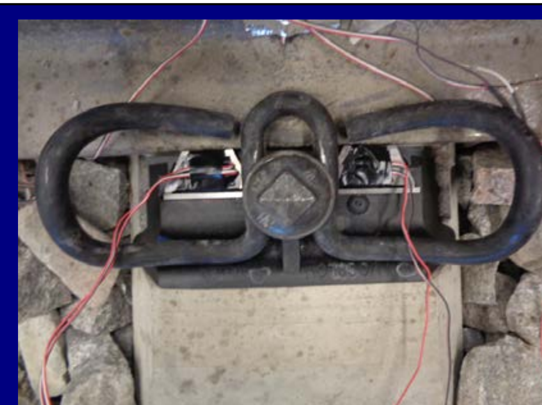
Lateral Load Performance of SkI-Style Fastening System
Laboratory and Field Results



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Donovan E. Holder, Sean Lin, Matthew V. Csenge, Yu Qian,
Marcus S. Dersch, and J. Riley Edwards

RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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Outline

- Motivation
- Overview of Fastening System Components
- Summary of Laboratory Experimentation
- Field Experimentation
  - Overview
  - Distribution of Lateral Load
  - Magnitude of Lateral Load
  - Lateral Stress on Crosstie
- Conclusions
- Contact Information

Motivation

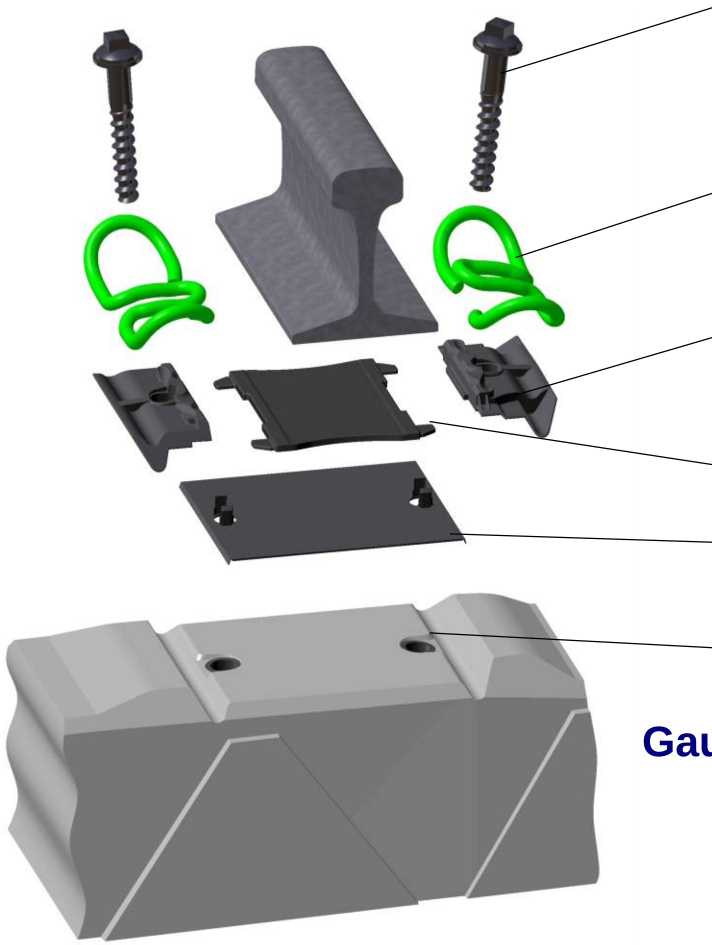
- Lateral forces through the fastening system are believed to contribute to crosstie and fastening system deterioration

