

# Monitoring and Evaluation of Plate Girder Bridges with Fatigue Problems

Douglas Wood, Brent M. Phares, Terry J. Wipf,  
Lowell Greimann, David Tarries  
Iowa State University

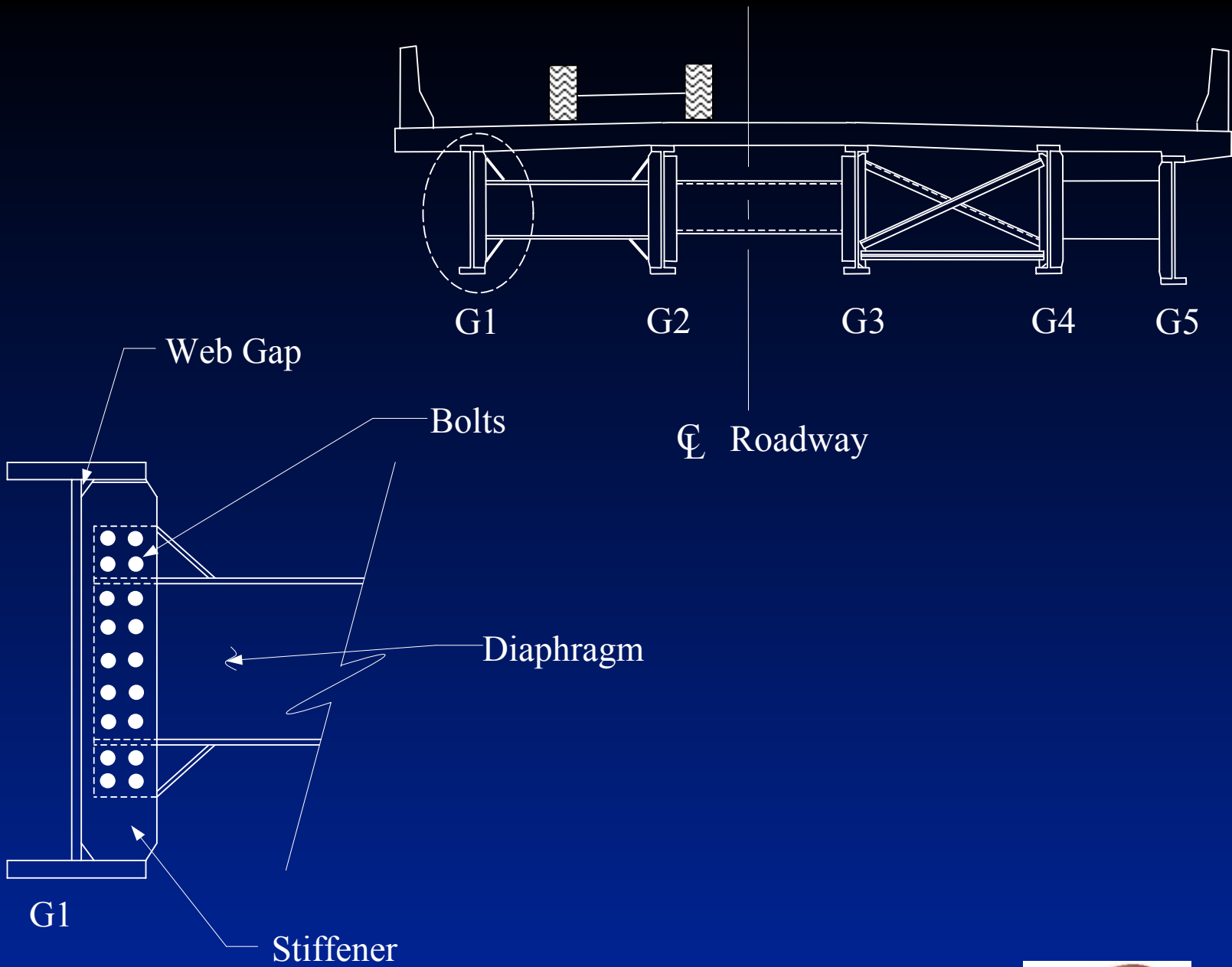
Bruce Brakke, Iowa DOT

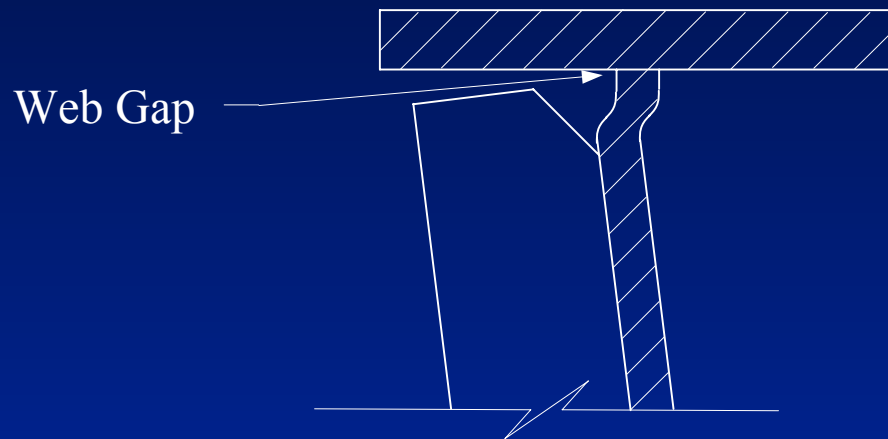
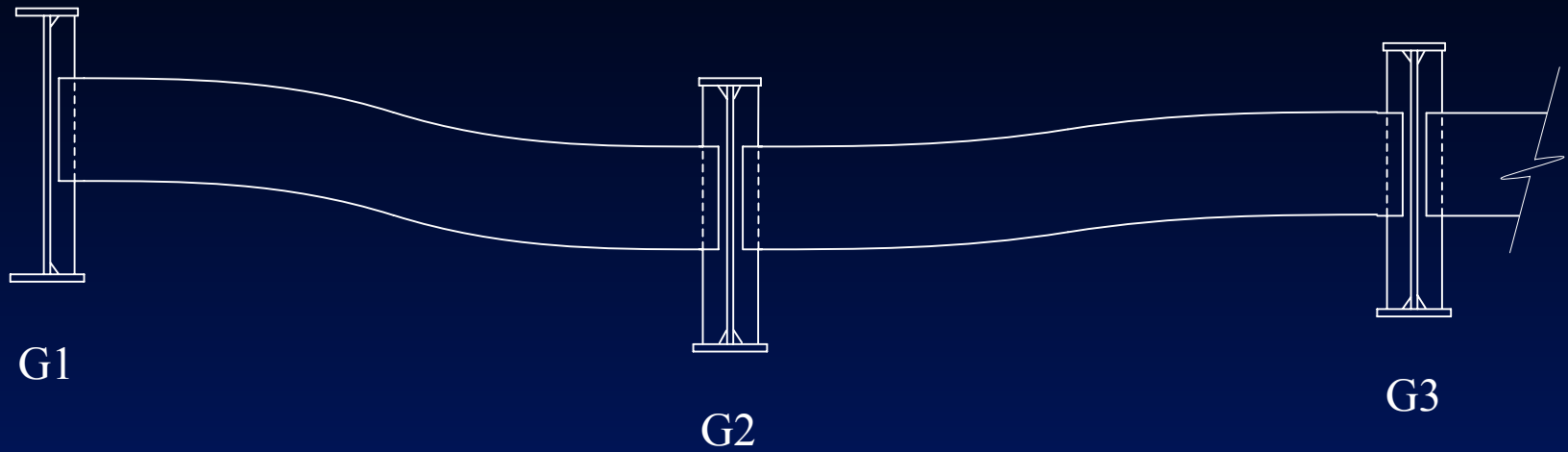


