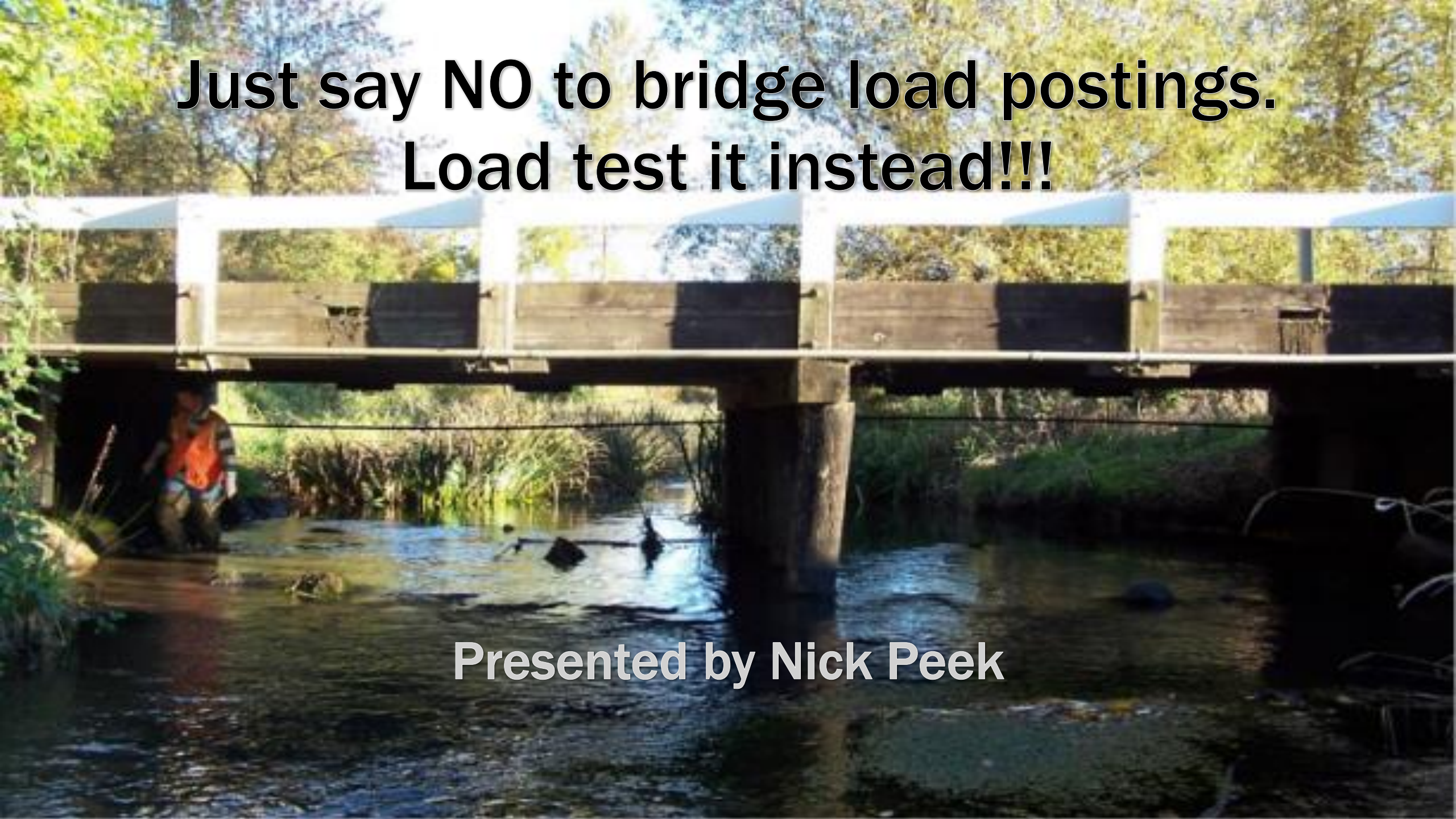

Just say NO to bridge load postings.
Load test it instead!!!
Presented by Nick Peek

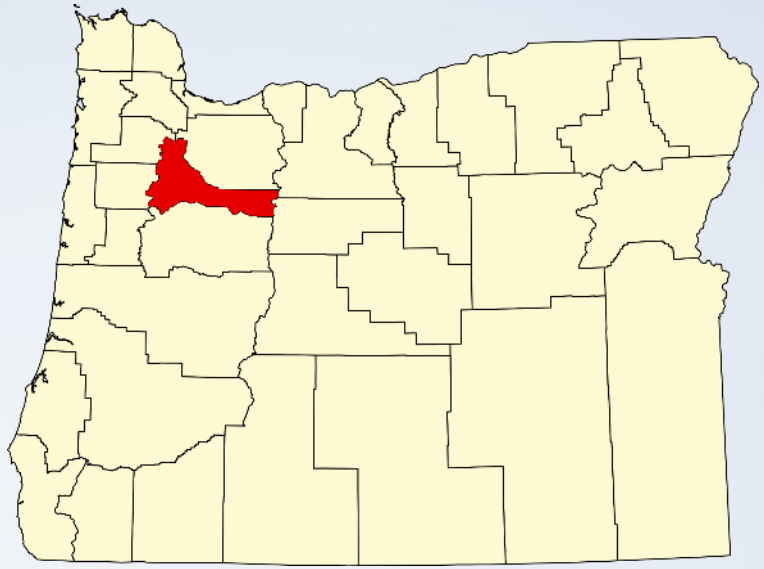
Overview

- Marion County Bridge Inventory
- Timber Slab Bridge Background
- Load Rating Basics
- What is a Load Rating Refinement?
- Live Load Testing
- Next Steps?

Project Location:

Marion County
OREGON

- 1194 sq mi
- Population of 347,000



Marion County Bridge Inventory

Rosebud Lane: Sidney Ditch

Marion County Has:

- 141 NBI (Over 20-ft) Bridges
- 61 Load Posted Bridges
- 22 Bridges In Good Condition
- 104 Bridges In Fair Condition
- 15 Bridges In Poor Condition

Load Posting Impacts:

- Increased Costs to Businesses for Detouring
- Limited Service to "Dead Ends"
- Emergency Response Delays

Posting Requirements:

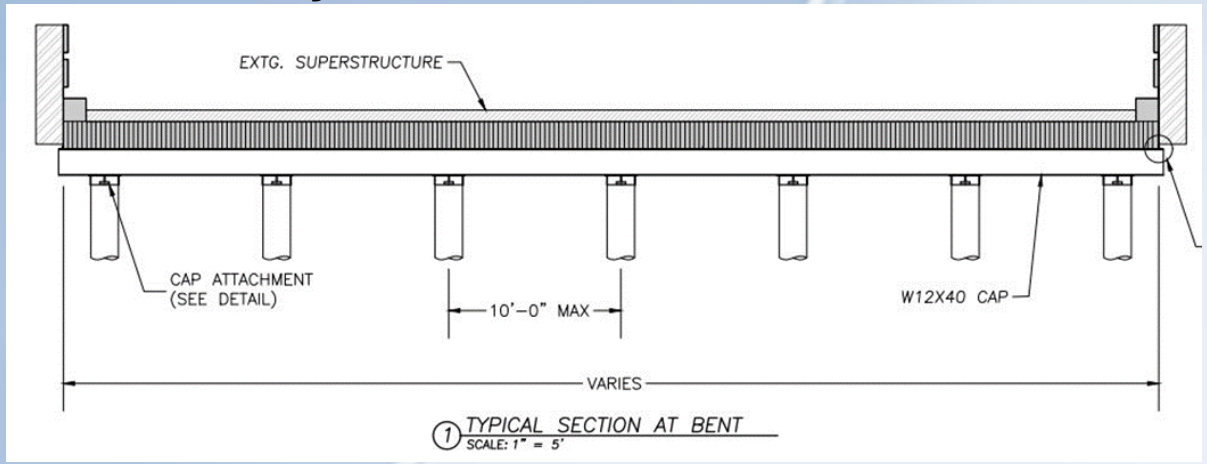
- Posted Within 30 Days Notice
- Posting Entails
  - Signing Plan
  - Ops Fabrication
  - Installation Time

