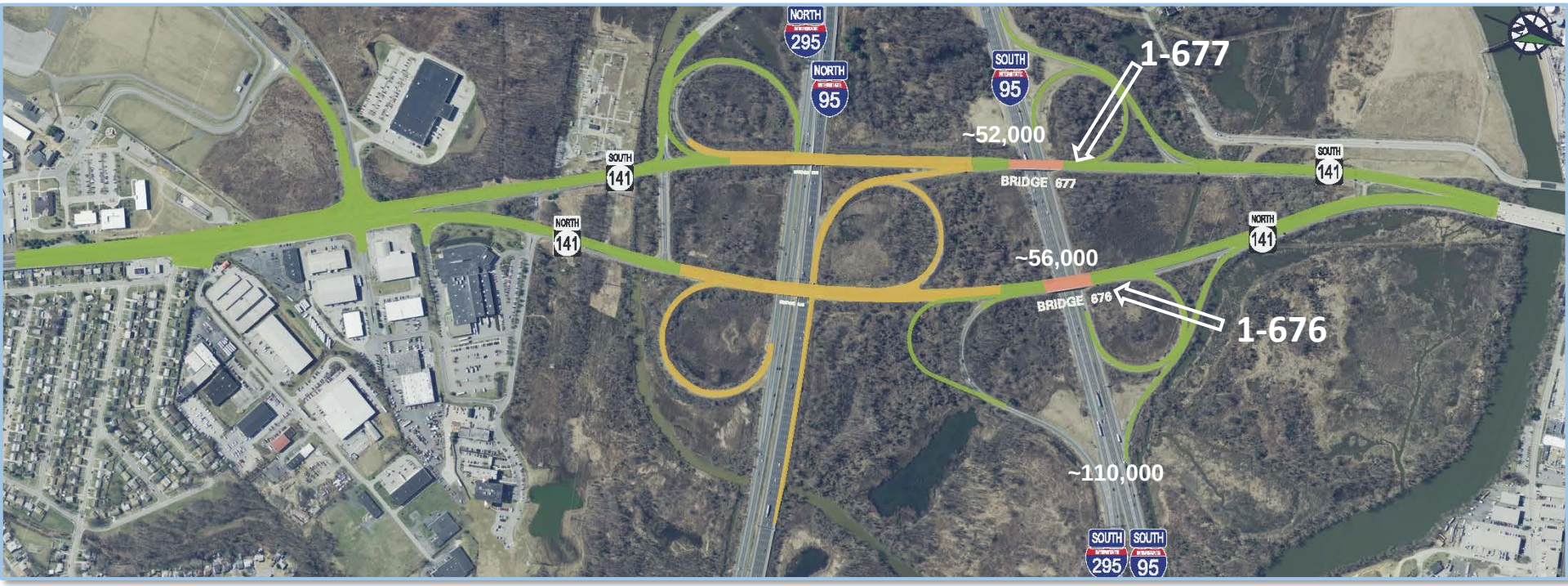
### Every Dollar

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

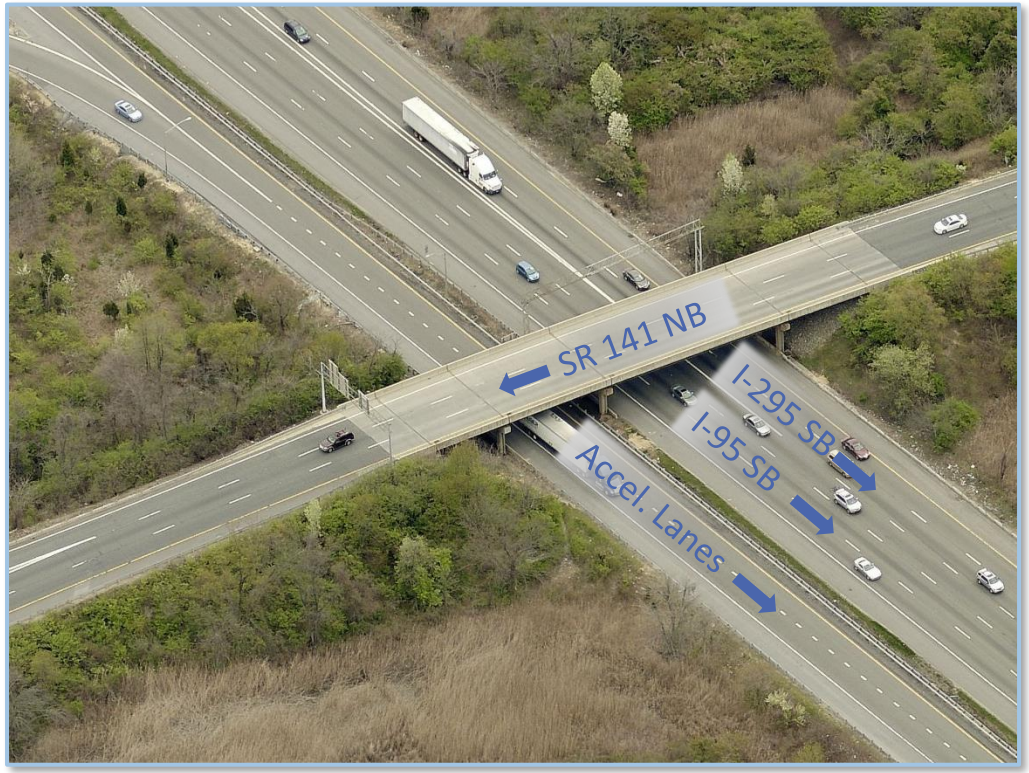
### Everyone

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

# Existing Site Conditions

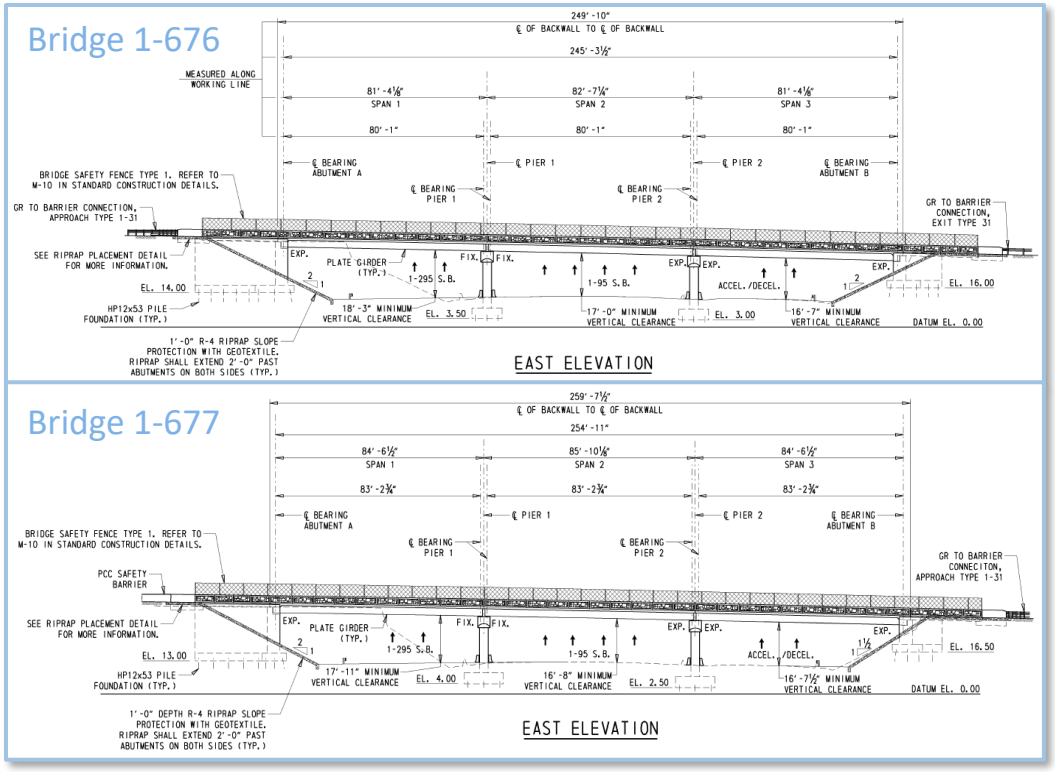


# Existing Bridge Conditions



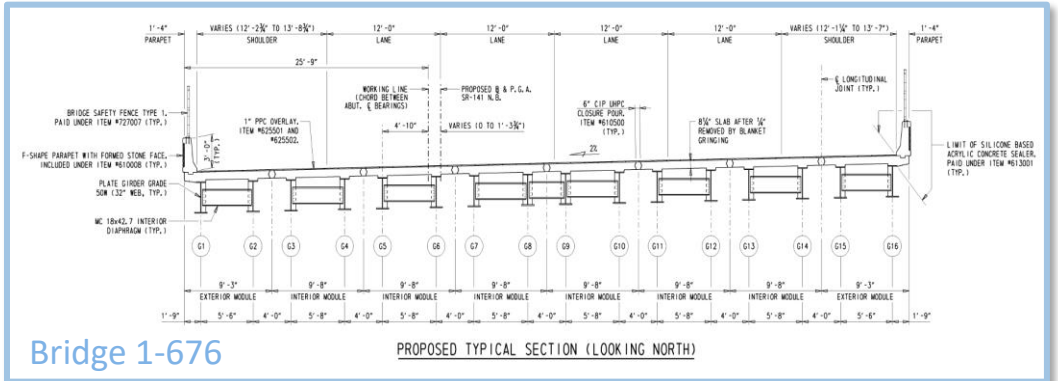

