Bridge Monitoring – Security and Smart Bridges

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and

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Bridge Security

- Cooperative research project initiated by the USDA Forest Product Laboratory and Iowa State University.
- A critical need identified – provide a level of protection to historic covered bridges.
  - Vandalism
  - Arson

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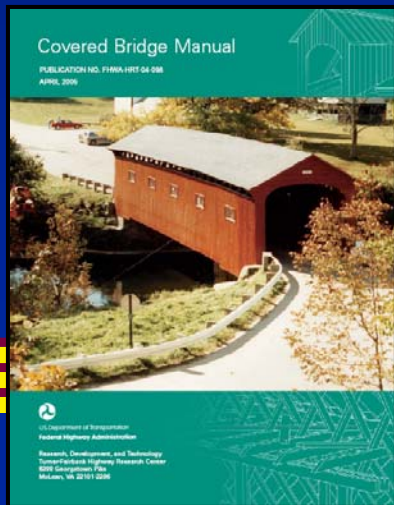
The Need in Madison County, IA

Initial Goals

- Develop & demonstrate a prototype remote security system
- Assist in the preservation of important timber bridges
- “Fill” a gap in the FHWA Covered Bridge Manual.



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First Generation System Configuration

- Three types of sensing systems:
  - Infrared camera
  - Flame detector
  - Fiber optic temperature sensors
- Data collected and processed on-site.
- Alarms sent via text message and e-mail to ISU and emergency responders.

Infrared Camera

- Detects both people and fire
- Mounted on utility pole
- "Sees" IR spectrum rather than visible light

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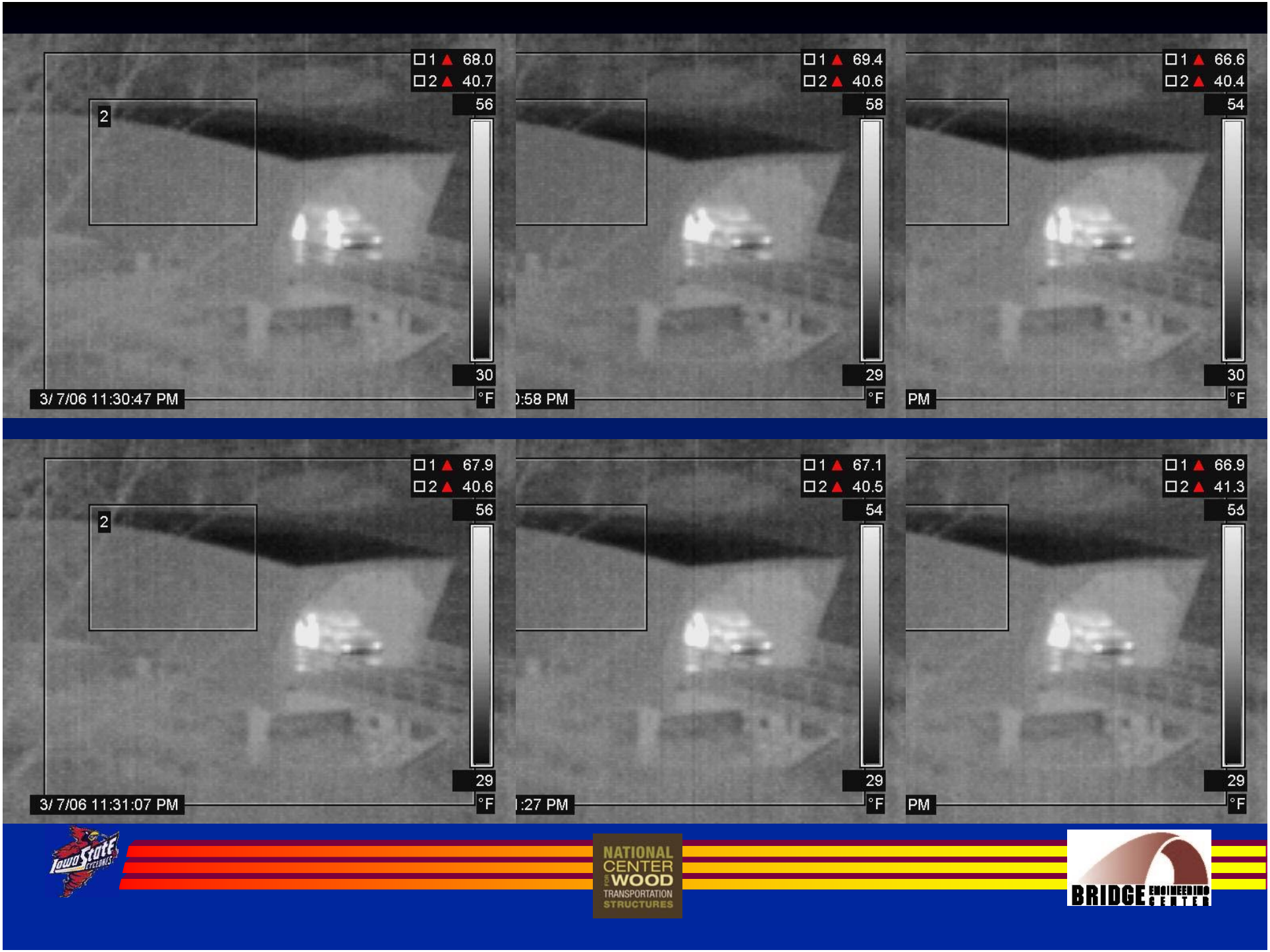

