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aci Spring 2018 | Salt Lake City
The Concrete Convention and Exposition

Rehabilitation of Longitudinal Joints in Double-Tee Girder Bridges

Presenter

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Research Team

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Funding Agencies and Collaborators

- South Dakota Department of Transportation.
- Mountain Plains Consortium (MPC) - University Transportation Center (UTC).

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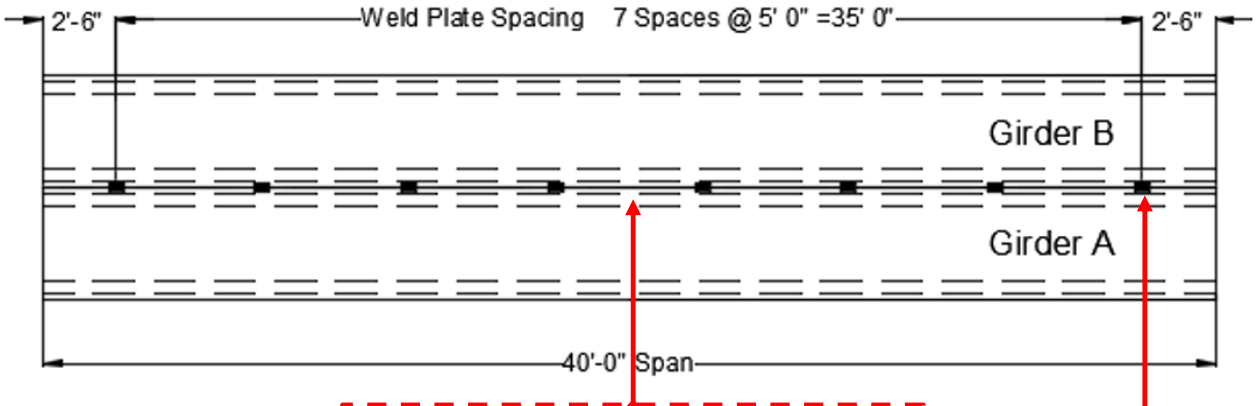
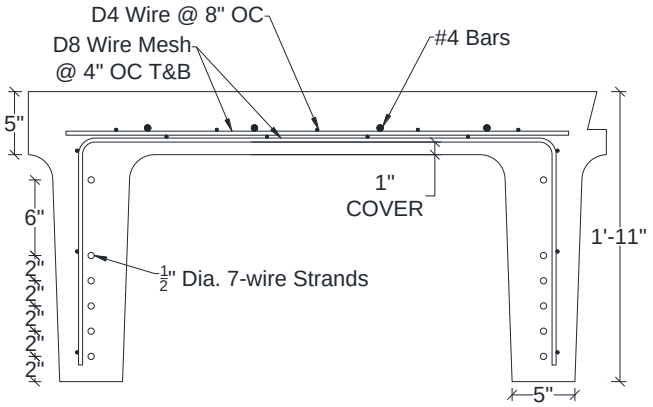
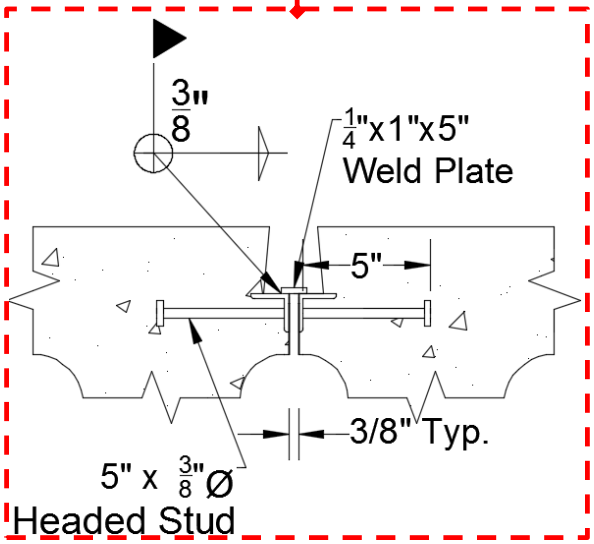
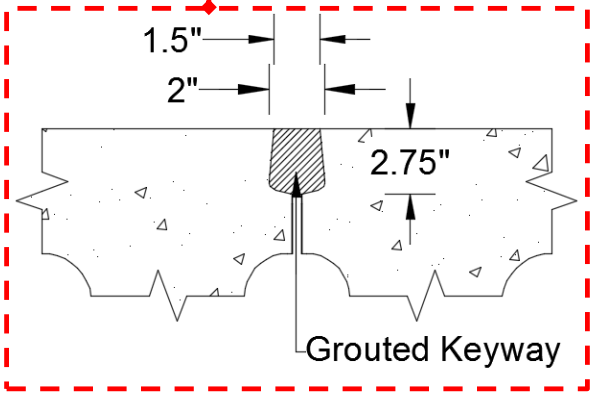
Background

