Development of a Continuous for Live Load Prefabricated Steel Accelerated Bridge Construction (ABC) Unit for Texas Bridges

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Outline

1. Introduction
2. Full-Scale Experimental Program
3. Computational Modeling
4. Parametric Study
5. Current Findings

INTRODUCTION

Project Goal & Objectives

***Project Goal*: Develop a bridge system where prefabricated steel ABC units perform continuous for live load.**

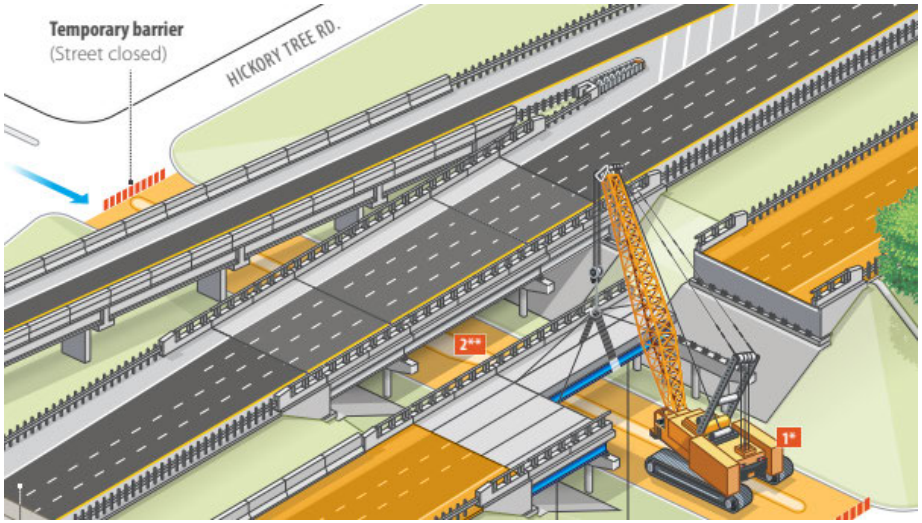
The objectives for this system are that it must be:

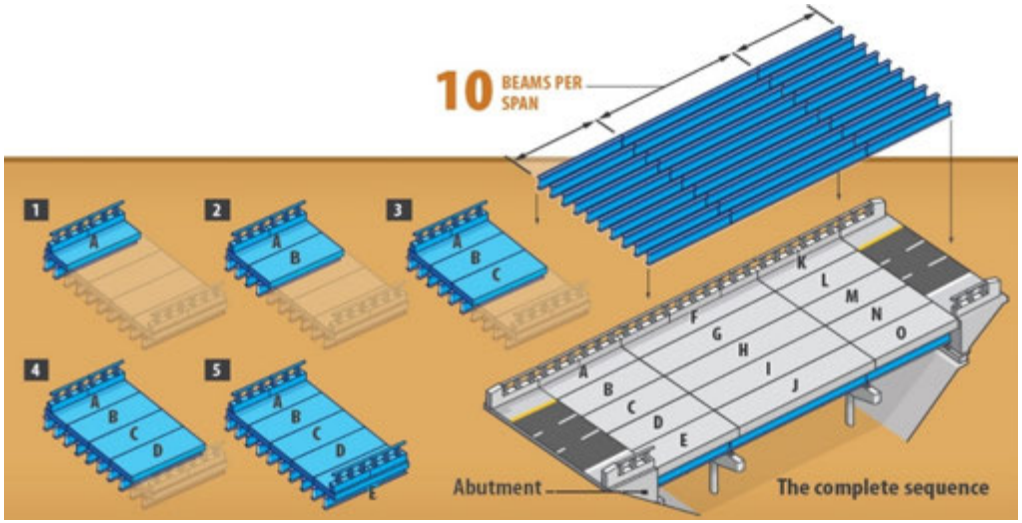
- *Easily constructible*
- *Fast to assemble*
- *Durable long-term*
- *Safe*
- *Cost-effective*

Research Background

IH 635 at Old Seagoville in Dallas, Texas

- Accelerated Bridge Construction

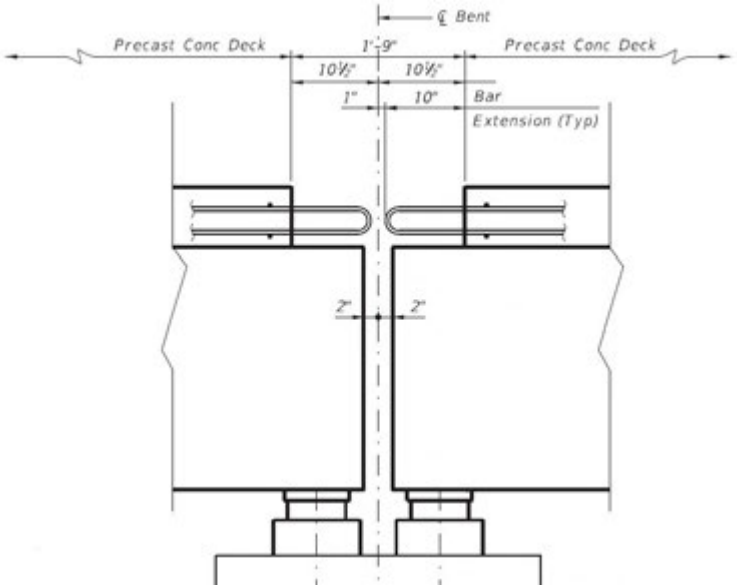




Research Background

IH 635 at Old Seagoville in Dallas, Texas

- Girder units simple span
- Continuous deck detail



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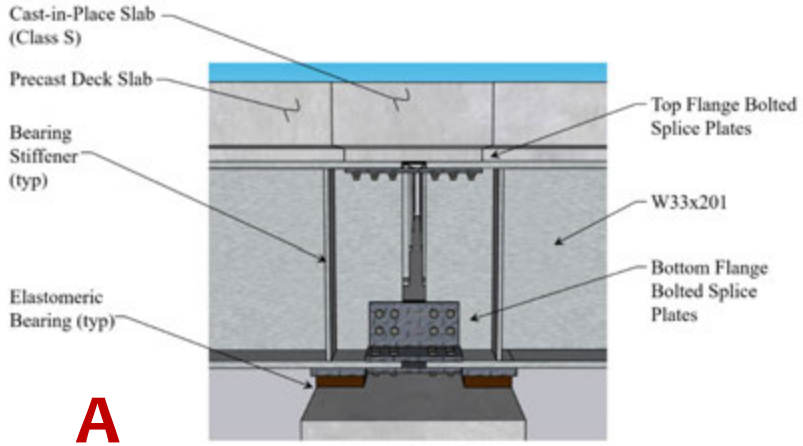
FULL-SCALE EXPERIMENTAL STUDIES

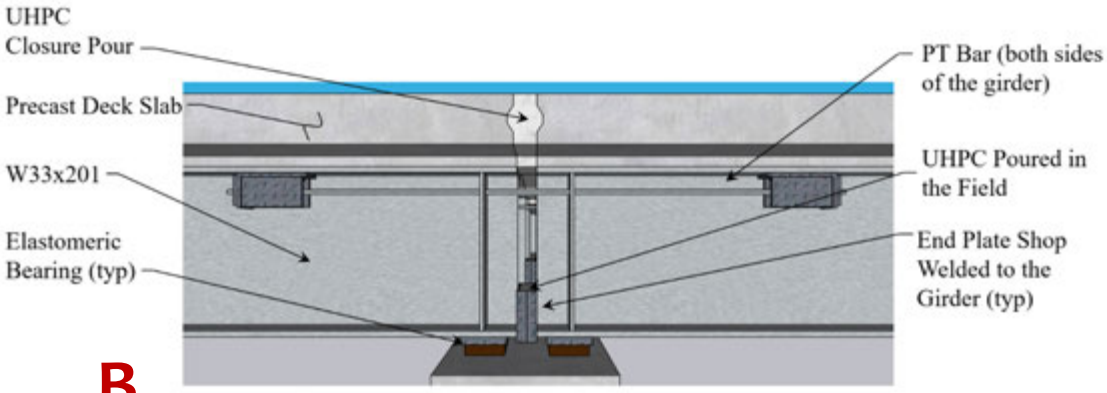
1. Concept A
2. Concept B
3. Concept C
4. Concept D