Broken/Worn Shoulder

Broken/Worn Insulator

Rail Seat Deterioration

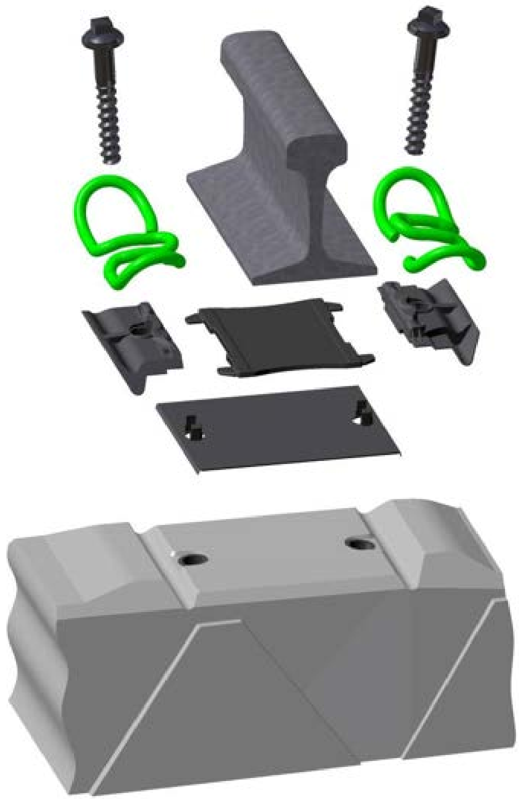
W 40 HH AP Fastening System Components

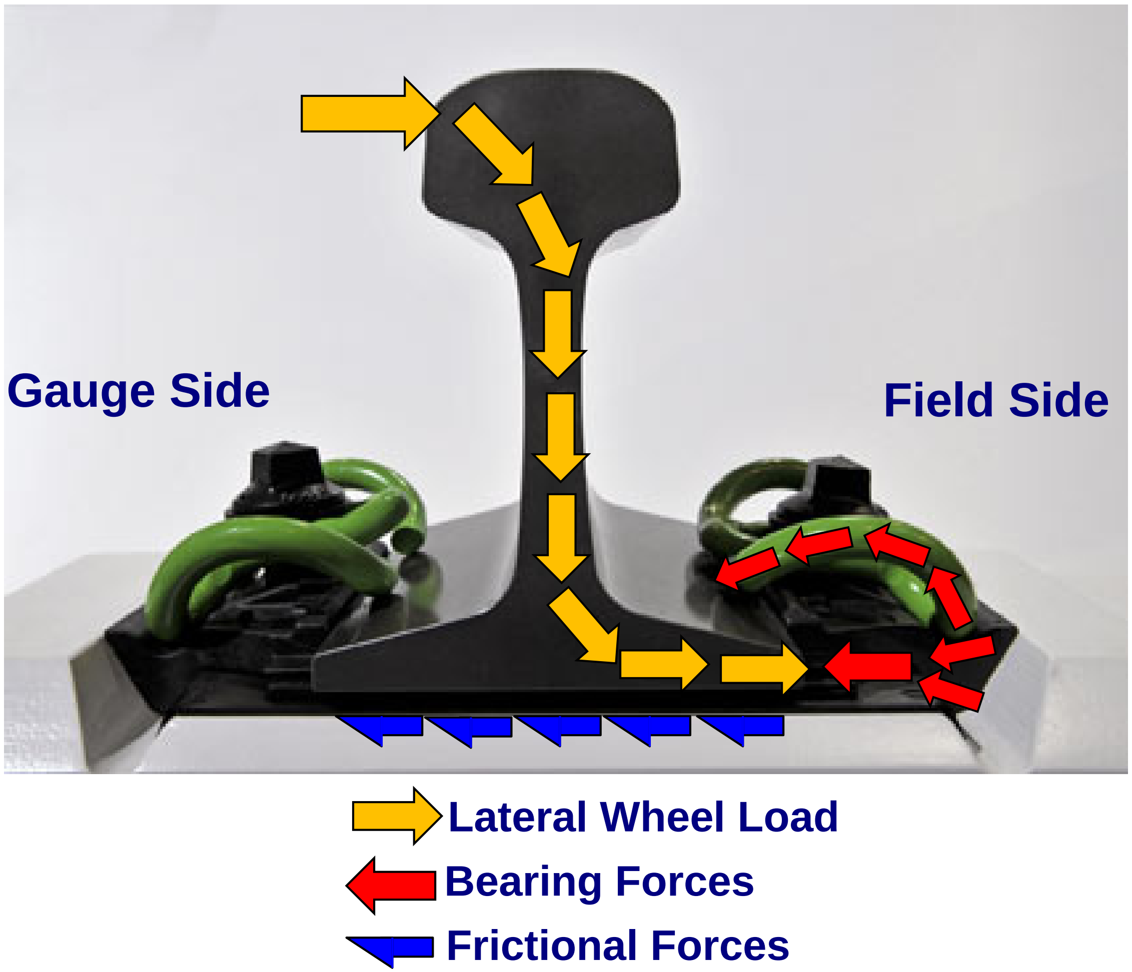


Field Side Angled Guide Plate

Gauge Side Angled Guide Plate

Lateral Load Path through Fastening System

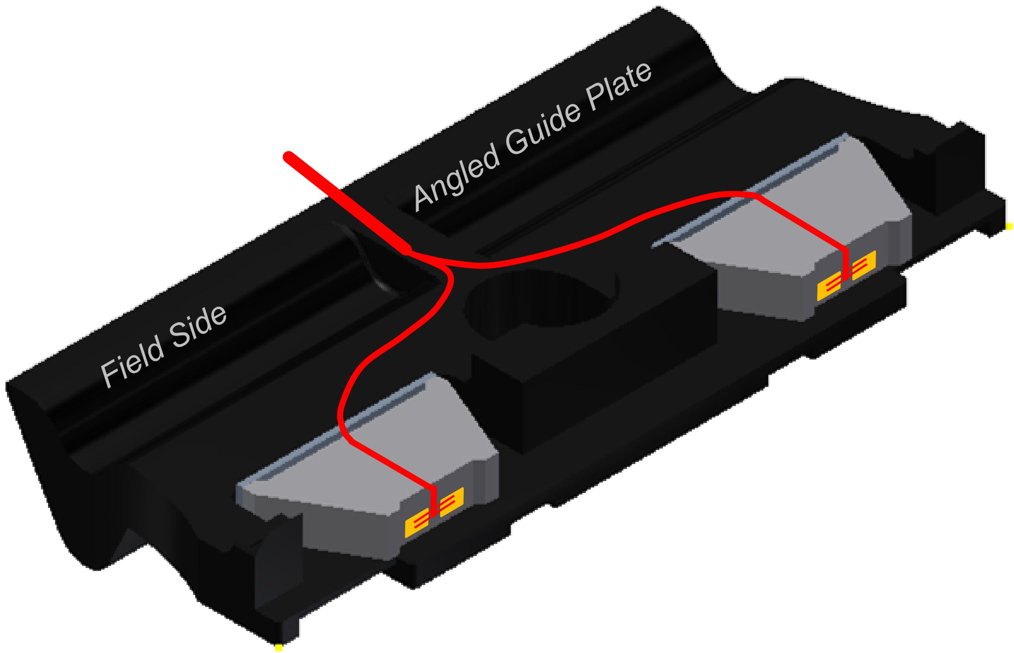


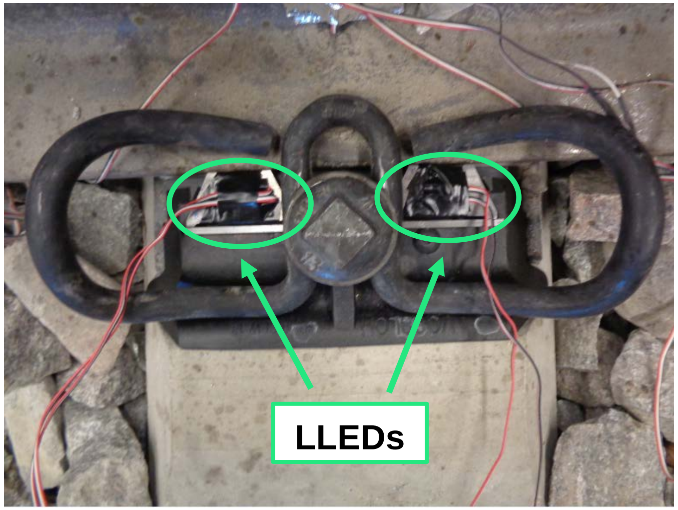


Instrumentation Overview

Lateral Load Through Fastening System

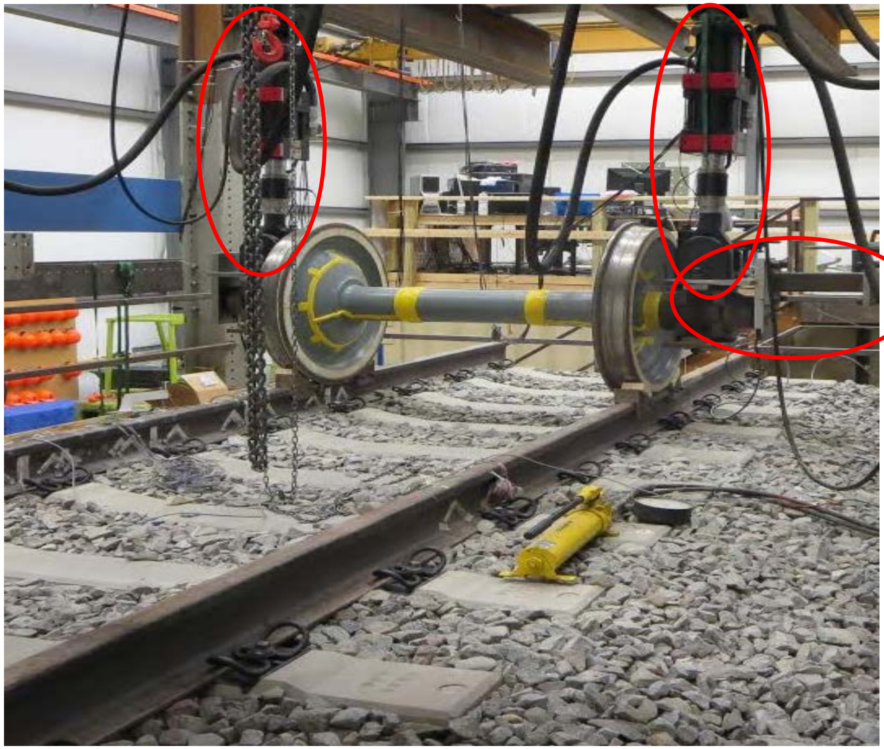
- **Governing critical questions:**
  - *What is the lateral stress on fastening system's rail bearing area?*
  - *Over how many crossties/fastening systems are lateral wheel loads distributed?*
- **Instrumentation description and methodology**

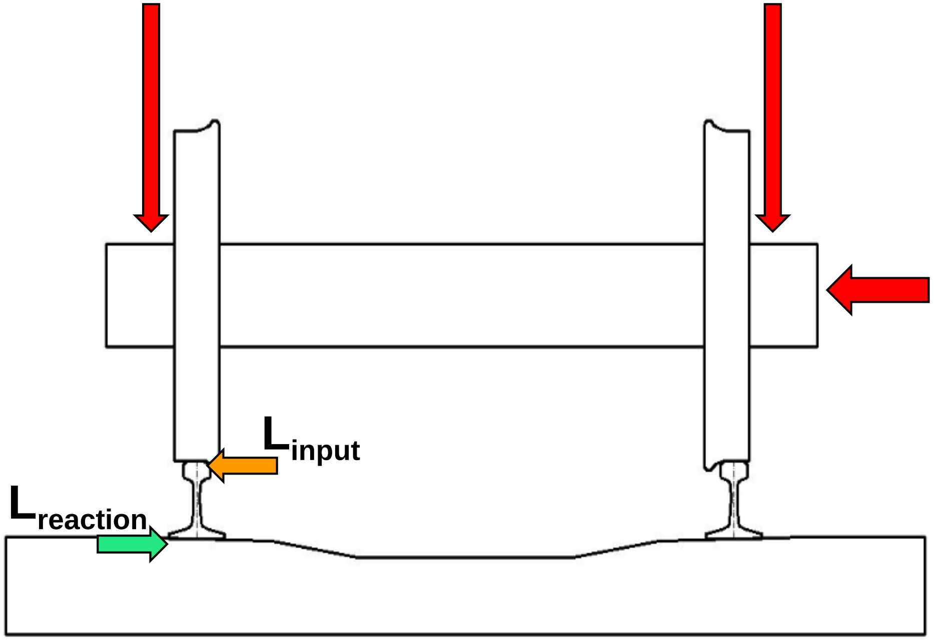




Summary of Laboratory Experimental Results on Lateral Load Magnitude and Distribution

Lab Experimental Setup
Track Loading System (TLS)



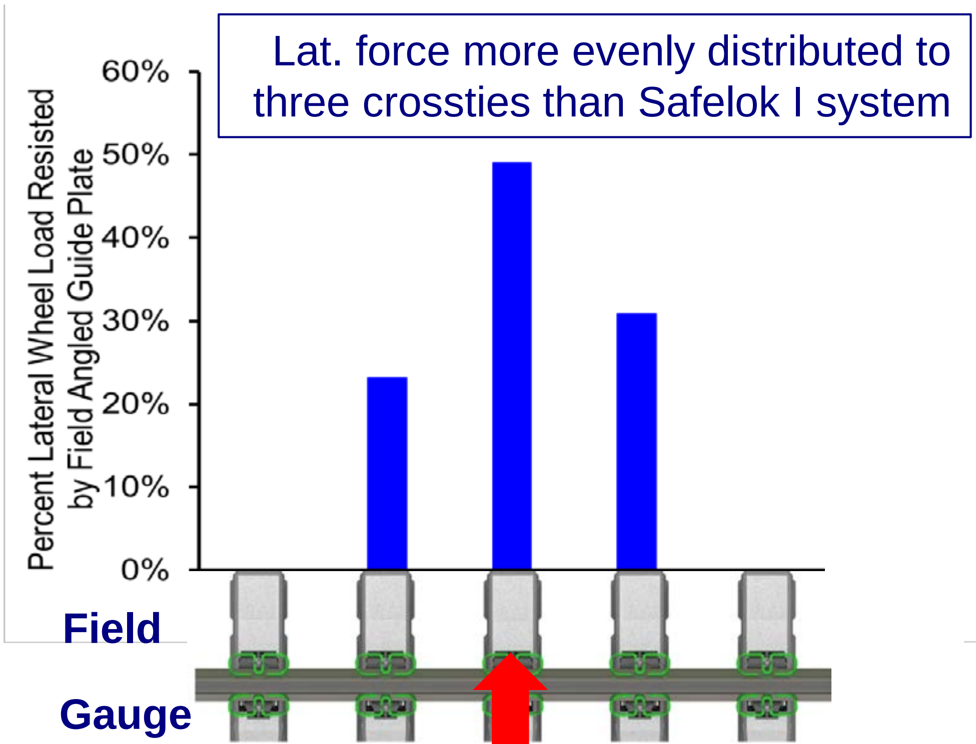


- RailTEC Track Loading System (TLS) allows for static testing of track infrastructure similar to field conditions.
- L_{input} is obtained from strain gauges attached to the rail
- $L_{reaction}$ is obtained from instrumentation installed in the shoulder or angled guide plate of sleepers being tested.

