



Vision

To be the provider of choice
for advancing railway safety
and technology

Transportation Technology Center, Inc., a subsidiary of the Association of American Railroads

Update on TTCl Tie and Fastener System Research and Testing

2016 Crosstie and Fastening System Symposium

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Senior Engineer

June 14, 2016
UIUC.



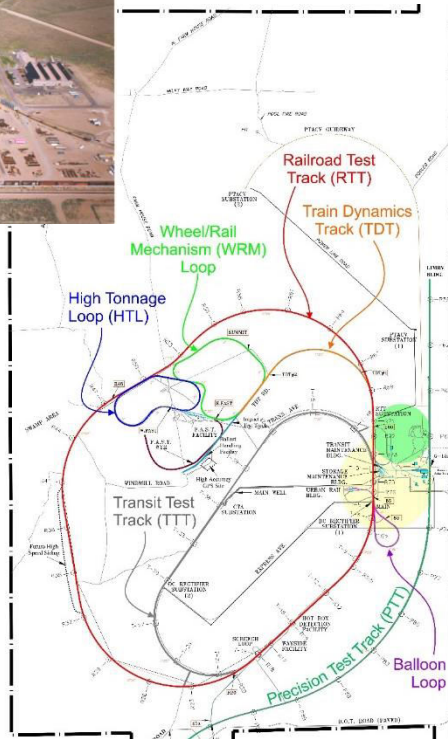
Outline

- ◆ **Overview of TTCL and the TTC**
- ◆ **TTCL's Tie and Fastening System Customers**
- ◆ **Project Highlights**
 - AAR SRI 12B – Tie and Fastener System Performance
 - FRA TO 322 – Dynamic Load Environment and RSD
 - FRA TO 333 – RSD Inspection/Detection
- ◆ **Commercial Research and Testing**
- ◆ **Composite Ties**



TTC and TTCI: Two Different Things

TTC: The Facility



TTCI: The Company

A Small Business Enterprise

- ◆ Wholly owned subsidiary of the Association of American Railroads
- ◆ Headquartered at TTC in Pueblo, CO
- ◆ Research and testing for American and international railway customers



U.S. Department of Transportation
Federal Railroad Administration



◆ Industry challenges being addressed:

- Economical improvement to the track structure
- Standards for premium wood tie fastening systems
- Detection of concrete tie failures
- Application of new alternative tie/fastener technologies
- Implementation of composite ties
- Improved modeling of the track structure – wheel-rail dynamics

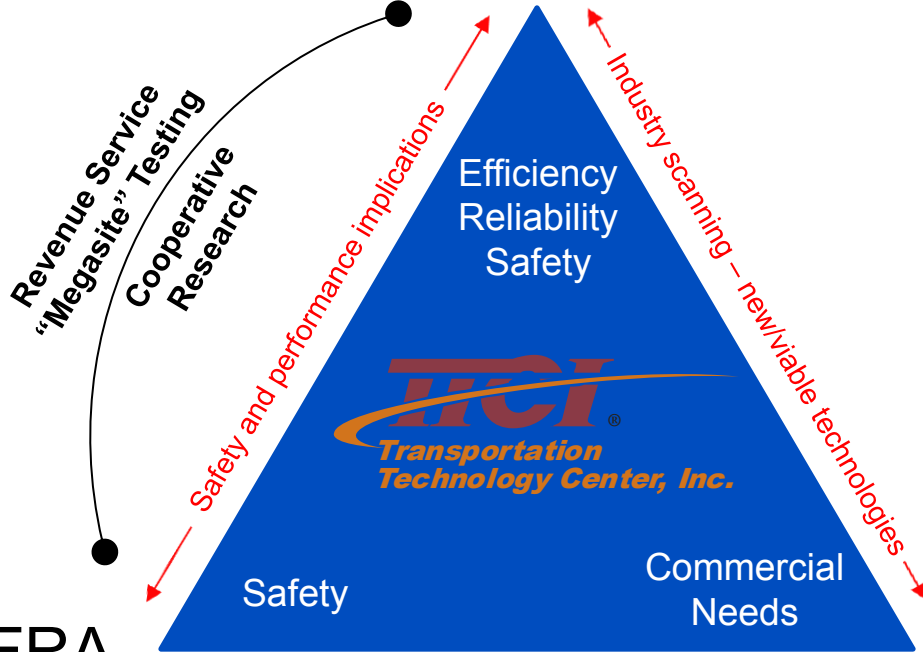
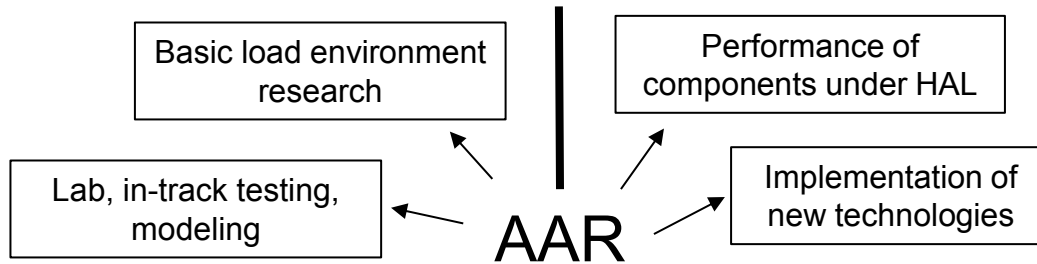
◆ Implementation through:

- Railroad guiding committees
- Publications and presentations
- AREMA Committee 30
- Improved degradation/costing model