Independence: Willamette River Bridge

Timber Slab Bridge

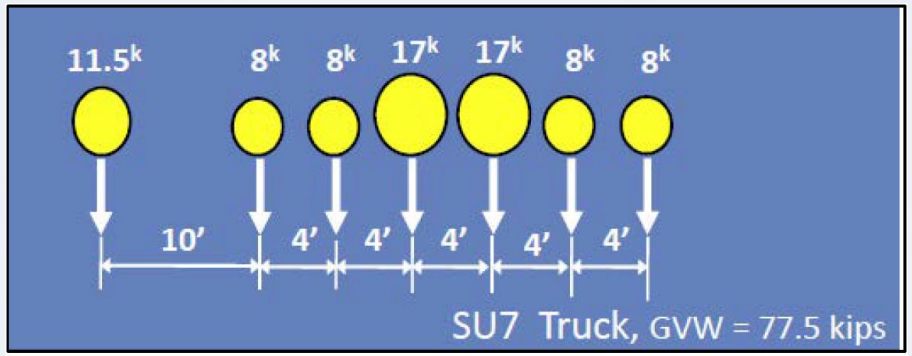
Marion County has 57 of these bridges

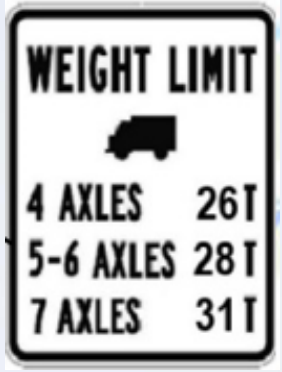
- What They Are:



- Their Condition
  - Good – 2
  - Fair - 51
  - Poor - 4

- Number of Timber Slabs Posted – 51
- Primary Configuration – Multi-Span
- Controlling Member – Interior Cap
- Controlling Load - SHVs



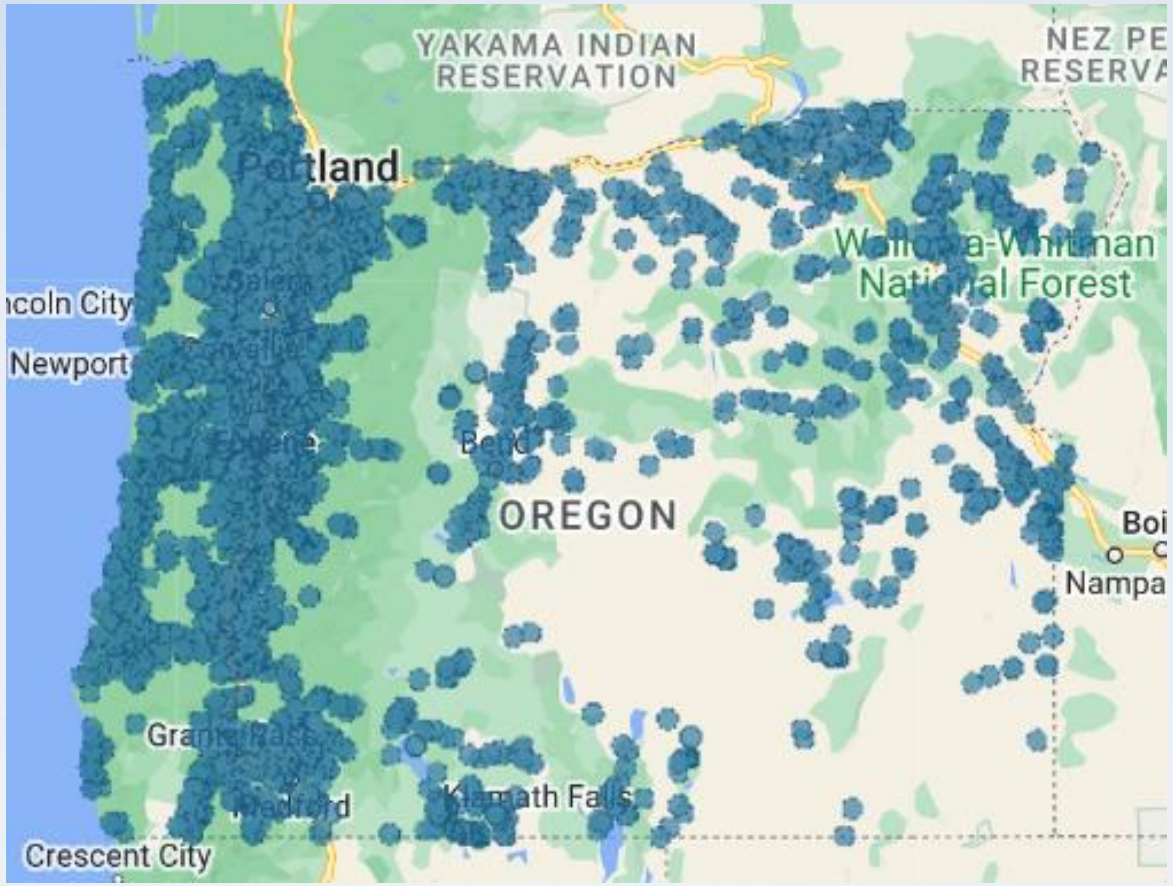


Trivia Challenge –
How many Bridges are in Oregon?

8,292

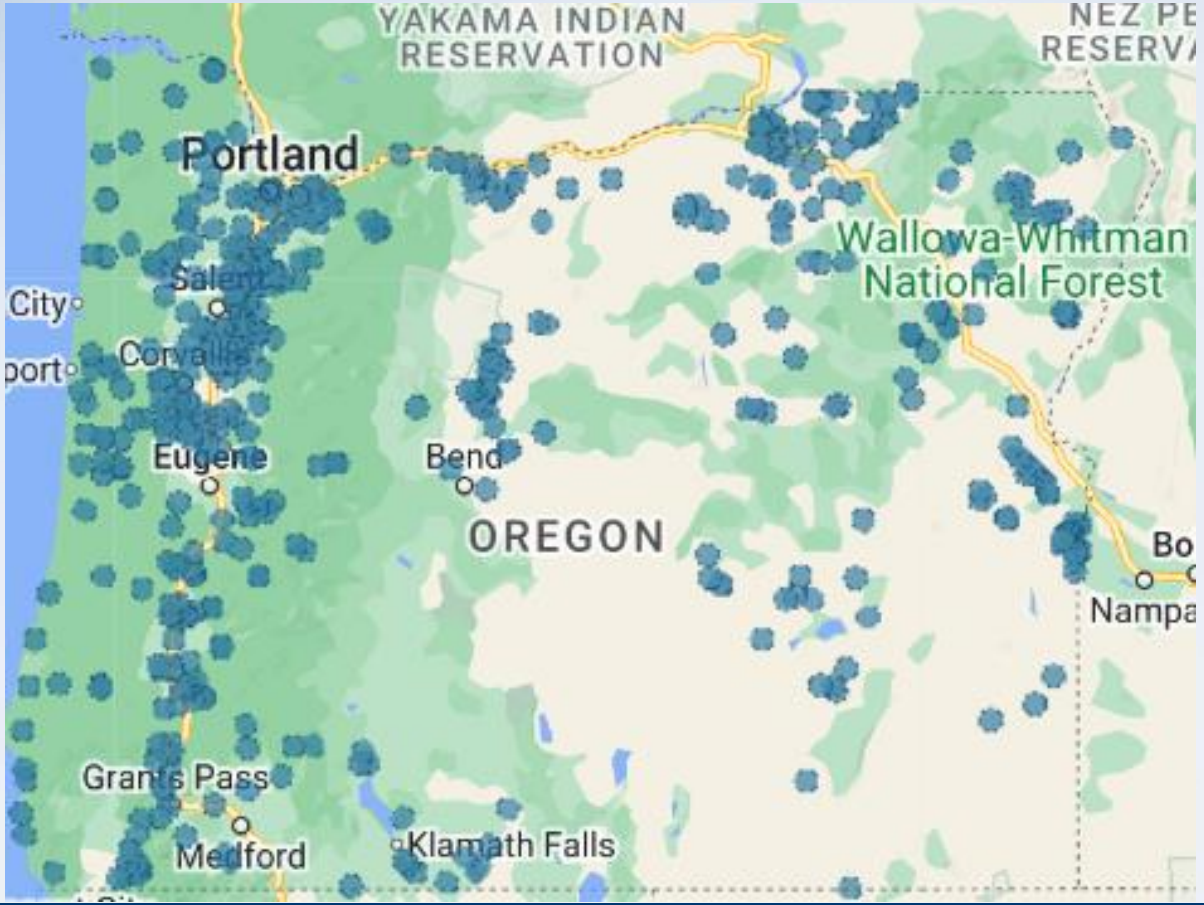
Trivia Challenge –
How many Bridges are owned by Counties?

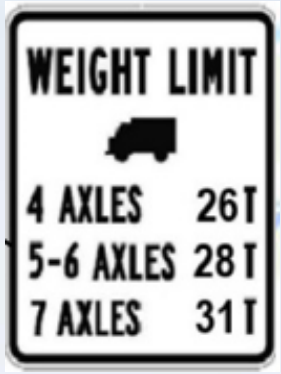
3,446



Trivia Challenge –
How many are load posted?

