

Resilient Concrete Crosstie and Fastening System Designs for Light Rail, Heavy Rail, and Commuter Rail Transit Infrastructure

**Funded by:
Federal Transit Administration (FTA)**

**Rail Transportation and
Engineering Center (*RailTEC*)**

**University of Illinois
at Urbana-Champaign**

**Industry Partners Meeting
4 November 2015**

RAILTEC

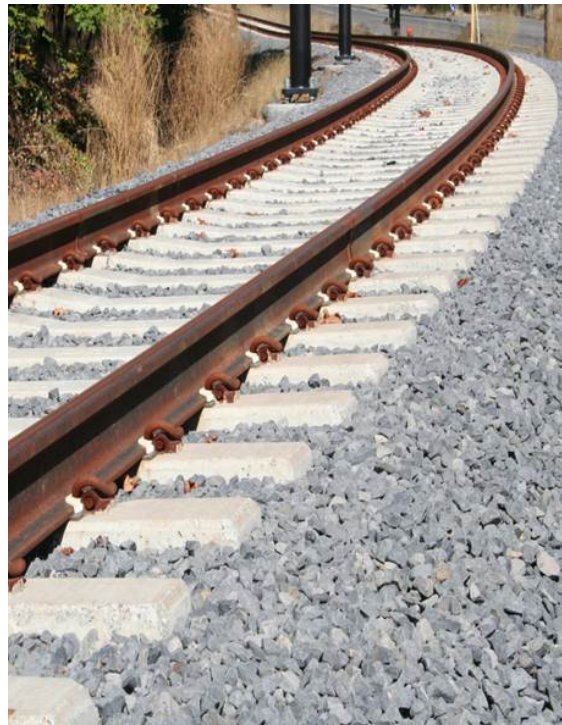


U.S. Department of Transportation
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Presentation Outline

- Introductions
- Overview of Project Objectives
- Project Team
 - UIUC Personnel
 - Industry Partners
- Work Package Discussion
- FTA Involvement
- Impact
- Progress to Date
- Comments and Questions



RailTEC's FTA Research Team

- **Technical Personnel**
 - Riley Edwards (Research Scientist and Principal Investigator (PI))
 - David A. Lange (Professor and Co-PI)
 - Bassem O. Andrawes (Associate Professor and Co-PI)
 - Conrad Ruppert (Senior Research Engineering and Co-PI)
 - Marcus S. Dersch (Senior Research Engineer)
 - Yu Qian (Research Engineer)
 - Matthew Csenge (Manager of Experimentation)
 - Aaron Cook, Xiao (Sean) Lin, Zhenboyang Gao & Abhishek Master (Graduate Research Assistants)
- **Administrative Personnel**
 - Tim Gress (RailTEC Managing Director)
 - Angie Stanford (Railroad Program Coordinator)
 - L.B. Frye (Railroad Program Coordinator)



RailTEC's Industry and Institutional Support



RAIL Grand Opening – 19 August 2015

Joseph Leader (NYCT Senior VP) with Matthew Csenge, Yu Qian, and Melanie Loots (Asst. Vice Chancellor for Research at UIUC)

FTA Oversight and Roles

- Terrell Williams
(Senior Engineer and Project Manager)
- Raj Wagley (Interim Project Manager)
- Roy Chen



FTA Industry Partner Acknowledgements



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FTA Industry Partner Roles

Transit Provider Partners

Transit	Project Phase		
	Provision of Specs ¹	Field Experimentation on Property (UIUC's Forces) ²	Prototype Installation (Partner's Forces) ³
NYCT	•	•	•
MetroLink	•	•	
Tri-Met	•		•
Metra	•		•

¹Involvement in UIUC's efforts to develop a comprehensive database of design specifications.

²Allow UIUC to conduct focused field experimentation to determine loading environment. All work will be completed by UIUC's forces, in coordination with the transit industry partner.

³Install prototype concrete cross-ties and fastening systems designed via this project through involvement from supplier Industry Partners. Designs will have undergone laboratory experimentation prior to field placement expectations.

FTA Industry Partner Roles

Supplier Partners

Supplier	Project Phase		
	Component Design ⁴	Supply of Existing Components ⁵	Prototype Development ⁶
Pandrol USA	•	•	•
Amsted RPS	•	•	•
GIC USA	•	•	•
CXT Concrete Ties	•	•	•

⁴Active involvement in UIUC's efforts to design new components.

