DAVID EVANS
AND ASSOCIATES INC.

Bridge Postings:
Where Do They Come From and What Can I Do

Presented by

Travis Kinney PE

Stewart Linz PE

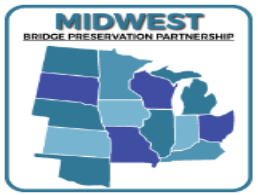
House Keeping

- Let us know what topic you'd like to see next.
- Add your contact info in the chat for future invites.
- Trainings every other month.

TYPE QUESTIONS INTO THE CHAT.

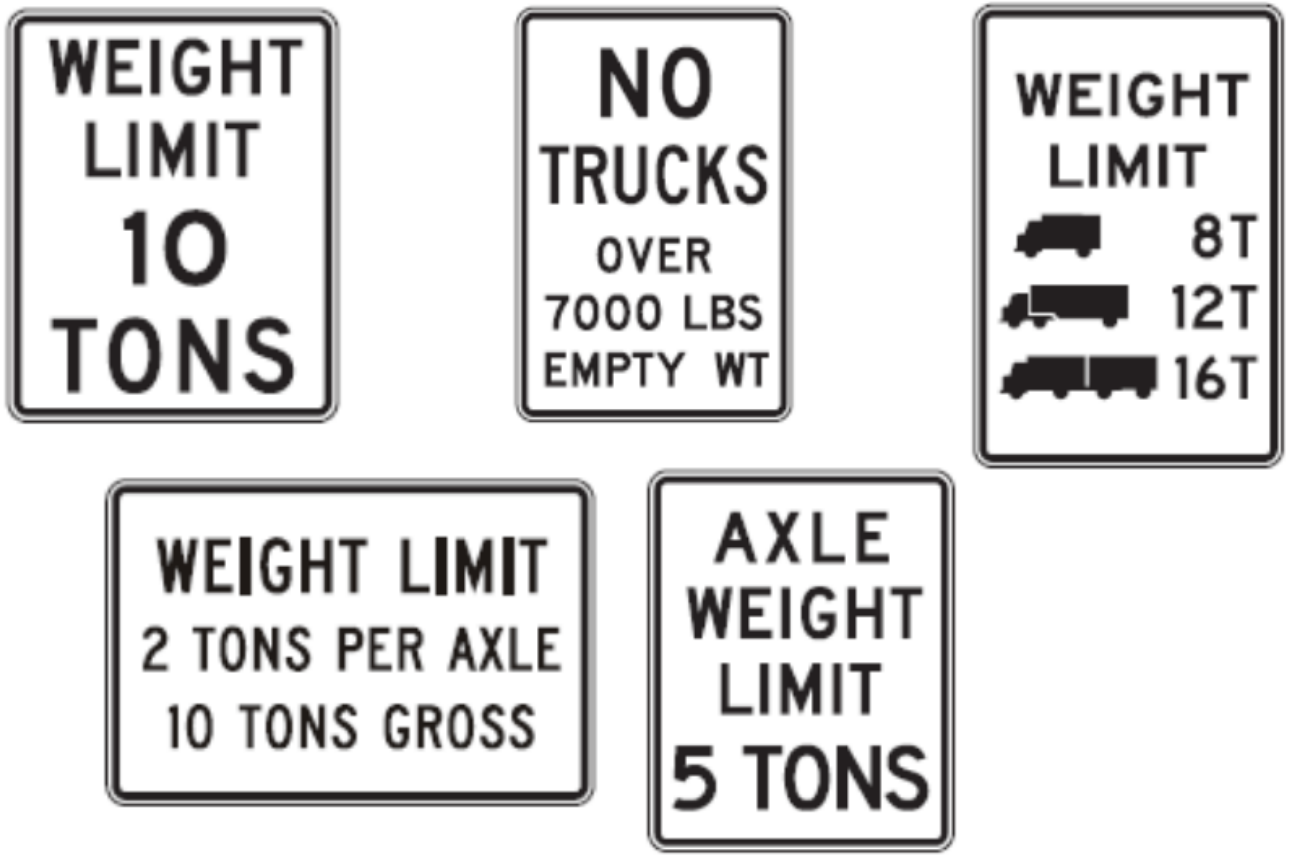
THE PRESENTATION WILL BE RECORDED AND MADE AVAILABLE.

