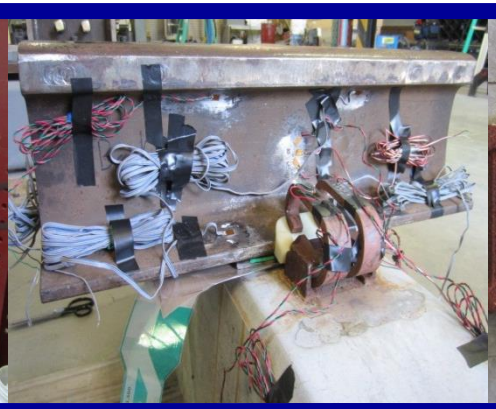
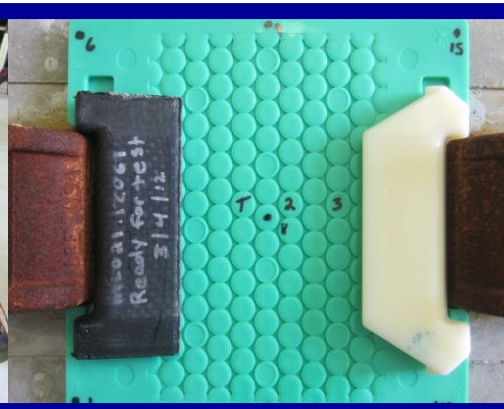
Top 10 Findings and Outcomes
FRA Crosstie and Fastening System BAA Research Program



FRA Tie and Fastener BAA Industry Partners Meeting

15 October 2014

Riley Edwards, Marcus Dersch, Brent Williams, and Yu Qian

RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

FRA Crosstie and Fastening System Research Program – Select Impacts

1. Quantification of wheel loads
2. Development of technique for measuring lateral forces
3. Quantification of rail seat pressures
4. Development of revised crosstie bending analysis methodology
5. Development of full-scale laboratory setup (RAIL)
6. FE model developed and validated
7. Simplified Design Tool (I-TRACK)
8. Revisions to AREMA Chapter 30 (Ties)
9. International Crosstie and Fastening System Symposia (2012 and 2014)
10. Workforce Development (Education of Students)

U.S. Department of Transportation
Federal Railroad Administration

FRA Tie and Fastener BAA Industry Partners:

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BNSF RAILWAY
AMTRAK®
Amsted RPS
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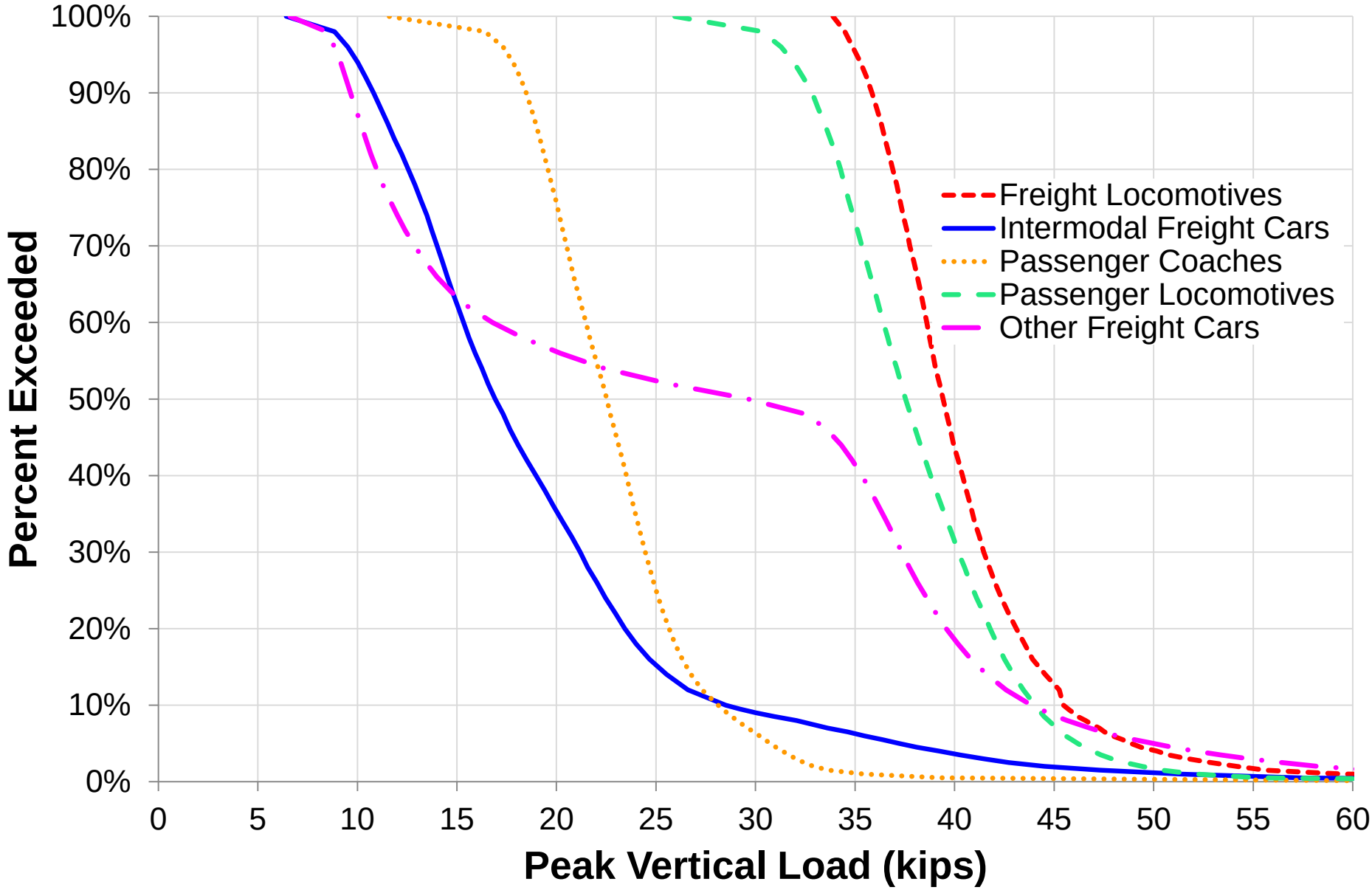
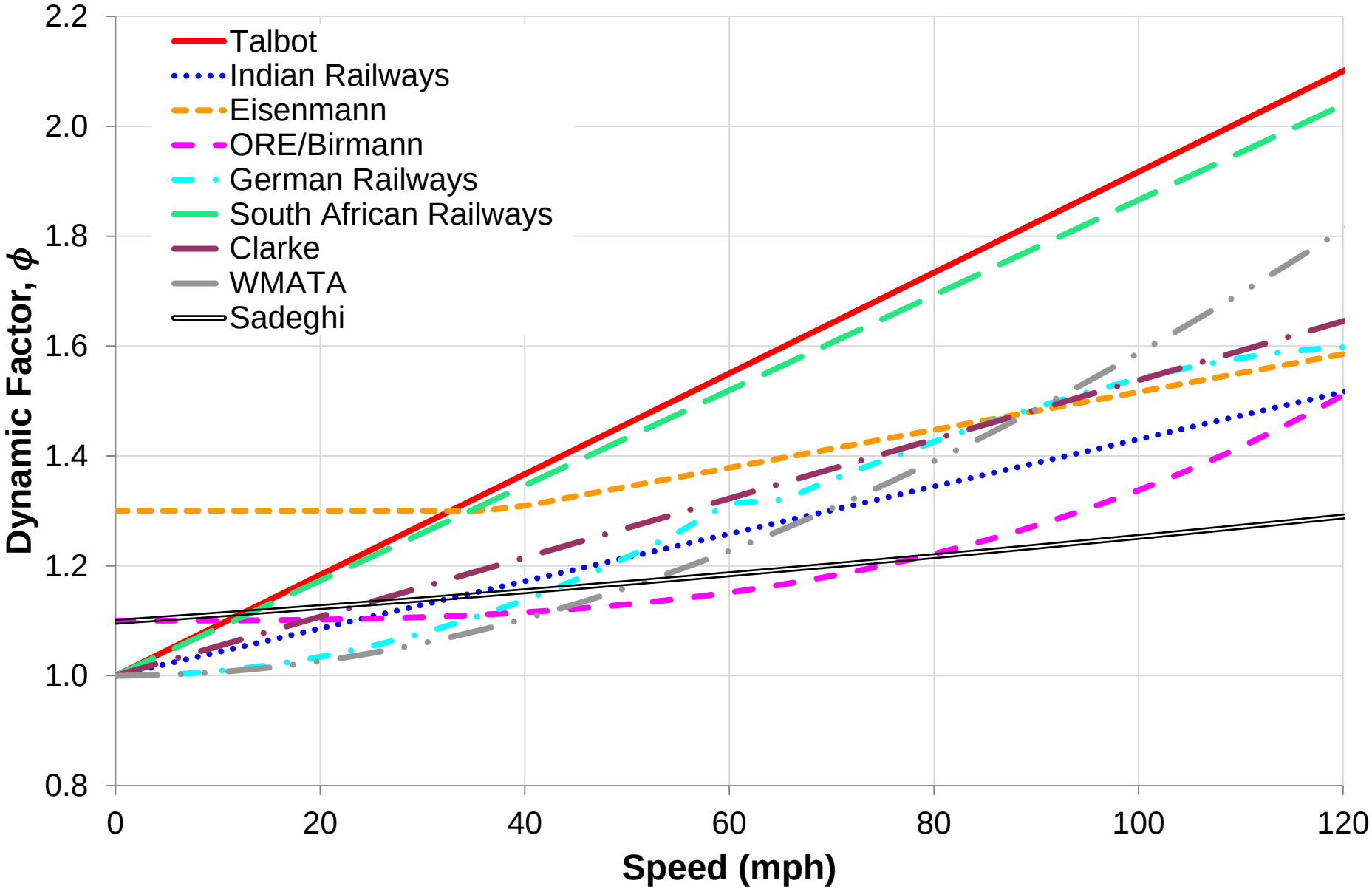
GIC
HANSON
LBFoster
CXT Concrete Ties
TTX