System Development



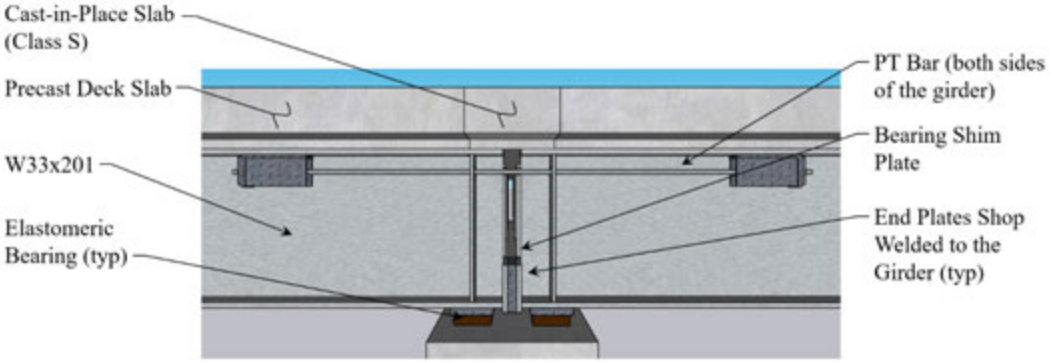
A

Bent Elevation



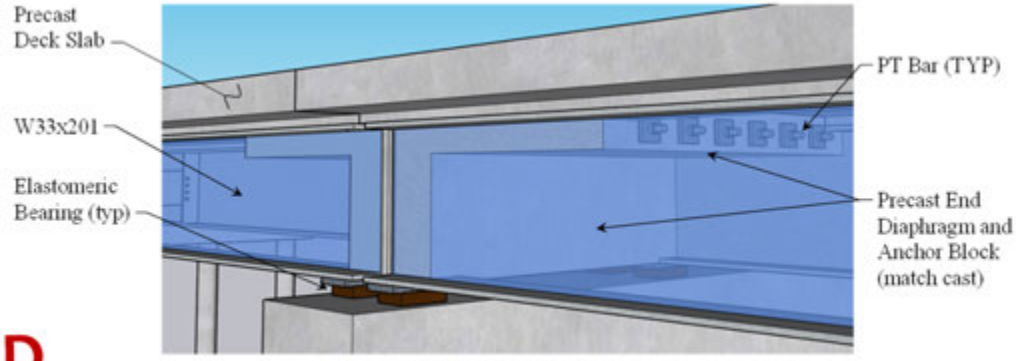
B

Bent Elevation



C

Bent Elevation



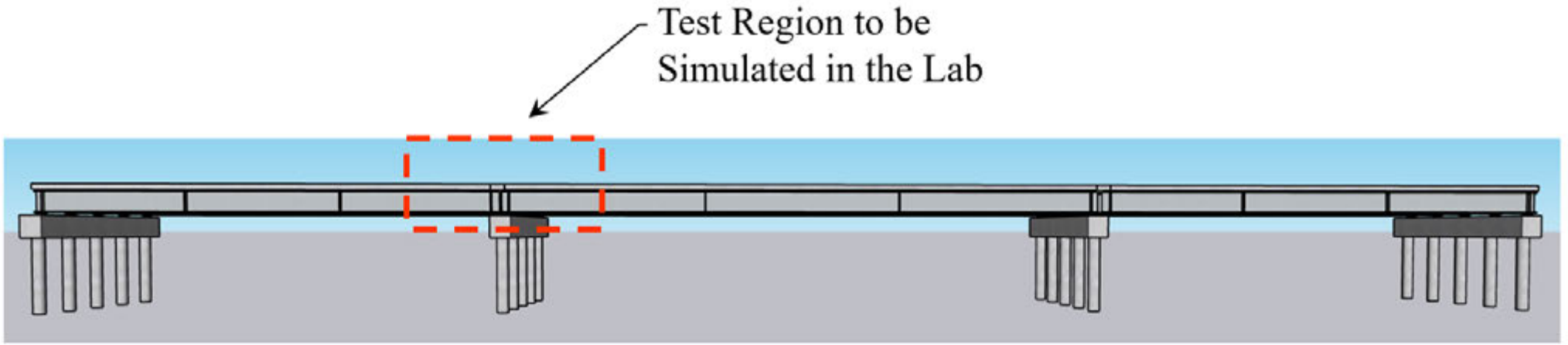
D

Bent Isometric View

Full-Scale Experimental Studies

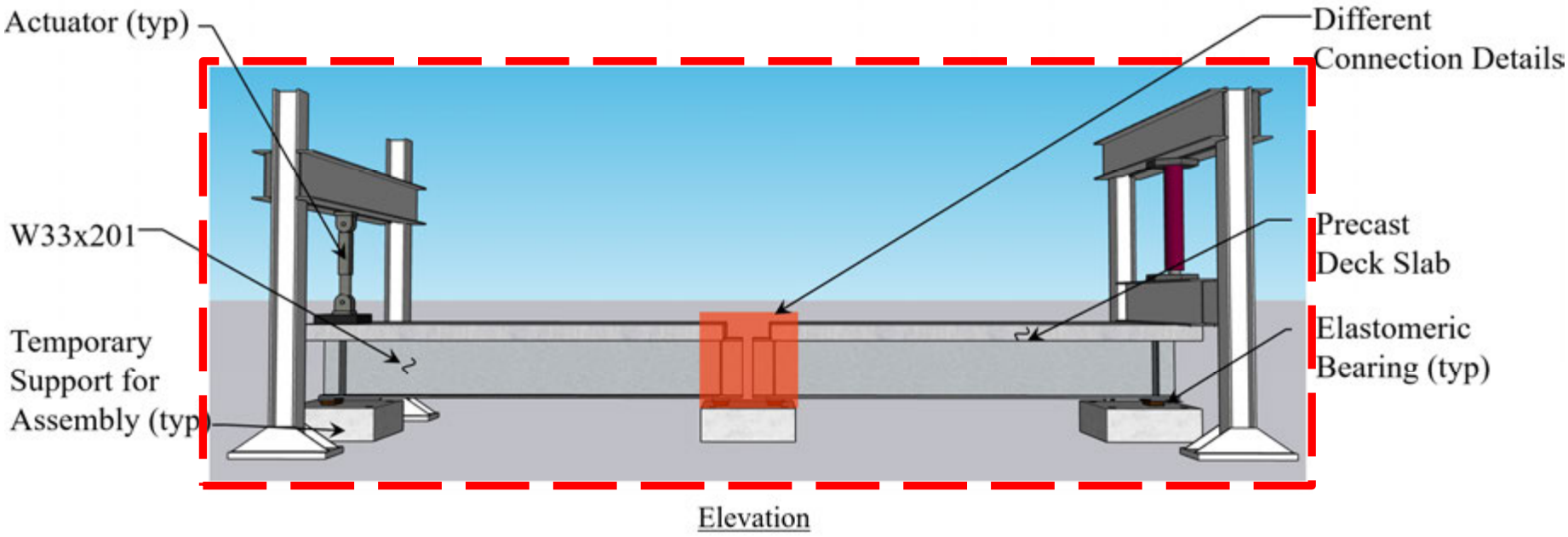
Approach

- Benchmark Bridge Design



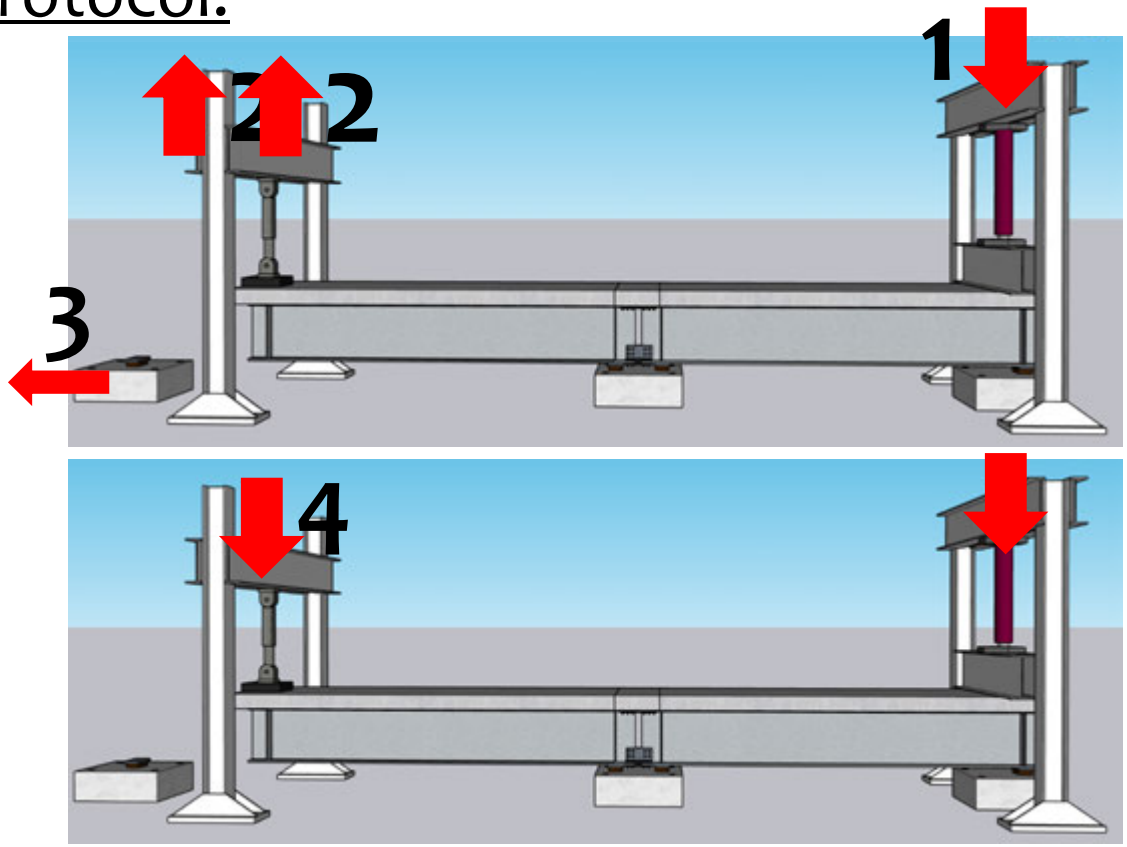
Full-Scale Experimental Studies

Laboratory Testing Setup



Full-Scale Experimental Studies

Concept Test Protocol:



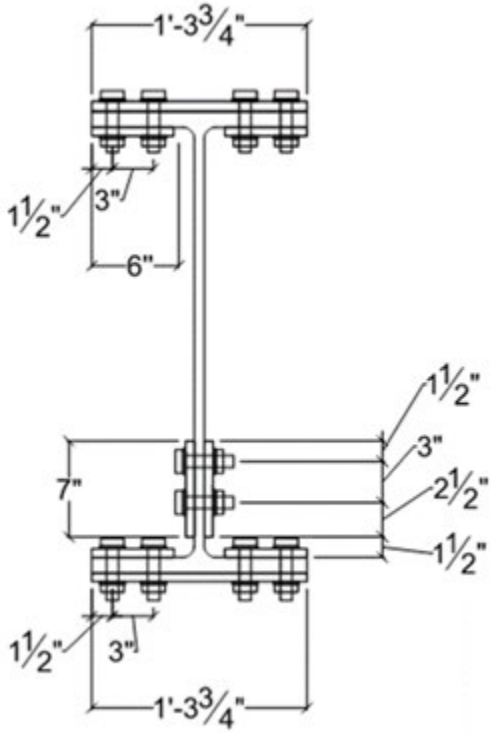
Full-Scale Experimental Studies

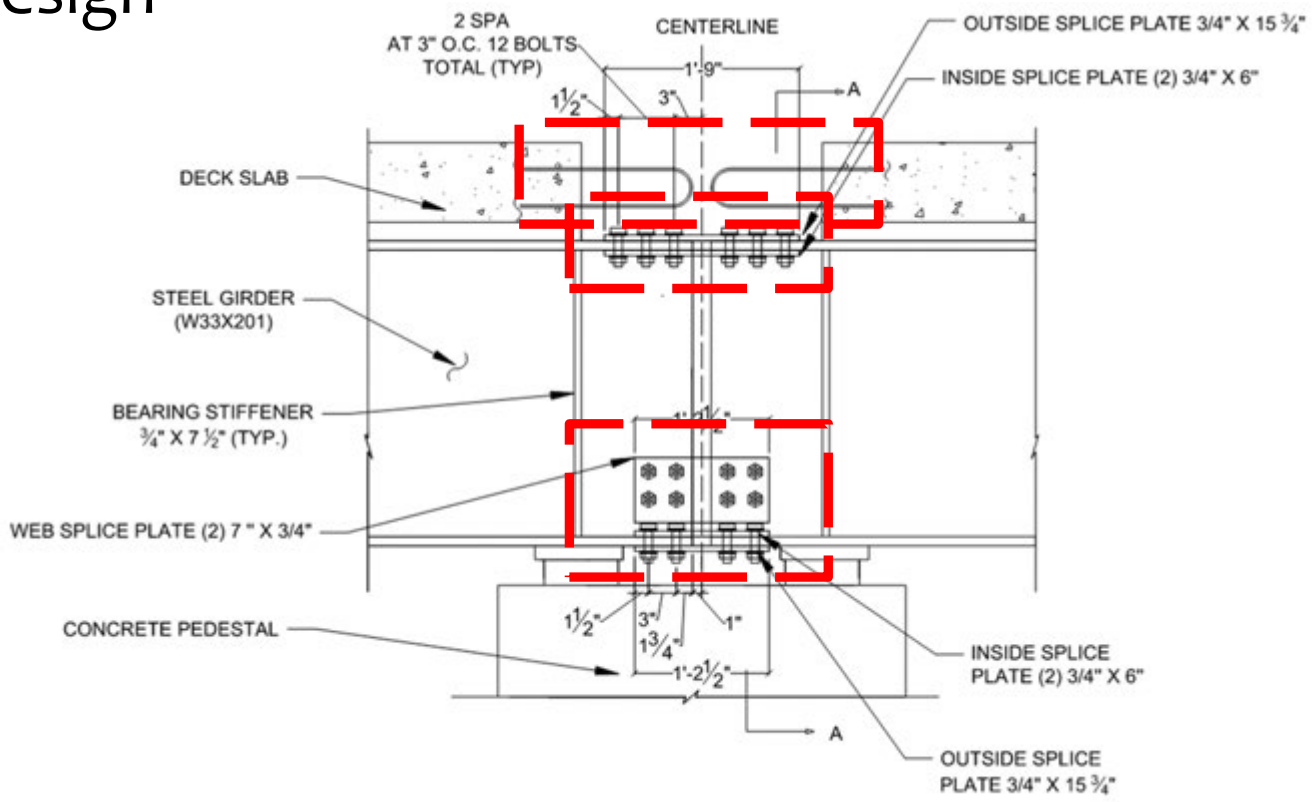
Loading (per Concept)

1. Static-level service loading - *Bending magnitude equivalent to HL-93 notional loading (28 kips from actuator)*
2. Dynamic level cyclic loading
3. Quasi-static ultimate strength testing