Our Areas of Research “Tie” Together

Member Railroads



Improved safety and implementation

FRA

Improved detection and inspection

Lab, in-track testing, modeling

New, untried technologies

Commercial Customers

Testing/characterization to address needs



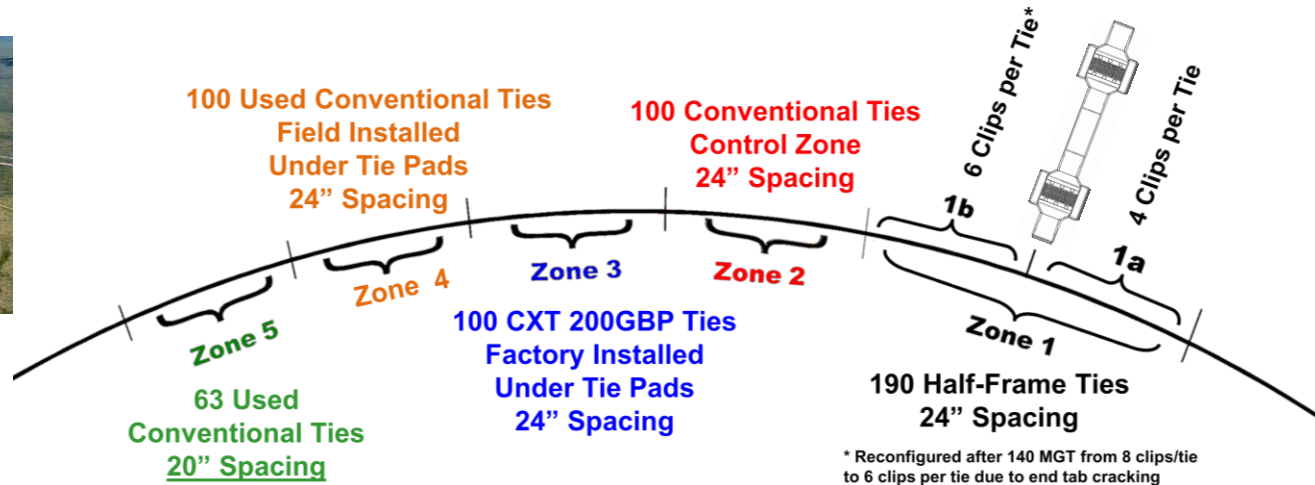
- ◆ **One of AAR's Strategic Research Initiatives (SRI)**
- ◆ **Industry funded and guided work**
- ◆ **Concrete, wood, and composite tie and fastener systems**
 - Laboratory and in-track testing
 - Long term evaluation at FAST under HAL – industry benchmark
 - New designs and technologies
 - Mechanistic and degradation modeling
- ◆ **Understanding and reducing stress state of the railroad**
- ◆ **Better purchasing and maintenance decisions**



SRI 12B: Improved Tie/Fastener Performance

◆ Evaluating Concrete Tie Performance Under HAL

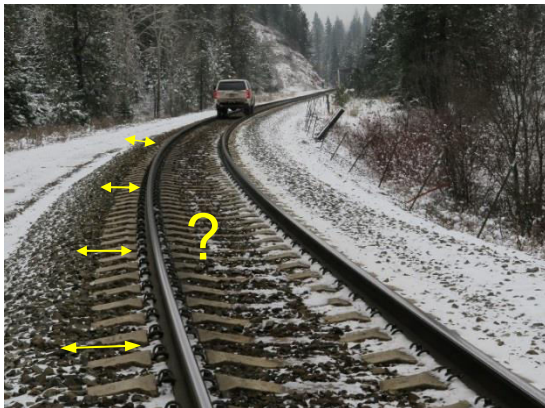
- 1000 MGT



◆ Half Frame Tie Revenue Service Testing – 140 MGT

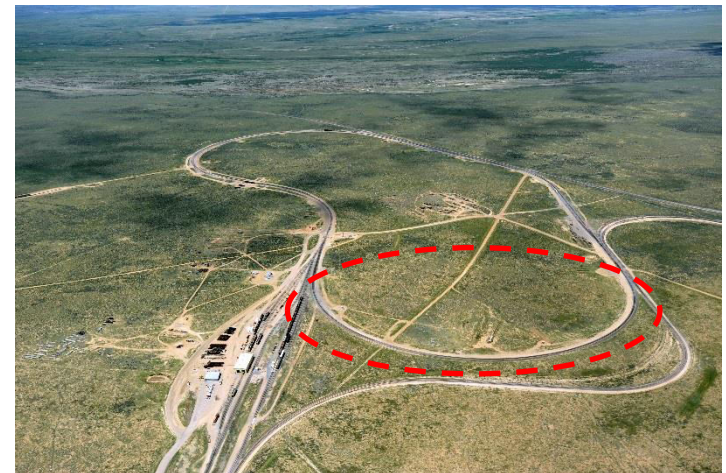
- 7 degree curve – 206 ties installed in curve body in 2012
- Thus far, no significant lateral movement detected
- Approximately 200 MGT to date

	October 22, 2013 Inspection	September 23, 2014 Inspection	December 2, 2014 Inspection	July 31, 2015 Inspection	Observed Seasonal Shift (inches)
Weather and time of measurement	64 degrees, clear, afternoon	60 degrees, partly cloudy, 9:30 am	25 degrees, cloudy, 1:00 pm	90 degrees, sunny 12:30 pm	
Approximate Rail Temp	65	60	25	105	
Location	Average Offset Distance (feet)				
Tie 107-108	54.68	54.67	54.66	54.66	<1/4 inch
Tie 148-149	52.02	52.02	52.03	52.03	<1/8 inch
Tie 175-176	64.88	64.88	64.87	64.87	<1/8 inch
Tie 223-224	60.87	60.87			
Tie 333-334	32.15	-	32.17	32.17	<1/4 inch



