Introducing RailTEC’s Research and Innovation Laboratory (RAIL)

FRA Tie and Fastener BAA - Industry Partners Meeting
Colorado Springs, CO
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Outline

• RailTEC’s Research Mission

• Current Experimental Systems and Capabilities
  – PLTM
  – SLTM
  – STT
  – UIUC’s Full Scale Track System
    • Mission and Objectives
    • Construction Timeline
    • Current Objectives (*for FRA BAA*)

• Laboratory Vision
RailTEC Research Mission Statement

• Understand the critical research needs in rail transportation, and develop practical, effective solutions.

• Conduct theoretical and applied research in critically important and current topics in railway engineering and transportation.

• Communicate the results of this research to the rail transportation community
Pulsating Load Testing Machine (PLTM)

- Owned by Amsted RPS
- Maintained and managed by UIUC since Spring, 2010
- Located at RailTEC’s Research and Innovation Laboratory (RAIL) at Schnabel (Champaign, IL)

**Experimental capabilities**
- One 50,000 lb (222 kN) vertical actuator
- One 35,000 lb (156 kN) lateral actuator

**Functionality**
- Ability to simulate various L/V force ratios (e.g. track conditions)
- Adaptability for other support and service conditions (e.g. ballast box and environmental chamber)
Static Load Testing Machine

- Owned by RailTEC since fall 2011
- Located at RailTEC’s Research and Innovation Laboratory (RAIL) at Schnabel (Champaign, IL)
- **Experimental capabilities**
  - One 100,000 lb hydraulic cylinders
- **Functionality**
  - Ability to simulate various support conditions (e.g. track conditions)
  - Ability to refine instrumentation techniques
  - Can be modified to suit the needs of other experimental needs
Static Tie Tester (STT)

- Owned by RailTEC since summer 2012
- Located at RailTEC’s Research and Innovation Laboratory (RAIL) at Schnabel (Champaign, IL)

**Experimental capabilities**
- Two 95,000 lb hydraulic cylinders

**Functionality**
- Ability to simulate various support conditions (e.g. track conditions)
- Ability to study the rail seat compression
- Ability to study the bending moment capacity of crossties
Full Scale Track Bed

- Operational since spring 2013
- Located at RailTEC’s Research and Innovation Laboratory (RAIL) at Schnabel (Champaign, IL)

**Experimental capabilities**
- Two 55,000 lb hydraulic actuators
- One 100,000 lb hydraulic cylinder

**Functionality**
- Full-depth track substructure for representative support conditions
- Eleven (11) crossties for representative end effects
- Loading via wheelset for representative loading conditions
- Ability to change the L/V and magnitude of loads applied
- Ability to answer hypothesis based questions pertaining to infrastructure and substructure
Industry Support

- **UIUC, CEE Department, NURail Center and RailTEC**
  - Provision of Laboratory Facility
  - Cleanup and Retrofit of Laboratory
  - Hydraulic Power Supply and Ancillary Equipment

- **Other Industry Partners**
  - Instrumented Wheel Set (IWS) [TTX]
  - Frame Price Reduction [Amsted Rail]
  - Hydraulic Power Unit Chiller [Amsted Rail]
  - Track Construction Materials [CN Railroad]
  - Track Construction Quality Control [Hanson Professional Services Inc.]

- **Federal Railroad Administration (FRA)**
  - Additional Frame Design, Materials, and Labor
  - Actuators
  - Control System
Full Scale Track Bed: Mission and Objectives

• **Mission:**
  – Design and execute a laboratory frame to accommodate representative full-scale track experimentation to improve the understanding of crosstie and fastening system component response and performance

• **Objectives:**
  – Improve upon existing full-scale crosstie and fastening system experimental setup deficiencies
  – Use wheel-rail contact to apply loads to track structure
  – Support track components with ballast, sub-ballast, and subgrade, compacted to achieve representative track stiffness
  – Facilitate multiple test protocols (e.g. static, dynamic) based on divergent experimental objectives
  – Ensure all varieties of track components can be accommodated
  – Facilitate measurement of loads, stresses, displacements, and strains
  – Allow for measurement of component degradation rates
Full Scale Track Loading System:
Full Scale Track Loading System:
Full Scale Track Loading System Construction:
September 23 – Subgrade Construction ~50% Complete
Full-Scale Track Loading System: November 6 – Instrumented Wheelset (IWS)
Full-Scale Track Loading System:
January 22 – Control Platform
Full-Scale Track Loading System:
January 22 – Control Platform
Full-Scale Track Loading System: February 28 – Successful Track Loading
Construction Timeline and Path Forward

• Construction
  – Frame modification and connections \(\rightarrow\) April-July 2013
  – Frame assembly \(\rightarrow\) July-October 2013
  – Track construction \(\rightarrow\) September-December 2013
    • Rail, ballast, subballast, and subgrade supplied by CN
    • Crossties supplied by LBFoster CXT Concrete Ties
    • Fastening systems supplied by Amsted RPS
    • IWS calibrated and provided by TTX
  – Finalize construction and begin shakedown and experimental matrix \(\rightarrow\) January-April 2014

• Hydraulic Systems Installation
  – Hydraulic system and actuators purchased from MTS
  – Hydraulic cooling system purchased from BAC

• Path Forward
  – Completion of Shakedown \(\rightarrow\) April 2014
  – Completion of experimental matrix \(\rightarrow\) April - May 2014
Experimental Matrix Objectives

• Compare track and component response on full scale track loading system to data from:
  – TLV
  – Train passes
  – PLTM

• Fill voids in field and laboratory experimentation
  – Application of additional load magnitudes and L/V ratios
  – Vary crosstie support conditions
  – Expand upon the instrumentation deployed at TTC

• Continue to refine and validate the UIUC 3D FE Model
Full-Scale Track Loading System (FSTLS) Instrumentation Placement Map

- Lateral Load Evaluation Device (LLED)
- Lateral and Rail Seat Load Circuits
- Vertical Load Circuit
- Lateral Load Circuit
- Rail Displacement (Base Vert. Gauge, Base Lat., Web Lat.)
- Rail Displacement (Base Vert. Field)
- Embedment Gauges
- Crosstie Surface Strains
- Lateral Crosstie Displacement
- Vertical Crosstie Displacement
Initial Experimentation

40 kips

Research and Innovation Laboratory (RAIL)
Preliminary Discussion on Support Conditions

Schnabel Static on Tie 4 - V = 40.0 kips; L = 0.0 kips

Load and Support Conditions
20 kips 20 kips
p = 0.5405 kips/in p = 0.5405 kips/in

Moment Diagram
Moment (kips-in)
45.4 -20.0 45.4

TEST

ANALYSIS
RAIL Research Vision

- Experimentation and testing focal areas:
  - Novel crosstie designs
  - Effect of various fastening system materials on load distribution
  - Insulated joints
  - Under sleeper pads
  - Composite crossties
  - Validation of GEOTRACK
  - Substructure research
  - Tie/ballast interaction
  - Deterioration testing (temperature, moisture, cycles, etc.)

- Other Areas of Focus?
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