Current longitudinal joint detailing



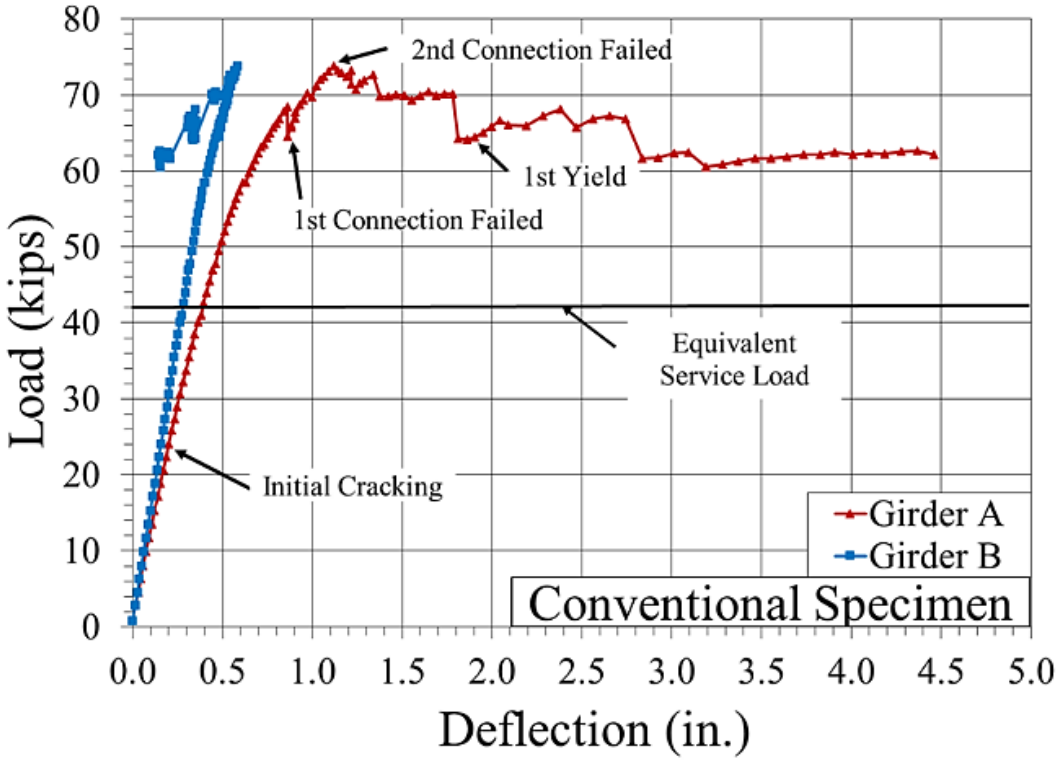


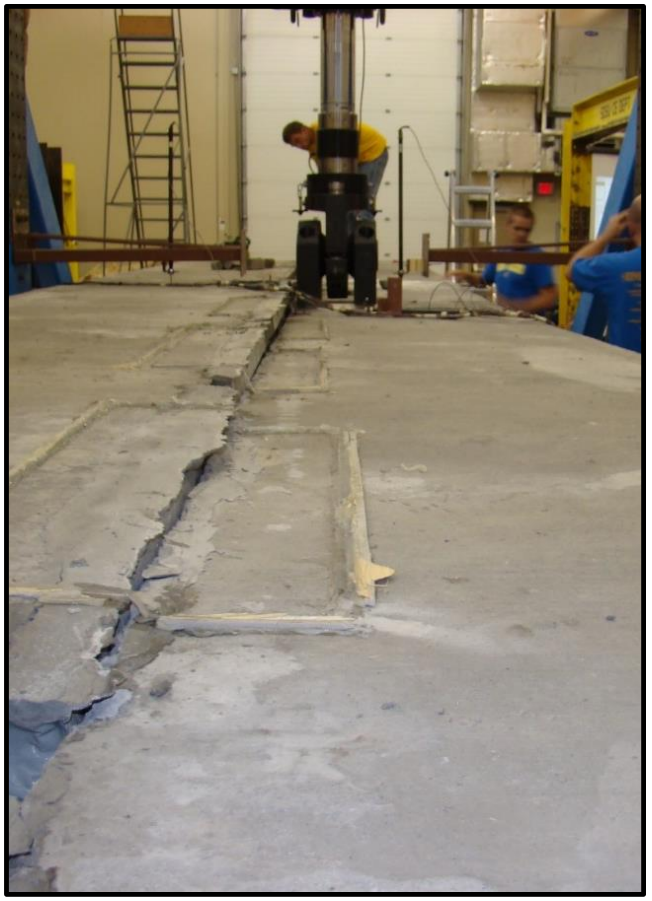




Background

- The current longitudinal joint detail for connecting adjacent double-tee bridge girders exhibits poor serviceability and strength performance





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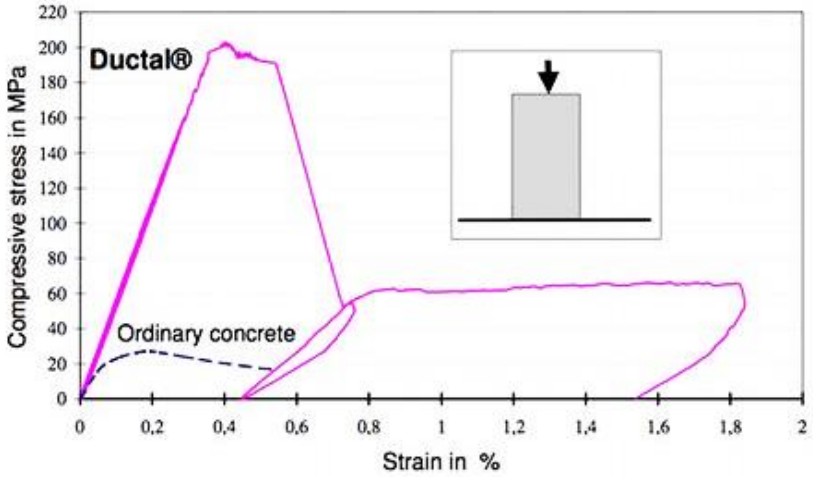
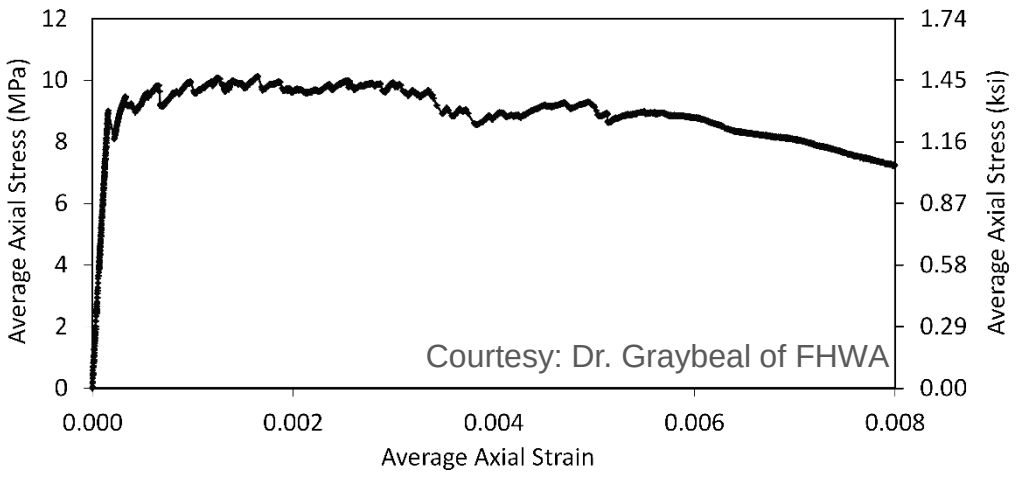
Ultra-High Performance Concrete

- Fiber-reinforced cementitious concrete
- Made with very fine aggregates in size of dust
- Usually with 2% volumetric steel fibers
- Better durability than concrete
- More than 22,000 psi (150 MPa) compressive strength
- Significantly higher tensile strength and strain capacity





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Summary of Activities

- ✓ 20 Rehabilitation Joint Detailing Alternatives.
- ✓ Testing of 13 Large-Scale Beams.
- ✓ Detailed Finite Element Analysis.
- ✓ Testing of 40-ft Conventional Double-Tee Bridge.
- ✓ Rehabilitation of the Conventional DT Bridge.
- ✓ Testing of Rehabilitated Bridge.
- ✓ Recommendations.

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Test Specimen and Setup

Two Double-Tee Girders

40-ft Long, approx. 8-ft wide

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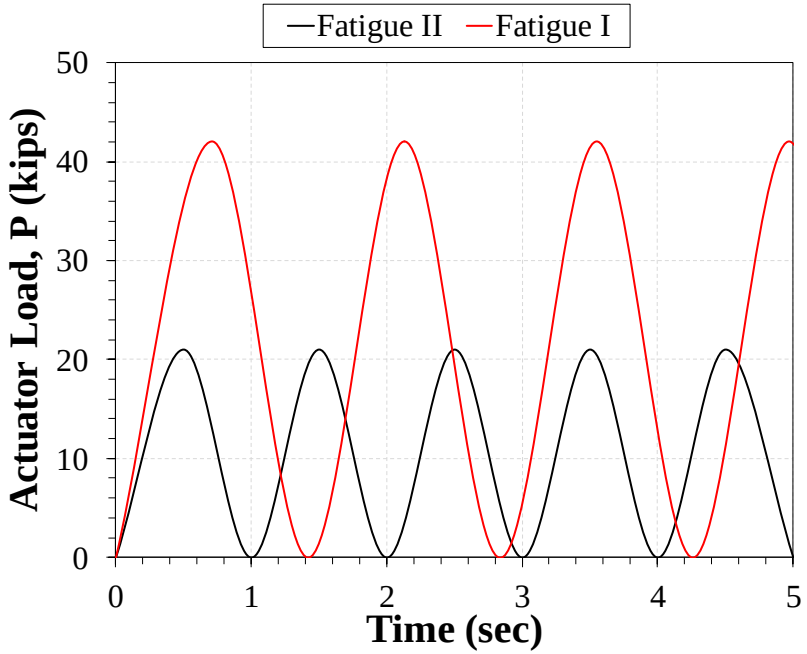
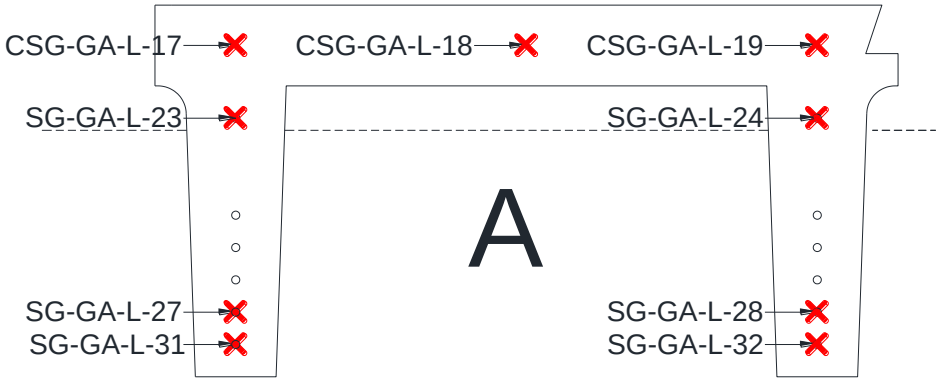
Testing Procedure

1. Fatigue testing of conventional DT – 250k cycles.
2. Monotonic testing of conventional DT to crack the joint.
3. Fatigue II testing of rehabilitated DT– 500k cycles.
4. Fatigue I testing of rehabilitated DT– 100k cycles.
5. Ultimate testing of rehabilitated DT to failure.