Full-Scale Experimental Studies

Concept A: Connection Design



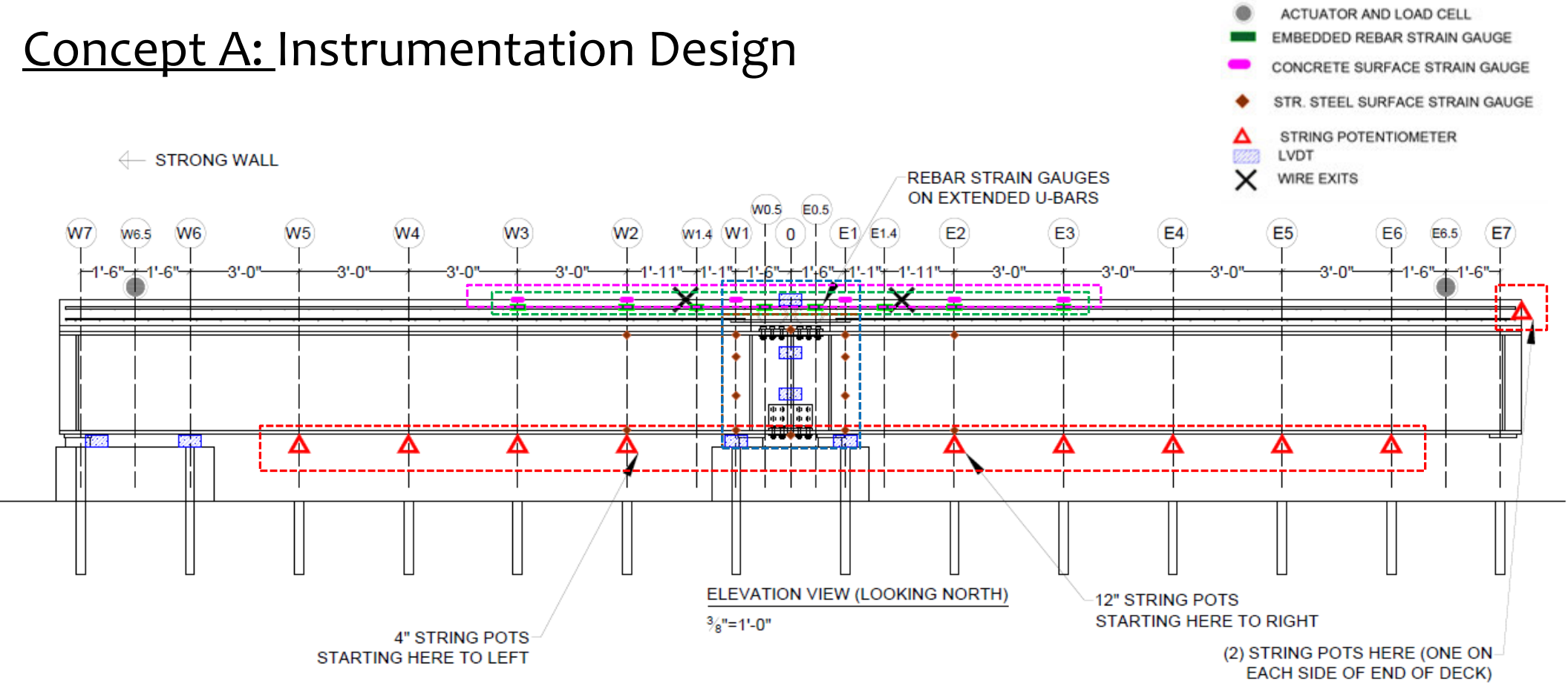


Full-Scale Experimental Studies

Concept A: Testing Setup

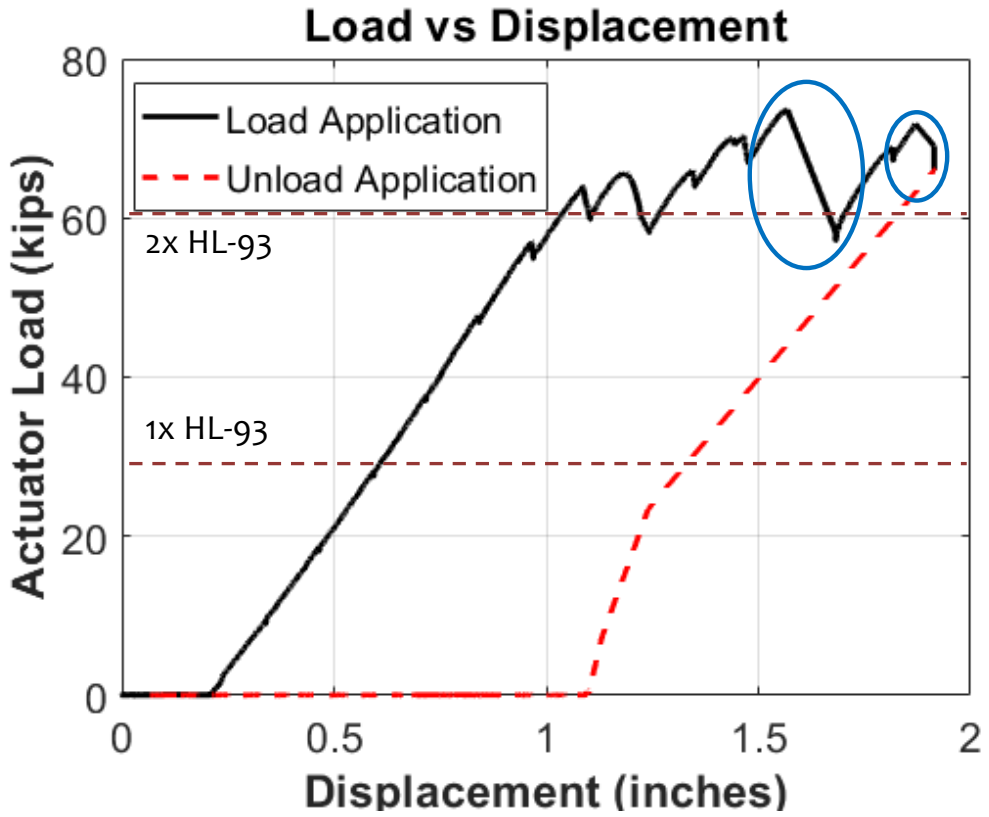
Full-Scale Experimental Studies

Concept A: Instrumentation Design



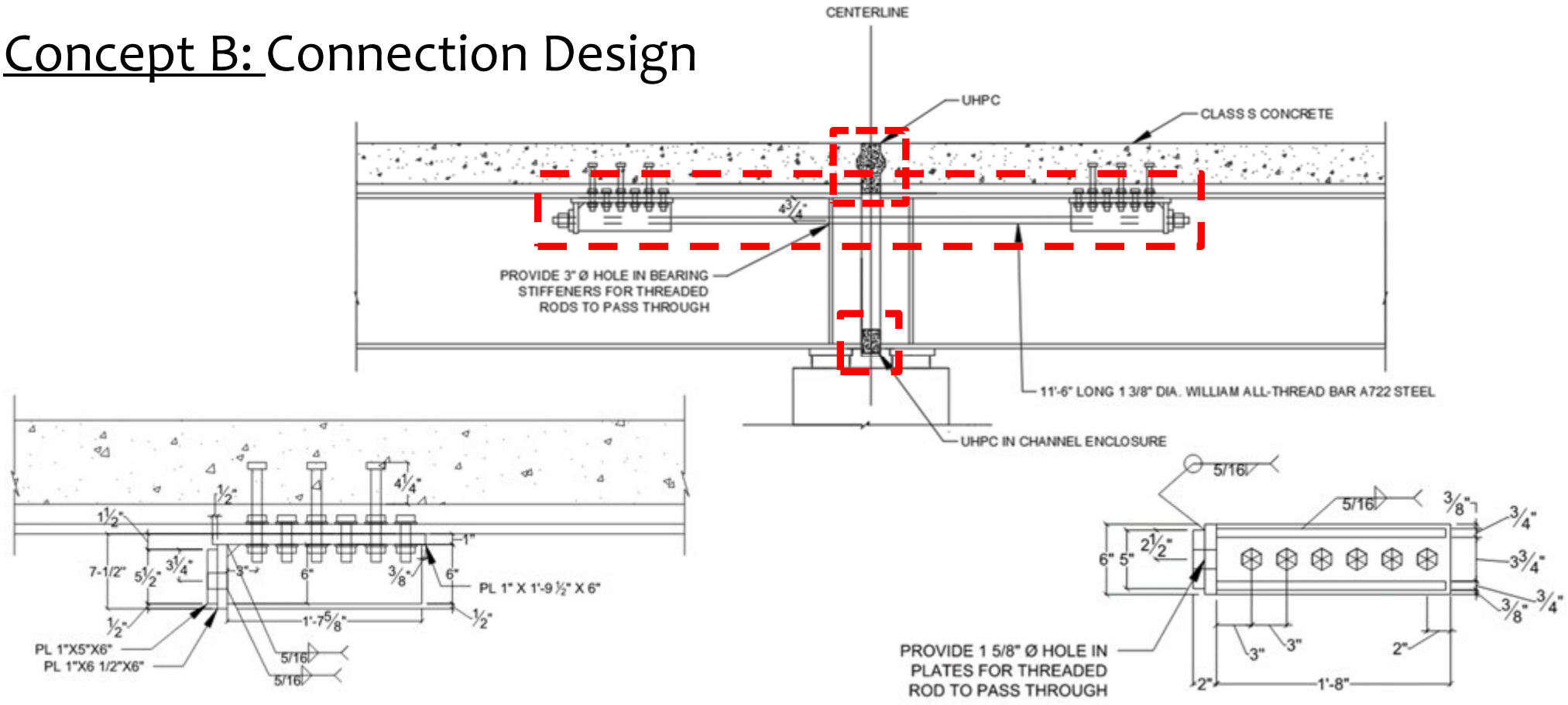
Full-Scale Experimental Studies

Concept A: Ultimate Test



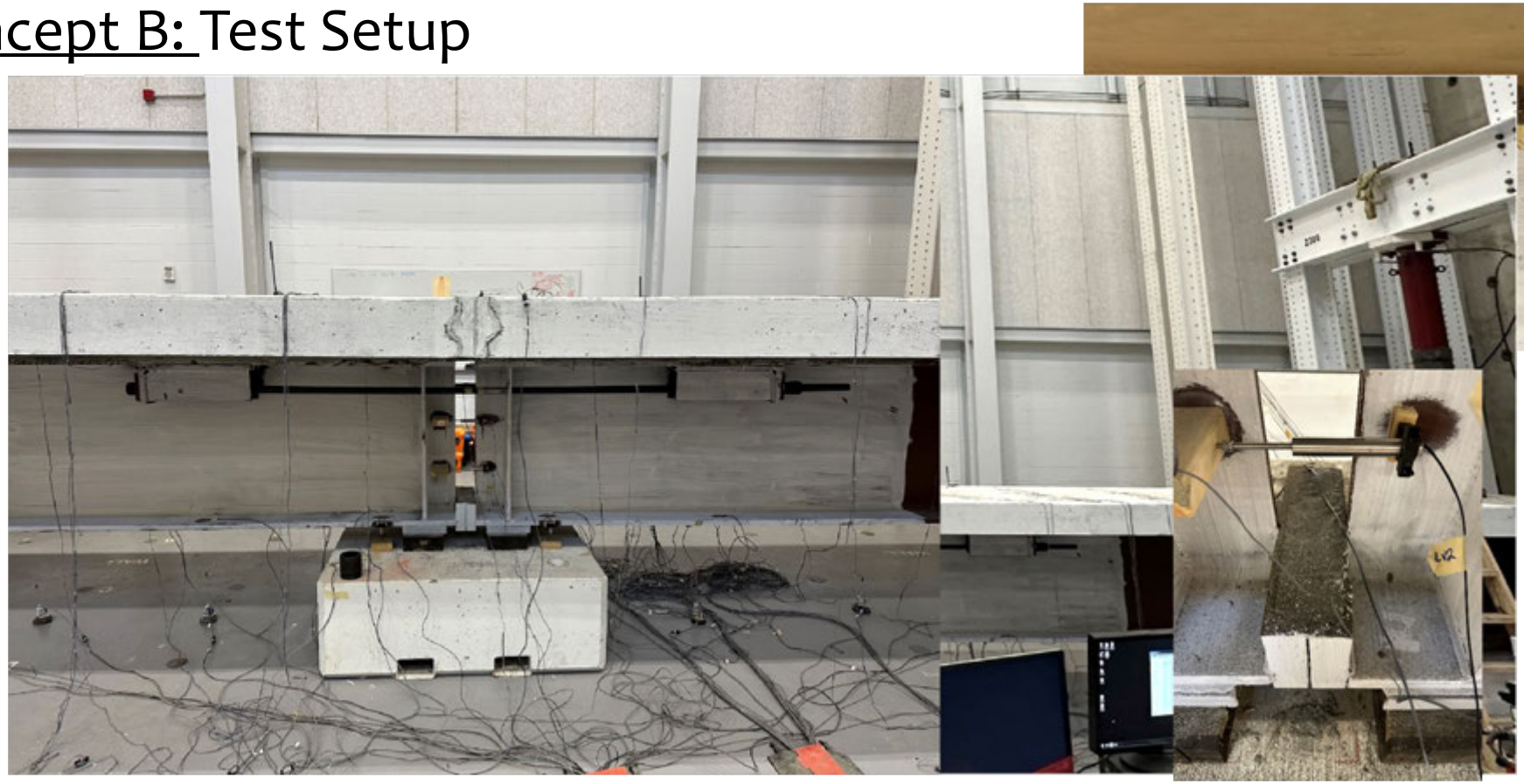
Full-Scale Experimental Studies

Concept B: Connection Design



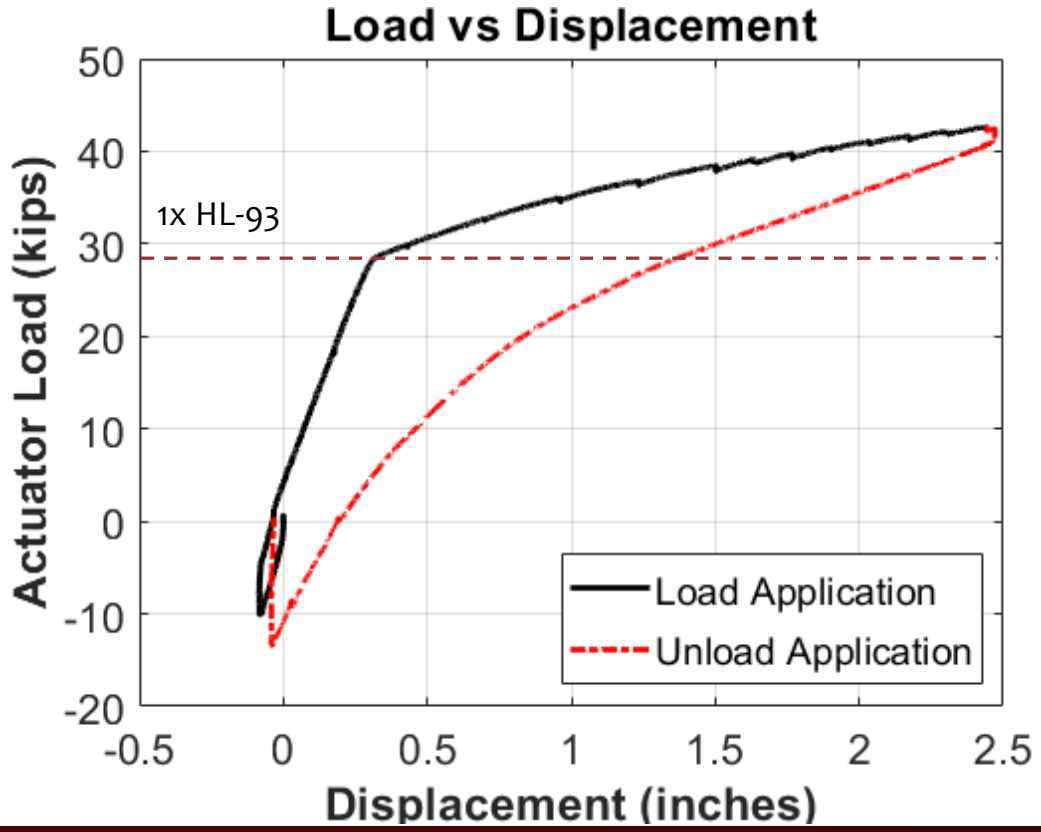
Full-Scale Experimental Studies