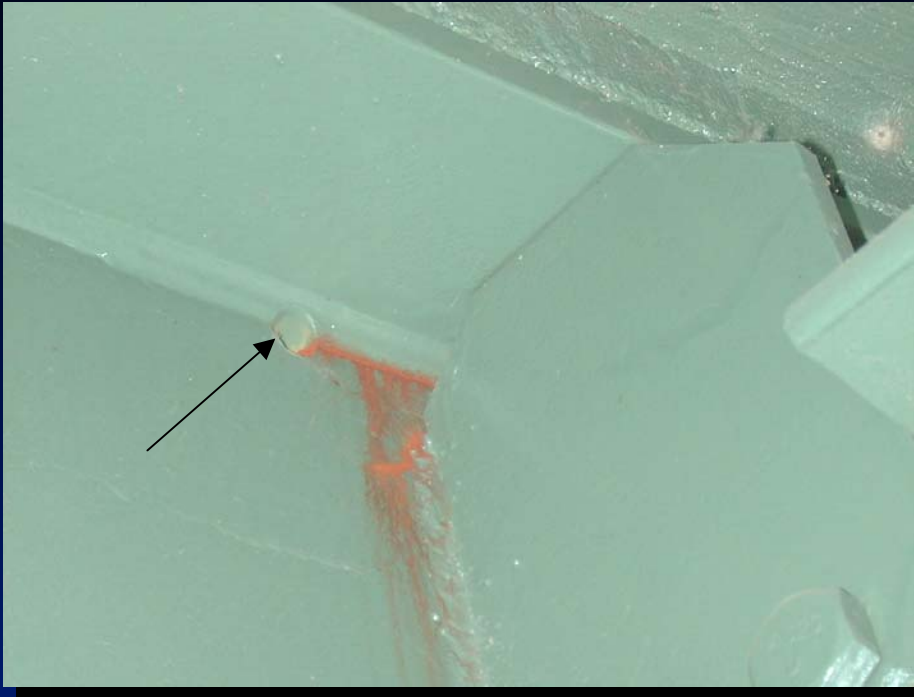
# Overview

- In Iowa, fatigue cracking in web gaps of multiple steel girder bridges in negative bending region becoming more common.
- Retrofit to relieve strain in web gap originally developed in coordination with Iowa DOT, but not tested long-term and only tested on X-type bracing.









# The Retrofit

- Loosen bolts in diaphragm/ girder connections in negative moment region.
- Leave diaphragms in place to support girders.



# Scope

- 3 bridges instrumented
  - Channel diaphragm.
  - I-section diaphragm.
  - X-type bracing
- Tested before and after retrofit
  - Short-term.
  - Long-term.

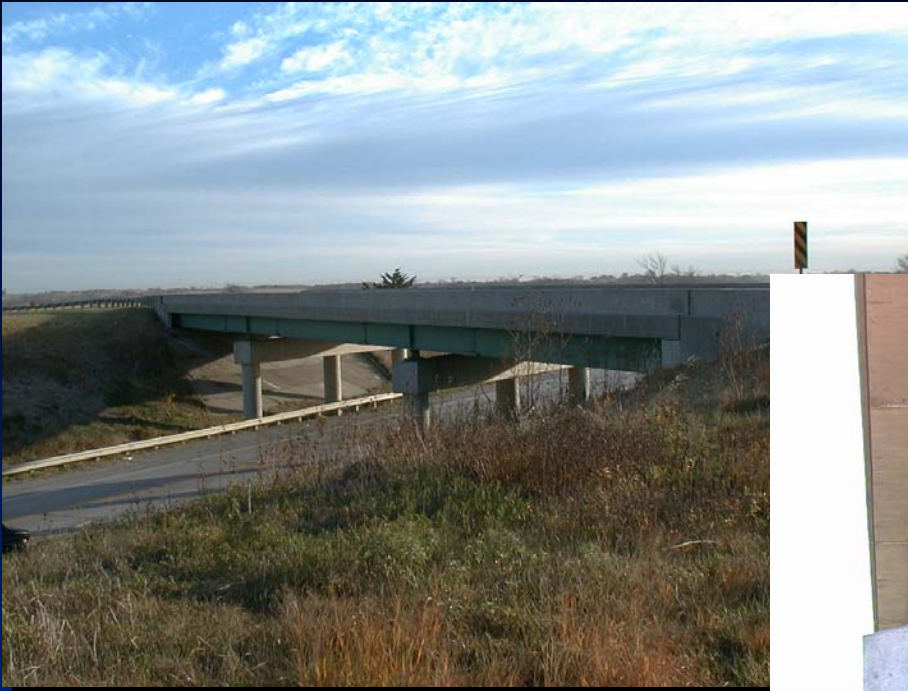


# Interstate-35 Bridge

- Three span, five girder bridge with channel diaphragms.
- Short-term testing.