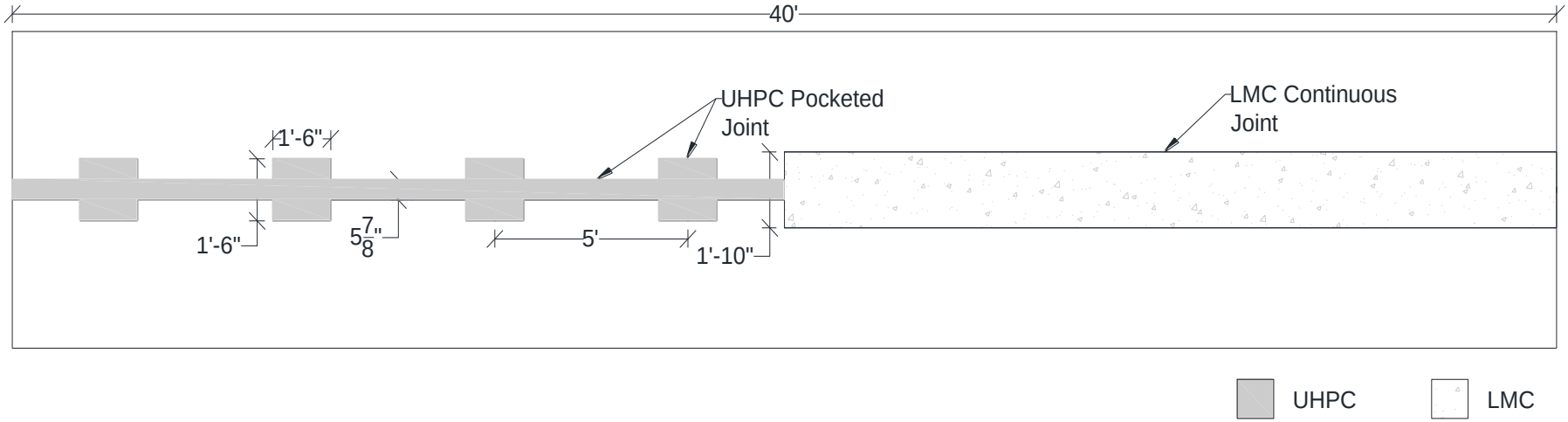


Instrumentation

- 34 Strain Gauges
- 14 LVDTs
- 4 String POTs
- 4 Load Cells
- 146-kip Actuator



Proposed Testing Plan



Pocket Detailing: UHPC filled pockets reinforced with steel bars.

Continuous Detailing: LMC filled joint reinforced with wire-mesh.

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Rehab after initial 200k Fatigue Testing

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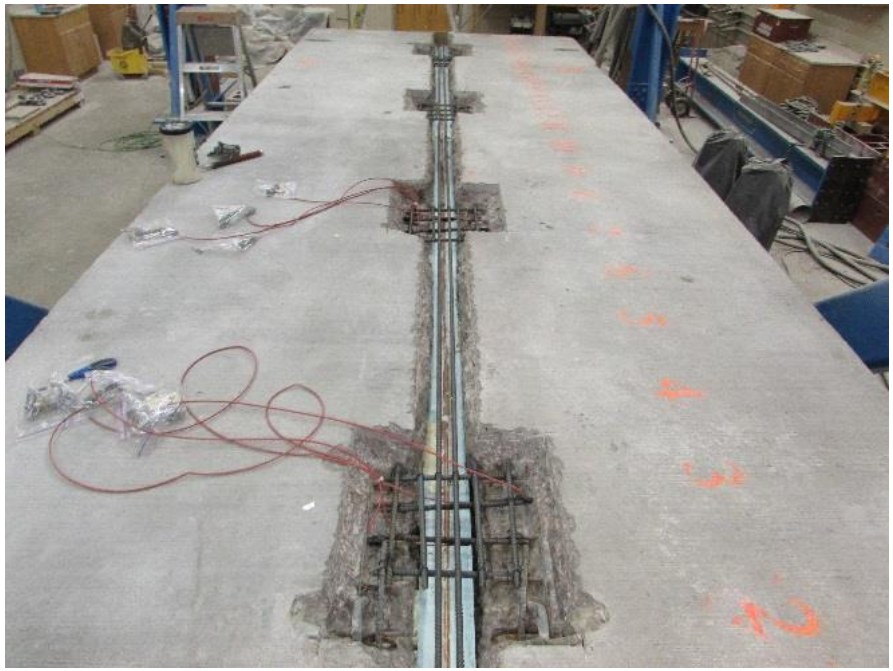
Rehab after initial 200k Fatigue Testing



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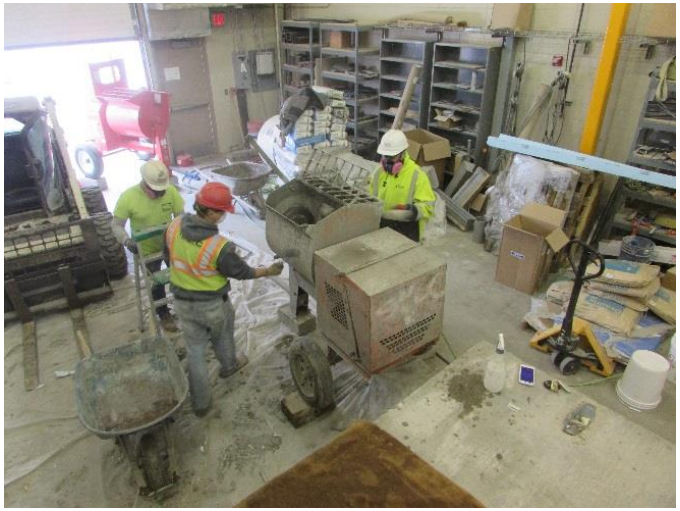
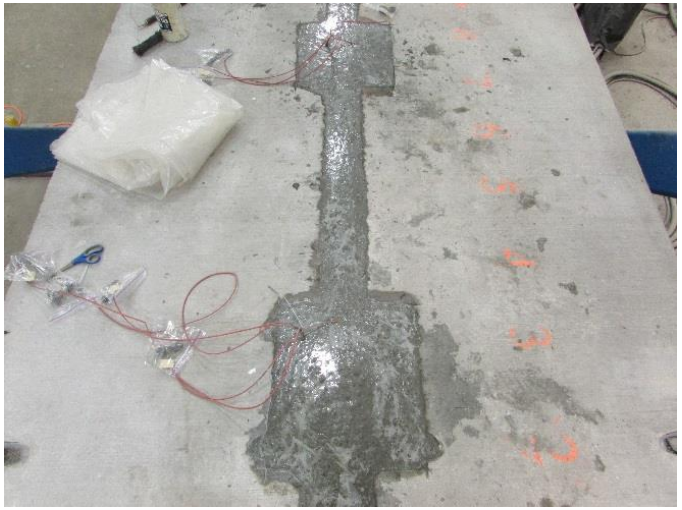
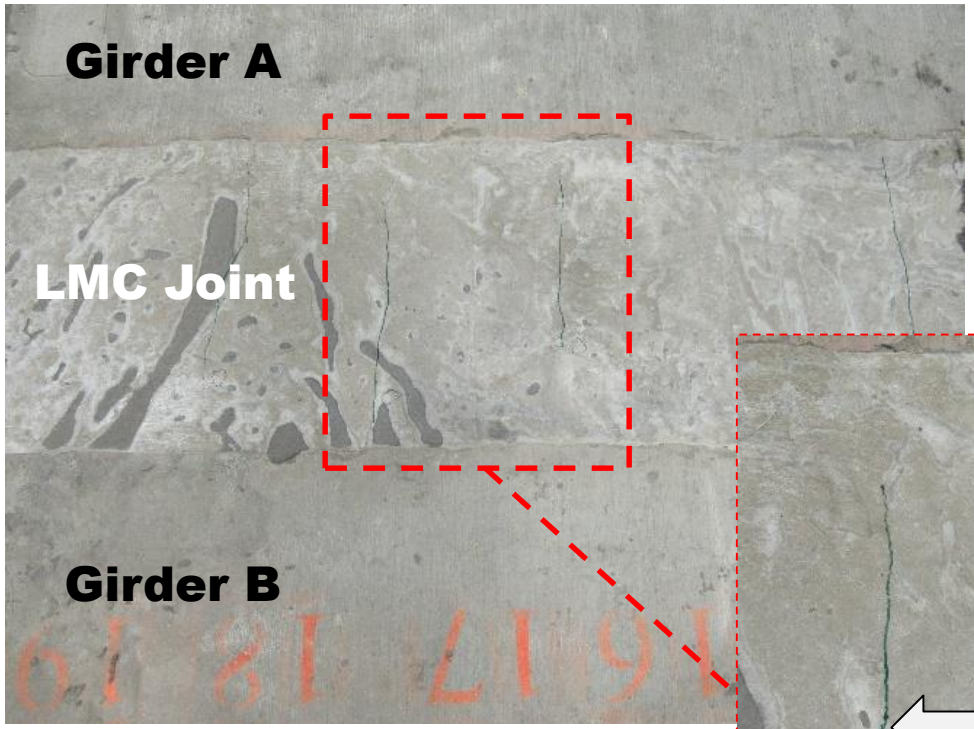
Joint Pour w/ UHPC & LMC