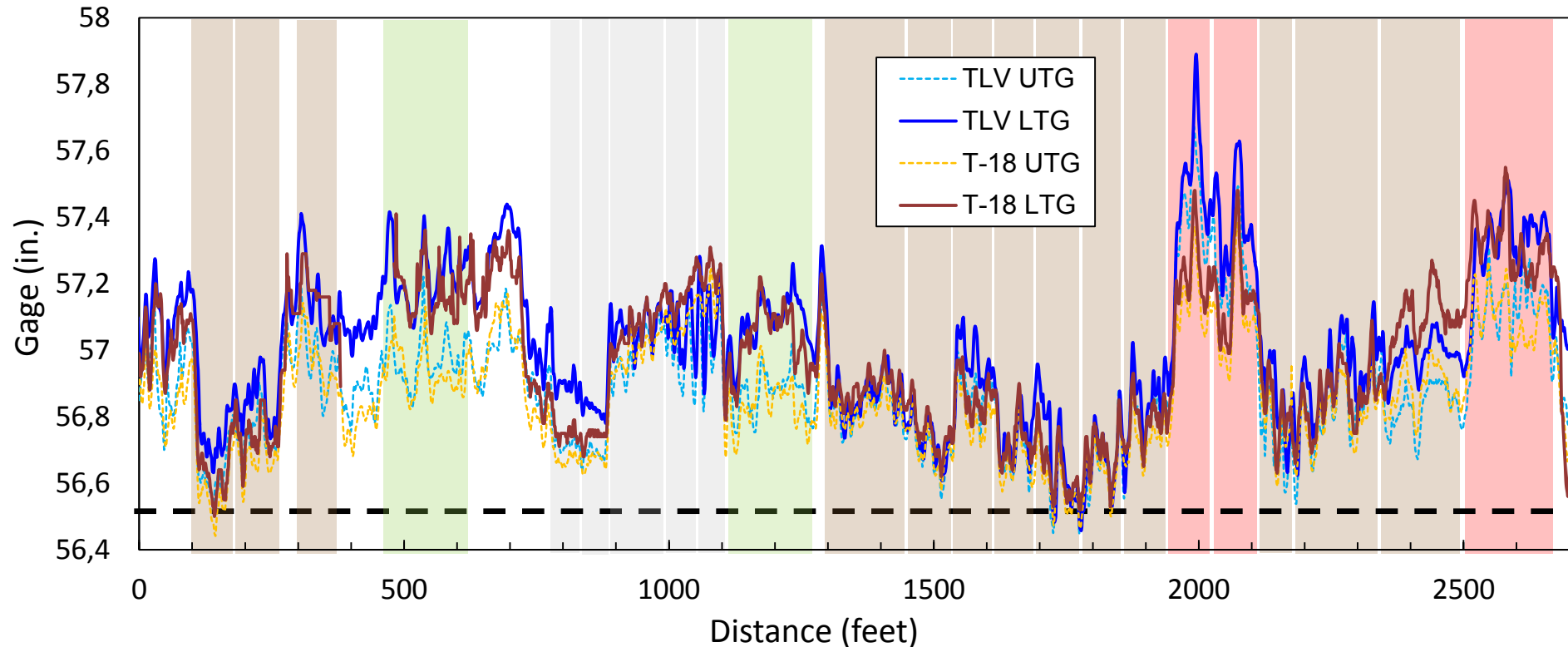
◆ Improved Performance Tie/Fastener Testing - FAST

- Variety of T/F systems
 - ▲ Timber, concrete, composite
 - ▲ Cut spikes, elastic fasteners
 - ▲ Cut, screw, and drive spike hold down
 - ▲ 14", 16" and 18" plates
- Evaluating performance
 - ▲ Gage Restraint
 - ▲ Track Geometry
- Documenting failure mechanisms
- Feeding into modeling



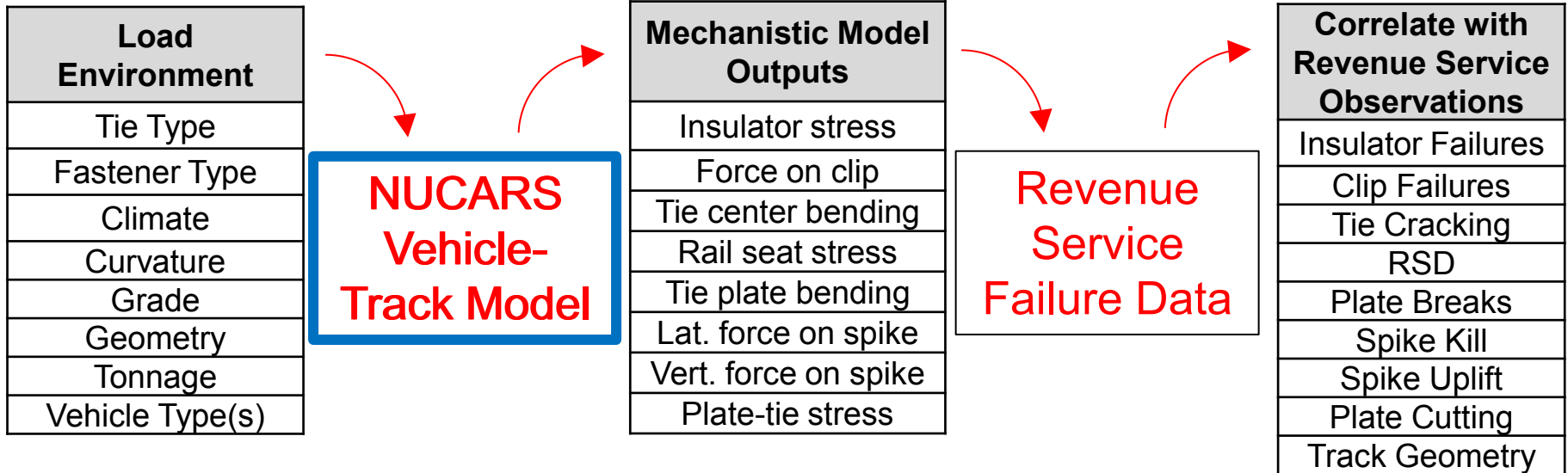
◆ Evaluation of Tie and Fastener Systems under HAL