555



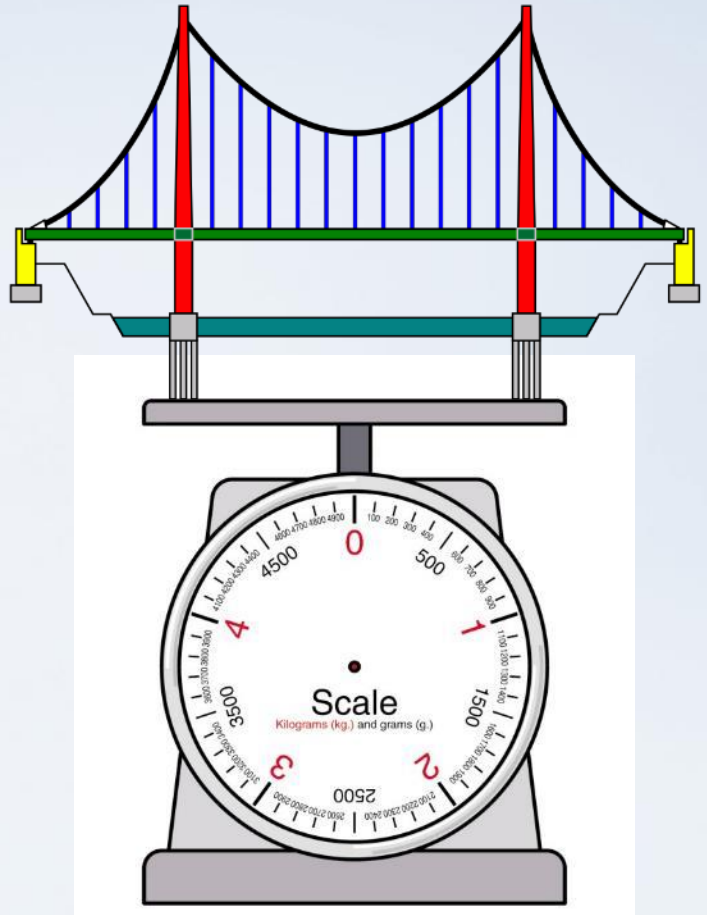


Load Rating Background

$$Rating\ Factor = \frac{Capacity\ - Dead\ Load}{Live\ Load}$$

LOAD RATING BASICS: DEAD LOADS

- ESTIMATE THE WEIGHT OF THE BRIDGE
- ESTIMATES ARE USED TO REDUCE THE EFFORT
- ESTIMATES ARE USUALLY CLOSE ENOUGH
- WHEN ALL THE WEIGHTS ARE SUMMED UP, WE INCREASE THE LOAD WITH A 1.25 FACTOR



LOAD RATING BASICS: LIVE LOADS

LIVE LOADS: SINGLE TRIP PERMIT EXAMPLE

LIVE LOADS: SHORT HAUL VEHICLE

LIVE LOADS: Other?

Load Rating

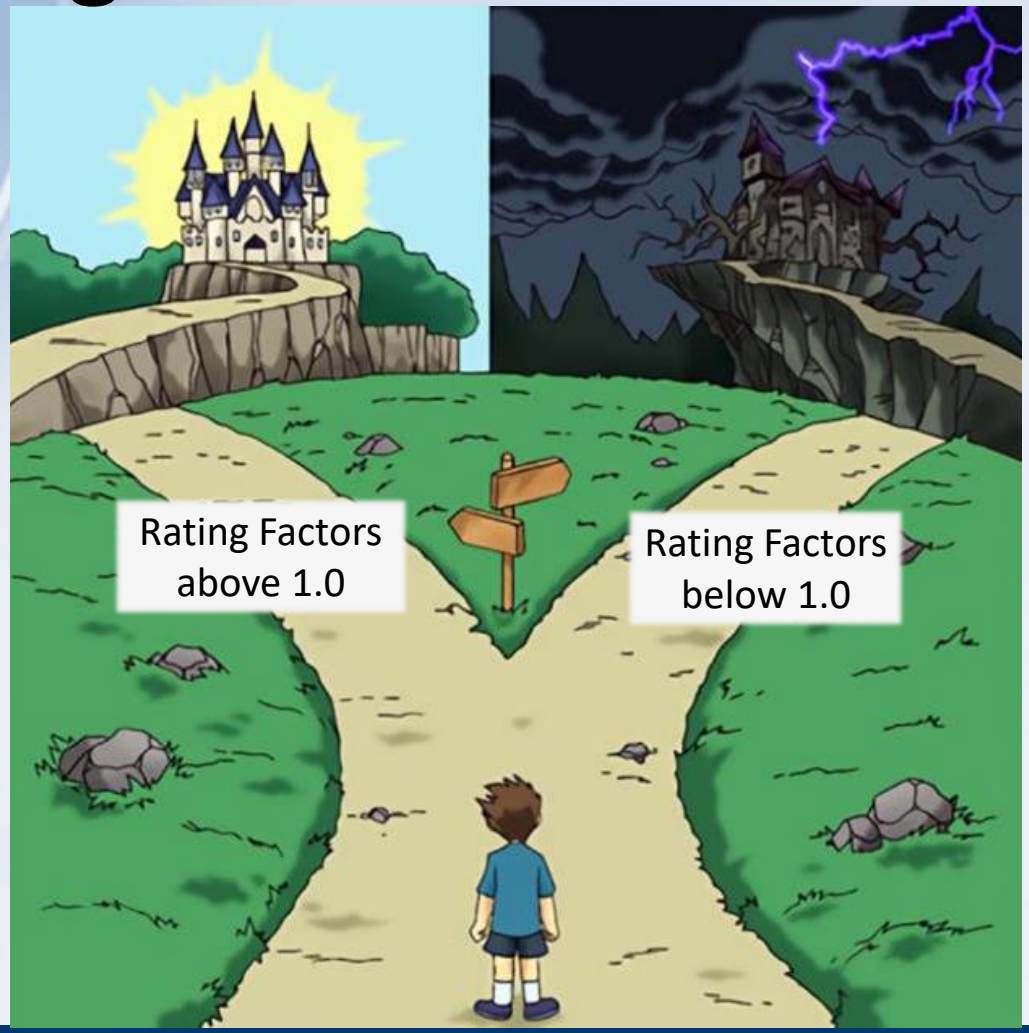
Where possible, load raters make conservative assumptions for the sake of simplicity and efficiency.

Similar members are identified, and ratings target the expected controlling cases of maximum demand and least capacity for each element. This helps reduce overall time required and control costs.

This approach is tested once the rater arrives at…

The Load Rating Crossroads

- Rating complete
- No load posting
- Good vibes



- Work to do
- Potential posting
- Bad news

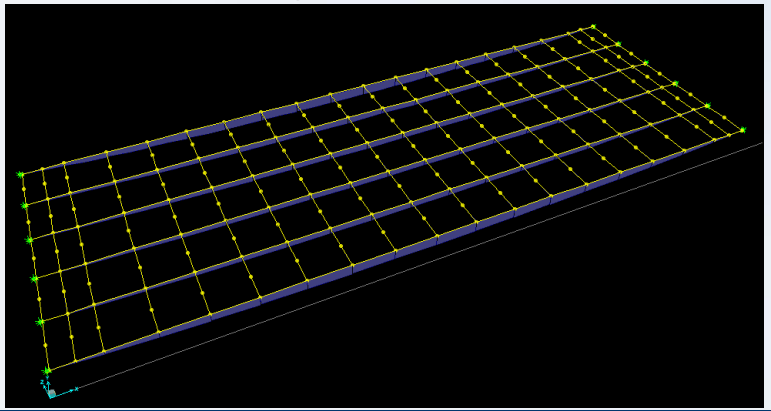
Load Rating - Refinements

What are load rating refinements?

- An attempt to revise simplifying assumptions or conservatism to remove or reduce potential load restrictions.
- Targeted to controlling members and locations.

Types of Refinements (ODOT LRFR Sect. 1.6)

- Inclusion of supplemental reinforcement
- Revised capacity calculations
- Restriction of load to in-service lanes
- Material Sampling
- Finite Element Models (refined load distribution)
- Load Testing



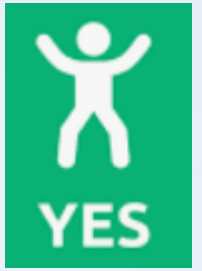
Load Rating - Refinements

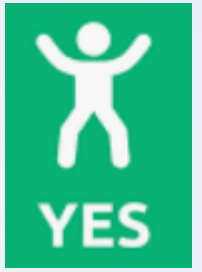
When should load rating refinements be considered?

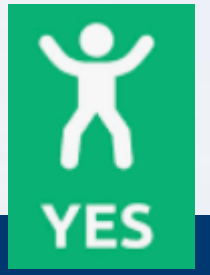
- Bridge is in good condition.
- When we have an explanation of why the bridge is performing better than expected.
- When the proposed posting is problematic for the bridge users.
- When the costs of load testing is less than the cost of strengthening

How about our timber slabs?