Prior to Testing LMC Cracking



Bridge Underneath

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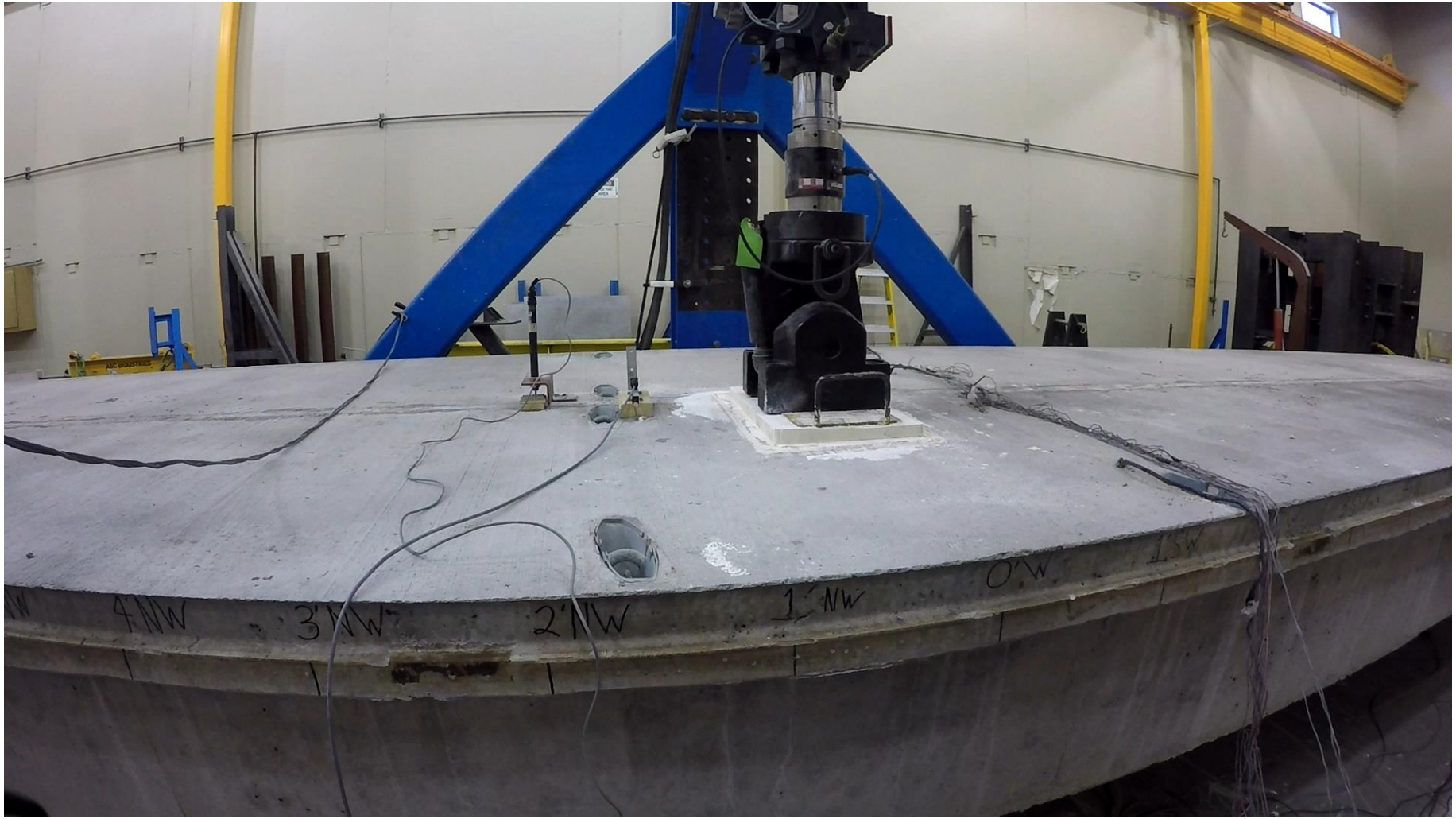
Fatigue Testing Video



