

# Development of Prefabricated Concrete Bridge Railings: Phase I Testing and Results

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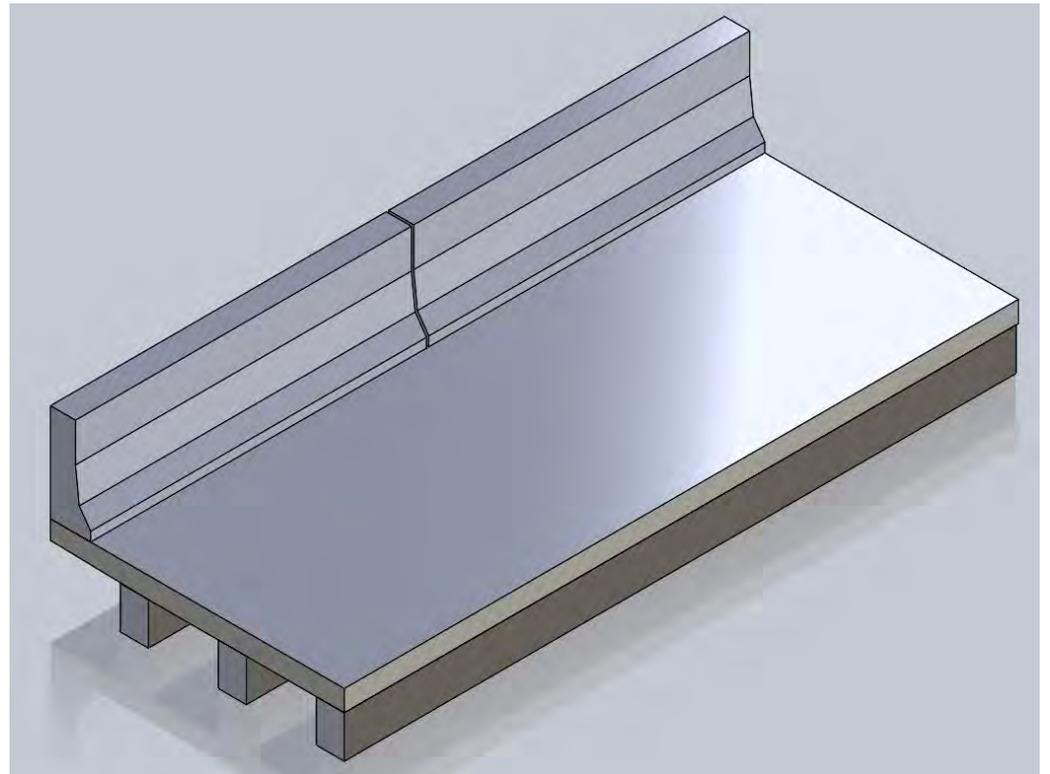


# Phase I

- **Develop and test prefabricated concrete (precast) barriers for ABC applications**
- **Design barriers for MASH Test Level 4**
- **Evaluate performance using quasi-static loads**

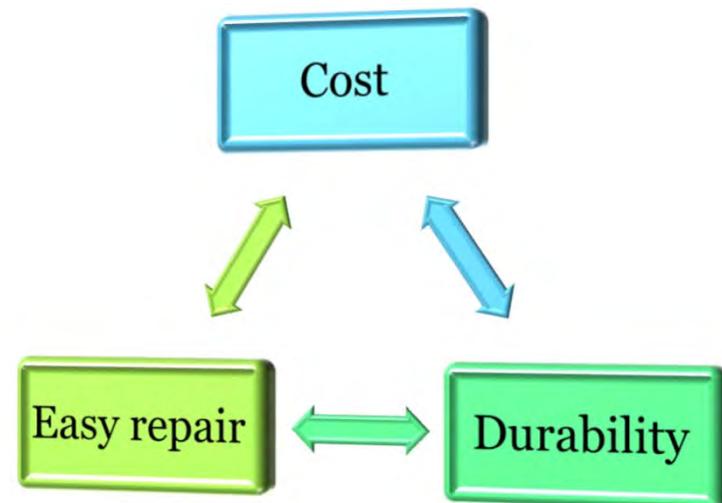
# Outline

- Objective
- Design
- Connection Details
- Testing
- Results



# Objective

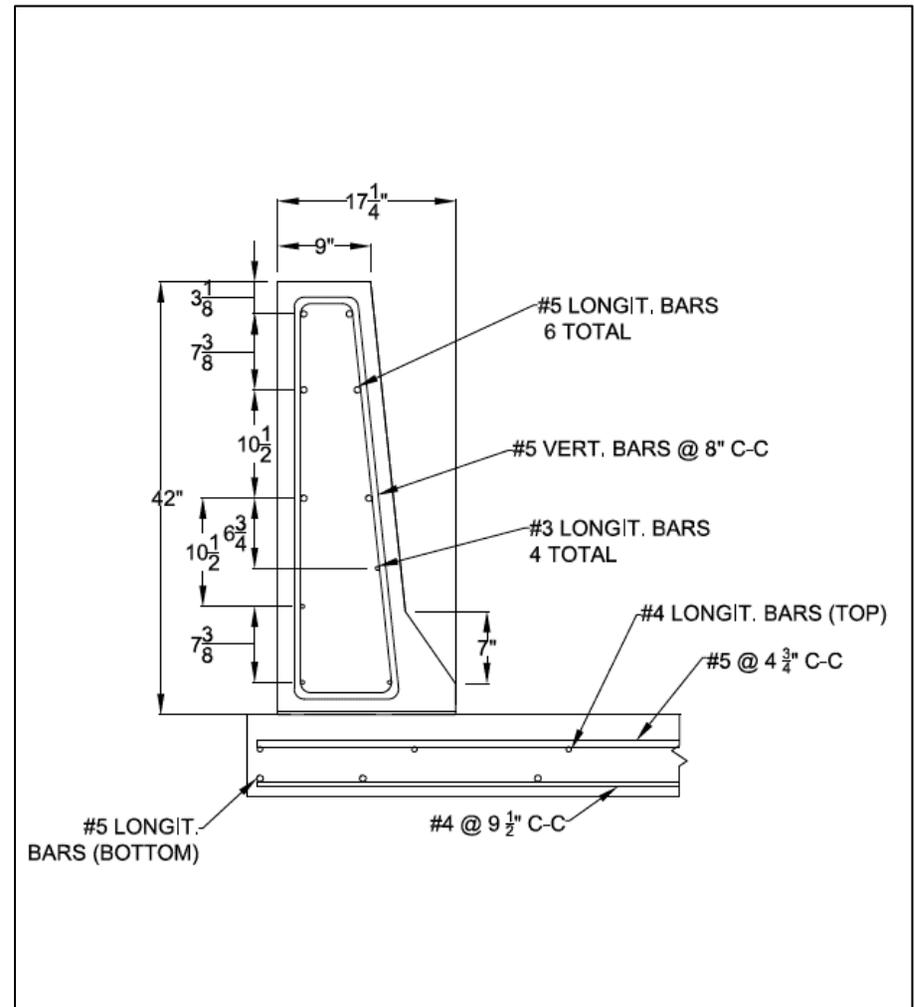
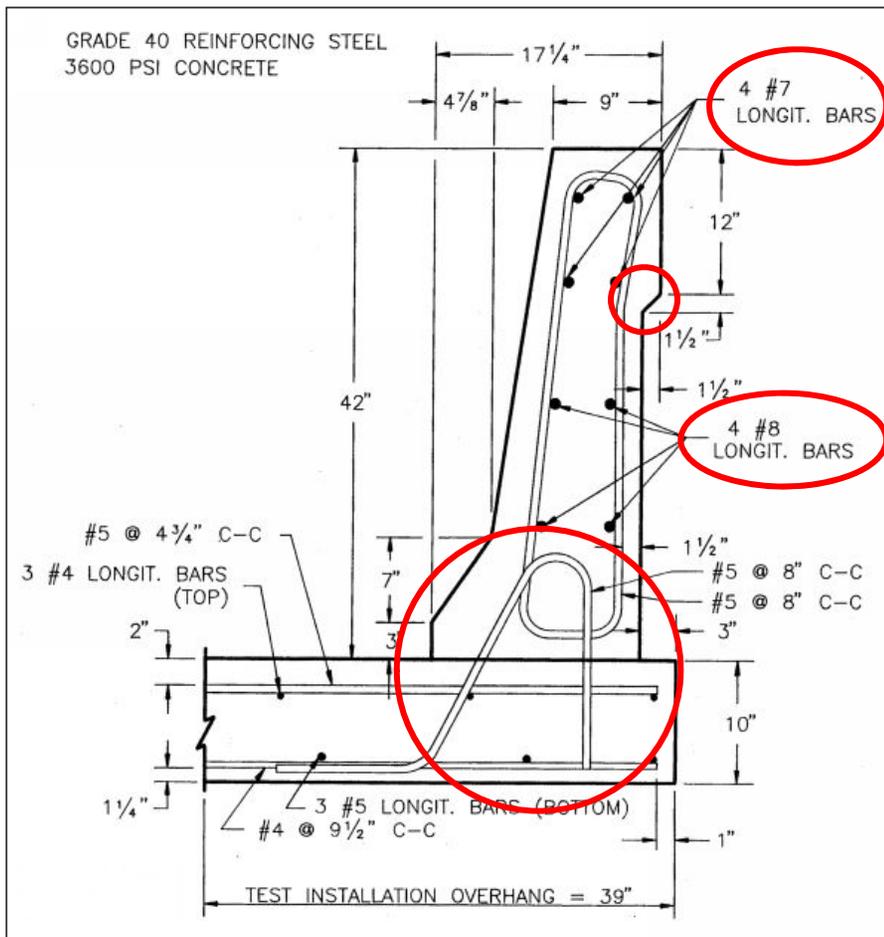
- Develop prefabricated concrete bridge barriers with dependable connections
- Give considerations to
  - Minimal damage to deck
  - Constructability
  - Easy repair
  - Durability
  - Cost



