

Rapid Repair of Low Volume Bridges: Mechanically Fastened FRP Strips

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5 axle tractor-trailer

Logging trucks represent heavy loads on bridges while being essential to the local economy



6 axle tractor-trailer

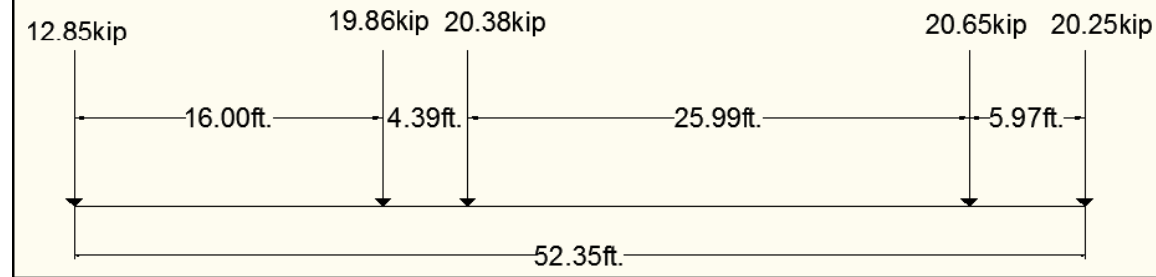


5 axle truck and pup

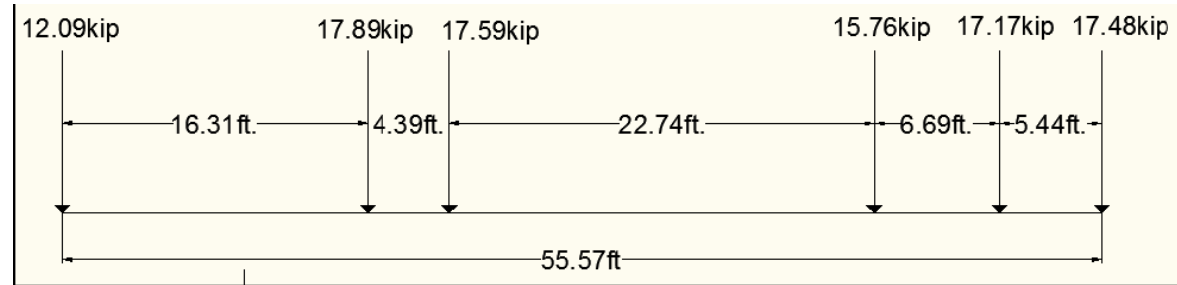
Measured logging truck weights



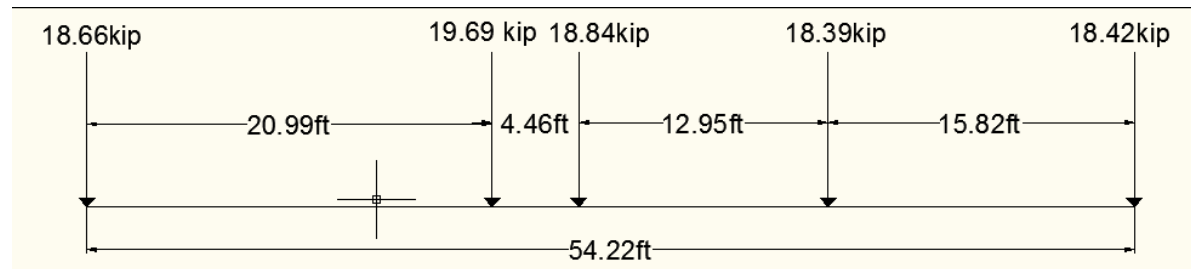
5 axle tractor-trailer – 94kip



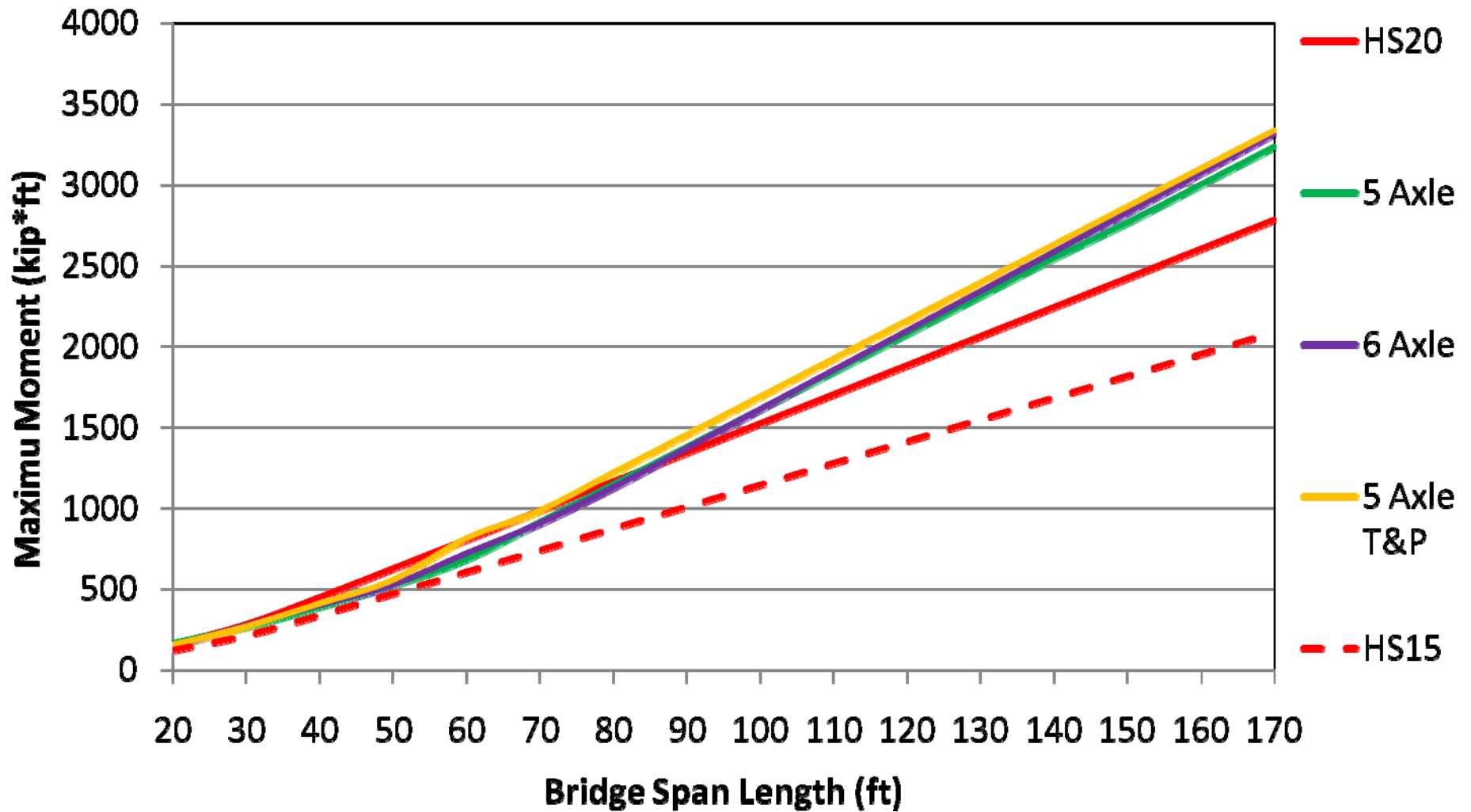
6 axle tractor-trailer – 98kip



5 axle truck and pup – 94kip



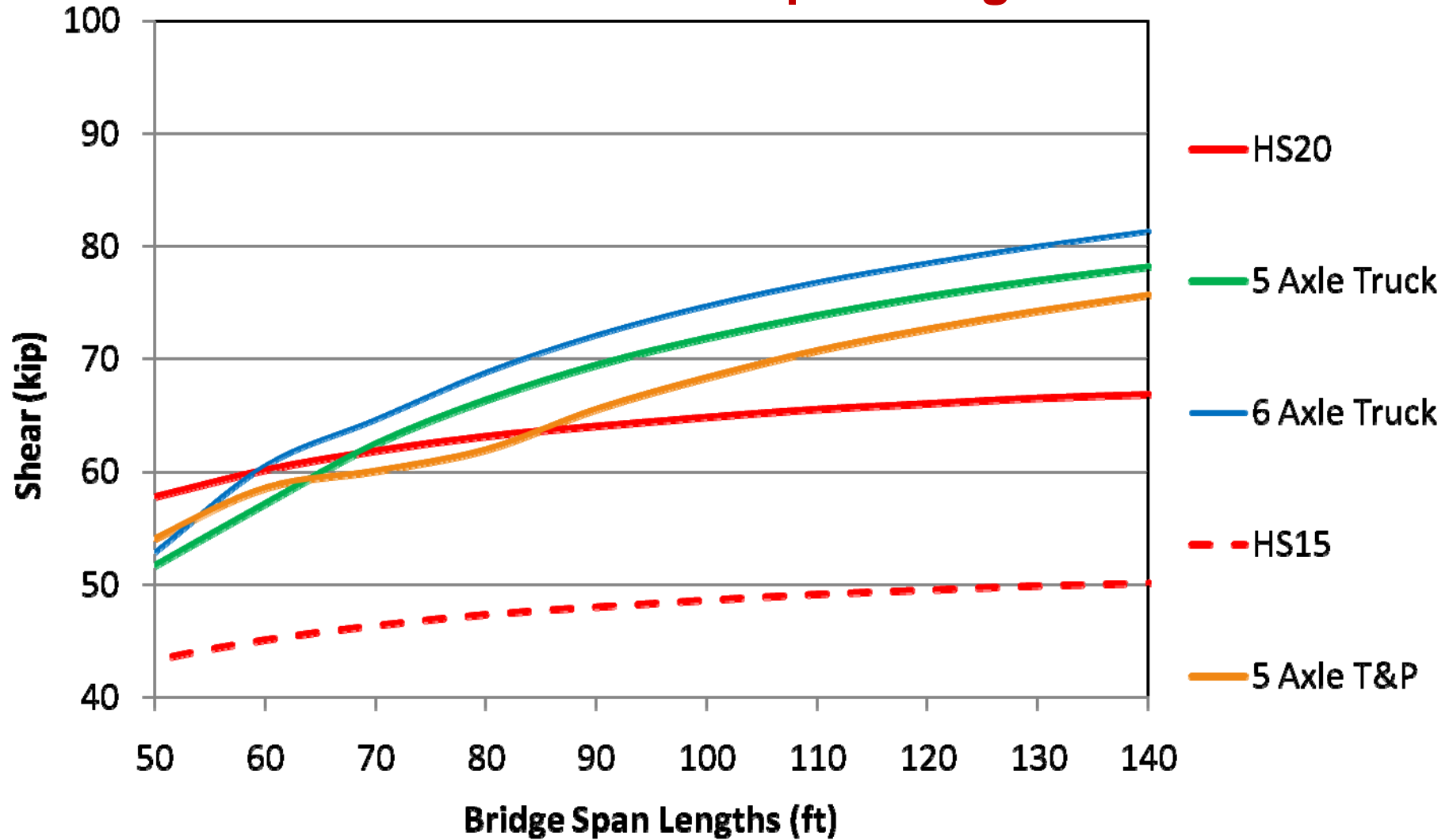
Maximum Moment vs. Span Length