1. Quantification of Peak Wheel Loads



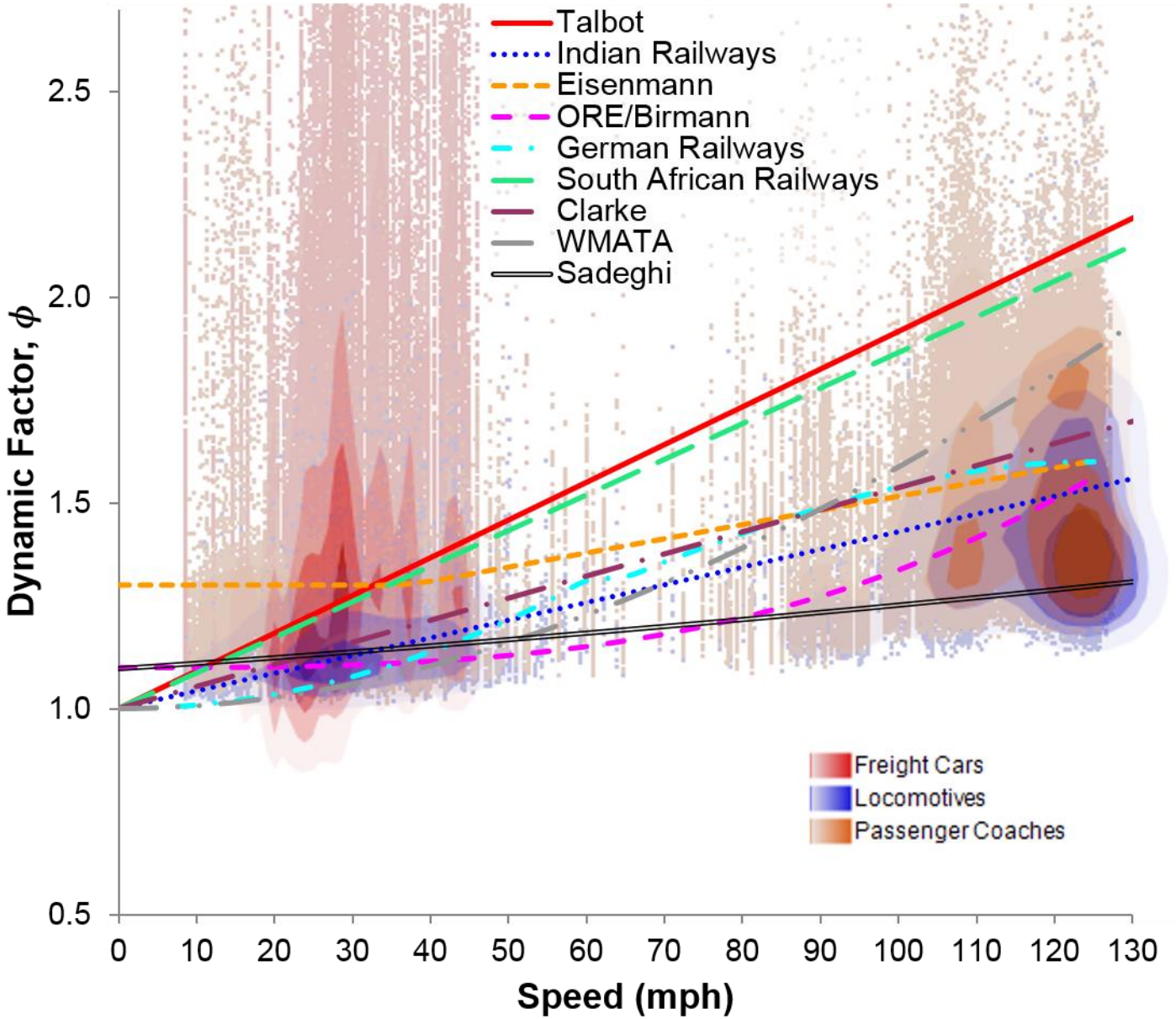
10 kips ≈ 45 kN

Comparison of Dynamic Wheel Load Factors



10 mph ≈ 16 kph

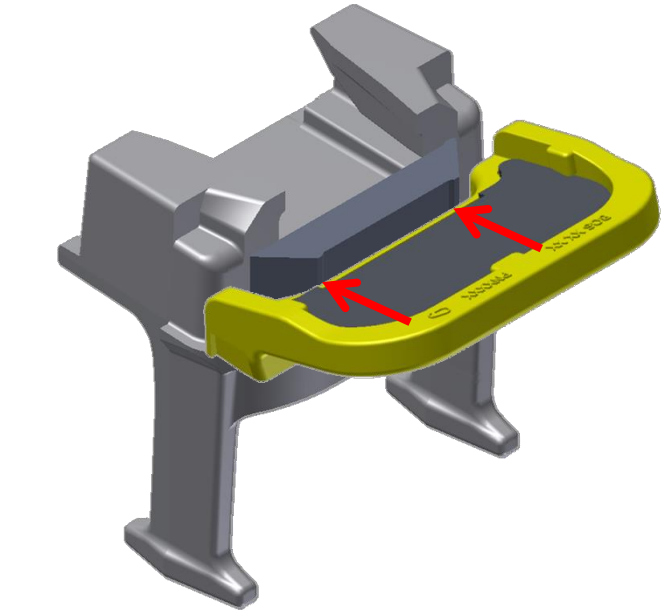
Dynamic Wheel Load Factors (Real Loads)

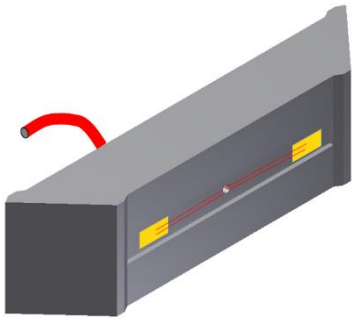


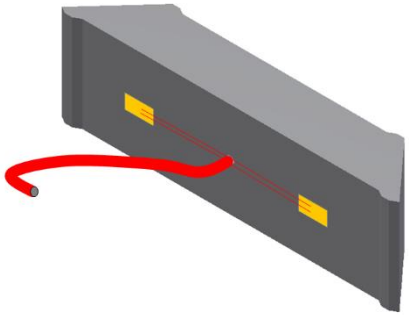
10 mph ≈ 16 kph