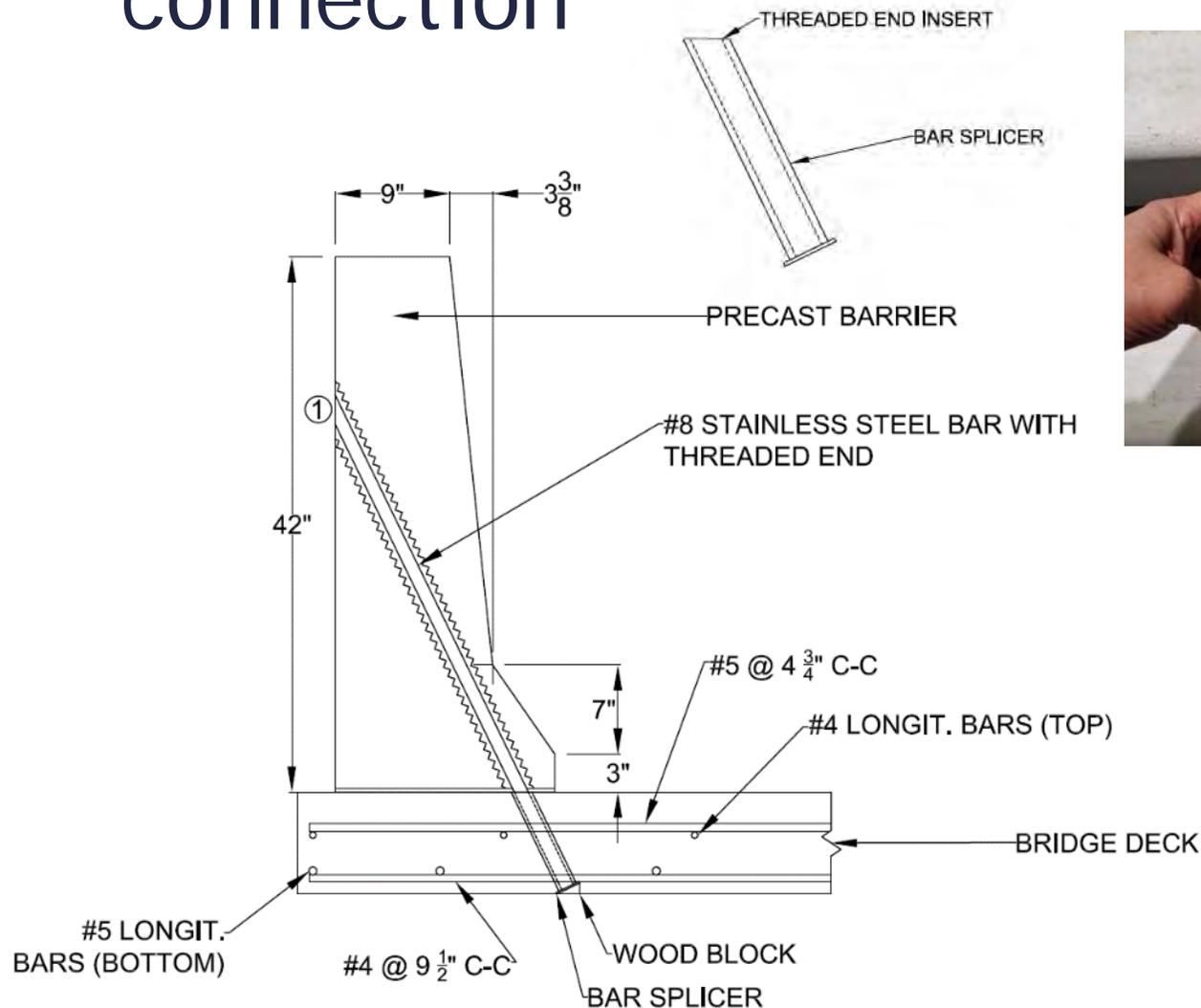
# Design Approach

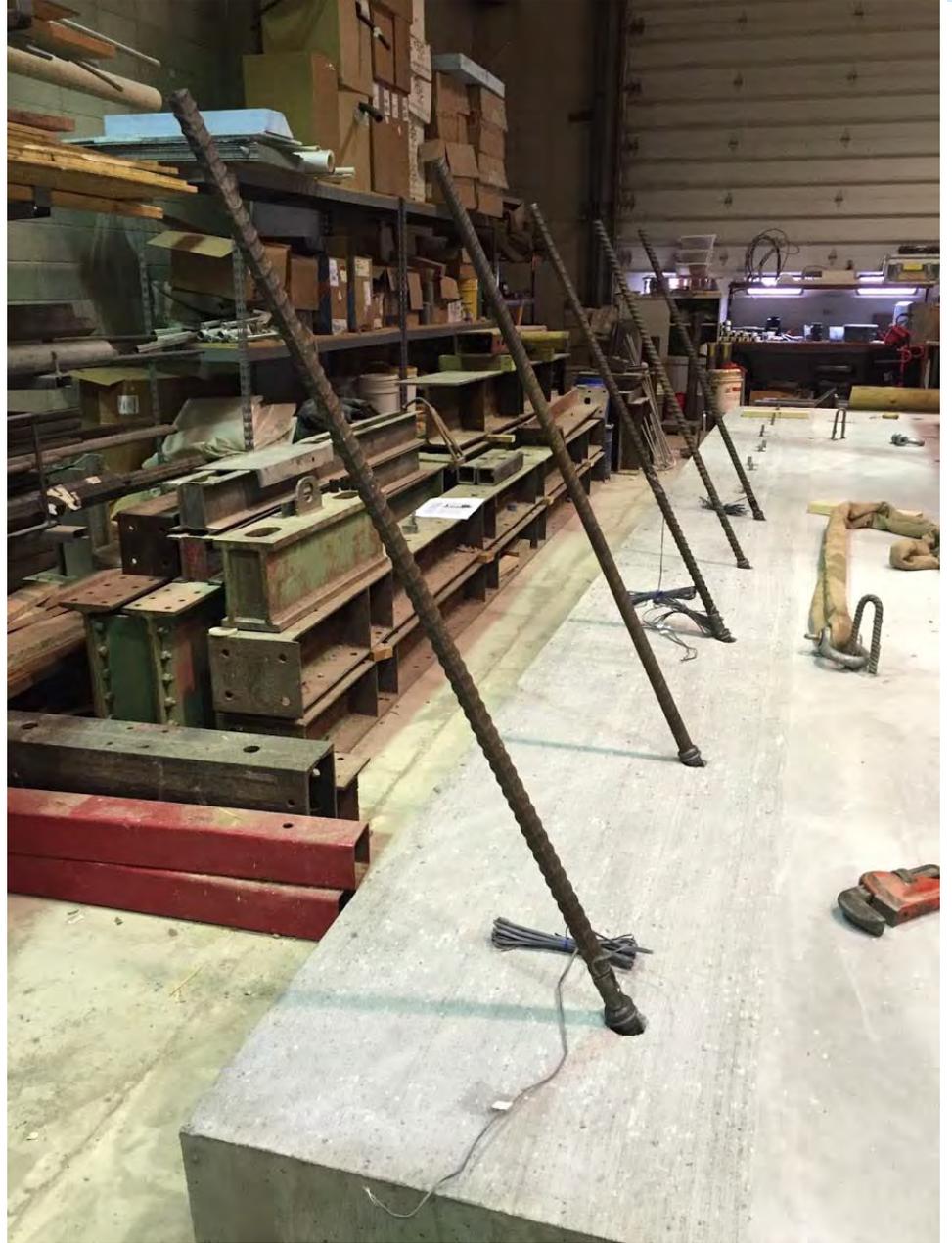
- **Test Level 4**
  - Design load = 54 kips
- **Failure mode**
  - Capacity protect barrier and deck
  - Force yielding to develop in the connections

# FHWA Standard 42-in F-Shaped Barrier



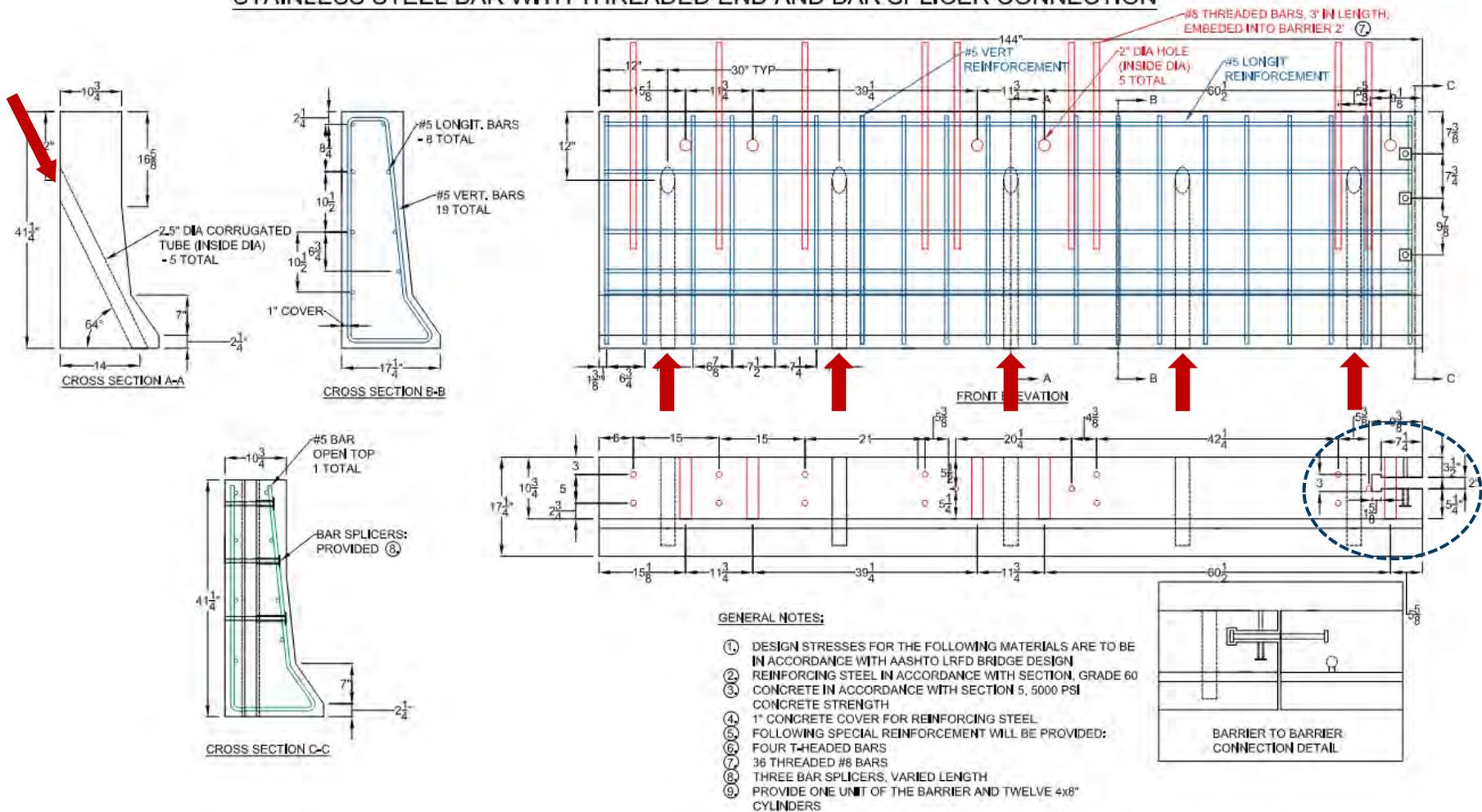
# Barrier-to-Deck Connection - PBI - Precast Barrier with Inclined bar connection