Iowa State Cyclones

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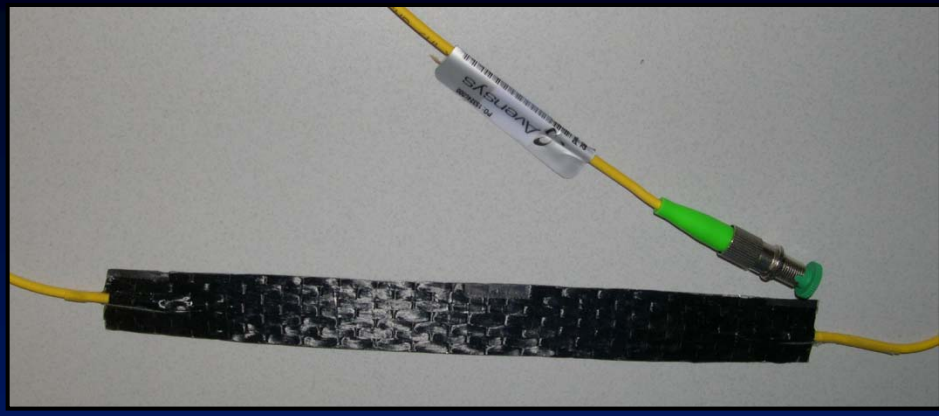
Flame Detector

- Detects presence of a flame using:
  - infrared
  - ultraviolet
  - visual technologies (flicker rate, etc.)
- Probability of false alarm is very small

Fiber Optics

- Measures temperature changes
- Length of sensor changes with temperature
- Installed in bridge behind trusses



On-site System

- Data transmitted from sensors using onsite wireless network
- Software processes data from all sensors
- Records data (including images) for use by law enforcement when alert issued

Notifications

>From popserve Fri Jun 16 04:10:33 2006
Date: Fri, 16 Jun 2006 04:10:34 -0500
From: bird@iastate.edu
Subject: Person Detected at Cedar Bridge
To: bird@iastate.edu, jmsmvs@iastate.edu, mlaviol@iastate.edu,
bphares@iastate.edu

System: FLIR A20M IR Camera
Date/Time: 6/16/2006 4:10:32 AM

A PERSON has been detected at the Cedar Bridge.