Concept B: Test Setup



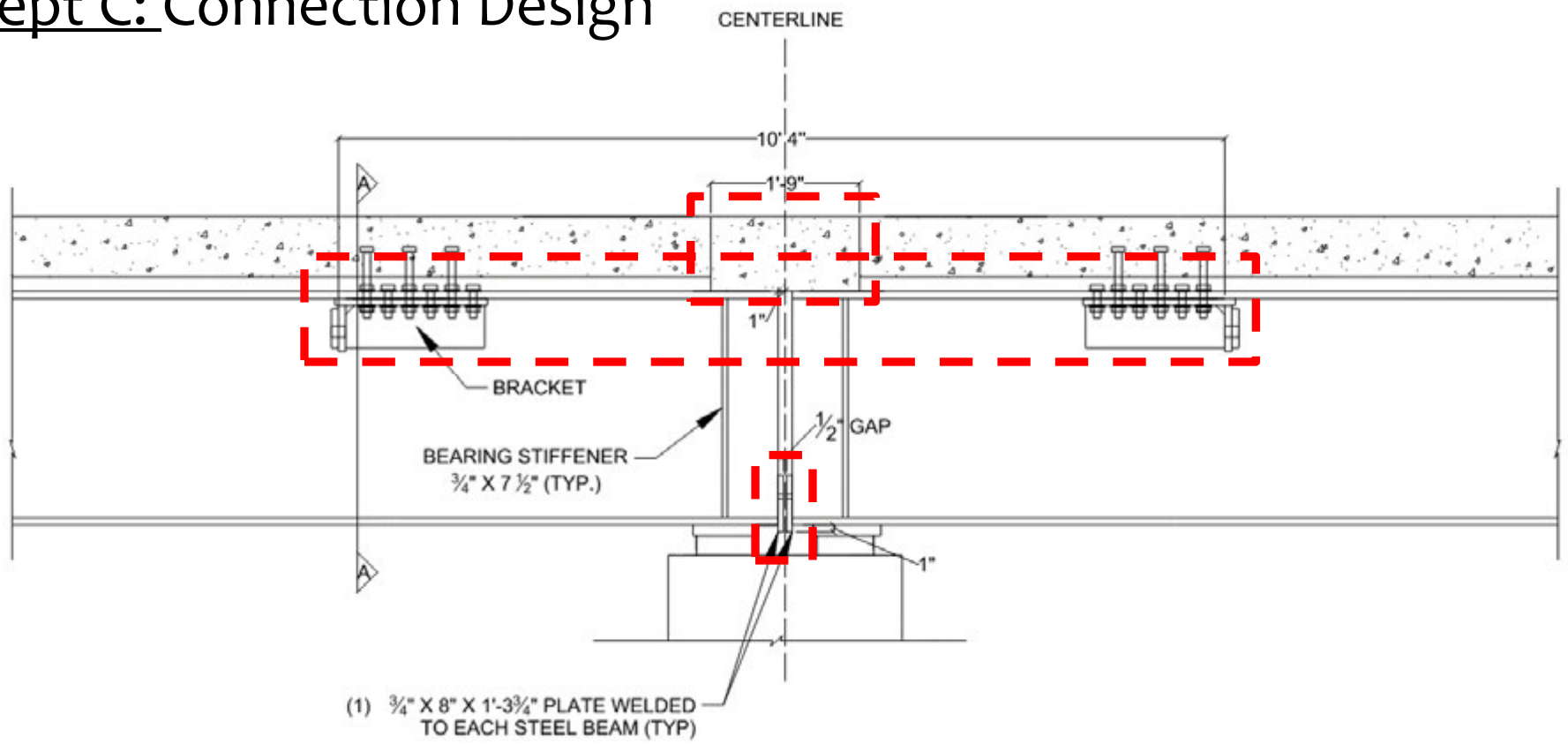
Full-Scale Experimental Studies

Concept B: Ultimate Test



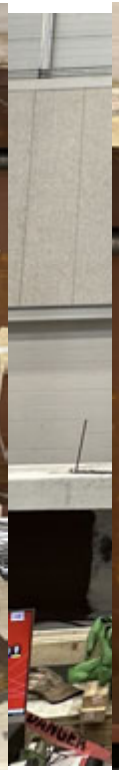
Full-Scale Experimental Studies

Concept C: Connection Design



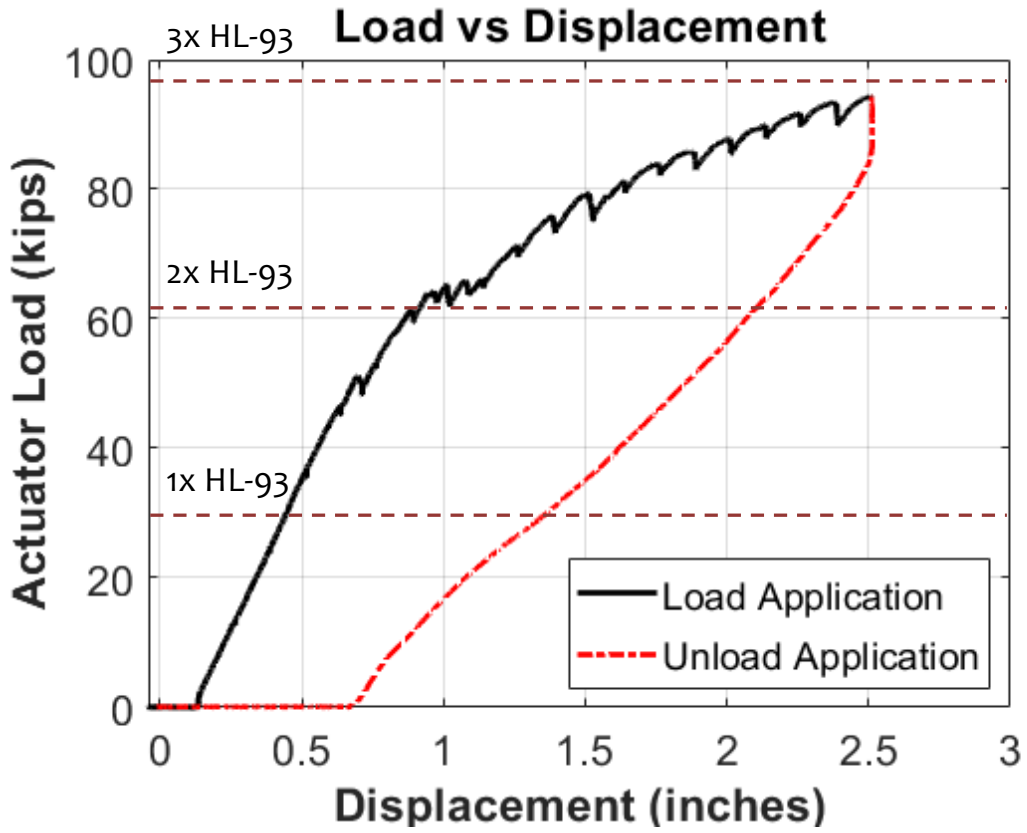
Full-Scale Experimental Studies

Concept C: Test Setup



Full-Scale Experimental Studies

Concept C: Ultimate Test



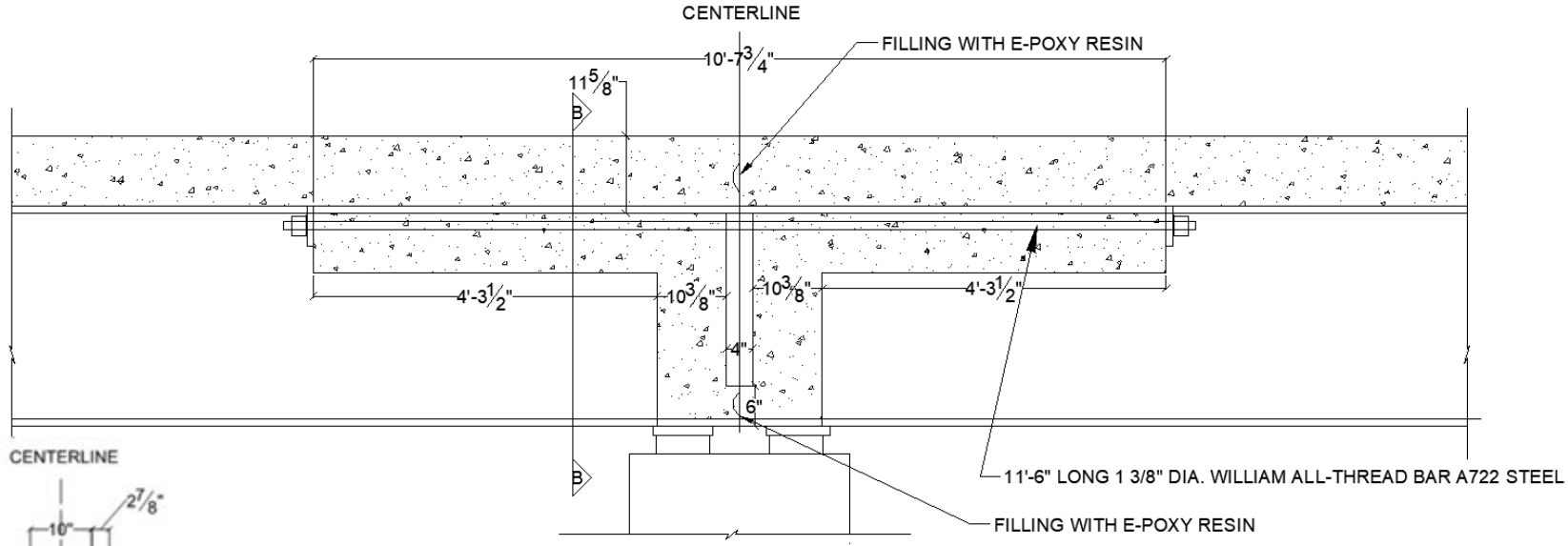
Full-Scale Experimental Studies

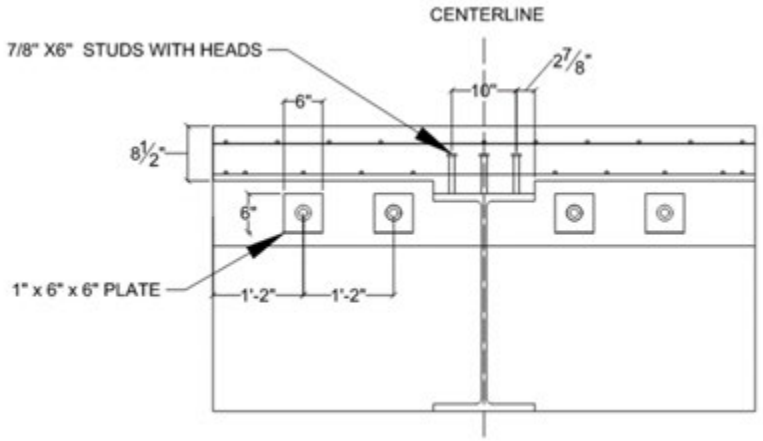
Concept A, B, C, and D: Cyclic Loading Tests

