Snake River Bridge Load Test Addressing Bridge Management Issues
WBES 2015 – Reno, NV

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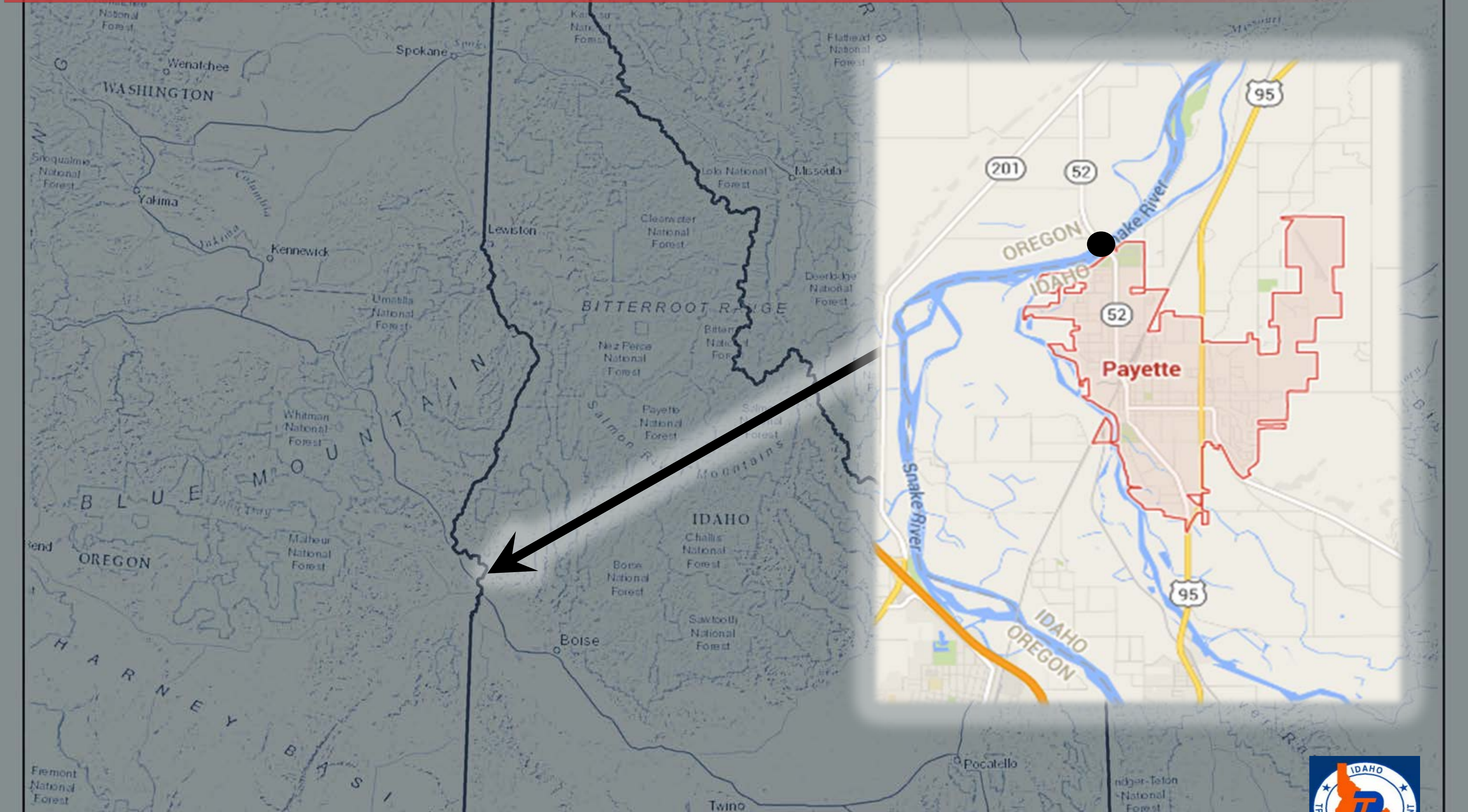
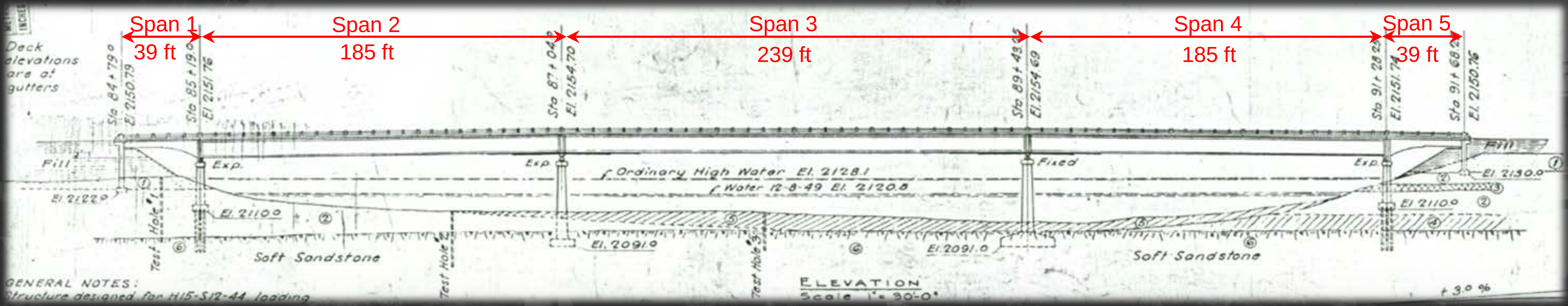
Presentation Outline

1. Description of the Structure
2. Standard Load Rating Results
3. General Problem & Selected Resolution
4. Testing Plan Overview
5. Data Review & Model Creation
6. Model Calibration Results
7. Refined Load Rating Results
8. Project Conclusions