- Bridge is in good condition.
- When we have an explanation of why the bridge is performing better than expected.
- When the proposed posting is problematic for the bridge users.
- When the costs of load testing is less than the cost of strengthening

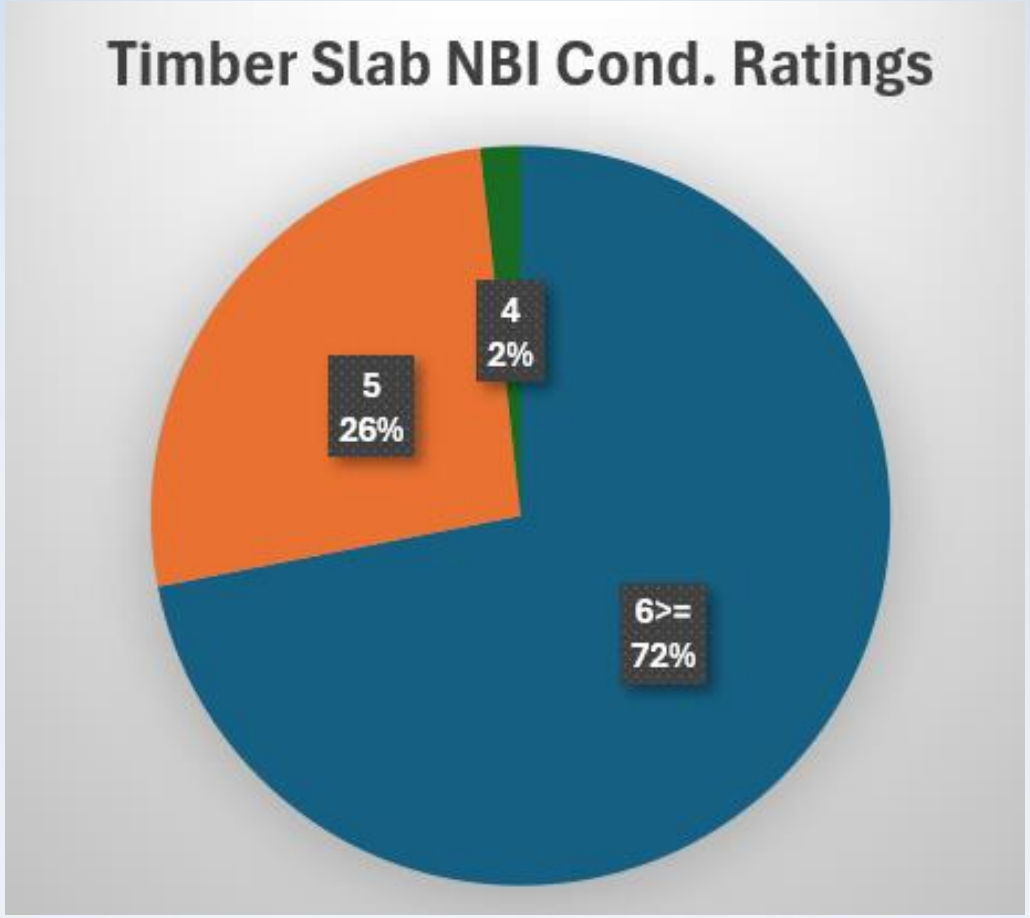




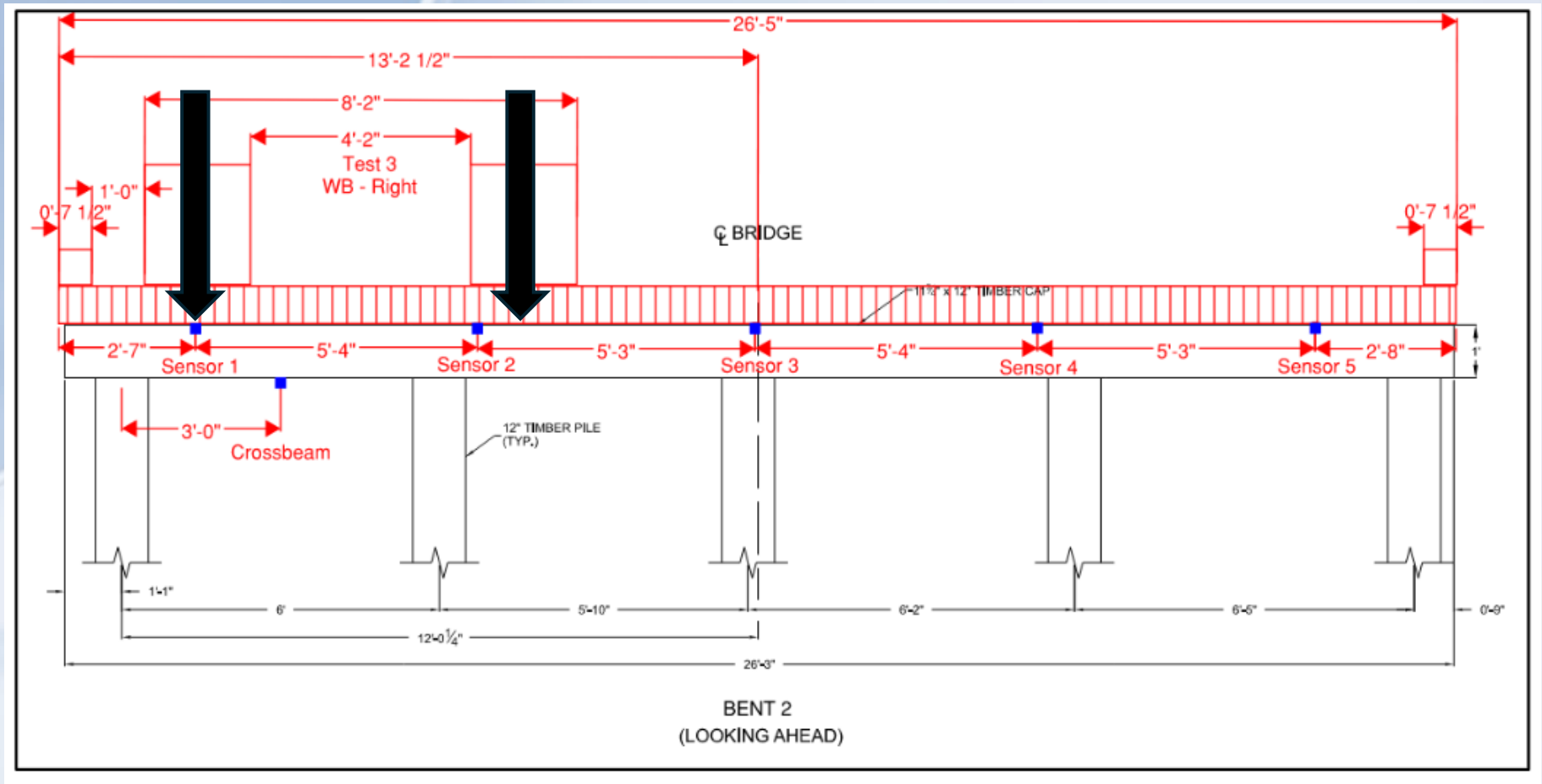


Bridge Conditions:

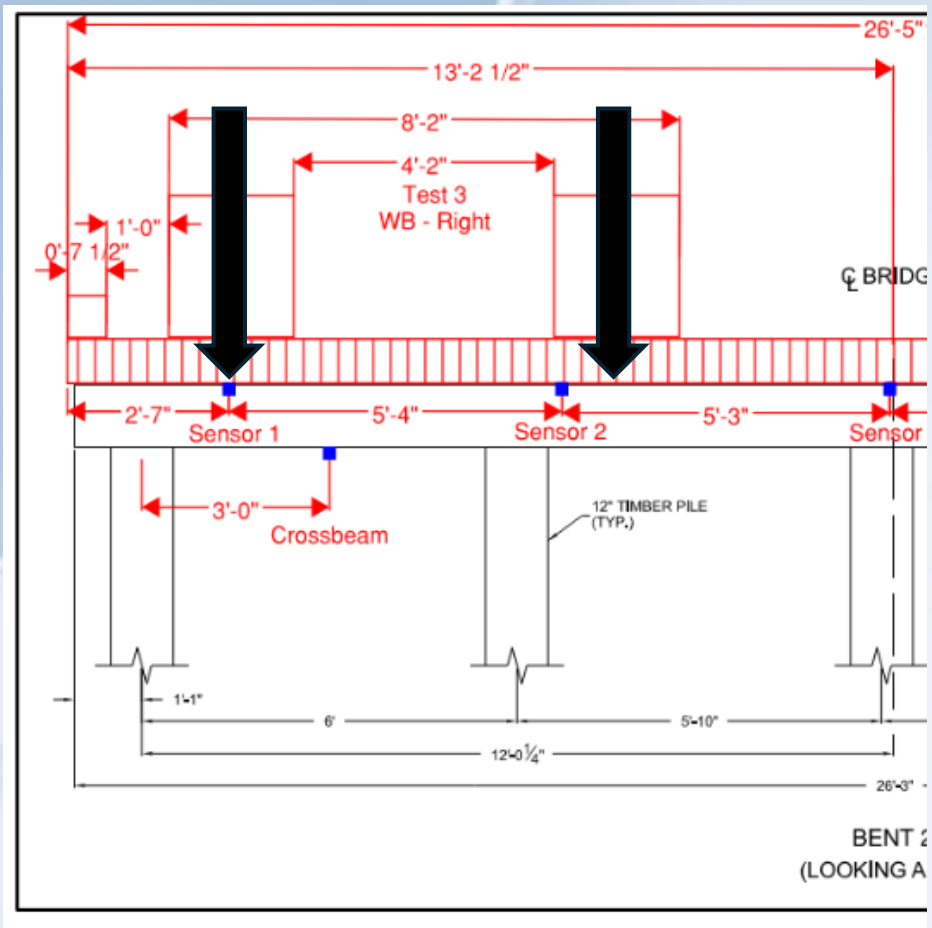
- All of the bridges were built between 1962 and 1974
- The consensus is Fair Condition.



