Bolt Loosening Retrofit to Inhibit Fatigue Cracking in Steel Girder Bridges

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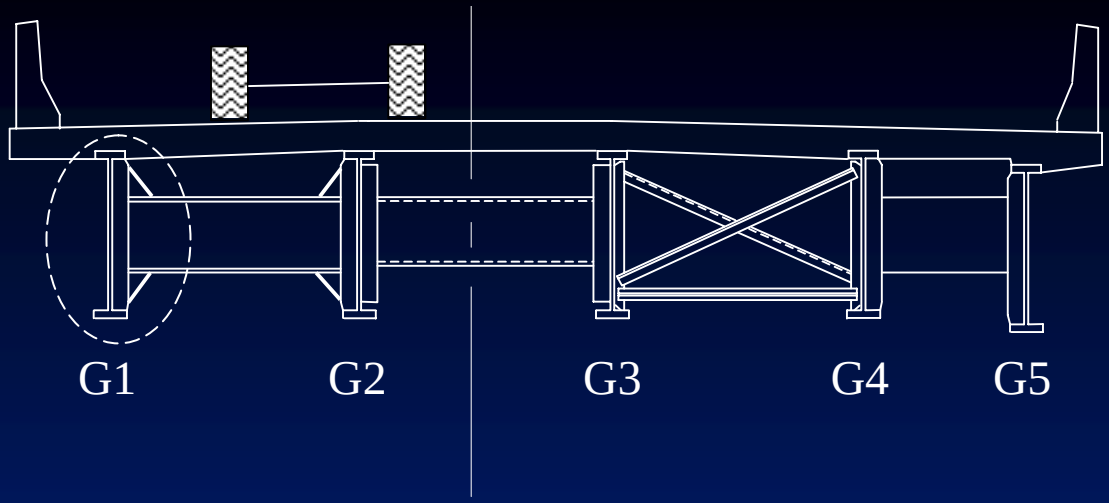
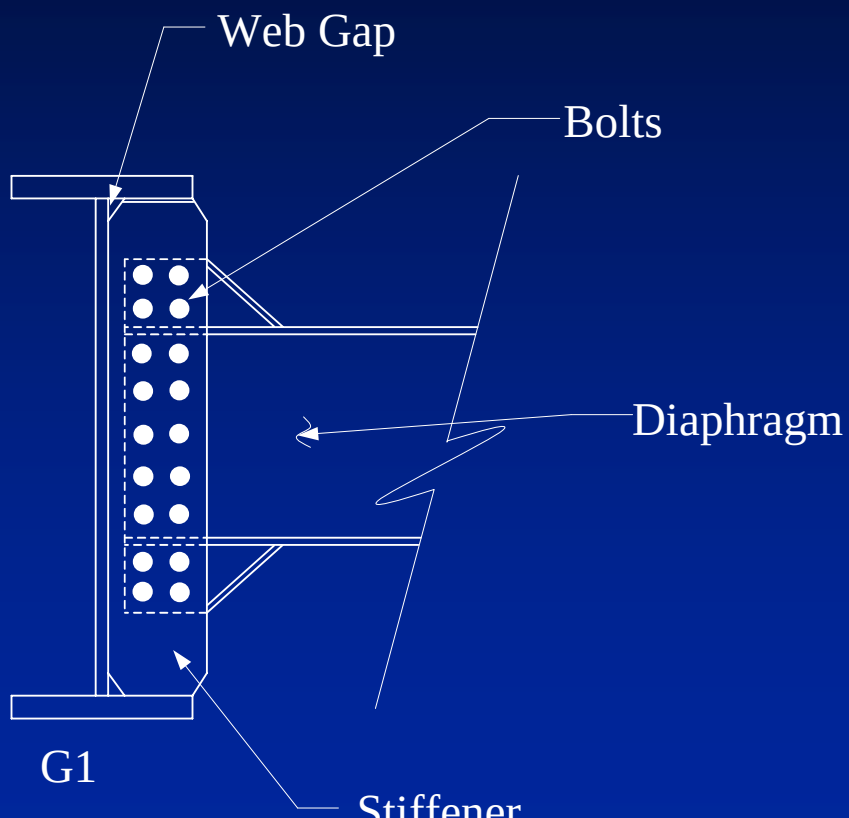
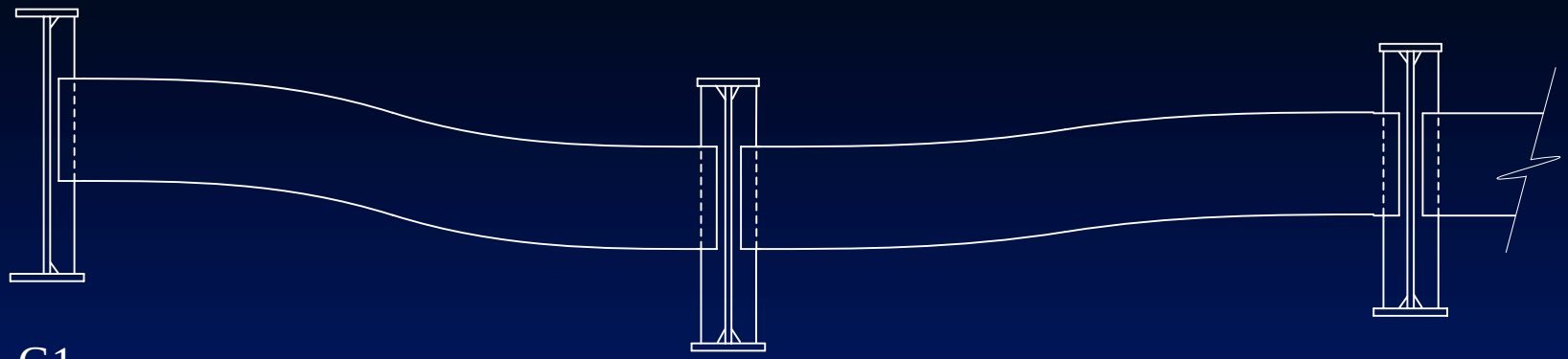
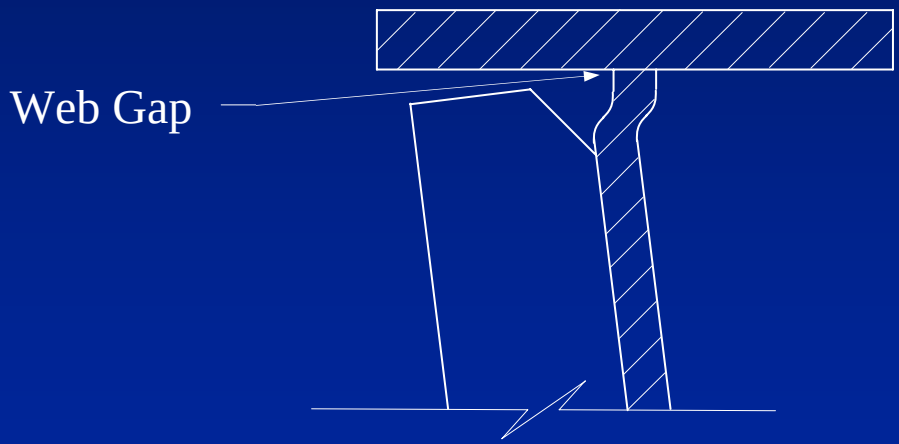
Overview