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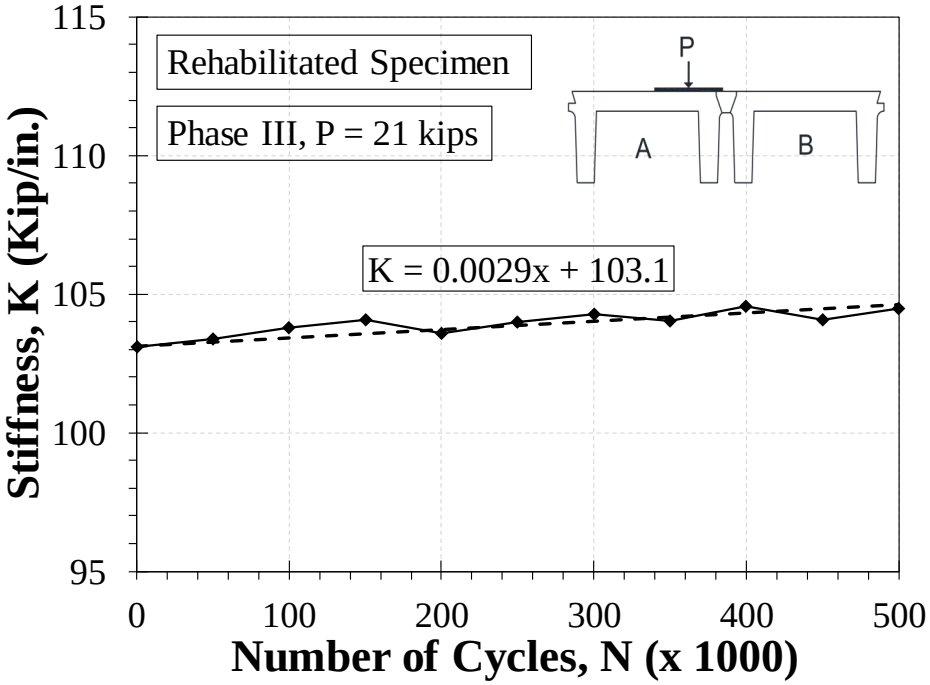
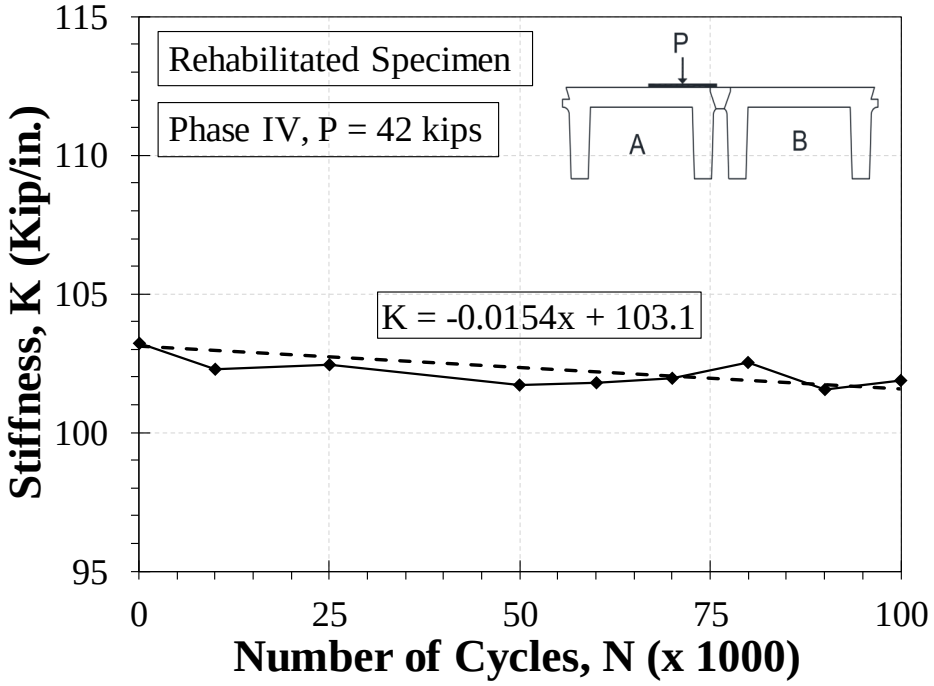
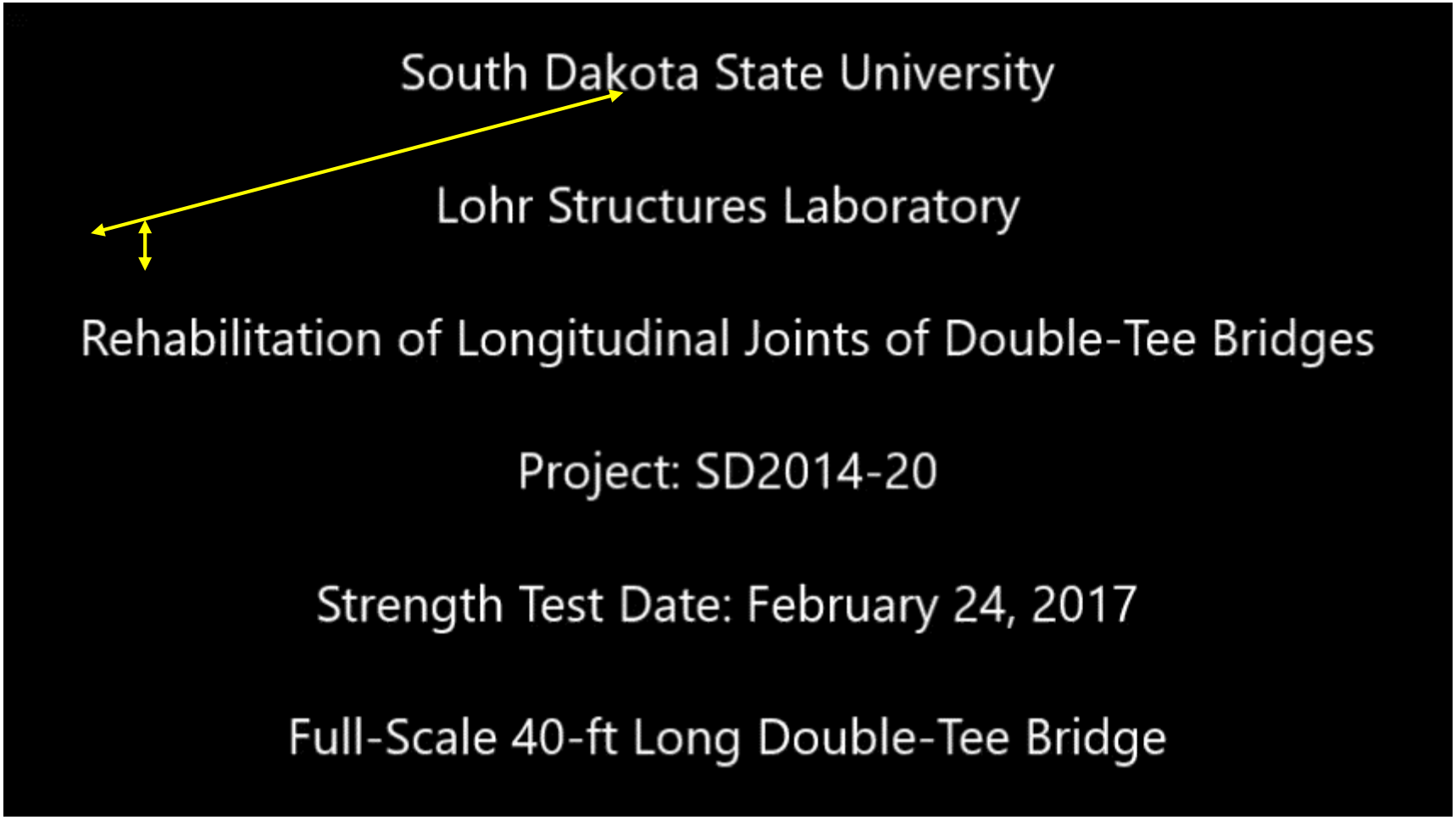
Fatigue Results



No stiffness degradation after 0.5 million cycles of AASHTO Fatigue II and 100k cycles of AASHTO Fatigue I.



Ultimate Testing Video



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Cracks and Failure Mode

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Rehabilitated Joints at Girder Failure

Minor cracks at the edge of Pocket and Continuous joints at girder failure.

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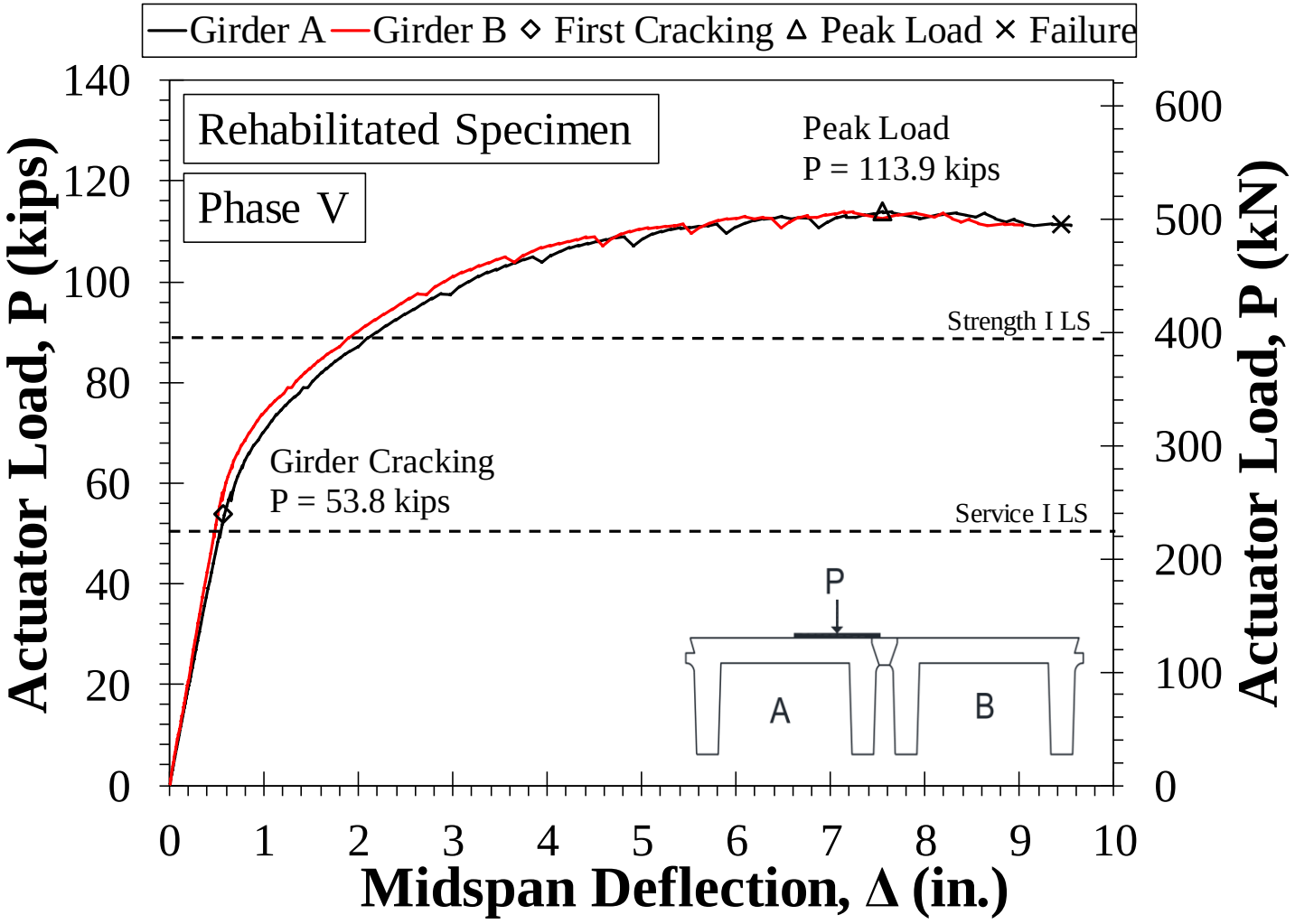
Ultimate Test Results