Snake River Bridge – Location

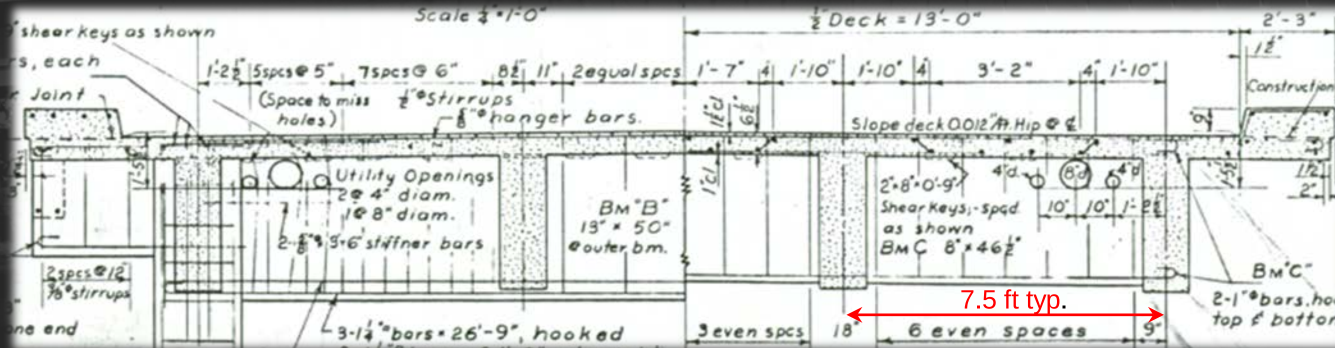


Snake River Bridge – Overall Details

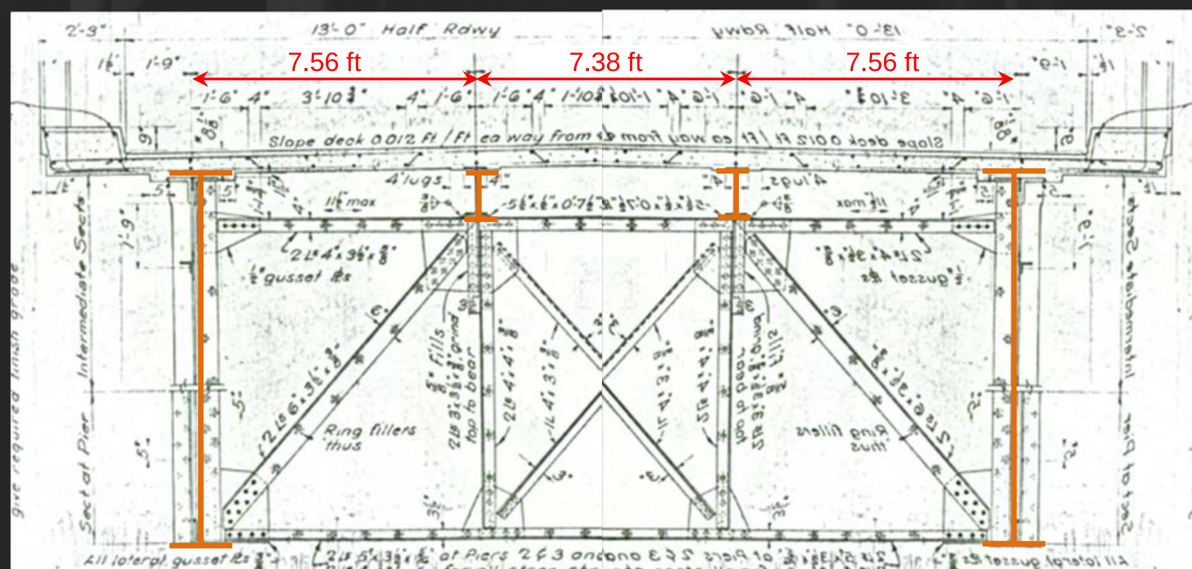


Snake River Bridge – Structure Type

Typical Section Spans 1 & 5 (Reinforced Concrete)



Half Typical Section Spans 2, 3, & 4 (Steel)



Snake River Bridge – Initial Load Rating Results

Oregon DOT Rating (LRFR) Using BRASS Software

Vehicle	Vehicle Wt. (kips)	LRFR Legal Rating Factors	Controlling Member	Controlling Location	Controlling Limit State
ODOT Type 3	50	1.00	Steel Girder	Span 2 @ 0.35L	Positive Flexure
ODOT Type 3S2	80	0.73	Steel Girder	Span 2 @ 0.35L	Positive Flexure
ODOT Type 3-3	80	0.73	Steel Girder	Span 2 @ 0.35L	Positive Flexure

TD Rating (LFR) Using AASHTOWare Bridge Rating Software

Vehicle	Vehicle Wt. (kips)	LFR Operating Rating Factors	Controlling Member	Controlling Location	Controlling Limit State
Idaho Type 3	54	0.62	Steel Stringer	Span 4 @ 2.0	Negative Flexure
Idaho Type 3S2	79	0.69	Steel Stringer	Span 3 @ 2.0	Negative Flexure
Idaho Type 3-3	79	0.72	Steel Stringer	Span 2 @ 9.0	Negative Flexure

Snake River Bridge – General Problem & Resolution

Diagnostic Testing Overview

Testing Goal - To capture the overall structural behavior of the primary girders and floor system.

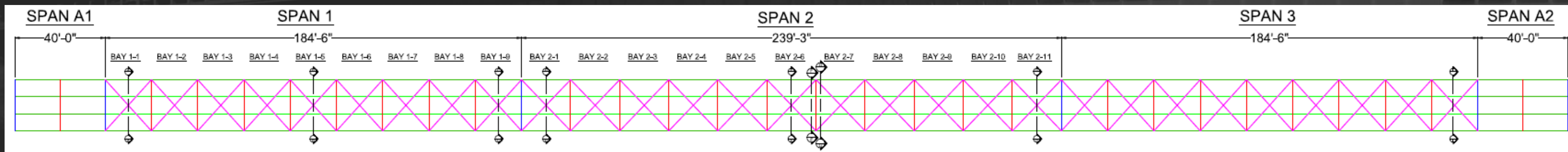
Key factors of testing plan:

- ❖ Recorded continuous data under a moving load
- ❖ Installed enough sensors to measure global structural behavior
- ❖ Applied large enough load to capture reliable readings

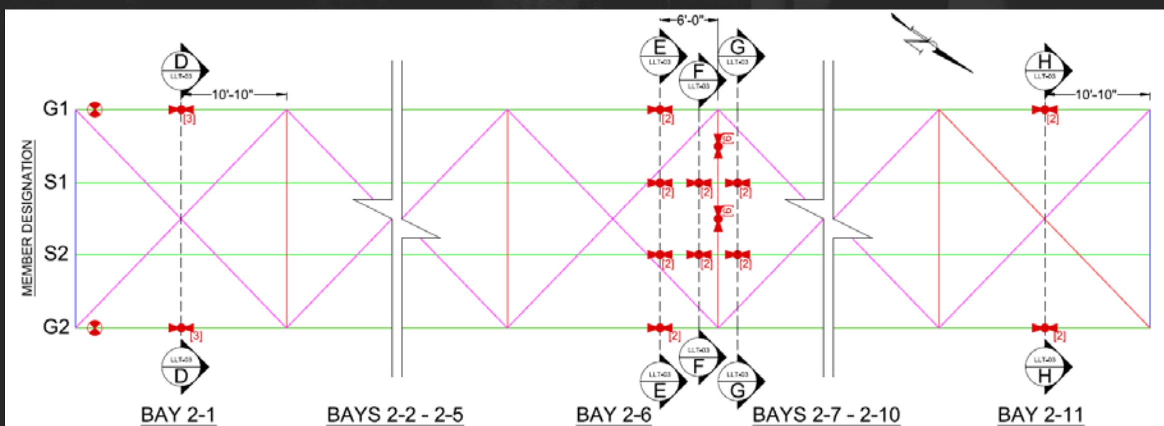
Instrumentation Plan Overview

The instrumentation plan included:

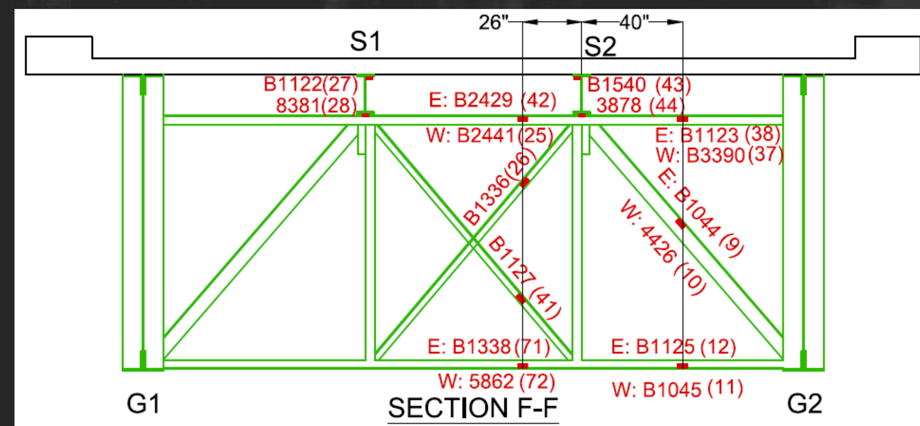
- 62 Strain Transducers
- 6 Rotation Sensors
- 1 Load Position Sensor