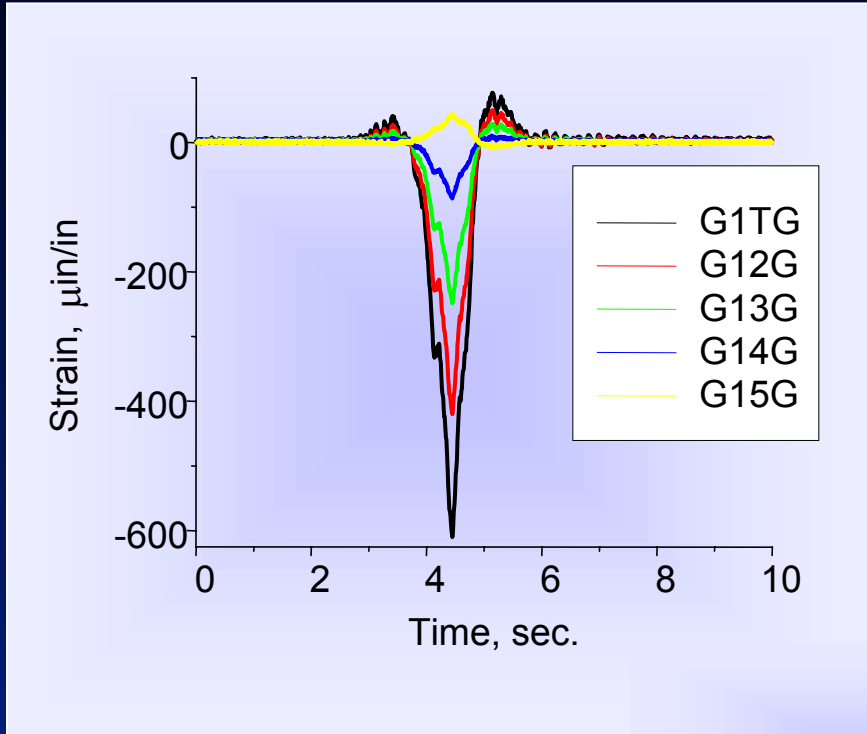
# Interstate-35 Bridge



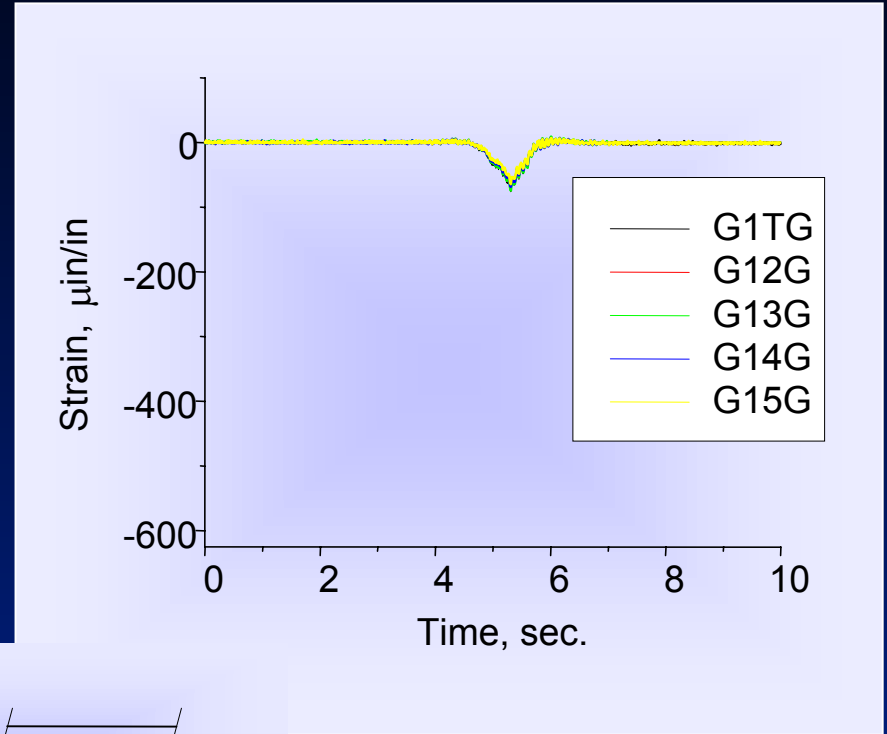
# Instrumentation



# Web Gap Strain

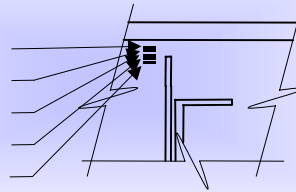


Tight

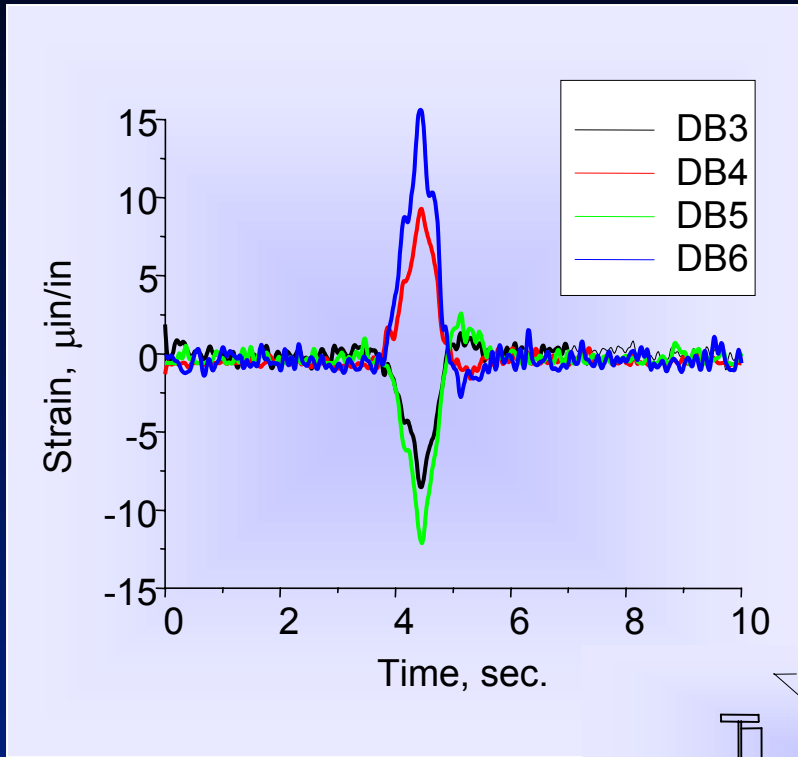


Loose

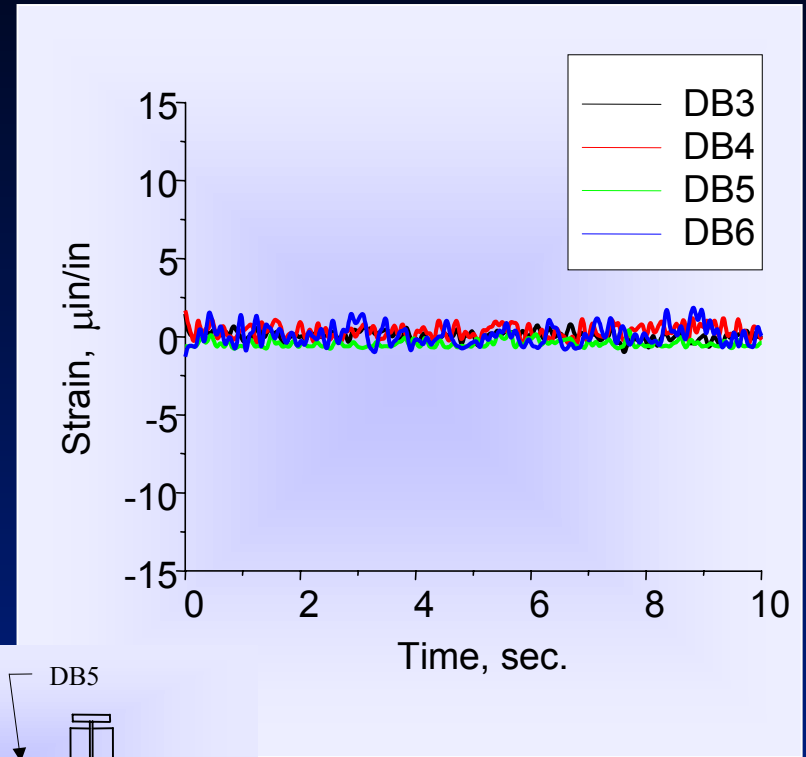
G1TG  
G12G  
G13G  
G14G  
G15G



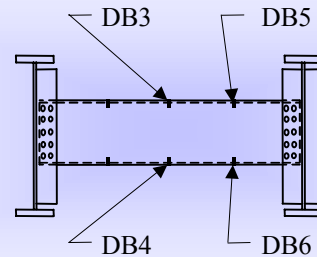
# Diaphragm Strain



Tight



Loose



