

Development of Deck Replacement Systems for Historic Covered Bridges

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NRRI Mission

**"To enhance near-term
economic development of
Minnesota's natural resources
in an environmentally
responsible manner."**

Forestry/Forest Products works
with 150+ companies and
cooperators/year in Minnesota, the
Great Lakes region and throughout
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Objective

- The objective of this research is to develop a technical testing information that can provide engineering guidance for replacement of decks and flooring systems in existing historic covered bridges in manual form.

Rationale

- Floor systems of covered bridges are replaced due to deterioration, structural damage, or excessive wear after approximately 30 to 40 years of service.
- Often, the floor system controls a bridge's capacity and replacement presents a unique opportunity to upgrade the entire structural system.
- There are a wide variety of general replacement systems currently in use. These systems have seen very little change years of implementation, creating an opportunity to develop new replacement flooring systems that improve both the deck system and the overall structural performance. It is envisioned that this is most effectively completed through the use of lightweight systems.

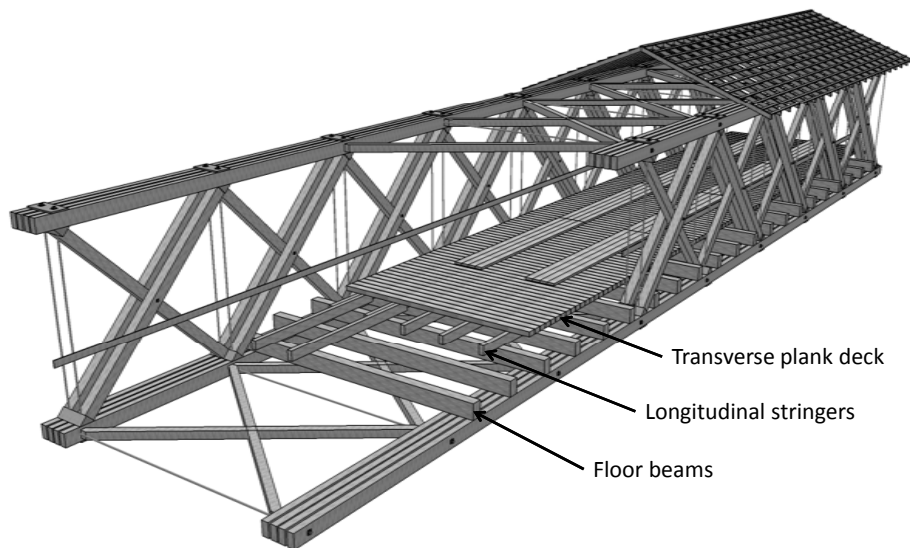
Project Activities

- Reviewed existing flooring systems
- Selected 3-4 promising designs (weight, historic implications, cost, constructability)
- Analyze designs for structural performance
- Acquire and construct promising designs
- Testing of designs (April - August 2013)
- Economic assessments and guidelines for designs (September - October 2013)
- Final Report (December 2013)

Floor Systems

- Floor systems are comprised of combinations of transverse beams, longitudinal beams, distribution beams, deck systems and running planks (All parts are not always included)
- Historically solid sawn lumber, but over time have transitioned to also include glulam beams and glulam decking

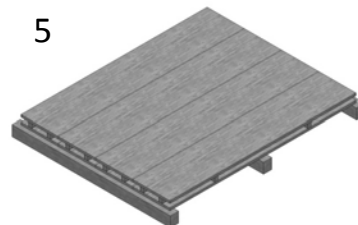
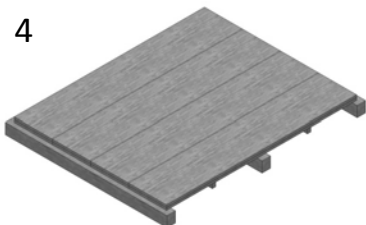
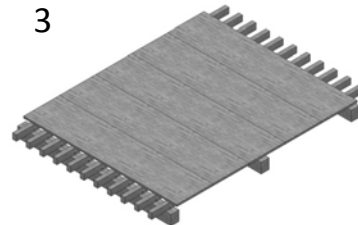
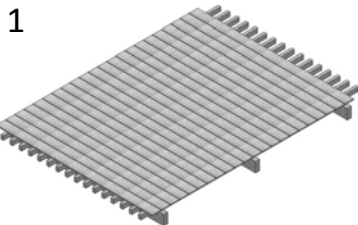
Floor Systems in Howe truss