Overall Plan

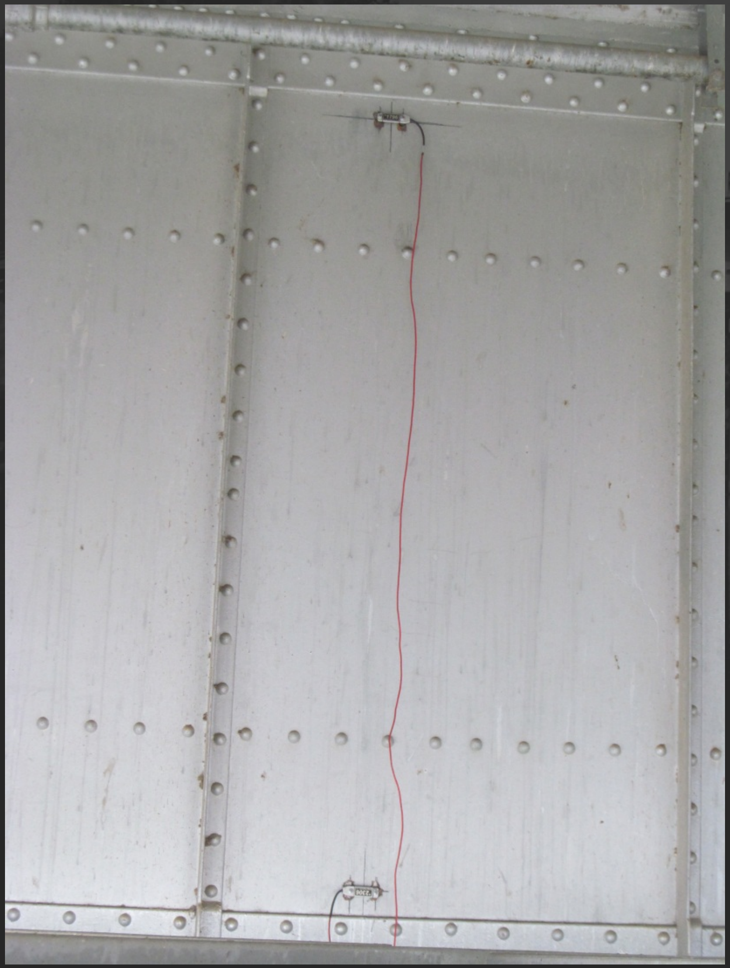


Span 2 Plan



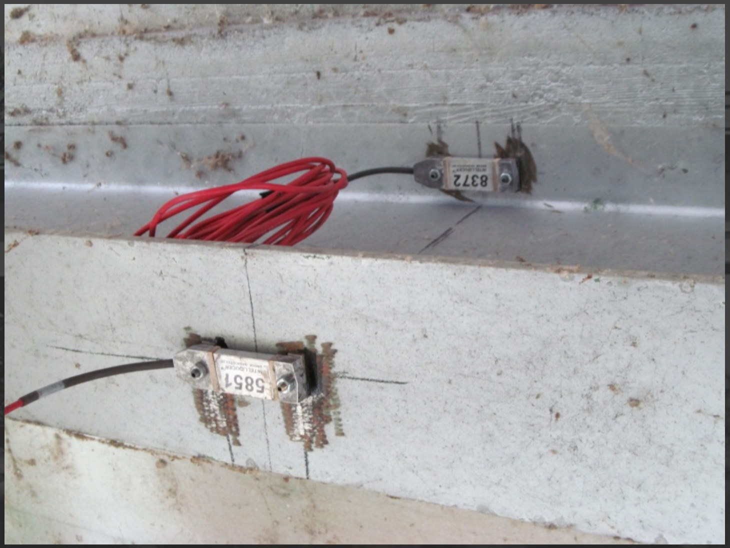
Cross-section near Bay Point

Instrumentation Details



Girder Flexure & Composite Action with Deck

Girder Rotations & Support Behavior

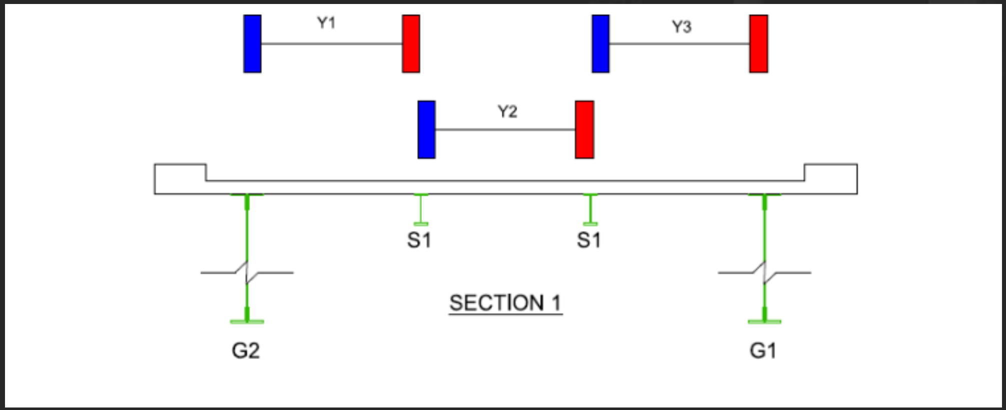


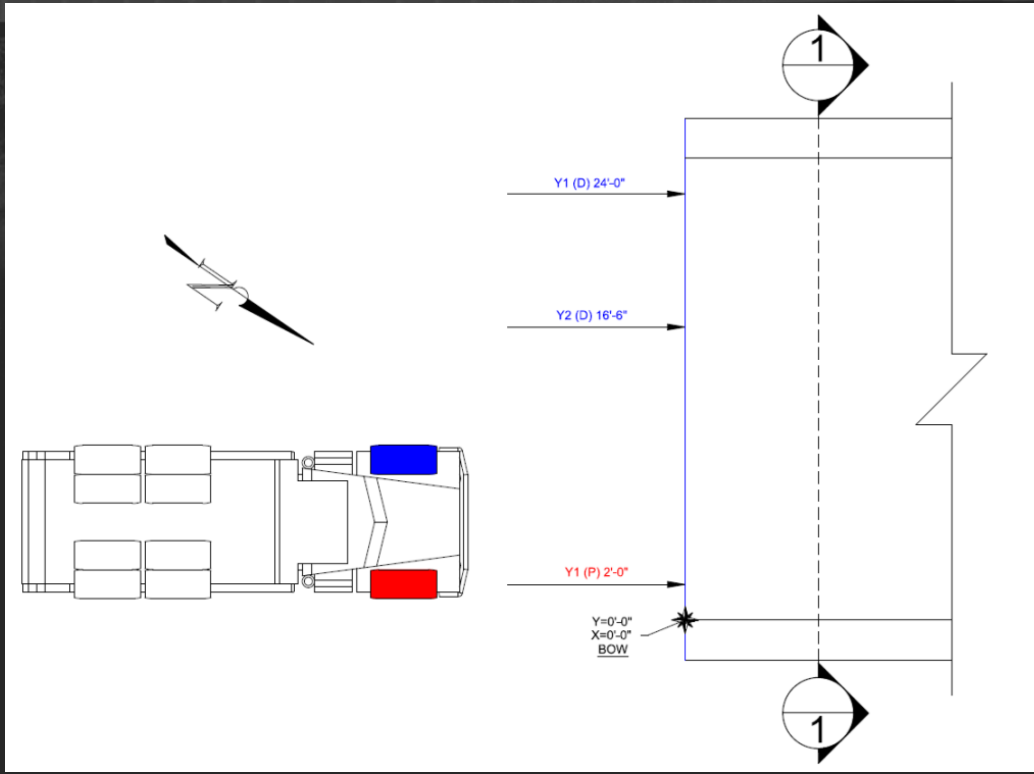
Stringer Flexure & Floor System Distribution

Bracing Forces & Distribution

Testing Plan Overview

- Single & double truck configurations
- Test vehicles were the only vehicle on the bridge
- Crossed the structure at 3-5 mph
- Symmetric load paths