Short Span Bridges designed to carry HS15 trucks
won't carry logging trucks



Maximum Shear vs. Span Length



Same applies to shear effects: HS15 bridges can't carry truck loads

In the North-west and in Wisconsin the local economy is strongly dependent on logging.

Current load posting of older bridges adds million dollar costs to the timber industry in Wisconsin.

Can bridges be quickly and economically strengthened to allow short term logging truck movement?



Mechanically Fastened Fiber Reinforced Polymer (MF-FRP) Strips

- Previously, common way of attaching FRP strips was with the use of epoxy
- Advantages of MF-FRP Strips
 - Very little surface prep is necessary
 - Can be attached to surfaces in poor condition
 - Can be installed by unskilled labor
 - No curing time; bridge can be immediately opened to traffic after installation is completed



MF-FRP Strips

- Uses a powder actuated fastener system (PAFS) to attach strips to external side of concrete
- Strips and concrete are predrilled and then fasteners inserted using a gunpowder gun



(Bank, 2004)



(Arora, 2003)

Previous MF-FRP Applications

- Application tested by the University of Wisconsin
 - Ultimate Load Test on bridge in Edgerton, WI
- Implemented on three bridges in Missouri with plans to strengthen up to 31 more



(Bank, Nanni, & Arora, 2004)