- Existing Structures
  - Total Bridge Length:
    - (4) Simple Spans
    - Bridge 1-676: ~223’-4”
    - Bridge 1-677: ~217’-6”
  - Out-to-out Bridge Widths: 48’-10”
    - (3) 12’-0” Travel lanes
    - Substandard Shoulders

# Replacement Solution

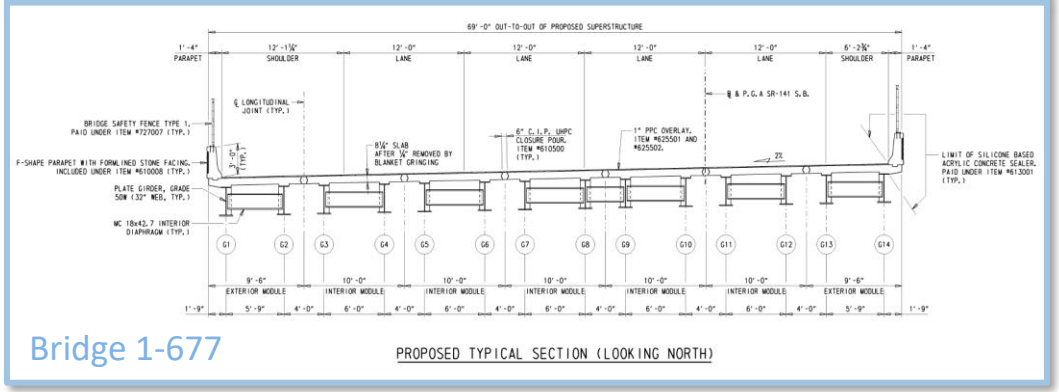



- Proposed Structure
  - Bridge 1-676:
    - (3) 80’-1” Spans = 249’-10”
    - Out-to-out Width = 76’-6”
      - (4) 12’-0” Travel Lanes
      - (2) 12’-0” Shoulders
  - Bridge 1-677:
    - (3) 83’-3” Spans = 259’-8”
    - Out-to-out Width = 69’-0”
      - (4) 12’-0” Travel Lanes
      - (1) 12’-0” Shoulder & (1) 6’-3” Shoulder

# Replacement Solution




Bridge 1-676




Bridge 1-677

- Proposed Structure
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# Why ABC?

