

FTA Field Experimentation Plan

Overview of Objectives and Instrumentation



FRA and FTA Crosstie and Fastening System Research Program Industry Partners (IP) Meeting

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U.S. Department of Transportation
Federal Transit Administration

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Outline

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- Industry Partners / Agencies and Current Timeline
- Critical Questions to Answer
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 - Instrumentation Maps
- Contact Information

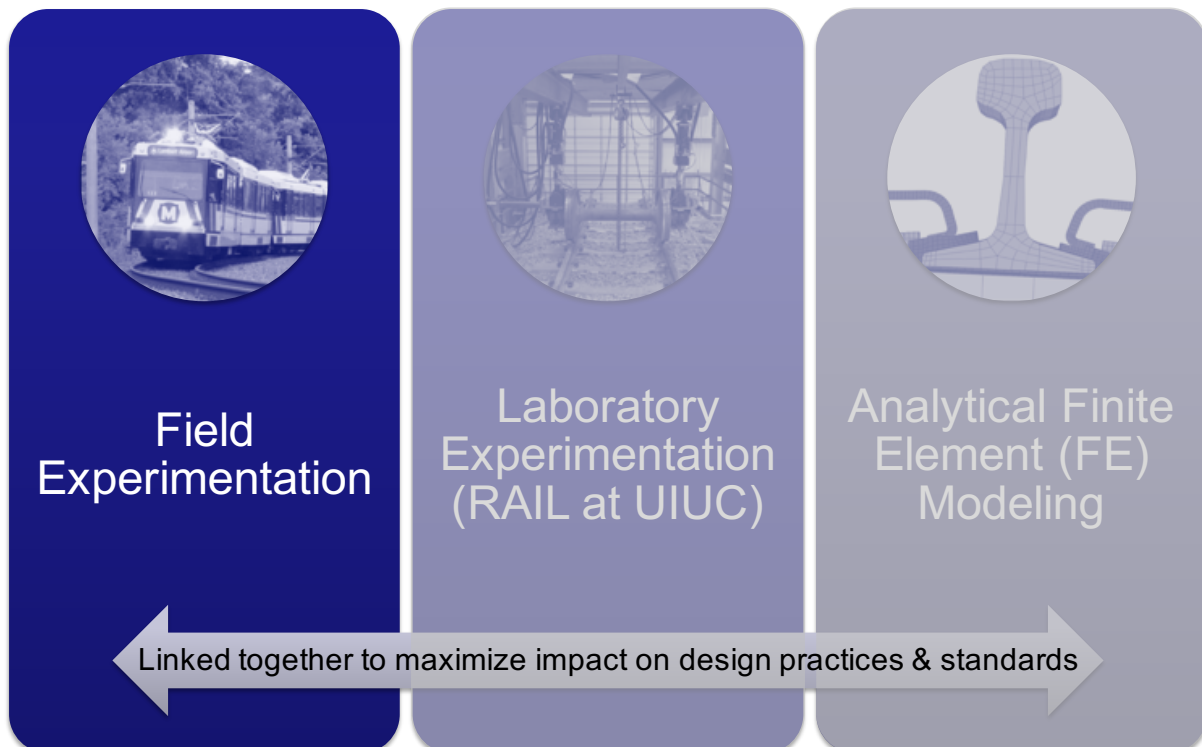


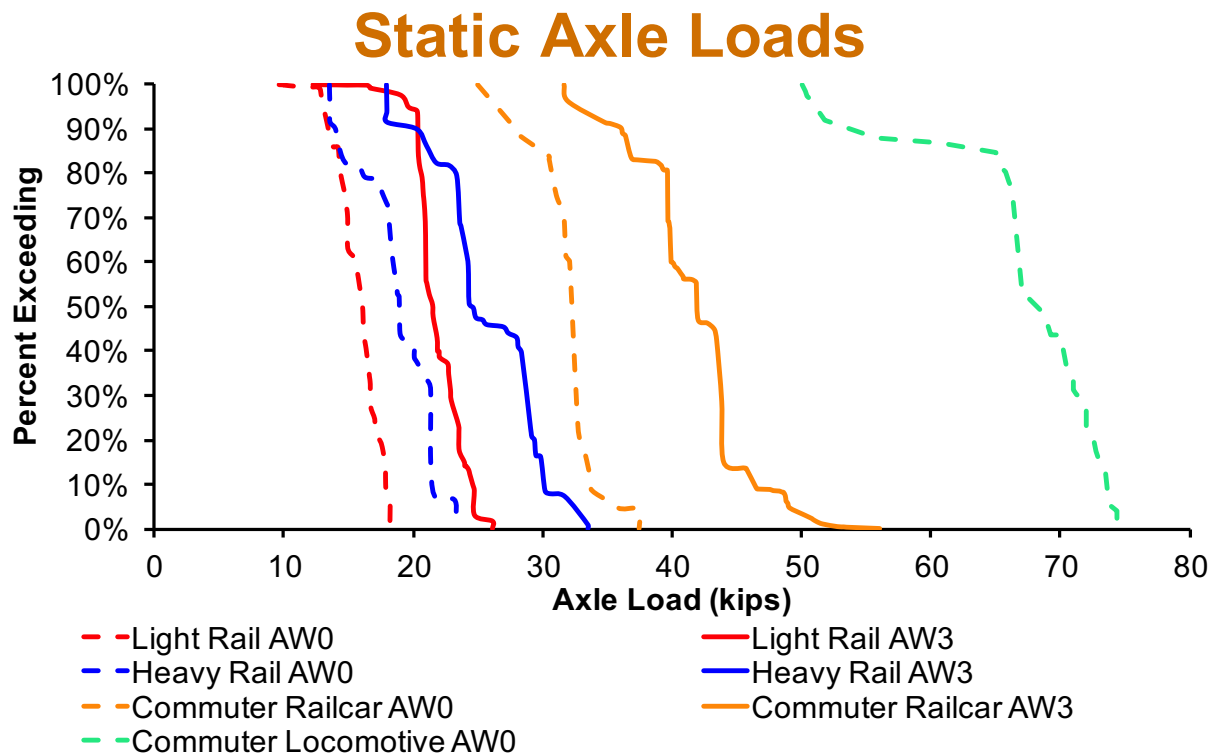
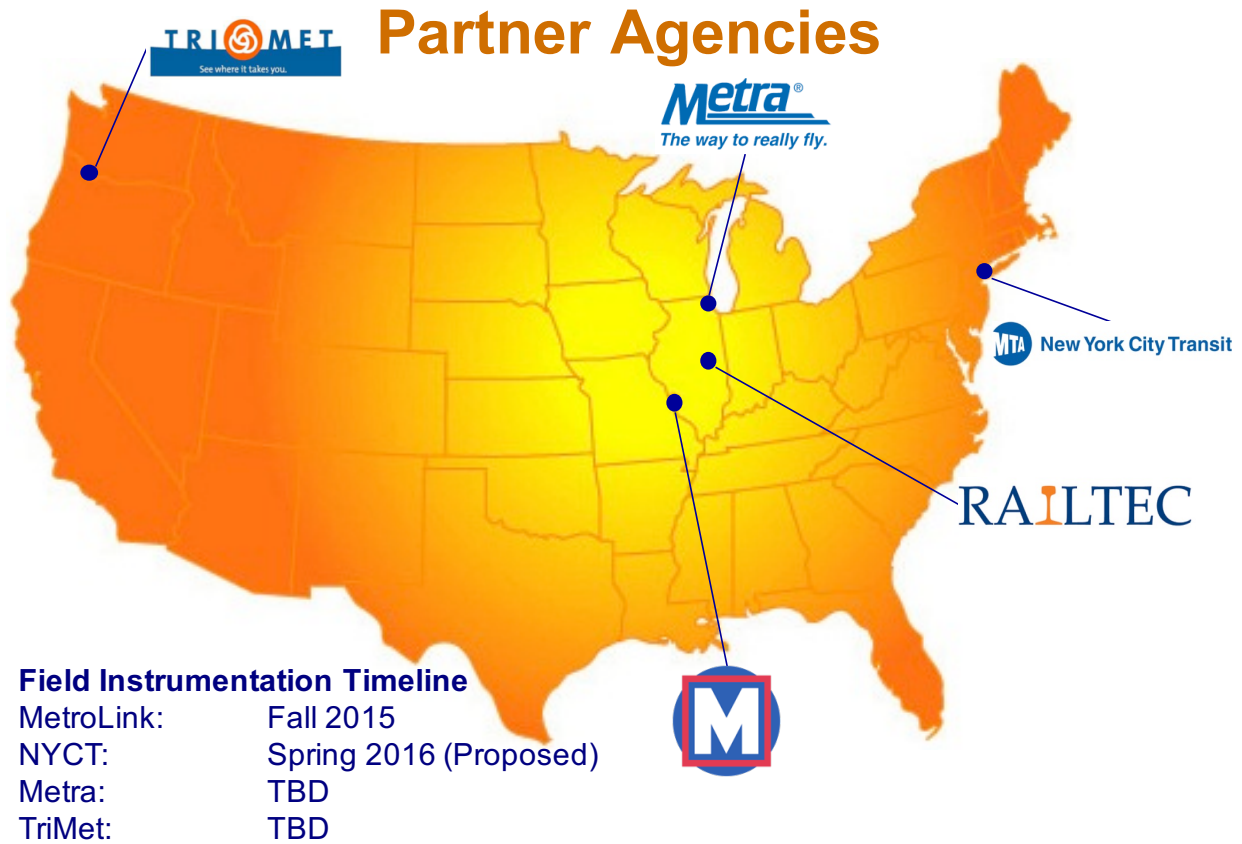
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Mission and Approach

