The Perfect Storm:
Lateral Vibration of a TxDOT Pedestrian Bridge

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One week later...

Texas Tech - Oklahoma State

Instrumentation by:
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Accelerometers
Span 10

Span 11

Time (s)

Acc-1-X (g)

Acc-1-Y (g)

Acc-1-Z (g)

Acc-1-X PSD (g²/Hz)

Acc-1-Y PSD (g²/Hz)

Acc-1-Z PSD (g²/Hz)

2400s to 2700s

2.32Hz

1.6Hz

0.799Hz

0.799Hz

0.799Hz

Frequency (Hz)

15 min
Span 10

Span 11

2400s to 2700s

Acc-7-X PSD (g^2/Hz)

Acc-7-Y PSD (g^2/Hz)

Acc-7-Z PSD (g^2/Hz)

Time (s)

Frequency (Hz)

2100 2400 2700 3000

0 0.025 0.05

-0.05 -0.025

-0.05 -0.025

0 0.025 0.05

-0.05 -0.025

0 0.025 0.05

-0.05 -0.025

0 0.025 0.05

-0.05 -0.025

Acc-7-X (g)

Acc-7-Y (g)

Acc-7-Z (g)

15 min
Span 10

Span 11

Disp Y (in)

Time (s)

Accelerometer 1

Accelerometer 7
Creating a structural model to recreate TT results

- Swaying Laterally at .80 Hz
- Ends of spans moved more than mid-span of both spans
- Ends of spans moved more than bent
- All elements moving in phase (no snaking)
Existing Bridge  N.F. = .80
STIFFENING SUPERSTRUCTURE

- Remove last few feet of slab ends and re-cut slab without an expansion joint

POOR-BOY CONTINUOUS SLAB

- Stiffens super by joining spans and eliminating "hinges" at bents
- Locate at least at Bents #11 and probably at Bents 10 & 12
- Not as inexpensive as shear keys
- Discourage to pedestrians, but could use staged construction w/ longitudinal cold joint to keep bridge open
- Some will see us destroying a portion of a brand new bridge
Solution: Poor-Boy Slab at 3 Bents  N.F. = .87
- Stiffens bent thru additional columns and frame action
- Can utilize existing forms--need header in cap form--
- Most expensive retrofit
- Non-disruptive installation
Solution: Multi-Column Bent  N.F. = .99
STIFFENING BEARING PADS

- Drill & Grout Bars
- Break bond w/ paper & grease

SHEAR KEYS

- Shear keys keep pads from translating laterally
- Locate, at a minimum, at Bents 10, 11 & 12
- Least expensive retrofit
- Non-disruptive installation
Solution: Shear Keys  N.F. = 1.11
Solution: Poor-Boy Slab with Shear Keys  N.F.= 1.34
Solution: Multi-Column Bent w/ Shear Keys  N.F. = 2.09
Solution: Multi-Column Bent w/ Shear Keys and Poor-Boy Slab  N.F. = 2.45
Natural Frequencies

- Existing: 0.80
- Poor-Boy Slab: 0.87
- Multi-Column Bent: 0.99
- Shear Keys: 1.11
- Shear Keys + Poor Boy Slab: 1.34
- Multi-Col Bent + Shear Keys: 2.09
- Multi-Col Bent + Sh. Keys + Poor Boy: 2.45
Ingredients for the Perfect Storm:

- No AASHTO Bridge Spec provision
- Long Spans
- Tall, narrow column
- Tall, soft, small pads
- ADA requirement—exp. joint at every span
- Aesthetics
- Proximity to large venue
Now they tell us...

**AASHTO 2008 Interim Specification**

1.3 Hz min. lateral
Success of Retrofit?
Questions ?