Bridge Preservation Partnerships

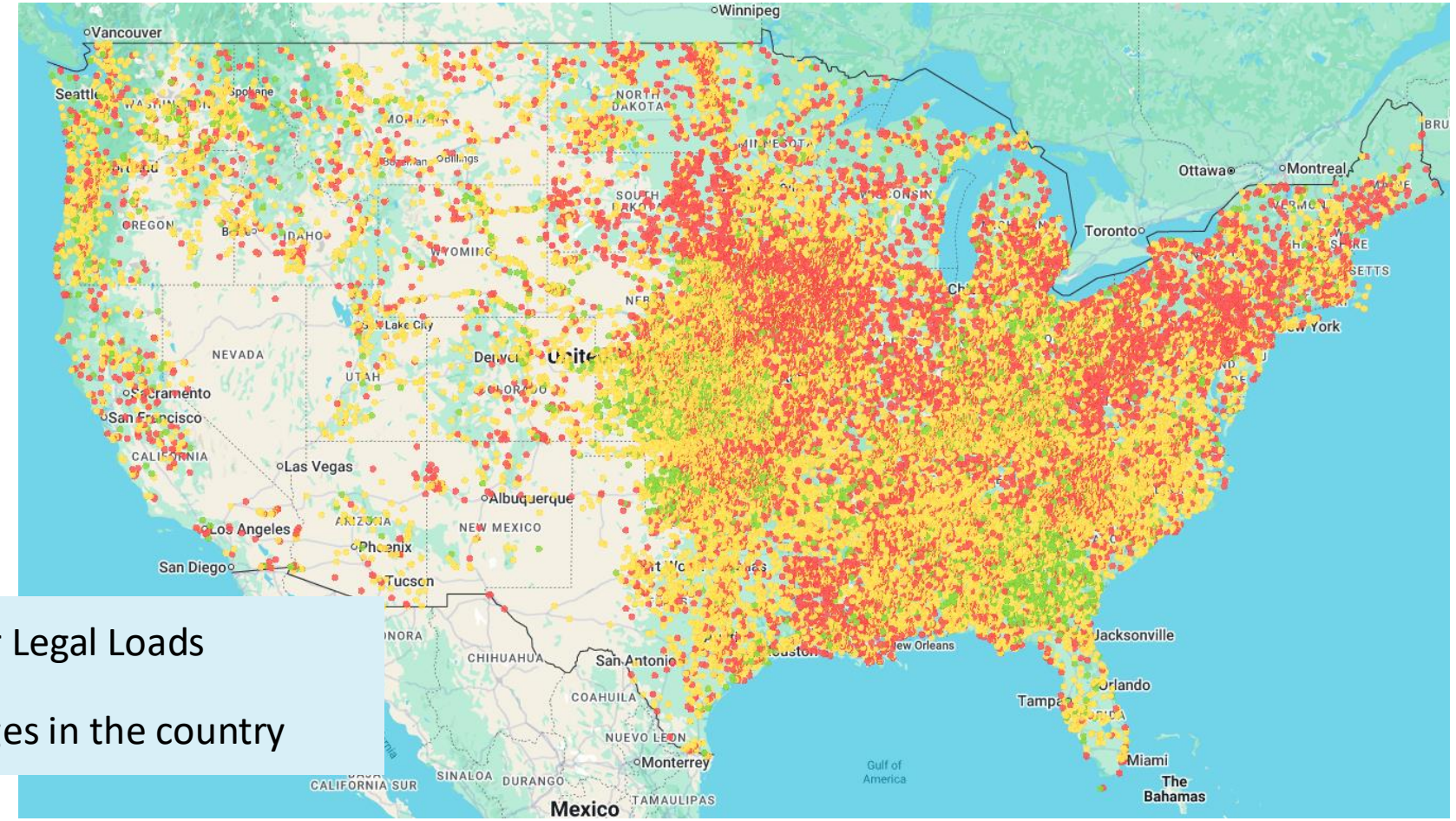


Overview

- Load Ratings Background
- Load Restriction Requirements
- Options for Maintenance
- Why Postings Matter



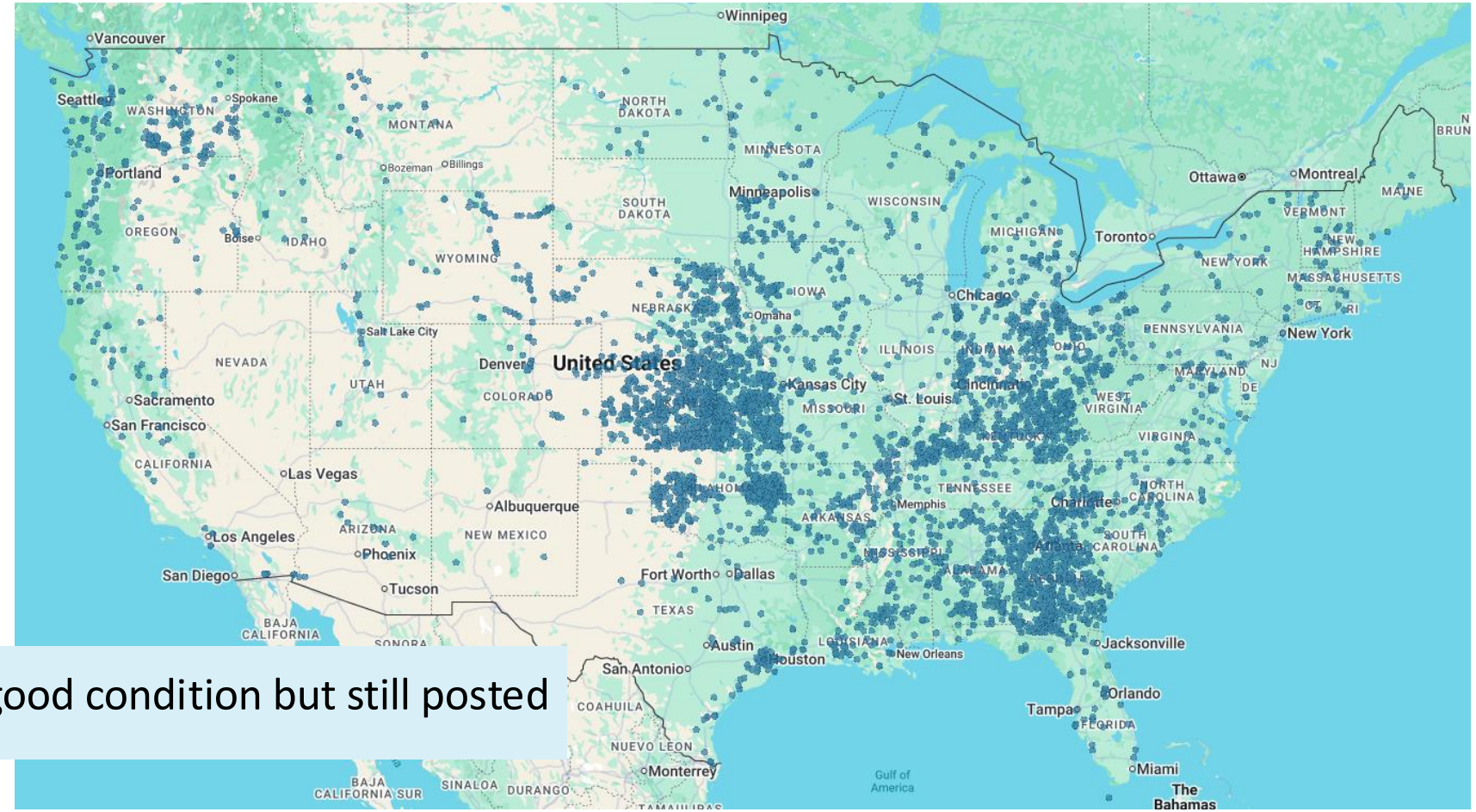
Bridges Posted for Legal Loads



- 56,651 Bridges are Posted for Legal Loads
- That is nearly 10% of all bridges in the country