# Iowa-17 Bridge

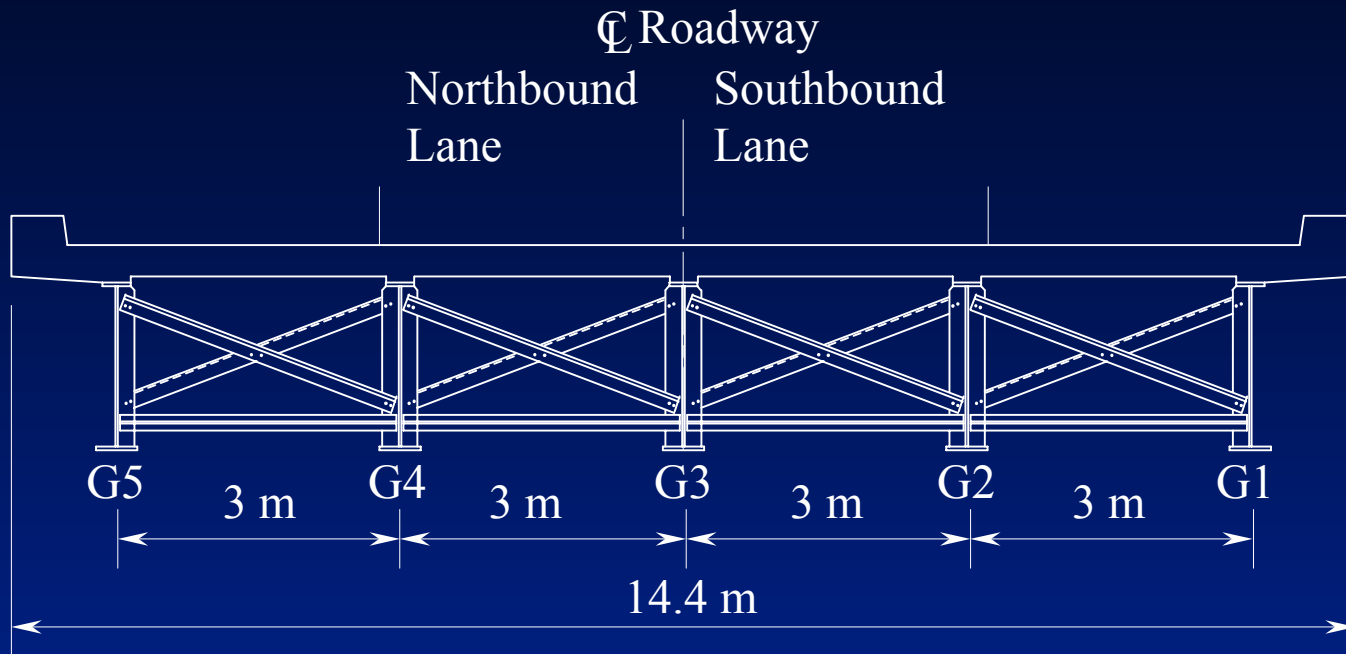
- Three span, five girder bridge with X-type cross-bracing.
- Long-term testing.



# Iowa-17 Bridge



# Bridge Cross-Section



# Health Monitoring System

- A Campbell Scientific CR 9000 was selected for remote monitoring of ambient truck traffic on the bridge.
- Strain gages, displacement transducers, and thermocouples were installed and connected to the CR 9000.