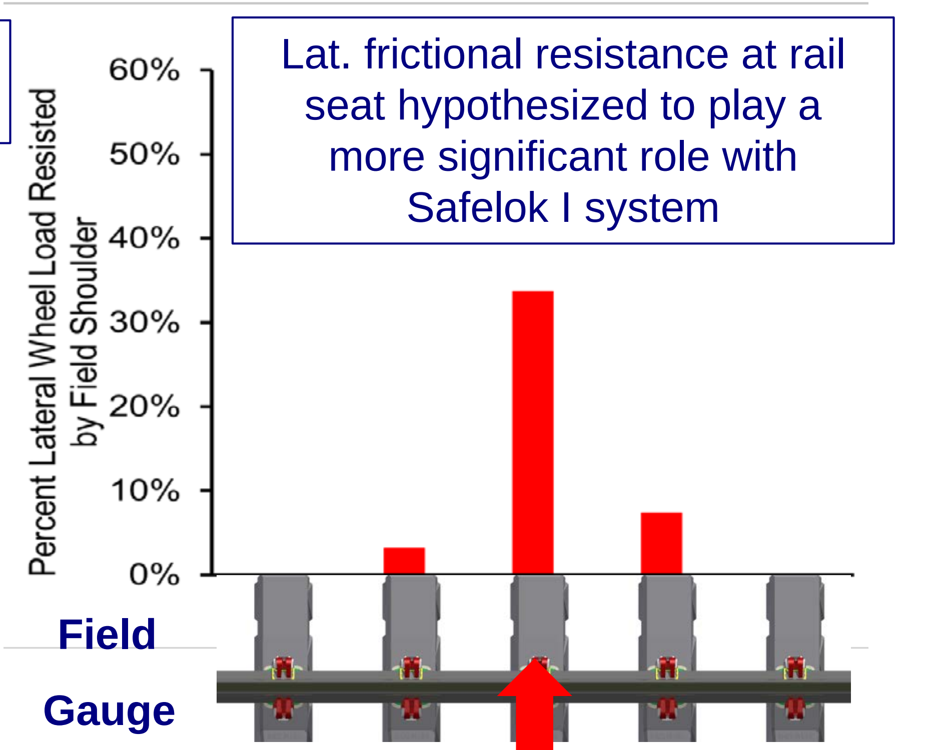
Global Distribution of Lateral Load

- Lateral load is mainly transferred to three crossties with both fastening systems
- Load distribution further confirmed with data collected from rail base displacement measurements

W 40 HH AP
Vert. Wheel Load Applied = 40 kips (178kN)
Lat. Wheel Load Applied = 9.9 kips (44kN)



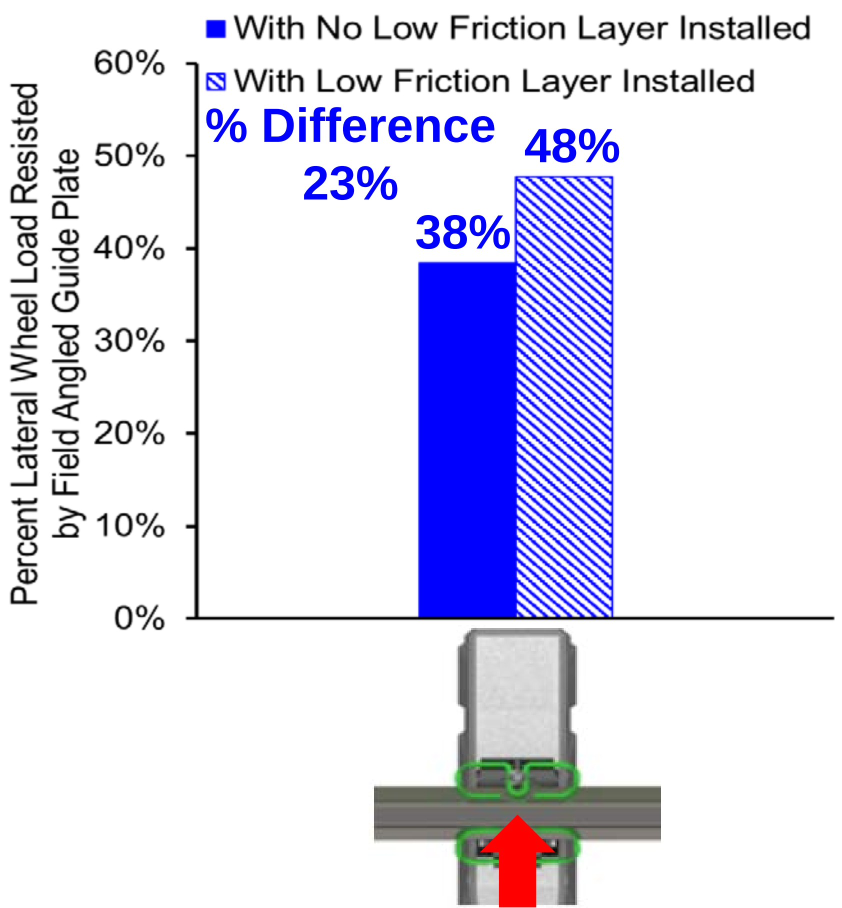
Safelok I
Vert. Wheel Load Applied = 40 kips (178kN)
Lat. Wheel Load Applied = 9.8 kips (43kN)



Contribution of Lateral Friction at Rail Seat

- W 40 HH AP relies less on lateral friction at rail seat to resist lateral wheel load. This is hypothesized to make the system less abrasive to concrete on rail seat

W 40 HH AP
Vert. Wheel Load Applied = 40 kips (178kN)
Lat. Wheel Load Applied = 9.9 kips (44kN)



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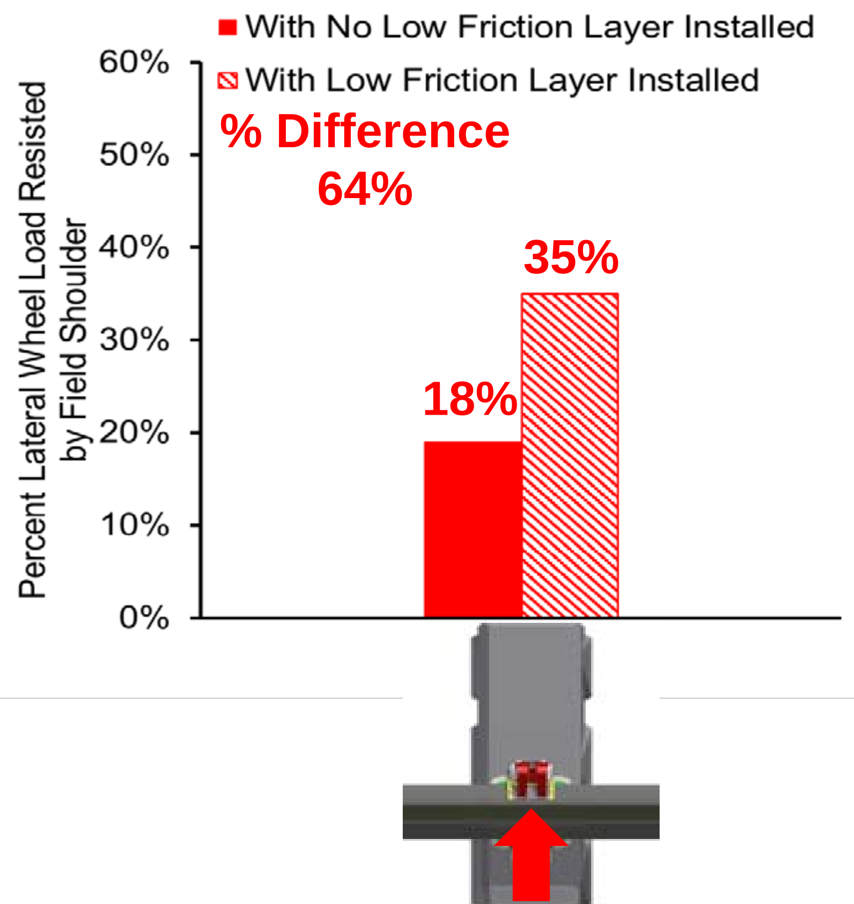
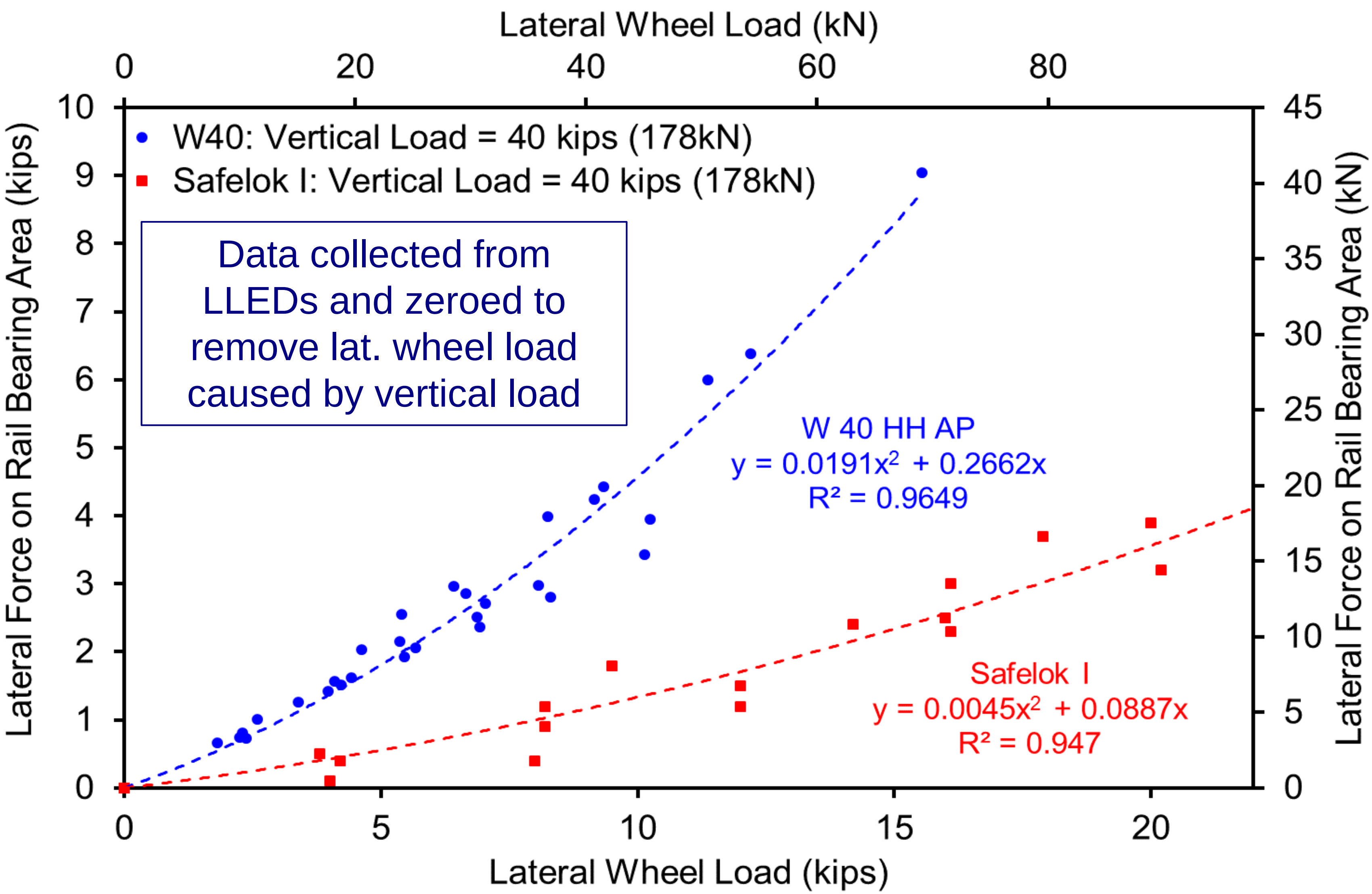