>From popserve Tue Jun 20 16:02:16 2006
Date: Tue, 20 Jun 2006 16:02:07 -0500
From: bird@iastate.edu
Subject: Fire Detected at Cedar Bridge
To: bird@iastate.edu, jmsmvs@iastate.edu, mlaviol@iastate.edu,
bphares@iastate.edu

System: FLIR A20M IR Camera
Date/Time: 6/20/2006 4:01:42 PM

A FIRE has been detected at the Cedar Bridge.

Current Activities

- Second generation system currently being deployed on an additional 5 bridges.
- A covered bridge security manual is currently being developed.

Development of a Smart Timber Bridge System

- Concept: A holistic approach to timber bridge management through the integration of sensors and on-board computing.
- Initially developed the scope of research needed for full development.
- Currently in the first phase of that work.

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Current Objective and Scope

- **Objective**
  - Develop methods for embedding in and attaching sensors to wood members.
- **Scope**
  - Design two types of sensors packages:
    - » One for structural adhesion.
    - » One to isolate the sensor from structural response.
  - Construction of small scale glulam specimens that are internally and externally instrumented.
  - Laboratory testing of the specimens under different loading and temperature conditions.
  - Selection of the best sensor packages.
  - Construction of a full scale beam specimen using selected packages and test under laboratory conditions.

Small Scale Laboratory Testing

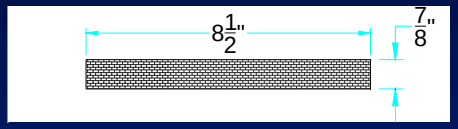
Nine specimens tested under:

- Bending
- Sustained loading
- Fast loading
- Pseudo cyclic loading
- Heat and sustained loading
- Cold and sustained loading

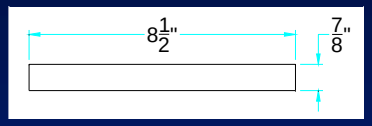
Structural Response Packages

External Packages:

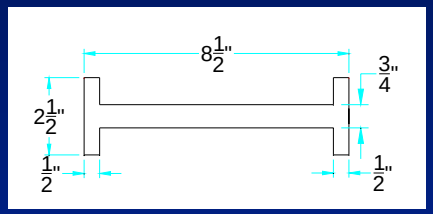
C-FRP Loctite 426



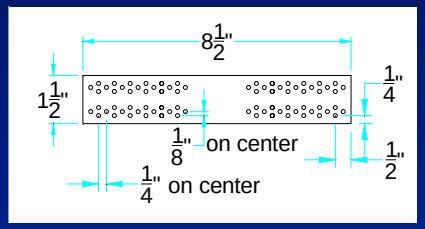
RS-SS Loctite 426



IS-SS Loctite 4212

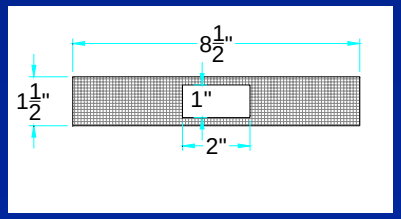


72H-SS Loctite 426



Internal Packages:

AM-SS Loctite 454



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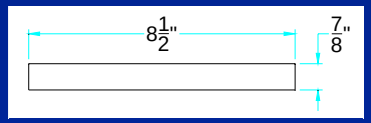
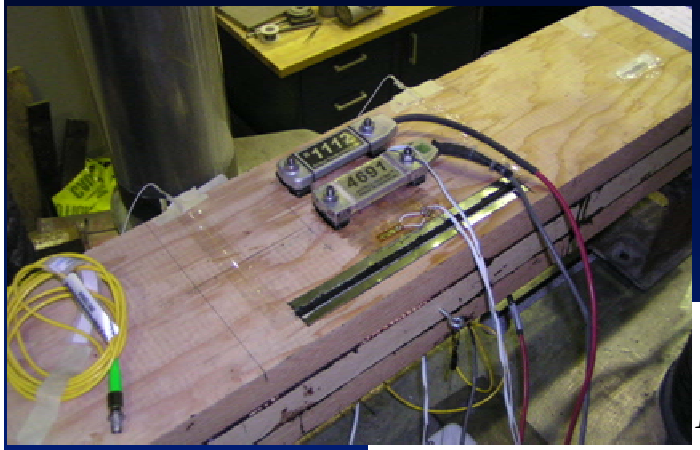
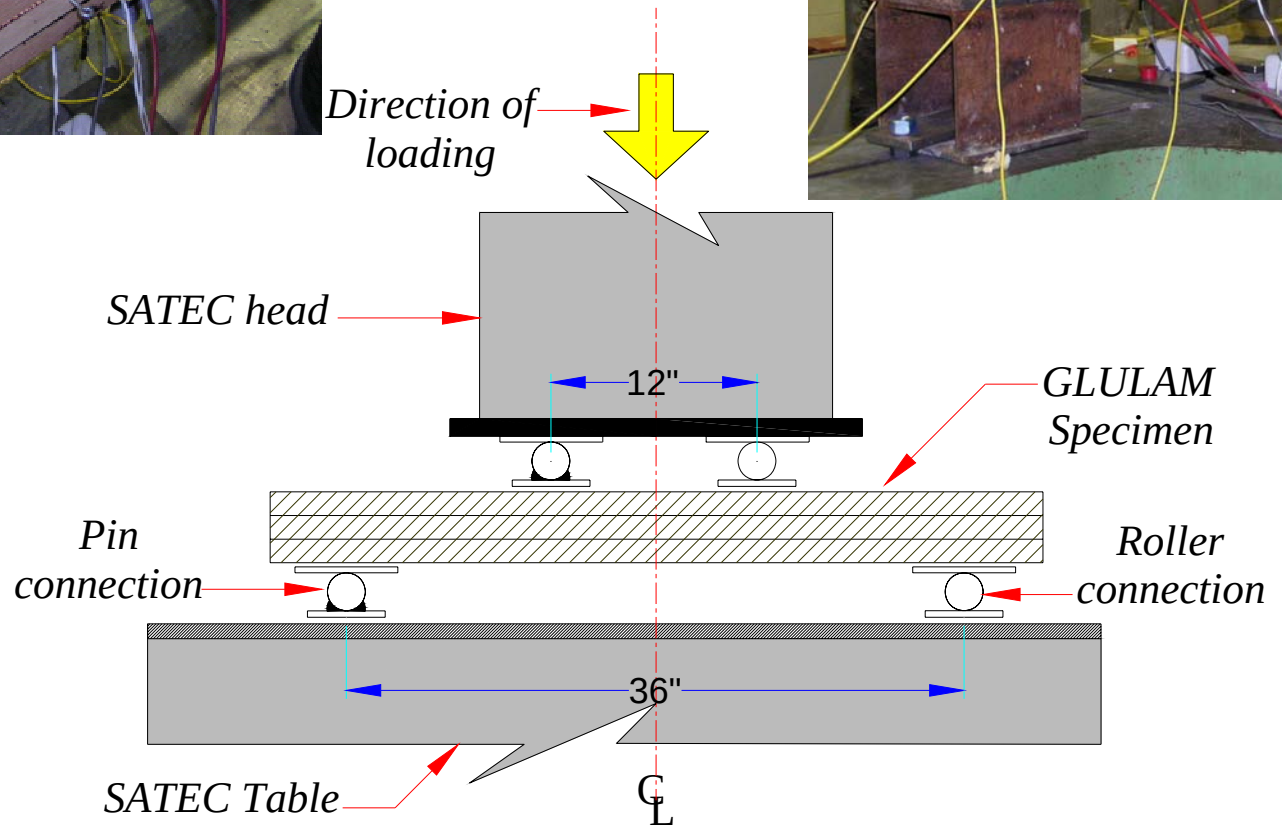
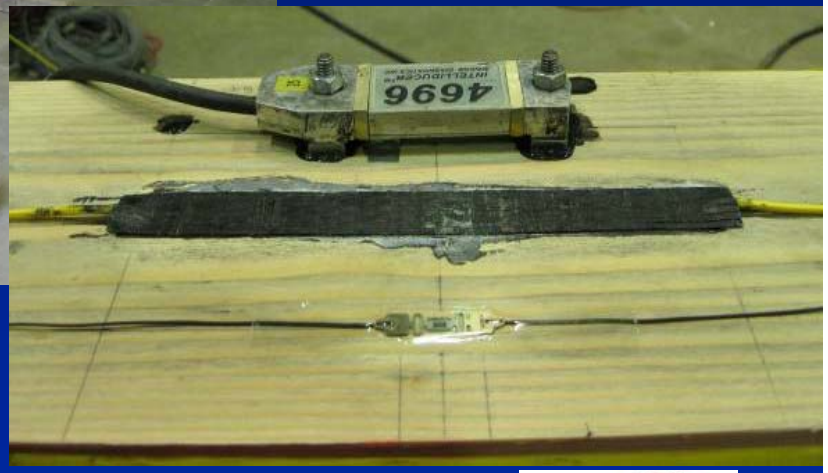