- Gage Strength Measurements at FAST 2014 and 2015



Hardwood		Concrete	
Softwood (Red Pine)		Composite	

◆ How does load environment relate to lifecycle cost?



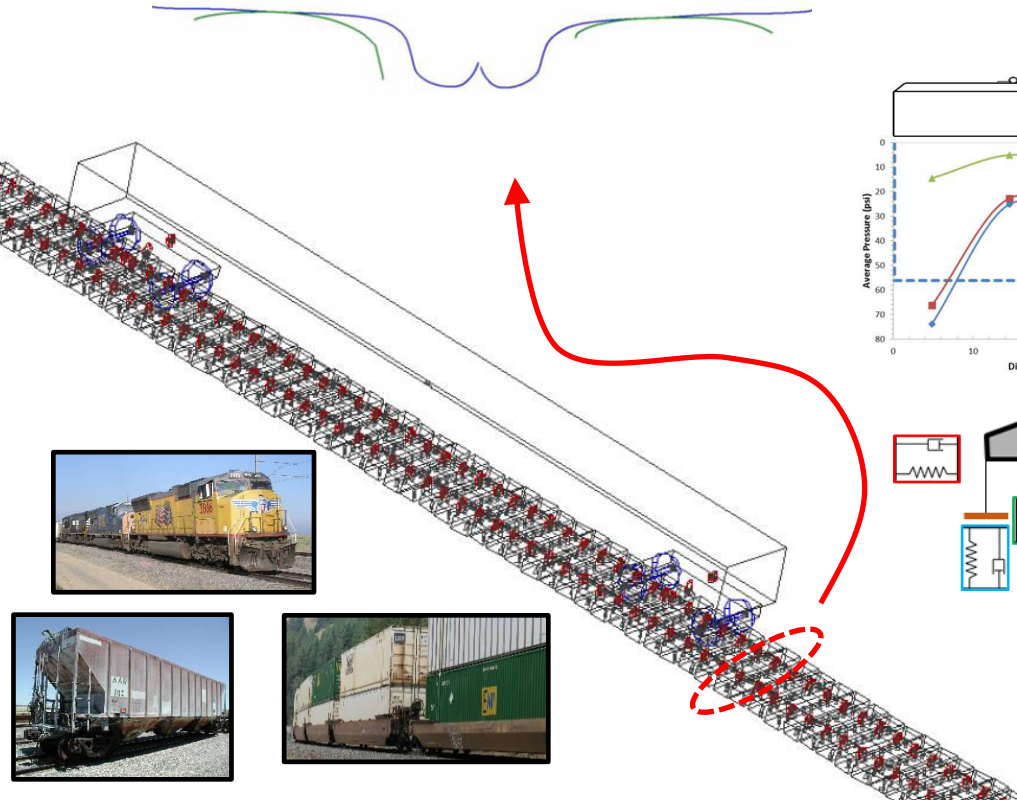
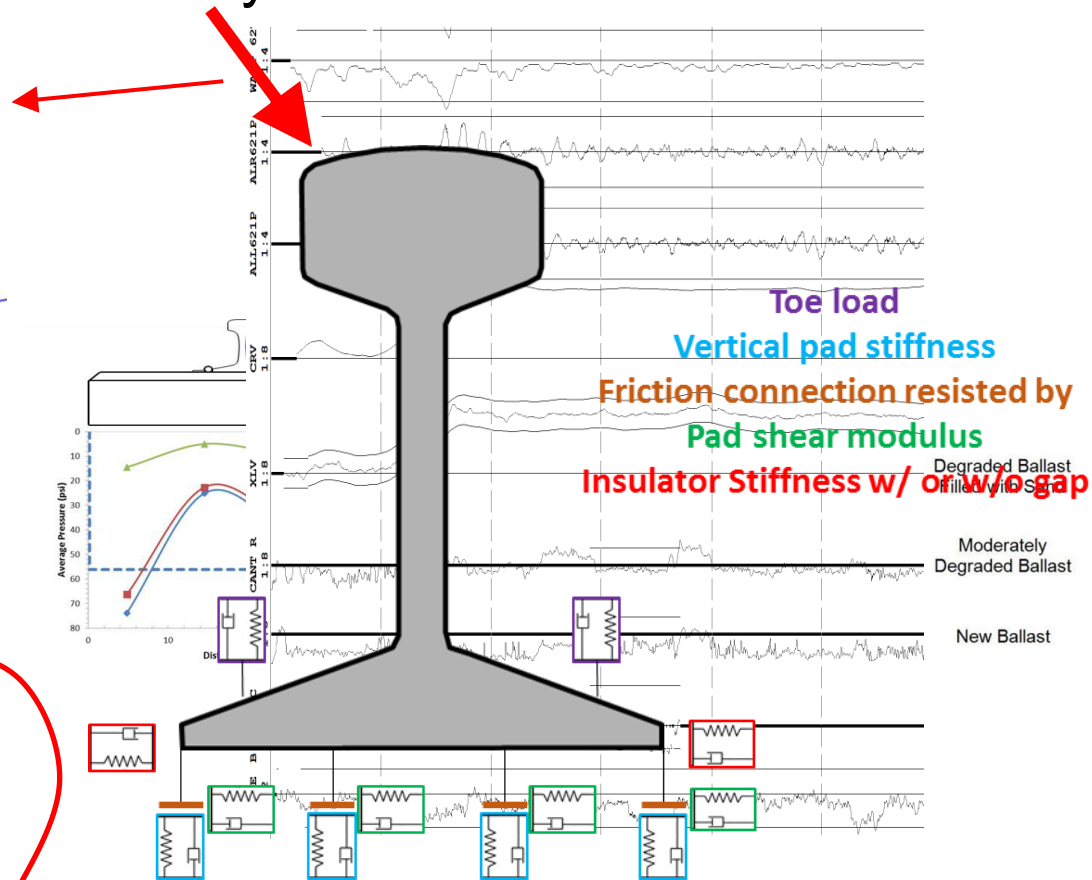
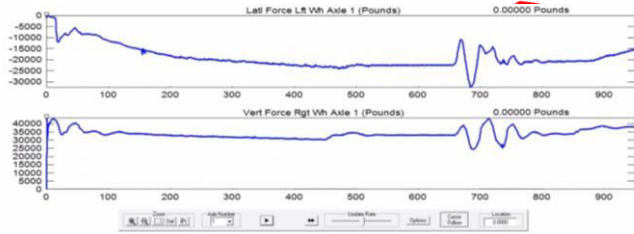
- Railroad data will provide maintenance thresholds and costs
- Objective: monetize the benefit of improved performance designs