Lateral Force on Rail Bearing Area

Vertical Load = 40 kips (178kN)

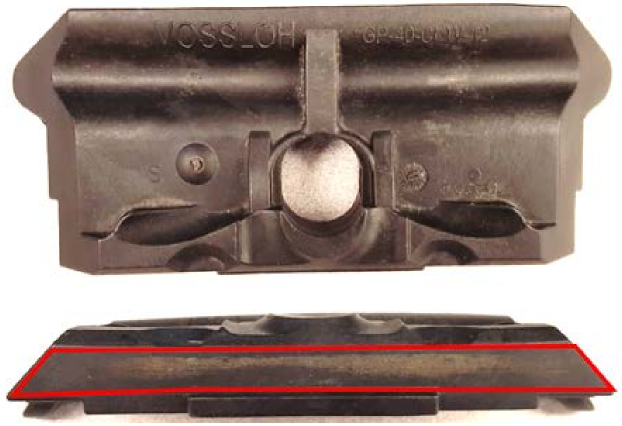


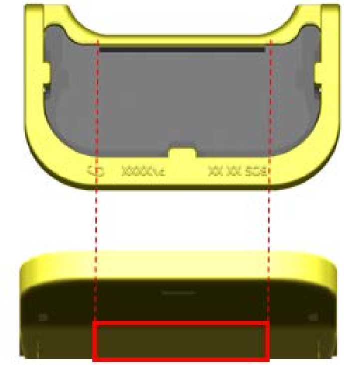
Quantifying Lateral Stress on Components

$$\text{Lateral Stress} = \frac{\text{LLED Force}}{\text{Bearing Area for Lateral Force}}$$