Deck Designs for Assessment

1 is sawn lumber

3, 4, & 5 are glulam



General Design

- Douglas fir solid sawn timbers (Hull Oakes and Buse Lumber) and glulam panels/beams (Alamco)



Construction and Testing at FPL

- 3-4 alternatives will be constructed at full scale (about 15 ft. wide and 30 ft. long)
- Strains and deflections will be measured at increasing load levels
- Repeated loading can be investigated for critical parts



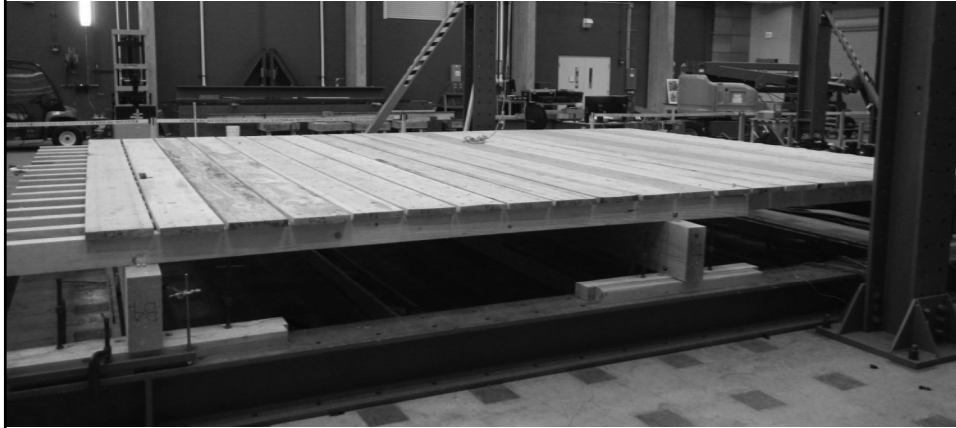
Dynamic MOE Estimation



Static MOE Testing



Construction



Construction



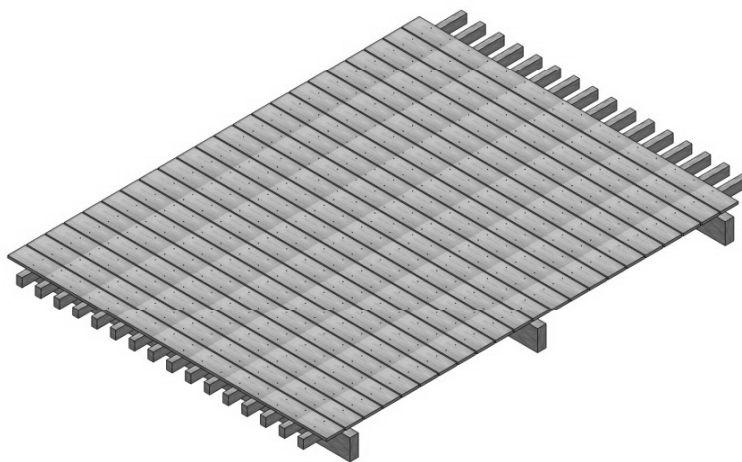
Threaded timber fasteners – donated by:



FPL Testing Deck 1A

May 6-7, 2013

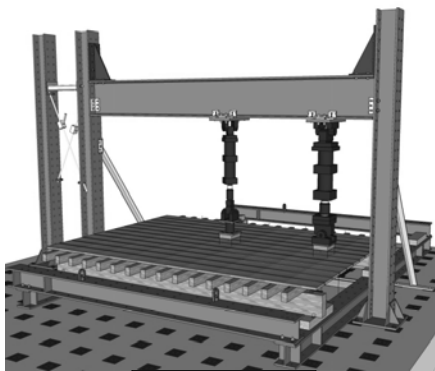
Solid Sawn Control – 1A



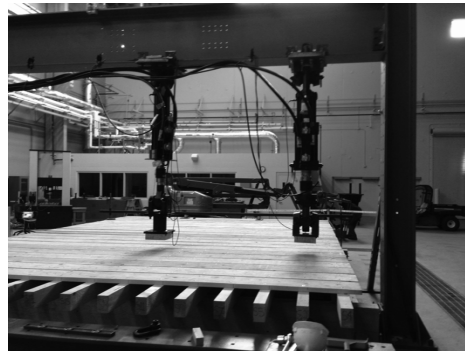
Control Design Specifications

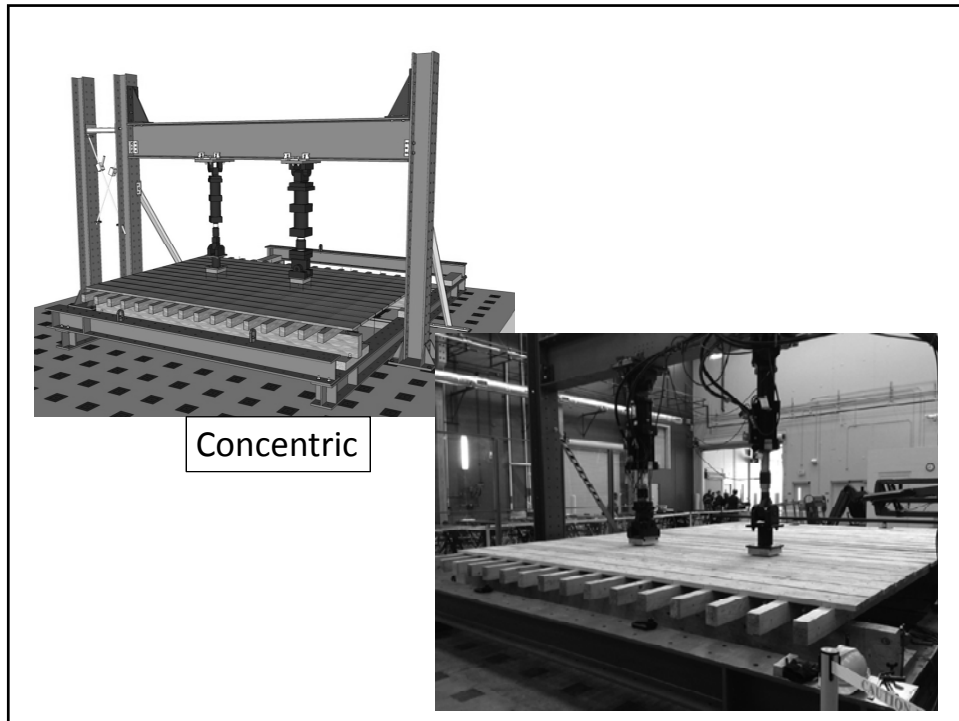
Douglas fir	2.5 Ton Load	5.0 Ton Load
Floor Beams	Dense #1 5.5 in. x 13.25 in. x 17 ft	Dense #1 5.5 in. x 13.25 in. x 17 ft
Longitudinal Stringers	No. 1 & Btr 3.5 in. x 5.5 in. x 14 ft	No. 1 & Btr 3.5 in. x 7.25 in. x 14 ft
Deck Planking	No. 1 & Btr 1.5 in. x 11.25 in x 16 ft	No. 1 & Btr 1.5 in. x 11.25 in x 16 ft
Fasteners	Self-tapping threaded timber fasteners	Self-tapping threaded timber fasteners
Weight	10.2 lbs/ft ³	11.8 lbs/ft ³