Source: Infobridge.fhwa.dot.gov

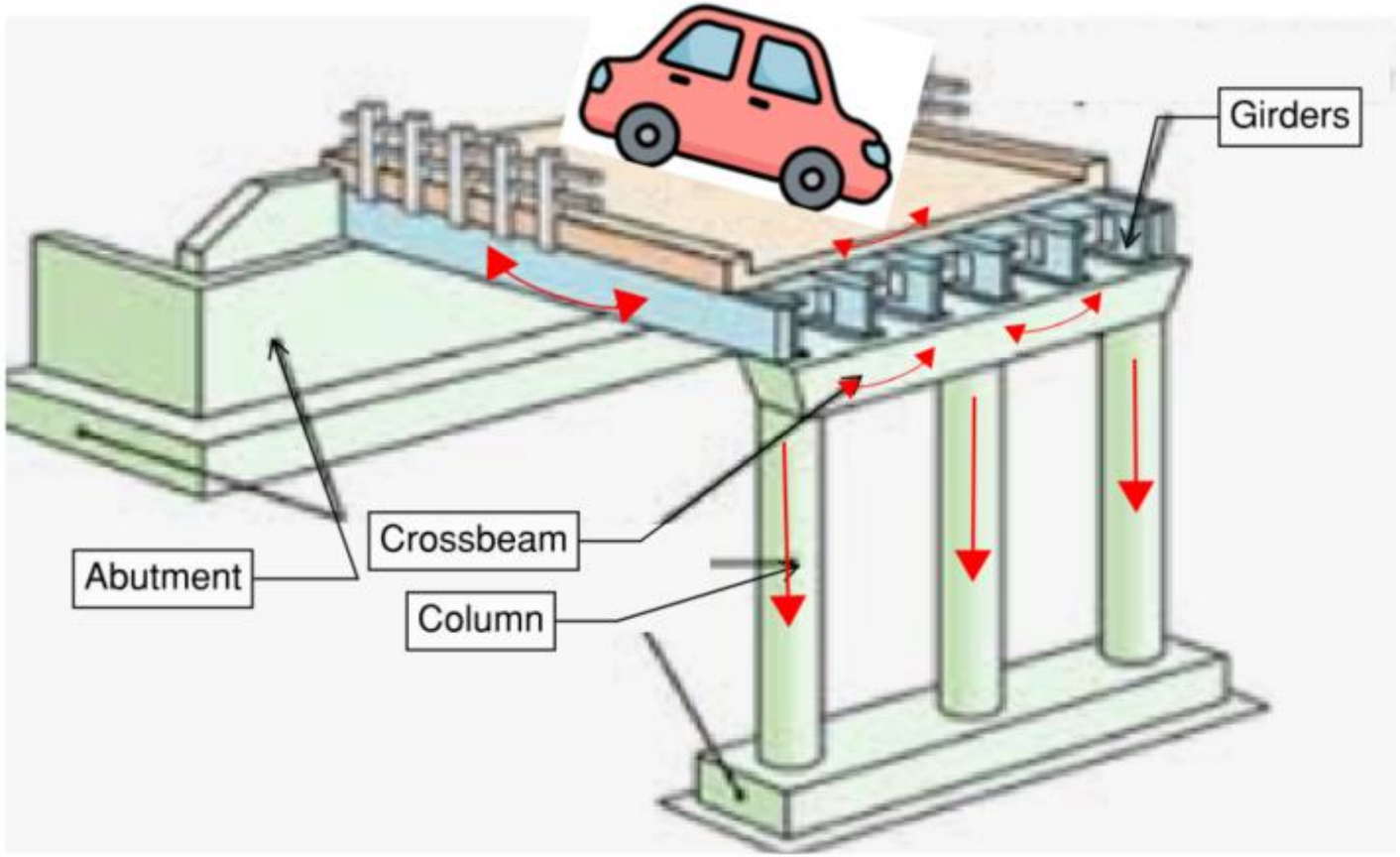
Bridges Posted for Legal Loads



5,425 are in good condition but still posted

Source: Infobridge.fhwa.dot.gov

Load Rating Basics: Beam/Girder



Load Rating Basics

$$RF = \frac{\text{Capacity - Bridge Weight}}{\text{Truck Weight}}$$

$$RF = \frac{\text{Reserve Capacity}}{\text{Truck Weight}}$$

Load Rating Basics

If Reserve Capacity > Truck Weight

$$RF = \frac{\text{Reserve Capacity}}{\text{Truck Weight}}$$

$RF > 1$ … No Restriction

Load Rating Basics

If Reserve Capacity < Truck Weight

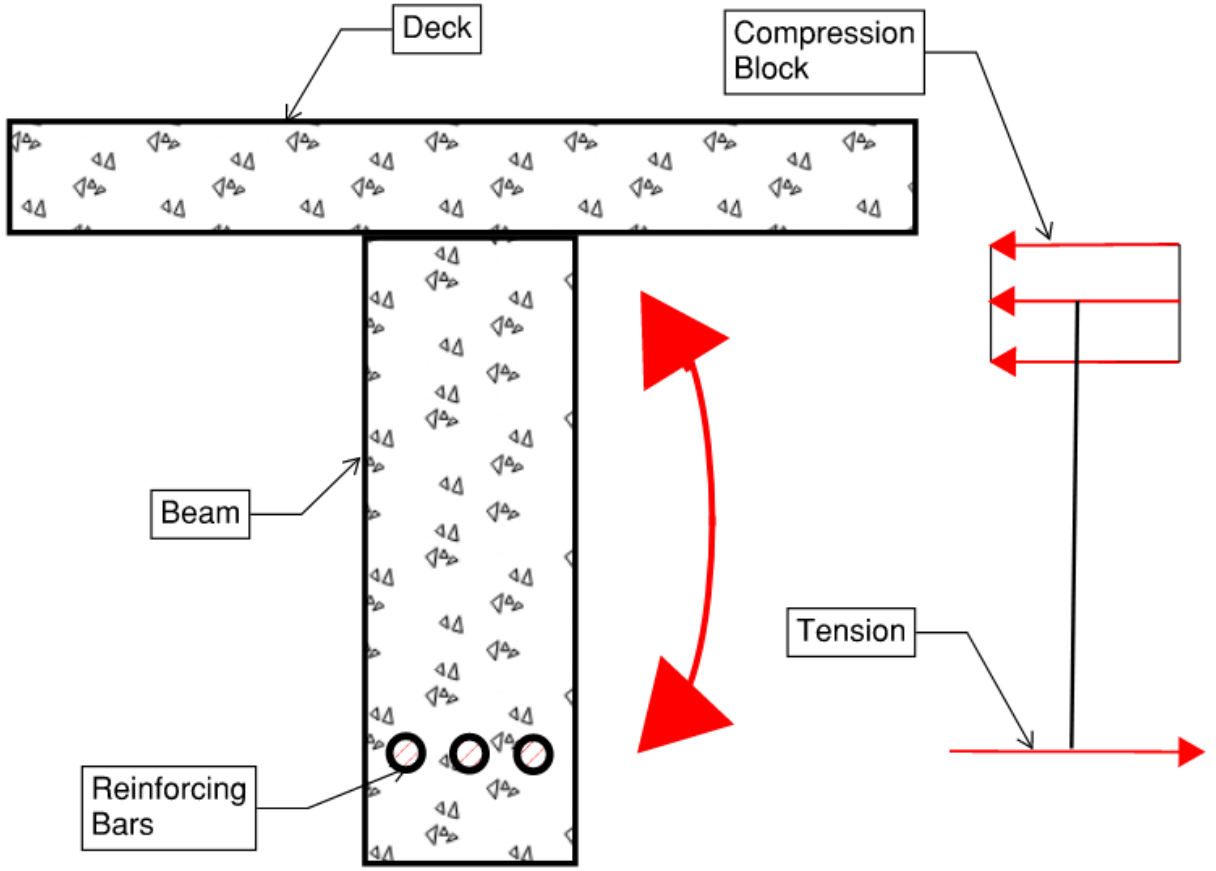
$$RF = \frac{\text{Reserve Capacity}}{\text{Truck Weight}}$$

RF < 1 … We Have a Problem

So what do engineers do?