- 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.


G1
G2
G3
G4
G5
℄ Roadway


Web Gap
Bolts
Diaphragm
G1
Stiffener


G1
G2
G3


Web Gap

The Retrofit

- Loosen bolts in diaphragm/girder connections.
- 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.

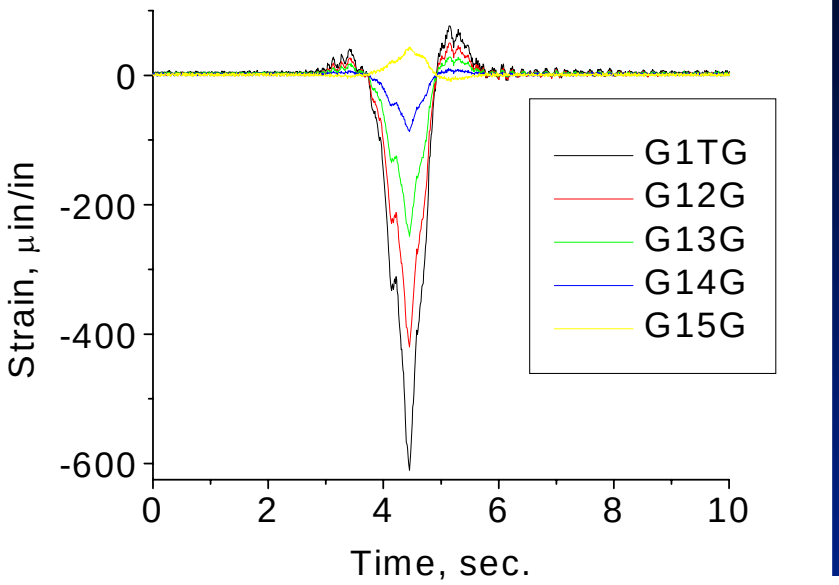
Interstate-35 Bridge

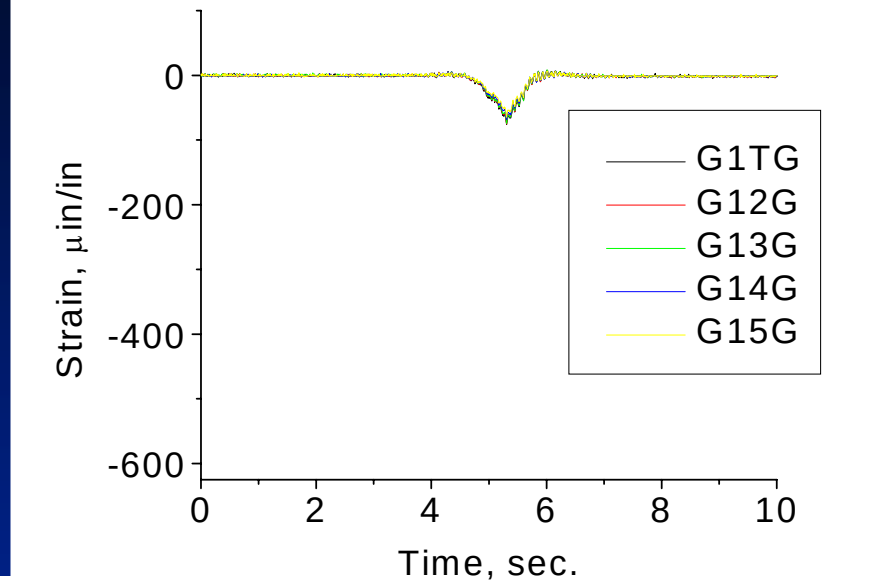
- Three span, five girder bridge with channel diaphragms.
- Short-term testing.