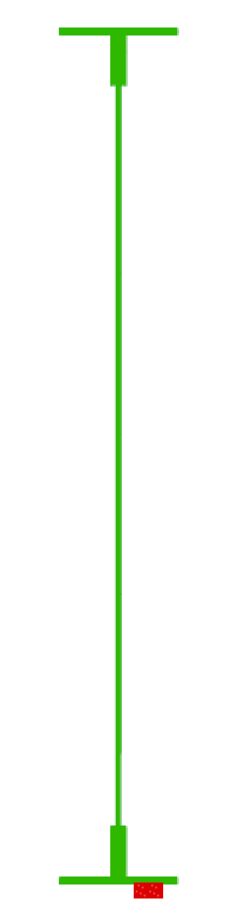
Load Configurations Used

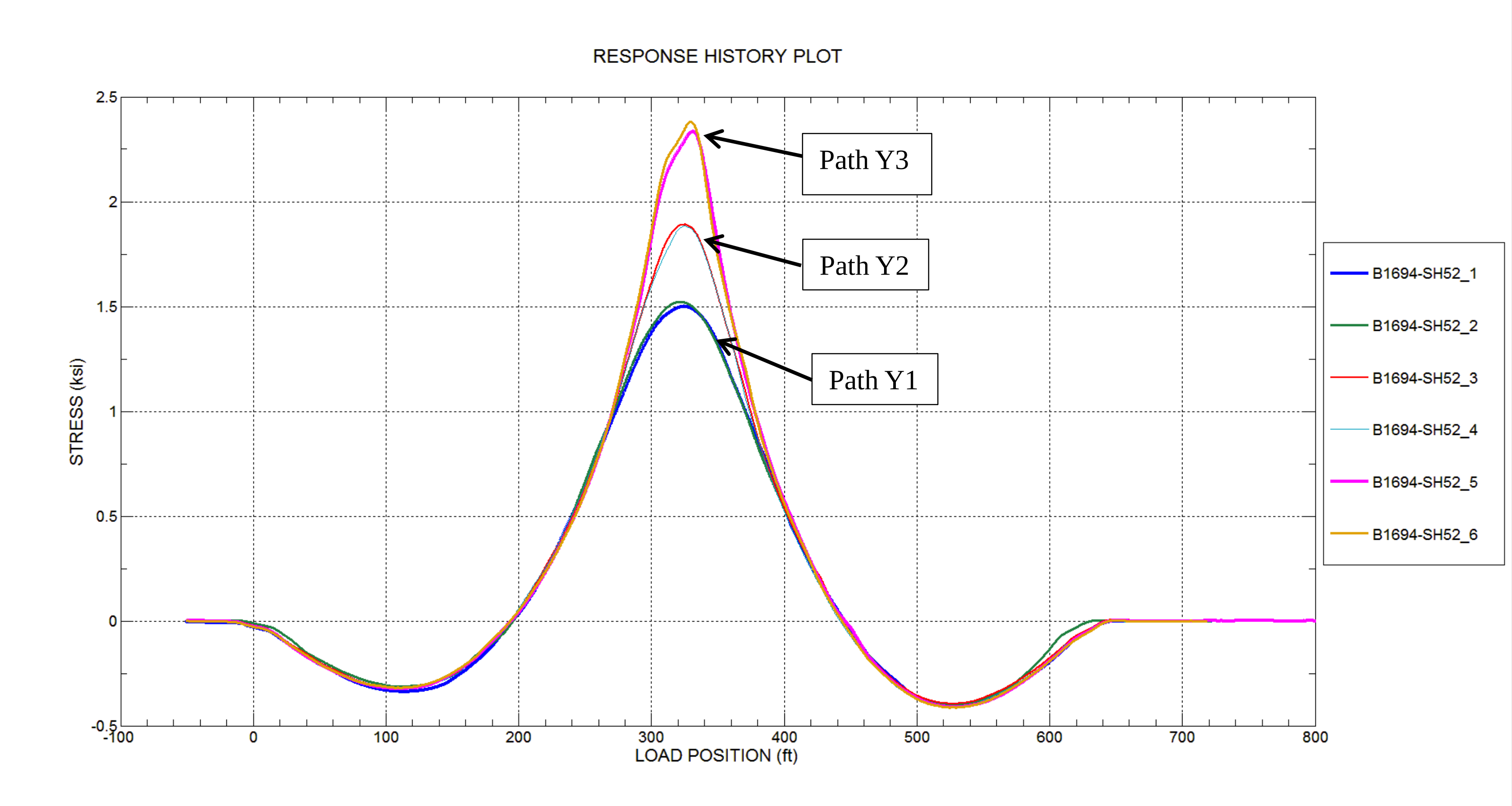
Test along Truck Path Y2

Setup of Tandem Double Truck Test

Data Quality Review

Girder Stress Reproducibility Plot

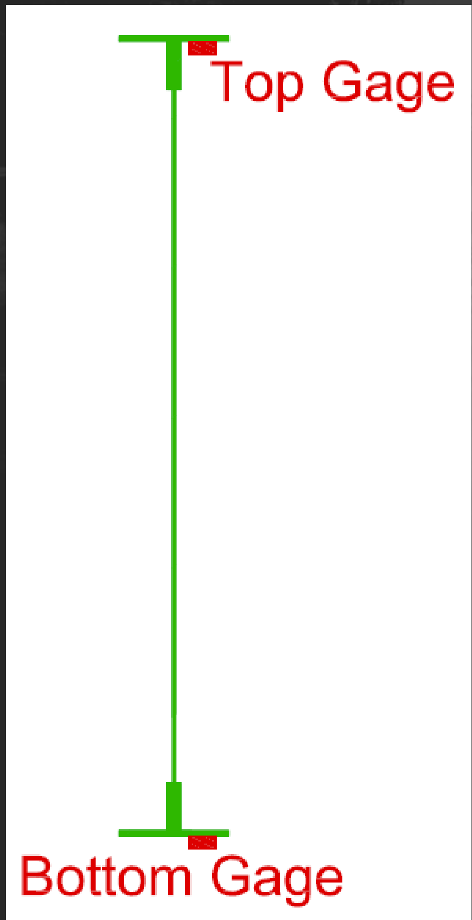


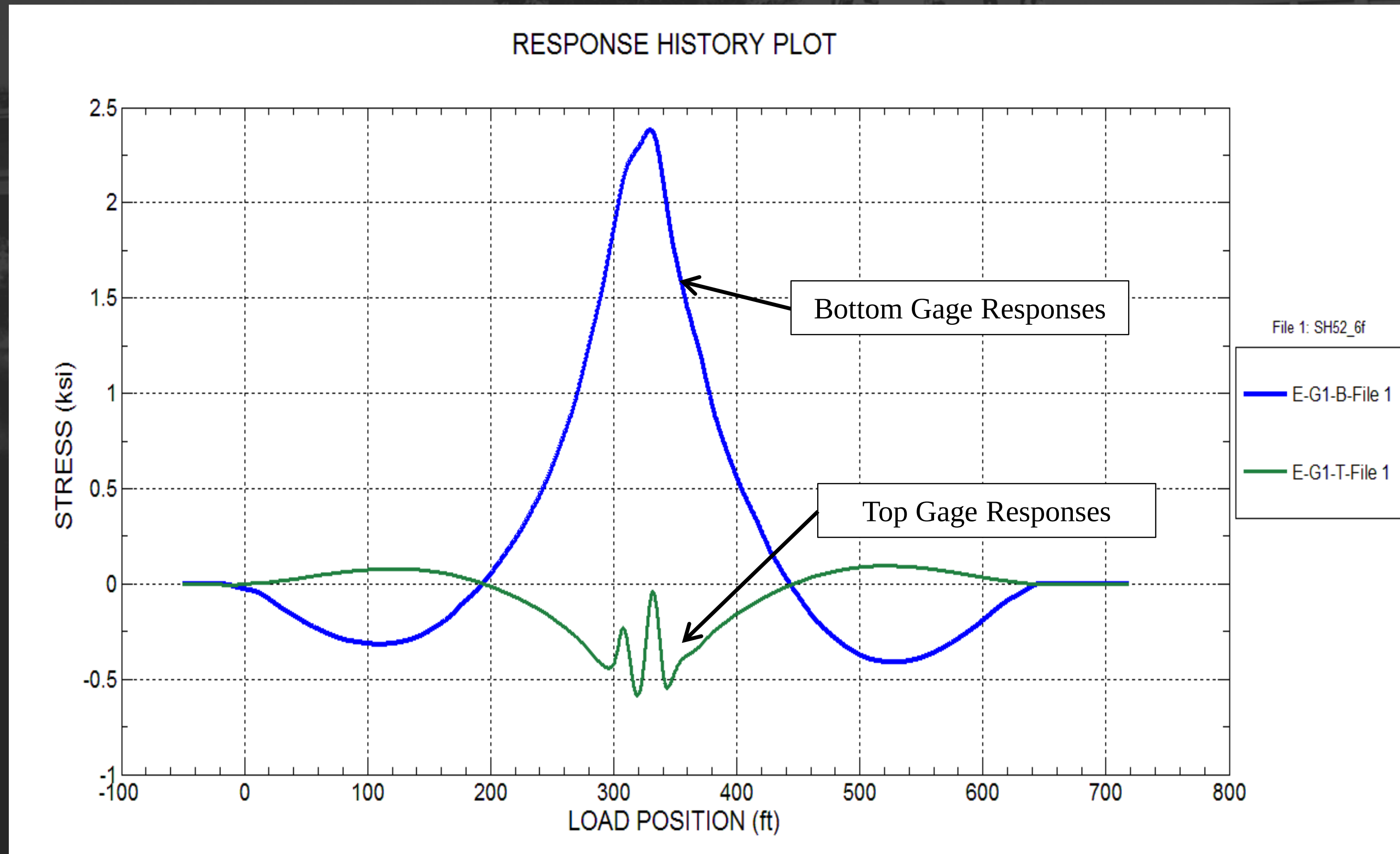


Bottom Flange Stress near Midspan

Response Behavior Review

Verification of Composite Behavior using gage pairs