Loading positions

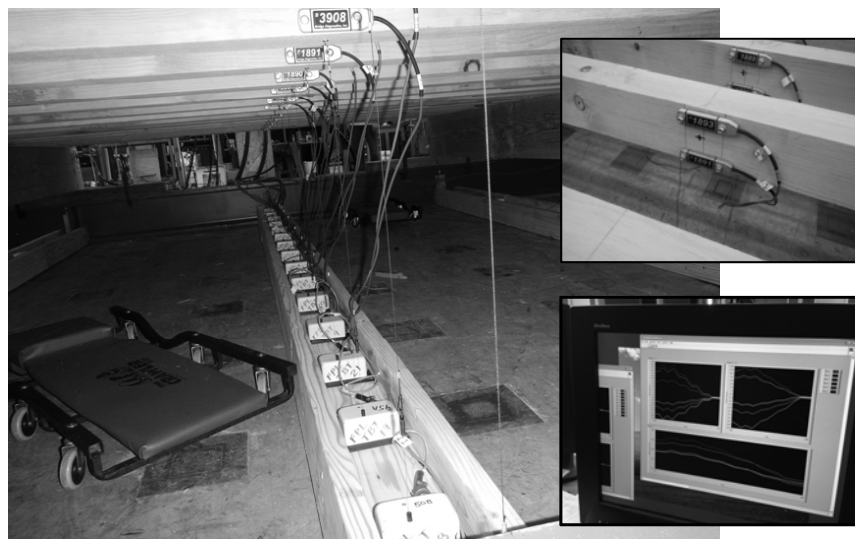


Eccentric

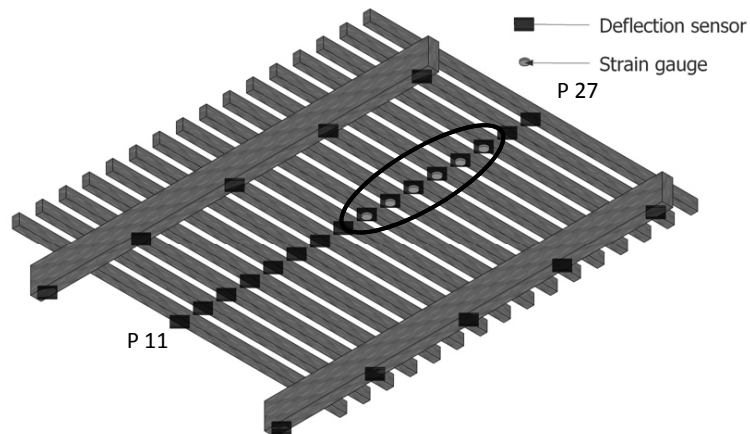




Displacement and Strain Sensors



Deflection and Strain Instrumentation Layout



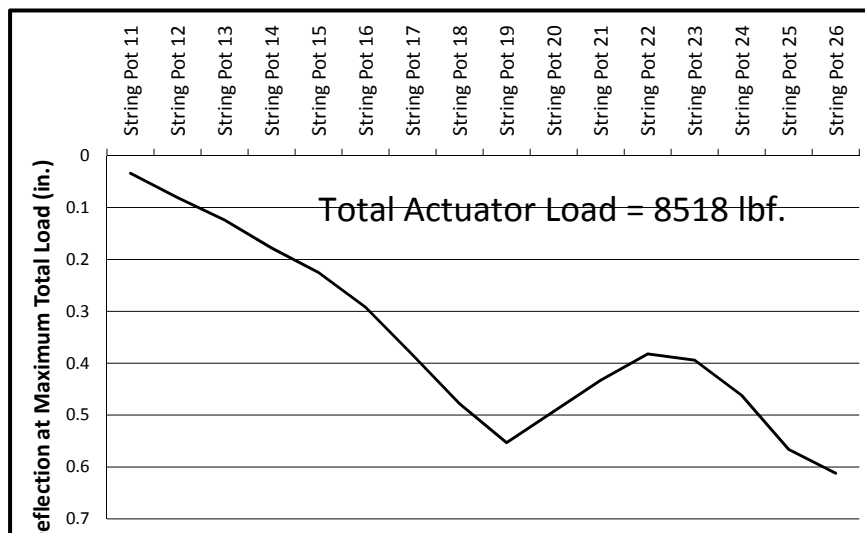


Testing Summary – 1A

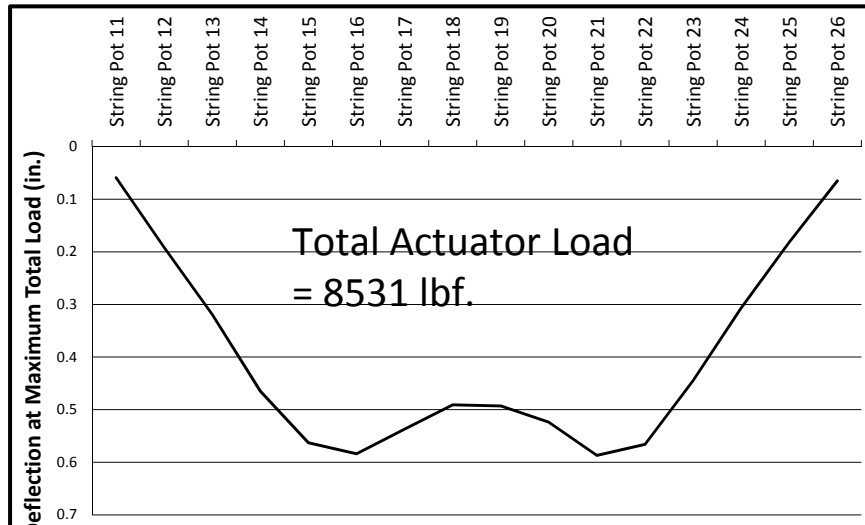
Design Load	2.5 Ton (4,200 lb/actuator)
Expected Deflection at DL	0.576 inches
Deflection at DL	0.584 inches
Maximum Load	41,000+ lb
Comments	Testing halted prior to complete failure on 1A, some failures noted in longitudinal stringers