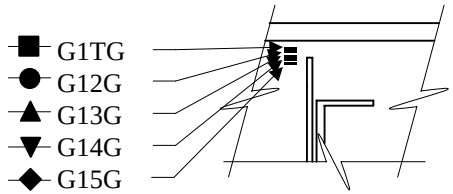
Interstate-35 Bridge

Instrumentation

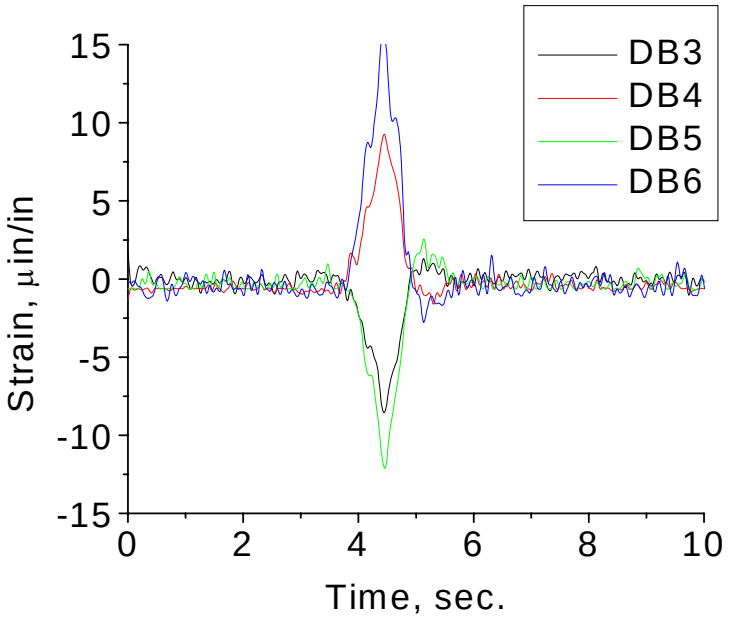
Web Gap Strain

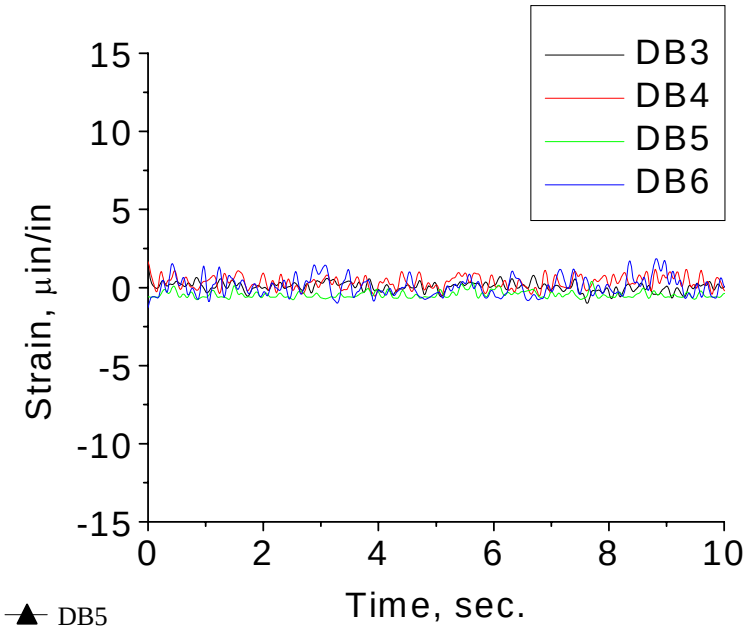


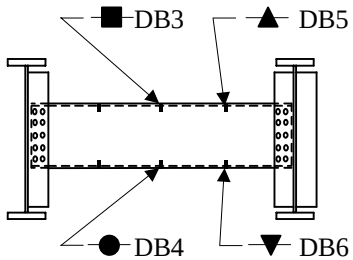




Diaphragm Strain





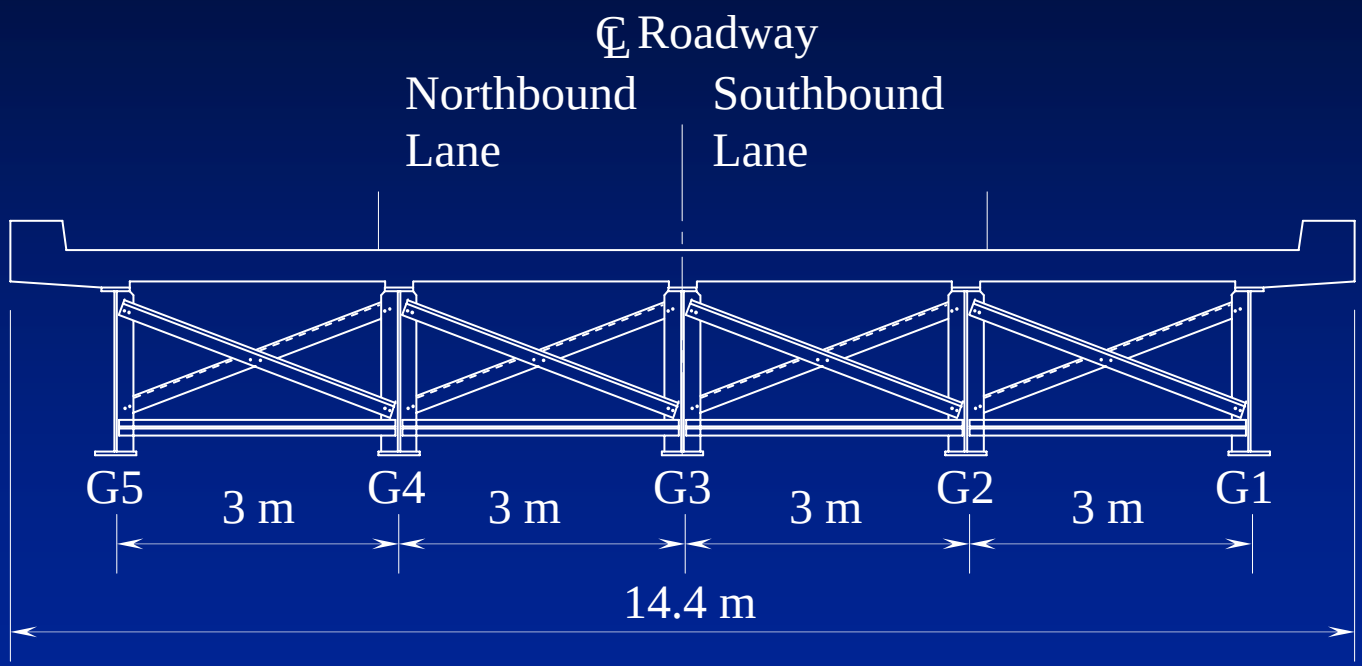


Iowa-17 Bridge

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

Iowa-17 Bridge

Bridge Cross-Section



Health Monitoring System

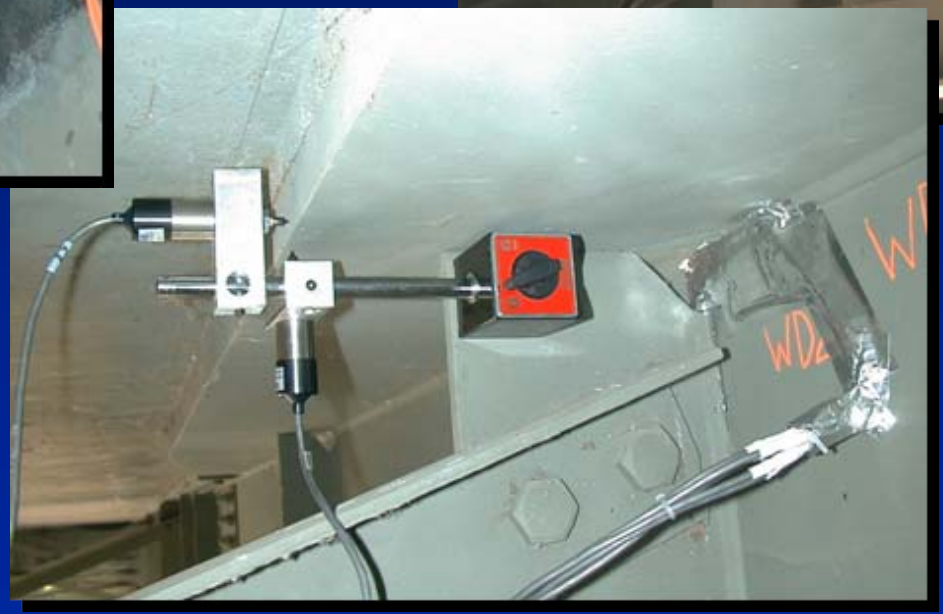
- A Campbell Scientific CR 9000 was selected for remote monitoring of ambient truck traffic on the bridge.
- Strain gages, displacement transducers, and thermocouples were installed and connected to the CR 9000.

Health Monitoring System

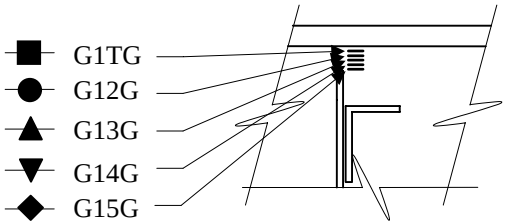
- 24 input channels.
- Connected to local power grid for continuous operation.
- Phone line installed to allow data acquisition and program adjustments.
- Trigger programmed into system to collect only data larger than a designated threshold set to register truck loads.