What's Our Hypothesis?



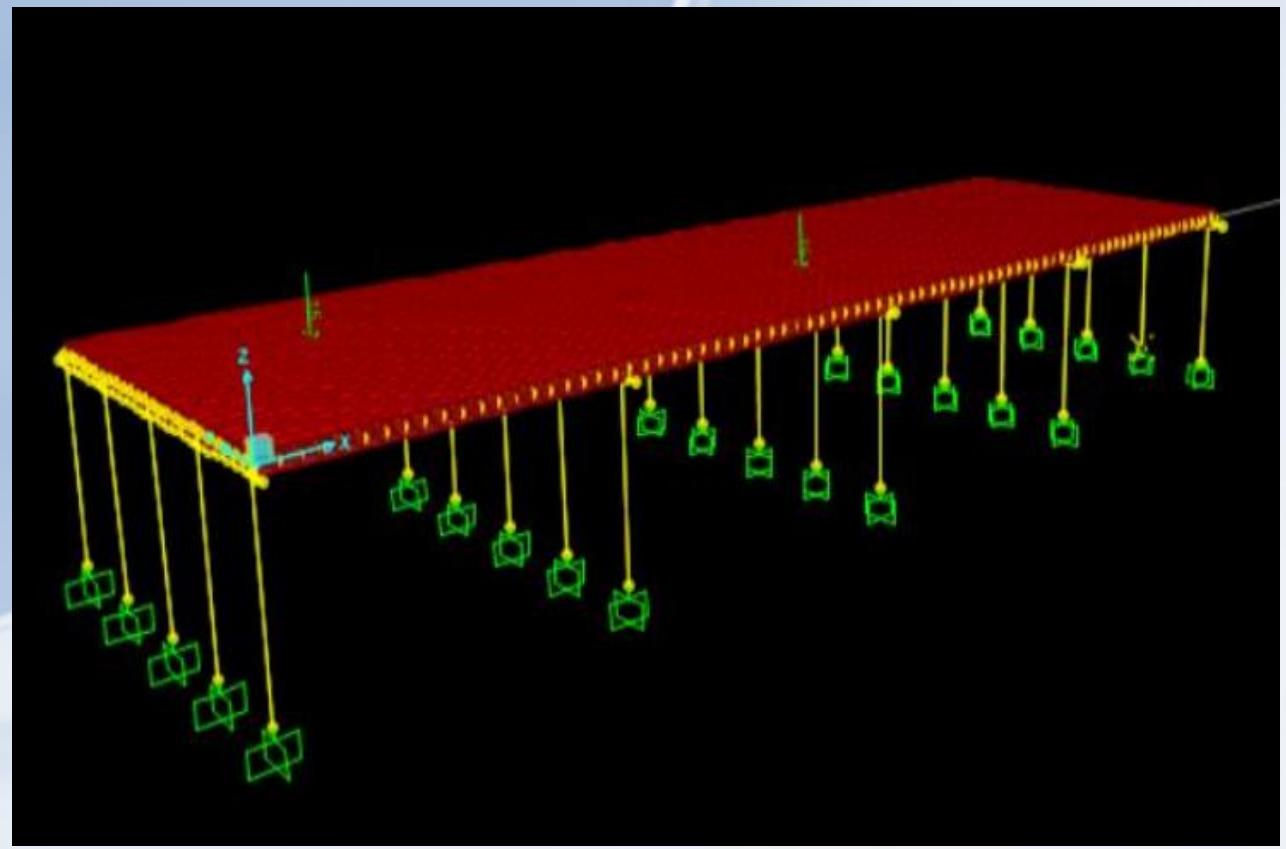
Live Load model for timber crossbeam:



What's the simplification?

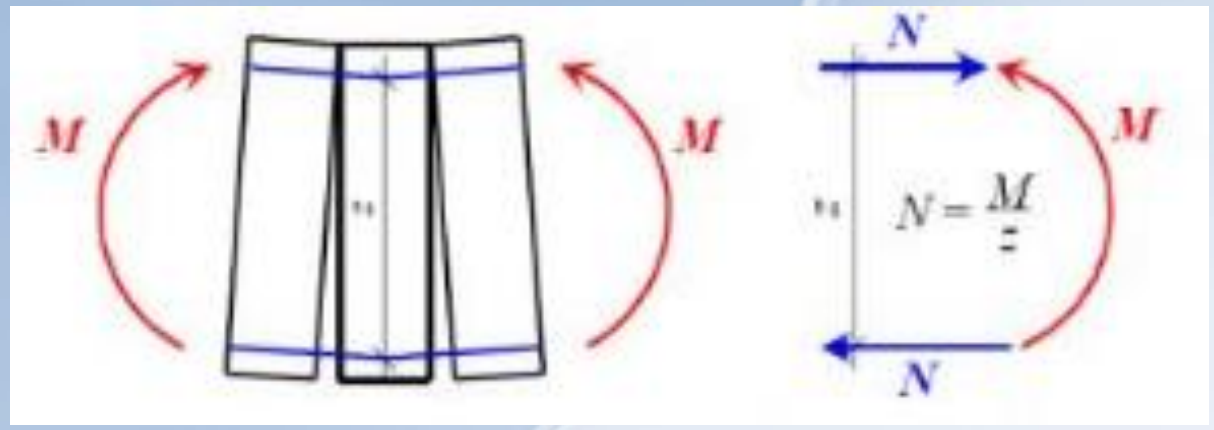
- The tire width is not considered in the model.
- The loading is applied directly to the crossbeam. It is not distributed through the deck.