- **Estimate** how much weight the members can hold. (Capacity)
- **Estimate** the weight of the bridge, including the weight of railing, and wearing surfaces. (Dead Loads)
- **Estimate** the weight of traffic. (Live Loads)

Estimate the Capacity: RC Beam



Account for Changes in Capacity

Rot in Timber

Changes in Capacity: What's left?

Steel Corrosion

Changes in Capacity

Concrete Deterioration

Changes in Capacity

Footing Scour

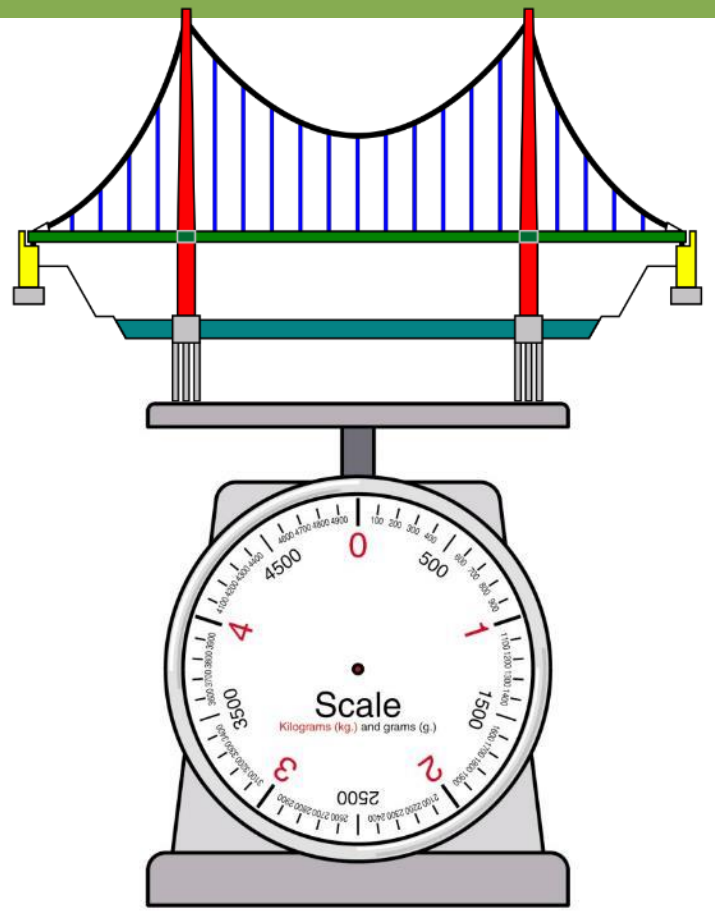
Bridge Design Loads:

- Permanent (Dead Loads):
  - Weight of the bridge
  - Wearing surface
- Transient Loads (Live Loads):
  - Trucks, Pedestrians, Vehicles
- Less Common: (Extreme Event)
  - Seismic
  - Ice loads
  - Blast Load
  - Vessel Collision