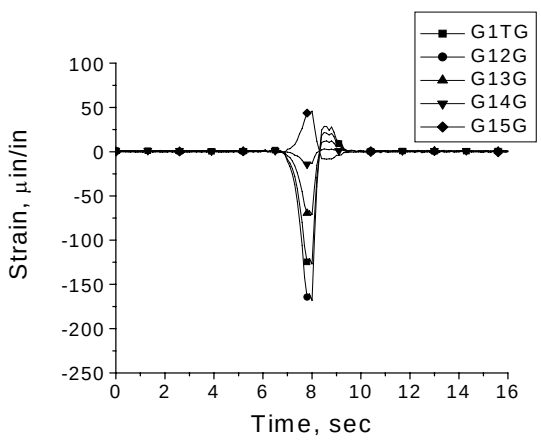
Health Monitoring System

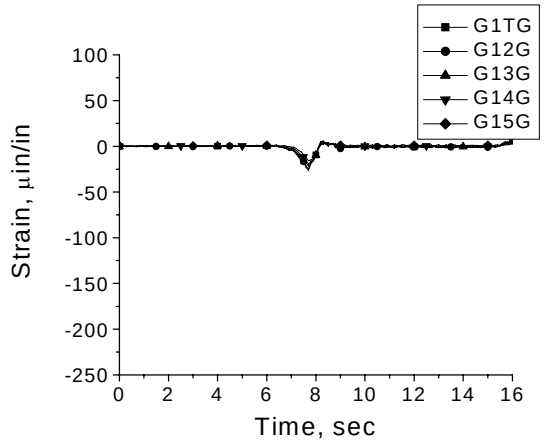
Instrumentation



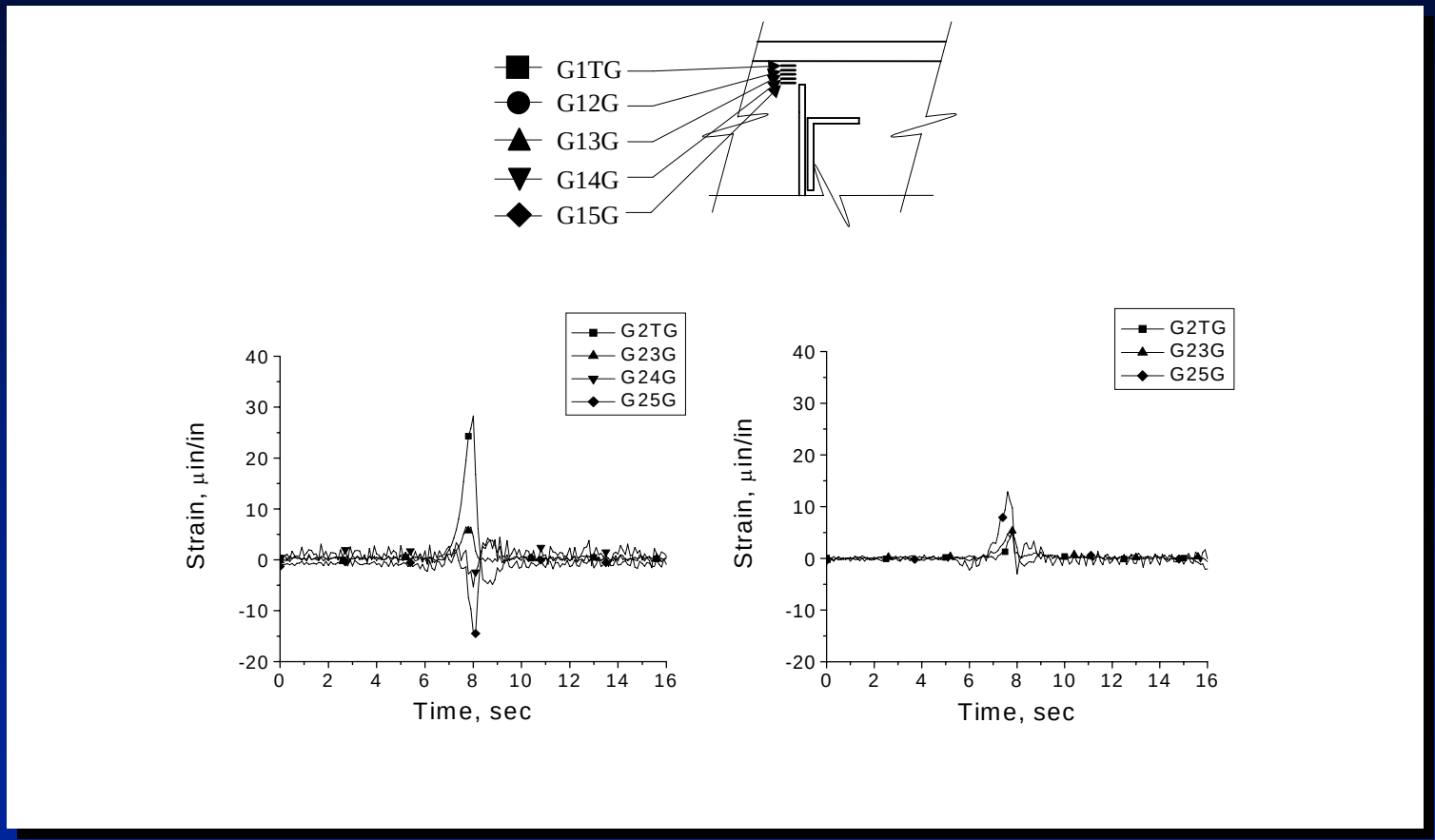
