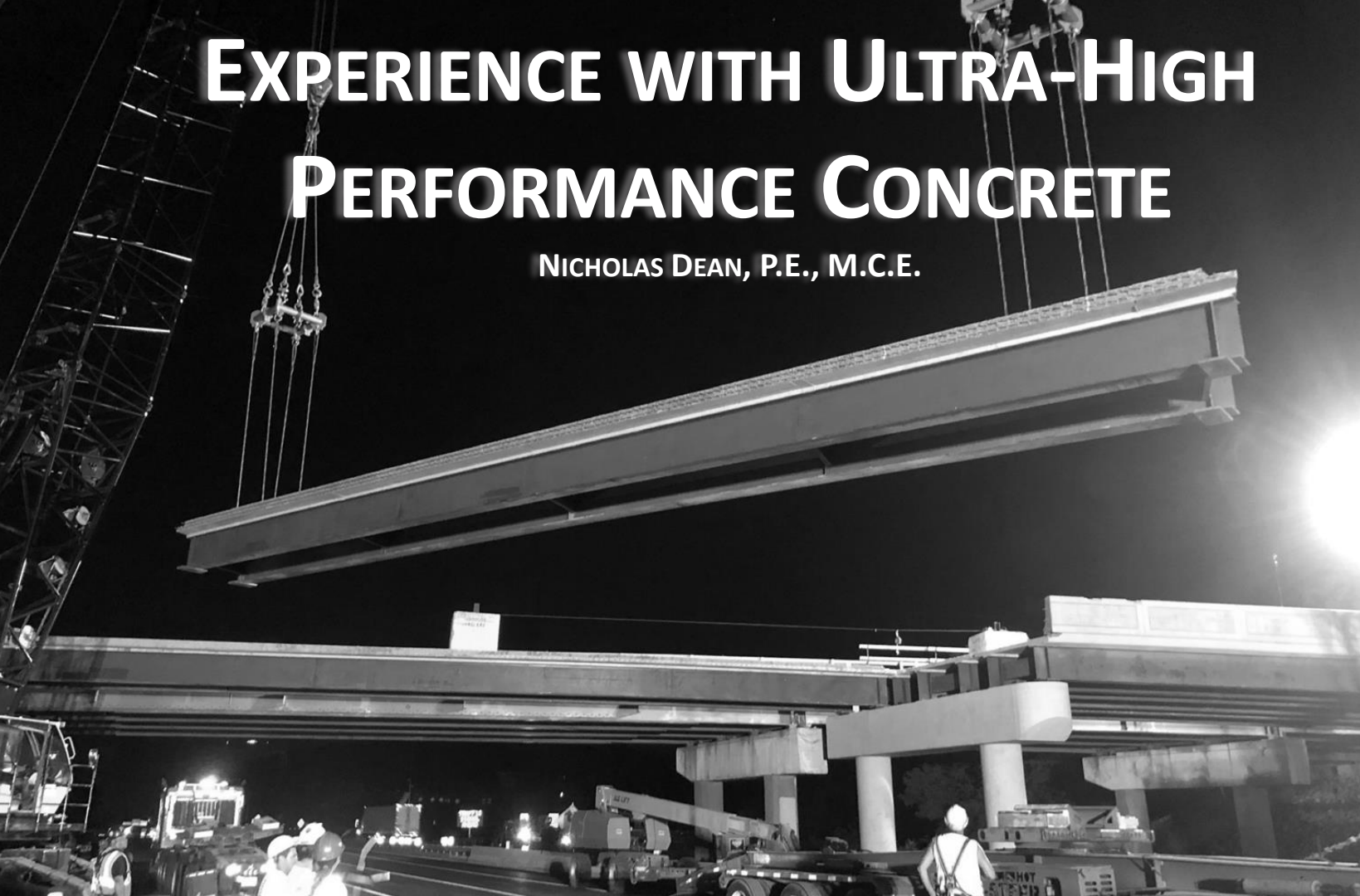


# EXPERIENCE WITH ULTRA-HIGH PERFORMANCE CONCRETE

NICHOLAS DEAN, P.E., M.C.E.



# Excellence in Transportation

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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.