Tie and Fastener Degradation Model

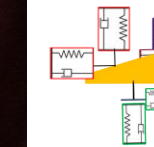
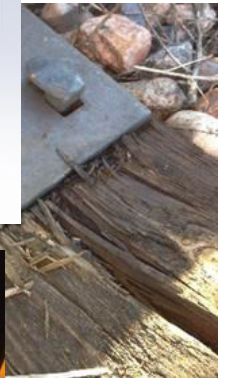
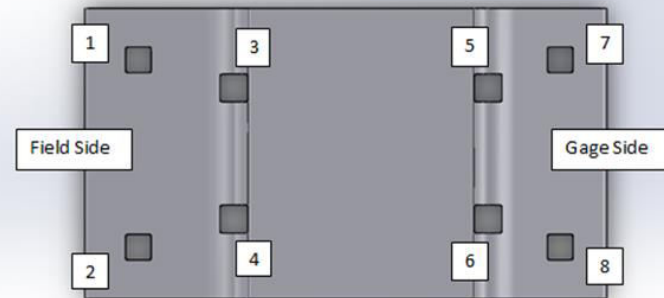
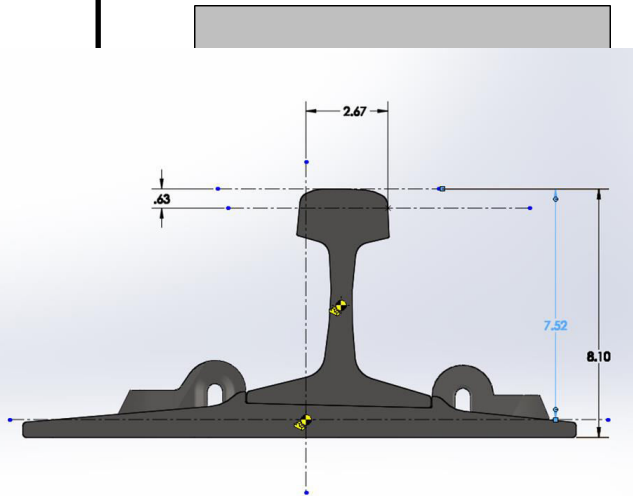
◆ Mechanistic Model – Quantifying Load Environment

● Using NUCARS® Vehicle-Track Dynamics Model



Tie and Fastener Degradation Model

- ◆ Development and Qualitative Example of Approach
Plate Cutting Stress Frequency Distribution



Cutting

Stress

◆ FRA TO 322 – Load Environment and Rail Seat Stresses

- Determine how certain track conditions (geometry, friction, component properties, etc.) contribute to a load environment that affects wedge shaped rail seat abrasion
- Vehicle-track dynamic modeling and in-track testing

◆ FRA TO 333 – RSD Detection

- Improve automated inspection and detection of concrete tie RSD
- Better understand behavior of rail during inspection testing with and without RSD present



