



# UHPC Closure Joint Performance for Accelerated Bridge Construction (ABC) Superstructure Systems

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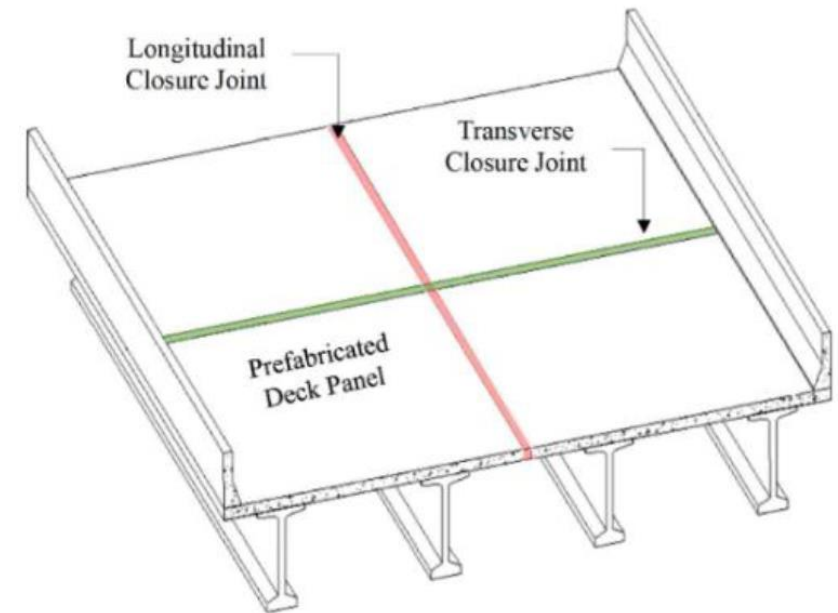
# Background-ABC & Precast Elements

## ➤ Accelerated Bridge Construction (ABC)

- Minimize traffic disruptions
- Optimize construction time
- Utilize precast bridge elements

## ➤ Closure Joints

- Combine precast elements
- Transfer shear & moment
- Require significant development length
- “weakest” link



# Background-Development

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➤ Federal Highway Administration

- “Bond Behavior of Reinforcing Steel in UHPC” (Graybeal)



Non-Contact Lap Splice

- “Design and Construction of Field-Cast UHPC Connections” (Graybeal)



6-inch Closure Joint &  $8d_b$  splice length

- “Performance of Grouted Connections for Prefabricated Bridge Deck Elements” (Haber & Graybeal)