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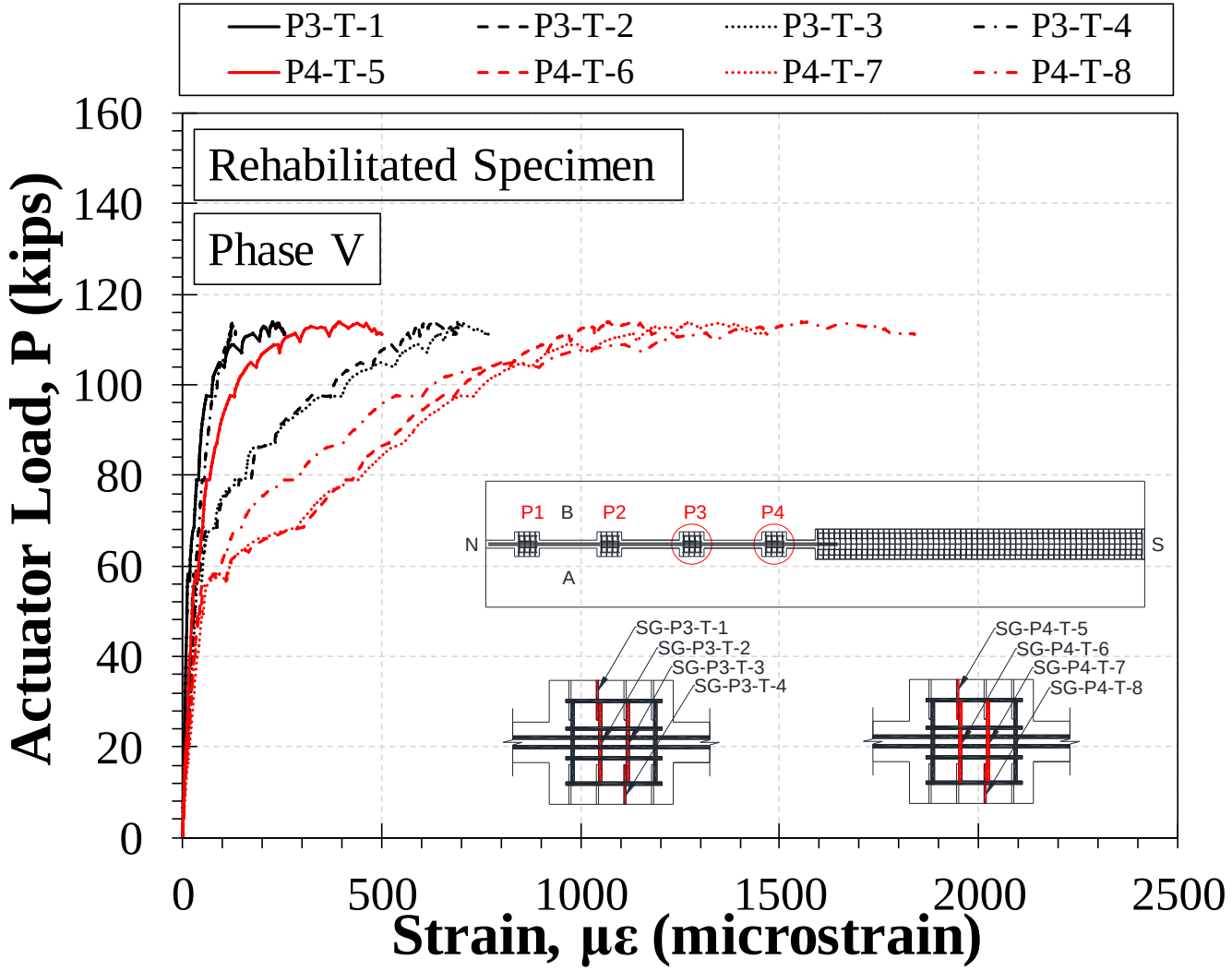
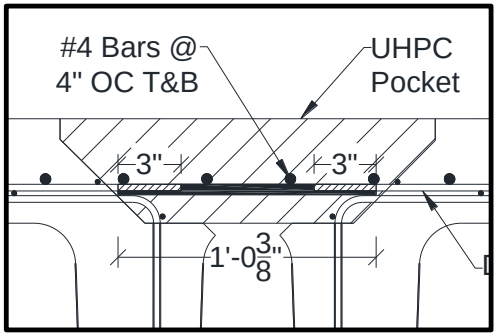
Ultimate Test Results