# WHY AM I HEARING ABOUT UHPC?

- FHWA's Every Day Counts Initiative
- COMMITMENT TO INNOVATION
  - ENTIRE DEPARTMENT
  - BRIDGE DESIGN COMMITMENT
- PROJECT SPECIFIC REASONING
  - FACILITATE THE USE OF PRECAST ELEMENTS
  - MINIMIZE JOINT SIZES
  - ACCELERATE CONSTRUCTION SPEED



# WHAT IS UHPC?

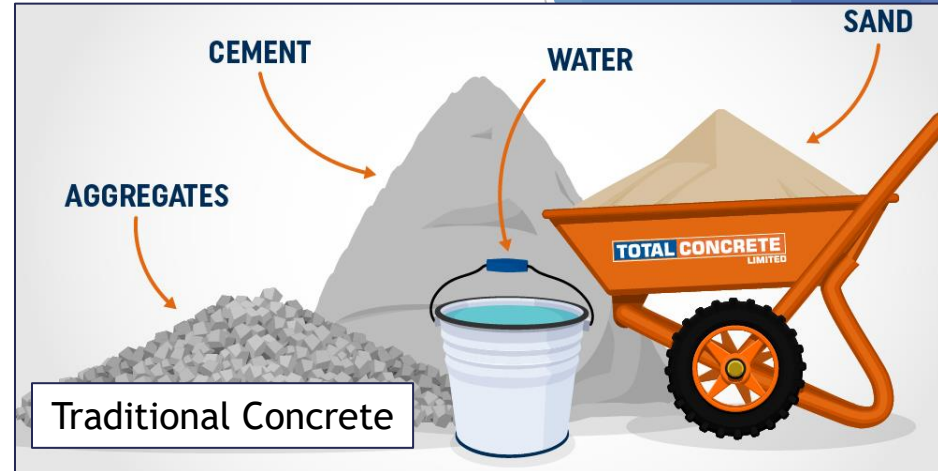
- FHWA DEFINITION
  - “UHPC IS A CEMENTITIOUS COMPOSITE MATERIAL COMPOSED OF AN OPTIMIZED GRADATION OF GRANULAR CONSTITUENTS, A WATER-TO-CEMENTITIOUS MATERIALS RATIO LESS THAN 0.25, AND A HIGH PERCENTAGE OF DISCONTINUOUS INTERNAL FIBER REINFORCEMENT.”



# WHAT IS UHPC?

- TRANSLATION FOR NORMAL FOLKS:

## IT'S DIFFERENT...

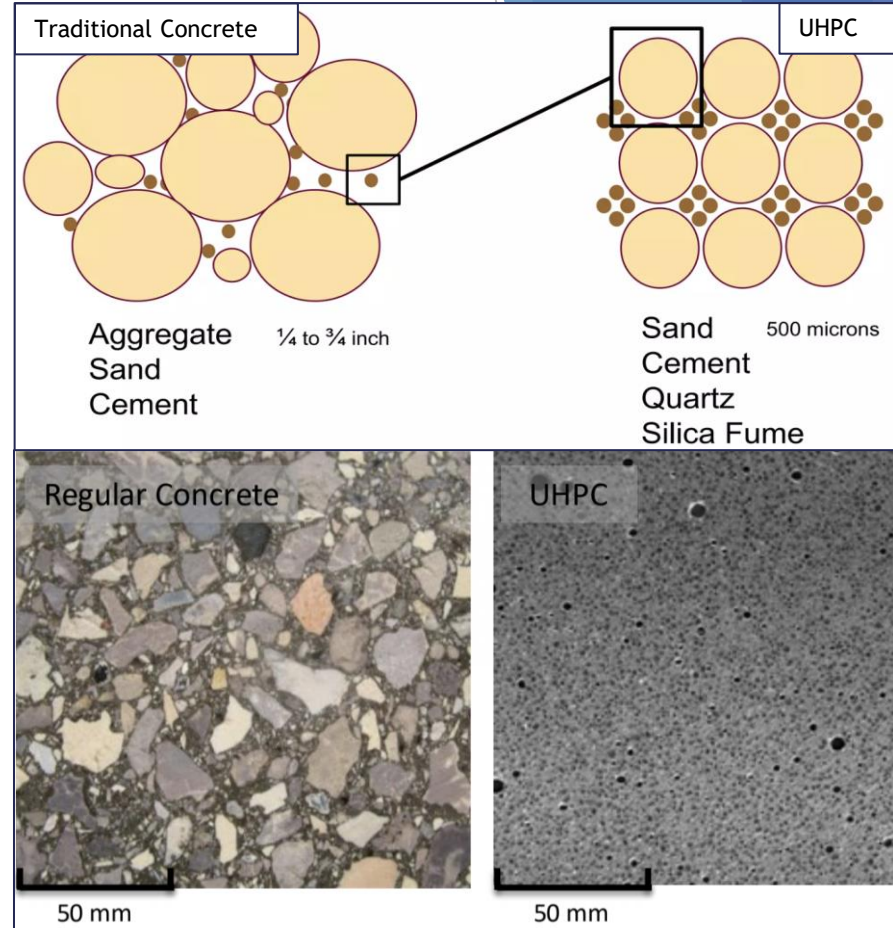


# WHAT IS UHPC?

- LET'S BREAK IT DOWN:
  - “CEMENTITIOUS COMPOSITE MATERIAL COMPOSED OF AN OPTIMIZED GRADATION OF GRANULAR CONSTITUENTS...”

MEANS...

- UHPC DOESN'T USE ANY AGGREGATE



# WHAT IS UHPC?

- LET'S BREAK IT DOWN...
- "A WATER-TO-CEMENTITIOUS MATERIALS RATIO LESS THAN 0.25..."

MEANS...

- UHPC USES MUCH LESS WATER THAN CONVENTIONAL CONCRETE
  - 37.5% - 50% LESS WATER

$$f = \frac{\text{mass of water}}{\text{mass of cement}} = \frac{w}{c}$$



# WHAT IS UHPC?

- LET'S BREAK IT DOWN:
  - “A HIGH PERCENTAGE OF DISCONTINUOUS INTERNAL FIBER REINFORCEMENT...”

MEANS...

- UHPC USES STEEL FIBERS





# TYPES OF UHPC MIXES

- UHPC JOINT MIX
  - LESS VISCOUS THAN CONVENTIONAL CONCRETE
    - FLOWS LIKE PANCAKE BATTER
  - USED FOR:
    - CONNECTION BETWEEN PRECAST ELEMENTS
    - LINK SLABS
- UHPC OVERLAY MIX
  - THIXOTROPIC MIX DESIGN
    - MOVES WHEN AGITATED
  - STIFFER THAN JOINT MIX
    - ACCOMMODATES 10% SUPERELEVATION