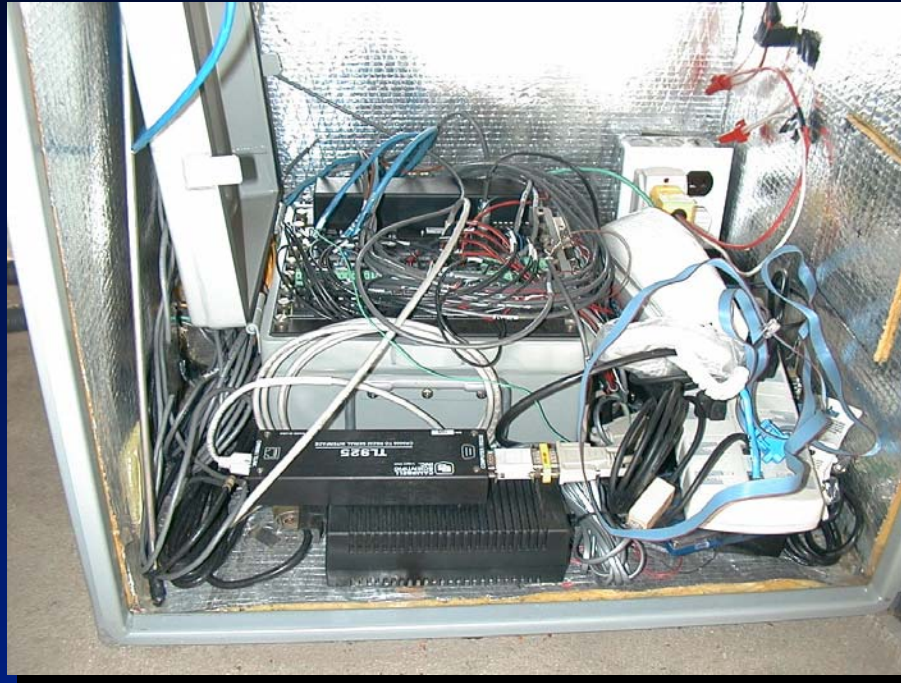


# Health Monitoring System

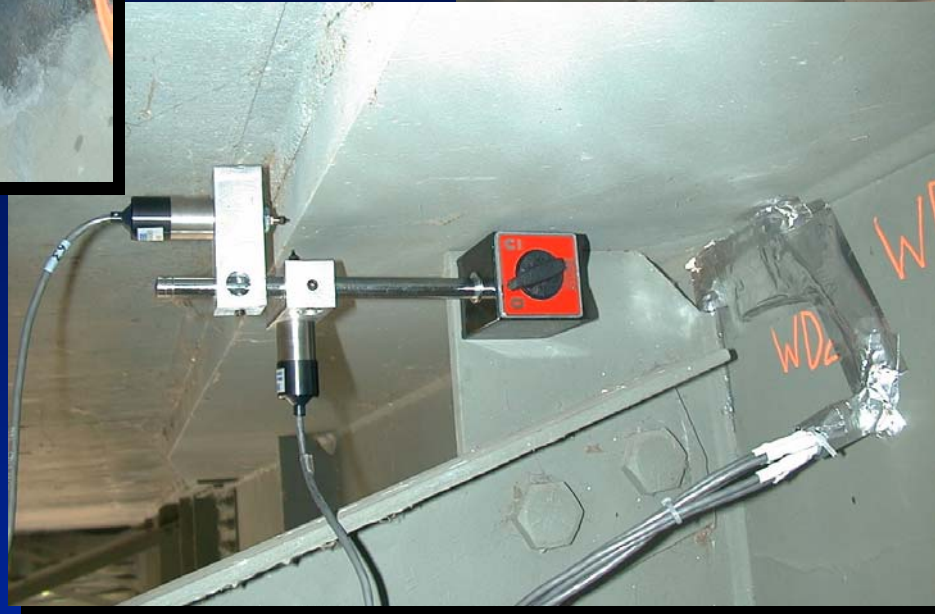
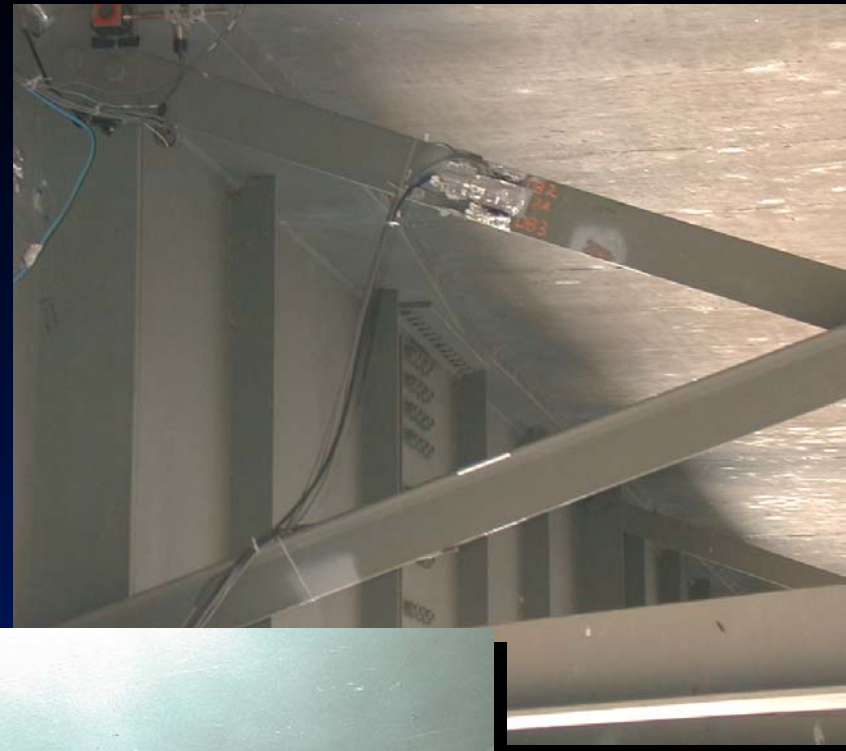
- 24 input channels.
- Connected to local power grid for continuous operation.
- Phone line installed to allow data acquisition and program adjustments.
- Trigger programmed into system to collect only data larger than a designated threshold set to register truck loads.