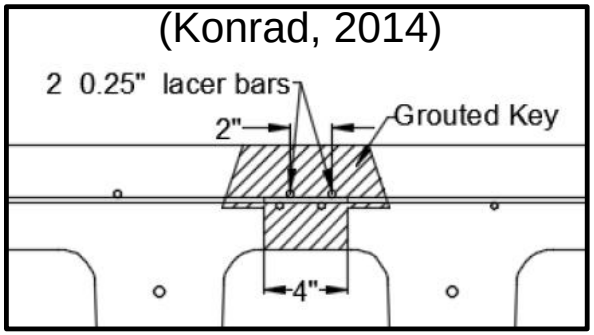


Evaluation

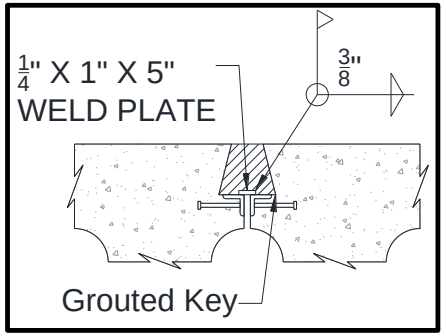
Rehabilitated Detailing

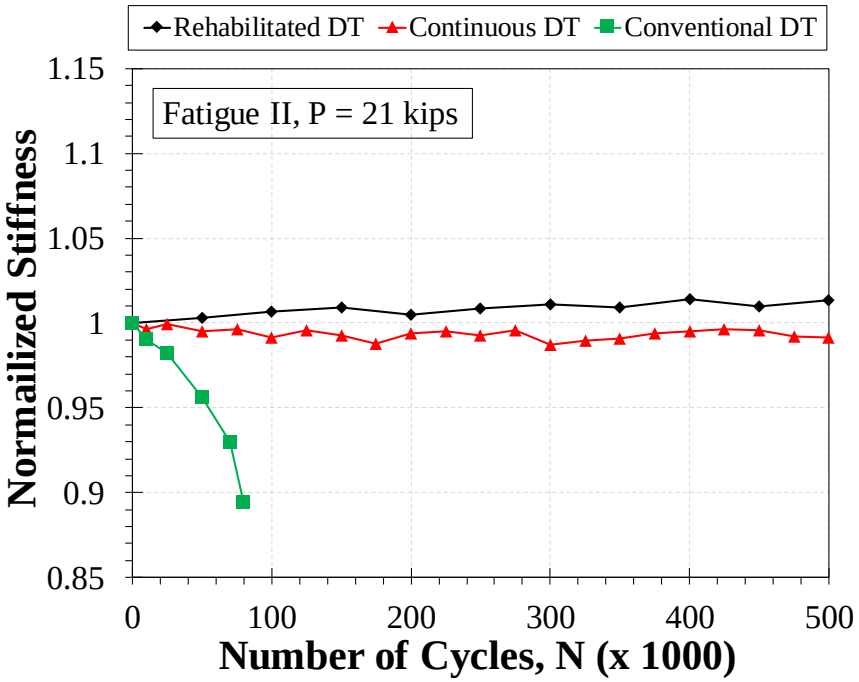


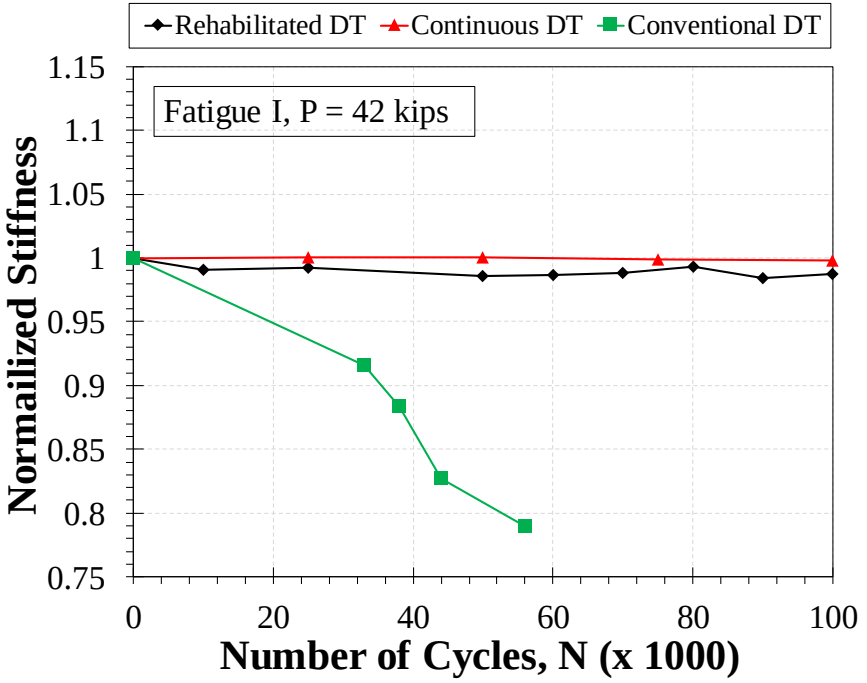
New Constr. Continuous Detailing (Konrad, 2014)



Conventional Detailing

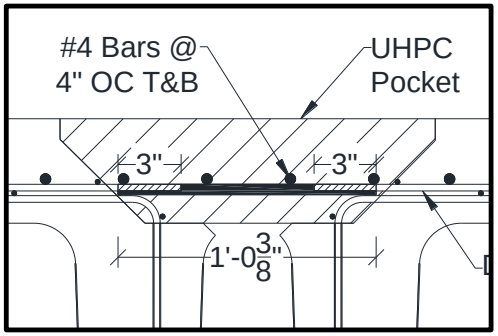






Evaluation

Rehabilitated Detailing



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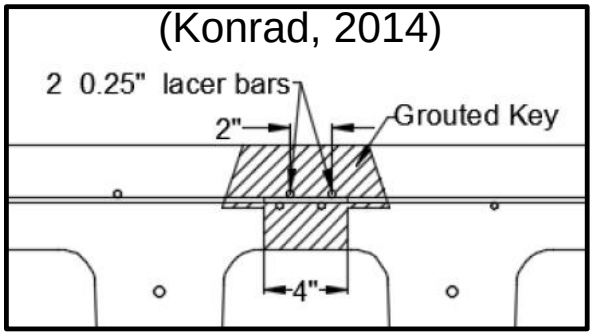
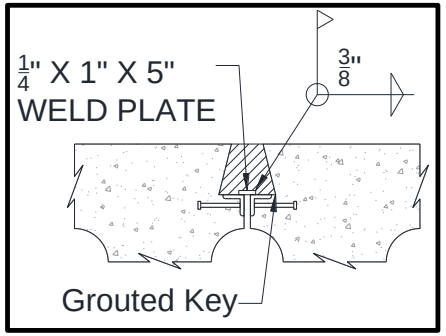
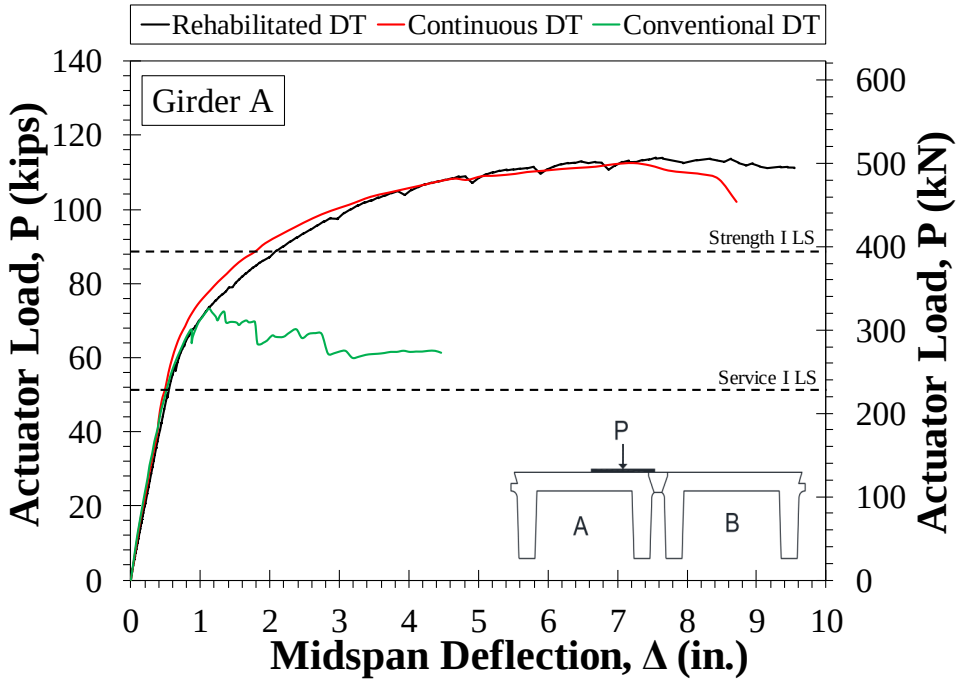


Conventional Detailing





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Evaluation

Cost estimate for: 40-ft long by 30.6-ft wide double-tee girder bridge having 8 girders and 7 long. Joints.

- Pocket joint rehabilitation cost is **28%** of that of replacement.
- Continuous joint rehabilitation cost is **57%** of that of replacement.

. **Rehabilitation vs. Replacement Cost for 40-ft Double-Tee Bridges**

Type	Item	Cost
Replacement	Girder Material and Fabrication	$79, 040
	Girder Demolition, Removal, and Construction	$15,000
	Crane Mobilization	$20,000
	Total	**$114,040**
Rehabilitation	Pocket Joint	$31,685 (or 28% of Replacement)
	Continuous Joint	$64,856 (or 57% of Replacement)

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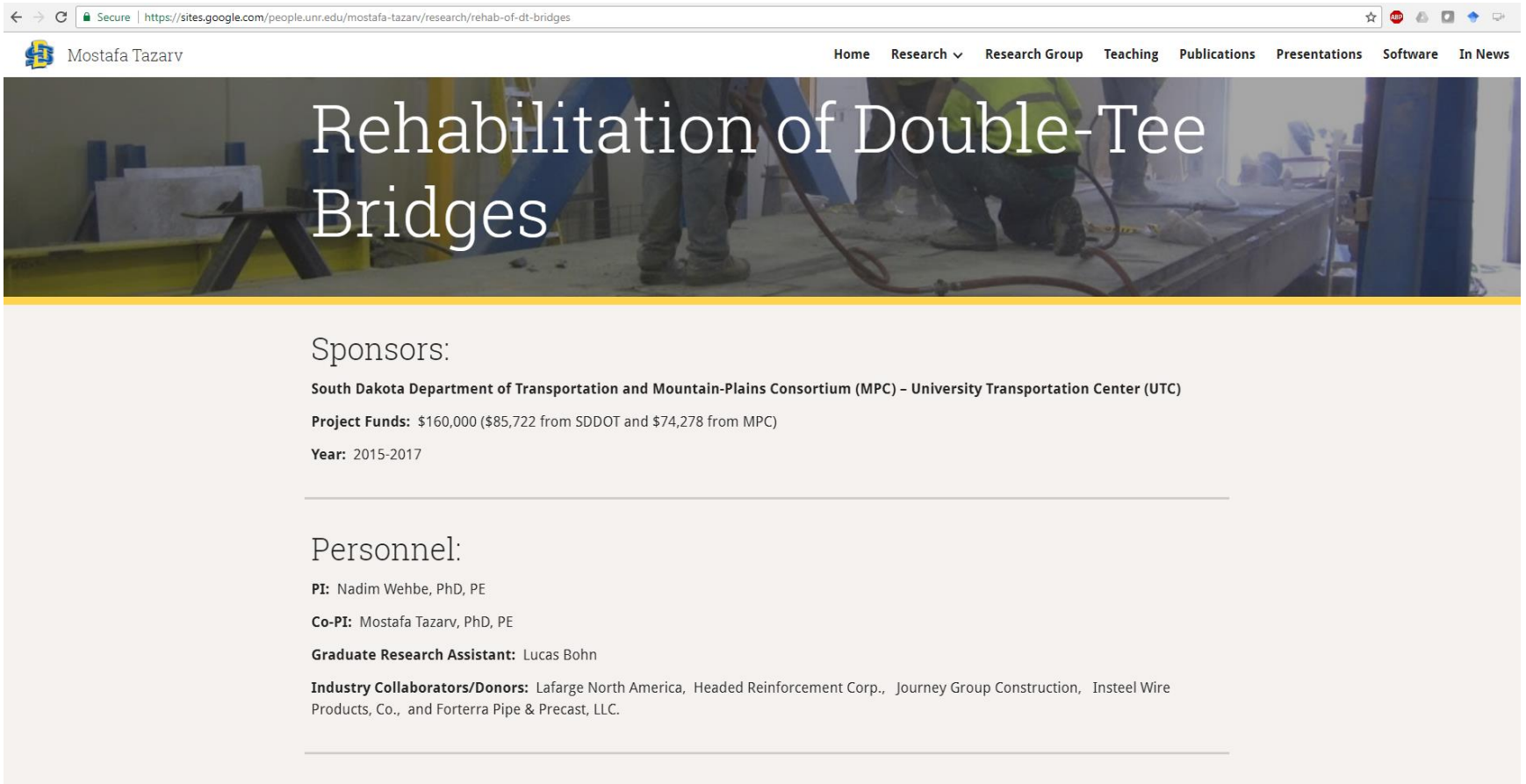
Conclusions