2. Successful Development of Lateral Force Measurement Technology

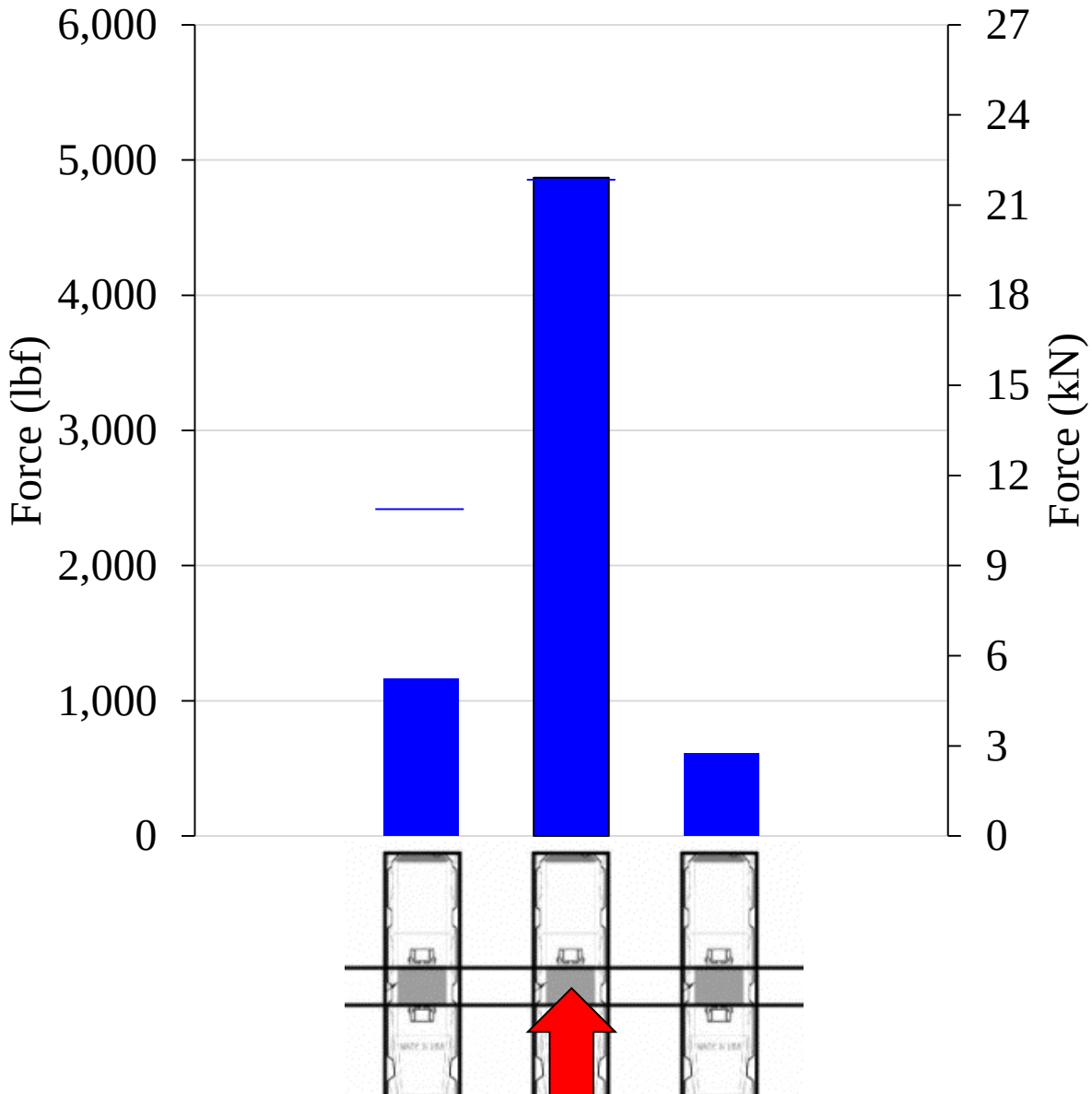
- Development and testing of Lateral Load Evaluation Device (LLED)
  - Original shoulder face is removed
  - Insert designed as a beam and optimized to replace removed section and maintains original geometry
  - Measures bending strain of beam under 4-point bending