Web Gap Strain Gradient-Close to Pier



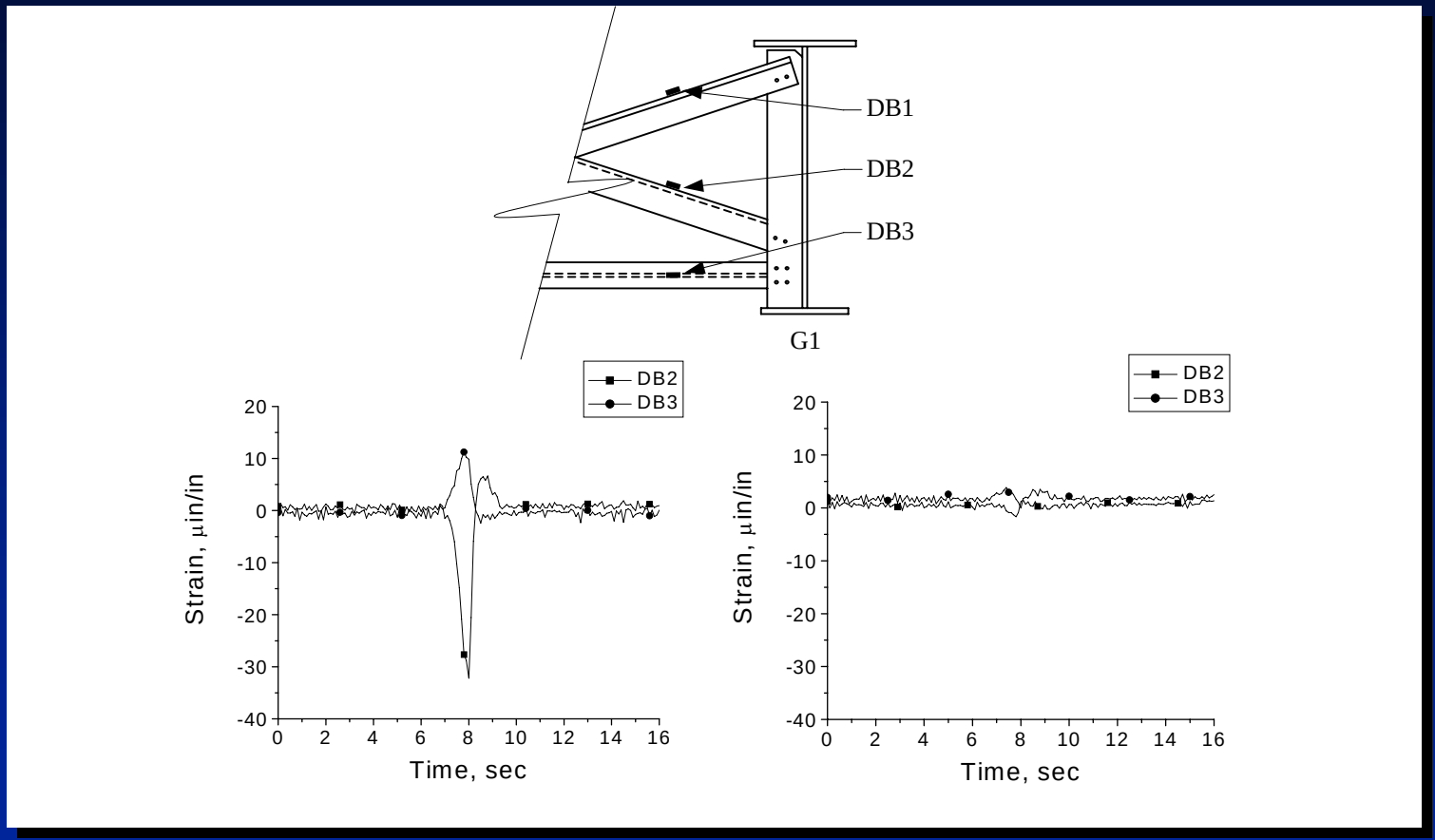




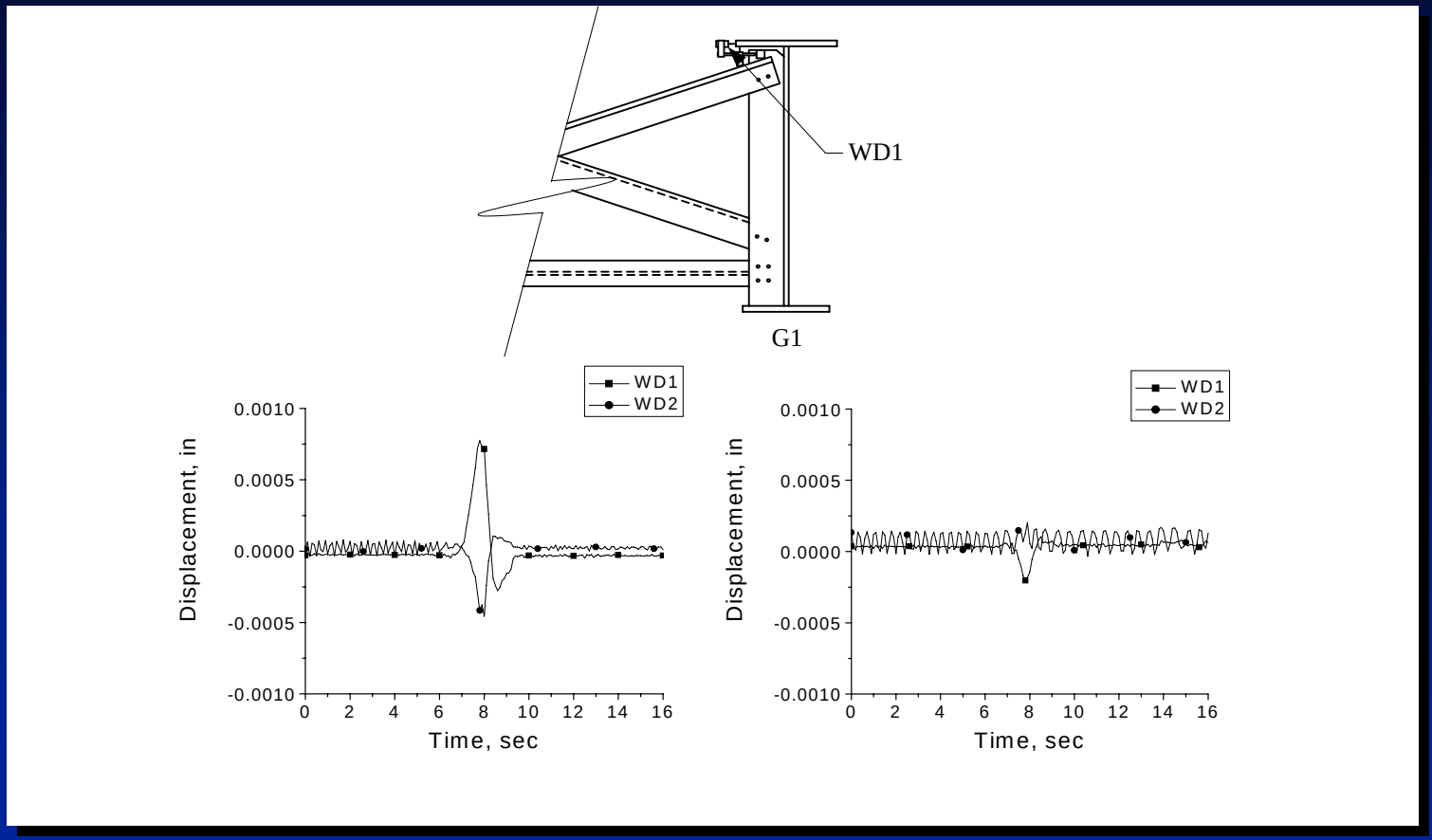