⁵Supply existing components for experimentation at UIUC and in the field (if needed).

⁶Design and manufacture new prototype components for laboratory experimentation and field installation.

FTA Industry Partner Roles

Other Project Partners

Partner	Project Involvement
Amtrak	Access to WILD Data on Northeast Corridor (NEC)
APTA	Assistance in conducting surveys (provision of contact info.), assistance in disseminating results, etc.
Hanson	Review of prototype design plans, general structural reviews, etc.

Field Experimentation Locations



Light rail: TriMet (Portland, Ore.)
 MetroLink (St. Louis, Mo.)

Heavy rail: New York City Transit (New York, NY)

Commuter rail: Metra (Chicago, Ill.)

Concrete Crossties – Overview of Use

- Typical Usage:
 - **Freight** → Heavy tonnage lines, steep grades, and high degrees of curvature
 - **Passenger** → High density corridors (e.g. Amtrak’s Northeast Corridor [NEC])
 - **Rail Transit** applications
 - Number of concrete crossties in North America*:
 - Freight → 30,000,000
 - Passenger → 2,000,000
 - Transit → Significant quantities (millions)
- *Approximate



FTA Project Overview, Objectives, and Expected Outcomes

- Project Objectives
- Keys to Success
- Industry Expert
- Work Packages
- Schedule
- Deliverables
- Impact of Project

UIUC Project Proposal: FTA-2013-005-TRI

STATEMENT OF WORK

Resilient Concrete Crosstie and Fastening System Designs for Light Rail, Heavy Rail, and Commuter Rail Transit Infrastructure

Project Proposal Prepared in Response to FTA-2013-005-TRI:
Solicitation of Project Proposals for Innovative Safety, Resiliency, and All-Hazards Emergency Response and Recovery Research Demonstrations

Theme Area: Infrastructure and Equipment Resiliency

Awarded to:
University of Illinois at Urbana-Champaign (UIUC)
Rail Transportation and Engineering Center (RailTEC)

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UIUC Technical and Administrative Staff: Marcus Dersach (Senior Research Engineer), Yu Qian (Research Engineer), Timothy Gress (Administrative Manager), LB Frye and Angela Stanford (Program Coordinators)

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FTA Research Project Objectives and Deliverables

- **Program Objectives**
 - Conduct extensive literature review regarding current design practices and needs
 - Quantify the loads entering rail transit infrastructure:
 - Laboratory and field experimentation
 - Finite Element Modeling (FEM)
 - Develop mechanistic design recommendations for crossties and fasteners
- **Program Deliverables**
 - Quantification of loading conditions for rail transit
 - Improved mechanistic design recommendations for concrete crossties and fastening systems for rail transit
 - Proposed revisions to AREMA Recommended Practices for rail transit



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FTA Tie and Fastener Industry Partners:



New York City Transit

TRIMET

See where it takes you.

Metra

The way to really fly.



RPS

RAIL PRODUCT SOLUTIONS™

PANDROL

TRACK SYSTEMS

© DELACHAUX GROUP

GIC

LB Foster

CXT Concrete Ties



Structure of FTA Resilient Crosstie Project

- Divided into 5 Work Packages (WPs)
 - 1) Field Load Environment Characterization
 - 2) Full-Scale Laboratory Experimentation for FE Model Validation
 - 3) Analytical Modeling and Development of Simplified Design Tool
 - 4) Prototype Crosstie and Fastening System Design, Construction, and Installation
 - 5) External Review, Planning, Management, Reporting, and Communications
- Each work package has an overall theme and objective
- Each work package will have many interim deliverables, and involves coordination with multiple Principal Investigators (PI's)

Work Package 1 - Field Load Environment Characterization

WBS ID	Description of Work	Work Schedule
1.1.1	Literature review of rail transit and commuter rail experiences with concrete crossties and fastening systems	Month 1-6
1.1.2	Conduct a survey on the use and performance of concrete crossties and fastening systems, and identify common types of failures and the design requirements	Month 1-4
1.1.3	Develop a comprehensive instrumentation plan	Month 1-5
1.1.4	Conduct field instrumentation at three locations, representing three different types of rolling stock	Month 2-16
1.1.5	Process data from field experimentation and develop a report	Month 3-19

Work Package 2 - Full-Scale Laboratory Experimentation for FE Model Validation

WBS ID	Description of Work	Work Schedule
1.2.1	Develop laboratory experimentation plan	Month 3-8
1.2.2	Conduct laboratory experimentation	Month 7-18
1.2.3	Process data from laboratory experimentation and develop reports	Month 14-22