- FHWA's Every Day Counts Initiative
- Department Commitment to Innovation
- Project Specific Reasoning:
  - Limit impact to traveling public
  - Take bridges off critical path for project completion


DelDOT
BRIDGE SECTION

# ABC Methods Implemented

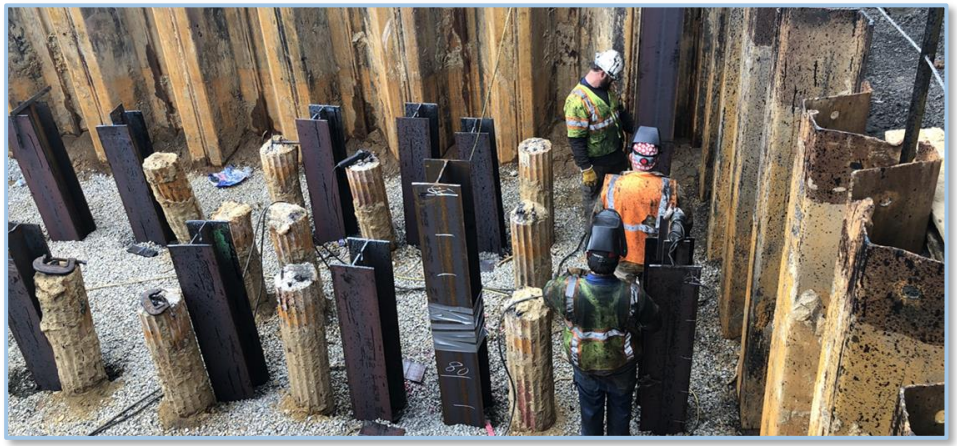
- Steel H-Piles
  - Innovative Design Approach?
- Firsts in Delaware
  - Precast Concrete Columns
  - Precast Concrete Caps
  - Prefabricated Superstructure Modules
- Ultra High Performance Concrete (UHPC)
  - Link Slabs
  - Shear Keys


# Contracting Method

- Design – Bid – Build
- Bid opening: June 4, 2019
- Awarded contractor: Richard E. Pierson Construction Company, Woodstown, NJ
- Total contract: $69,915,319
  - Bridge 1-676: $9,535,151 (22% less than EE)
  - Bridge 1-677: $10,791,013 (16% less than EE)
- Steel Fabricator: High Steel Structures, Lancaster, PA
- Precast Fabricator: Precast System Inc., Allentown, NJ

# Steel H-Piles

- Common Construction Practice
  - Easy to maneuver
  - Easy to Splice
- Innovation in Design
  - Specifications allow for 3” tolerance
  - Designed to move 1’-0” in any direction
    - Avoided costly delays in review
- Piles Driven
  - Bridge 1-676:
    - 218 total piles
    - 80’-90’ long
  - Bridge 1-677:
    - 220 total piles
    - 75’-90’ long



# Precast Pier Columns

- Bridge 1-676:
  - 5 columns per pier
  - Height: 16’-8½” to 18’-9½”
  - Weight: 8.76 tons to 10.26 tons
- Bridge 1-677:
  - 4 columns per pier
  - Height: 17’-3” to 17’-11½”
  - Weight: 9.15 tons to 9.67 tons
- Major Challenges
  - Accommodating tolerances
  - Connection between elements
  - Fabrication
- Installation Times: ~50 min. per column
  - Setting: ~15 min. per column
  - Bracing: ~12 min. per column
  - Closure pour: ~23 min. per column

# Precast Pier Caps

- (2) Precast Sections Per Pier:

| | | Section 1 | Section 2 |
|---|---|---|---|
| Bridge 1-676 | Weight: | ~58.9 Tons | ~48.4 Tons |
| | Length: | 40’-0” | 32’-0” |
| Bridge 1-677 | Weight: | ~47.5 Tons | ~50.3 Tons |
| | Length: | 31’-9” | 34’-3” |

- Major Challenges
  - Precast voids
  - Connection between elements
  - Large crane picks
  - Achieving appropriate elevations
- Installation Times: ~46 min. per cap
  - Column preparation & Rebar cage placement: ~28 min. per cap
  - Cap Placement: ~18 min. per cap

# Prefabricated Superstructure Modules

| | | Interior Unit | Exterior Unit |
|---|---|---|---|
| Bridge 1-676 | Length: | 82’-1” | 82’-1” |
| | Weight: | ~52 Tons | ~77 Tons |
| | Width: | 9’-2” | 9’-0” |
| Bridge 1-677 | Length: | 85’-2¾” | 85’-2¾” |
| | Weight: | ~56 Tons | ~79 Tons |
| | Width: | 9’-6” | 9’-3” |