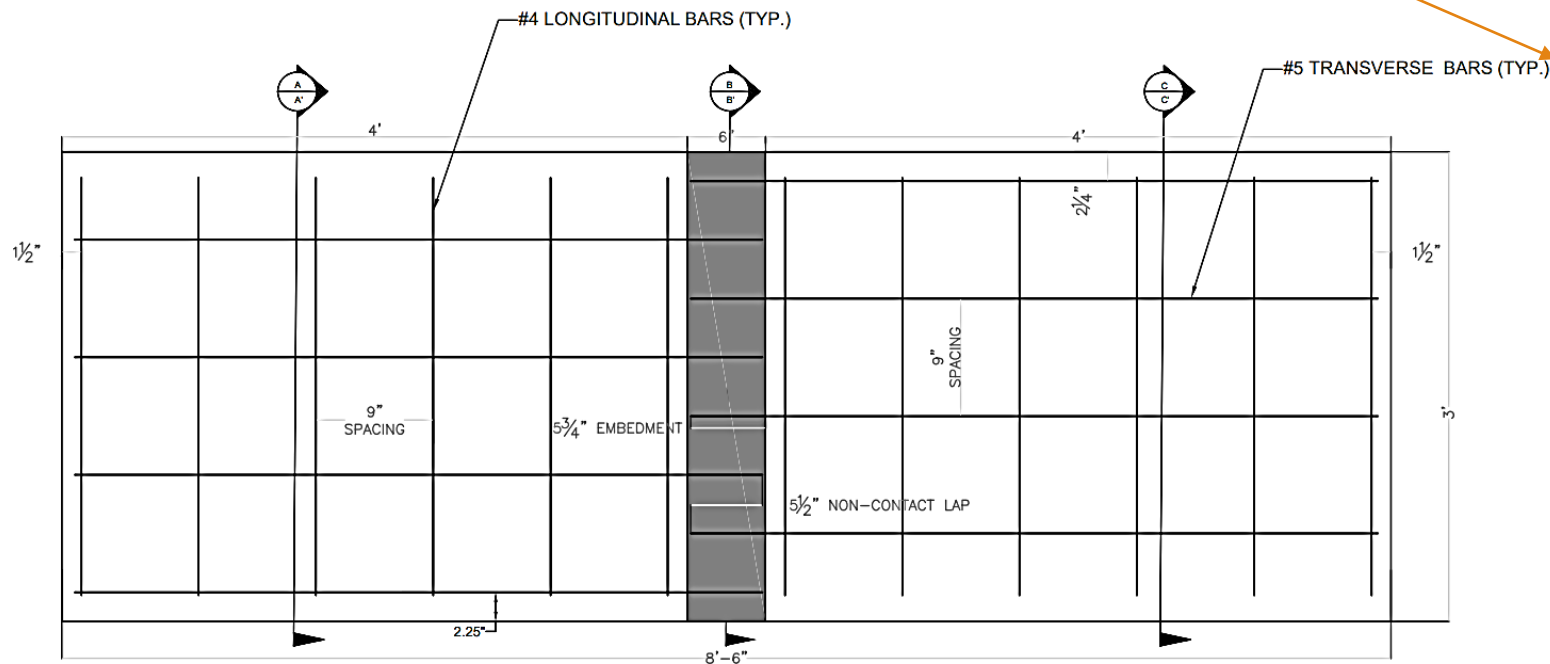


Shear key geometry irrelevant to performance & Precast surface preparation is essential

However, these papers researched performance at 28-day strength!

# Experimental Program-Specimen Design

This presentation!



