Initial Field Response and Modeling of Two Skewed Steel I-Girder Bridges

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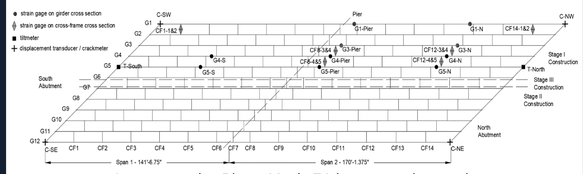
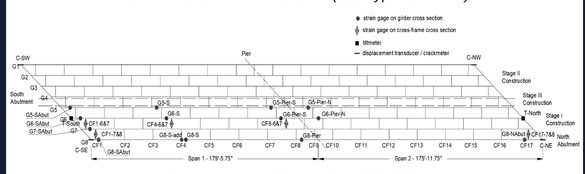
INTRODUCTION

- Short-term bridge response of major bridge superstructure components and long-term thermally-induced stresses and deformations are complicated by skew effects.
- Two two-span continuous steel I-girder bridges are instrumented for field monitoring
  - Skew = 41° with seat-type abutments (Mattis-74)
  - Skew = 48° with integral abutments (Mattis-57)
- Data acquisition system is capable of high frequency sampling up to 20Hz, data collection was started before deck pour.
- 3D finite element analyses are conducted to provide enhanced understanding of the bridge behavior.

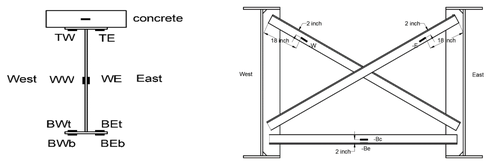
Bridge Instrumentation Plans



Instrumentation Plan – Mattis-74 (seat-type abutment)



Instrumentation Plan – Mattis-57 (IAB)



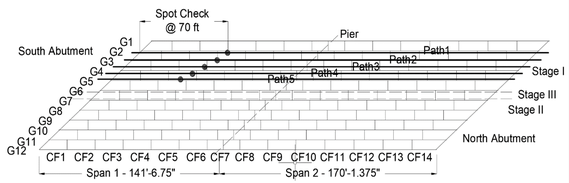
Girder and Cross-Frame Instrumentation Layout

Truck Testing

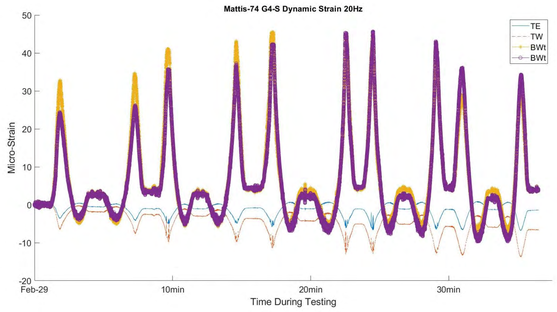
Truck testing was conducted Mattis-74 after the completion of Stage I construction.

Test truck

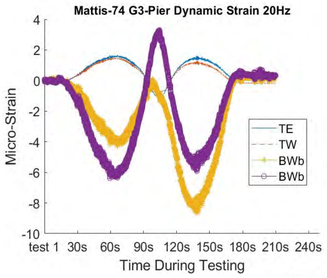
Truck paths



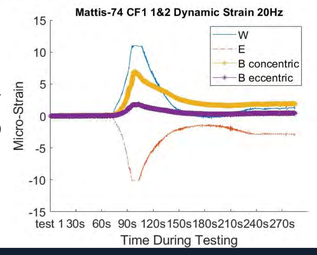
Truck Paths and Spot Check Locations on Mattis-74 Plan View



Dynamic Strain Record of Ten (10) Truck Tests – Girder Location G4-S



Dynamic Record of Girder Location G3-Pier under Truck Path 4 (Test 7)