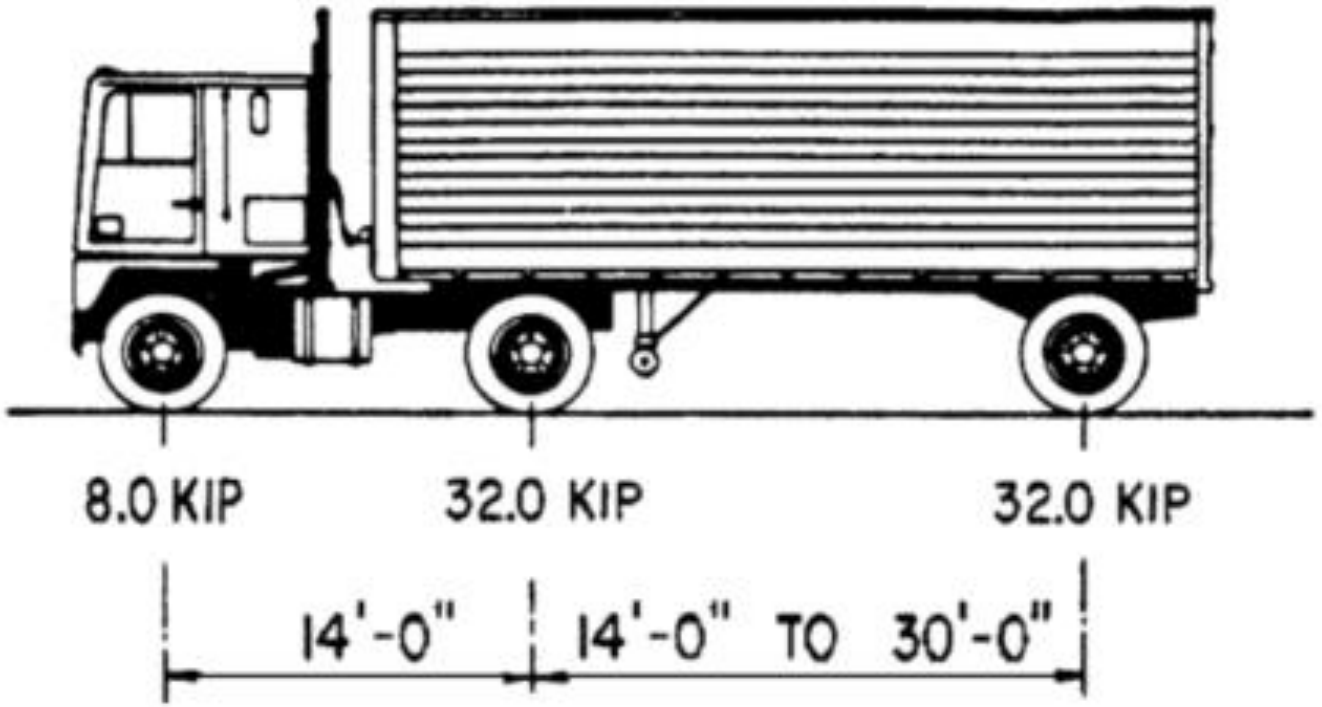
Load Combination Limit State	*DC DW EH EV ES EL PS CR SH*	*LL IM CE BR PL LS*	*WA*	*WS*	*WL*	*FR*	*TU*	*TG*	*SE*	*DR*	Use One of These at a Time				
											EQ	*BL*	*IC*	*CT*	*CV*
Strength I (unless noted)	γ_p	1.75	1.00	—	—	1.00	γ_{TU}	γ_{TG}	γ_{SE}	γ_{DR}	—	—	—	—	—
Strength II	γ_p	1.35	1.00	—	—	1.00	γ_{TU}	γ_{TG}	γ_{SE}	γ_{DR}	—	—	—	—	—
Strength III	γ_p	—	1.00	1.00	—	1.00	γ_{TU}	γ_{TG}	γ_{SE}	γ_{DR}	—	—	—	—	—
Strength IV	γ_p	—	1.00	—	—	1.00	γ_{TU}	—	—	—	—	—	—	—	—
Strength V	γ_p	1.35	1.00	1.00	1.00	1.00	γ_{TU}	γ_{TG}	γ_{SE}	γ_{DR}	—	—	—	—	—
Extreme Event I	1.00	γ_{EQ}	1.00	—	—	1.00	—	—	—	1.00	1.00	—	—	—	—
Extreme Event II	1.00	0.5/ 1.00	1.00	—	—	1.00	—	—	—	1.00	—	1.00	1.00	1.00/	1.00
Service I	1.00	1.00	1.00	1.00	1.00	1.00	γ_{TU}	γ_{TG}	γ_{SE}	1.00	—	—	—	—	—
Service II	1.00	1.30	1.00	—	—	1.00	γ_{TU}	—	—	—	—	—	—	—	—
Service III	1.00	γ_{LL}	1.00	—	—	1.00	γ_{TU}	γ_{TG}	γ_{SE}	1.00	—	—	—	—	—
Service IV	1.00	—	1.00	1.00	—	1.00	γ_{TU}	—	1.00	1.00	—	—	—	—	—
Fatigue I—*LL*, *IM* & *CE* only	—	1.75	—	—	—	—	—	—	—	—	—	—	—	—	—
Fatigue II—*LL*, *IM* & *CE* only	—	0.80	—	—	—	—	—	—	—	—	—	—	—	—	—