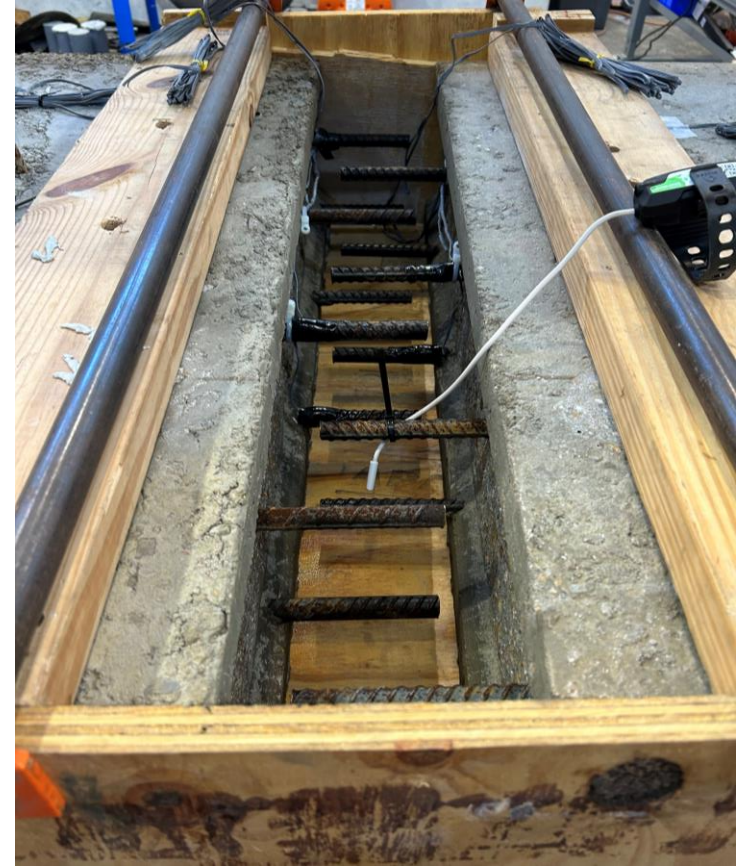
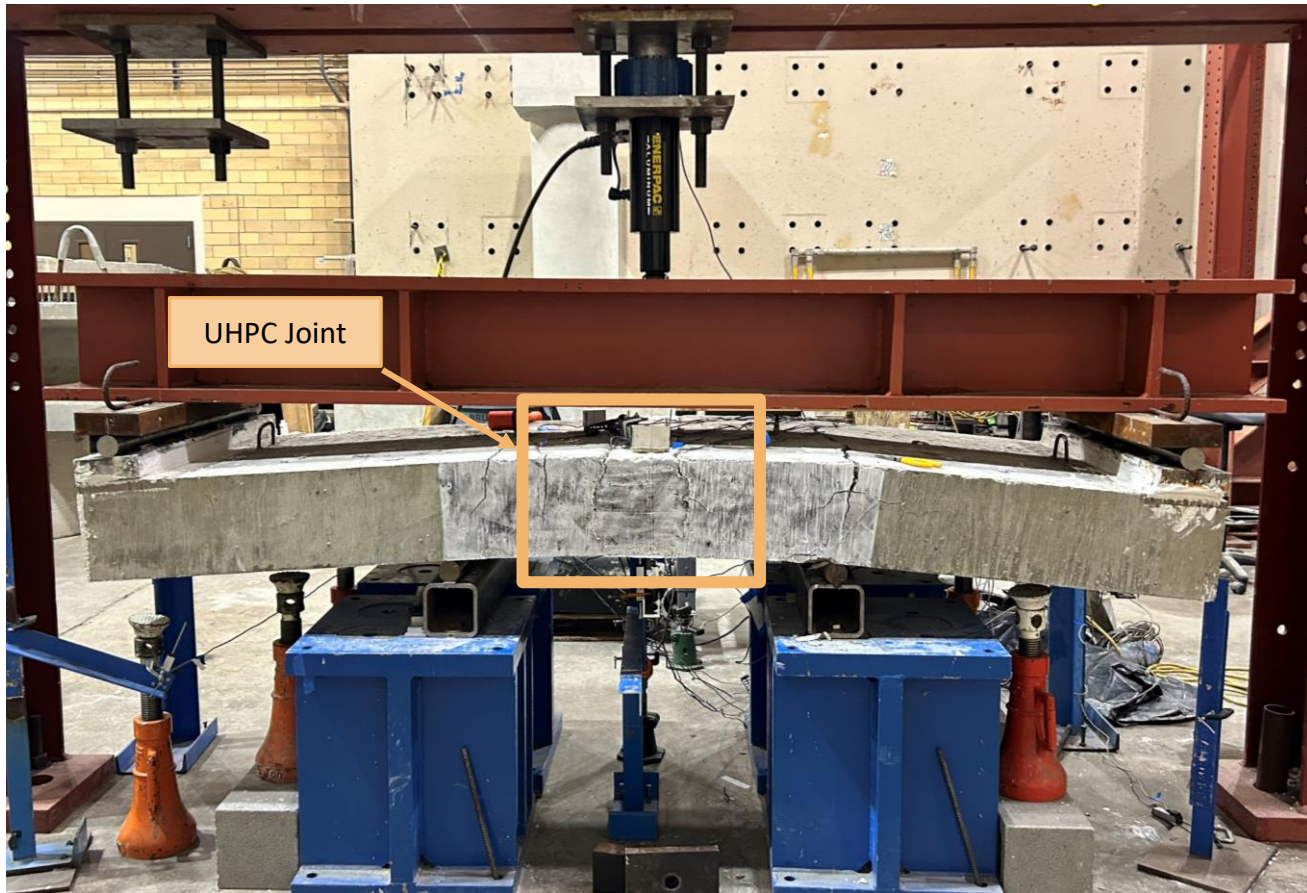
**CLOSURE JOINT DECK SPECIMEN**

**Large-Scale Structural Testing Matrix**

| Loading Type | Test ID | Joint Detail  |   |   |
|--------------|---------|---|---|---|
|              |         | Control (Monolithic)<br>Standard Bridge Deck Detail | Proprietary UHPC<br>Straight Bar w/ Shear Key | Non-Proprietary UHPC<br>Straight Bar w/ Shear Key |
| Flexure      | F1      |   |   |   |
|              | F2-S    |   |   |   |
|              | F2-L    |   |   |   |
|              | F3-S    |   |   |   |
|              | F3-L    |   |   |   |
| Shear        | S1      |   |   |   |
|              | S2-S    |   |   |   |
|              | S2-L    |   |   |   |
|              | S3-S    |   |   |   |
|              | S3-L    |   |   |   |