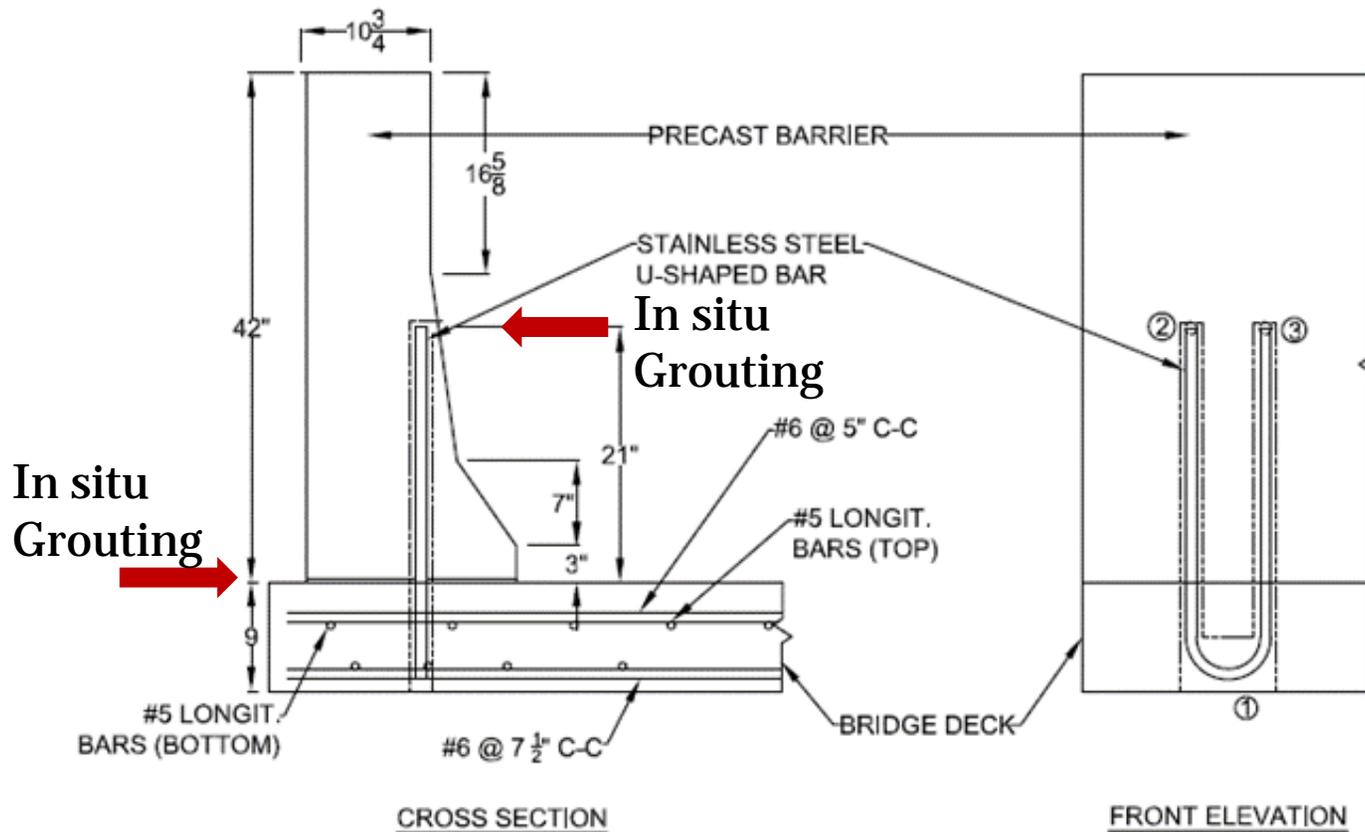


# PBI - Precast Barrier with Inclined bar connection

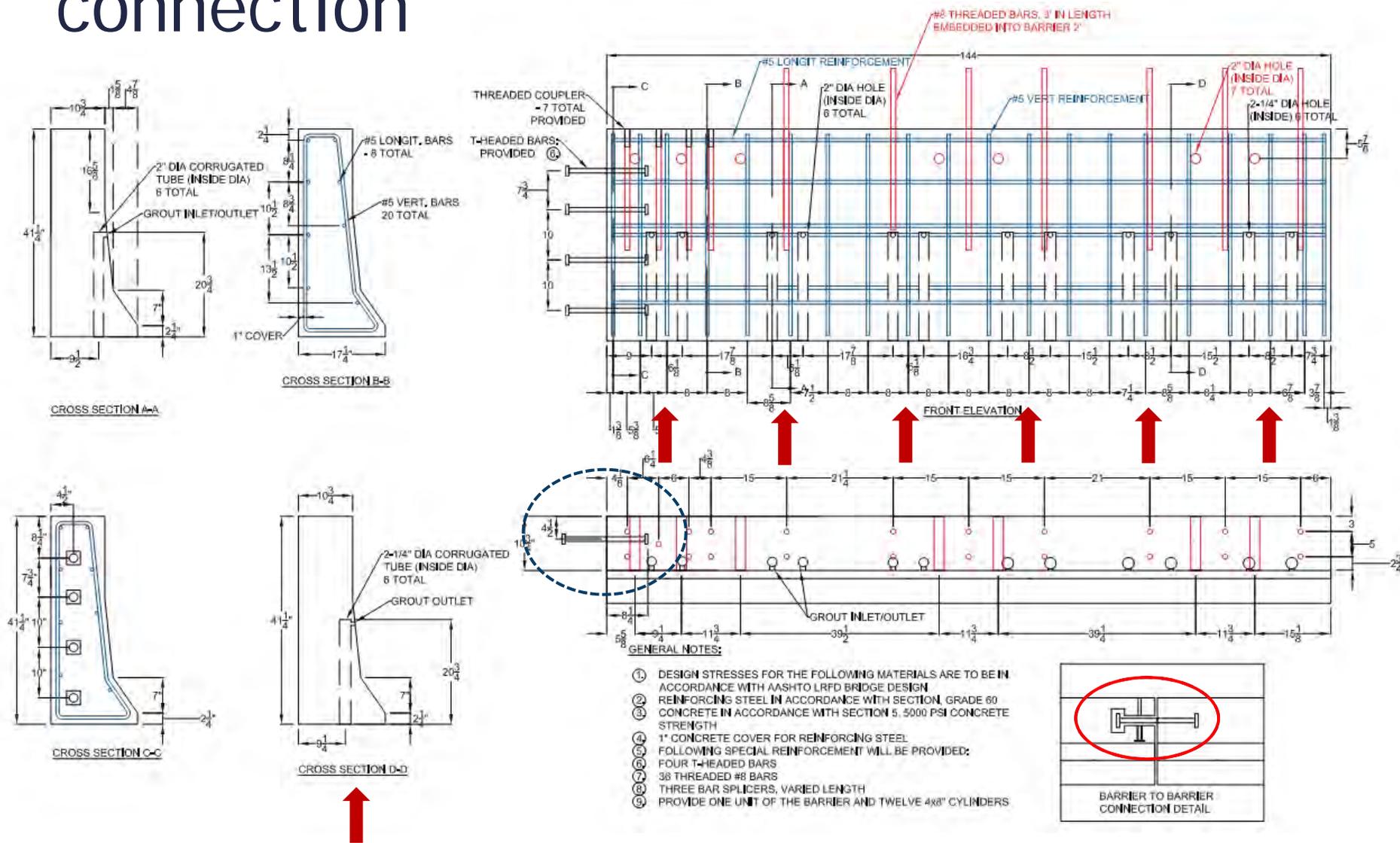
## STAINLESS STEEL BAR WITH THREADED END AND BAR SPlicer CONNECTION



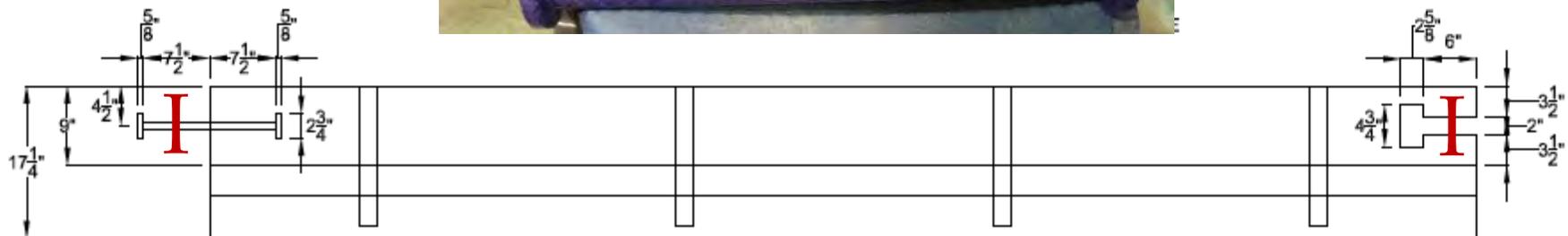
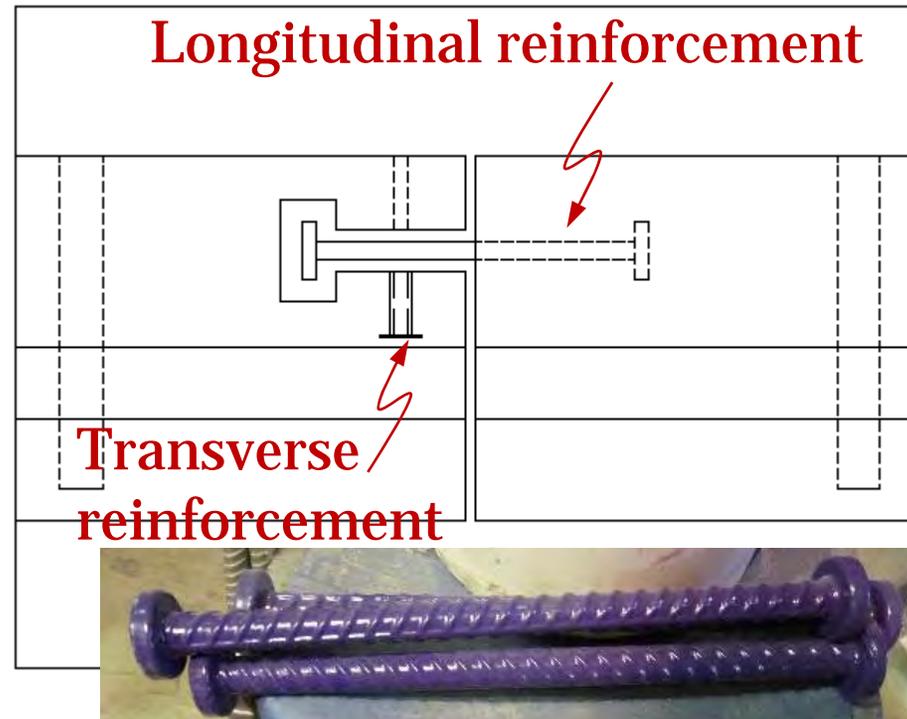
# Barrier-to-Deck Connection - PBU - Precast Barrier with U-bar connection



# PBU - Precast Barrier with U-bar connection



# Barrier-to-Barrier Connection



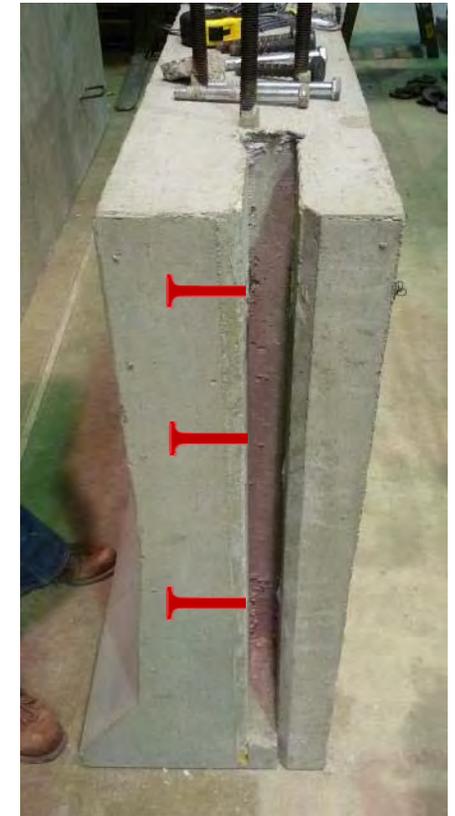
# Full-scale Testing

- Use two 12-ft long precast barriers
- Model both PBI and PBU
  - **Test them individually**
- Establish the Barrier-to barrier connection
  - **Test the entire unit with application of loads at multiple places**