- **Mission:**
 - *Characterize the desired performance and resiliency requirements for concrete crossties and fastening systems, quantify their behavior under load, and develop resilient infrastructure component design solutions for concrete crossties and fastening systems for rail transit operators.*
- **Approach:**
 - Quantify static loads (Paper Study)
 - Quantify dynamic loads (Field & Laboratory Study)
 - Develop finite element (FE) model of crosstie and fasteners (Numerical Modelling)
 - Use FE model, input loads, and laboratory verification to design more resilient crosstie (Design)
 - Deploy and monitor new crosstie design (Field Study)

FTA Project Approach





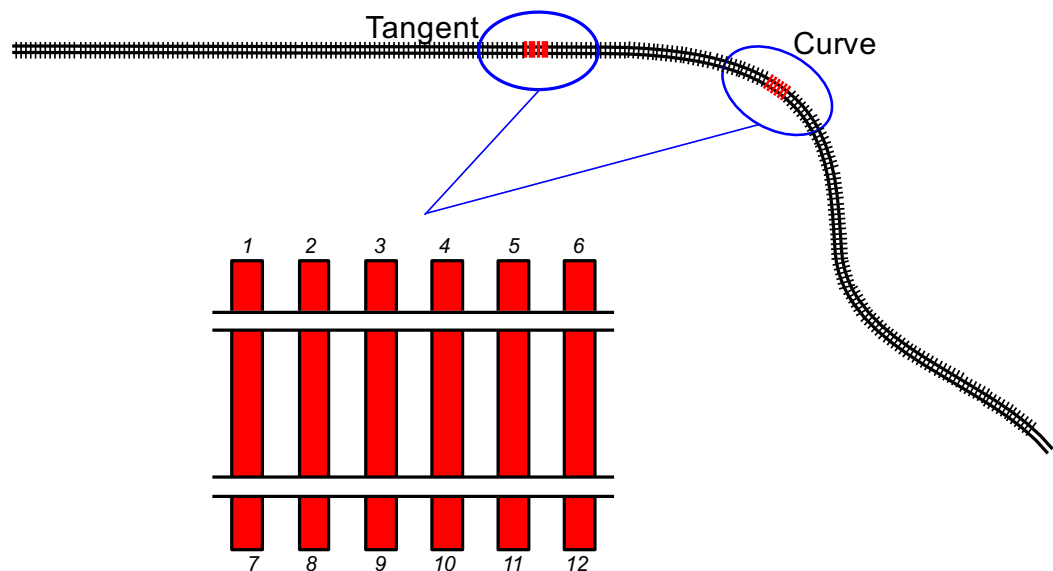
We know what static loads are for transit vehicles and that they differ between modes. But what are the dynamic loads?

Critical Questions to Answer

- What are the in-service loads transit vehicles impart on the infrastructure?
- What are the maximum vertical loads experienced by the concrete crosstie at the rail seat?
- How much lateral restraint is necessary to prevent the rail from displacing or rotating outside of allowable tolerances?
- What magnitudes of flexural demands are transferred into crossties by transit vehicles?
- How much variability is there in the support conditions underneath the crosstie?

What questions do you, our industry partners, have that we should add?