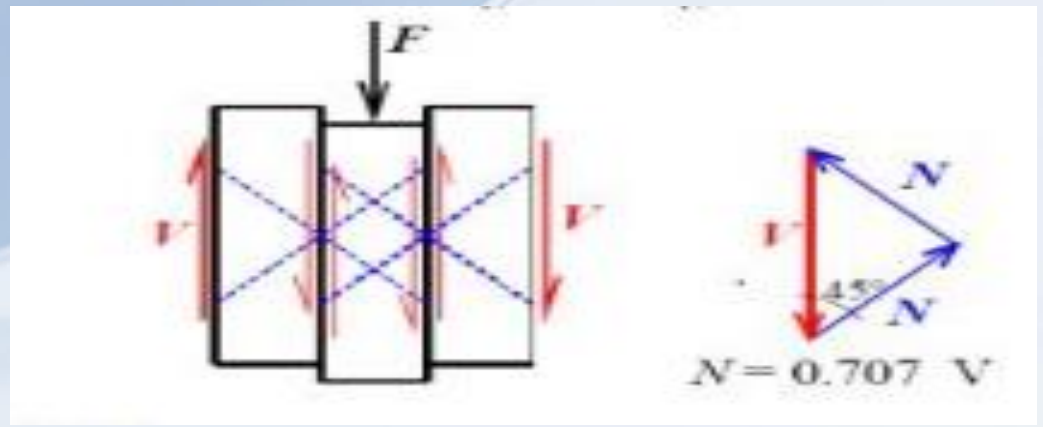
Let’s use a better model



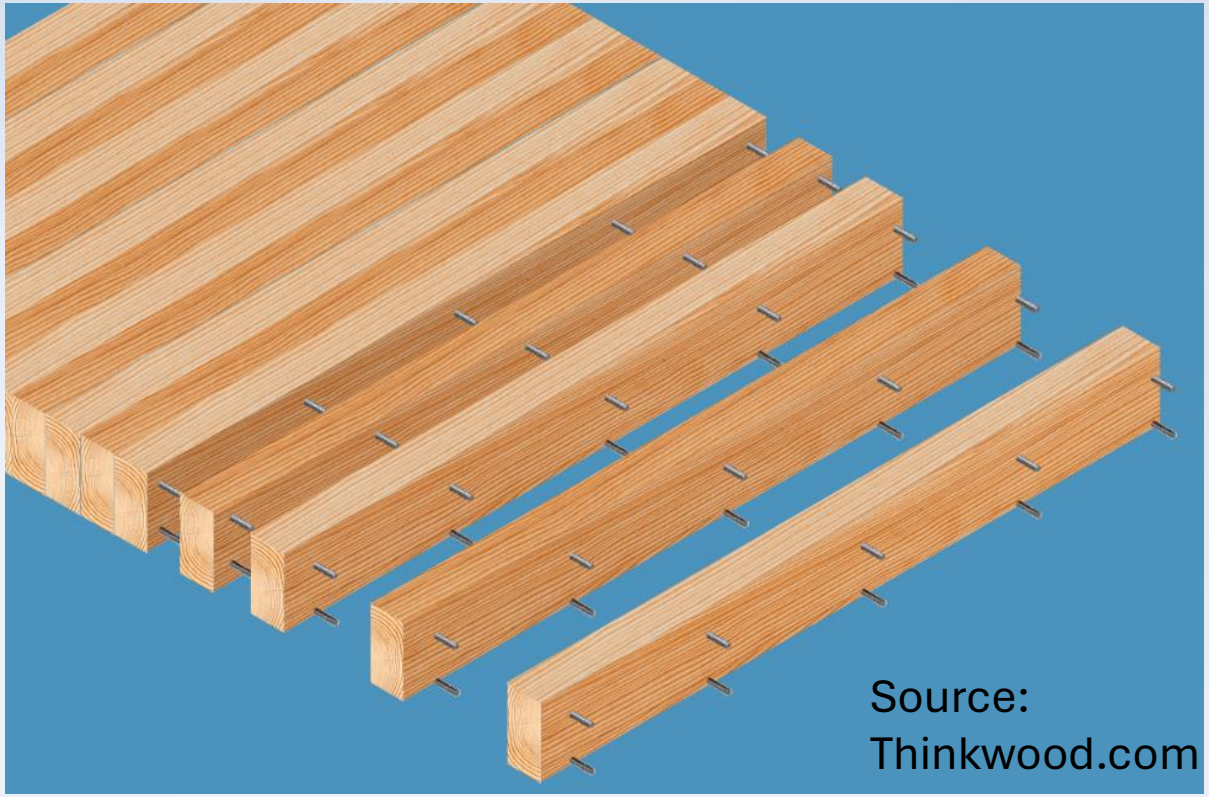
- Careful with boundary conditions.
- Are there secondary members that affect the analysis?
- How confident are we that our model represents the bridge response?

How Stiff are Nail Laminated Slabs???





Source: *Widmann, 2001*



Source: Thinkwood.com

How Stiff are Nail Laminated Slabs???

- What's the nailing pattern?
- What nails were used?
- How has decades of truck loads affected the stiffness?
- Has deterioration impacted the stiffness?

Let’s measure it!

Develop a Load Testing Plan

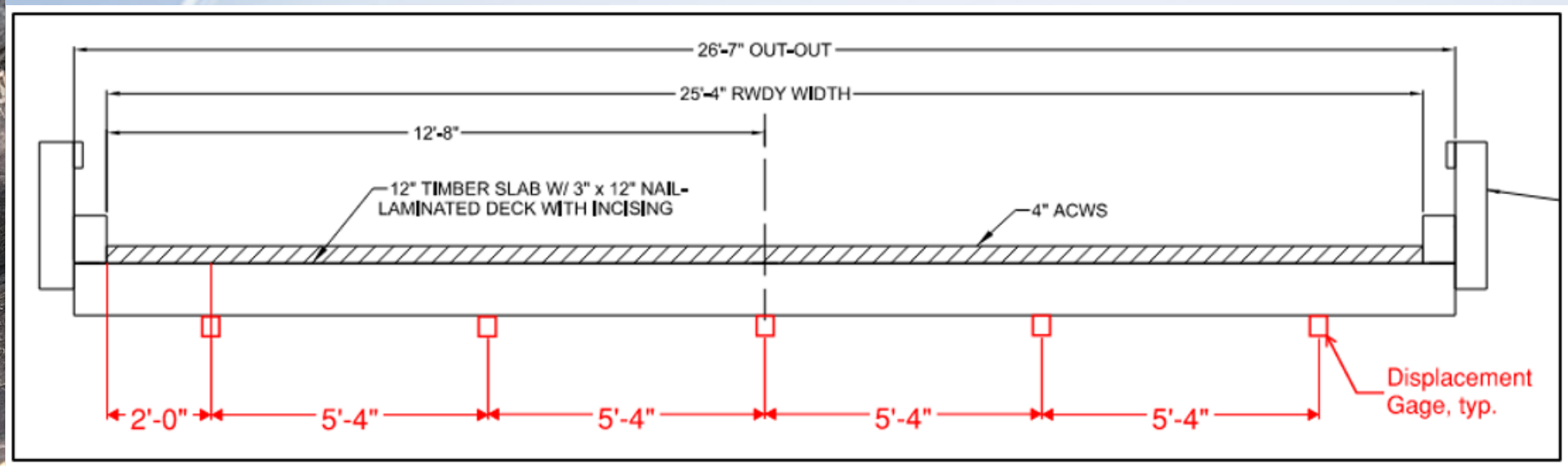
- Proof Load Test

- Diagnostic Test

Diagnostic Calibration Test

- Measure the Bridges Response to Known Loads
  - Directly Calibrate the Standard RFs using an Adjustment Factor → Useful when we can directly measure the load of interest. (Flexure in a girder)
  - Develop a Calibrated Model and Recalculate the RFs → Useful for refinements that can't easily be measured directly.

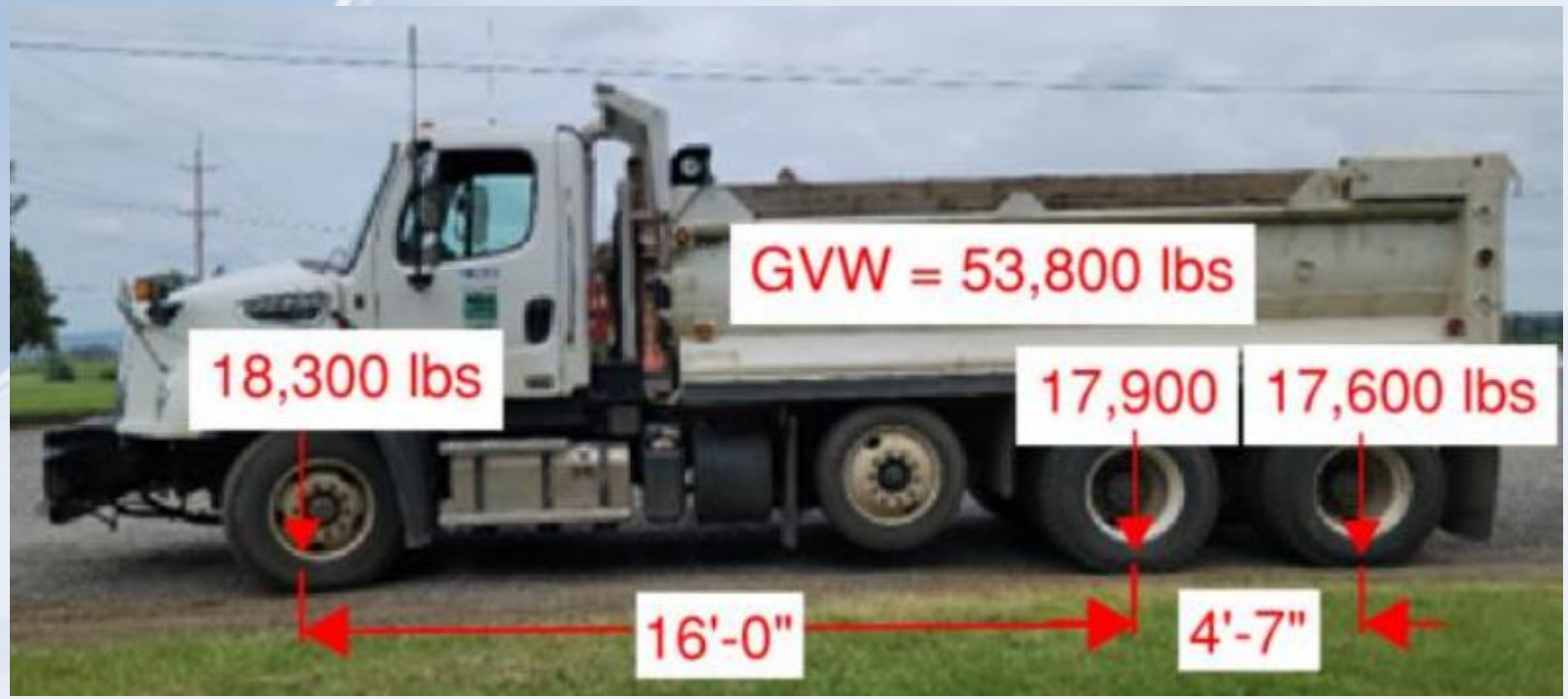
Displacement Gage Layout Cross-Section




AIR RIDE
765
0.40 L


3

Test Truck




8'-2"
4'-2"

Hold Traffic and Collect Data

Collected 6 Runs per Bridge

1. Center of the passenger-side, tandem axle tire 2ft from bridge curb line.
2. Center driver's side, tandem axle tire 2ft from bridge centerline on the same side as previous load case.
3. Center the test vehicle on the centerline of the bridge.
4. Center driver's side, front axle tire 2ft from bridge centerline in the opposite direction as load case 2.
5. Center of the passenger-side, front axle tire 2ft from the opposite curb line as load case 1.
6. Center of a tandem axle tire at the midspan of crossbeam between piles 1 and 2.