# Prefabrication



PBU

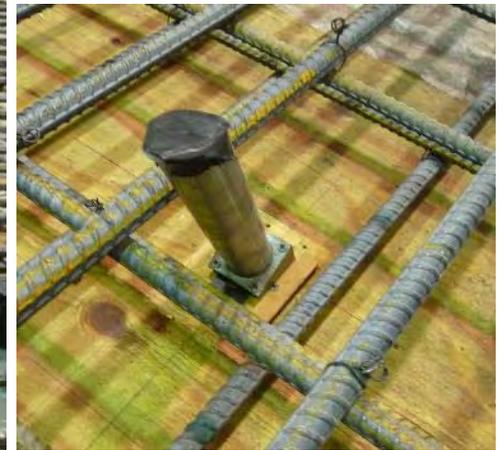


PBI

# Barrier-to-Barrier Connection



# Deck Construction



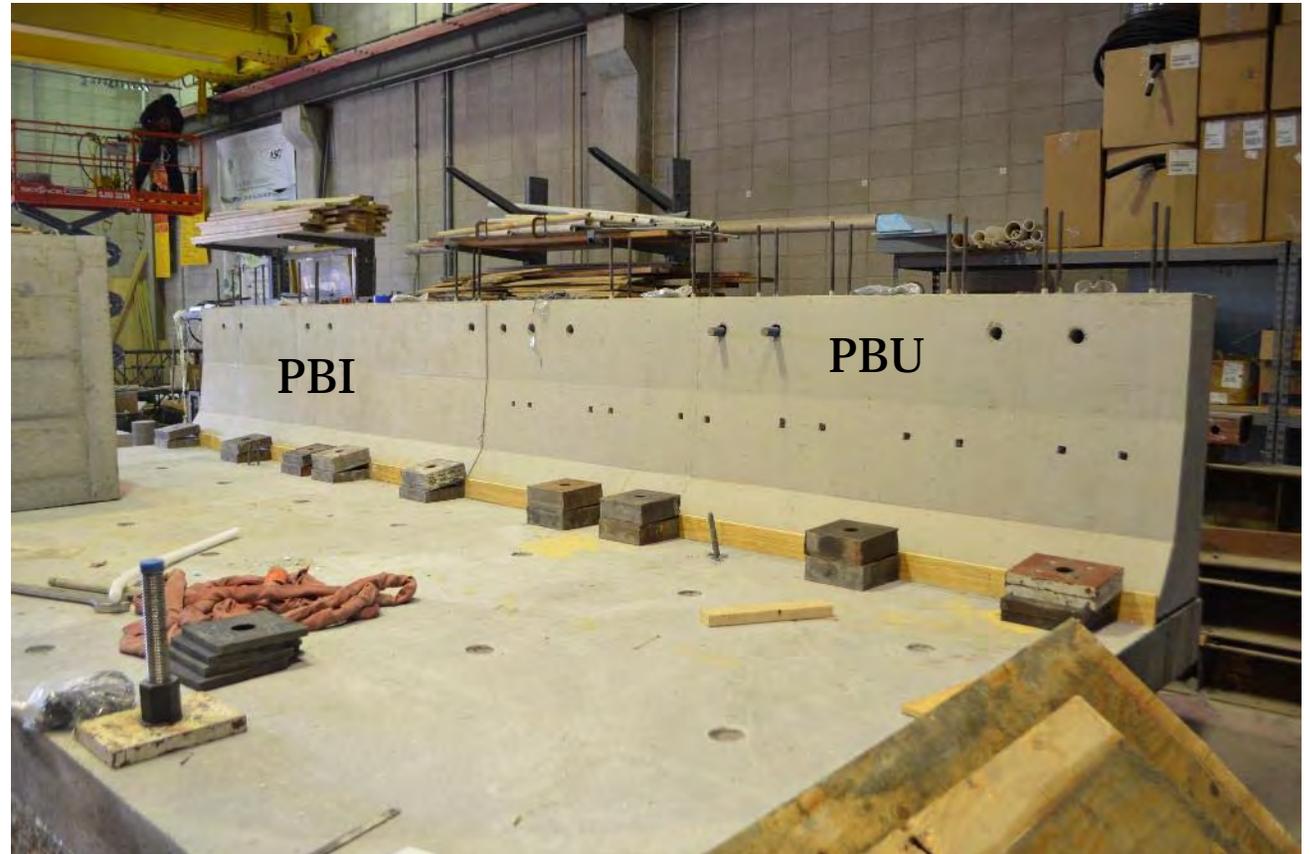
# Deck Construction



# Deck Construction



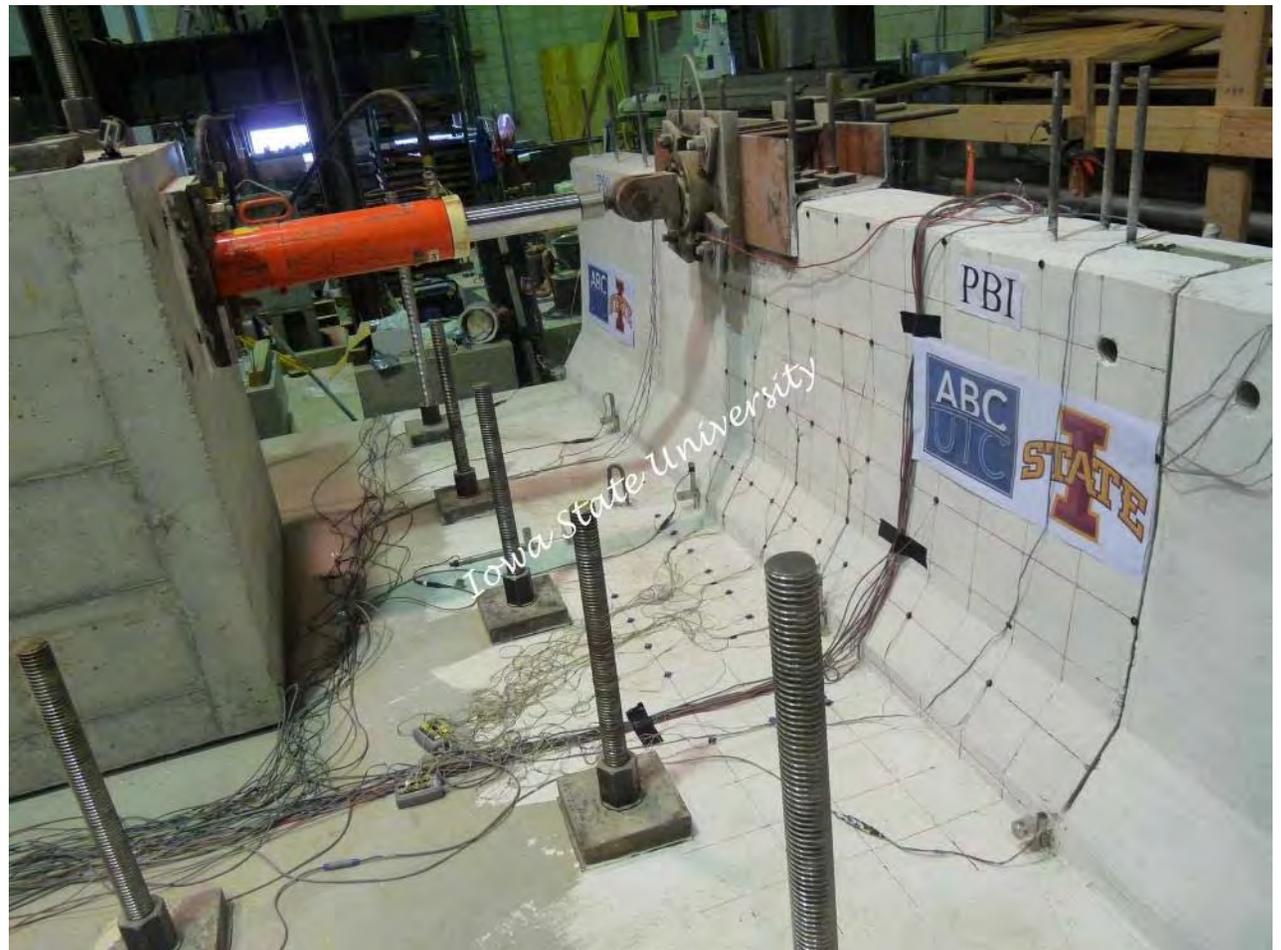
# Assembly of Barrier



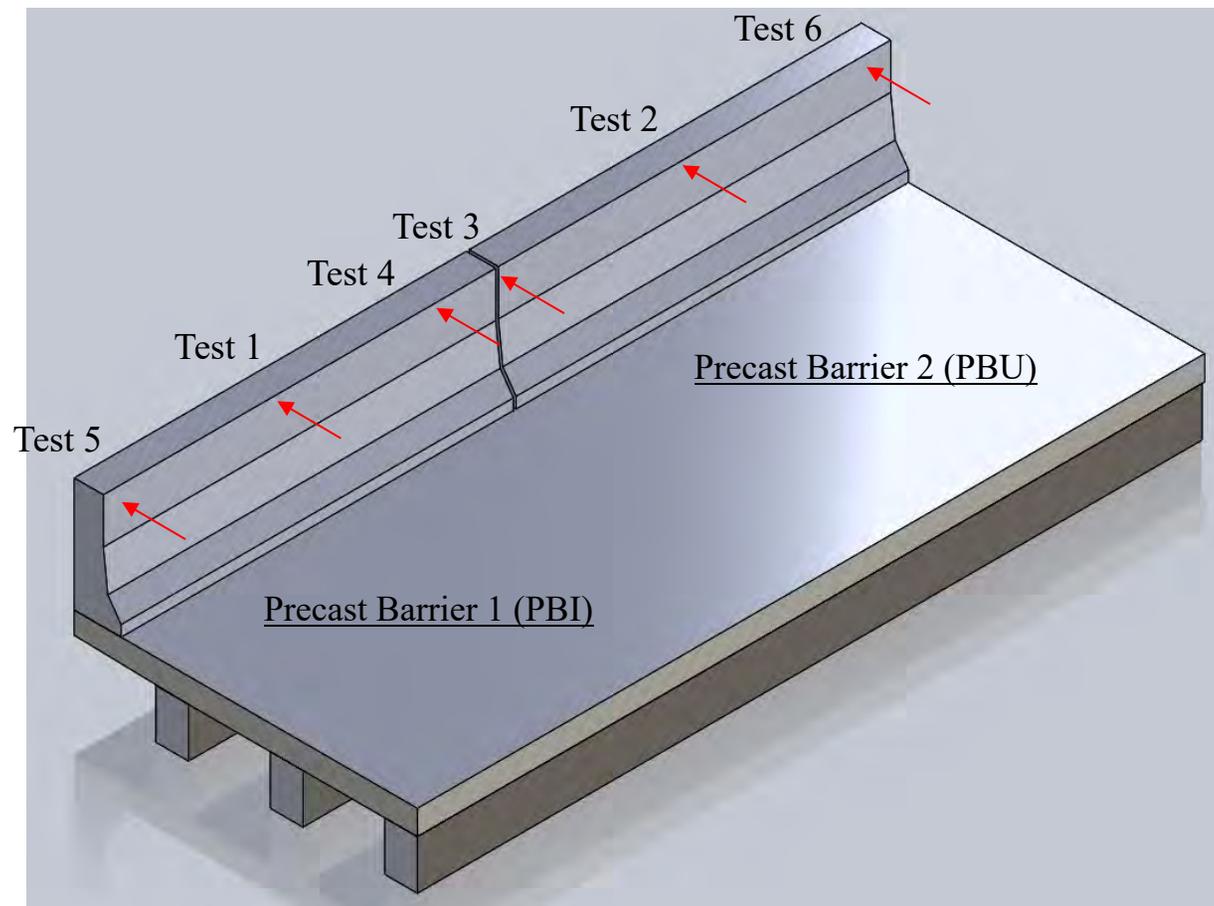
# Assembly of Barriers



# Test Set-up



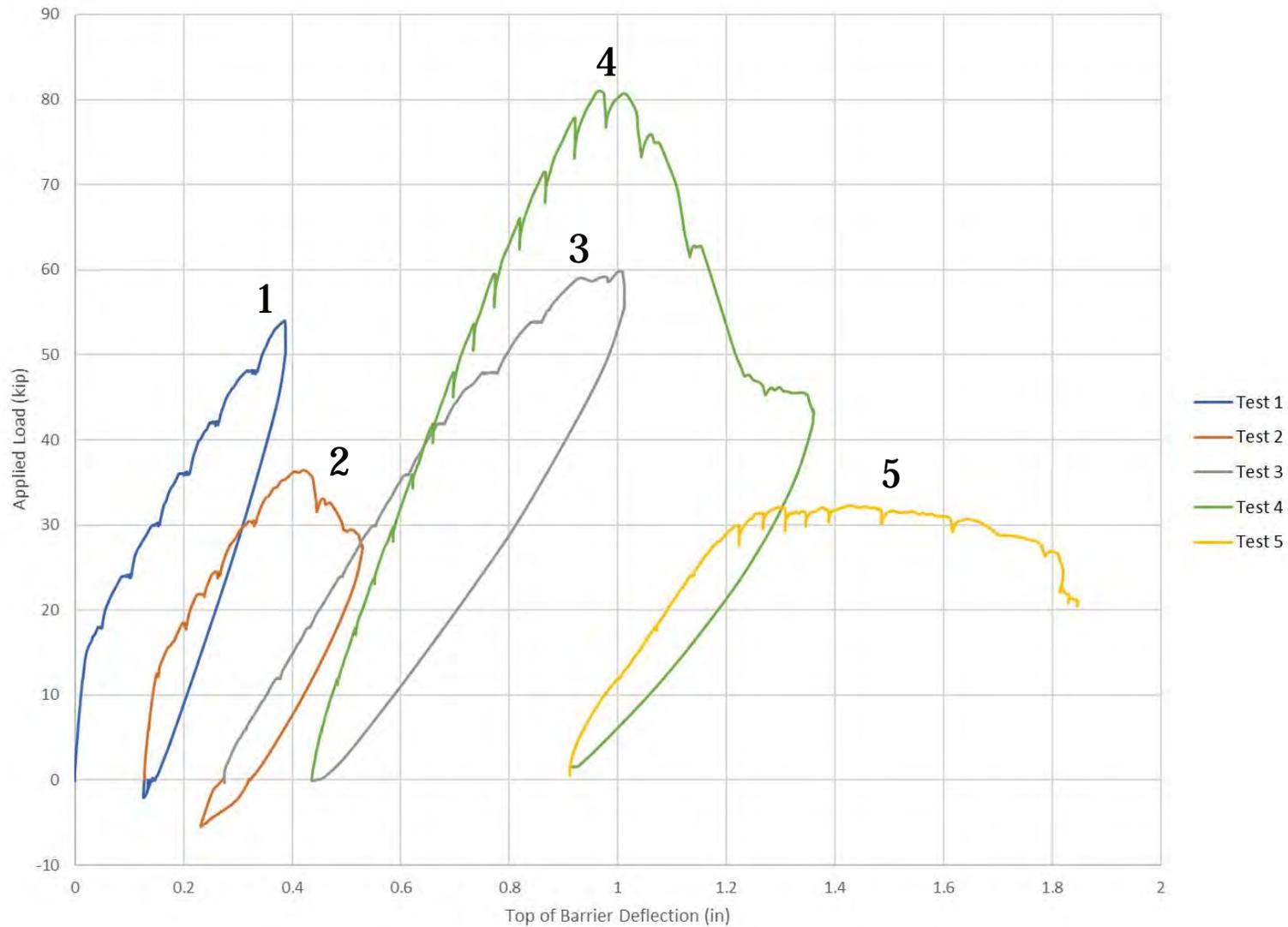
# Test Sequence



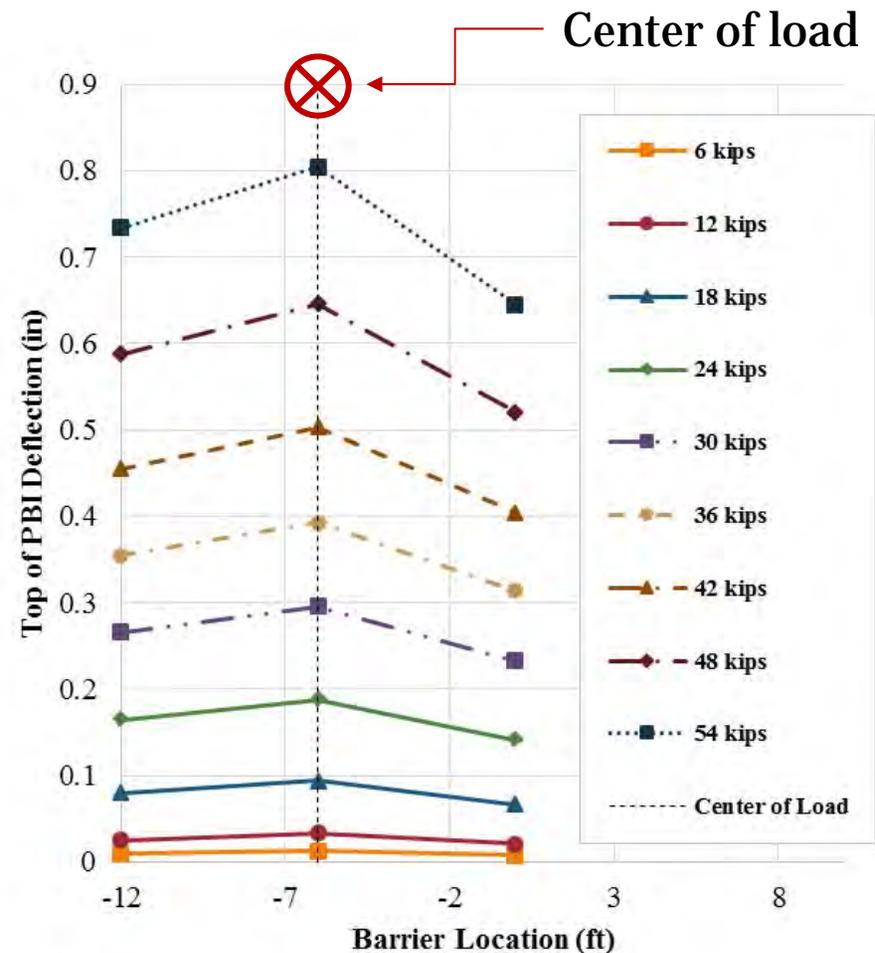
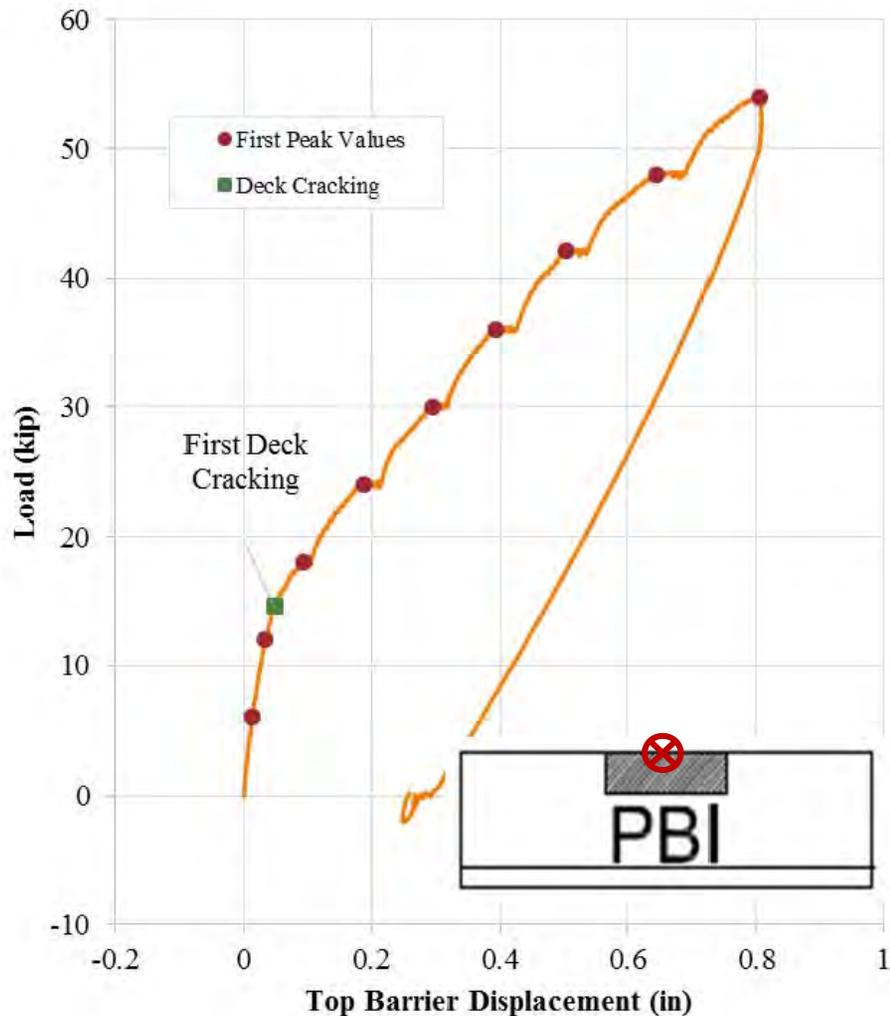
# Summary of Tests