Test Sites Overview

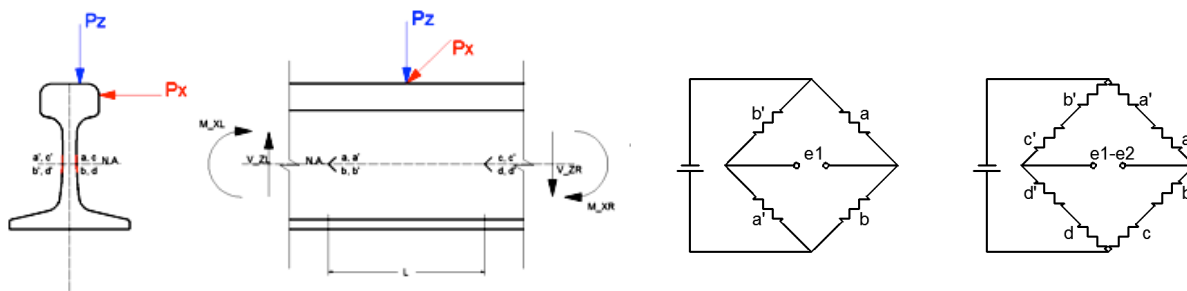
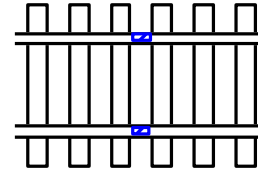


The instrumentation will be installed at a tangent and at a curve location

Instrumentation Overview

Vertical and Lateral Wheel Loads

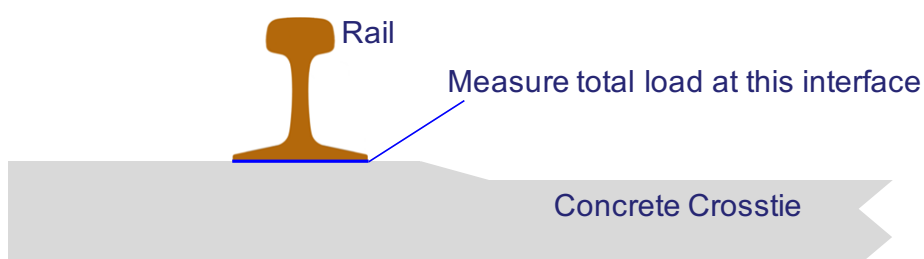
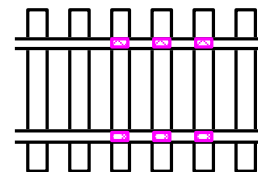
- **Desired data:**
 - Vertical and lateral loads at the wheel-rail interface and rail seat
- **Instrumentation description and methodology:**
 - Industry standard strain gauge bridges applied to rail web and flange, similar to a wheel impact load detector (WILD) site
 - Based on previous UIUC field instrumentation, one instrumented crib per rail to approximate wheel loads throughout whole test section



Instrumentation Overview

Rail Seat Loads

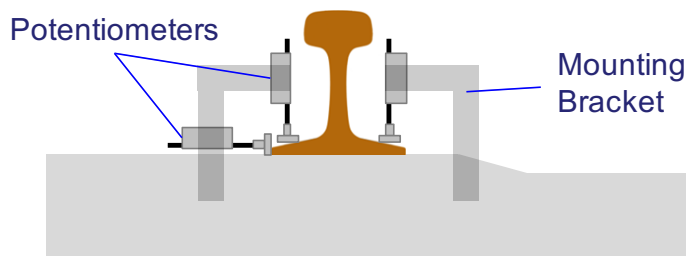
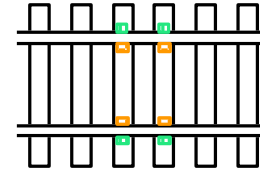
- **Desired data:**
 - Rail seat load
- **Instrumentation description and methodology:**
 - This instrumentation is currently being tested and developed in the laboratory (crosstie- or rail-mounted strain gauges)
 - Three consecutive instrumented rail seats to capture distribution of forces as trains pass over test section



Instrumentation Overview

Rail Restraint

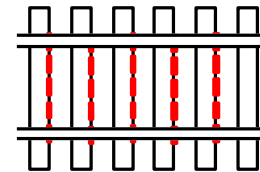
- **Desired data:**
 - Vertical and lateral rail base displacements
- **Instrumentation description and methodology:**
 - Linear potentiometers fixed to manufactured rapidly-deployable brackets that affix non-permanently to cross-tie
 - Displacements measured at rail seats with instrumentation to:
 - Calculate rail rotation and translation



Instrumentation Overview

Crosstie Bending

- **Desired data:**
 - Crosstie center bending strains
- **Instrumentation description and methodology:**
 - Surface strain gauges mounted along the chamfer of the cross-tie
 - Based on previous UIUC research, gauges will be placed at rail seats and center of cross-ties to account for most critical design moments
 - Intermediate gauges placed between rail seats and center will allow for more precise back-calculation of support conditions