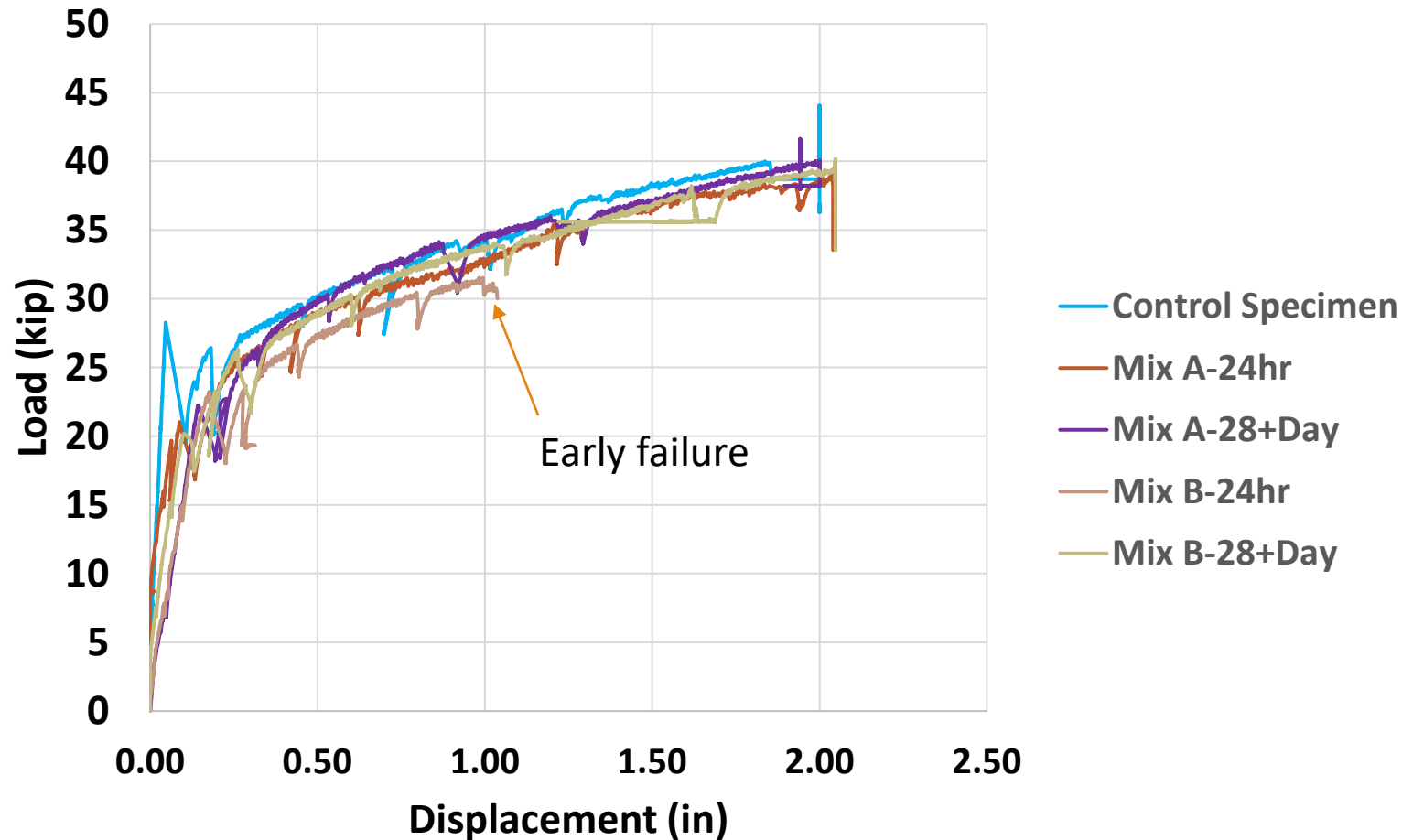
- S refers to short-term (24 hrs)
- L refers to long-term (28+days)