- Major Challenges
  - Accommodating tolerances
  - Fit-up around reinforcement
  - Large crane picks
  - Camber in fabrication
- Installation Times: 1 Night per span
  - Bridge 1-676: ~53 min. per girder
  - Bridge 1-677: ~49 min. per girder

# Superstructure Fabrication Issues

- Coordination Between Fabricators
  - Steel vs. Concrete
- Unexpected Camber:
  - Heavy steel formwork
  - Autogenous Shrinkage
- Solution:
  - Collaborative effort
  - Adjusted curing procedure
  - Cribbing

# UHPC Link Slabs

- Developed by FHWA
  - Popularized by NYDOT
- Advantages
  - Pushes joint to approach slabs
  - Decreases maintenance & increases life of bridge bearings
- Installation Time: 1 Night per phase for each bridge

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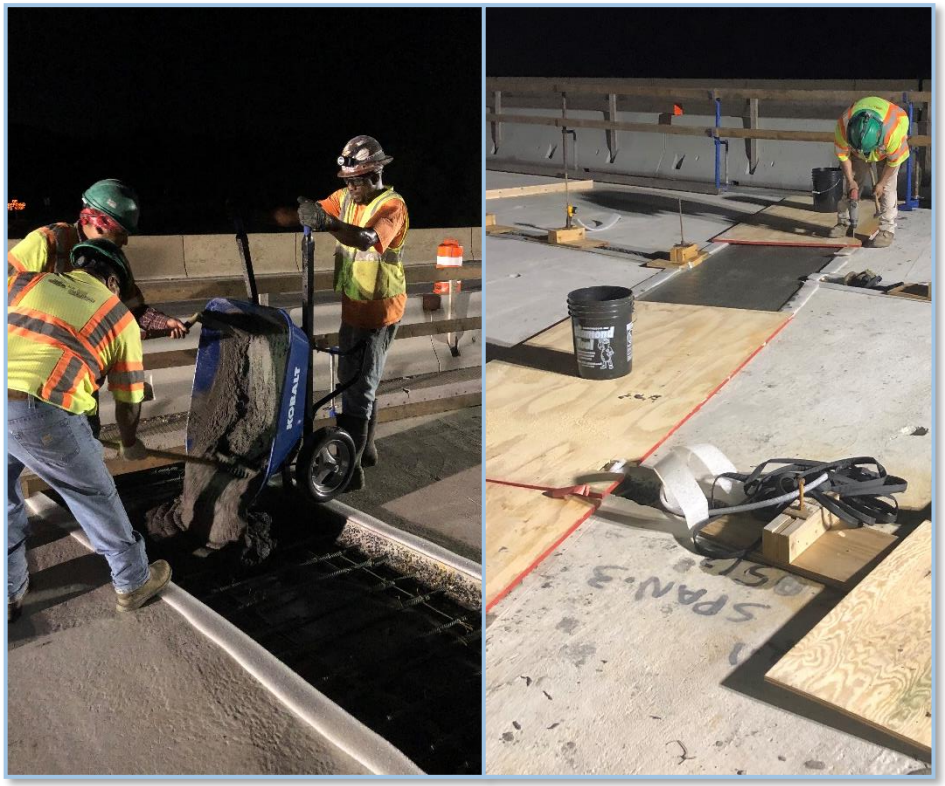
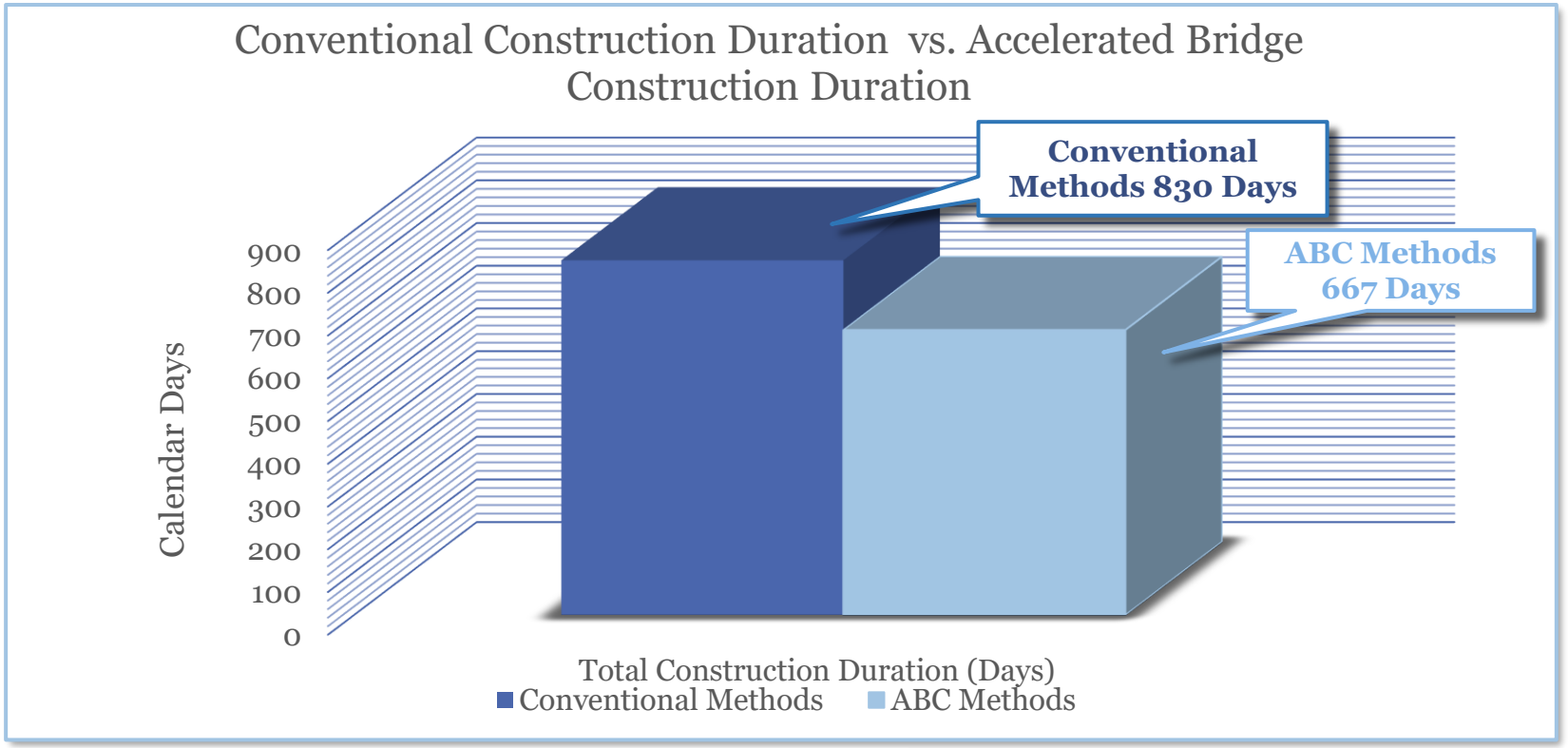