Small Scale Test Setup

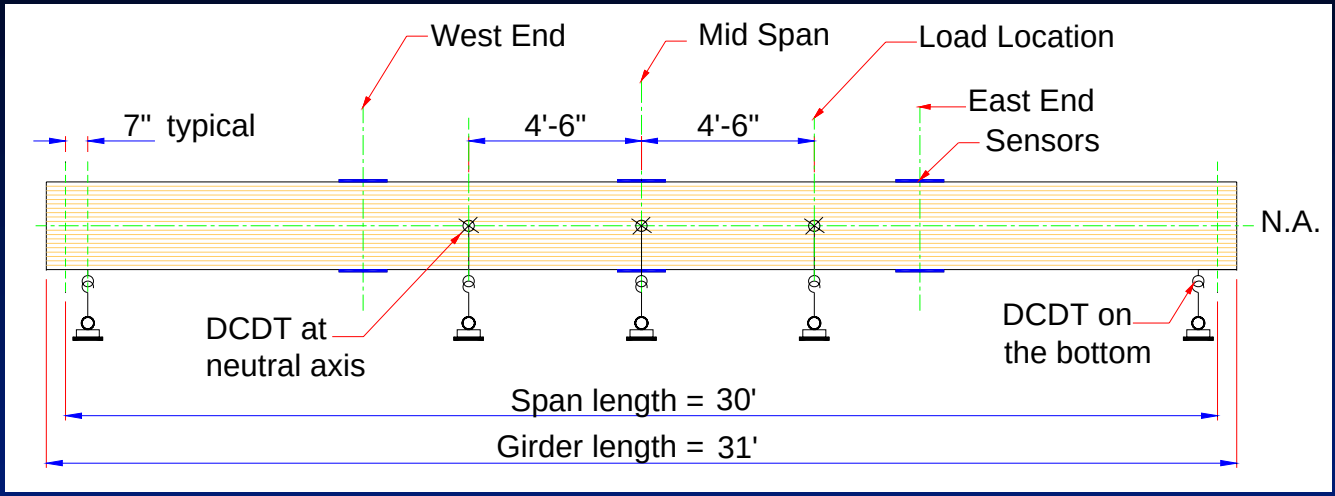




Full Scale Beam



Full Scale Beam Testing