<b>Test</b>	<b>Maximum Load</b>	<b>Maximum Displacement</b>
<b>PBI Middle (Test 1)</b> Target: 54 kips	Push = 54 kips Pull = 2 kips	0.81 inches Final resting position = 0.26 inches
<b>PBU Middle (Test 2)</b> Target: 54 kips	Push = 36 kips Pull = 4 kips	0.80 inches Final resting position = 0.3 inches
<b>Center – Attached (Test 3)</b> Target: 54 kips	Push = 60 kips	0.56 inches Final resting position = 0.17 inches
<b>Off Center, PBI (Test 4)</b> Target: Failure	Push = 81 kips	Loaded until 1.5 inches
<b>End of PBI (Test 5)</b> Target: Failure	Push = 30 kips Pull = 22 kips	4.85 inches When pulled, loading beam 51 inches from loading block
<b>End of PBU (Test 6)</b> Target: Failure	Push = 24.8 kips	6.0 inches

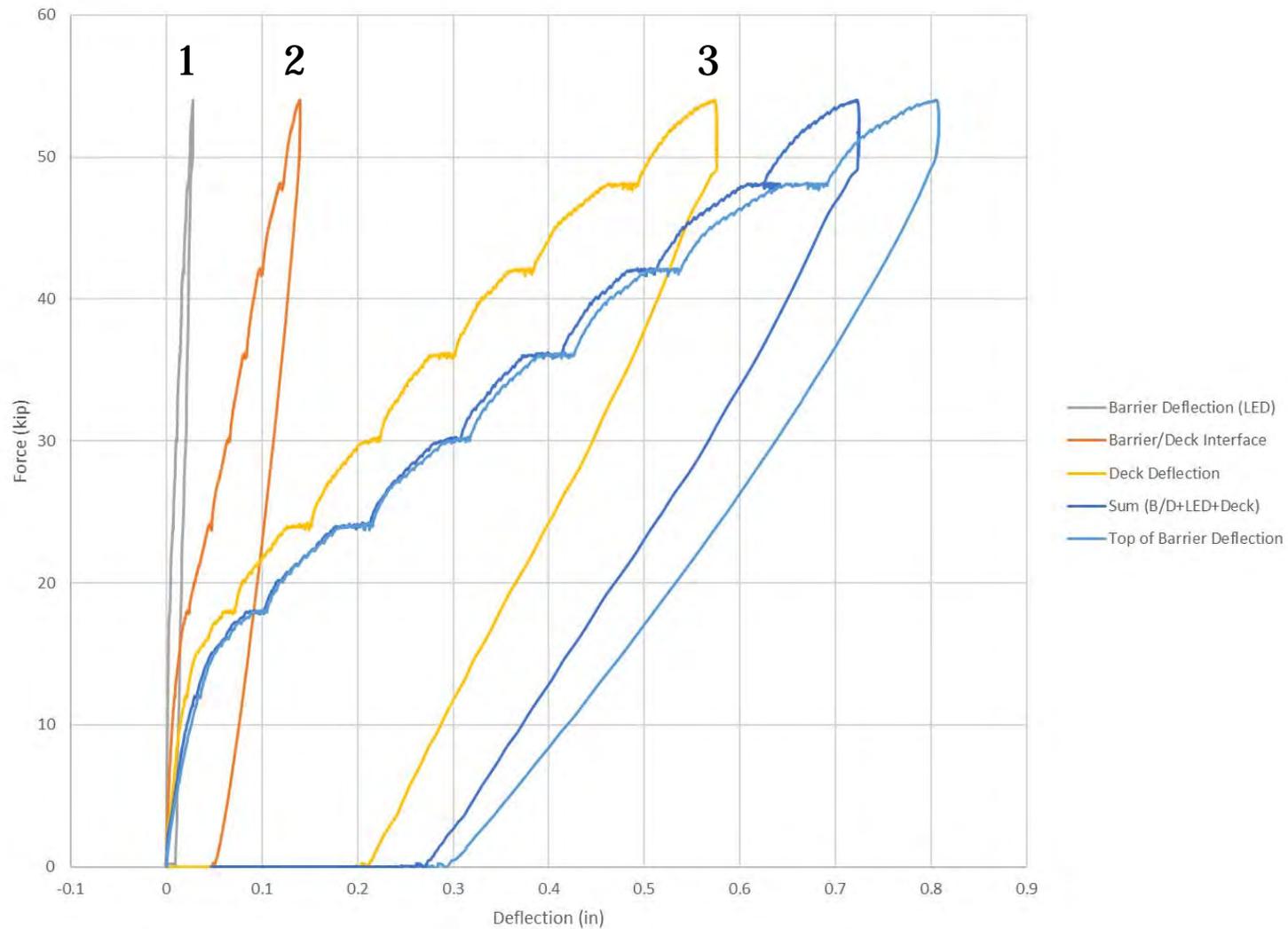
# Summary of Tests



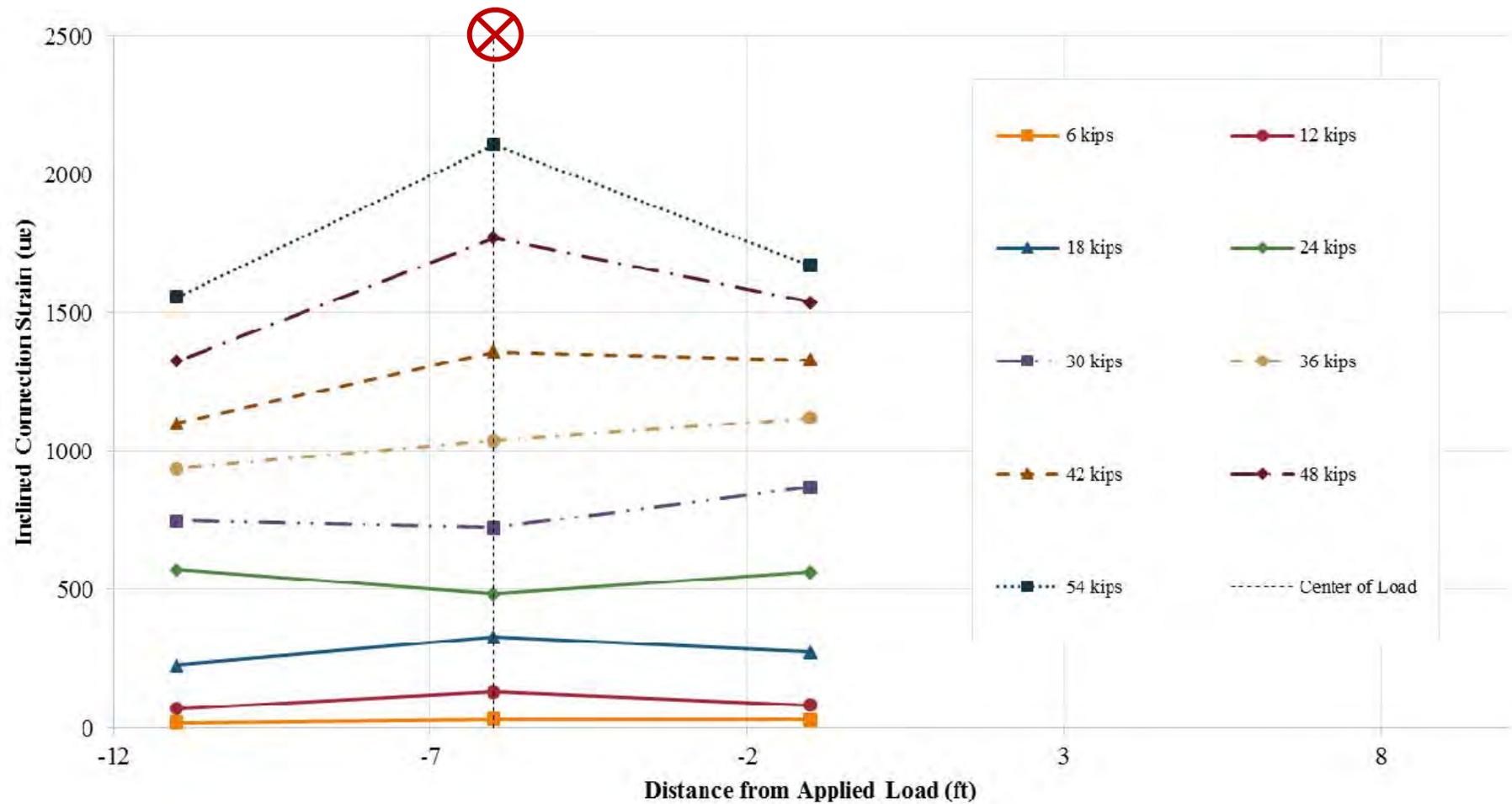
# Test 1 - Inclined Connection (PBI)