W 40 HH AP | **Safelok I**

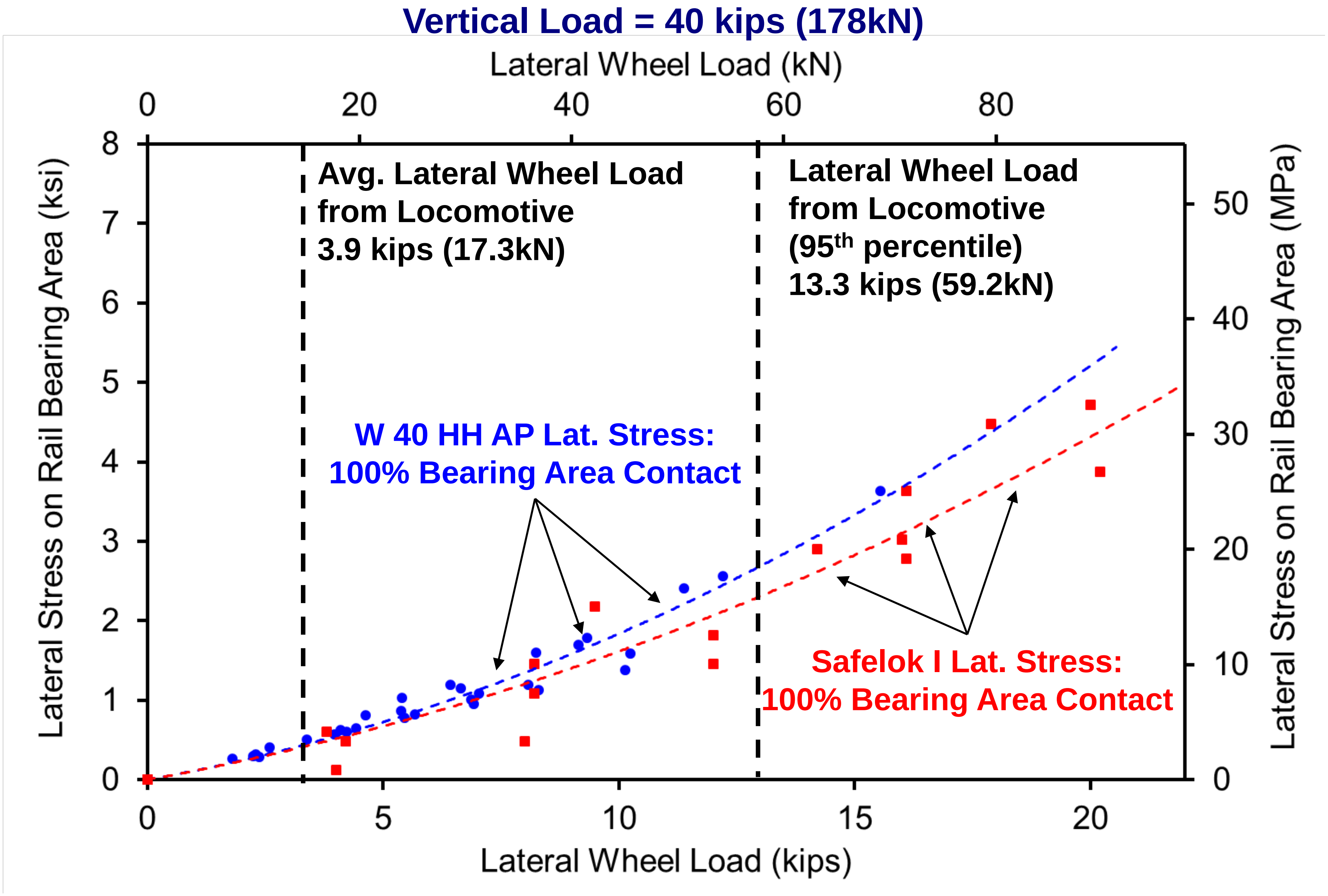
Rail Bearing Area for Lateral Force



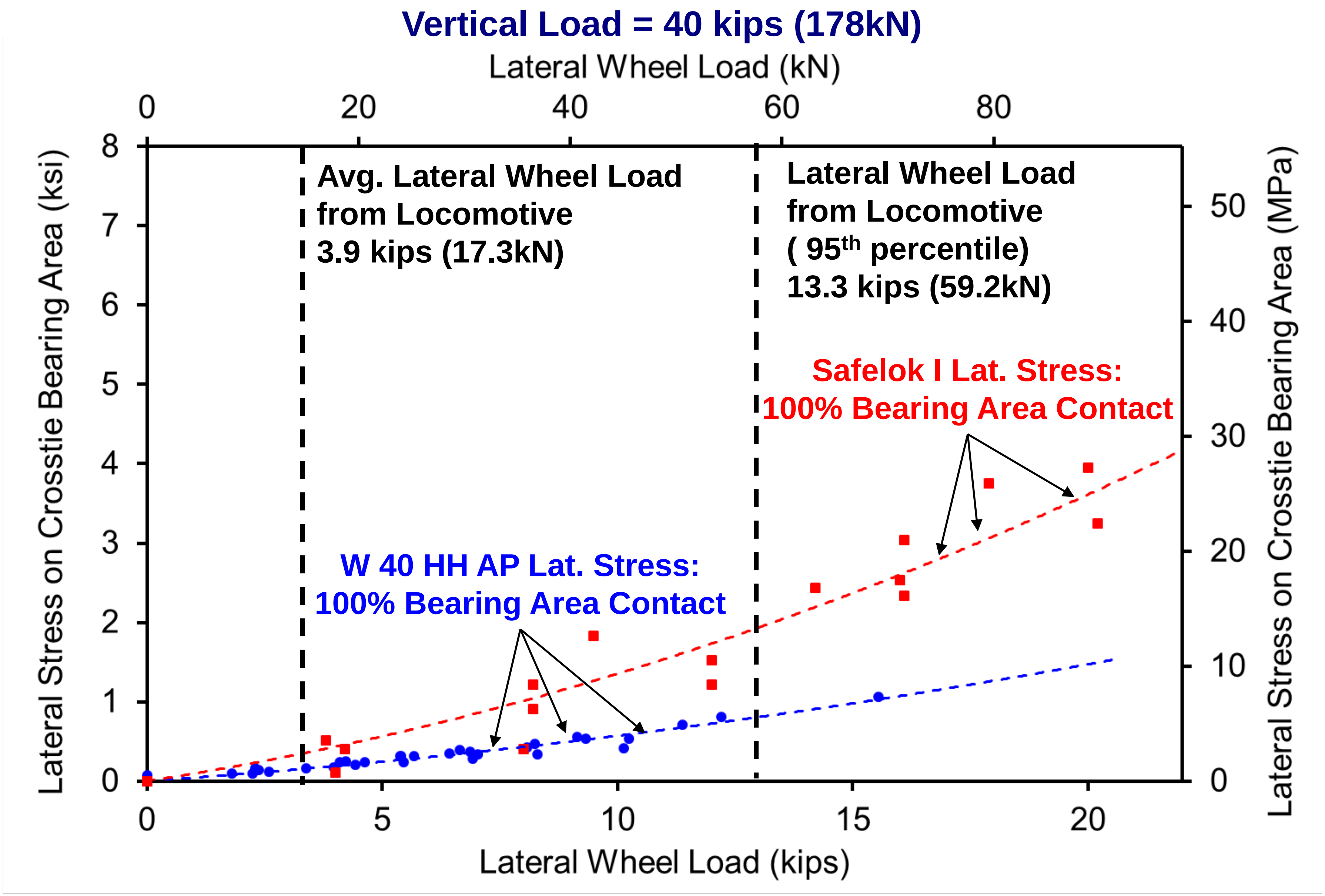


Crosstie Bearing Area for Lateral Force

Lateral Stress on Rail Bearing Area



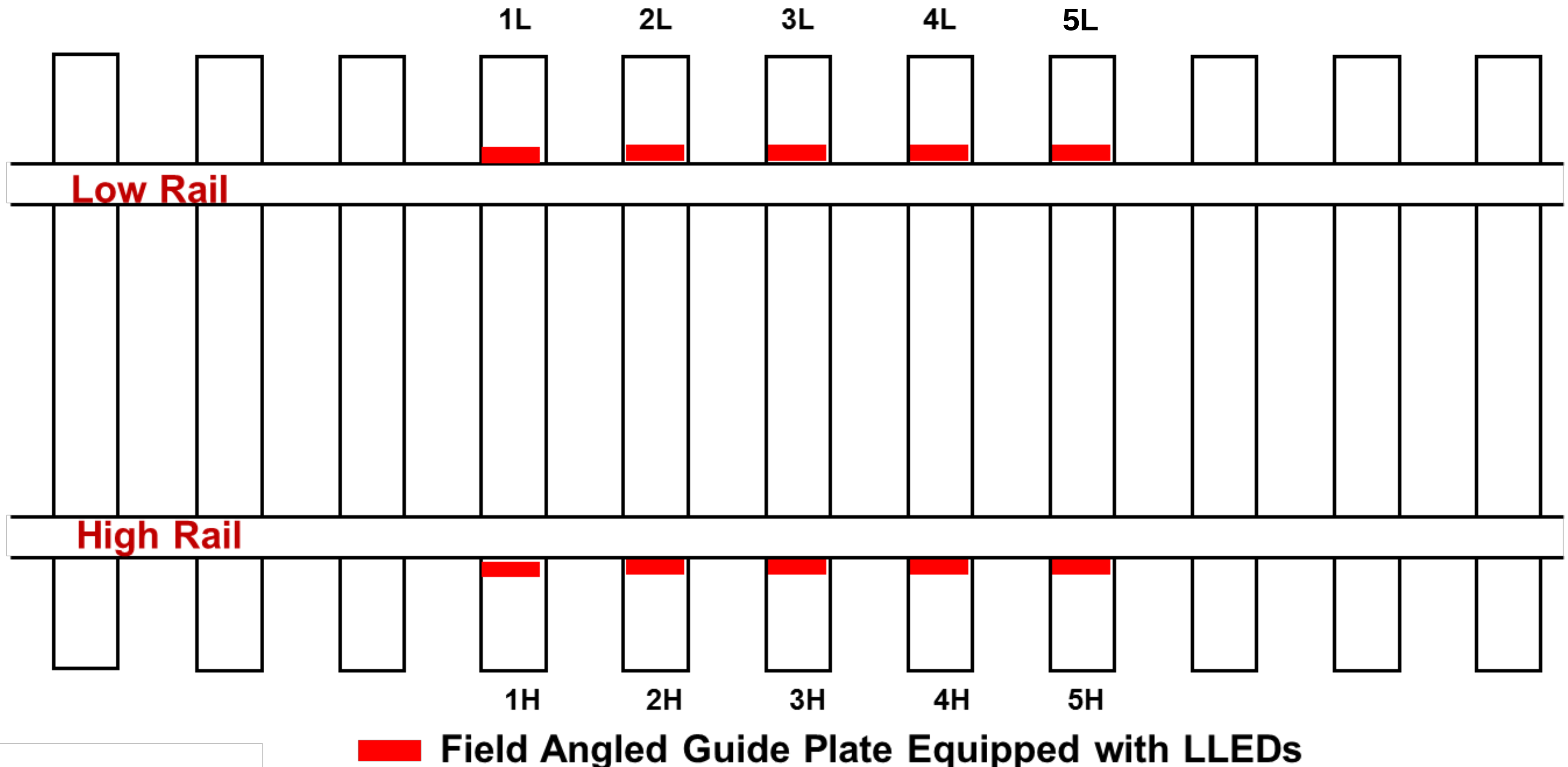
Lateral Stress on Crosstie Bearing Area



Field Experimentation

Lateral Load Magnitude
Lateral Load Distribution

BNSF Field Instrumentation Layout



- Field experimentation conducted on Crawford Hill in Northwest Nebraska on BNSF Railway’s Butte Subdivision
- Grade: 1.31%
- Degree of curvature: 8˚ (Radius of 218 m)
- Data collected 22-24 March 2016

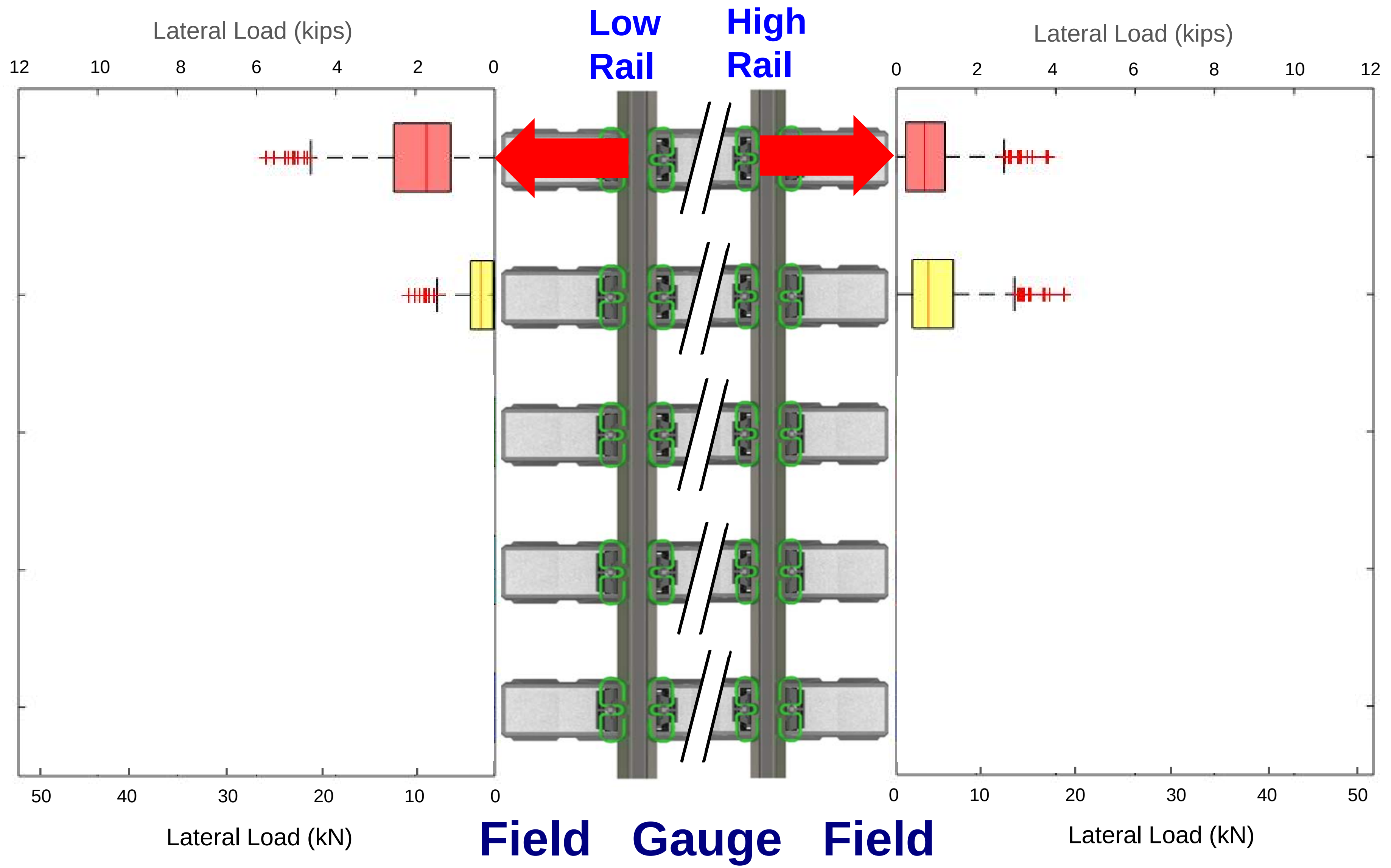
BNSF Crawford Hill, NE
Field Testing Site