(Rizzo A. , Galati, Nanni, & Jones, 2005)

Cost of Previous Strengthening Projects

Bridge	Total Cost	Length of FRP Used
Missouri Bridge No. 1330005	\$16,502	688 ft
Missouri Bridge No. 3855006	\$13,115	666 ft
Missouri Bridge No. B2210010	\$11,200	502 ft

	Cost of Materials	Installation Time
Edgerton Bridge (WI)	\$7,572	3 days

Edgerton, WI Bridge

- Concrete slab bridge built in 1930
- 2 Main Purposes of bridge project:
 - Demonstrate the real world application of MF-FRP
 - Full scale testing to show increase of flexural capacity as a result of applying the MF-FRP strips

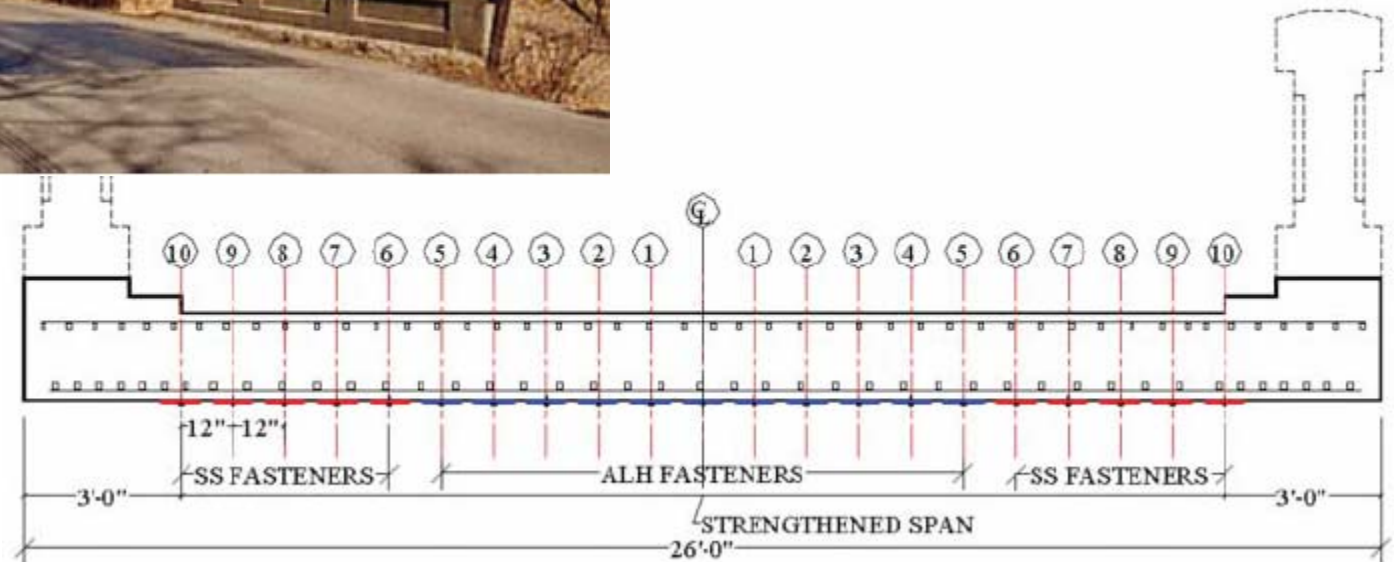


(Arora, 2003)



Bridge Strengthening

- 21 FRP Strips spaced 12in on center
- Strengthening increased bridge from HS17 to HS25 capacity (30.6 tons to 45 tons)



Edgerton Bridge Full Scale Testing

- Strengthening resulted in an increase of flexural capacity:
- West section (3 strips): 25.2% higher at 2 inches deflection ($L/125$),
- East section (5 strips) was 47.7% greater at the same deflection.



Environmental Effects

- Strengthening system endured a Wisconsin winter and was then inspected



(use stainless steel fasteners!)

Flexural strengthening is successfully used in concrete beam and slab type bridges



Shear strengthening?



Future: MF-FRP strips
for shear strengthening

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- System doesn't require skilled labor or surface preparation to the concrete underside of the bridge
- **Strong potential to alleviate problems rural commerce industries have with old deteriorating bridges**

Summary of MF-FRP system

- Software is available to make design simple and straight-forward

Questions?