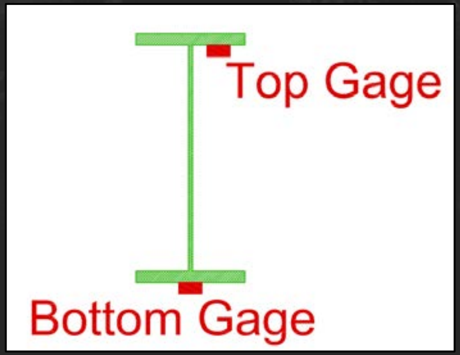


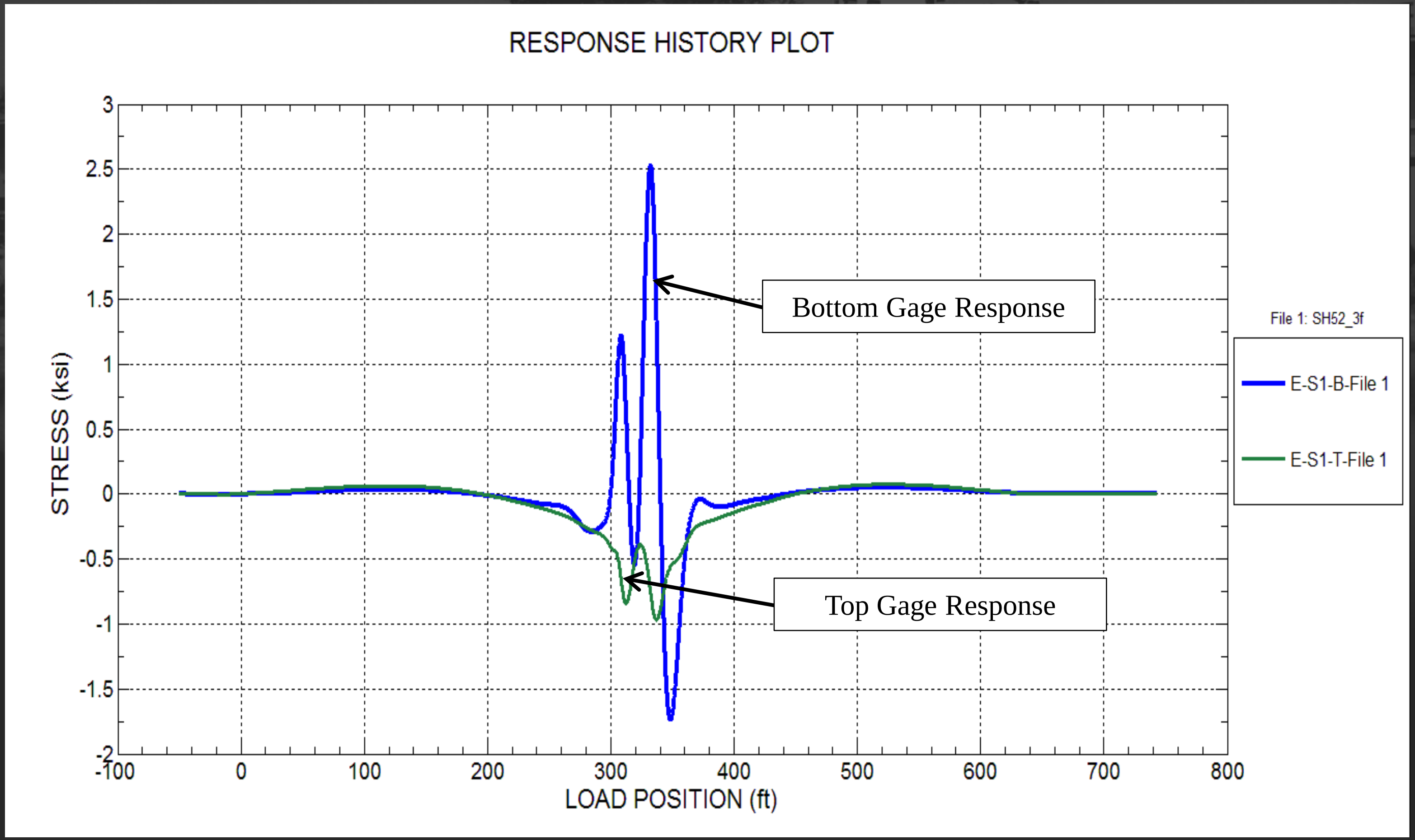


Gage Pair on Girder – Showing composite action

Response Behavior Review

Verification of Composite Behavior using gage pairs

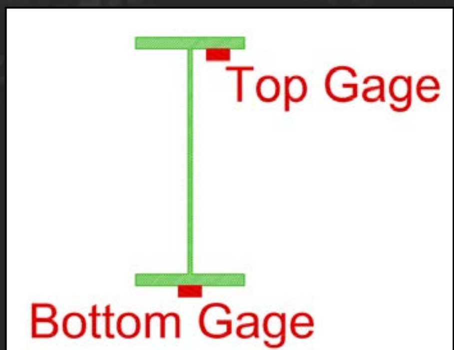


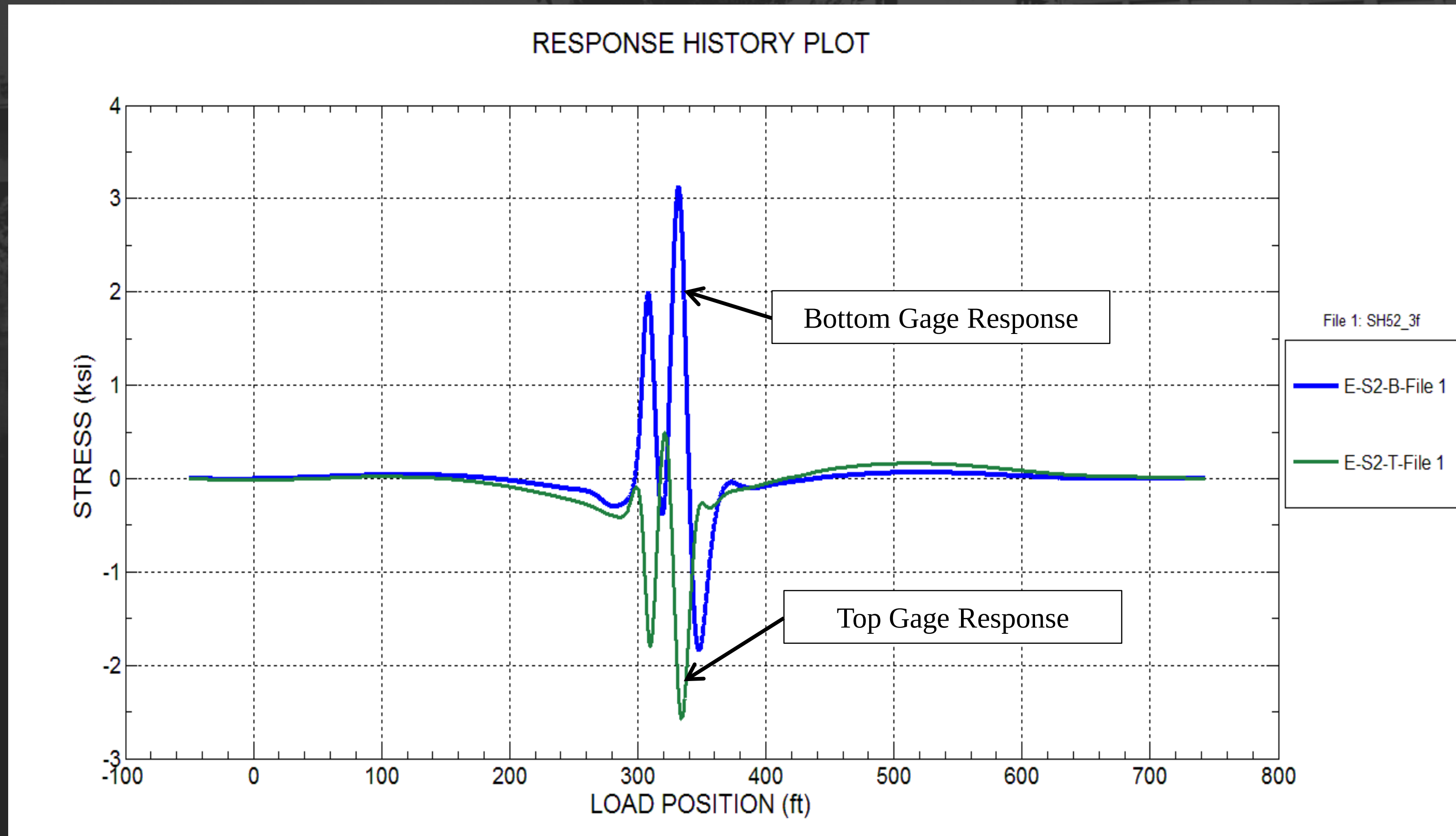


Partial composite action in Stringer

Response Behavior Review

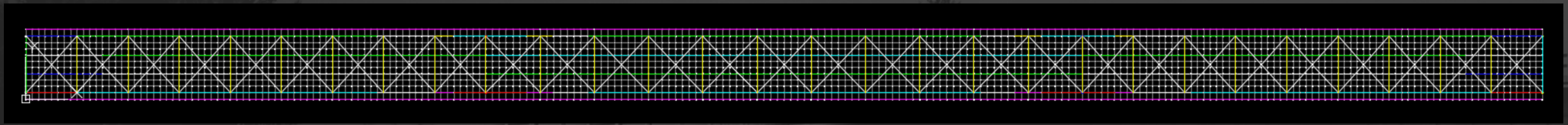
Verification of Composite Behavior using gage pairs