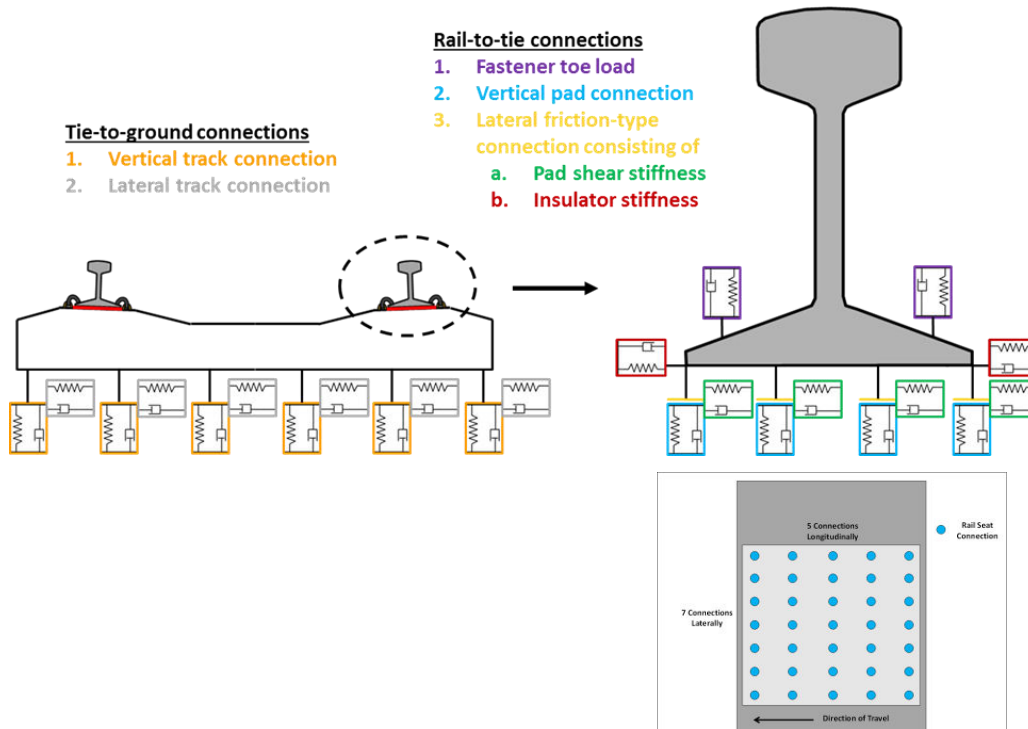
FRA TO 322 – Assessment of Rail Seat Abrasion Patterns and Load Environment

◆ Approach:

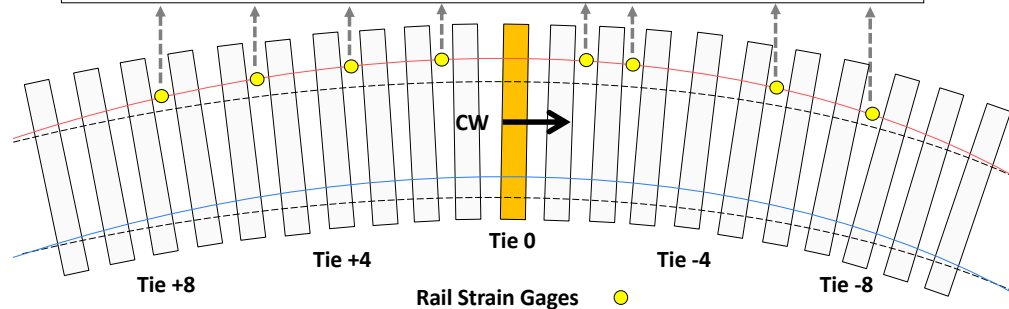
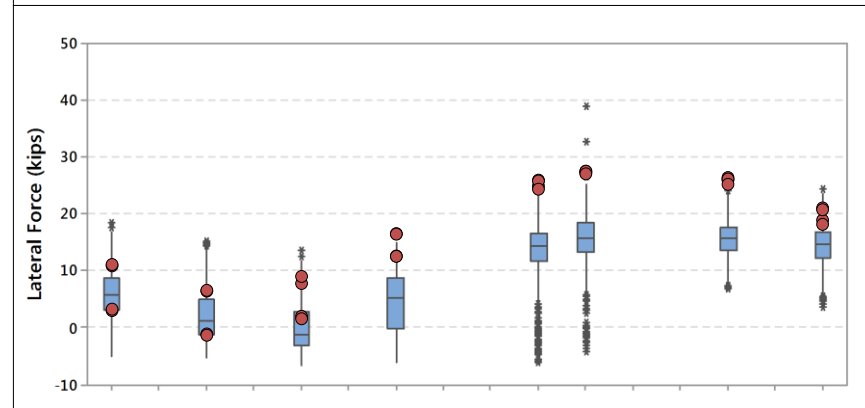
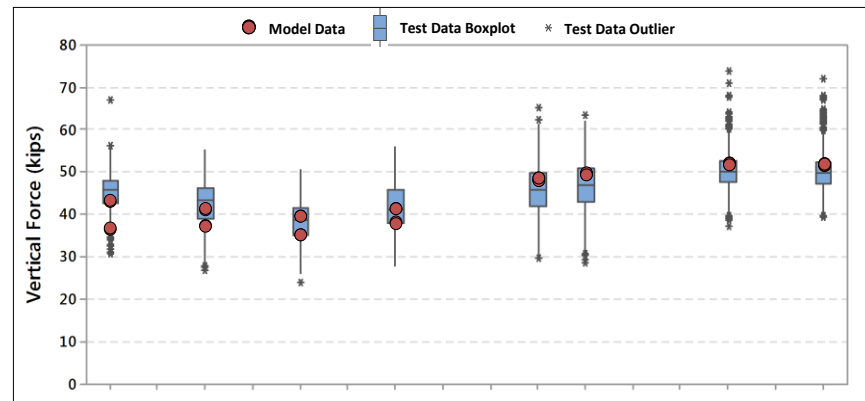
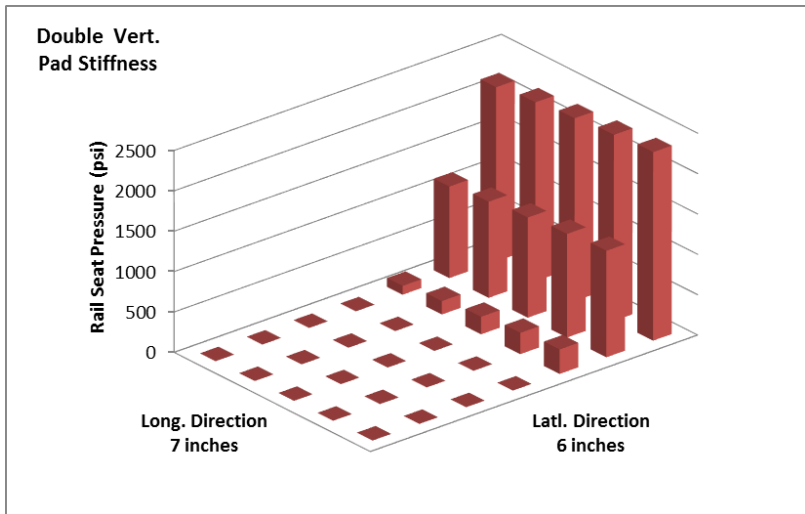
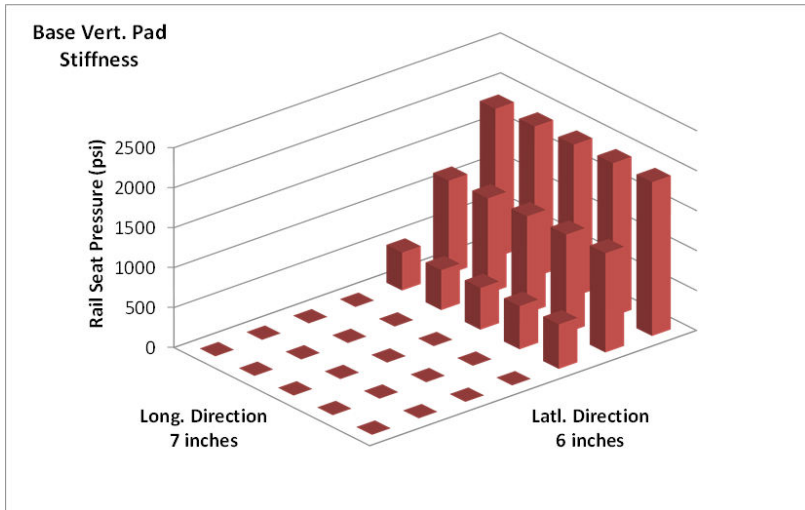
- 1) NUCARS® Vehicle-Track Model simulations
- 2) Use of model results to drive test zone design
- 3) In-track test section to characterize load environment using instrumentation