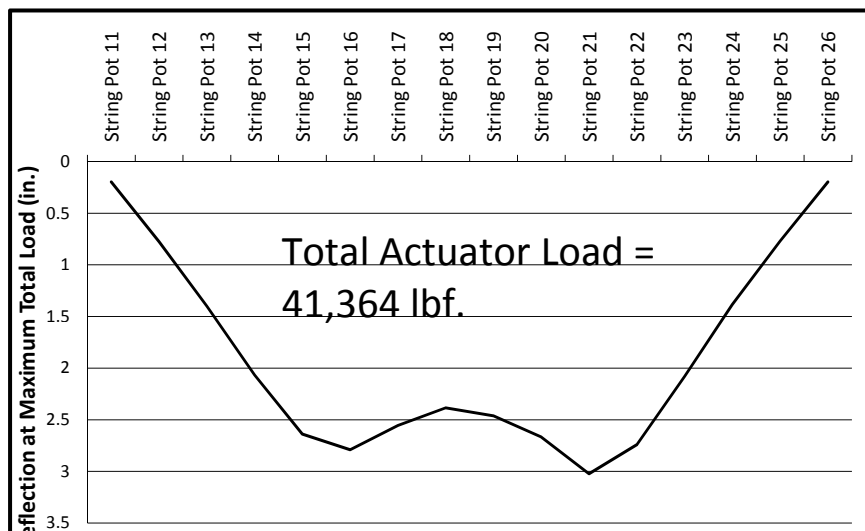
1A – Eccentric Loading

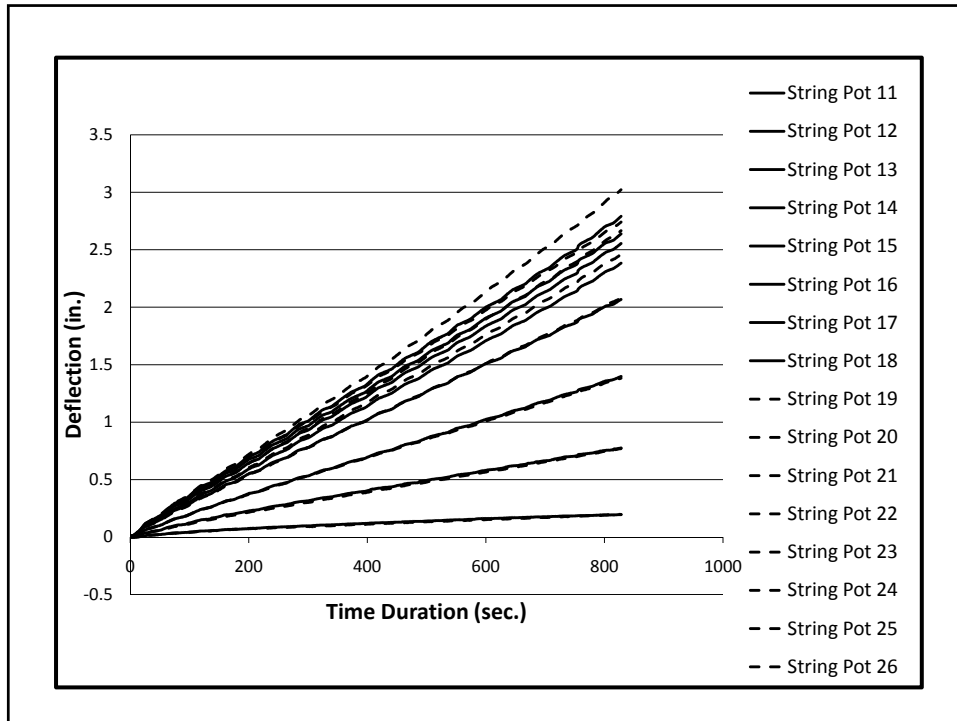


1A – Concentric @ 2.5 Ton DL

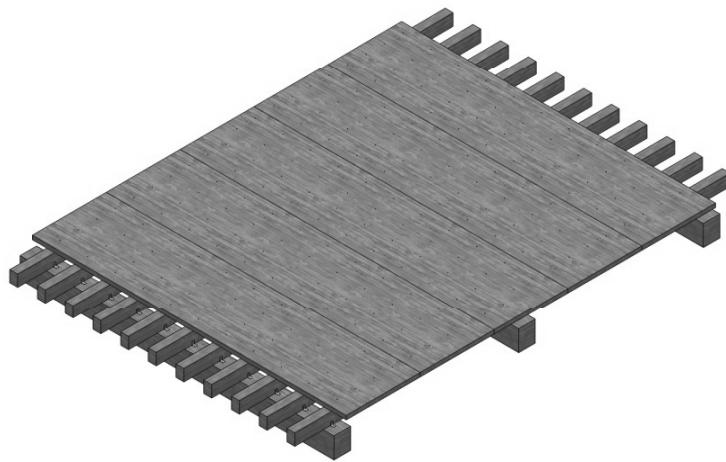


1A – Centric Max Load





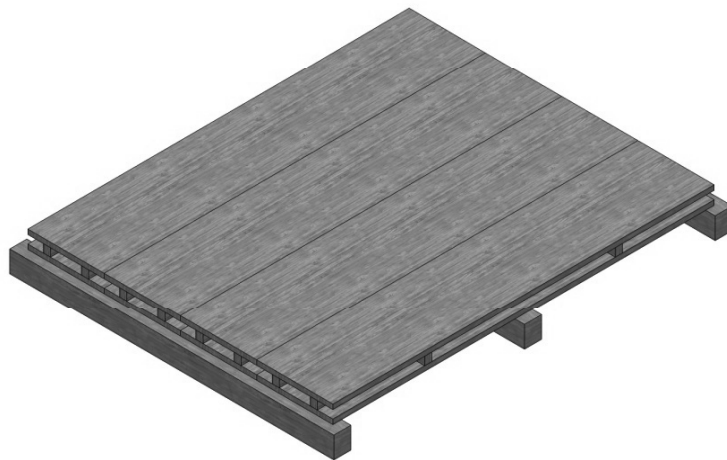
3 – Glulam Beam, Glulam Stringer, Glulam Deck (10 tons)



**4-Glulam Floor and Spreader Beams,
Glulam Deck**



**5-Glulam Floor Beam, Modified Glulam
CLT**



Acknowledgements

This study is part of the Research, Technology and Education portion of the **National Historic Covered Bridge Preservation (NHCBP)** Program administered by the Federal Highway Administration. The NHCBP program includes preservation, rehabilitation and restoration of covered bridges that are listed or are eligible for listing on the National Register of Historic Places; research for better means of restoring, and protecting these bridges; development of educational aids; and technology transfer to disseminate information on covered bridges in order to preserve the Nation's cultural heritage.

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Thank you!



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