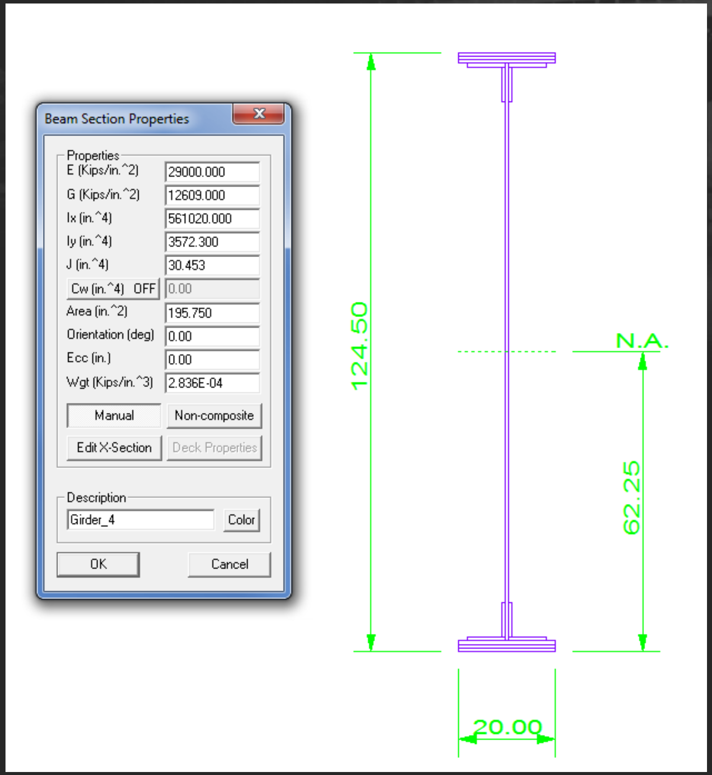


Non-composite action in Stringer

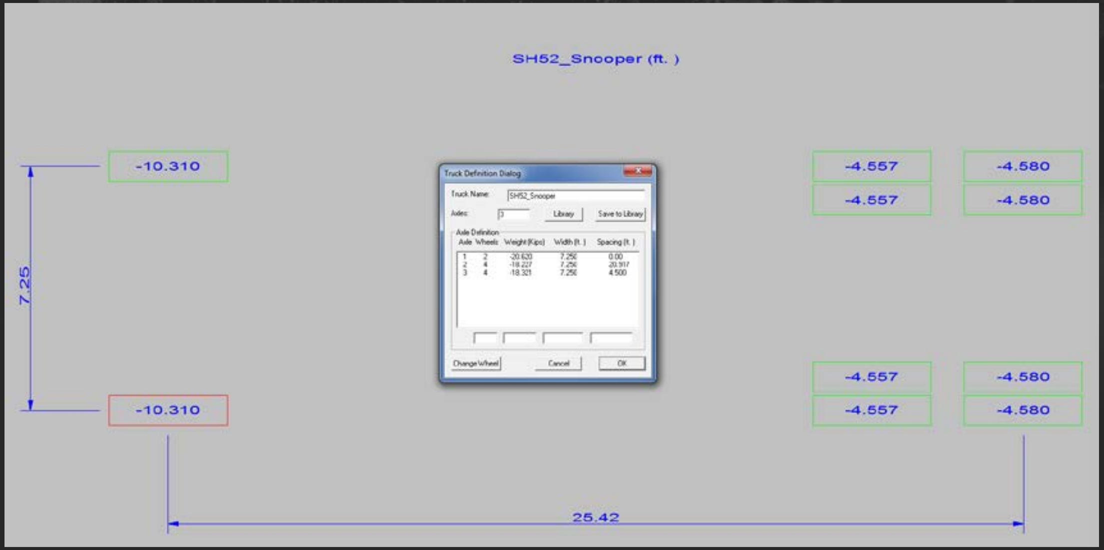
Model Creation and Test Simulation



Plan View of Structure Model

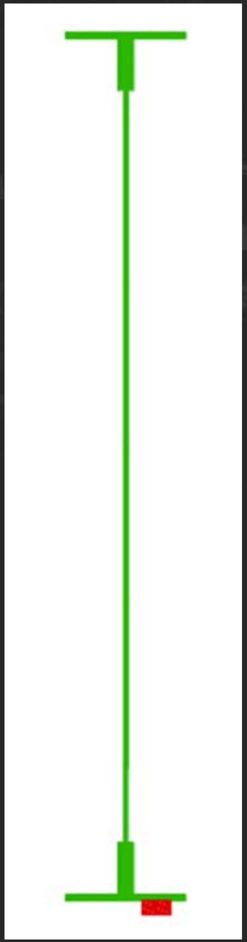


Modeling of Members

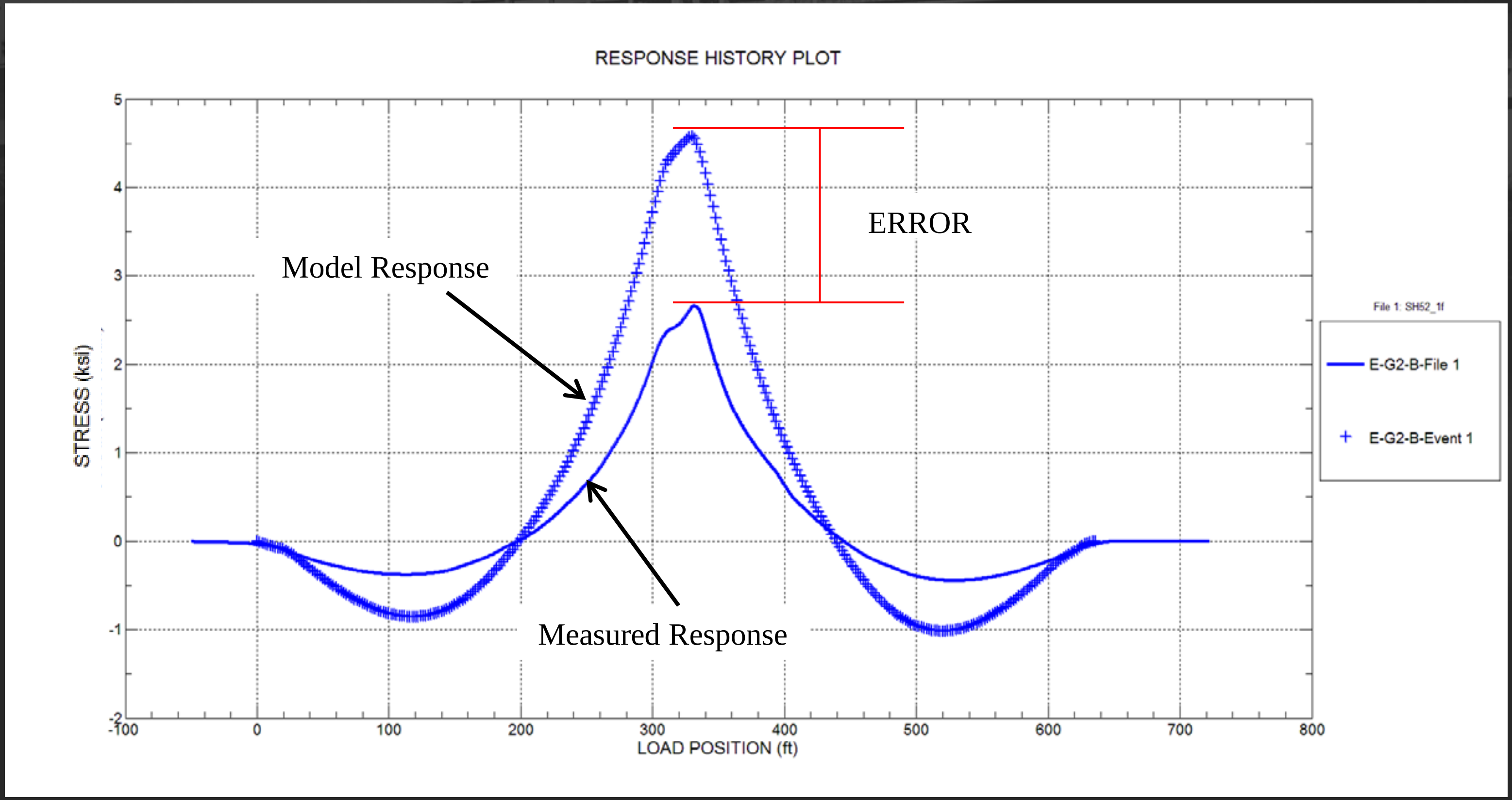


Modeling of Test Load

Model Calibration – Response Comparisons



Initial Model Comparison Plot



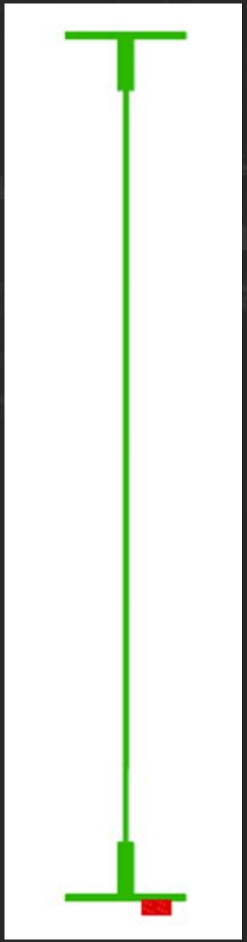
Girder Bottom Stress near Midspan

Model Calibration Overview

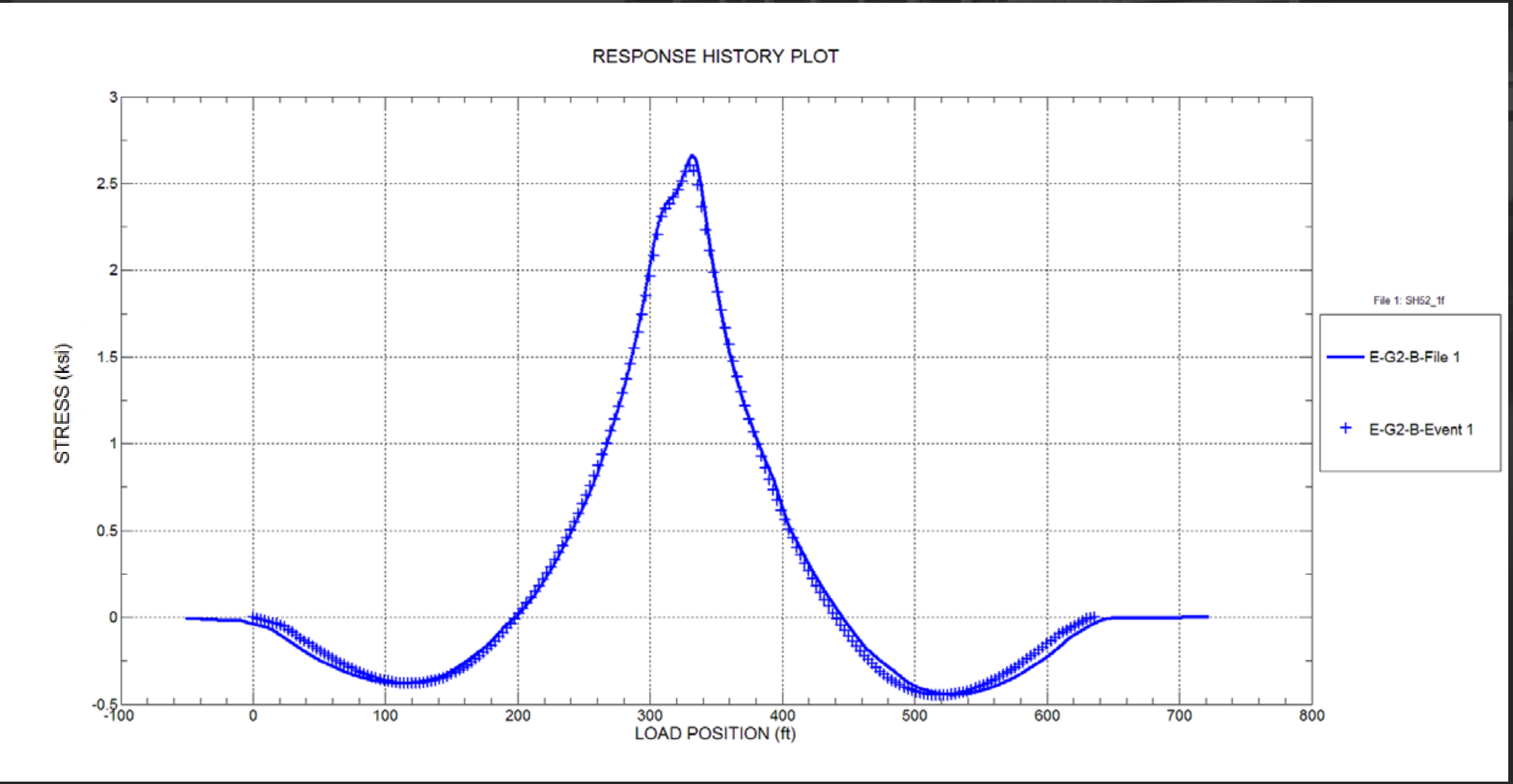
Key optimization parameters:

- ❖ Composite action in the girders and stringers
- ❖ End restraint at the supports
- ❖ Continuity between spans
- ❖ Load distribution of the floor system
- ❖ Load distribution between girders

Model Calibration – Response Comparisons



Final Model Comparison Plot



Girder Bottom Stress near Midspan

Model Calibration – General Results

- Girder composite action with deck varied
  - Composite at midspan
  - Non-composite near the ends of the steel spans
  - Partially composite near and over the piers
- Varying composite action in the stringers but did not greatly effect the floor systems' distribution
- The bottom cross-bracing (at bay points) was found to play a large part in the girders' load distribution
- Friction based end-restraint behavior reduced the girder moments

Refined Load Rating Procedures

Once calibrated, the model was adjusted to ensure the reliability of all optimized model parameters.