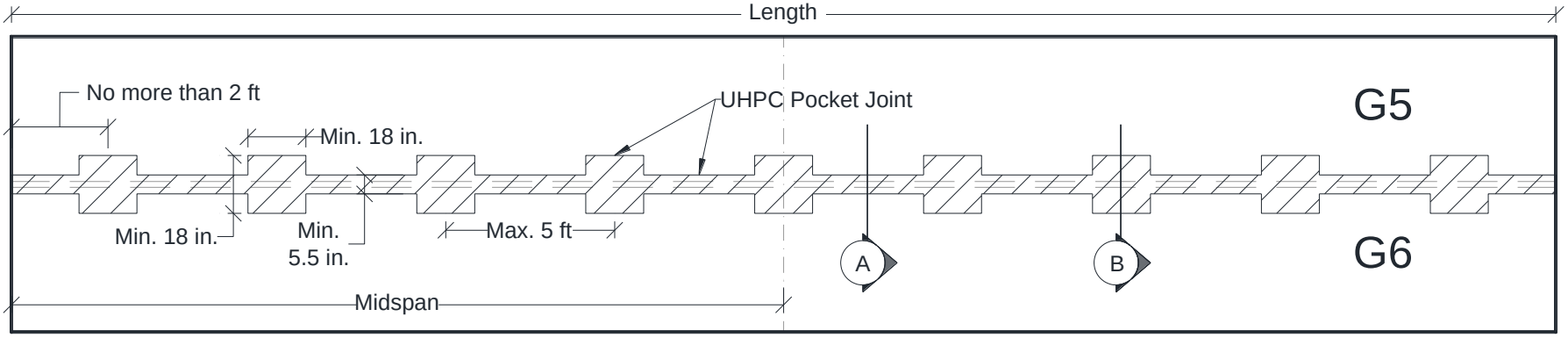
- Both pocket and continuous rehabilitation methods are viable solutions to rehabilitate Double-Tee bridges. Only UHPC should be used for field applications.
- The pocket joint rehabilitation method is the most cost effective solution.

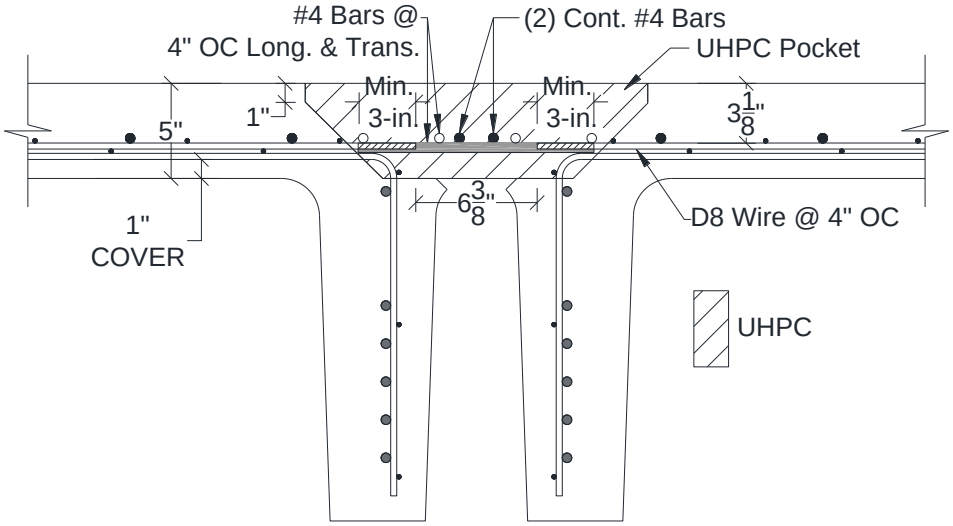
Comments/Questions



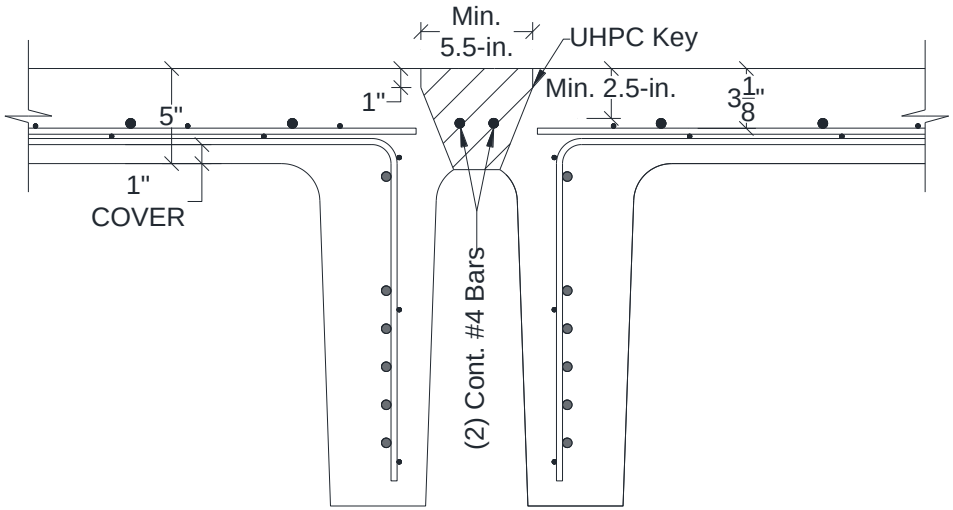
https://sites.google.com/people.unr.edu/mostafa-tazarv/research/rehab-of-dt-bridges

Recommendations





Section B - Pocket Joint Detailing



Section A – Shear key Detailing

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Recommendations

➢ Preparation

1. 1-in. Saw-cut around perimeters.
2. Hammer-chip at 45 degree slope, 20 degrees between pockets:
    a. 30-lb chippers for first 2.5 inches.
    b. 15-lb chippers around reinforcement.
3. Hydro-demolition shall be permitted as an alternative.
4. Joint surface shall be sand-blasted and pre-wetted for 24 hours prior to pouring.
5. Formwork shall be water tight and installed from top of bridge.

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Recommendations

➢ Pocket Detailing

1. UHPC filled square pockets with minimum side dimensions of 18 inches. Spacing shall not exceed 5 ft c/c.
2. UHPC filled continuous key with a minimum width of 5.5 inches.
3. Pockets reinforced with four Gr. 60 No. 4 bars each direction. Continuous key reinforced with two Gr. 60 No. 4 longitudinal bars.
4. Minimum lap-splice of 3 inches between pocket reinforcement and exposed wires.