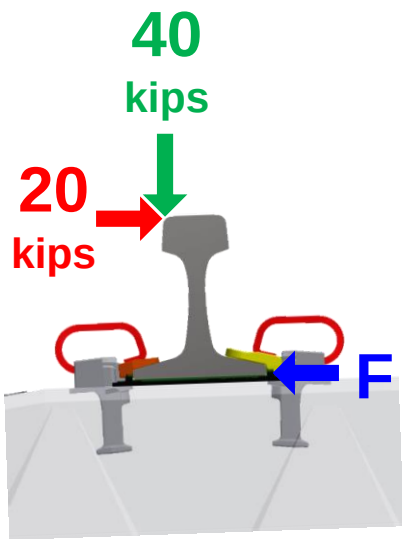




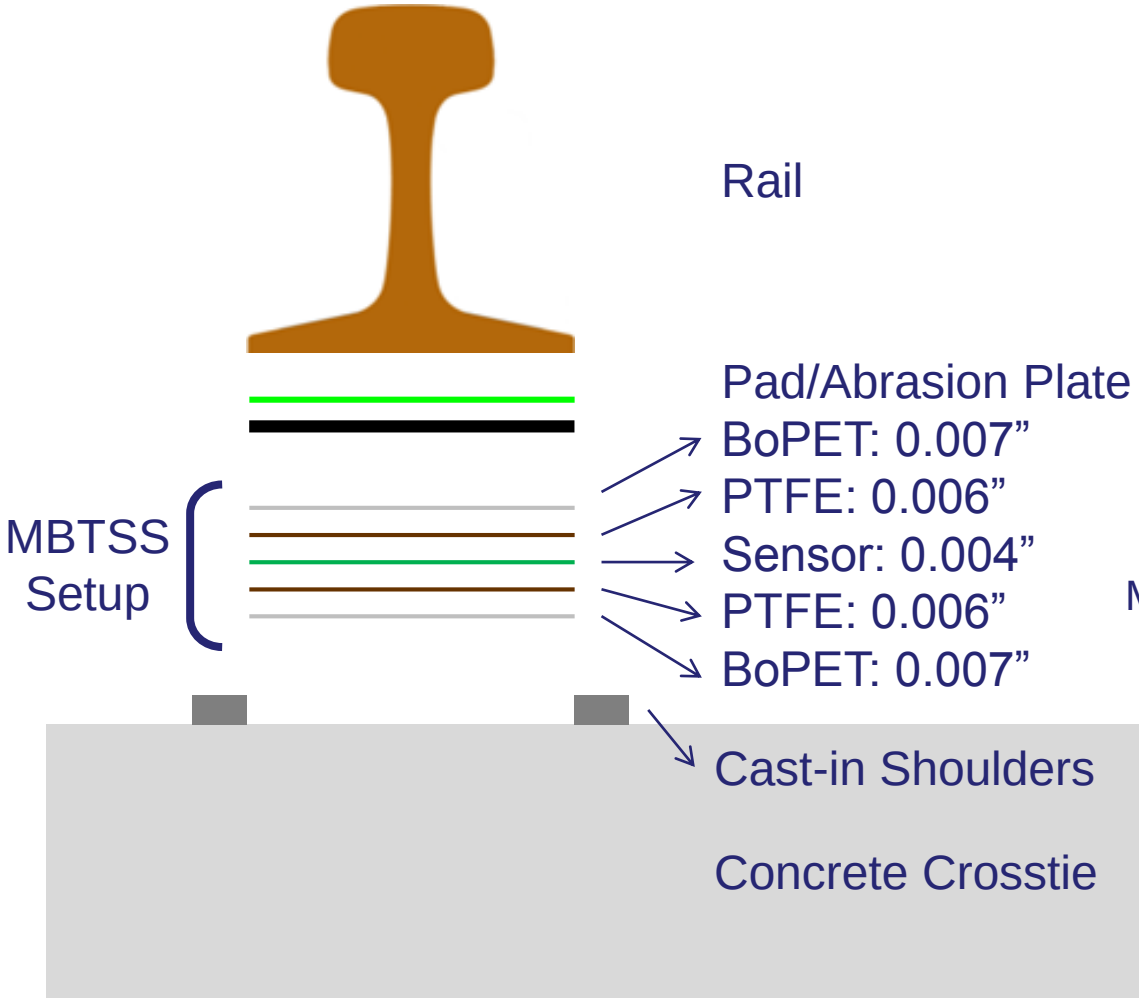


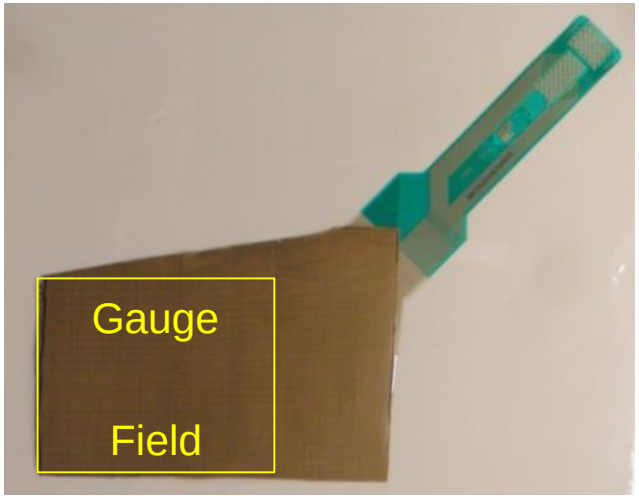
Lateral Load Data – Sample Field Results





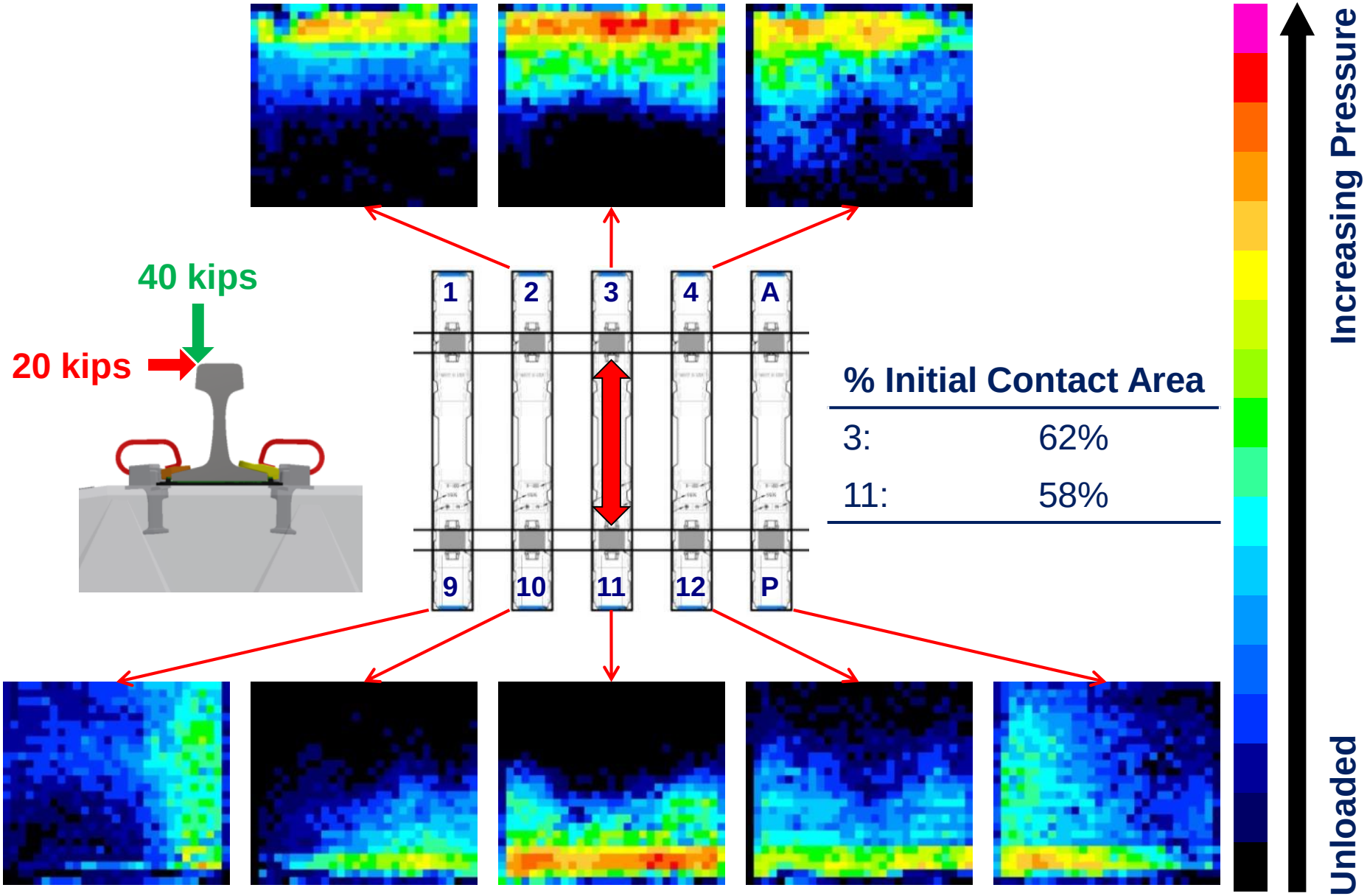
3. Quantifying Rail Seat Pressure Magnitude and Distribution