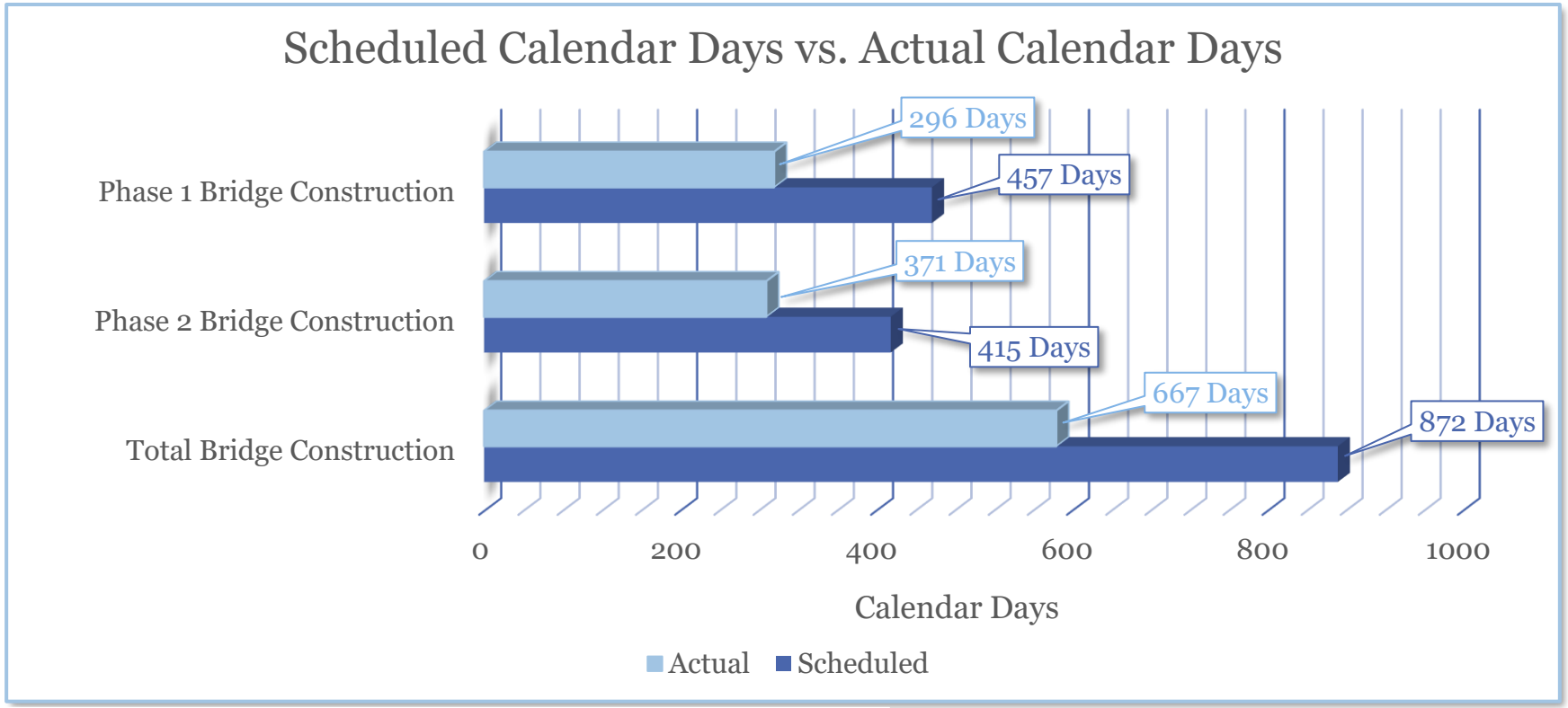
# UHPC Shear Keys

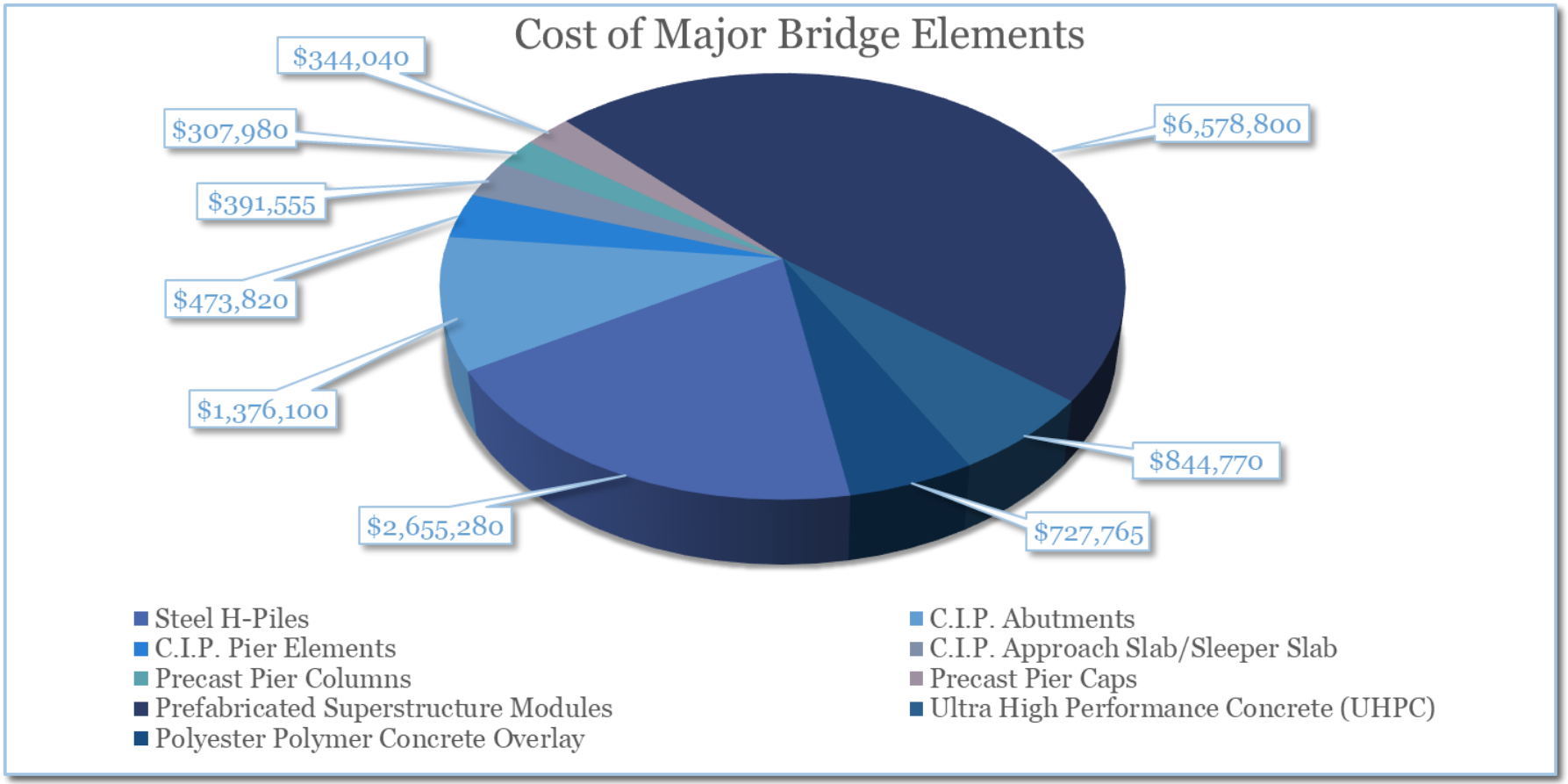
- Developed by FHWA
  - DelDOT standard for connecting most precast elements
- Advantages
  - Facilitates use of Prefabricated Superstructure Modules
  - Minimizes closure pour size & cure times
  - Impermeable Deck
- Installation Time: 1 Night per phase for each bridge

# Scheduling


Conventional Construction Duration vs. Accelerated Bridge Construction Duration
Conventional Methods 830 Days
ABC Methods 667 Days
Calendar Days
900
800
700
600
500
400
300
200
100
0
Total Construction Duration (Days)
Conventional Methods
ABC Methods

# Scheduling


Scheduled Calendar Days vs. Actual Calendar Days
Phase 1 Bridge Construction
Phase 2 Bridge Construction
Total Bridge Construction
296 Days
457 Days
371 Days
415 Days
667 Days
872 Days
0
200
400
600
800
1000
Calendar Days
Actual
Scheduled


Cost of Major Bridge Elements
$344,040
$307,980
$391,555
$473,820
$1,376,100
$2,655,280
$6,578,800
$844,770
$727,765
Steel H-Piles
C.I.P. Pier Elements
Precast Pier Columns
Prefabricated Superstructure Modules
Polyester Polymer Concrete Overlay
C.I.P. Abutments
C.I.P. Approach Slab/Sleeper Slab
Precast Pier Caps
Ultra High Performance Concrete (UHPC)

# Lessons Learned

- Communication
  - Precaster & Designer
  - Contractor & Department
- Precast Elements
  - Level of detail
  - Connections & Tolerances
- UHPC Pours
  - Planning is key
  - Care with formwork
- Don’t Fear Change!

# Precast Pier Column Placement

# Precast Pier Cap Placement

# Prefabricated Modular Girder Placement

# Questions

**Kevin Lindell**
Phone: 302-760-2318
kevin.lindell@delaware.gov

**Scott Walls**
Phone: 302-760-2317
scott.walls@delaware.gov