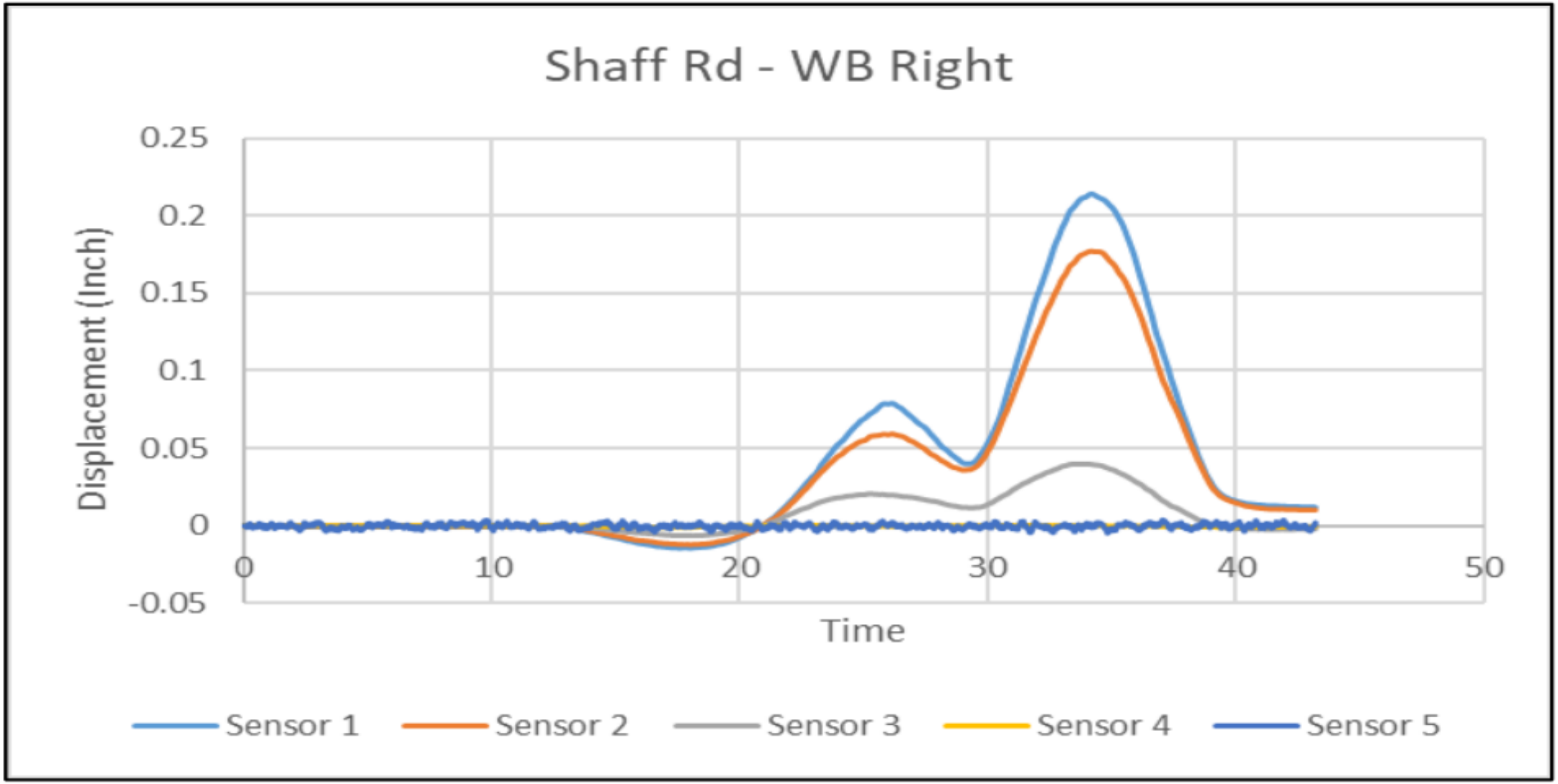
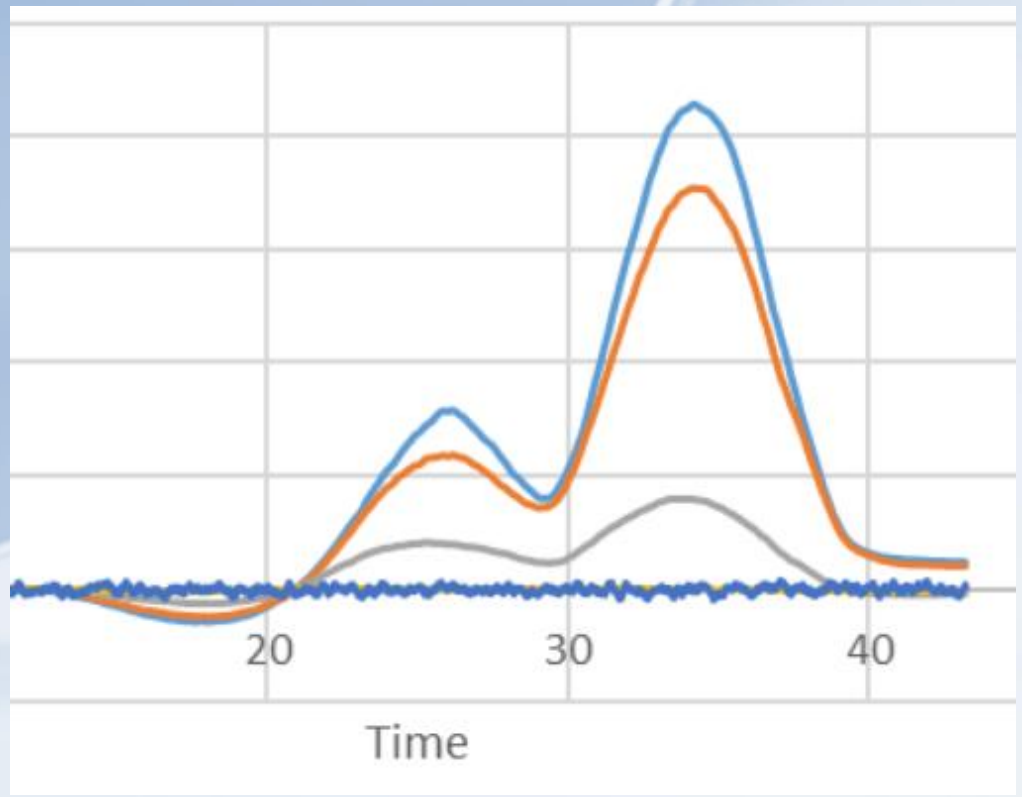
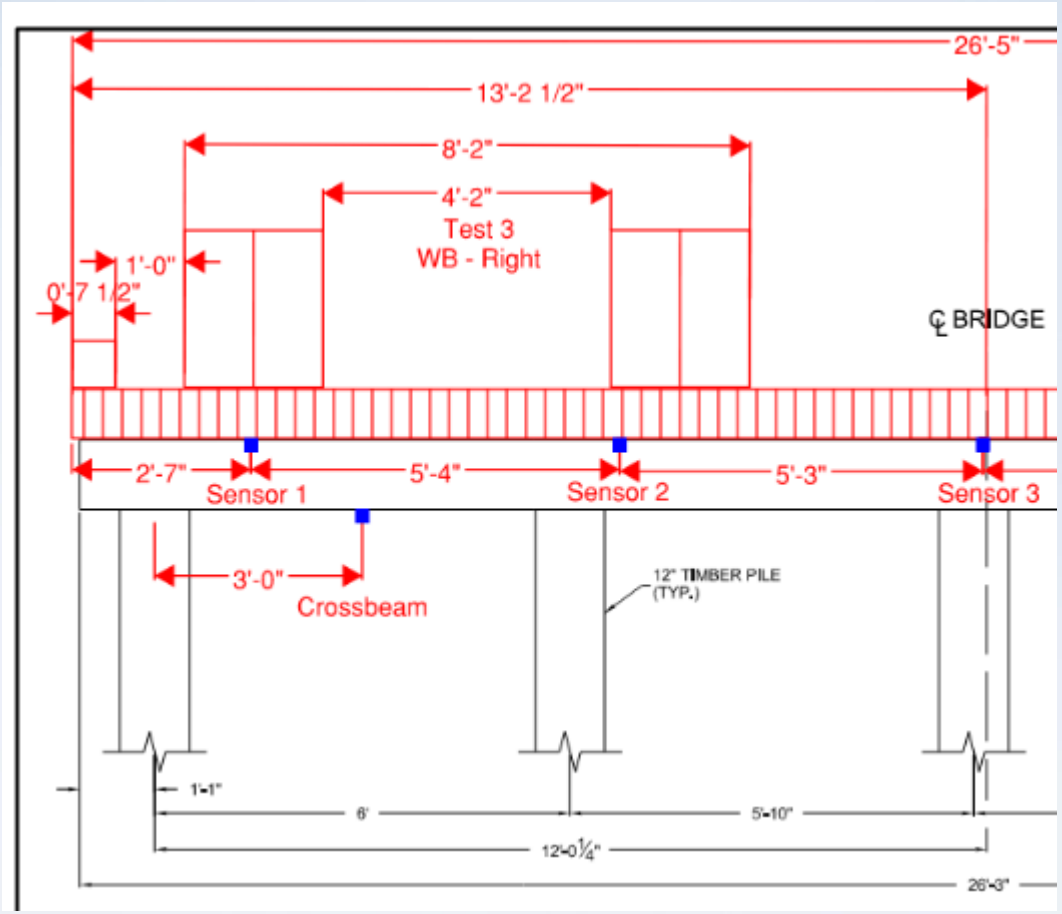