Web Gap Strain Gradient-Away From Pier



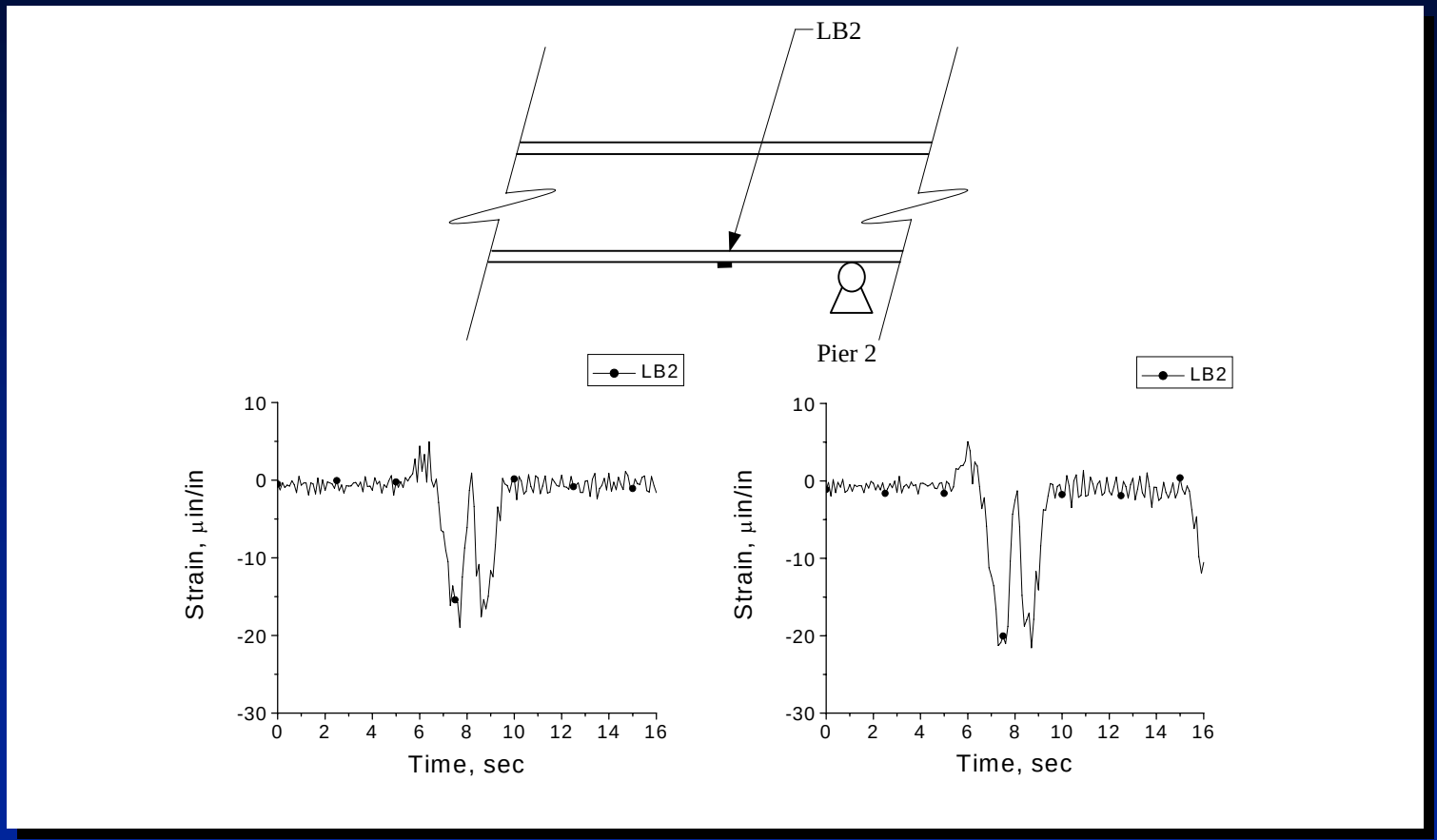
Cross-Frame Behavior



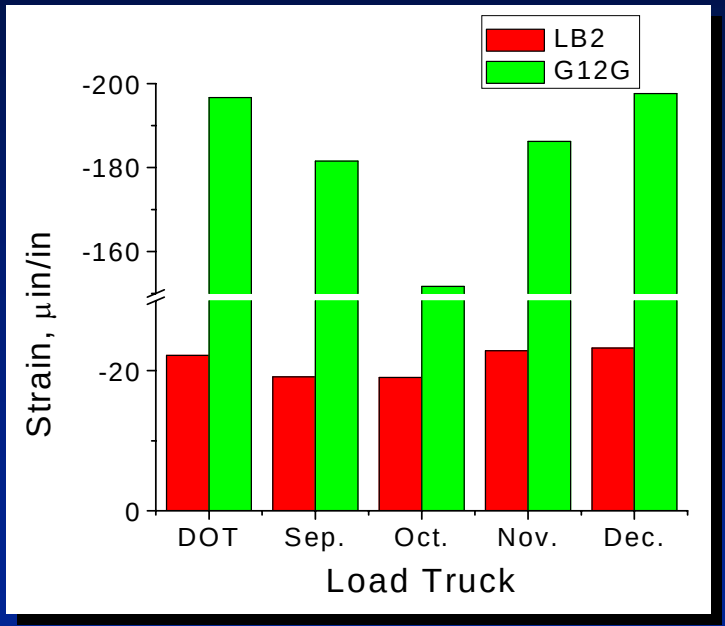
Out-of-Plane Displacement