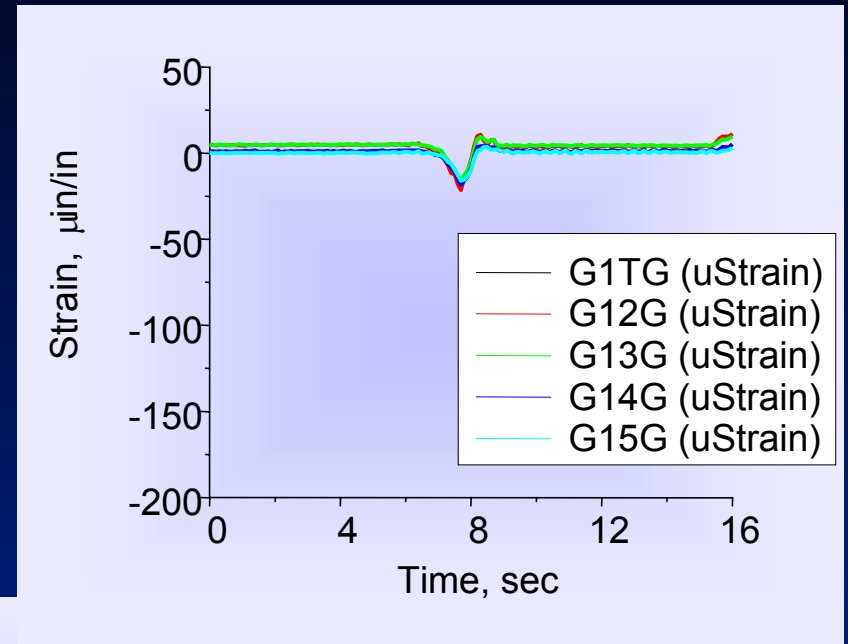
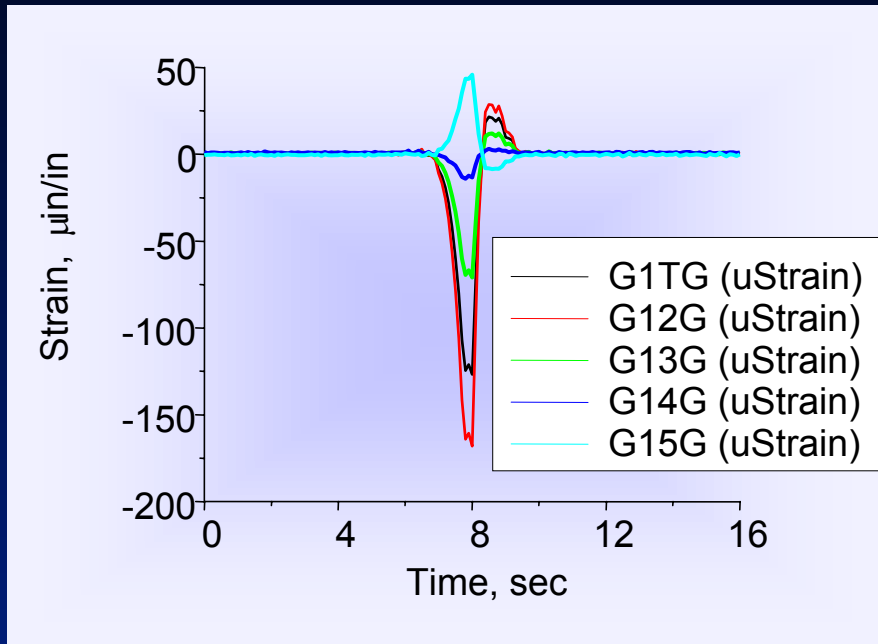
# Health Monitoring System



# Instrumentation

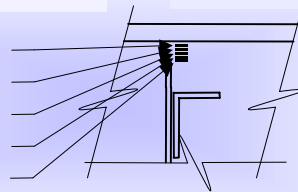


# Web Gap Strain Gradient



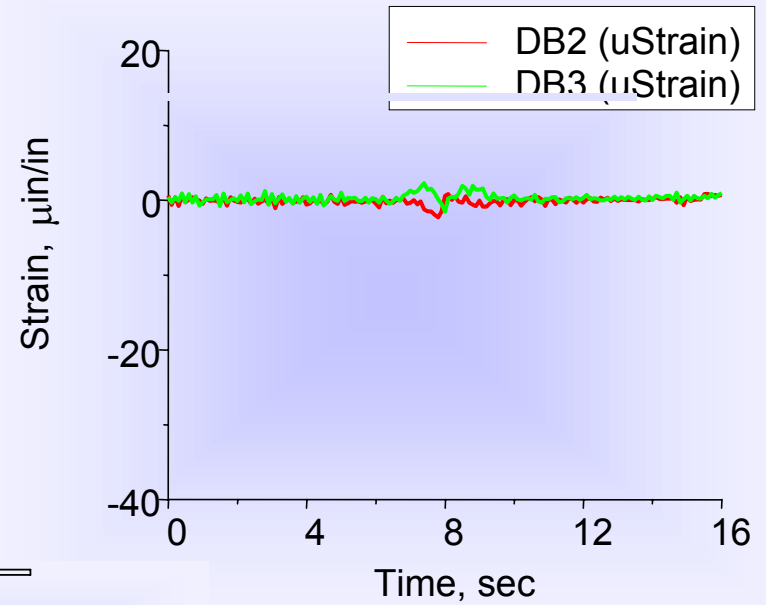
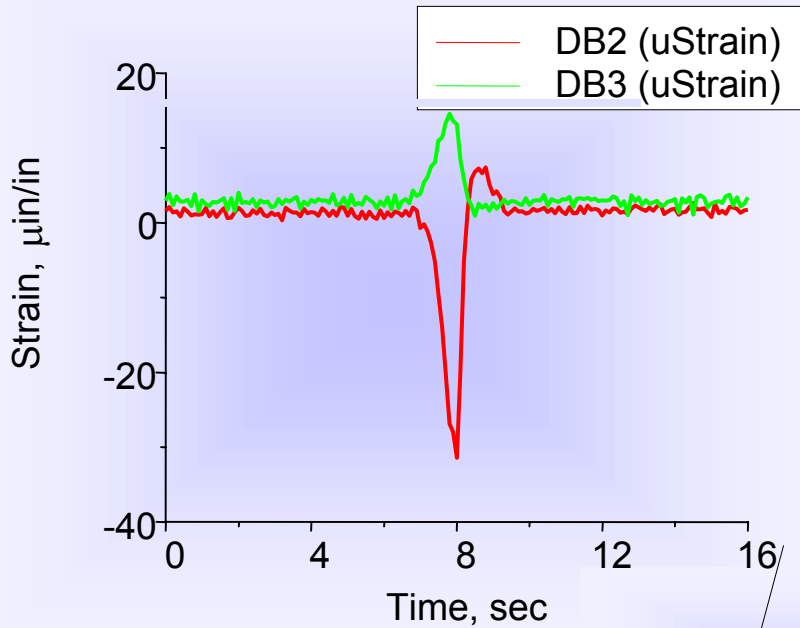
Tight