◆ “Out,” “in,” and “down and out” perturbations installed

- Wheel-rail loads and deflections measured under full speed FAST operations

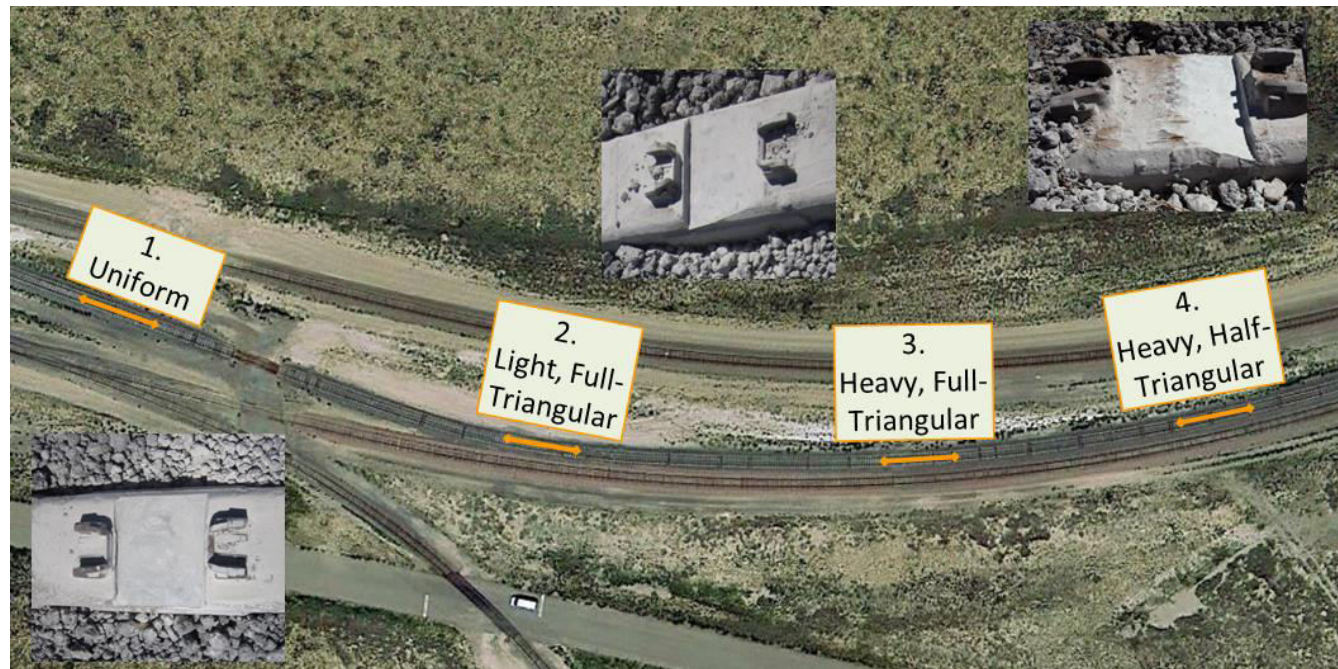


FRA TO 322 – Assessment of Rail Seat Abrasion Patterns and Load Environment



◆ Approach:

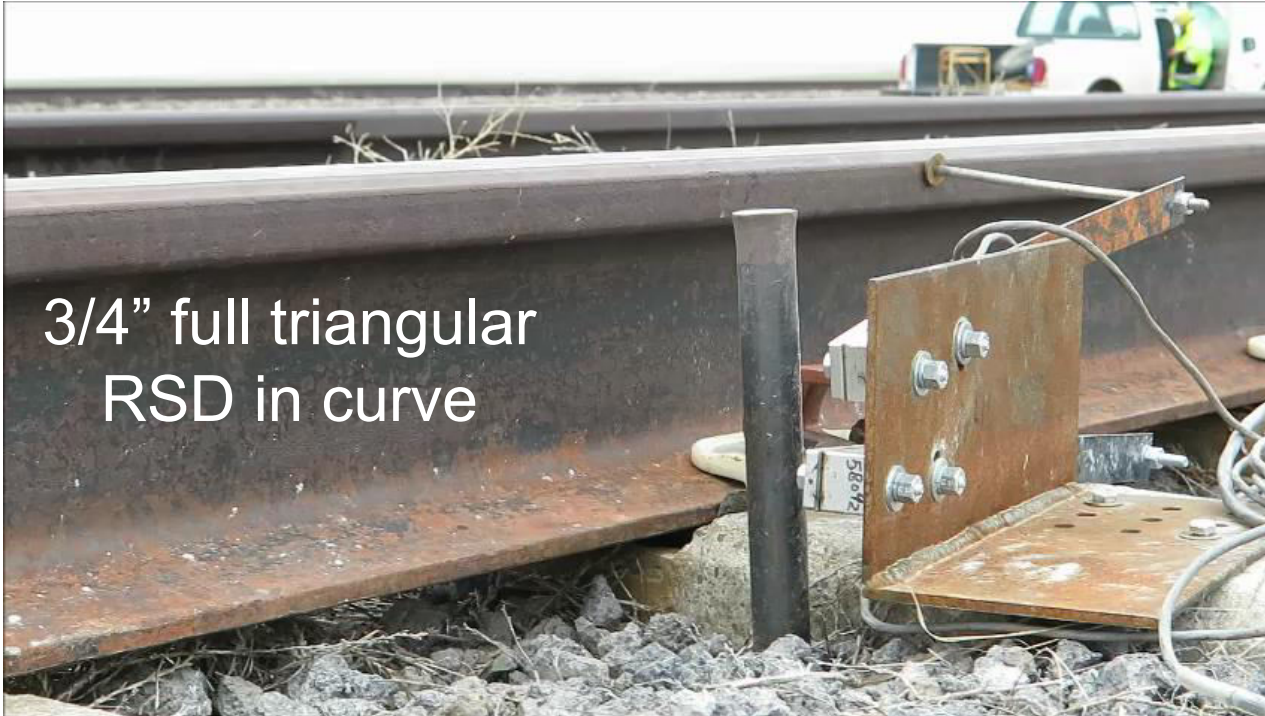
- Laboratory testing to characterize rail behavior on various RSD
- In-track test zone at FAST
 - ▲ Artificial RSD installed
 - ▲ Various detection/inspection vehicles being tested
 - ▲ GRMS at variety of loads and L/V ratios





FRA TO 333 – Concrete Tie RSD Detection

◆ In-track testing



3/4" full triangular
RSD in curve

```
Line Seg LineSeg  
Subdiv Subdivision  
Position 200KI 652FT  
Track x  
Class x  
TskSpeed x  
Speed 15.5 mph  
Direction x  
Date 20110308  
Type x  
Time 13:51:44  
Latitude 38.4463731  
Longitude -104.328911  
Descript Unknown  
Severity low  
Comment
```



- ◆ **Provide research and testing for commercial customers**
- ◆ **New and untried technologies**
- ◆ **Tie and fastener systems**
 - AREMA recommended lab testing
 - Short in-track testing
 - Longer, full-length test zones
 - Customized laboratory and in-track testing as needed
- ◆ **Facilitation of contacts with the industry**
- ◆ **Providing practical railroad expertise**
- ◆ **Implications of specific design features or failure modes**

- ◆ **Industry interest has grown in recent years**
- ◆ **Currently a major portion of SRI 12B work**
- ◆ **Additional Cooperative Research with FRA being proposed**
- ◆ **Previous AAR and FRA funded work**
 - Basic characterization – track modulus, gage strength
 - Handling and installation loads
- ◆ **Major questions being addressed**
 - Performance and consistency of current composite tie designs
 - Evaluation of current composite ties at FAST
 - Improving recommended guidelines for design – AREMA Committee 30

THANK YOU!