Matrix Based Tactile Surface Sensor

Rail Seat Pressure Distribution Data



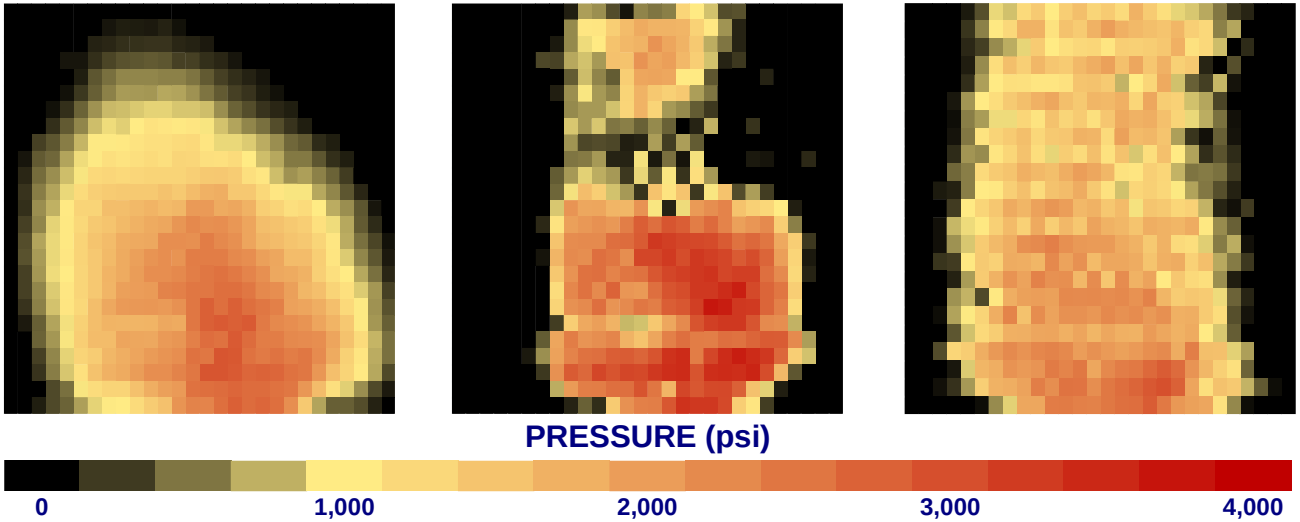
% Initial Contact Area	
3:	62%
11:	58%

Rail Pad Assemblies - Pressure Distribution

Loading: 32.5kip (145kN) vertical, 16.9kip (75kN) lateral (0.52 L/V Force Ratio)

Pulsating Load Testing Machine (PLTM)

GAUGE



	TPV	MDPE	Two-Part Pad Assembly
Contact Area: in^2 (cm^2)	25.8 (166)	19.0 (123)	23.9 (154)
Max Pressure: psi (kPa)	2,925 (20,000)	3,721 (25,600)	2,990 (20,600)

4. Development of Revised Crosstie Bending Moment Analysis Method

(Comparison of Methods)

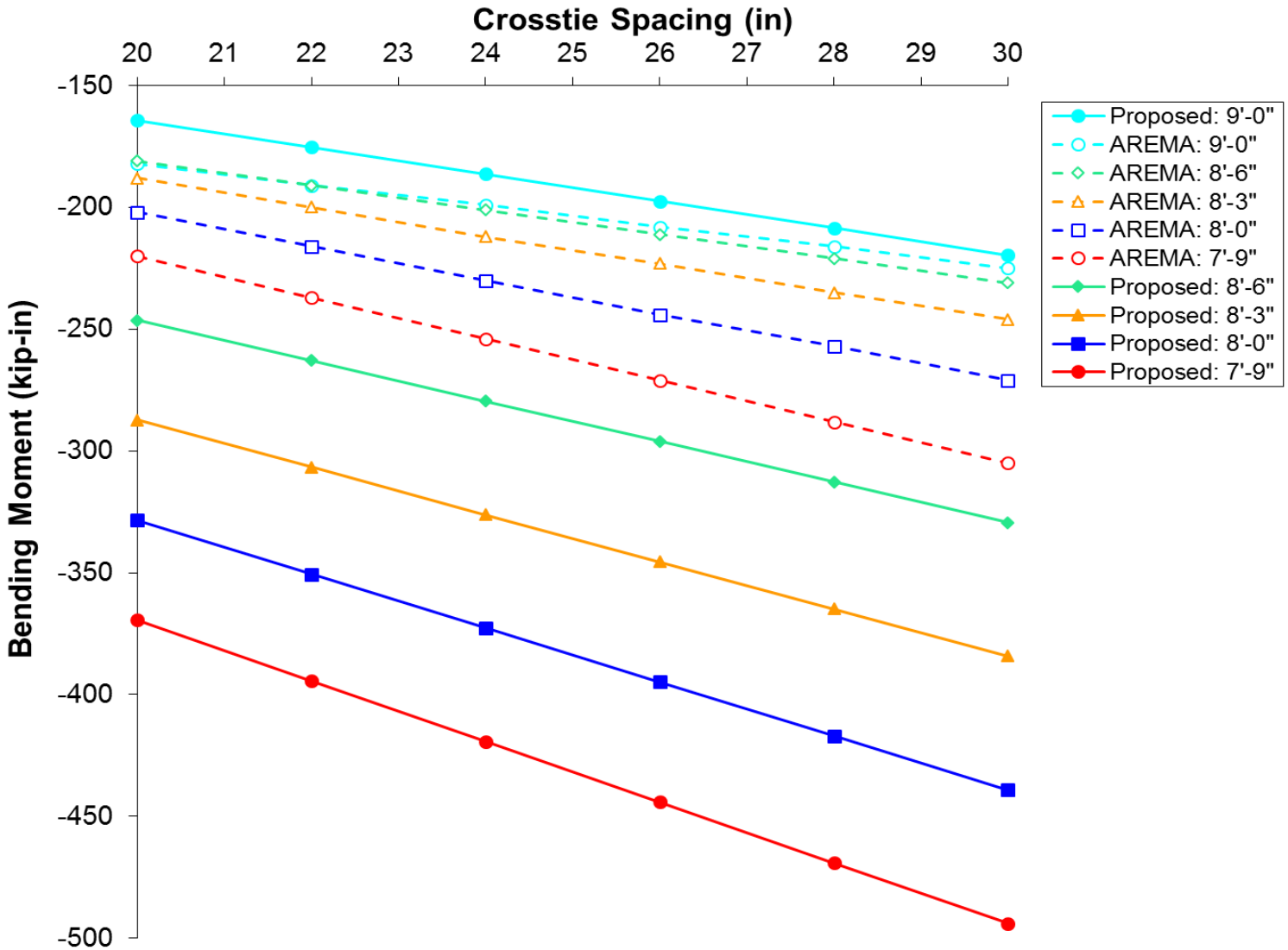
	AREMA C30.4	UIC 713R	AS 1085.14
Rail Seat Load kips (kN)	62.1 (276.2)	**66.4 (295.4)**	53.3 (237.1)
Rail Seat Positive kip-in (kN-m)	**300 (33.9)**	224 (25.3)	280 (31.6)
Rail Seat Negative kip-in (kN-m)	-159 (-18.0)	-112 (-12.7)	**-187 (-21.1)**
Center Positive kip-in (kN-m)	141 (15.9)	**209 (23.6)**	112 (12.7)
Center Negative kip-in (kN-m)	-201 (-22.7)	**-299 (-33.8)**	-240 (-27.1)

