State of the Program Address
RailTEC Crosstie and Fastening System Research Program

FRA Tie and Fastener BAA Industry Partners Meeting
2 April 2014
Riley Edwards, Marcus Dersch, and Ryan Kernes

RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Outline

• Introduction
• Vision, Pyramid, and Objectives
• Current Projects, Sponsors, and Team
• Research History Timeline
• Successes
• Current Areas of Focus
• Key Meetings and Future Events
• Questions and Comments
Previous Personnel
• At least 7 Graduate Research Assistants (Zeman, Gutierrez, Kernes, Shin, Grasse, Rapp, Van Dyk)
• At least 10 Undergraduate Research Assistants
• 1 Post Doctoral Researcher

Current Personnel
• 11 Graduate Research Assistants
• At least 5 Undergraduate Research Assistants
• 2 Research Engineers
• 4 Principal Investigators (Pis)
Crosstie Program Vision

Investigate real-world engineering challenges related to concrete crossties and fastening systems, serving the railroad industry and University, while developing strong mentor leaders.
Crosstie Team Pyramid

Vision
- Develop Mentor Leaders

Goals
- Thrive as a Research Team
- Build into the Lives of Others
- Build Lasting Relationships
- Grow as Individuals
- Prepare Each Team Member for Next Phase of Life
- Serve Railway Industry and Scientific Community
- Gain Additional Opportunities (New Projects)
- Produce High Quality Research

Objectives
- Teamwork
- Passion
- Teachability
- Professionalism
- Proactiveness
- Attention-to-Detail
- Industriousness

Foundation
Crosstie Program Objectives

• Solve real-world design and performance challenges associated with concrete crossties and fastening systems

• Maintain a balanced portfolio of research projects
  – Projects \((\text{and the resulting experiments and models})\) should be traceable to specific failure modes in the field
  – Strive for a healthy balance of materials, component, and system-level research and testing projects
  – Strive for balance of laboratory, field, and analytical (modeling) projects

• Meet railroad industry and University objectives

• Foster student interest in the subject, training future mentor leaders in the fundamentals of railway engineering
Crosstie Program Research Levels (and Examples)

**Materials**
- Concrete Mix Design
- Rail Seat Surface Treatments
- Pad / Insulator Materials

**Components**
- Fastener Yield Stress
- Insulator Post Compression
- Concrete Prestress Design

**System**
- Finite Element Modeling
- Full-Scale Laboratory Experimentation
- Field Experimentation
# Crosstie Research Program Levels and Deployment Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Materials</th>
<th>Components</th>
<th>System</th>
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<tbody>
<tr>
<td><strong>Laboratory</strong></td>
<td>Abrasion Resistance Comparison - Small Scale Testing for Abrasion Resistance (SSTAR)</td>
<td>Crosstie Flexural Capacity Experiments – Static Tie Tester (STT)</td>
<td>AREMA Test 6 - Wear/Deterioration Test - Pulsating Load Testing Machine (PLTM)</td>
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<td><strong>Analytical</strong></td>
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<td>Model of Transfer Length Based on Wire Pattern – Kansas State University (KSU)</td>
<td>Full-Scale FEA Modeling and Model Iterations</td>
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Research Sponsors

- Federal Railroad Administration (FRA) (Fastening System Design, Performance, Wear, Fatigue, Cracking, Environmental, etc.)
- Amsted RPS / Amsted Rail, Inc. (Fastening System Wear and Fatigue)
- Association of American Railroads (AAR) Technology Scanning Program (RSD and Fastening System Wear and Fatigue)
- Kansas City Southern (KCS), GIC Ingeniería y Construcción, and IntegriCo (Crosstie Design)
- NEXTRANS Region 5 Transportation Center (RSD)
- National University Rail (NURail) (Fastening System Wear and Fatigue)
- CN Fellowship in Rail Engineering (RSD)
Research Program Timeline

2008 August – Hired First Graduate Research Assistant (John Zeman)

2008 October – Attendance at First AREMA C-30 Meeting in Savannah, GA

2009 January – First Research Project (CN and AAR funding)

2009 August – Hired Second Graduate Research Assistant (Mauricio Gutierrez)

2009 October – Second Research Project (Amsted RPS funding)

2010 August – Hired Third Graduate Student (Ryan Kernes)

2011 January – Hired Full-Time Research Engineer (Marcus Dersch)

2011 January – Third Research Project (NEXTRANS Co-Funding)

2011 June – FRA Tie and Fastener BAA awarded (Hired Graduate Research Assistants (Sihang Wei, George Chen, Justin Grasse, and Brandon Van Dyk)

2011 Summer – Hired Graduate Research Assistants for Amsted RPS and NEXTRANS Projects (Chris Rapp and Amogh Shurpali)
Research Program Timeline (Cont.)