Trains Captured:

- 5 – Loaded Coal Trains
- 3 – Empty Coal Trains
- 3 – Manifest Trains

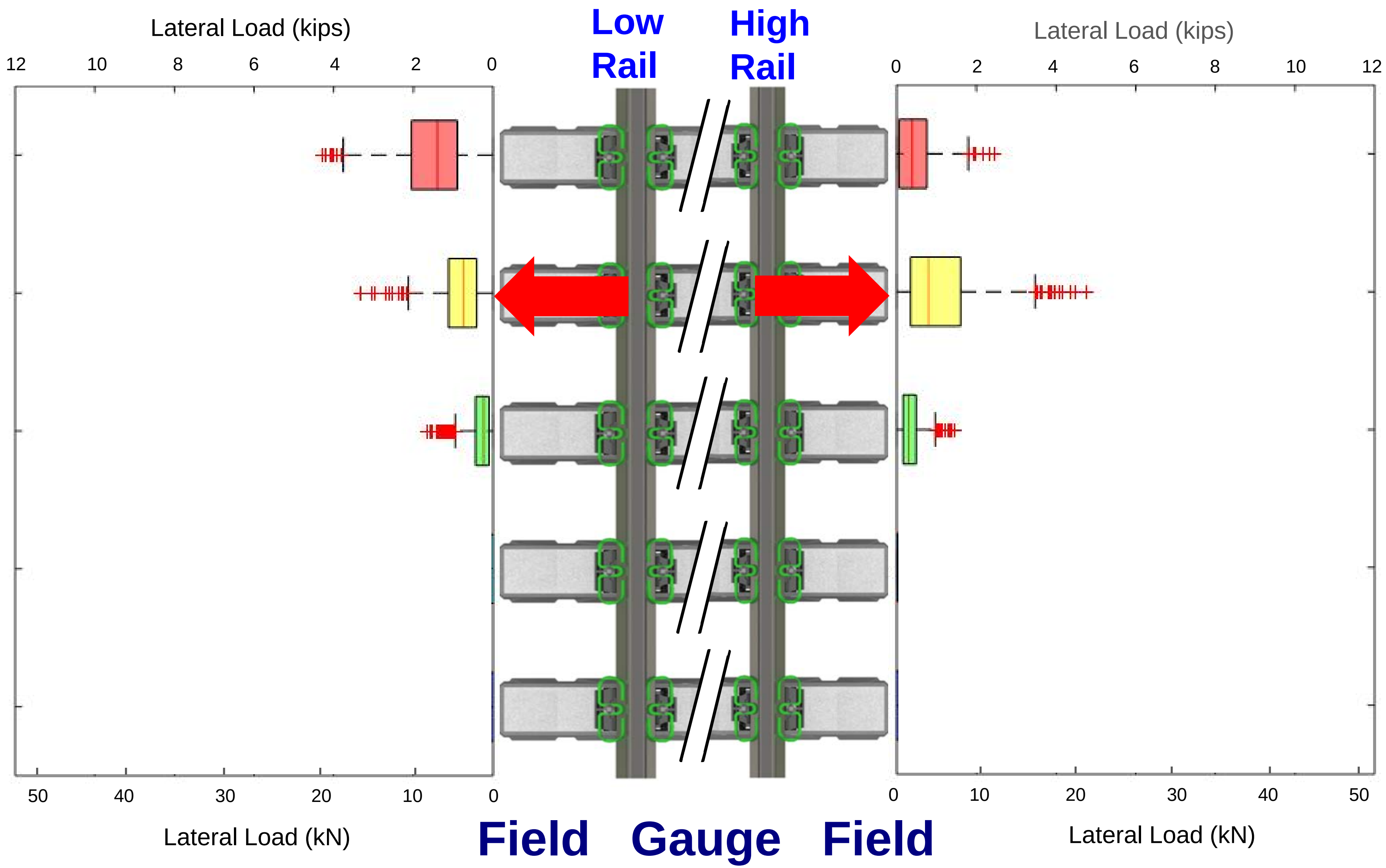
Lateral Load Distribution

Captured When Wheel Directly Over Tie 1



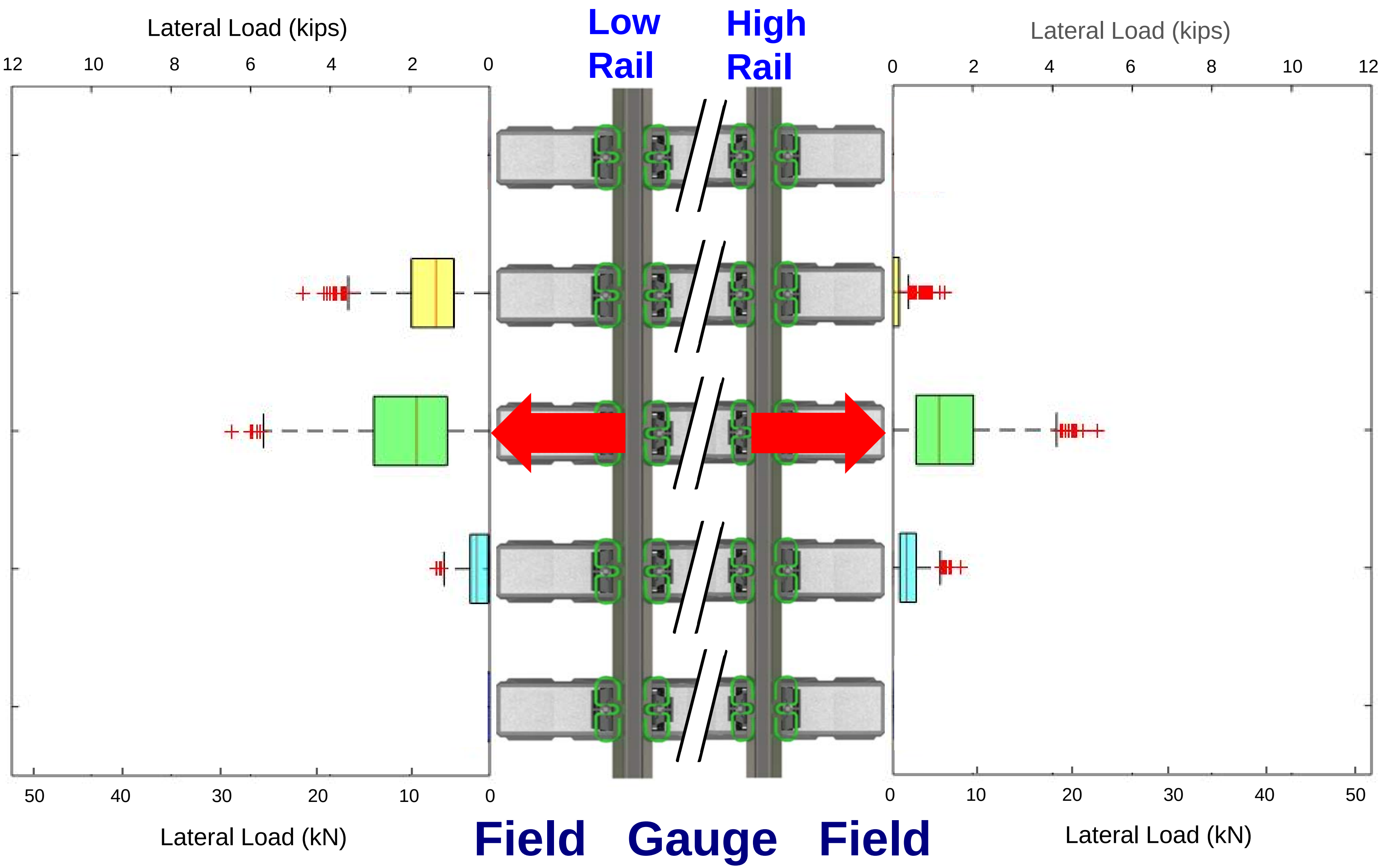
Lateral Load Distribution

Captured When Wheel Directly Over Tie 2



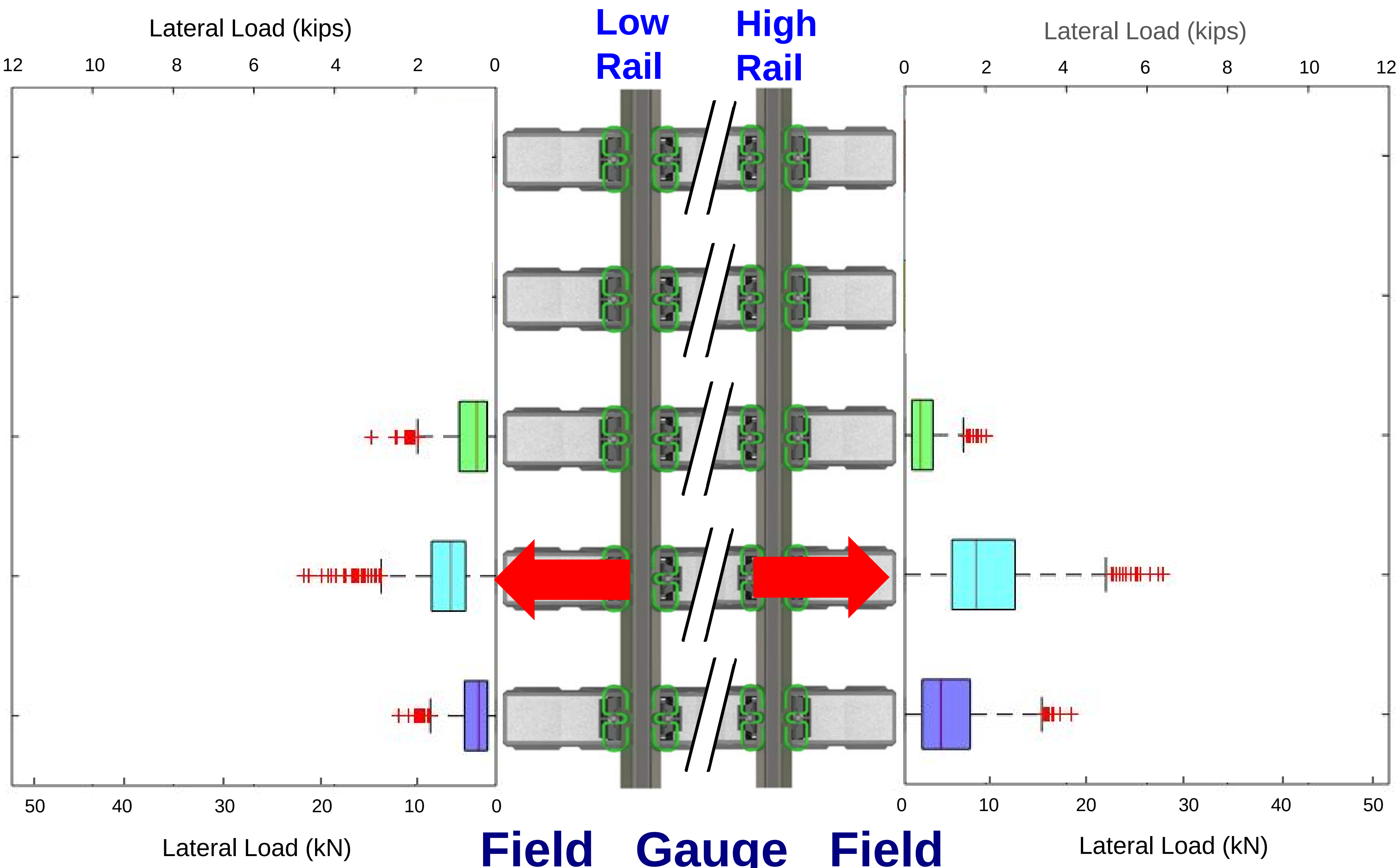
Lateral Load Distribution

Captured When Wheel Directly Over Tie 3



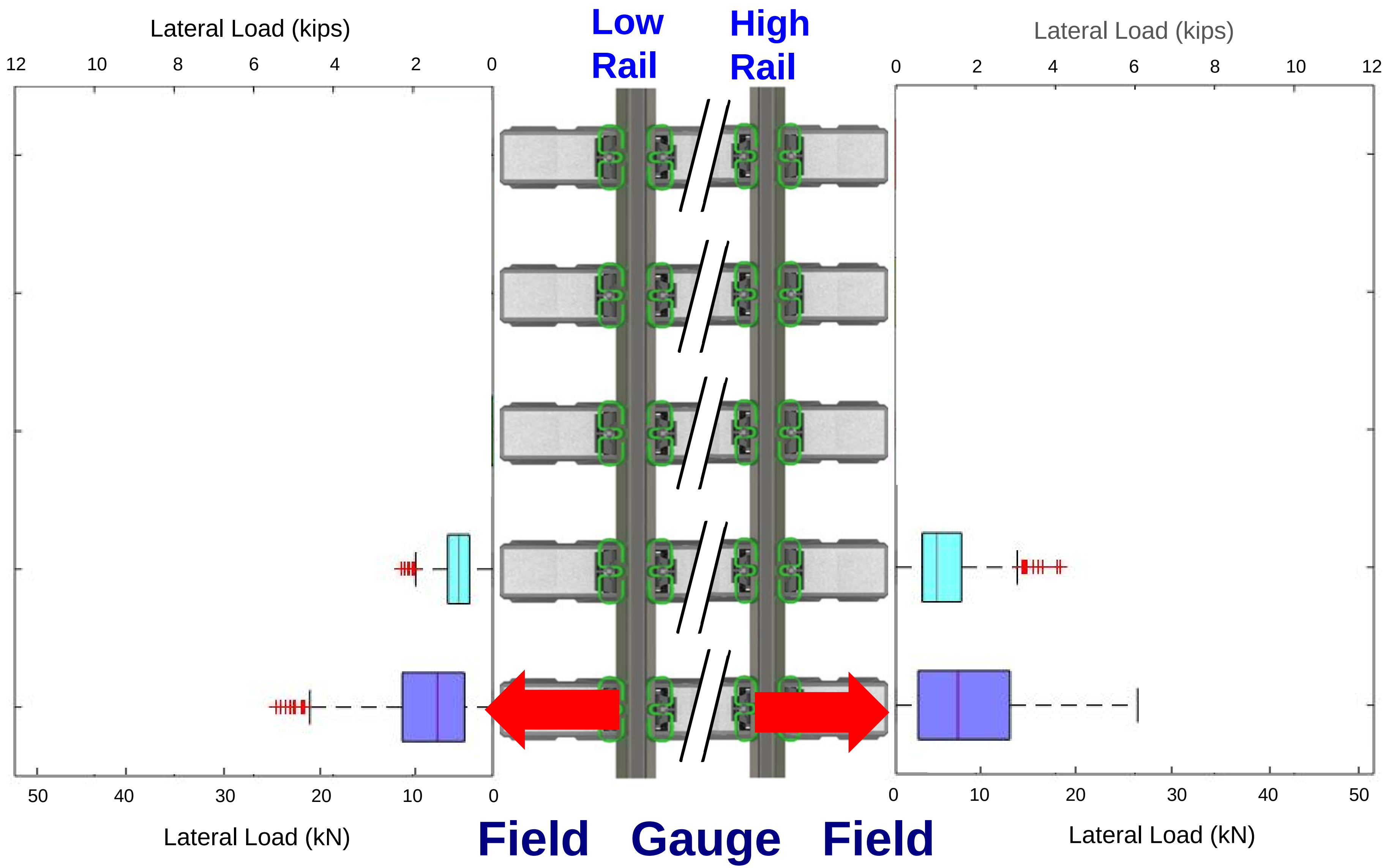
Lateral Load Distribution

Captured When Wheel Directly Over Tie 4



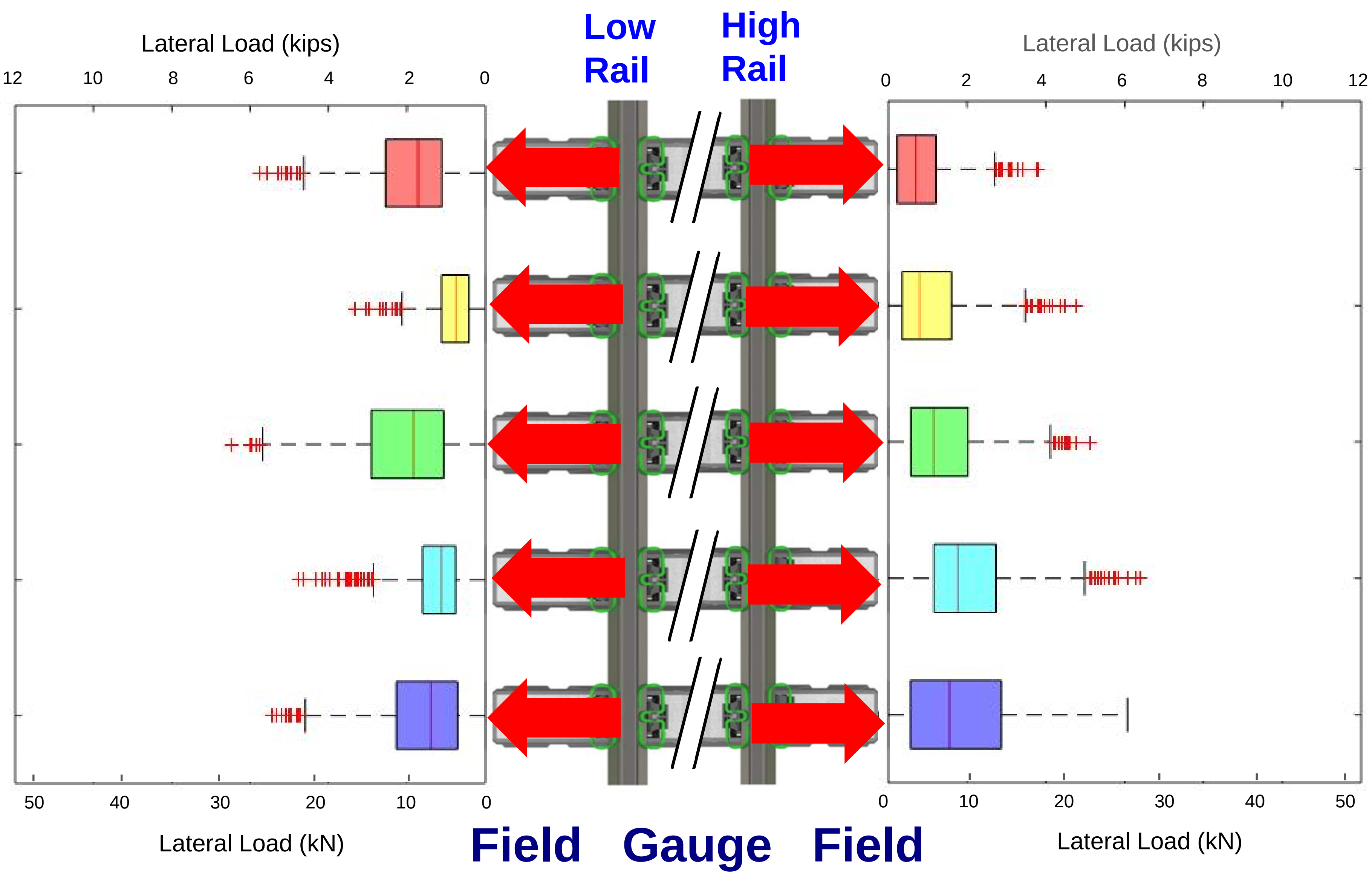
Lateral Load Distribution

Captured When Wheel Directly Over Tie 5



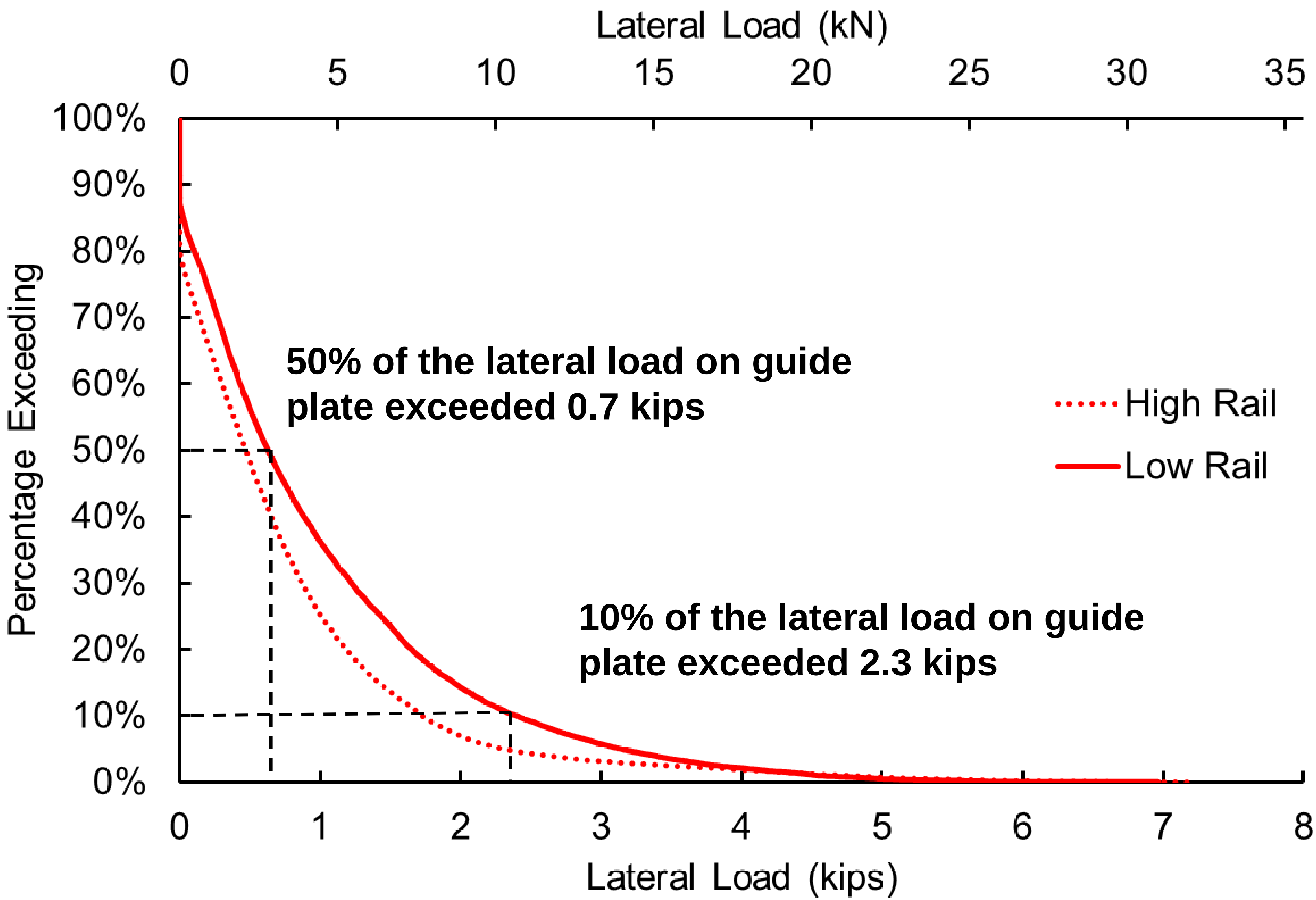
Lateral Load from Instrumented Guide Plate

Captured When Wheel was Directly Over The Crosstie Shown



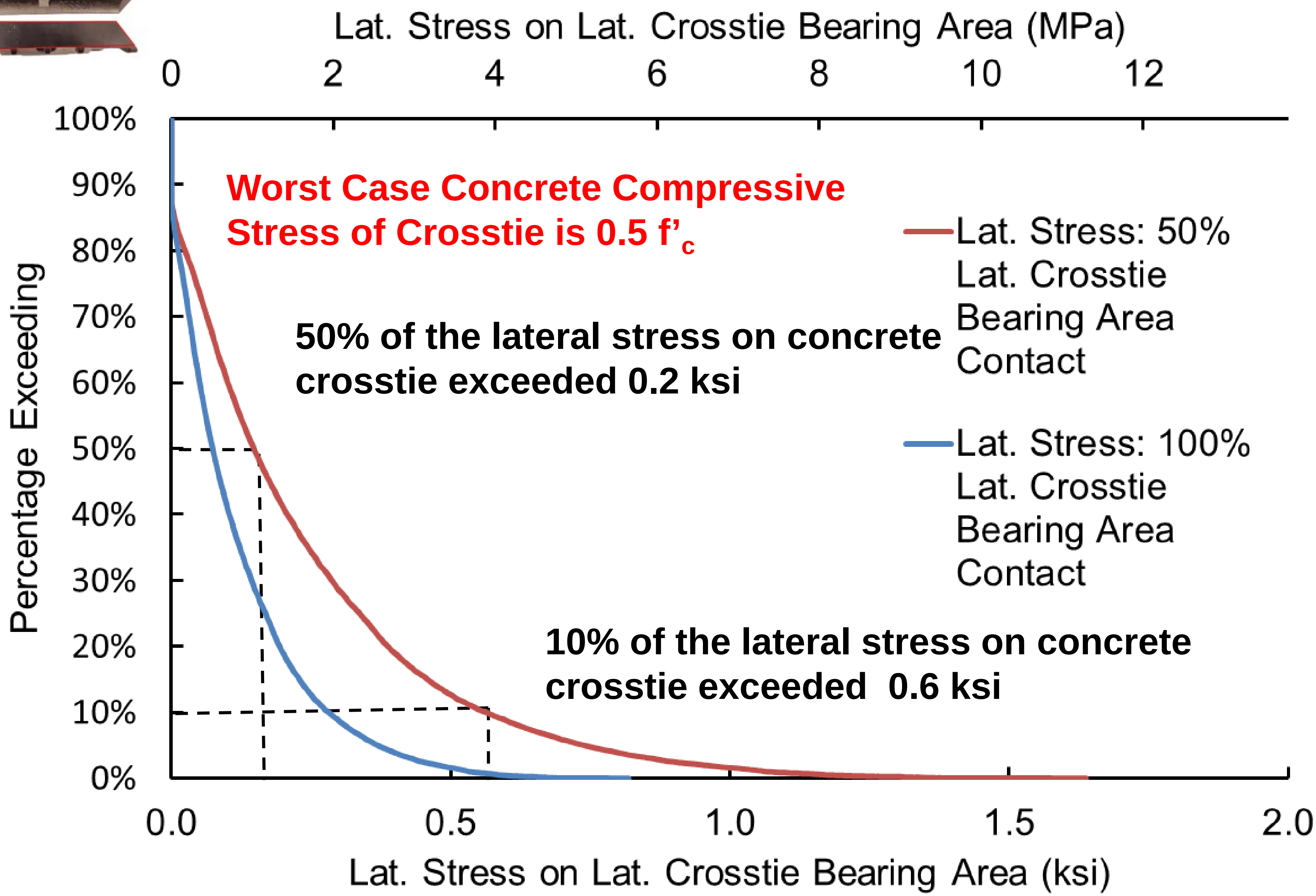