Bridge Weight

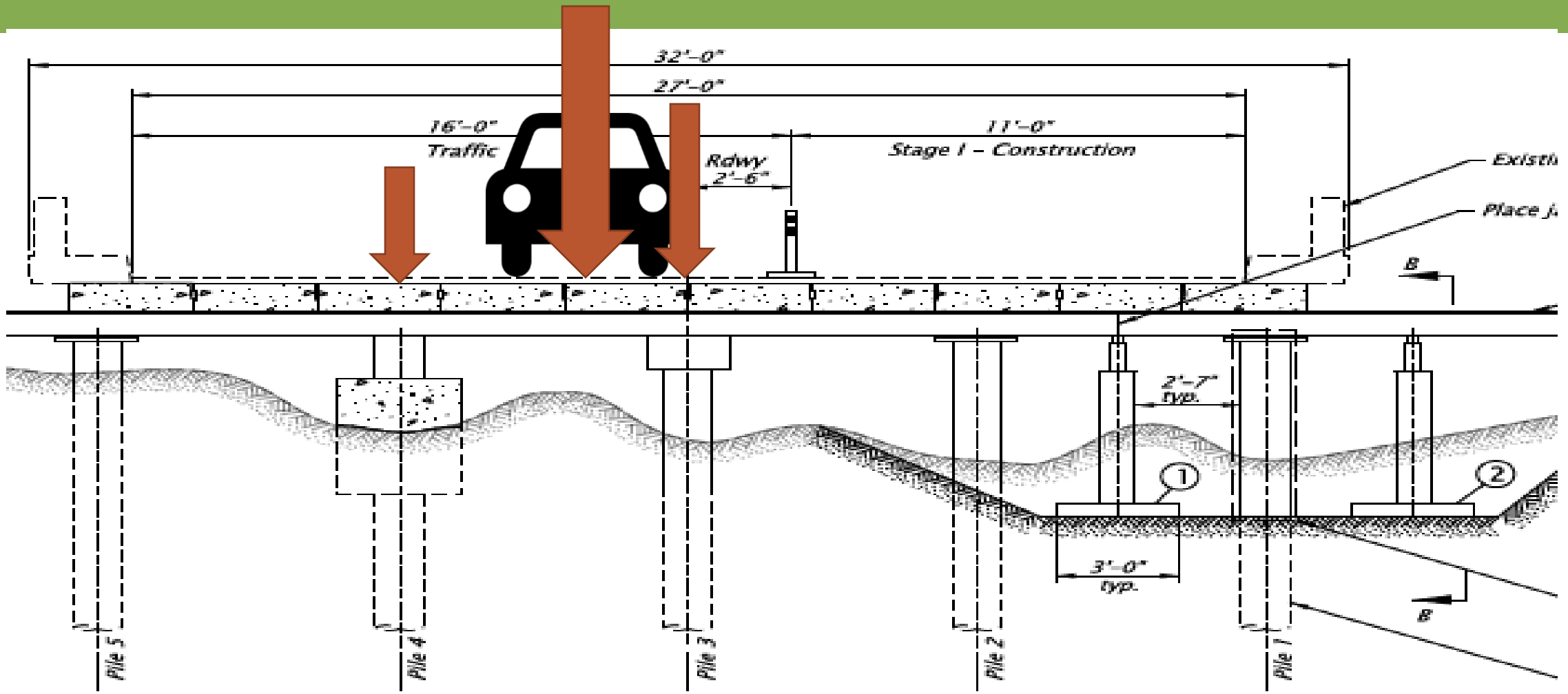
- Can be **estimated** pretty close.
- Estimates are used to shorten work.
- When all the weights are added up. Increase the weight by 25%-50% to make sure the results are conservative.



Vehicle Loads:



Live Load Distribution



How does the LL work through the bridge?

Empirical Equations:

- Type of bridge
- Girder Spacing
- Span Length
- Number of Girders
- Stiffness Properties

Type of Superstructure	Applicable Cross-Section from Table 4.6.2.2.1-1	Distribution Factors	Range of Applicability
Wood Deck on Wood or Steel Beams	(a), (l)	See Table 4.6.2.2.2a-1	
Concrete Deck on Wood Beams	(l)	One Design Lane Loaded: $S/12.0$ Two or More Design Lanes Loaded: $S/10.0$	$S \le 6.0$
Concrete Deck or Filled Grid, Partially Filled Grid, or Unfilled Grid Deck Composite with Reinforced Concrete Slab on Steel or Concrete Beams; Concrete T-Beams, T- and Double T-Sections	(a), (e), (k); also (i) and (j) if sufficiently connected to act as a unit	One Design Lane Loaded: $0.06+\left(\frac{S}{14}\right)^{0.4}\left(\frac{S}{L}\right)^{0.3}\left(\frac{K_g}{12.0Lt_s^3}\right)^{0.1}$ Two or More Design Lanes Loaded: $0.075+\left(\frac{S}{9.5}\right)^{0.6}\left(\frac{S}{L}\right)^{0.2}\left(\frac{K_g}{12.0Lt_s^3}\right)^{0.1}$	$3.5 \le S \le 16.0$ $4.5 \le t_s \le 12.0$ $20 \le L \le 240$ $N_b \ge 4$ $10{,}000 \le K_g \le 7{,}000{,}000$
		use lesser of the values obtained from the equation above with $N_b = 3$ or the lever rule	$N_b = 3$
Cast-in-Place Concrete Multicell Box	(d)	One Design Lane Loaded: $\left(1.75+\frac{S}{3.6}\right)\left(\frac{1}{L}\right)^{0.35}\left(\frac{1}{N_c}\right)^{0.45}$ Two or More Design Lanes Loaded: $\left(\frac{13}{N_c}\right)^{0.3}\left(\frac{S}{5.8}\right)\left(\frac{1}{L}\right)^{0.25}$	$7.0 \le S \le 13.0$ $60 \le L \le 240$ $N_c \ge 3$ If $N_c > 8$ use $N_c = 8$

Truck Loads

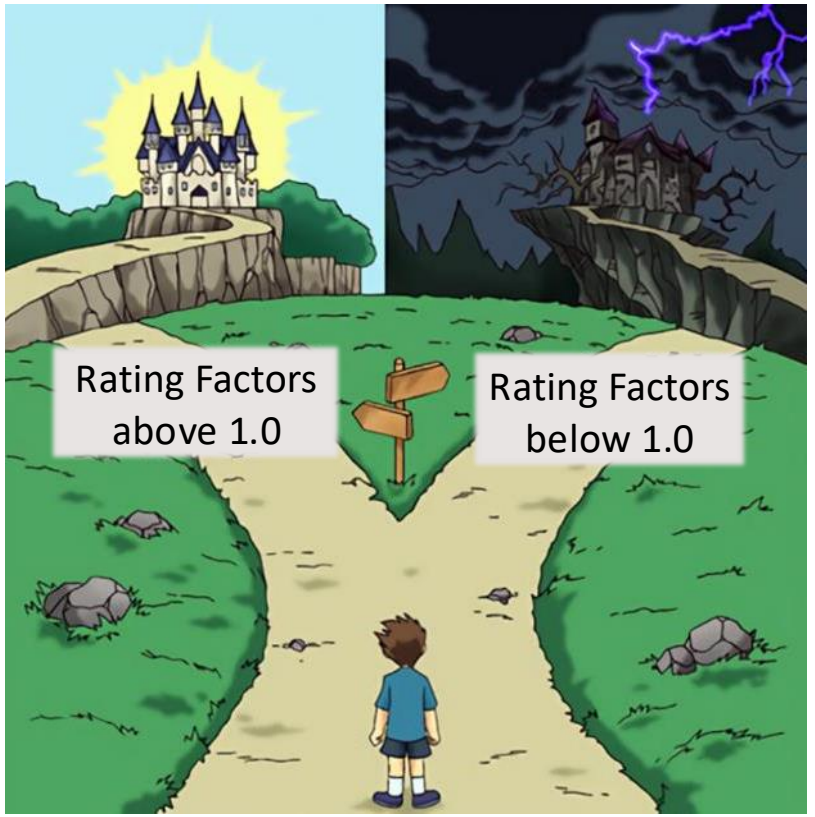
- A lot more variability than figuring out the bridge weight.
- Need more conservatism with **estimating** the weight.
- Typically 2-3 times larger than just the bridge weight.
- Increase the truck weight by 135% (175% design) to account for variation.