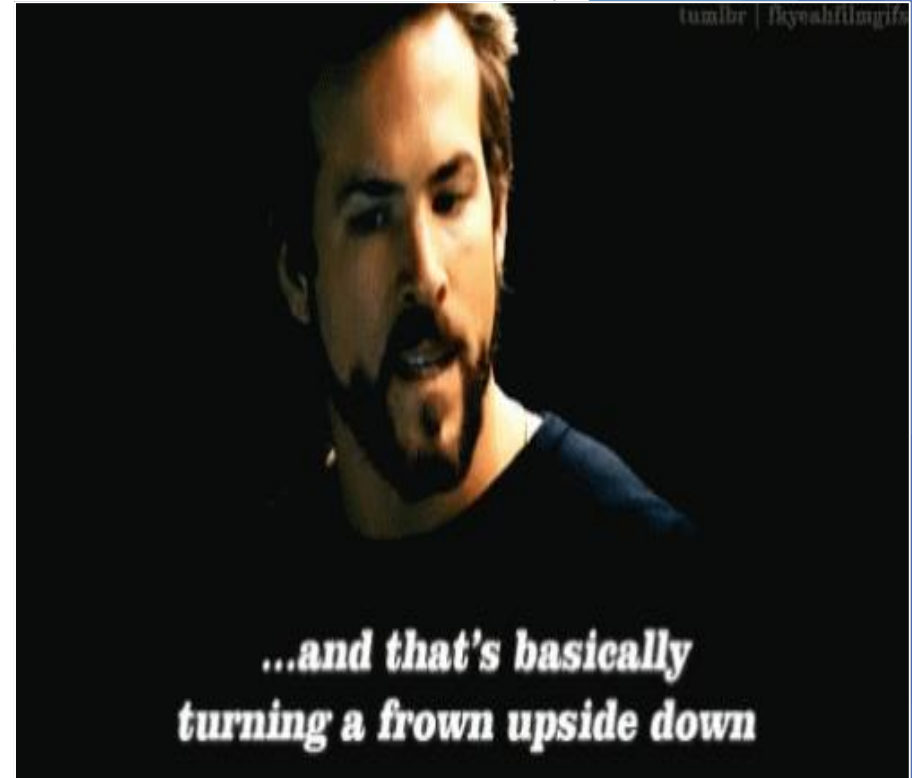
# ADVANTAGES OF UHPC

- IMPERVIOUS & PREVENTS CRACK PROPAGATION
  - CRACKS DON'T EXPAND
  - WATER & CHLORIDES DON'T PENETRATE
- IT'S STRONG...
  - ...LIKE REALLY REALLY STRONG
  - JOINTS: 22 KSI MIN. COMPRESSIVE STRENGTH
  - OVERLAY: 14 KSI MIN. COMPRESSIVE STRENGTH
- GAINS STRENGTH QUICKLY
  - TYPICALLY ~13 KSI IN 2 DAYS
  - AS FAST AS 12 KSI IN 12 HOURS



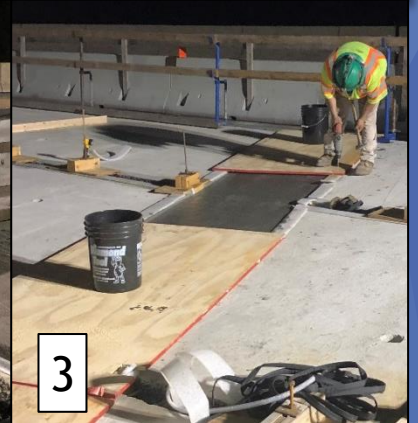
# ADVANTAGES OF UHPC JOINTS

- PREVIOUS ISSUES WITH JOINTS
  - REFLECTIVE LONGITUDINAL CRACKING
  - LEAKING BETWEEN BEAMS
- FACILITATES THE USE OF PRECAST ELEMENTS
  - ALLOWS FOR:
    - SMALLER CONNECTIONS
    - SHORTER DEVELOPMENT LENGTHS
    - ACCELERATES CONSTRUCTION
- TURNS A PREVIOUS WEAK POINT ON BRIDGES INTO A STRENGTH!



# ADVANTAGES OF UHPC LINK SLABS

- PREVIOUS ISSUES AT PIERS
  - JOINTS GET DAMAGED/CLOGGED
    - MOVEMENT IS PROHIBITED
    - WATER AND DE-ICING SALTS LEAK ONTO BEARINGS
- PUSHES JOINTS OFF THE BRIDGE
  - PREVENTS WATER AND DE-ICING SALTS FROM REACHING BEARINGS AND BEAM ENDS
  - LESS JOINTS = LESS MAINTENANCE



# ADVANTAGES OF UHPC OVERLAY

- PREVIOUS ISSUES WITH DECKS/OVERLAYS
  - CRACKING OF DECKS
  - CORROSION OF REINFORCEMENT
  - DURABILITY OF CERTAIN OVERLAYS
- VERSATILE BRIDGE PROTECTION
  - NEW CONSTRUCTION
    - ADDED LAYER OF PROTECTION FOR BRIDGE ELEMENTS
  - RETROFITS / REHABILITATIONS
    - EXTENDS THE LIFE OF THE BRIDGE
    - CAN ADD STRUCTURAL STRENGTH TO THE DECK