G1TG  
G12G  
G13G  
G14G  
G15G

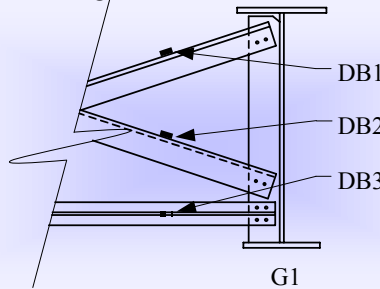


Loose

# Cross-Frame Behavior

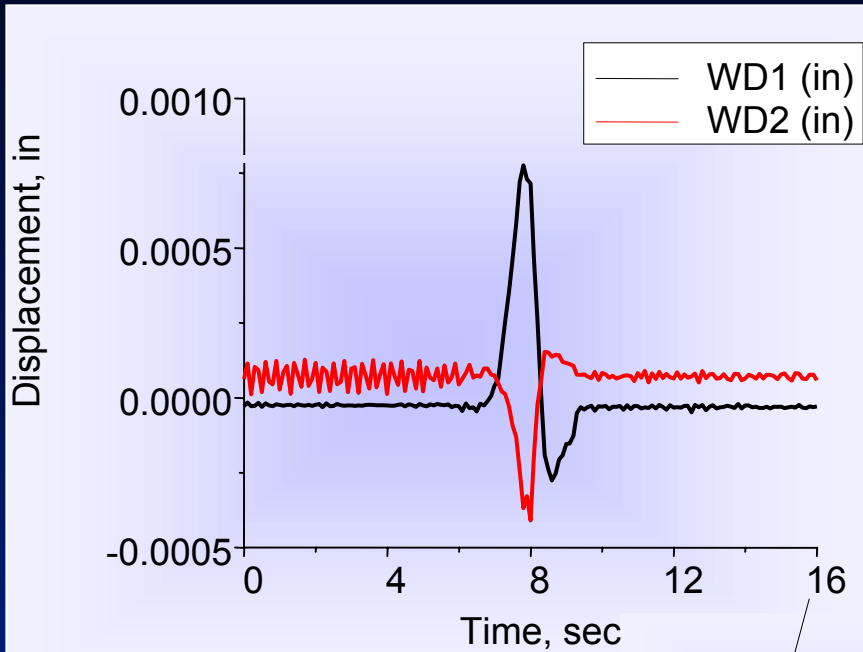


Tight

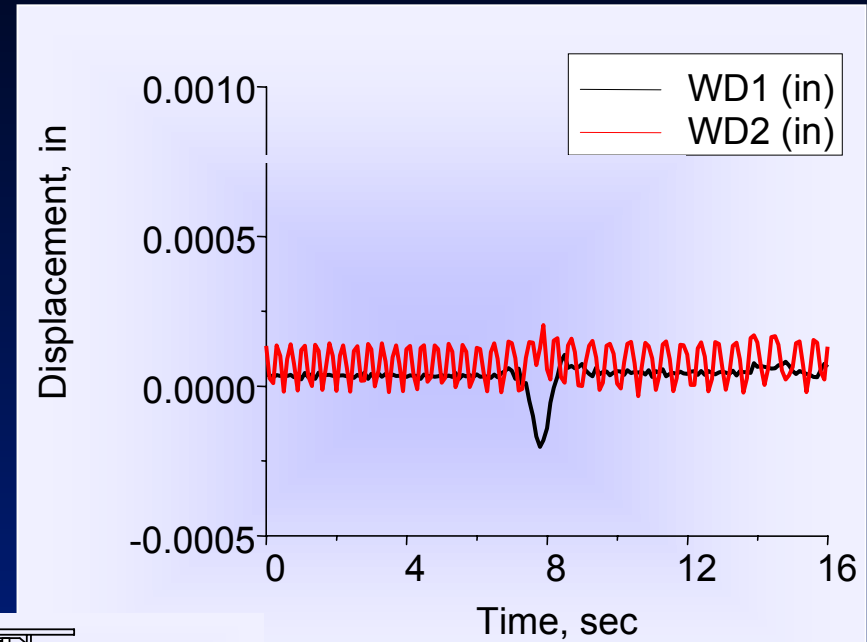


Loose

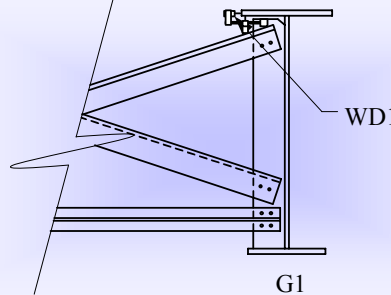
# Out-of-Plane Displacement



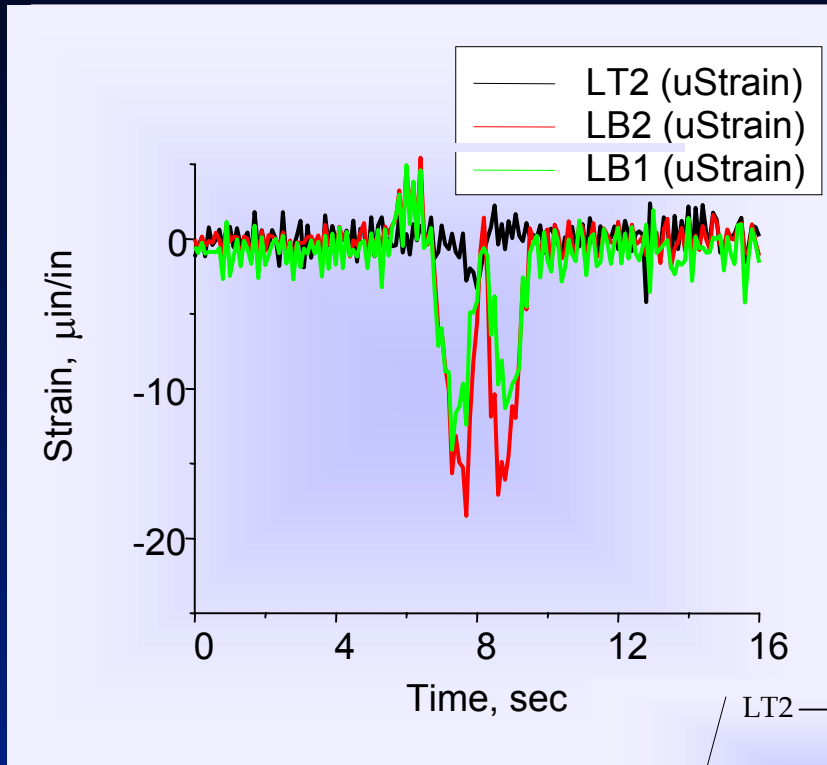
Tight



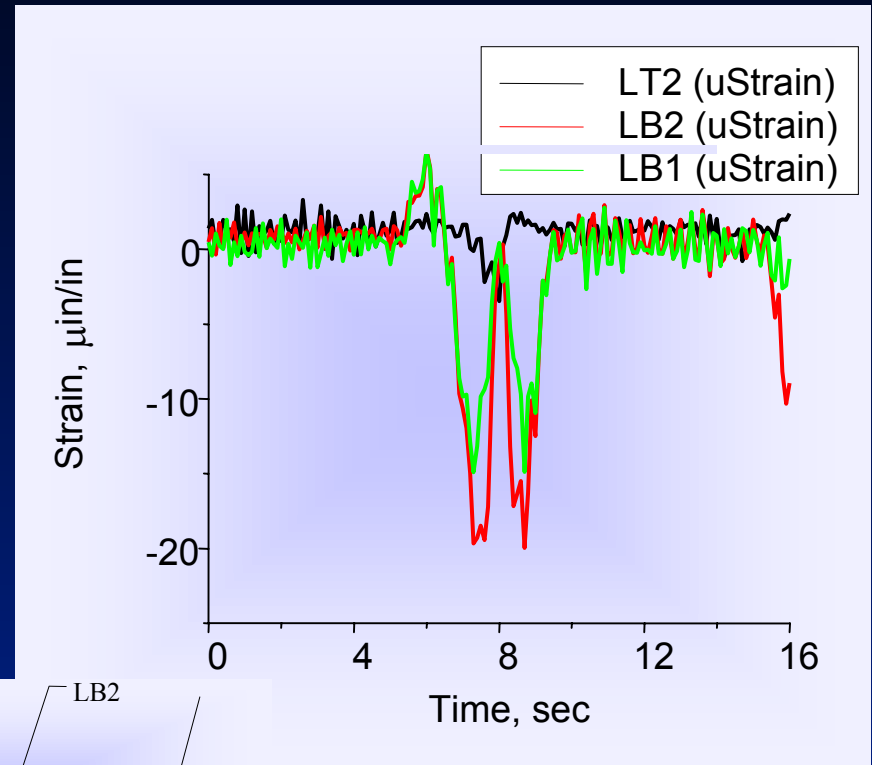
Loose



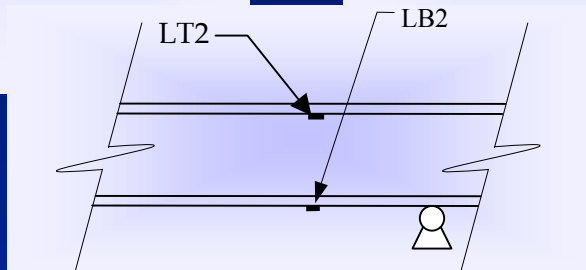