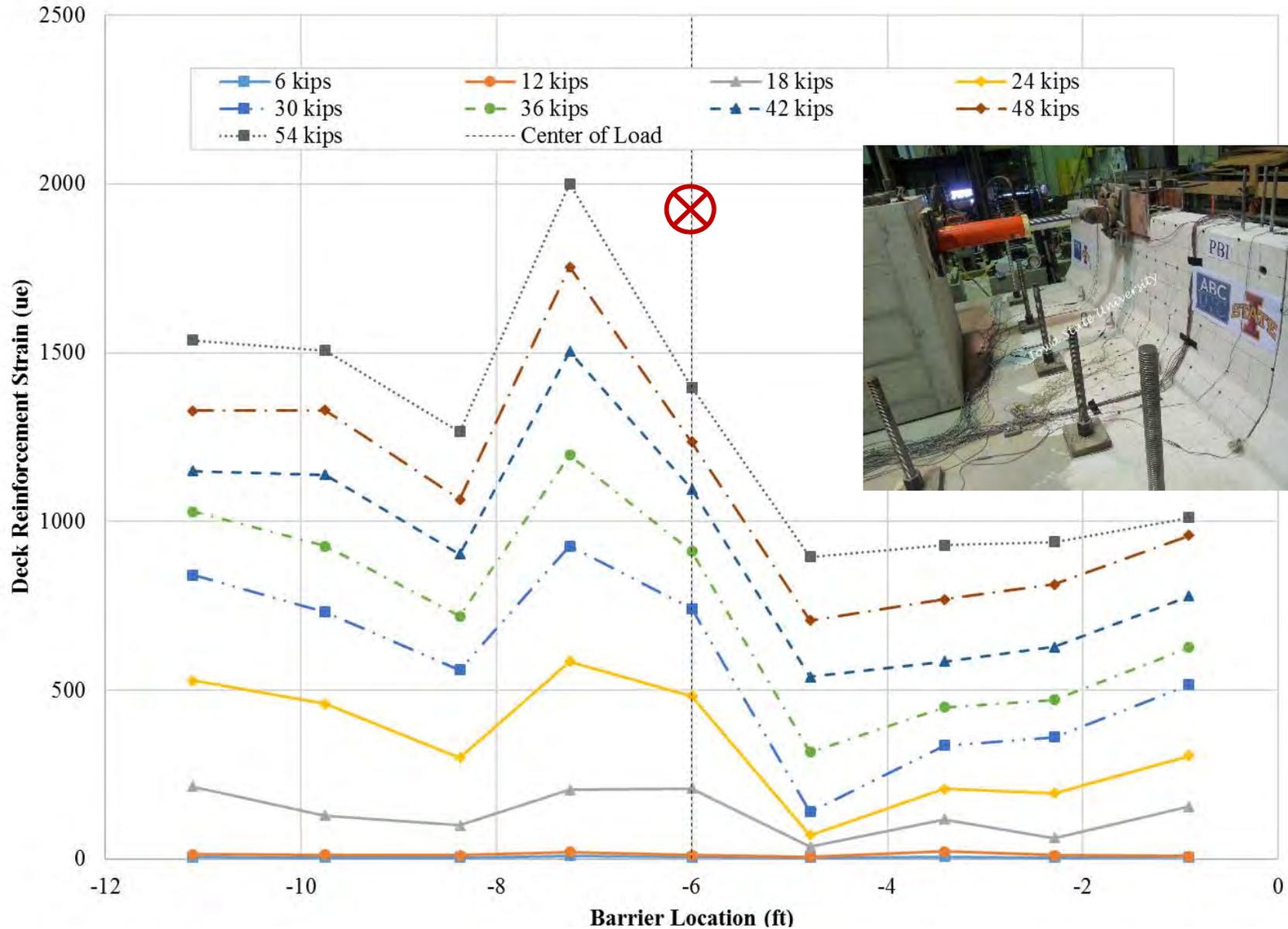
# Deflection Components



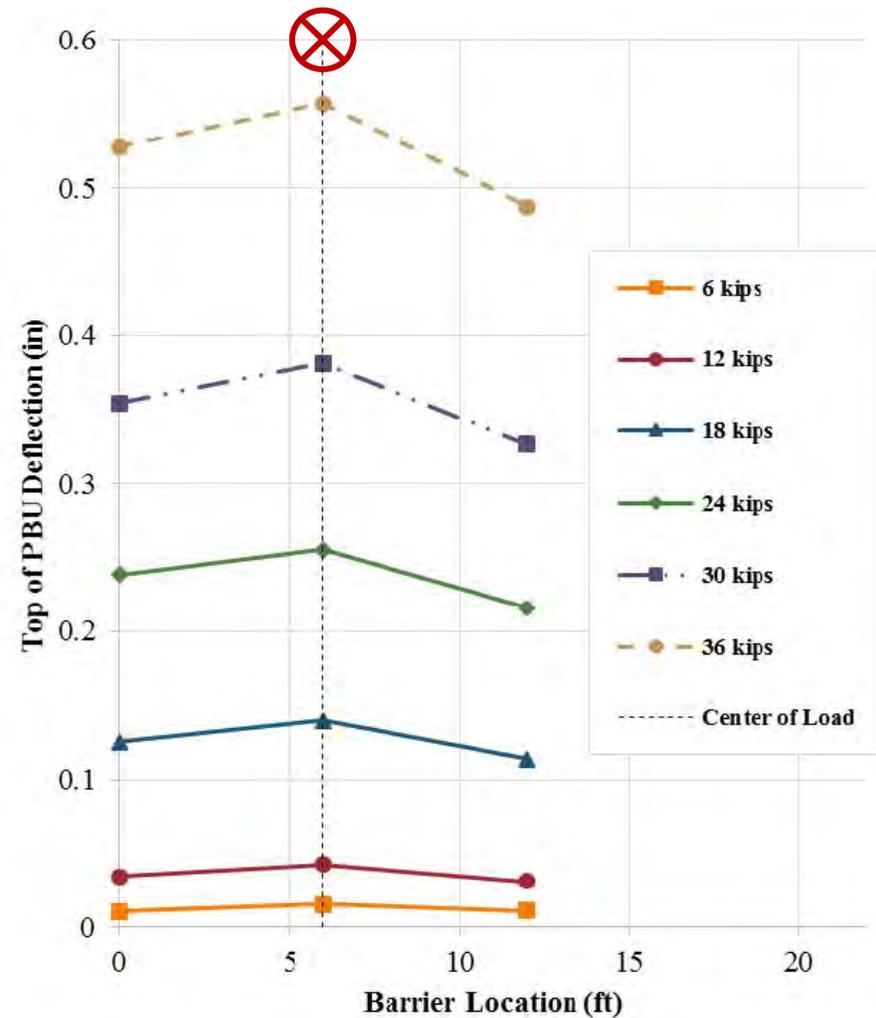
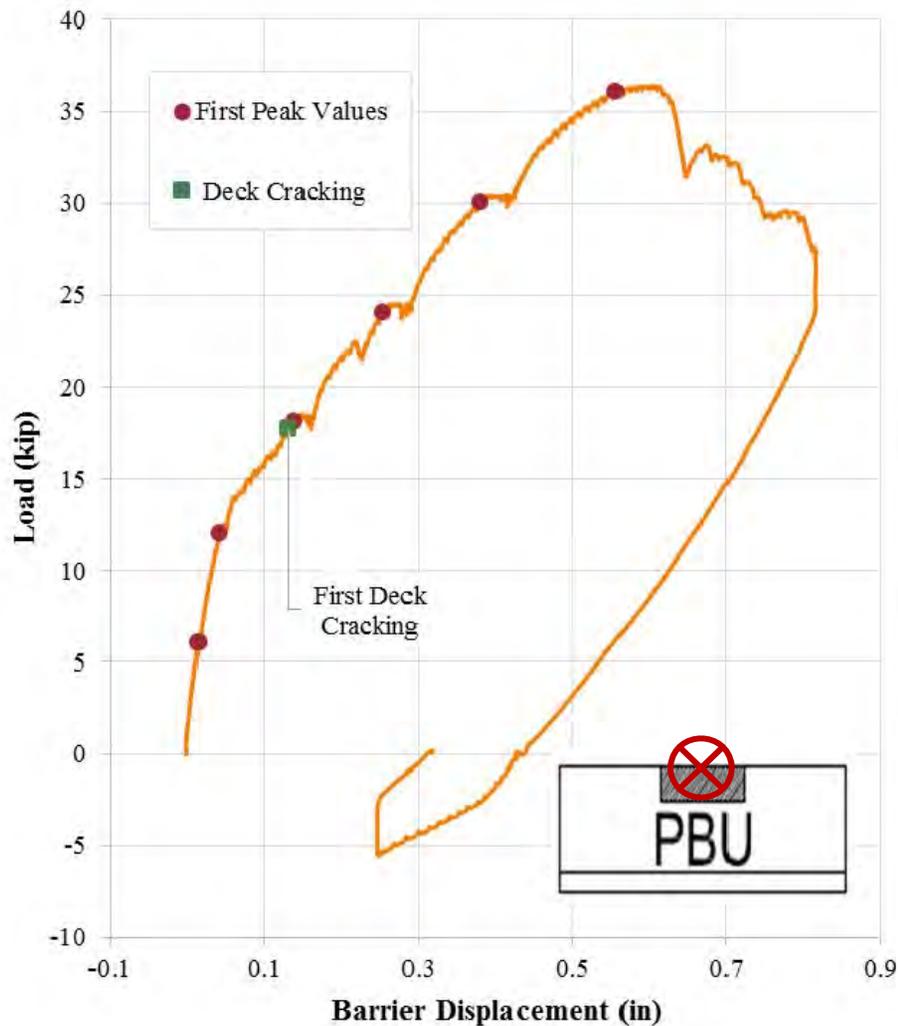
# PBI - Strain in Connection Rebar