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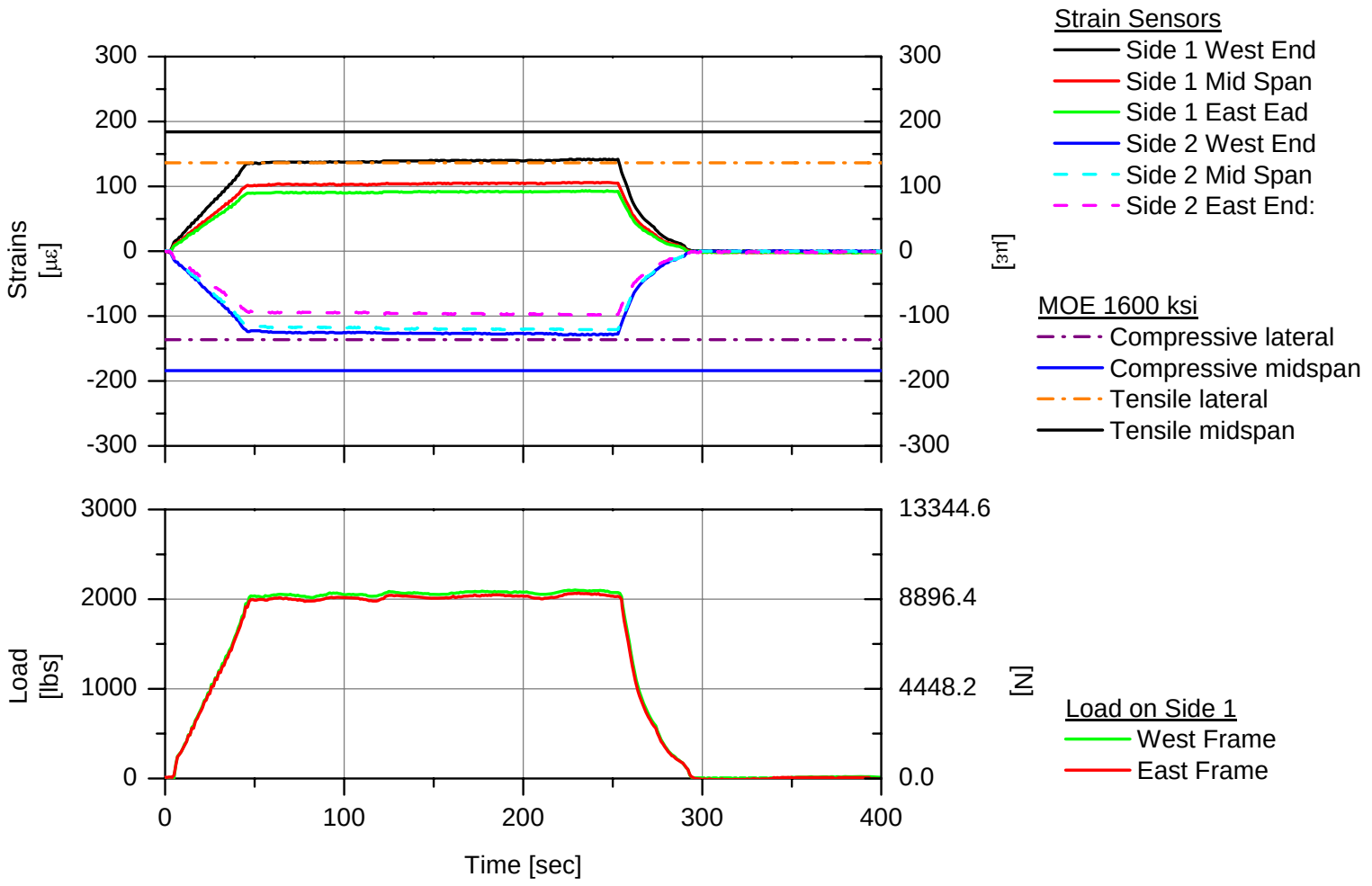
Typical Results