	Concept A	Concept B	Concept C	Concept D
Load Rate	1 Hz	1 Hz	1 Hz	0.25 Hz
Total cycles	430,000	125,000	514,800	154,800
Loading Range	+31kip to -13kip	+30kip to -15kip	+28kip to -10kip	+32kip to -10kip
Disp. Range	+0.4'' to -0.15''	+0.4'' to -0.15''	+0.3'' to -0.1''	+0.5'' to -0.1''

Full-Scale Experimental Studies

Concept D:



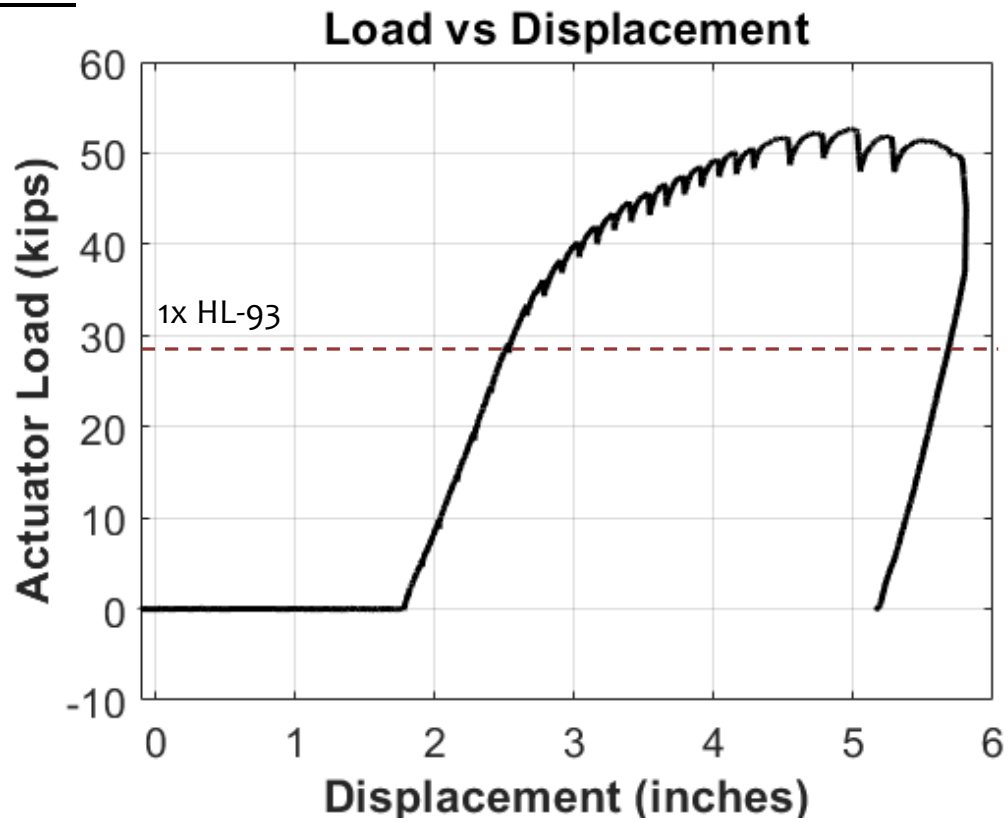


Full-Scale Experimental Studies

Concept D: Experimental Setup

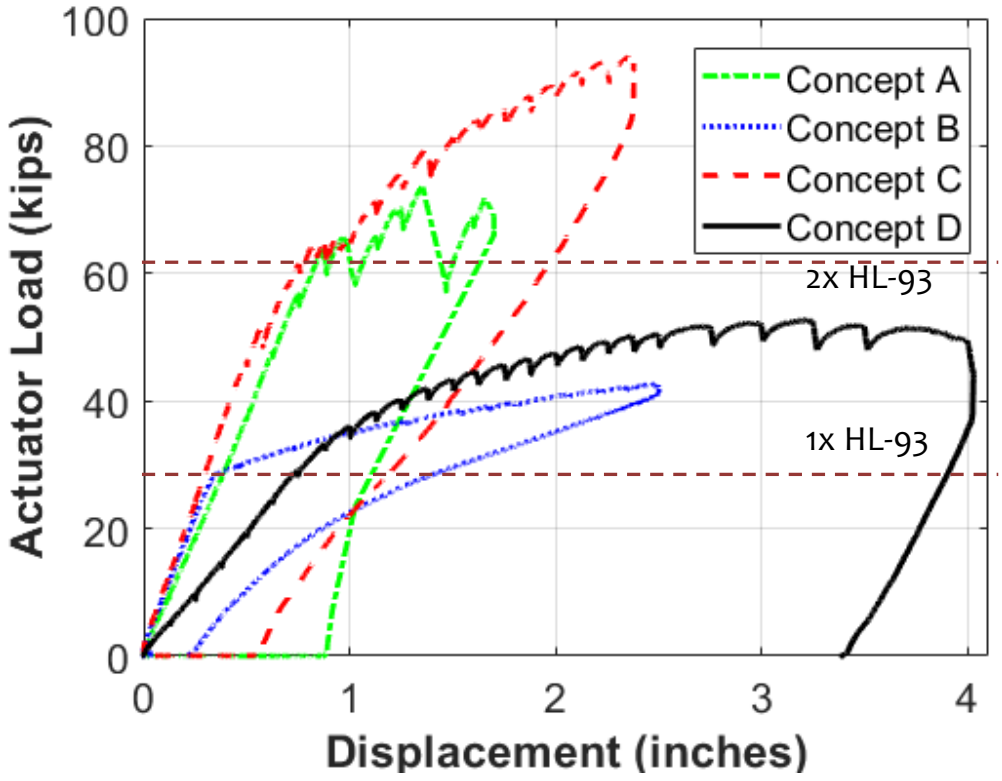
Full-Scale Experimental Studies

Concept D: Ultimate Test



Full-Scale Experimental Studies

Comparison:



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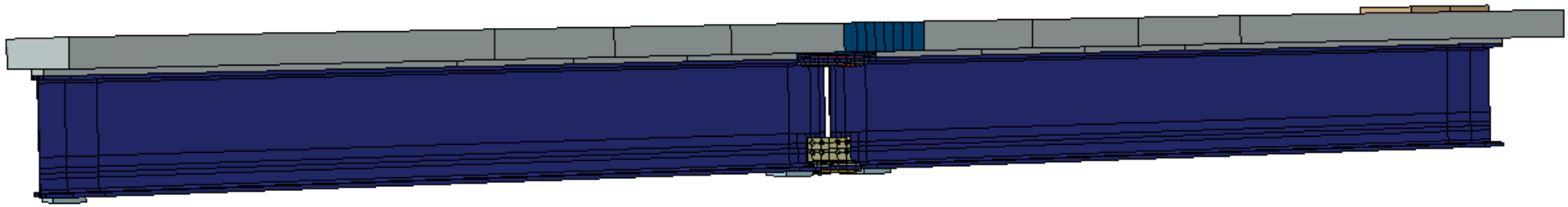
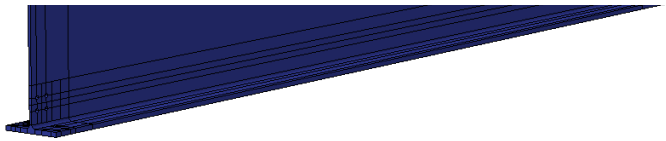
COMPUTATIONAL MODELING

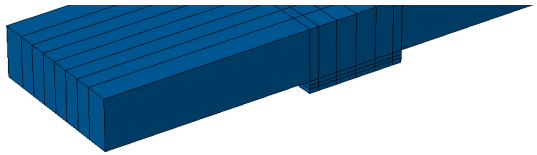
1. Test Setup Model Description
2. Model Validation with Experimental Results