Load Rating

$$RF = \frac{\text{Capacity - Bridge Weight}}{\text{Truck Weight}}$$

The Load Rating Crossroads

- Rating complete
- No load posting
- Good vibes



- Work to do
- Potential posting
- Bad news for maintenance

What Can Maintenance Do?

- Post the Bridge
- Remove Weight
- Shore the Bridge
- Strengthen/Repair the Bridge

FHWA - 30 Day Load Posting Requirement

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **ACTION:** Timeframe for Installing Load Posting Signs at Bridges

Date: April 17, 2019

From: /Original signed by/
Joseph L. Hartmann, Ph.D., P.E.
Director, Office of Bridges and Structures

In Reply Refer To: HIBS-30

To: Division Administrators
Federal Lands Highway Division Directors

Communication:

- Understand how the restriction would impact nearby businesses
- Ask what is causing the restriction and how it could be addressed
- Decide on a course of action

Print Signs and Post the Bridge

Temporary Shoring: Localized

Temporary Shoring: Whole Bent

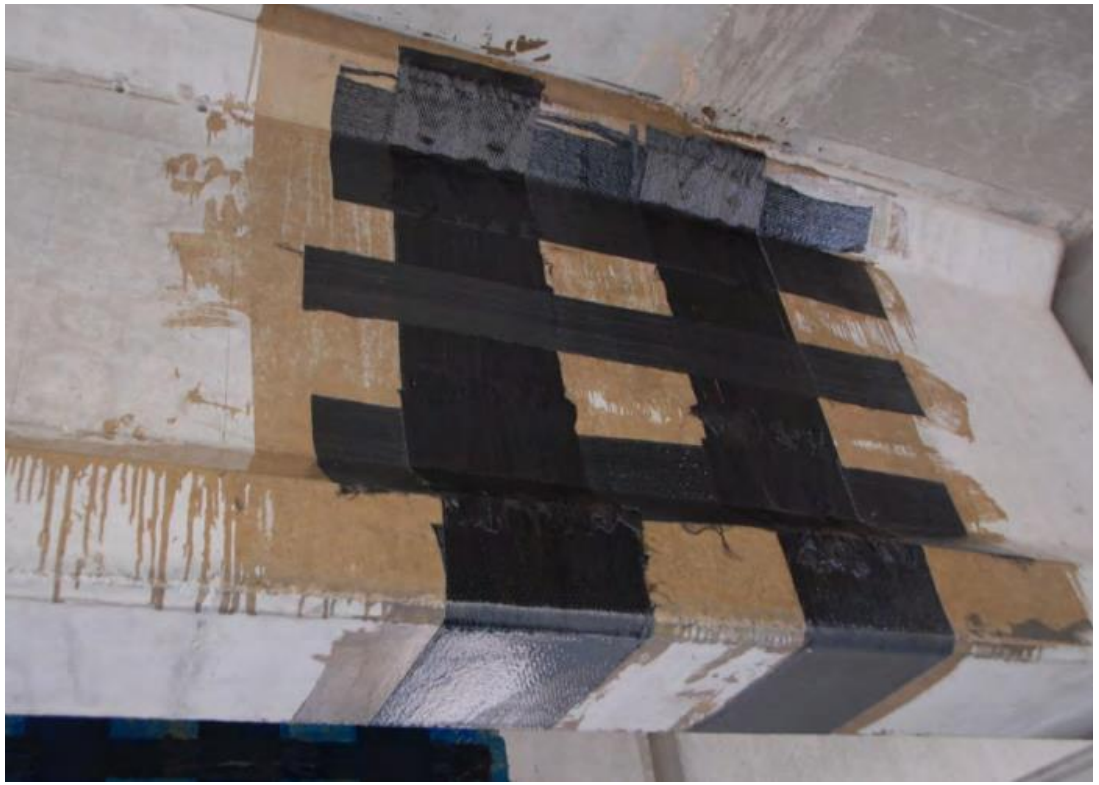
Permanent Shoring?