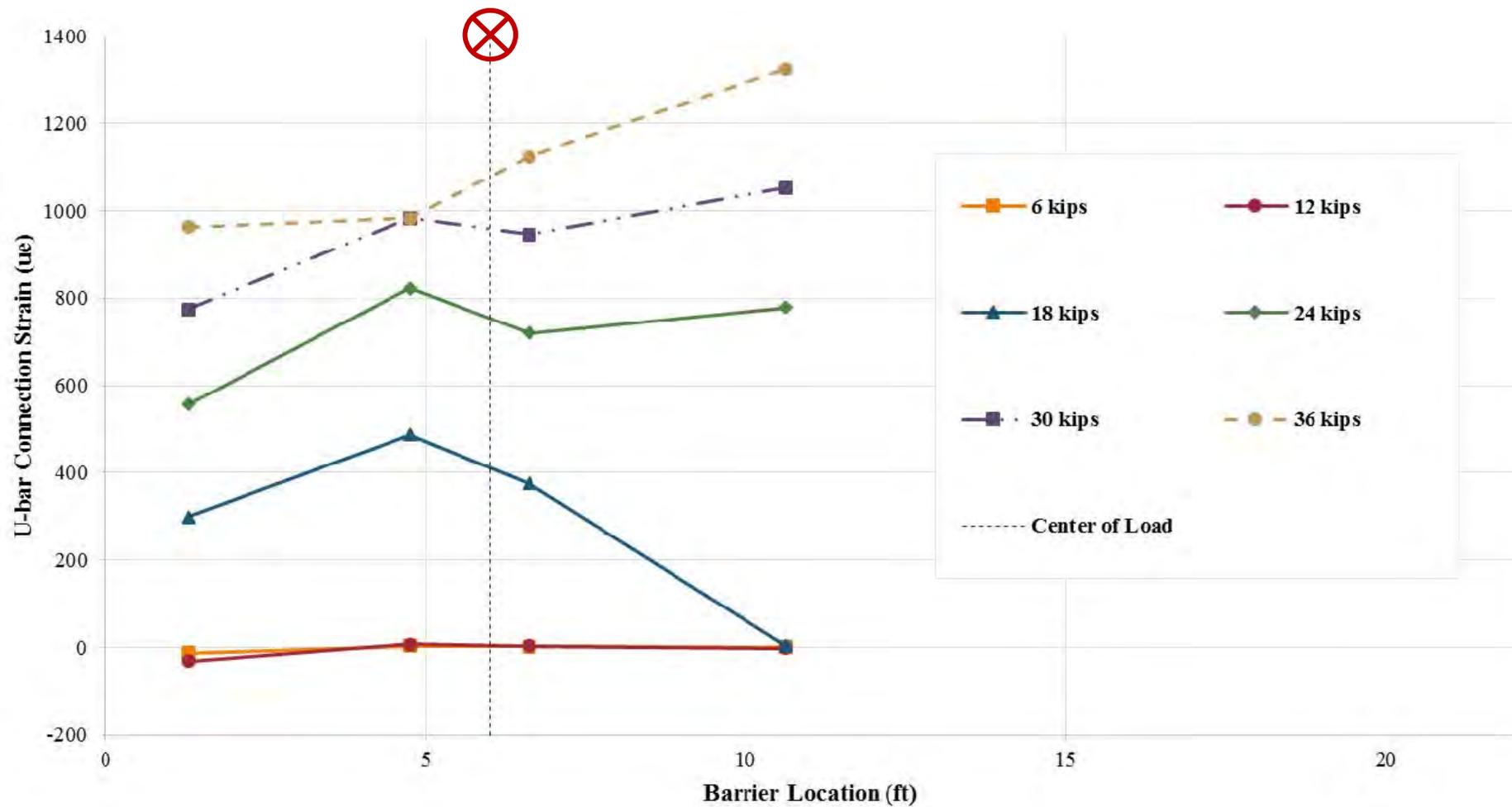
# Strain in Deck Reinforcement



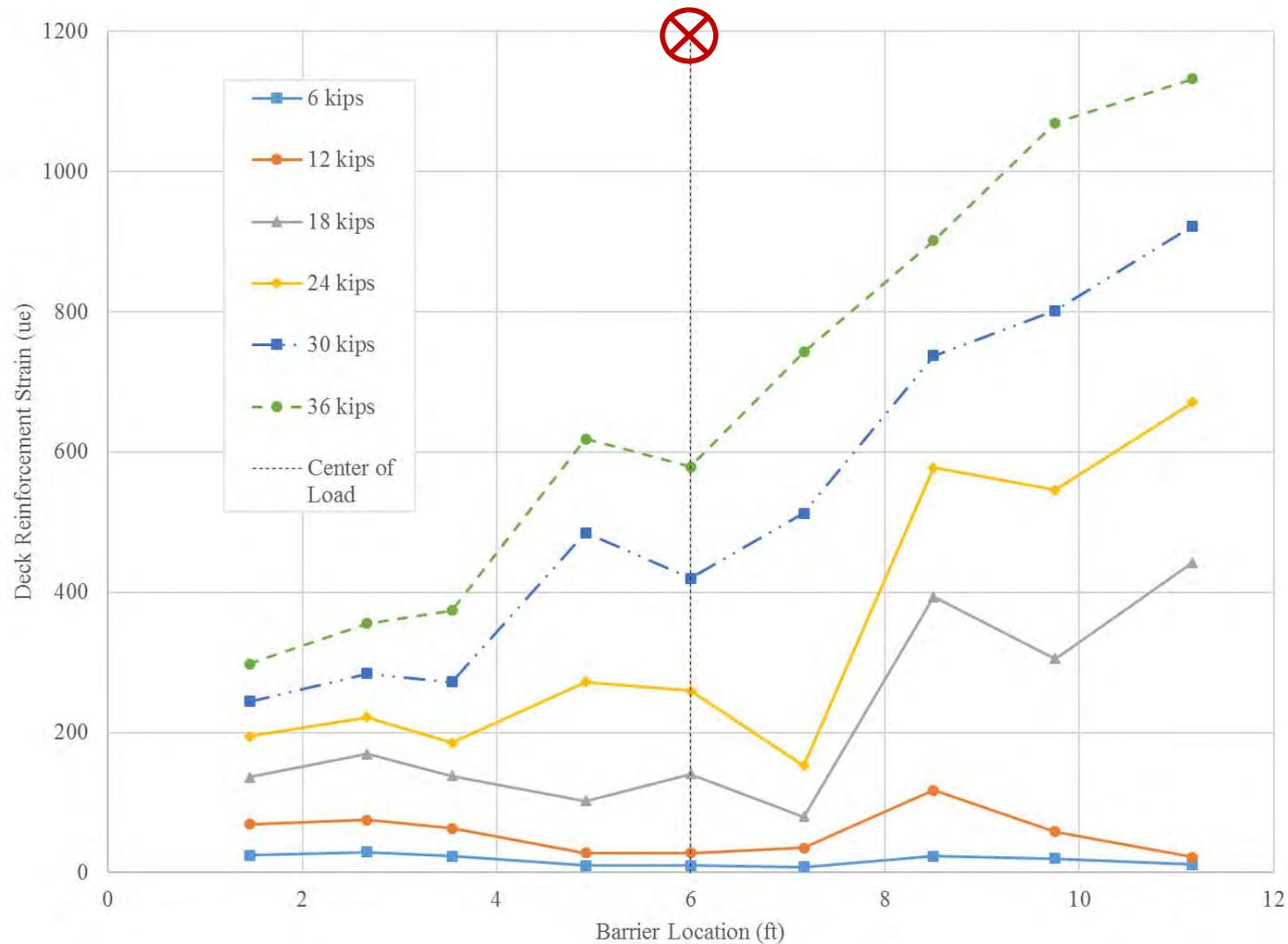
# Test 2 - U-bar Connection (PBU)



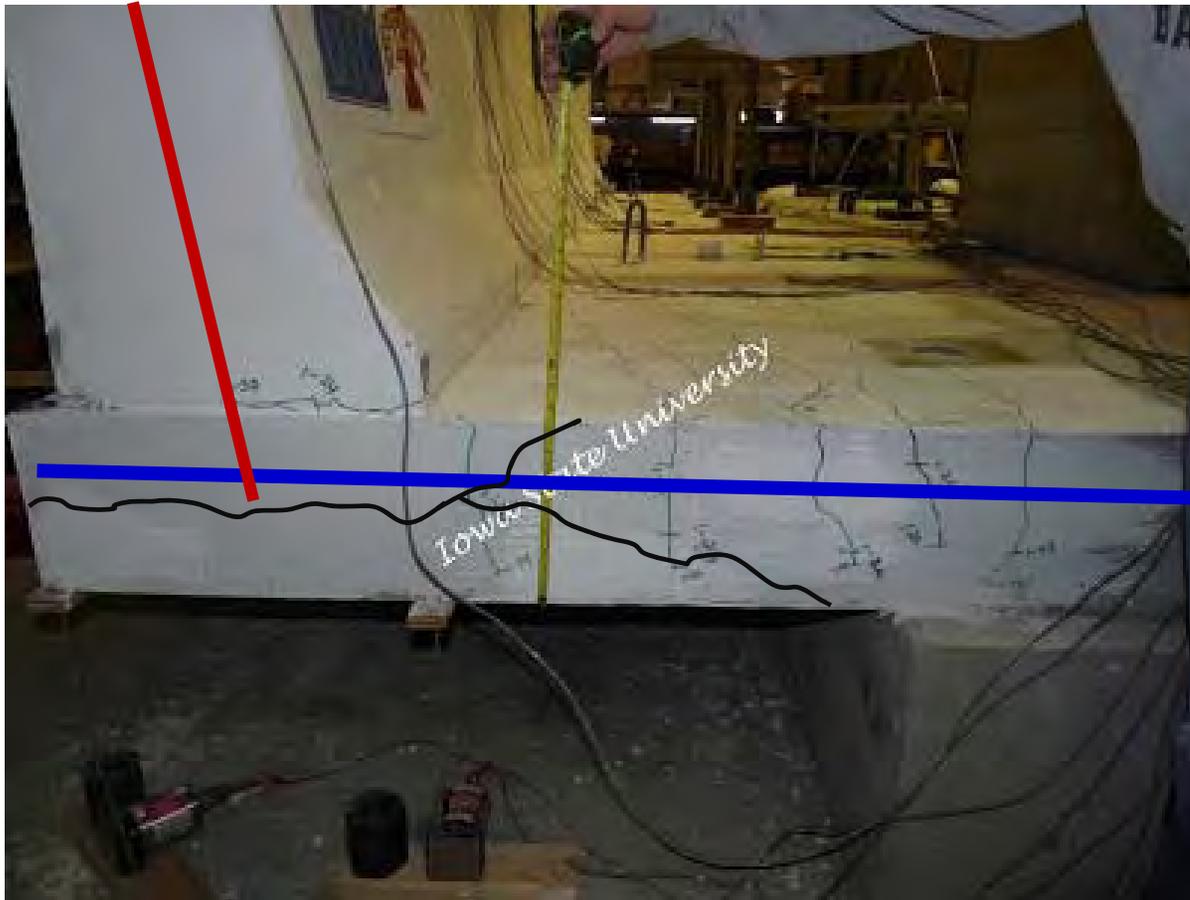
# U-bar Deck Connection Strain



# Strain in Deck Reinforcement



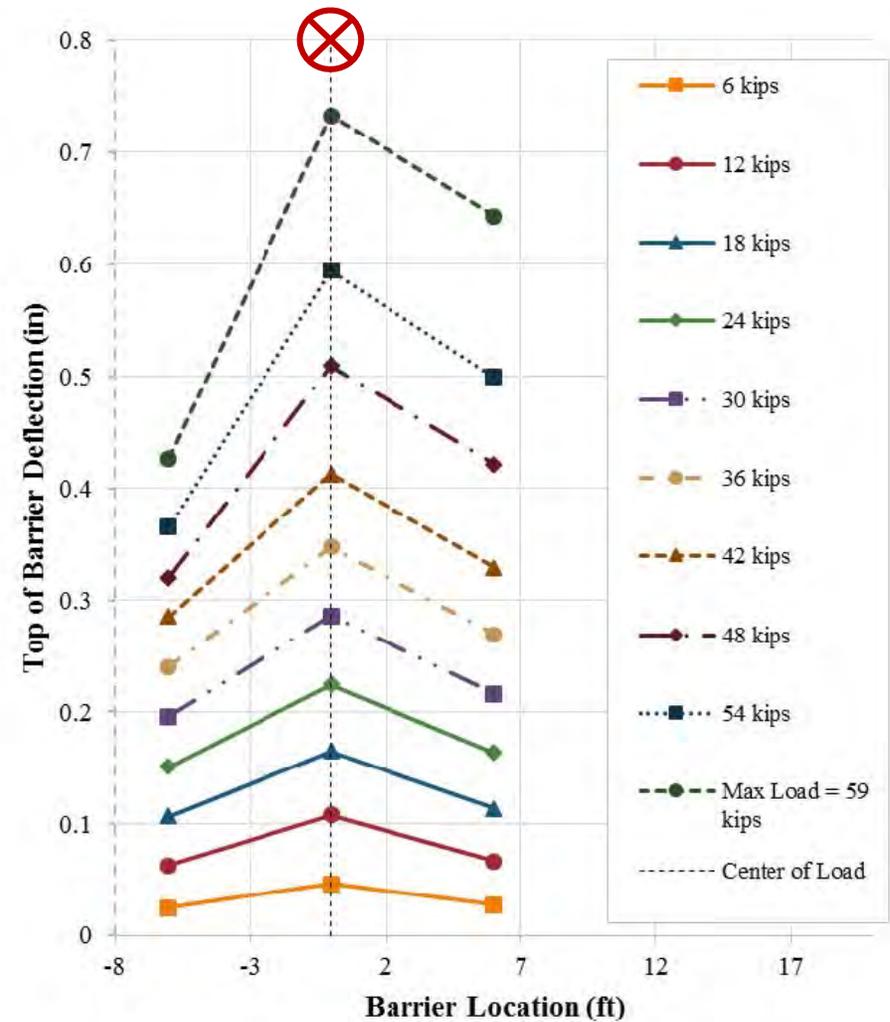
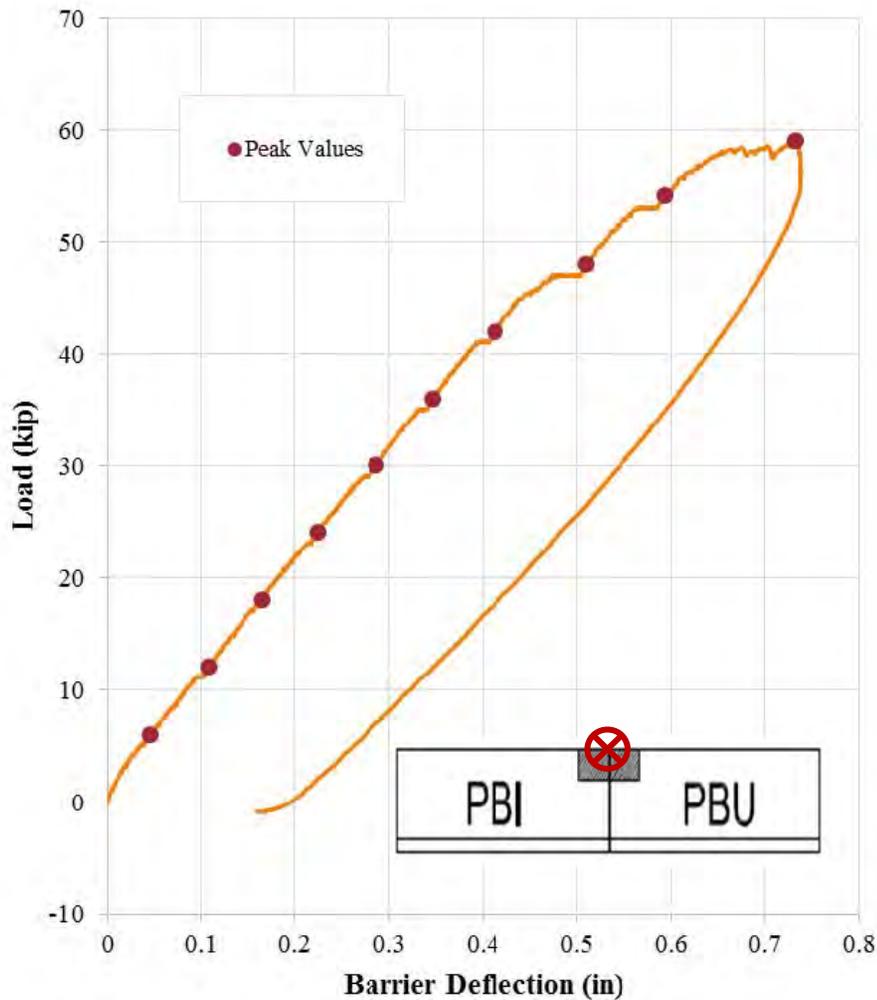
# Splitting Crack in the Deck