# Test Frame & Joint Cast





# Test Results-Load-Displacement Behavior

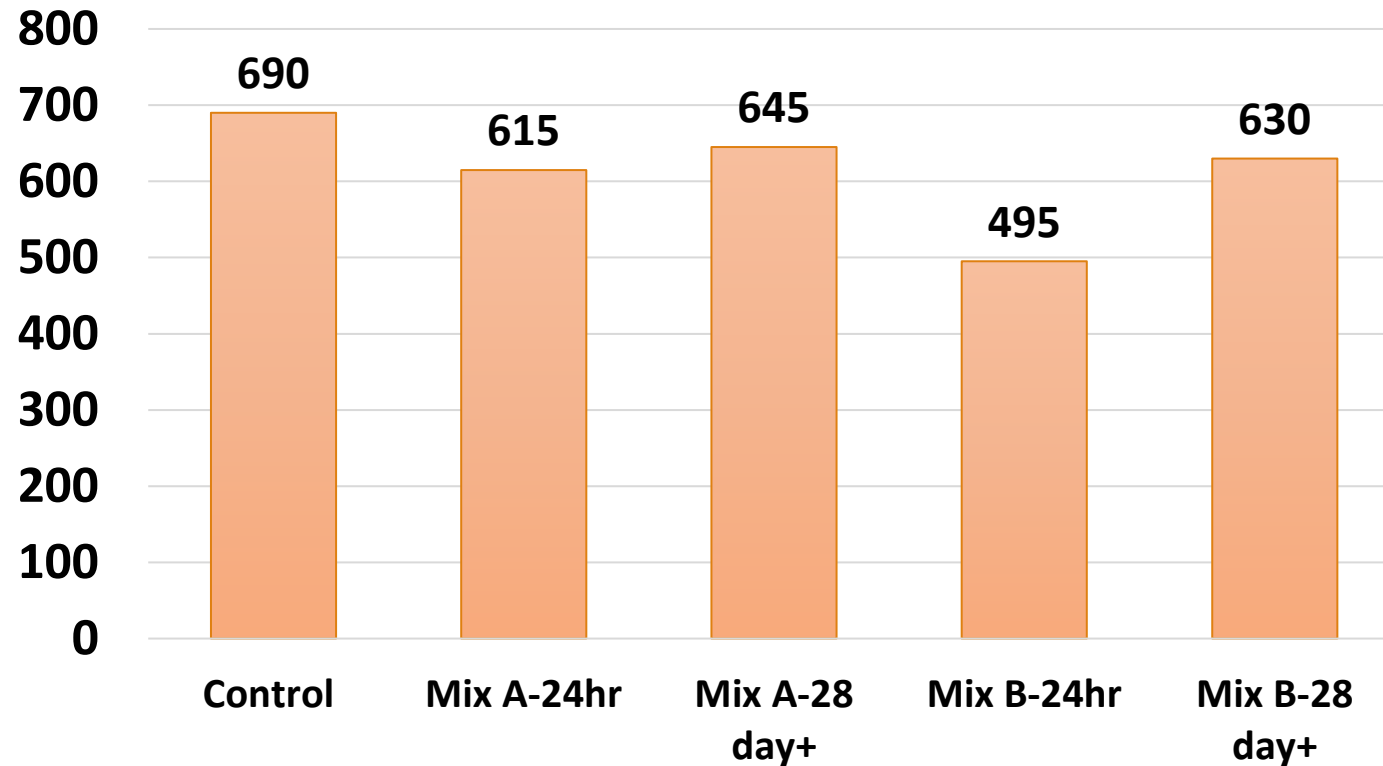


## Center Load When 2 in. Deflection Reached (kip)

|          |       |
|----------|-------|
| Control  | 38.71 |
| Mix A-24 | 38.40 |
| Mix A-28 | 39.73 |
| Mix B-24 | NA    |
| Mix B-28 | 39.14 |