AREMA American Railway Engineering and Maintenance-of-Way Association

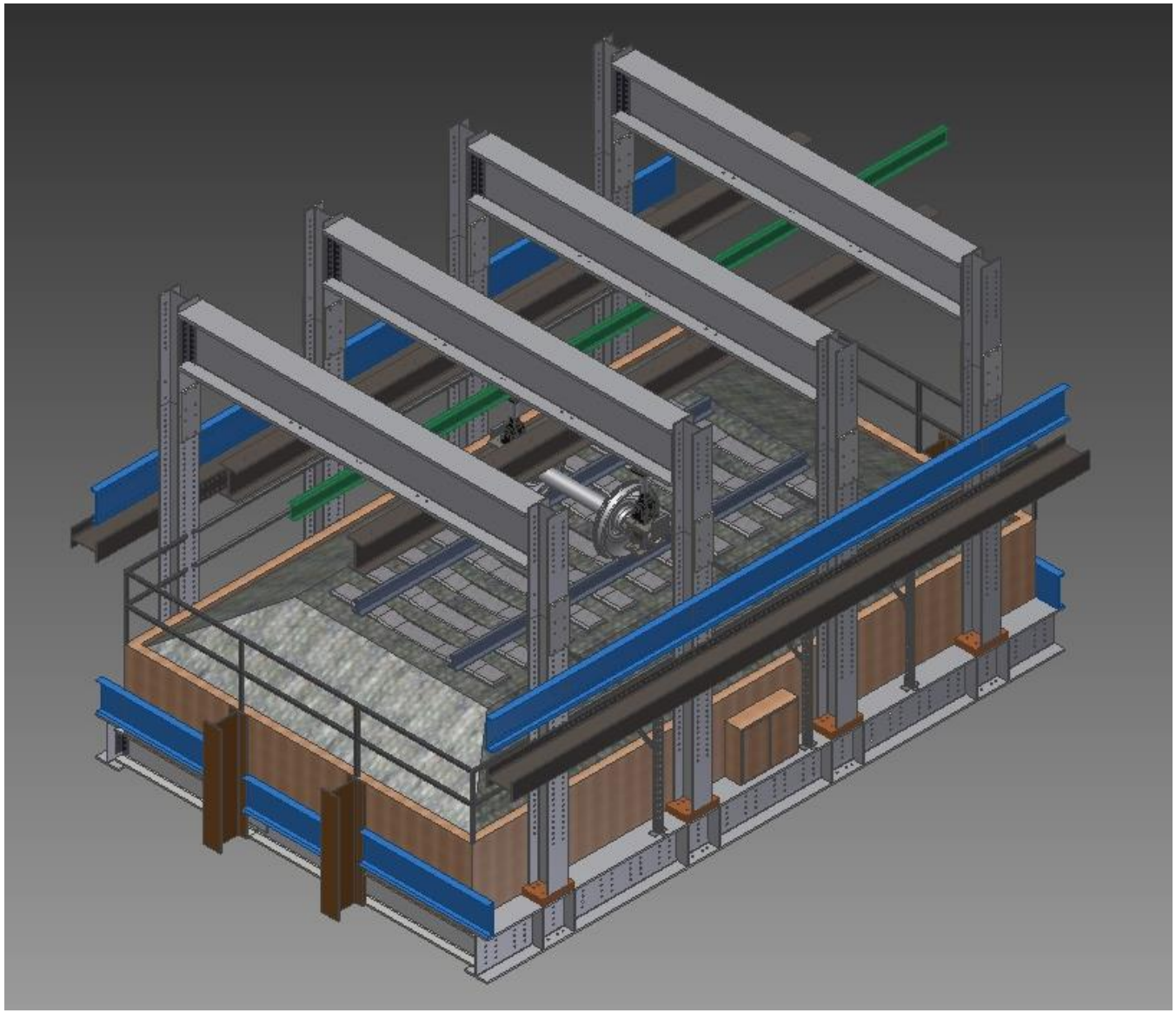
UIC INTERNATIONAL UNION OF RAILWAYS

STANDARDS Australia

Comparison Between Current and Proposed (M_{C-})



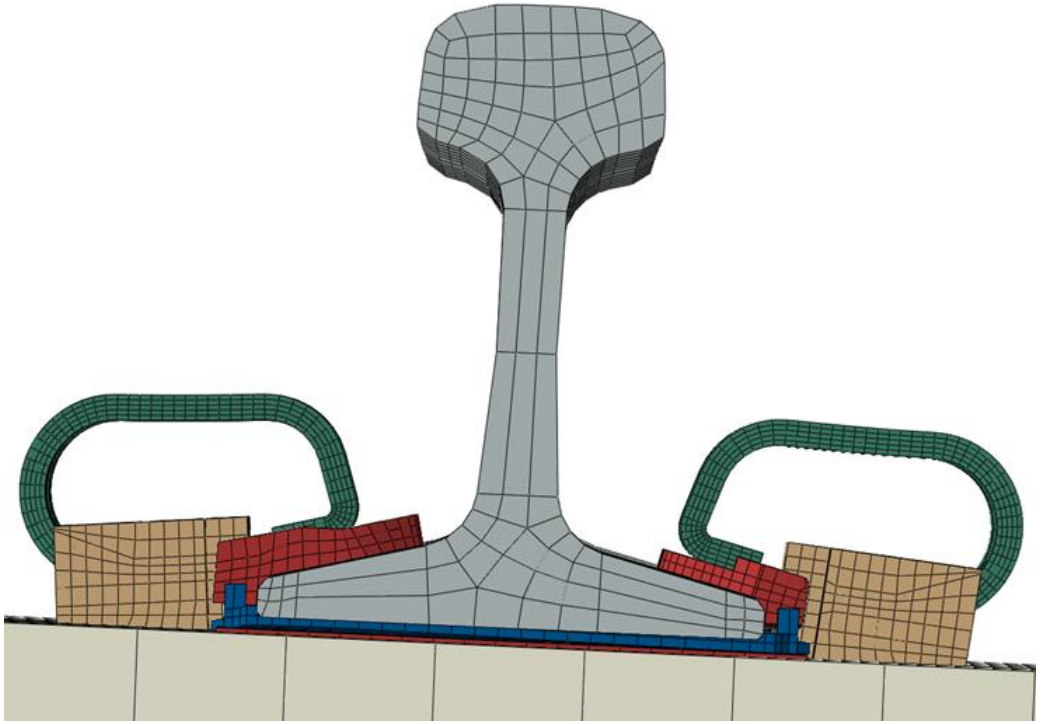
5. Development and Use of a Full-Scale Track Loading System