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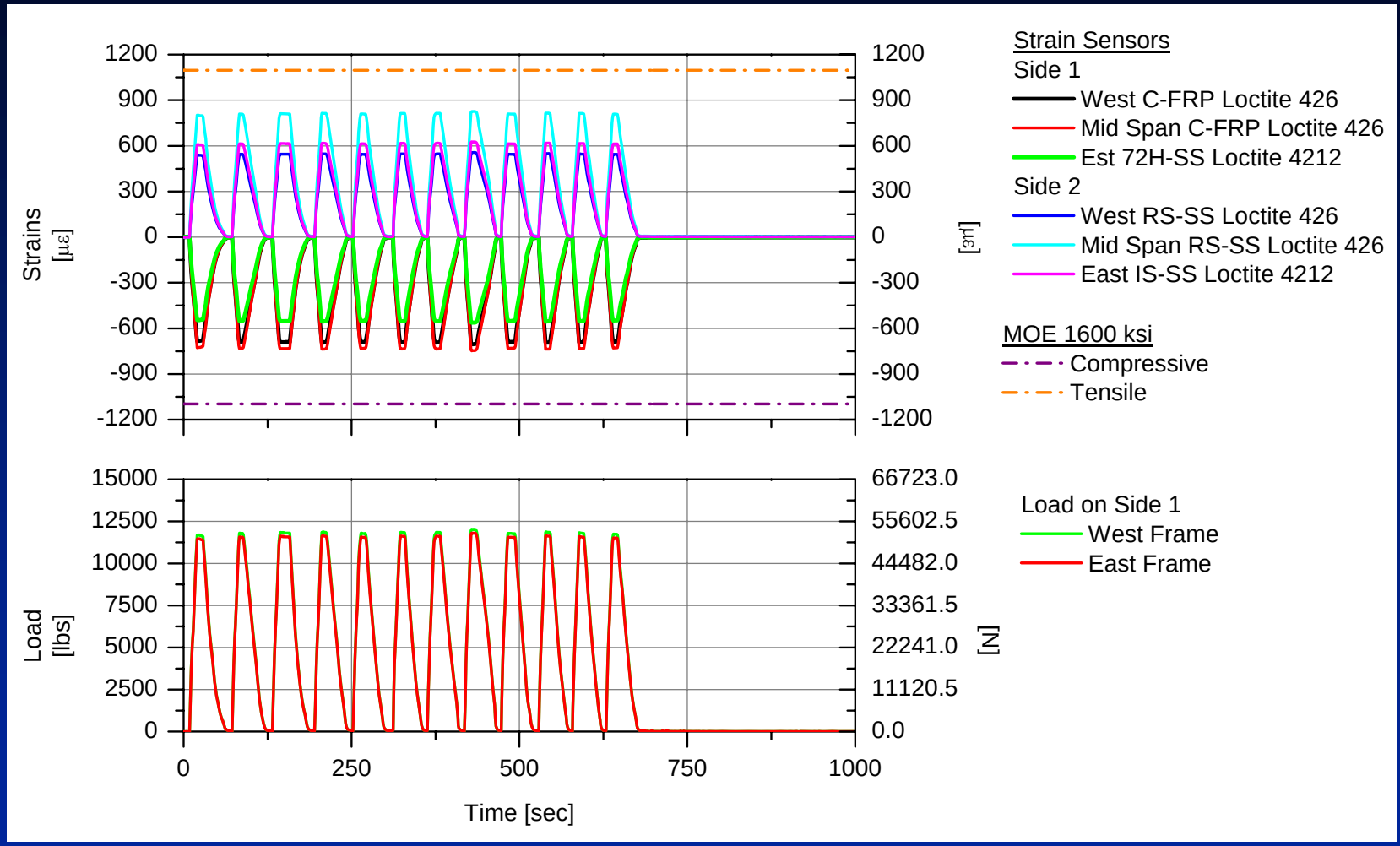

Questions?

Thank you!

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www.bec.iastate.edu