# Bottom Flange-Trigger Data



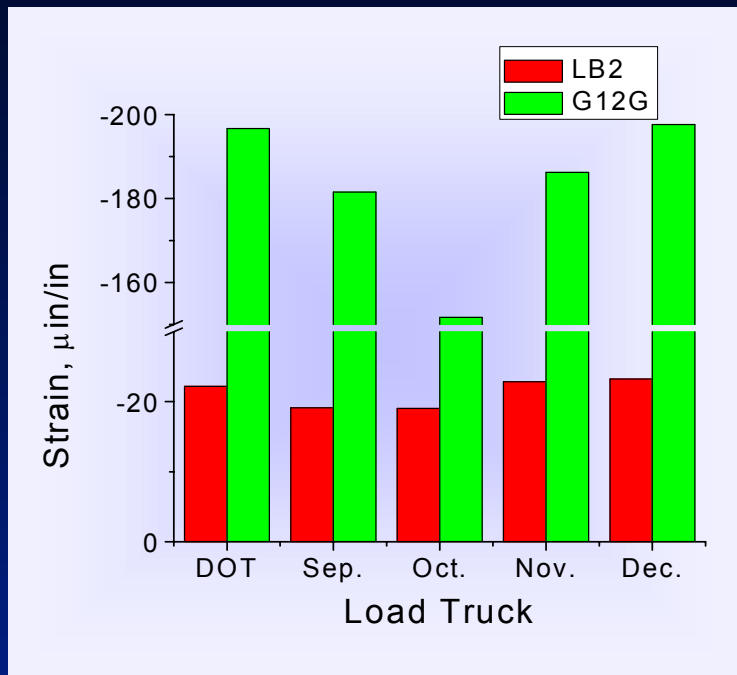
Tight



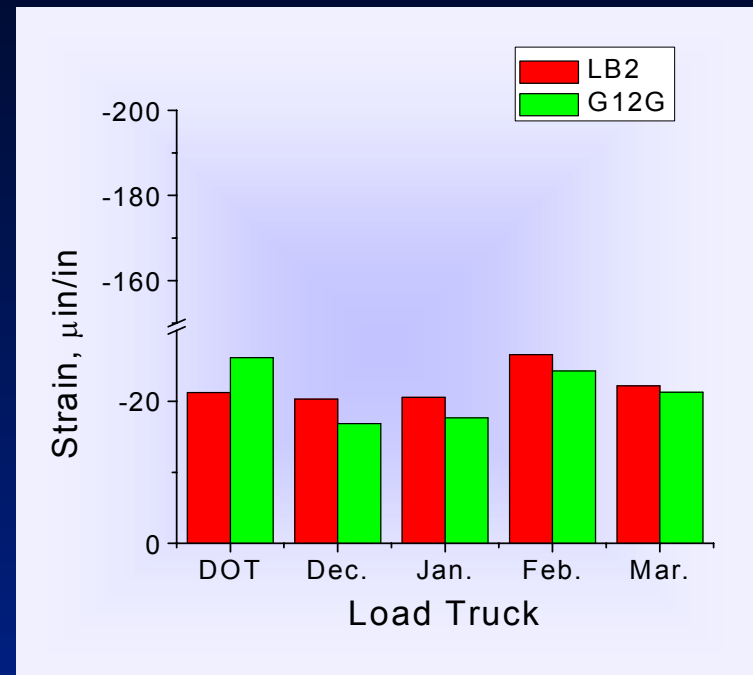
Loose



# Loading Variability



Tight



Loose

# Conclusions

- Collected data showed a reduction in strain in the web gap resulting from the retrofit of approximately 75%.
- Long-term data trends suggest the effectiveness of the retrofit is not affected over time by vibrations and temperature changes.