# Test Results-Ultimate Capacities

## Ultimate Moment Capacity (Kip-in)

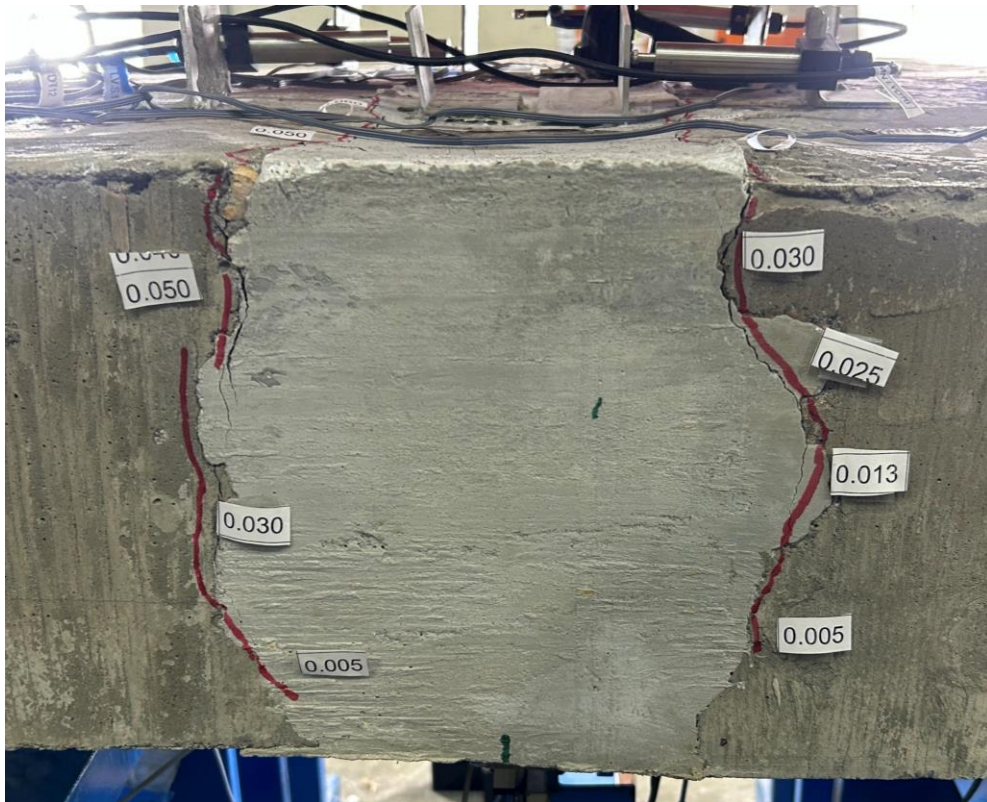


## Compressive Strength $f'_c$ on the test day (ksi)

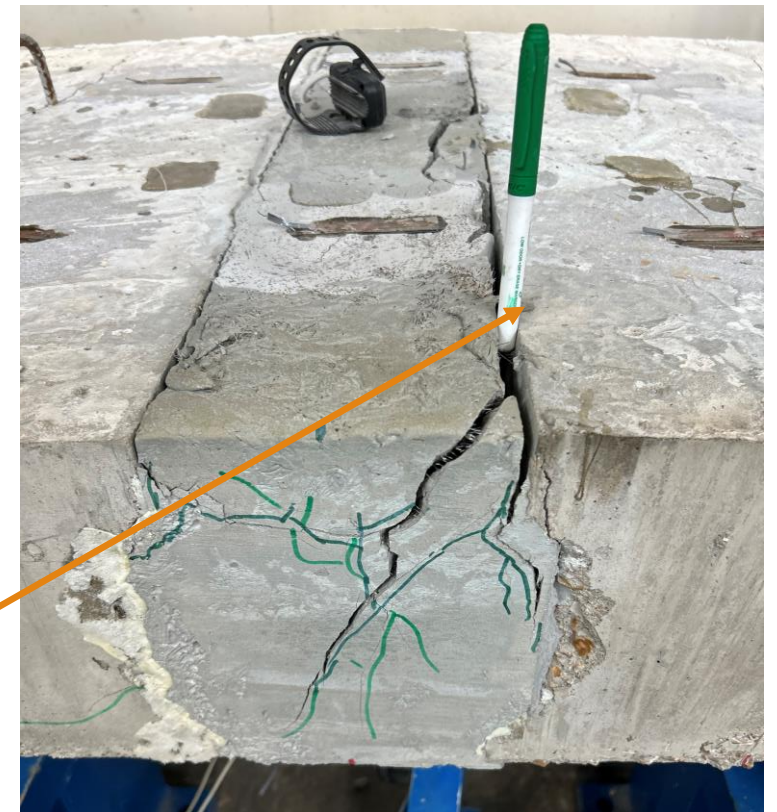
|                   |      |
|-------------------|------|
| Control & Precast | 11   |
| Mix A-24          | 12   |
| Mix A-28          | 22.5 |
| Mix B-24          | 8    |
| Mix B-28          | 18   |

# Test Results-Interface Behavior

Mix A-28+ Day



Mix B-24 Hr



## Average Interface Opening at Failure (in)

|          |      |
|----------|------|
| Control  | NA   |
| Mix A-24 | 0.23 |
| Mix A-28 | 0.27 |
| Mix B-24 | 0.25 |
| Mix B-28 | 0.34 |