Figure 10: Example Displacement Time History Plot

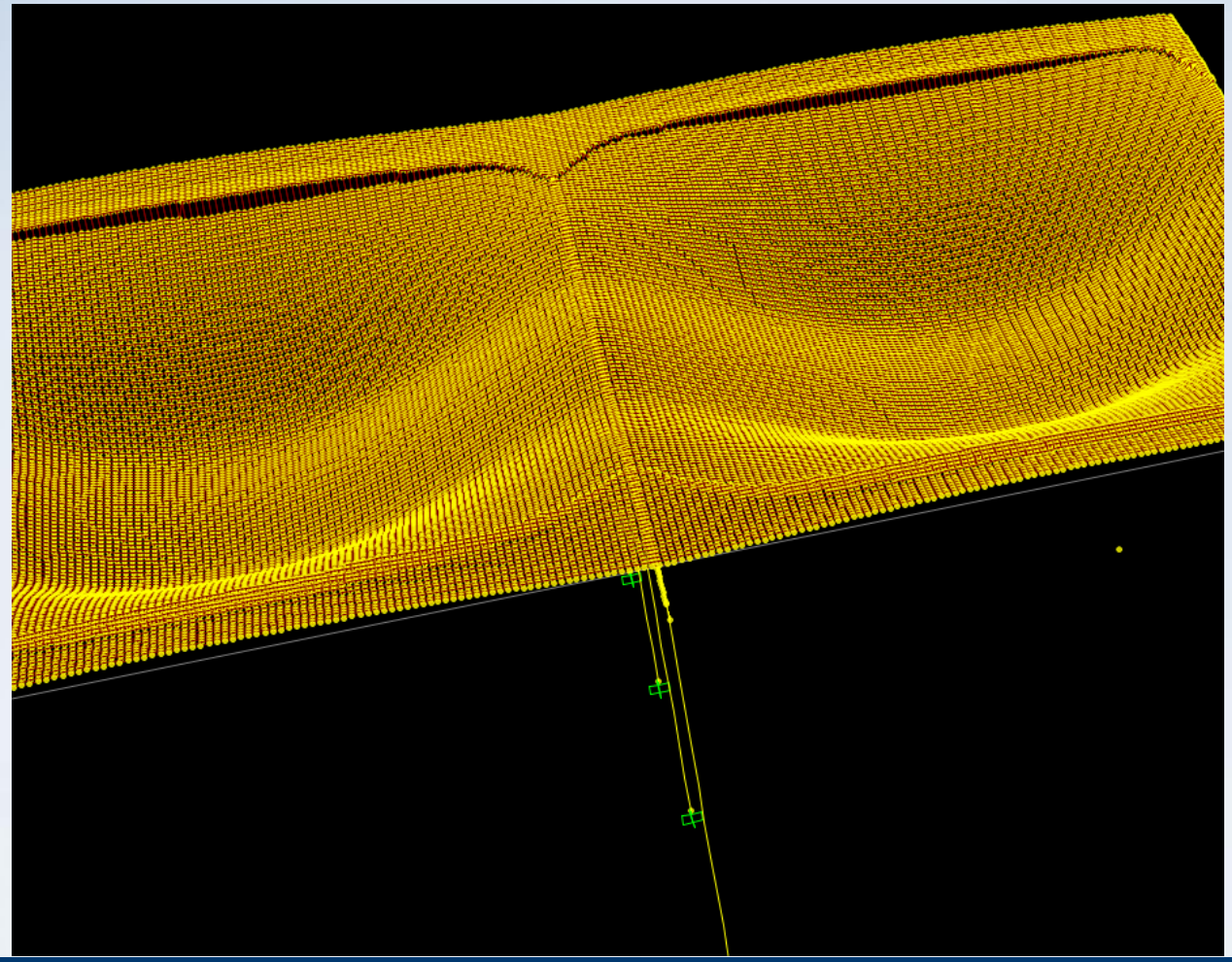
Time History vs. Load Placement





Calibrate Models:

- The Live Load Vehicle was added to the models and run through at the test locations.
- Transverse Shear/Moment stiffness iterated until results match test.



What doesn't this all mean?

Shaff Road RF Comparison

Model:	Orig Rating	CSI-Bridge	% Change
MEMBER (eg. Int. girder):	Bent 1	Bent 1	
SPAN (eg. 1 of 4):	5 of 6	5 of 6	
LOCATION (eg. 0.1L):	0.22L	0.22L	
HL93 (INVENTORY)	0.50 St1	0.54 St1	7%
TYPE 3 (50K)	0.86 St1	1.14 St1	32%
TYPE 3S2 (80K)	0.83 St1	1.11 St1	34%
TYPE 3-3 (80K)	1.05 St1	1.39 St1	32%
SU4 TRUCK (54K)	0.78 St1	1.06 St1	36%
SU5 TRUCK (62K)	0.76 St1	1.02 St1	35%
SU6 TRUCK (69.5K)	0.76 St1	1.02 St1	35%
SU7 TRUCK (77.5K)	0.74 St1	1.02 St1	39%

Battle Creek LR Comparison

Model:	Orig Rating	CSI-Bridge	% Change
MEMBER (eg. Int. girder):	Bent 2	Bent 2	
SPAN (eg. 1 of 4):	2 of 6	2 of 6	
LOCATION (eg. 0.1L):	0.77L	0.77L	
HL93 (INVENTORY)	0.62 St1	0.98 St1	37%
TYPE 3 (50K)	1.17 St1	2.19 St1	46%
TYPE 3S2 (80K)	1.06 St1	2.02 St1	48%
TYPE 3-3 (80K)	1.48 St1	2.71 St1	45%
SU4 TRUCK (54K)	0.96 St1	1.88 St1	49%
SU5 TRUCK (62K)	0.91 St1	1.79 St1	49%
SU6 TRUCK (69.5K)	0.81 St1	1.67 St1	51%
SU7 TRUCK (77.5K)	0.76 St1	1.62 St1	53%

What about the problem bridge?

Marion Hill RF Comparison

Model:	Orig Rating	CSI-Bridge	% Change
MEMBER (eg. Int. girder):	Bent 2	Bent 2	
SPAN (eg. 1 of 4):	5 of 6	5 of 6	
LOCATION (eg. 0.1L):	0.19L	0.19L	
HL93 (INVENTORY)	0.48 St1	0.56 St1	17%
TYPE 3 (50K)	0.89 St1	1.21 St1	37%
TYPE 3S2 (80K)	0.87 St1	1.17 St1	34%
TYPE 3-3 (80K)	1.09 St1	1.50 St1	38%
SU4 TRUCK (54K)	0.76 St1	1.03 St1	36%
SU5 TRUCK (62K)	0.71 St1	0.99 St1	40%
SU6 TRUCK (69.5K)	0.65 St1	0.90 St1	39%
SU7 TRUCK (77.5K)	0.61 St1	0.85 St1	40%

Costs?

- Testing - 3 days of field work = $14,500 ($5,000 per bridge)
- Model Calibration and Load Rating Updates = $60,000 ($5,500 per bridge)
- Total Project Cost = $82,000 ($7,500 per bridge)

Marion County Results and Next Steps

Results:

- 11 Bridges Were Refined with Postings Greatly Reduced or Removed
- Improved Heavy Vehicle Access Along Several Routes Including to Areas with Limited Access
- Saved County Bridge Crew Years of Time and Materials Costs

Next Steps:

- Prioritize Remaining Timber Slab Load Restricted Structures
- Work Through Priority Refinements as Budget Permits

Questions???

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