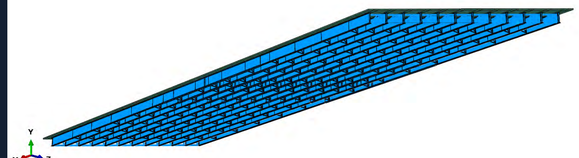


Dynamic Record of Cross-Frame Location CF1 1&2 under Truck Path 1 (Test 1)

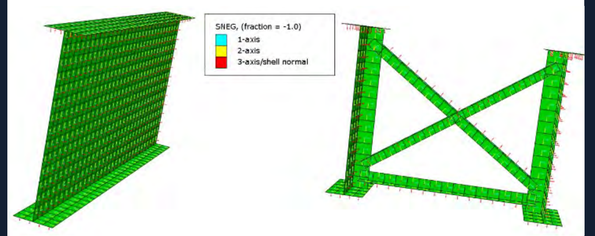
Numerical Simulations

3D finite element analysis was conducted using ABAQUS/CAE.

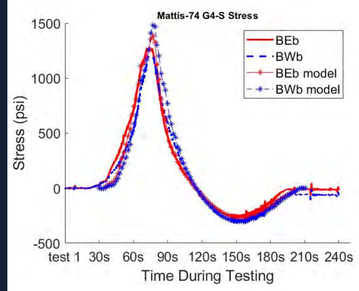
- Shell elements: steel I-girders, concrete slab and haunch, cross-frames, stiffeners
- Beam elements: bearing diaphragms
- Tie constraints: composite behavior between girders and slab, steel connection components
- Spring elements: bearings
- DLOAD user-subroutine: truck load



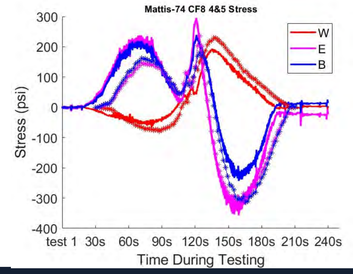
3D FEM Model of Mattis-74



Sample Mesh for Girder and Cross-Frame

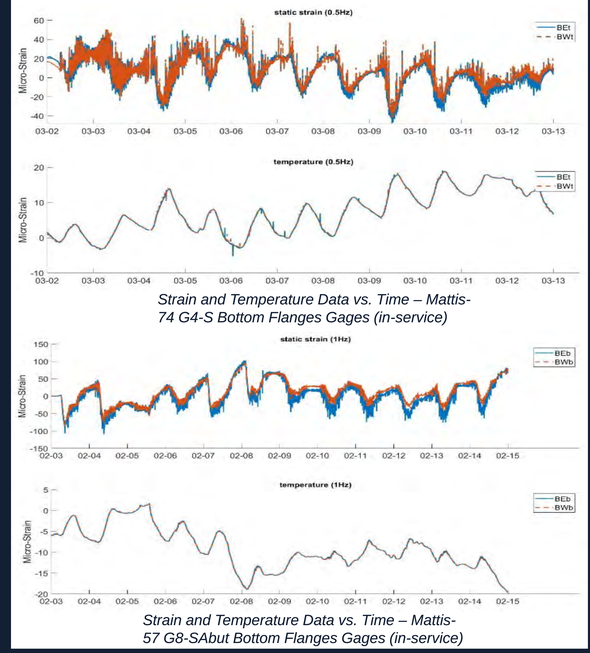


Model Validation for Bottom Gage Locations of Girder Location G4-S under Truck Path 3 (Test 5)



Model Validation for Cross-Frame Location CF8 3&4 under Truck Path 3 (Test 5)

Bridge Service Response



Strain and Temperature Data vs. Time – Mattis-74 G4-S Bottom Flanges Gages (in-service)

Strain and Temperature Data vs. Time – Mattis-57 G8-SAbut Bottom Flanges Gages (in-service)

CONCLUSIONS

- This study enriches the database of superstructure response for steel I-girder bridges and furthers the understanding of skewed steel I-girder bridge behavior.
- Numerical simulation results match well with data from field testing, which facilitates future parametric studies.

ACKNOWLEDGEMENTS

- Illinois Department of Transportation
- Illinois Center for Transportation, Project R27-194

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