Worst Case  
0.44 inch



# Test Results-Failure Types

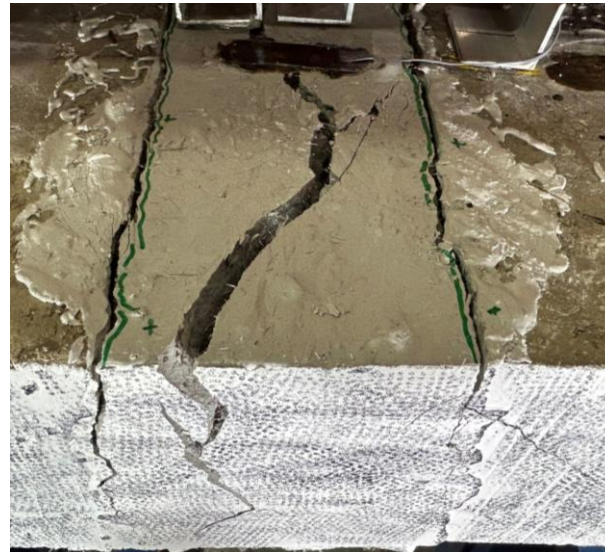
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Control



**Crushing/Flexural**

Mix A-24 Hr



**Pull-out Failure**

Mix A-28+ Days

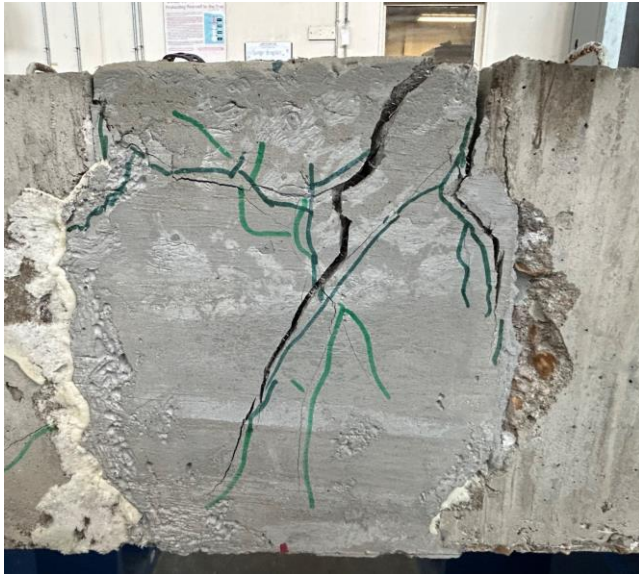


**Crushing/Flexural**

# Test Results-Failure Types Cont.

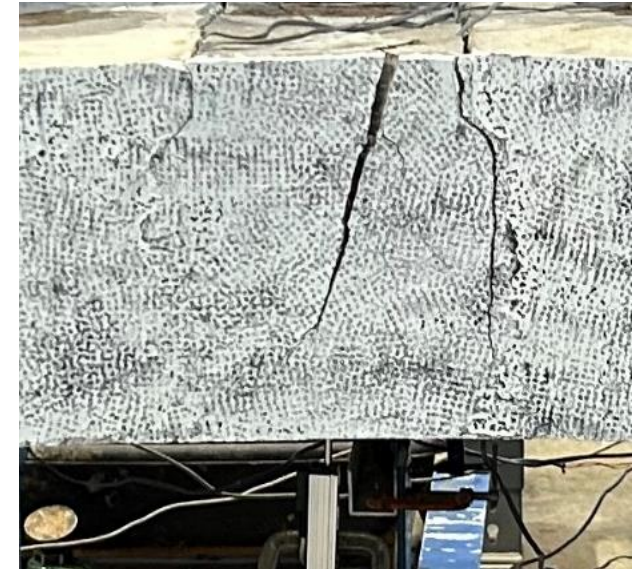
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Mix B-24 Hr



**Pullout**

Mix B-28+ Days



**Pullout &  
Flexural/Crushing**

# Test Results-Conclusions

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**Closure joints failure mode related to age**

**24-hr closure joints adequately transfer moment**

**24-hr specimens comparable to control & 28+ day specimens  
in ultimate capacity**



# Recap

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- Mix A-24hr capacity was 89% of the control
- Mix B-24hr capacity was 71% of the control
- Why do we want this?
  - Reduced construction time!
  - Shorter Route Closures
  - Less Traffic Disruption
  - Cost



# Thank You!

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## Questions?