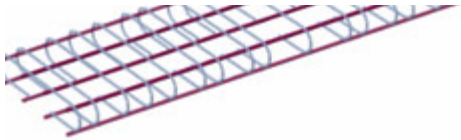
Computational Modeling

Concept A: Model description



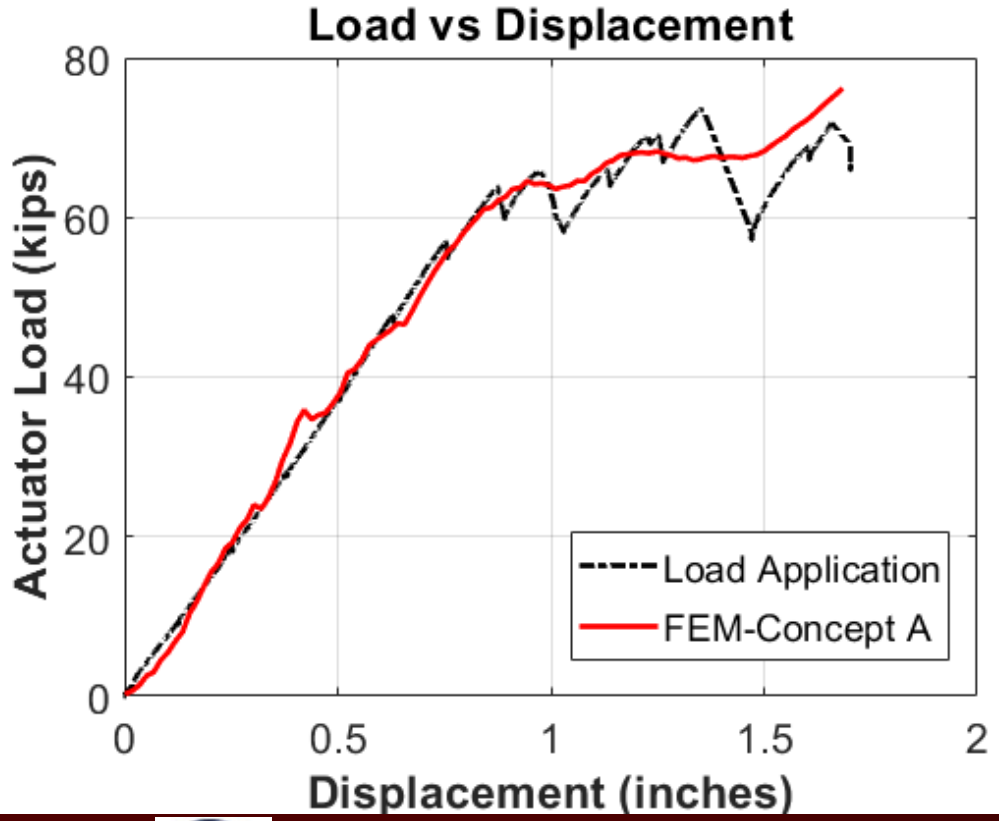






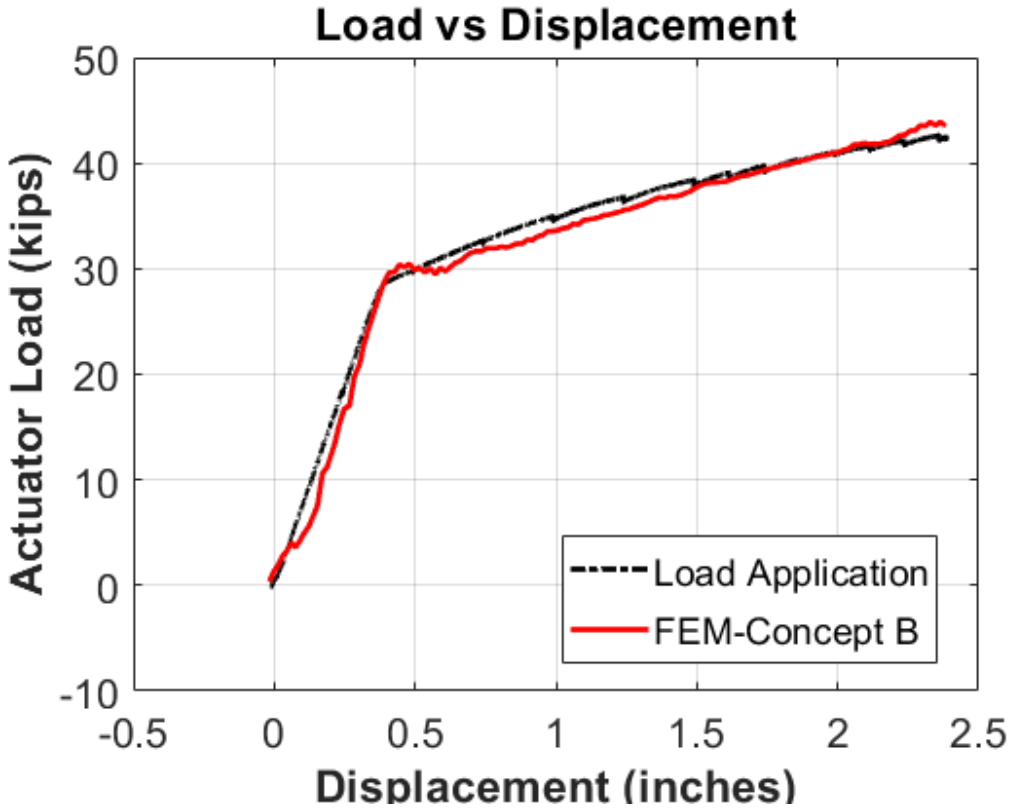
Computational Modeling

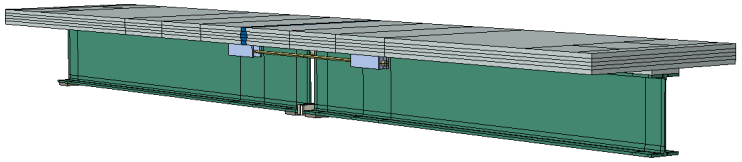
Concept A: Model validation with experimental results



Computational Modeling

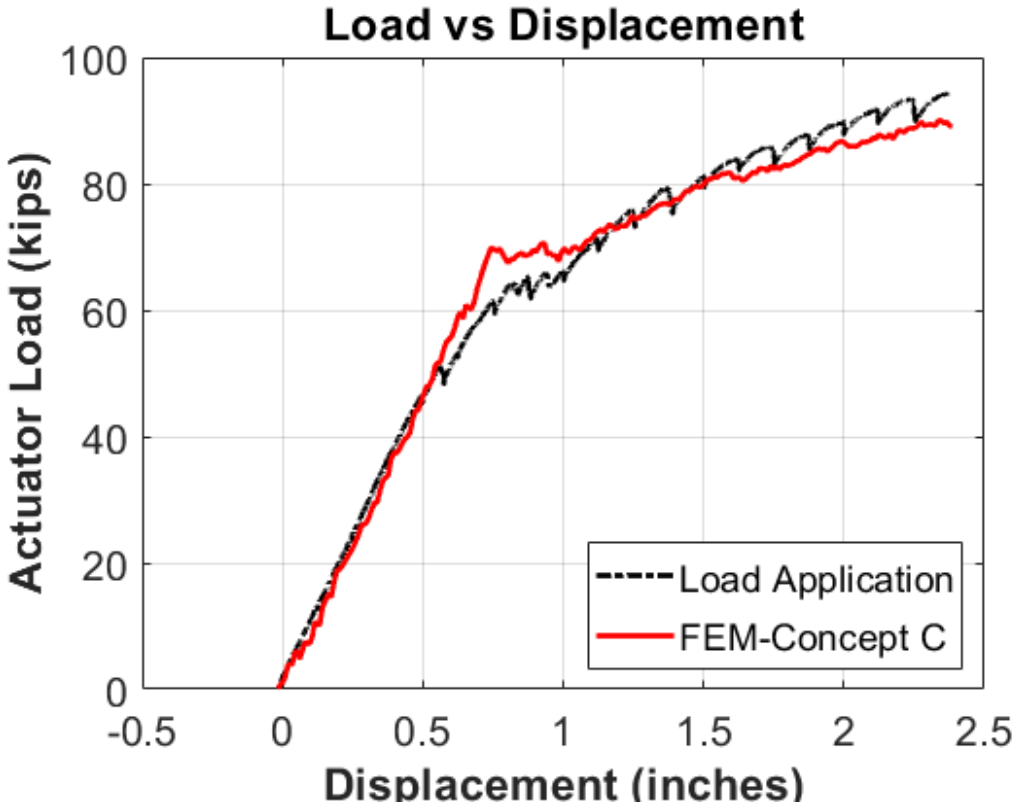
Concept B: Model validation with experimental results

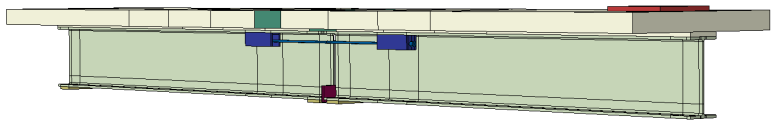




Computational Modeling

Concept C: Model validation with experimental results





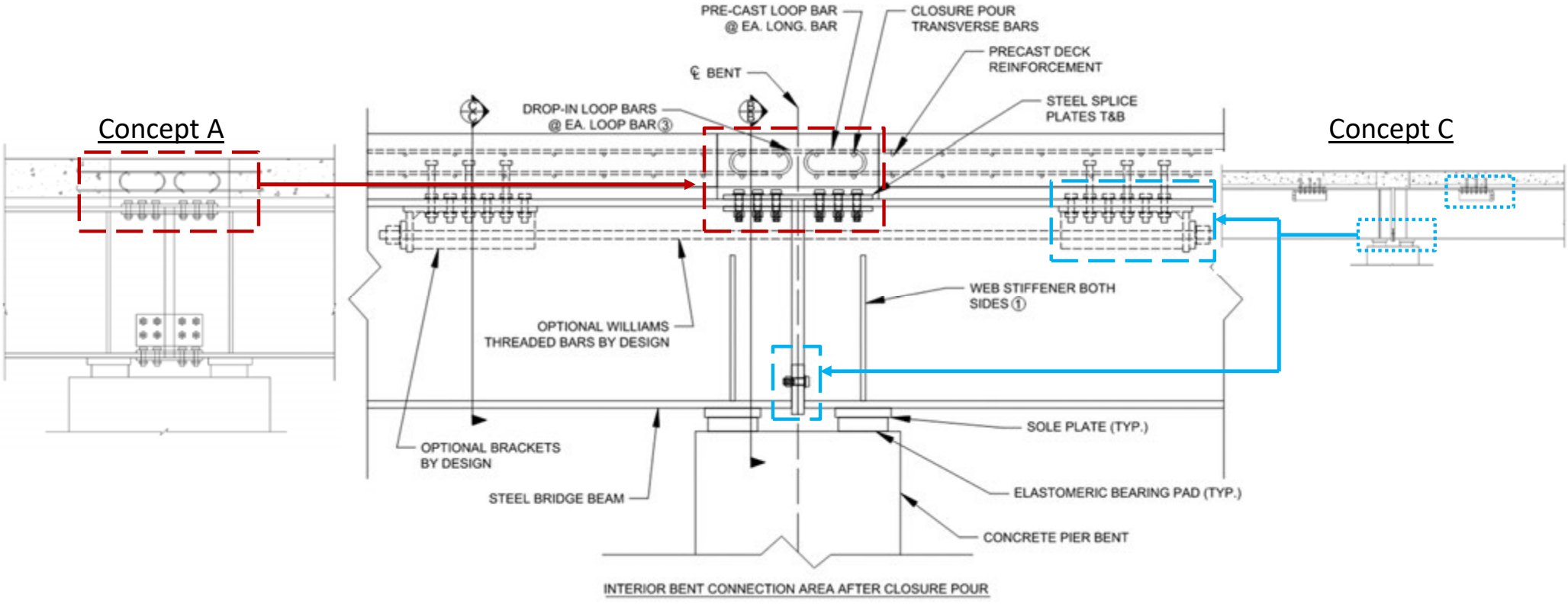
4

PARAMETRIC STUDY

Hybrid Concept Model (Post-Tensioning Optional)