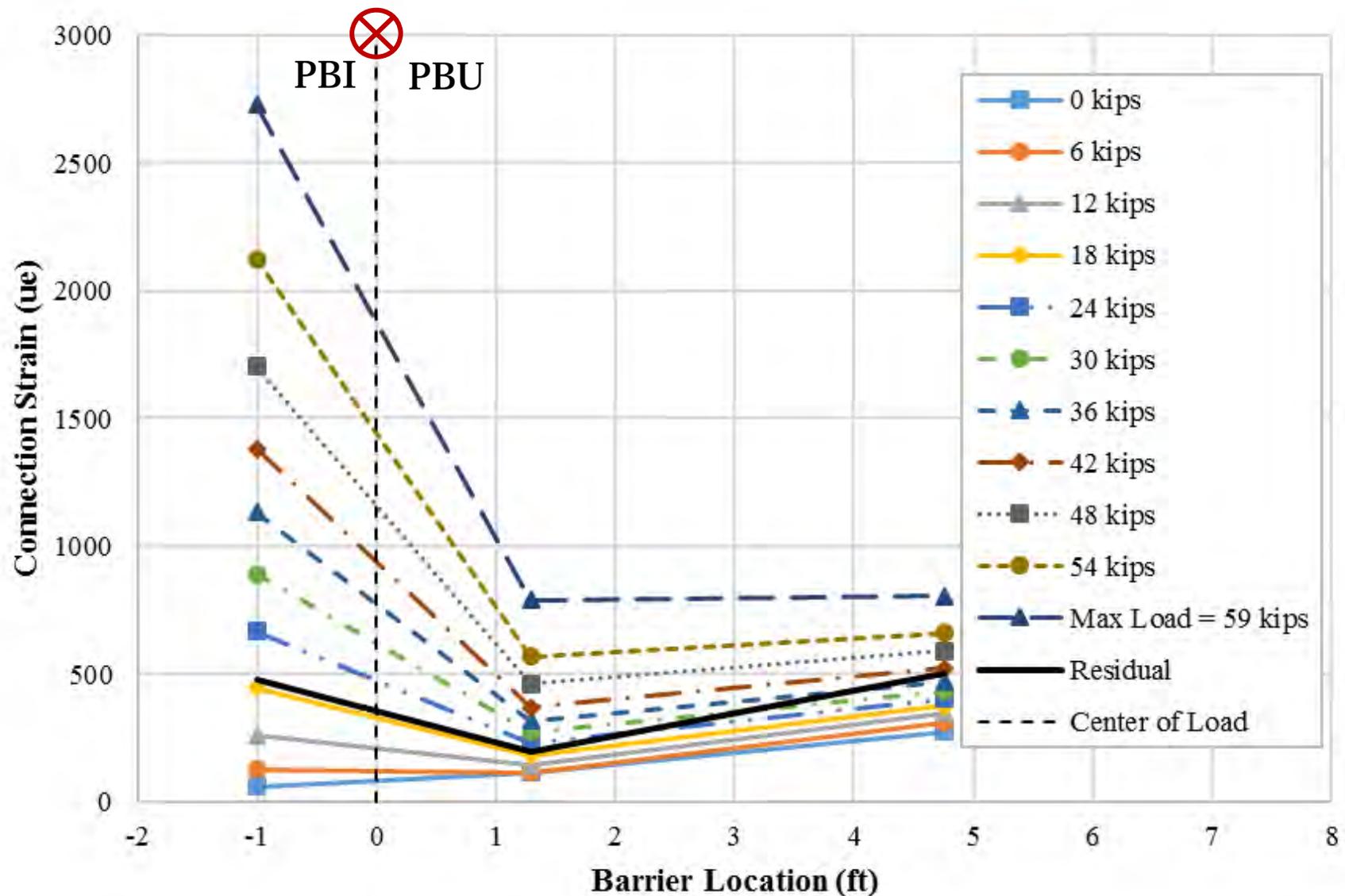
On YouTube: Precast Barrier Test Video - Jan 2017  
<https://youtu.be/up6sMEeqfaU>



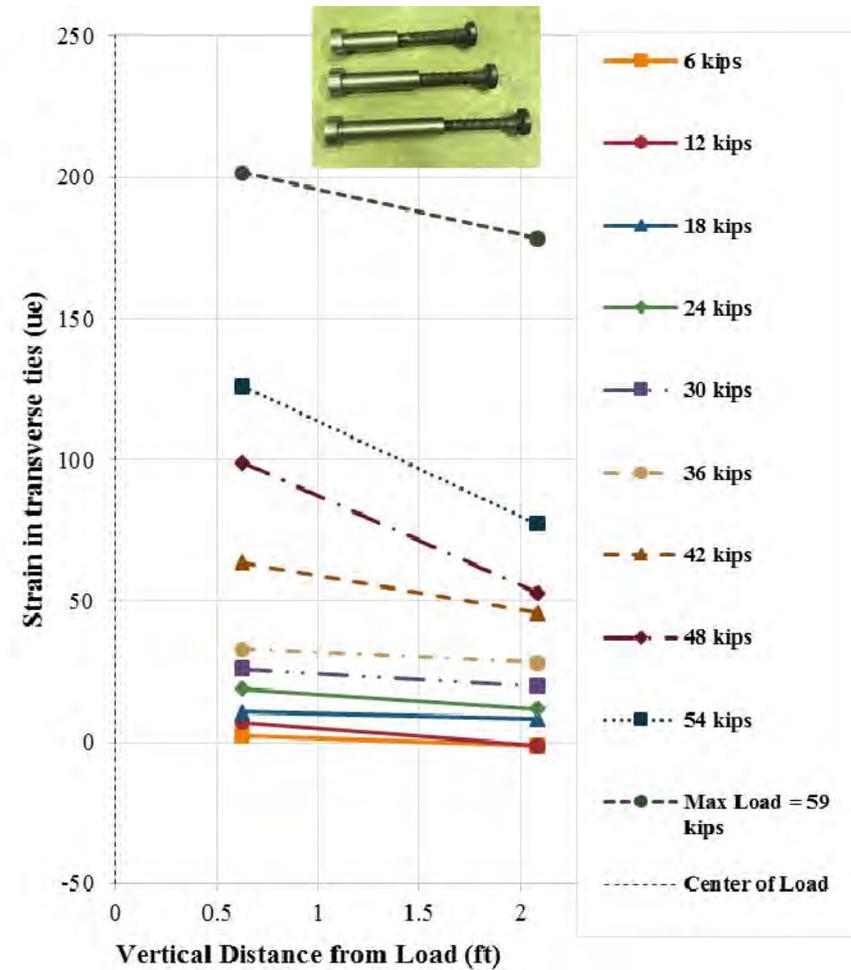
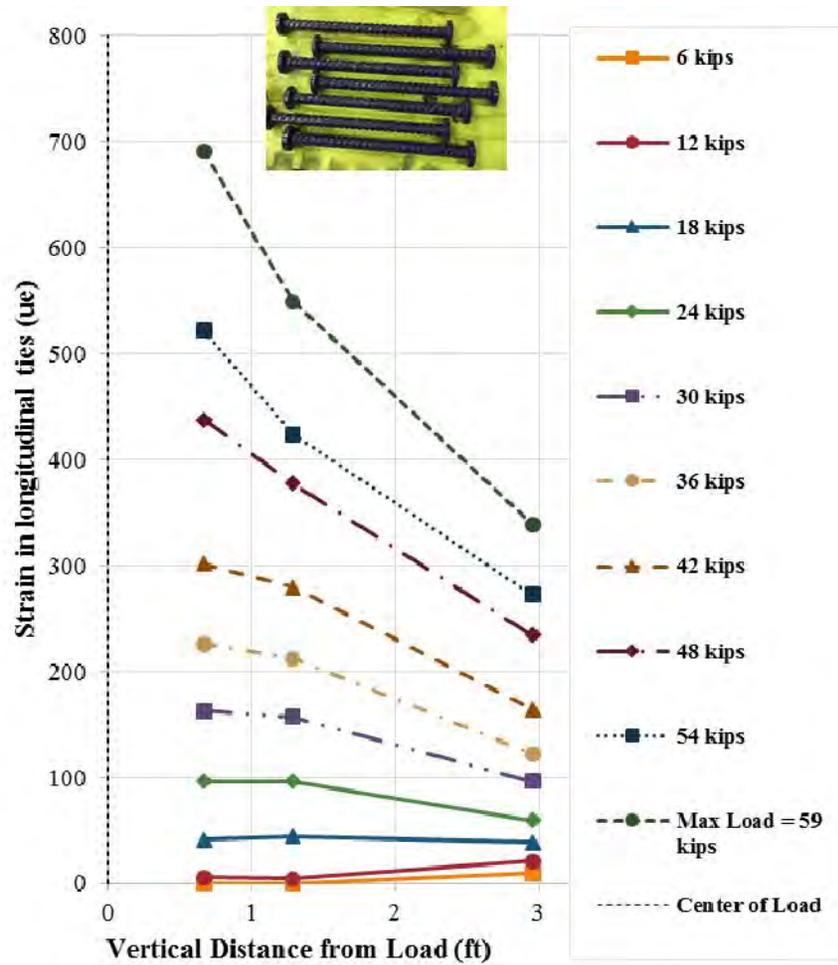
# Test 3 - Barrier to Barrier Connection



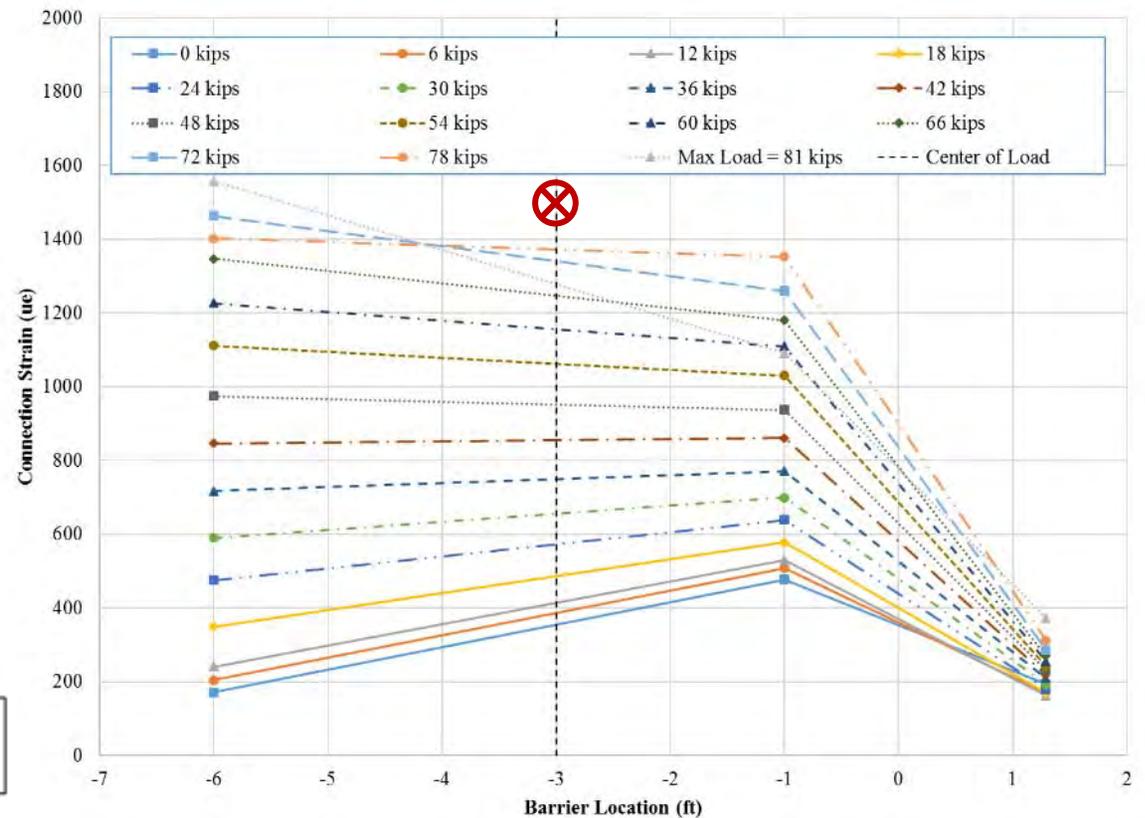
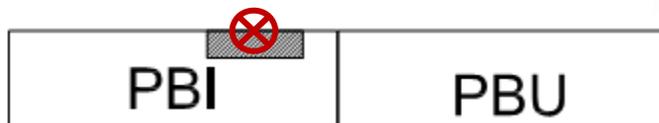
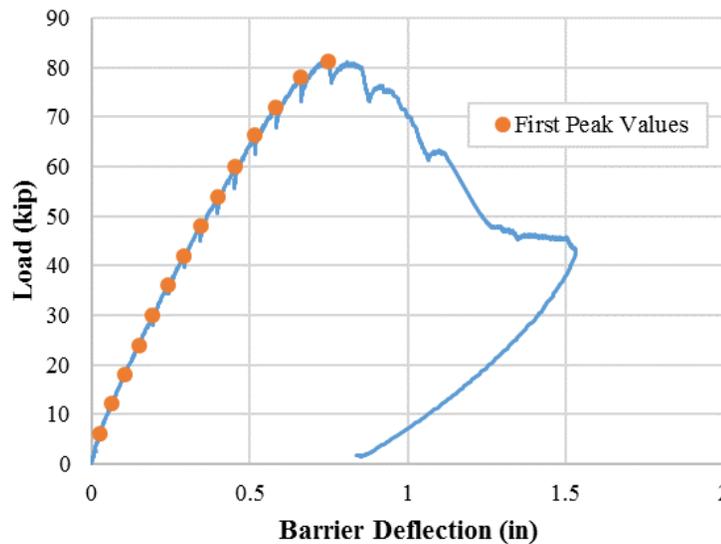
# Strain in Connection Rebar



# Barrier to Barrier Connection Strain



# Test 4 - Off-Center Barrier to Barrier Connection



# Progression of Damage



# End of Test



# Demolition



# Conclusions

- Use of precast barrier for ABC projects is very feasible
- Barrier-to-deck connections
  - PBI – performed as expected and remained elastic under design load
  - PBU – failed prematurely, but the detail can be improved
- Performance of Barrier-to-barrier connection was satisfactory
- All connections are fairly easy to accomplish in the field; PBI will facilitate easy replacement
- All connections are required to be verified under dynamic loads.

## Next Steps - Phase II

### Evaluation and Full Scale Testing of Concrete Fabricated Bridge Rails under Dynamic Loading

- **Lead Agency and Contact:**  
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**Phone: 515-239-1471**
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**Benjamin Beerman**  
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**Phone: 404-422-7209**
- **Committed Partners: FL, IA, NC, NJ, OH, OR, TX**
- **Solicitation Expires: July 7, 2017**
- **Commitments Required \$600,000.00**
- **Commitments Received \$420,000.00**

More details: <http://www.pooledfund.org/Details/Solicitation/1436>