2012 January – Hired Postdoctoral Researcher (Moochul Shin)

2012 Summer – Hired Second Research Engineer (Ryan Kernes) and Graduate Research Assistants (Thiago Bizarria, Emily Van Dam, and Brent Williams), Two Additional FRA BAA Projects Awarded

2013 Spring – FRA BAA Modification #2 Awarded

2013 Summer – Hired Graduate Research Assistants for Amsted RPS and FRA Tie and Fastener BAA Projects (Matthew Greve and Kartik Manda) and FRA BAA Modification #3 Awarded

2013 Fall – Hired Graduate Research Assistants Matthew Csenge and Andrew Scheppe, GIC Project Awarded

2014 Spring – Hired Graduate Research Assistant Henry Wolf, IntegriCo Project and FRA RSD Projects Awarded
## Papers, Posters, and Presentations

<table>
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<tr>
<th>Year</th>
<th>Conference / Meeting</th>
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**Total**: 42 Papers, 50 Presentations, 19 Posters
FRA Tie and Fastener BAA Status

• Currently in Month 35 (April 2014) of 43 (December 2014)
• Financial status through Month 33 (February 2014):
  – Funding Level: $3,129,348 (includes all financial mods)
  – Expended: $2,708,006 (87%)
  – Remaining: $421,342
• Major Efforts Between Now and End of Project (Month 43)
  – Additional Validation and Refinement of the FEM
  – Additional Laboratory Testing (construction and operation of full scale track bed at Schnabel)
  – Coordination of Experimental and Modeling Efforts
  – 2nd International Crosstie and Fastening System Symposium
  – Development of Mechanistic Design Practices
  – I-TRACK Development and Release
  – Final Report Completion
Final Report Development - Process

1. Chapters Drafted Internally at UIUC by Project Sub-teams (e.g. modeling)
2. Internal Review by Research Engineers and Faculty
3. Internal Revision and Re-review
4. Chapters (1 to 2 at a time) sent to FRA for Technical Review
5. Process repeats until all chapters are reviewed and approved
6. Final report released
# Final Report - Table of Contents

## Executive Summary

### Volume 1
1. Introduction and Background
2. Laboratory and Field Instrumentation Results
3. Mechanistic Design of Concrete Crossties and Fastening Systems
4. Conclusions
5. References
6. Abbreviations and Acronyms

## Volume 2
1. International Survey Results
2. Loading Quantification Document
3. Laboratory Instrumentation Plan
4. Laboratory Instrumentation Results
5. Field Instrumentation Plan
6. Field Instrumentation Results
7. Modeling Methodology and Development
8. Modeling Results (Parametric Analyses) and Conclusions
9. Analytical Model (I-TRACK) Development and Capabilities
10. References
11. Abbreviations and Acronyms
## Final Report - Table of Contents - *(Progress)*

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### KEY

- Future
- Under Development
- Under Review
- Complete
Major Accomplishments

- International Survey
- Loading Quantification Study and Report
- 2012 International Symposium
- Document Depository
- Papers and Presentations
- Lab and Field Experimentation
  - Lateral load quantification
  - Rail seat pressure measurement
  - Rail seat bending moments for mixed traffic
- FEA Model Development and Refinement
- Full-Scale Track Loading System Design and Construction
- Preliminary Development of I-TRACK
Where are we going?

• **Current and Near-Term Focus:**
  - Continue to serve key research sponsors (Amsted Rail, etc.)
  - Finish strong on current FRA Tie and Fastener BAA
  - Completion of first build out of RAIL at UIUC
  - Pursuit of research projects in additional areas:
    • Insulated Joints (IJs)
    • Under Sleeper Pads (USPs)
    • Composite Crossties

• **Long-Term Vision:**
  - Balanced research funding from private and public sectors
  - **Balanced approach with laboratory experimentation, field experimentation, and modeling**
FRA Crosstie and Fastening System Program
Overall Project Deliverables

**Mechanistic Design Framework**
- Literature Review
- Load Path Analysis
  - International Standards
  - Current Industry Practices
  - AREMA Chapter 30

**Finite Element Model**
- Laboratory Experimentation
- Field Experimentation
- Parametric Analyses

**I – TRACK**
- Statistical Analysis from FEM
- Free Body Diagram Analysis
- Probabilistic Loading
Future Meetings and Key Events

- AREMA C-30 and Industry Partners Meetings
  - Champaign-Urbana, IL → June 2014
    - Co-located with International Symposium
  - Orlando, FL → October 2014
    - Co-located with C-30 meeting and RTA
- 2nd International Concrete Crosstie and Fastening System Symposium, Urbana, IL → 3-5 June 2014
Hosting 2014 International Crosstie and Fastening System Symposium

• Co-organized by: AREMA Committee 30 (Ties), Railway Tie Association (RTA)

• Three day conference with presentations, discussions, and a technical tour

• Focus → state of the art in timber, concrete, and composite crosstie and fastening system design, performance, research, modeling, and inspection

• 3 - 5 June 2014 – Sessions on UIUC campus
4 June 2014 – Technical tour to UIUC Research and Innovation Laboratory (RaIL) and voestalpine Nortrak facility in Decatur, IL

• Strong domestic and international participation; addressing topics including:
  – Laboratory and Field Testing
  – Component and System Modeling
  – Automated Inspection Technologies

RAILTEC

2014 International Crosstie & Fastening System Symposium
3-5 June 2014

Rail Transportation and Engineering Center (RailTEC)
University of Illinois at Urbana-Champaign (UIUC)
Newmark Civil Engineering Lab
205 N. Mathews Avenue
Urbana, IL 61801
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- Federal Railroad Administration

- National University Rail Center
- Amsted RPS
- GIC
- ASSOCIATION OF AMERICAN RAILROADS
- Mextrans
- Kansas City Southern Lines
- CN

FRA Tie and Fastener BAA Industry Partners:

- UNION PACIFIC
- BUILDING AMERICA®
- BNSF RAILWAY
- LB Foster CXT Concrete Ties
- AMTRAK®
- HANSON
Other Supporting Organizations
Questions and Comments?

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