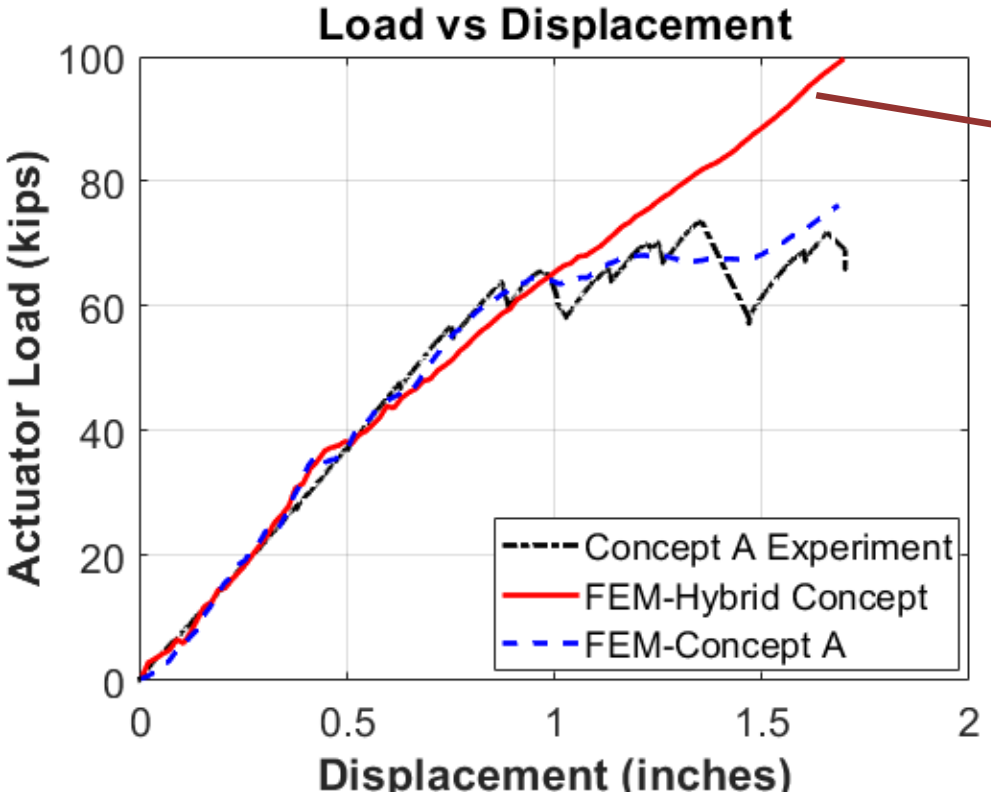
Computational Modeling Studies

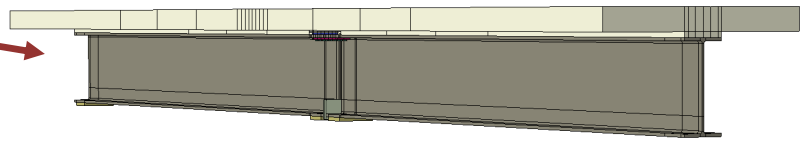
Hybrid Concept (Post-Tensioning Optional)



Computational Modeling Studies

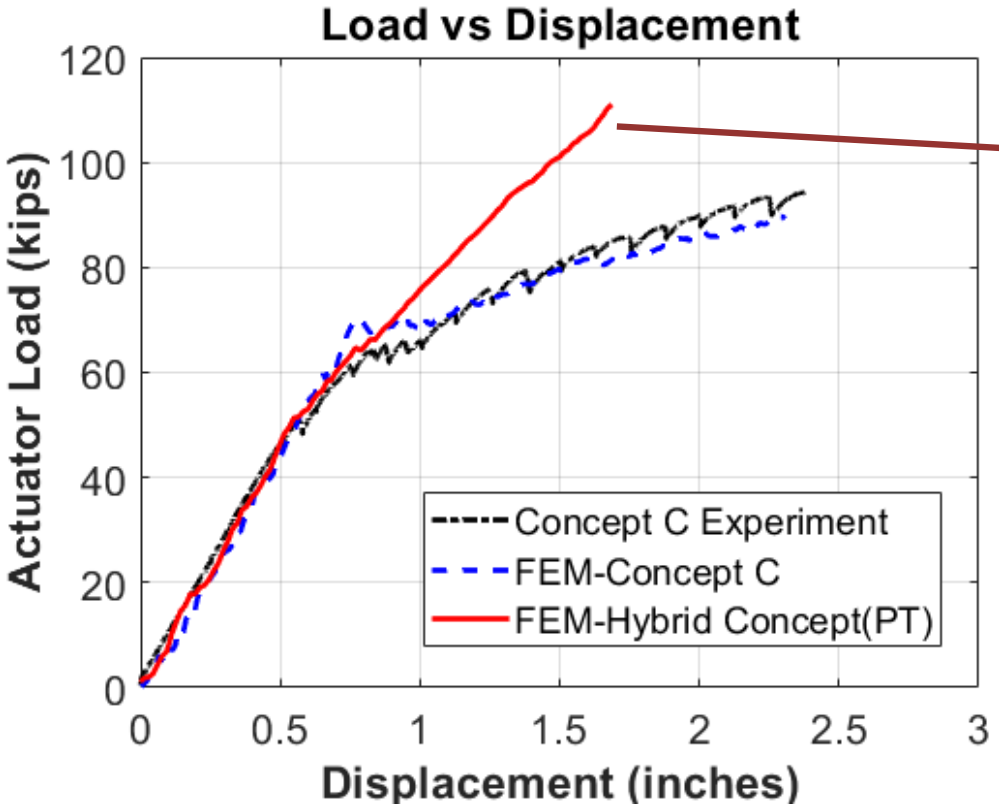
Hybrid Concept : Model results comparison

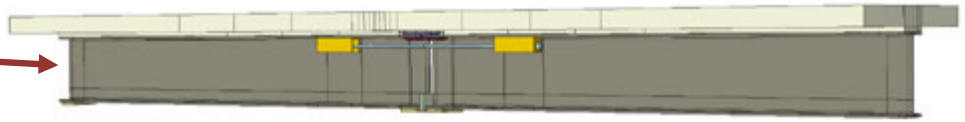




Computational Modeling Studies

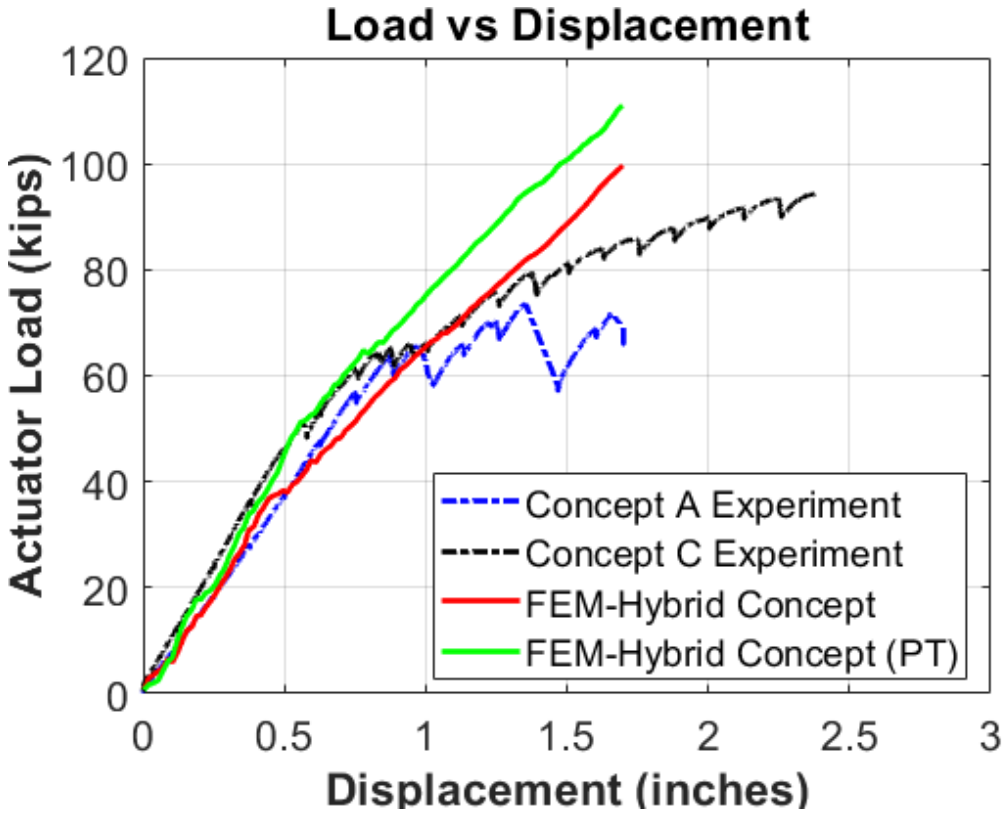
Hybrid Concept (PT): Model results comparison





Computational Modeling Studies

Hybrid Concept : Model results comparison



5

CURRENT FINDINGS

Current Findings

- The SDCL prefabricated ABC unit is a unique technique for bridge construction to
  - easily assemble precast units
  - reduce the construction time
  - decrease the construction-related cost.
- Experimental service level behavior was performed better than anticipated.
- Ultimate strength of Concept A and Concept C are adequate, which were above 200% of the equivalence HL-93 notional loading.

Current Findings

- Validated FE models effectively simulated overall structural behavior, and captured more information on the specimen performance during the load application.
- Analytic study identified :
  - Failure mechanism
  - Elastic behavior
  - Cracked behavior
  - Post-yield behavior
  - Patterns of damage
- Parametric study was conducted to develop the Concept A & C hybrid system based on each concept FE model.