Lateral Force on Angled Guide Plate

All 5 Loaded Coal Trains



Lateral Stress on Crosstie Bearing Area

All 5 Loaded Coal Trains



Conclusions

- A three crosstie distribution of lateral wheel load observed both in the laboratory and in field experimentation on Crawford Hill
- The W 40 system appears to rely less on lateral frictional resistance at the rail seat than the Safelok I. This could help mitigate abrasion of the rail seat, which is a potential cause of rail seat deterioration
- More lateral force enters the field side angled guide plate of the W 40 system than the shoulder of the Safelok I system, but the lateral stress on the crosstie is lower
- From the loaded coal train data collected, higher lateral load was imparted on the low rail due to a combination of the train going uphill and operating below the balanced speed
- Data collected from Crawford Hill showed the lateral stress on concrete crosstie was significantly below the worst case concrete compressive fatigue limit for the W 40 system

Acknowledgements

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  - Vossloh Fastening Systems America (VFSA)
- BNSF Railroad
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Contact Information

RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Donovan Holder
Bridge EIT
email: Donovan.Holder@hdrinc.com

Sean Lin
Graduate Research Assistant
email: xiaolin4@Illinois.edu

Matthew V. Csenge
Manager of Experimentation
email: csenge2@Illinois.edu

Yu Qian
Research Engineer
email: yuqian1@Illinois.edu

Marcus S. Dersch
Senior Research Engineer
email: mdersch2@Illinois.edu

J. Riley Edwards
Research Scientist and Senior Lecturer
email: jedward2@Illinois.edu