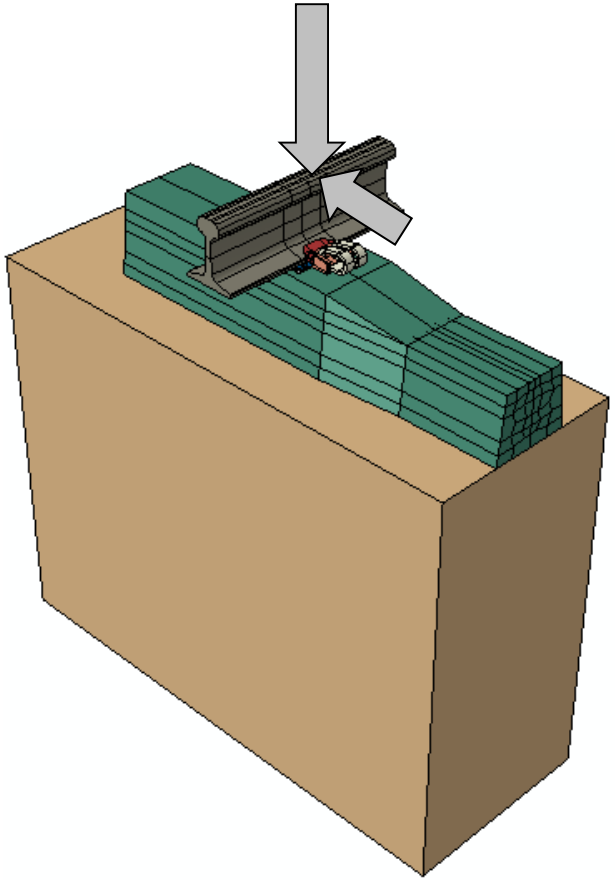


Full-Scale Track Loading System – Vertical and Lateral Loads Being Applied

6. Development and Validation of Crosstie and Fastener Finite Element (FE) Model

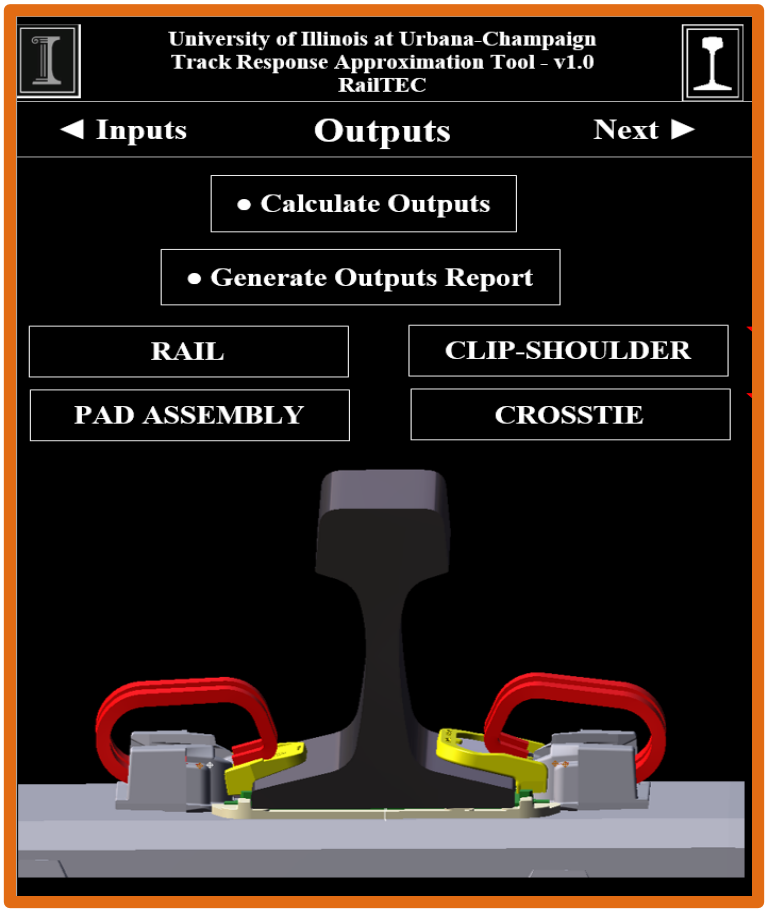
- Development of both multiple-tie and single-tie models
- Validated with laboratory and field data
- Ability to run parametric analyses