- ❖ All girder and stringer elements were made fully non-composite with the deck
- ❖ The end-restraint at the supports was significantly reduced
- ❖ The slab stiffness was reduced

Once the model was adjusted:

- ❖ Structural responses were obtained from the adjusted model
- ❖ Member capacities were determined from AASHTO LFD Standard Specifications

Refined Load Rating Procedures & Results

Load rating was performed on all stringer & girder elements using AASHTO LFR guidelines

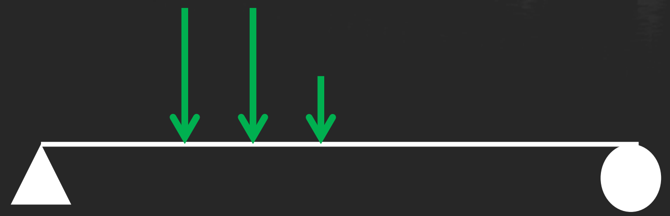
Rating Vehicle	Location/Limiting Capacity	Inventory Rating Factor	Inventory Rating Weight, Tons	Operating Rating Factor	Operating Rating Weight, Tons
HS-20	Girder Midspan / Positive Flexure	1.27	45.7	2.12	76.3
Idaho Type 3	Stringer / Positive Flexure	1.86	50.2	3.10	83.7
Idaho Type 3S2	Girder Midspan / Positive Flexure	1.50	59.3	2.50	98.8
Idaho Type 3-3	Girder Midspan / Positive Flexure	1.48	58.5	2.47	97.6
Idaho 121K	Girder Midspan / Positive Flexure	1.09	65.9	1.82	110.1
Idaho NRL	Girder Midspan / Positive Flexure	1.32	52.4	2.20	88.0

Testing Conclusions #1 - Girders

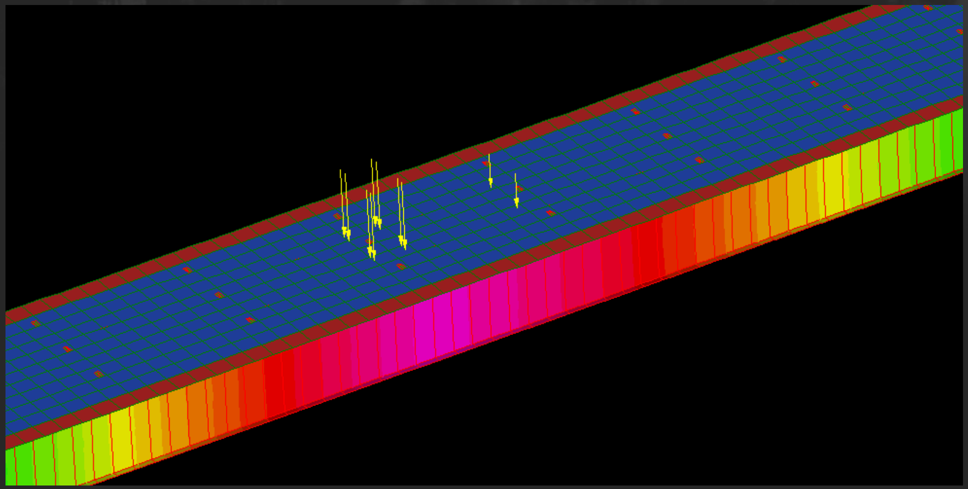
The distribution of live-load between the girders was 8 to 20 % better than AASHTO distribution factors.

Structural conditions that influenced the actual load distribution included:

- The presence of the bay point bracing
- Wheel loads applied near the middle of the roadway reach the girders in a distributed fashion rather than as point loads

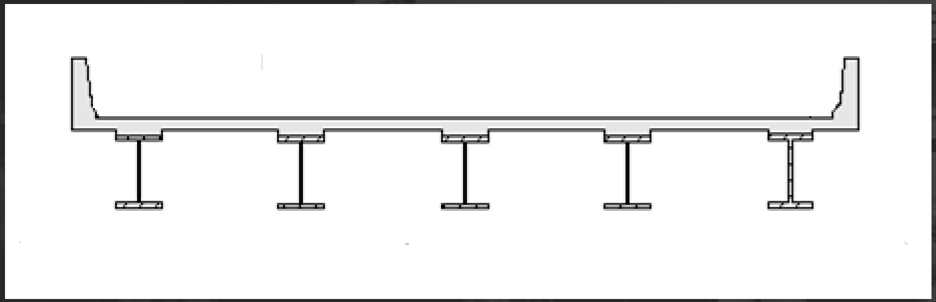


VS

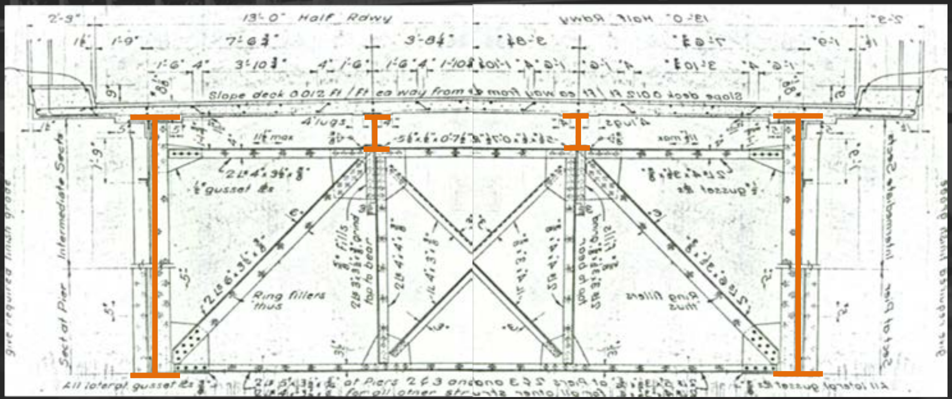


Testing Conclusions #2 - Stringers

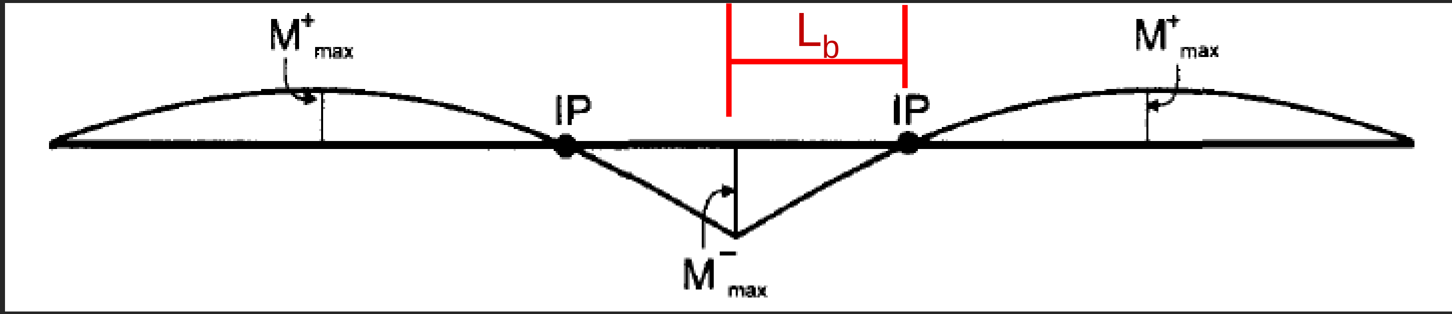
Stringer live-load effects were also found to be significantly different than calculated by AASHTO DFs **(~60% better)**



VS



Through the field-verified model, BDI was able to increase the stringer negative moment capacity



Overall Conclusions - ITD

- ITD used BDI's findings and reanalyzed the structure internally
- POSTING REMOVED!
- User costs were not increased due to retrofit and the community's economy and fire response time was no longer hindered
- This case study shows how bridge owners used evaluation tools at their disposal to solve a bridge management problem

THANK YOU!
QUESTIONS?