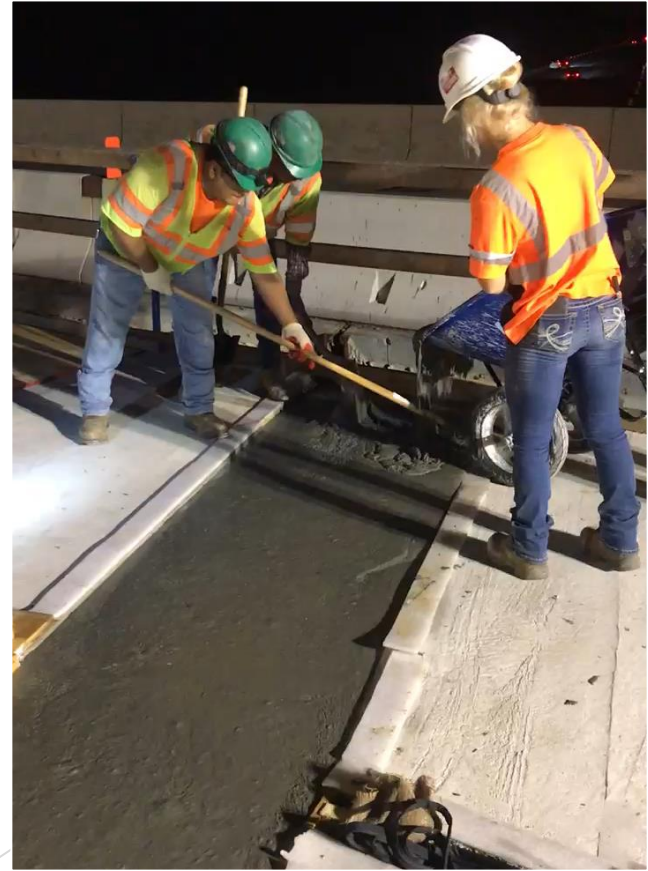
# DELAWARE UHPC JOINT PROJECTS

- COMPLETED APPLICATIONS: 11
  - ADJACENT BOX BEAMS: 4
  - NEXT BEAMS: 2
  - DECK PANELS: 3
  - MODULAR GIRDERS: 2



# DELAWARE UHPC LINK SLAB PROJECTS

- COMPLETED APPLICATIONS: 3
  - NEW CONSTRUCTION: 1
  - RETROFIT / REHABILITATION: 2



# DELAWARE UHPC OVERLAY PROJECTS

- COMPLETED

## APPLICATIONS: 2

- NEW CONSTRUCTION: 1
  - BLACKBIRD, DE
  - PILOT PROJECT
- RETROFIT / REHAB: 1
  - LITTLE HEAVEN, DE
  - ISSUES WITH DECK POUR





# BIGGEST CONSIDERATIONS WITH UHPC

- **PLANNING**

- PRE-BID MEETING
- PRE-POUR PLAN
  - STAGING
  - SEQUENCE
  - METHOD
- PRE-POUR MEETING

- **PERSONNEL & EQUIPMENT**

- MIXING, TRANSPORTING, TOP-FORMING, ETC.

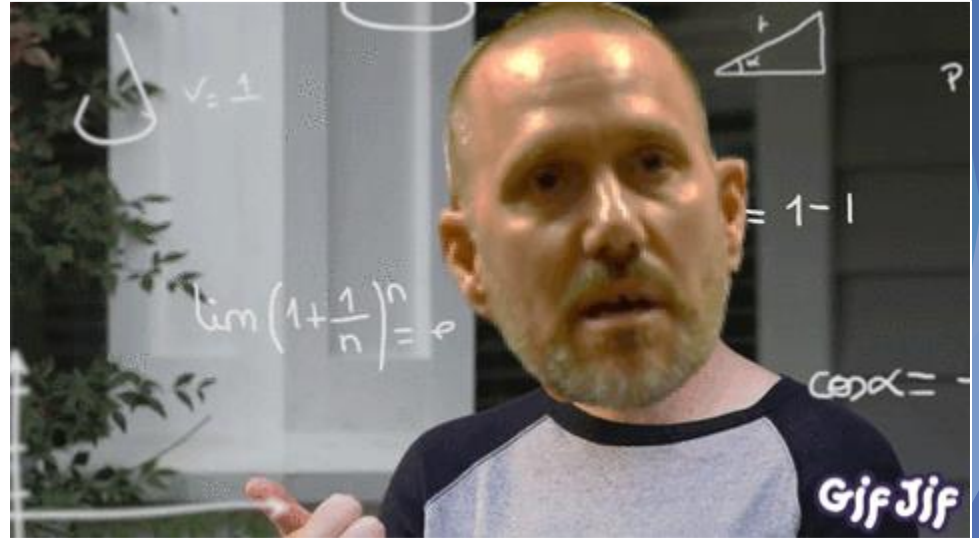
- **FORMWORK**

- TAKE EXTRA TIME TO ENSURE FORMWORK IS SOUND
- SPENDING EXTRA TIME ON FORMWORK ULTIMATELY SAVES TIME & MONEY
- BUILT IN BULKHEADS LIMIT LOSSES



# LESSONS LEARNED

- COMMUNICATION
  - CONTRACTOR & DEPARTMENT
- CONNECTIONS & TOLERANCES
  - WITH SMALLER JOINTS COME SMALLER CONNECTIONS
  - ACCOMMODATING CAMBER
- UHPC POURS
  - PLANNING IS KEY
  - CARE WITH FORMWORK



# QUESTIONS?