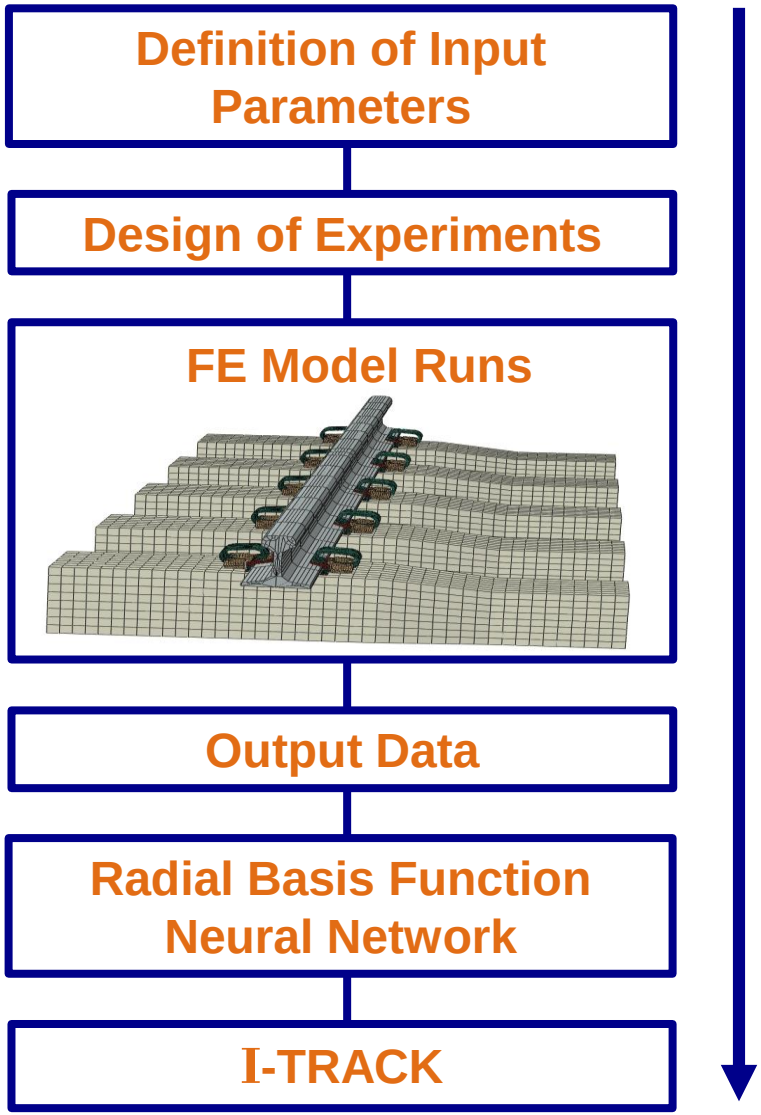


7. Development of Simplified Design Tool (I-TRACK)

- Software based on statistical analyses of the UIUC FE model
- A neural network model was developed to predict track components responses based on user defined inputs



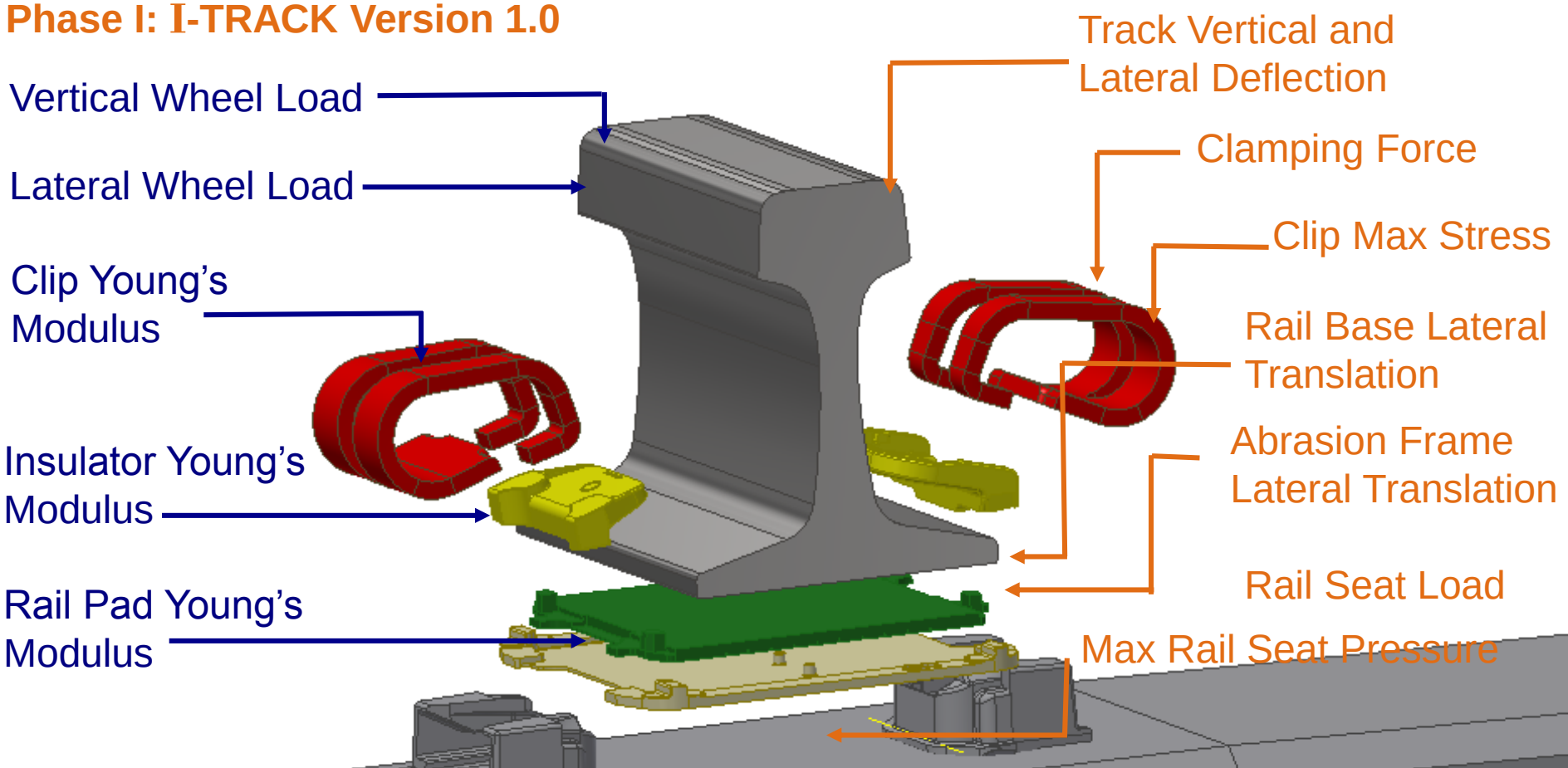
Development of I-TRACK



I-TRACK Preliminary Project Phases

- The development of I-TRACK follows a systematic process. The project was divided in 3 phases, which add additional complexity and analysis capabilities
- Goal: expedite the development of I-TRACK, test the model accuracy and functionalities on a continuous basis, and provide interim utility to end users

Phase I: I-TRACK Version 1.0



8. Changes to AREMA Chapter 30 (Ties)

- Multiple proposed changes to AREMA Chapter 30 (5 Total)
- Driven by students funded on this project (and through IPs)
- Expected to continue for some time…

Proposed Ballot Title	Description of Ballot	Lead Student
Addition of Rail Seat Load Distribution	Introduce language characterizing the loading environment at the rail seat, which may affect crosstie failure mechanisms associated with Rail Seat Deterioration (RSD).	Matthew Greve
Amendments to Loading Environment	Update section 1.2 Load Environment, which covers wheel to rail loads of North American freight and passenger traffic. Revisions are intended to update the load table currently provided in AREMA using modern traffic data.	Andrew Scheppe
Addition of Lateral Load Distribution	Add language to the proposed sections stating that lateral load distribution may not mimic vertical load distribution as previously hypothesized. Also, that fastening system design (e.g. friction, stiffness) will have an effect on lateral load distribution.	Brent Williams
Crosstie Flexural Capacity Analysis Method	Update sections on flexural analysis of concrete crossties to address issues with current analysis process and introduce new and improved method of analysis.	Henry Wolf

9. Successful International Crosstie and Fastening System Symposia (2012 and 2014)

- Co-organized by: **AREMA Committee 30 (Ties), Railway Tie Association (RTA)**
- ***2014 Event: 140 total attendees***
- **Focus → state of the art in timber, concrete, and composite crosstie and fastening system design, performance, research, modeling, and inspection**
- Presentations available at: http://railtec.illinois.edu/Crosstie/2014/presentation.php
- **THANKS FOR SPONSORSHIP from INDUSTRY PARTNERS!**

10. Our role in Rail Workforce Development…

RailTEC Tie and Fastener Team in June 2014

Acknowledgements

Research Sponsors:

U.S. Department of Transportation
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Questions and Comments?

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