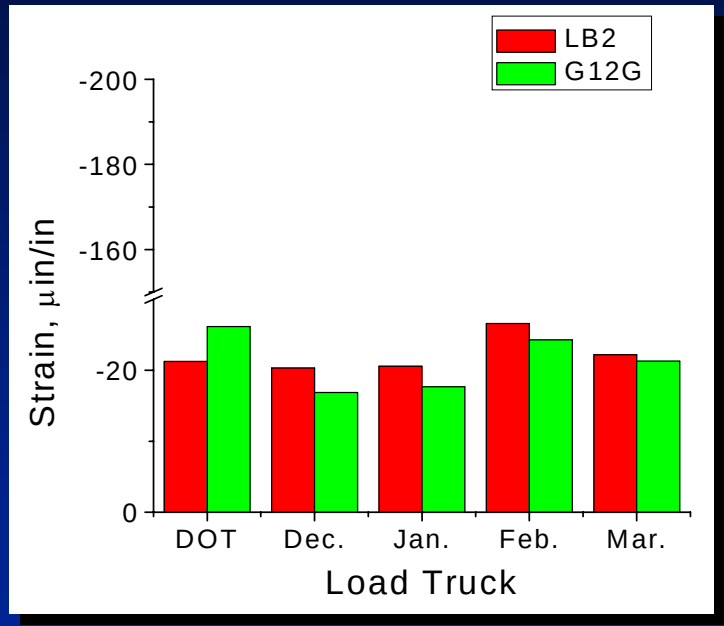


Bottom Flange-Trigger Data



Loading Variability





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.