Center and intermediate gauges

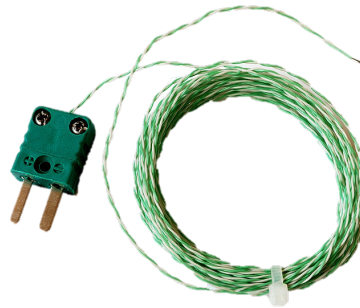
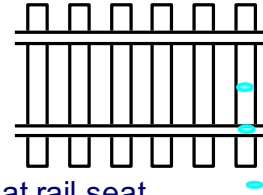


Rail seat gauge

Instrumentation Overview

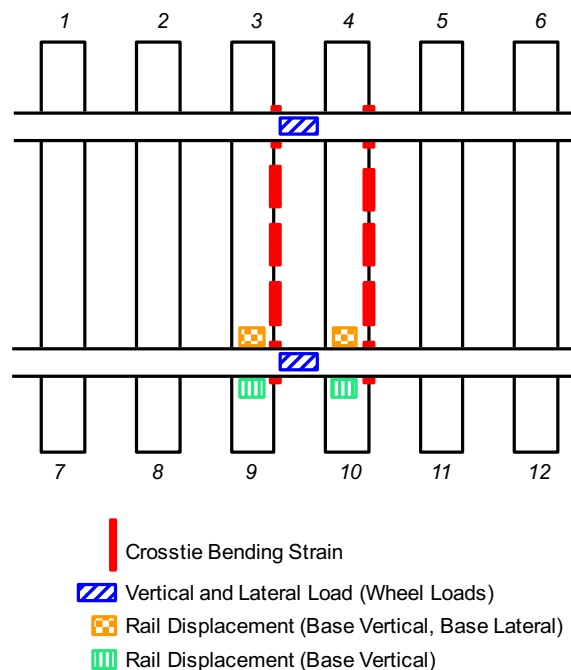
Thermocouples

- **Desired data:**
 - Ambient and crosstie temperatures
- **Instrumentation description and methodology**
 - Surface thermocouples mounted on tie, below ballast, at rail seat, and near track
 - Based on previous UIUC research, thermal gradients warping the tie may cause support conditions to change

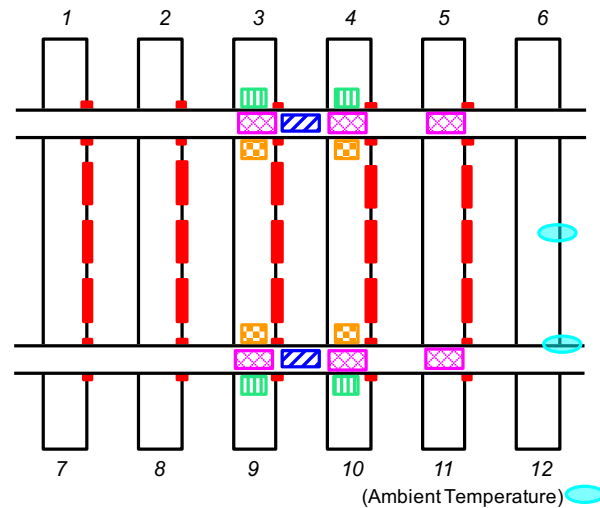








(May not be exact model/type used)

Pilot Instrumentation Map



Final Instrumentation Map



-  Crosstie Bending Strain
-  Vertical and Lateral Load (Wheel Loads)
-  Rail Displacement (Base Vertical, Base Lateral)
-  Rail Displacement (Base Vertical)
-  Thermocouple
-  Rail Seat Load

** Final map may vary depending on results of pilot installation*

Acknowledgements



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Federal Transit Administration



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- Federal Transit Administration (FTA)
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- LBFoster
- GIC Inc.
- Hanson Professional Services, Inc.
- Amtrak



New York City Transit



Questions or Comments?

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General Research Topics (for Discussion)

- **Materials Level**
 - Concrete mix design optimization due to climate
 - Need for air entrainment in concrete mix design
 - Fiber reinforced concrete (FRC)
- **Component Level**
 - Optimization of prestress
 - Corrosion of fastening systems
 - Concrete crosstie instrumentation with RFID (e.g. center strain gauges)
 - Rail pads for transit applications
 - Crosstie geometry trade off – length to surface area

General Research Topics (*for Discussion*)

- **System Level**
 - Demands on the fastening systems for slab track vs. concrete crossties
 - Impact of crosstie spacing (looking into rail stresses)
 - System level testing to serve transit sector (model specification)
 - Under tie pads and ballast mats