Strengthen Bridge


HILTI
HDE 500-A18
B22 5.2

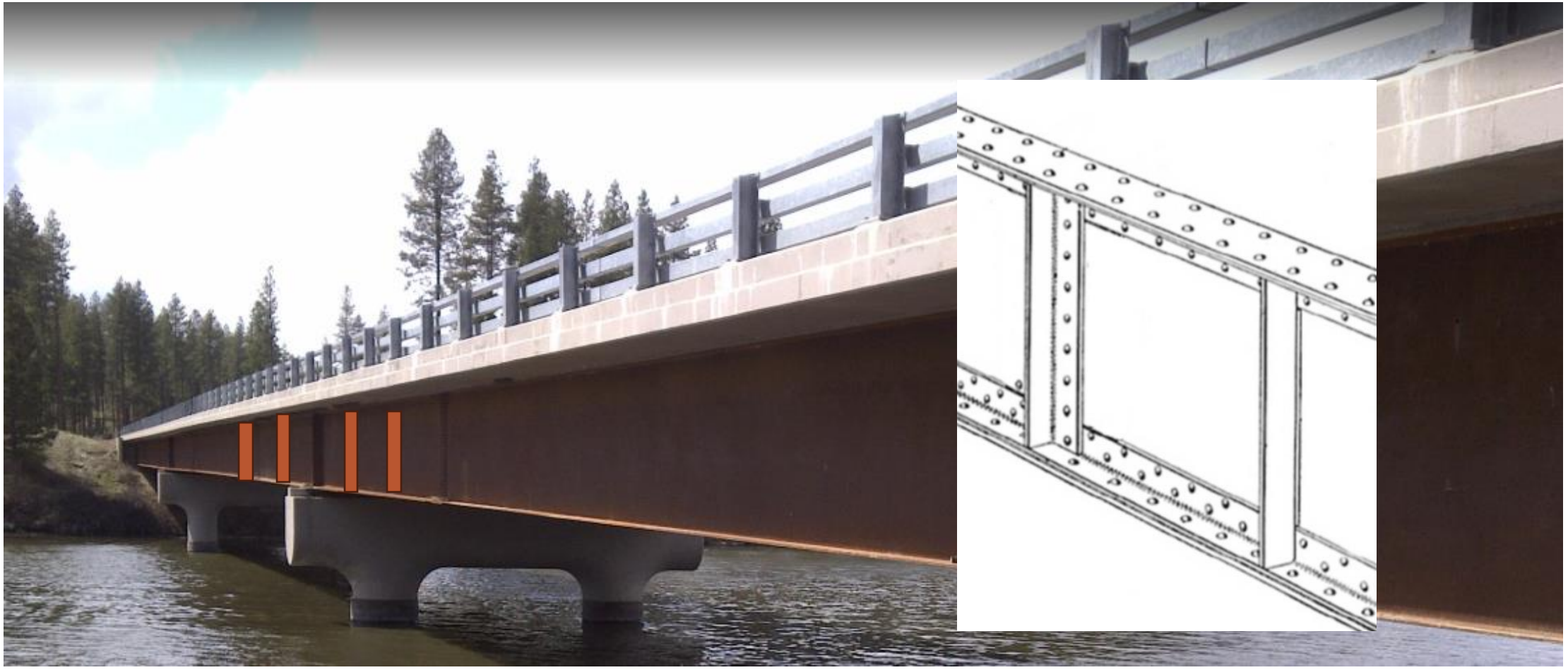
Concrete Beam Encapsulation:

CFRP Wraps



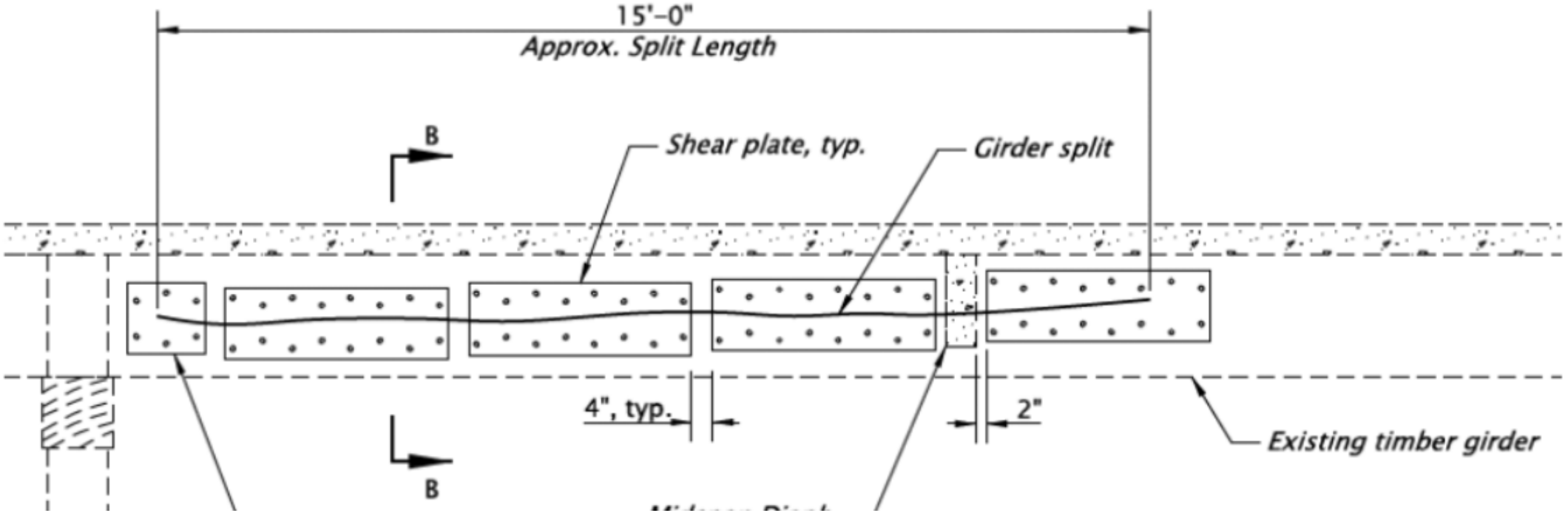
Strengthening Steel Members

Steel Girder Bridge: Bolt on Stiffeners



Timber Girder Split Repair:

Fish Plating: New Repair



Timber Repairs: Timber Girder Split

Timber Pile Repair: Helper Pile

Pile Repair: Banding

- Piles tend to fail but mushrooming outwards.

- Installing steel sleeves to hold the pile together can buy some time.

Cap Repairs: Encapsulation

Why do you want to implement posting?

- As a matter of public safety and as a way of safeguarding vital transportation infrastructure, State and local law enforcement agencies enforce weight restrictions on trucks and heavy vehicles traveling public roads.

  - To protect the Public
  - To protect the Bridge
  - To protect Ourselves and Agency

HOW DO WE DO THIS

- MAINTAIN ACCURATE LOAD POSTING and SIGNAGE
  - Ensure Posting Signs Match Rating
  - Signs are Not Obstructed, Legible and are Properly Placed


HYUNDAI
6365


WEIGHT
LIMIT
03T
04T
06T
ROAD
CLOSED
YCRD
BRIDGE
OUT

Upcoming BPP Meeting:

Midwest and Northeast

- October 13th-15th
- Chicago, Illinois

Questions

Travis Kinney

David Evans and Associates

Travis.Kinney@DEAINC.com