Work Package 3 - Analytical Modeling and Development of Simplified Design Tool

WBS ID	Description of Work	Work Schedule
1.3.1	Develop a detailed finite element (FE) model	Month 5-12
1.3.2	Use laboratory and field experimental data to validate FE model	Month 10-18
1.3.3	Run parametric analyses with FE model	Month 16-26

Work Package 4 - Prototype Crosstie and Fastening System Design, Construction, and Installation

WBS ID	Description of Work	Work Schedule
1.4.1	Develop technical memorandum of critical crosstie qualities	Month 18-26
1.4.2	Design prototype crossties and fastening systems	Month 24-28
1.4.3	Manufacture prototype crossties and fastening systems	Month 28-33
1.4.4	Installation of prototype crossties and fastening systems on two of the following systems: light rail, heavy rail, or commuter rail transit	Month 34-36

Schedule of Deliverables

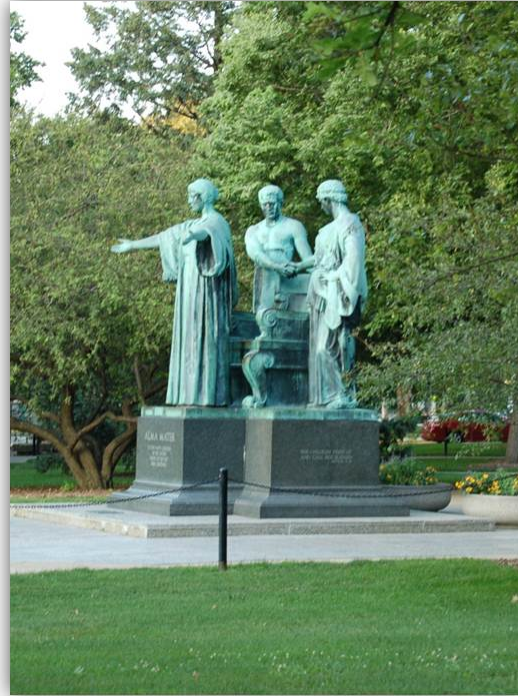
WP	Deliv.	Description of Deliverable	Month
Field Load Environment Characterization	D1.1.1	Technical memorandum of literature review	6
	D1.1.2	Technical memorandum of the survey results	4
	D1.1.3	Comprehensive field experimentation plan	5
	D1.1.4	Report of field loading environment & critical findings	19
Full-Scale Laboratory Experimentation	D1.2.1	Comprehensive laboratory experimentation plan	8
	D1.2.2	Report summarizing laboratory loading environment and critical findings.	22
Analytical Modeling	D1.3.1	Report on FE model development and functionality	12
	D1.3.2	Fully-validated FE model	18
	D1.3.3	Report on results from FE model parametric analyses	26
Prototype Crosstie and Fastening System Design, Construction, and Installation	D1.4.1	Report of critical tie qualities that govern the design of crossties and fastening systems	26
	D1.4.2	Design for prototype crossties and fastening systems	28
	D1.4.3	Prototype crossties and fastening systems	33
	D1.4.4	Installation of prototype crossties & fastening systems	36

Schedule of Deliverables

WP	Deliv.	Description of Deliverable	Month
External Review, Planning, Management, Reporting, and Communications	D1.5.1	Publically-accessible Website for Downloadable Resources Related to this project.	3
	D1.5.2	Quarterly project reports (linked to invoicing).	3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33, and 36
	D1.5.3	Conference presentations, conference papers, and other presentations.	Varies, Minimum of 3 Abst./Year
	D1.5.4	Organize an international concrete crosstie and fastener symposium	11, 35
	D1.5.5	Weekly internal project team meetings	Weekly
	D1.5.6	Annual Meetings with Industry Partners.	3, 15, 27
	D1.5.7	Deliver final project report	36
	D1.5.8	Deliver external advisor final report	24,36

RaiITEC/UIUC Keys to Success

- Strong University Backing
- Diverse and Experienced Team (Prior FRA and Private Sector Project Experience)
- Newly opened Research and Innovation Laboratory (RAIL)
- Technology Readiness
- Literature Resources
- Strong Industry Support/Partners
- Other Industry experts and contacts
 - Both Domestic and International



Industry Expert and External Advisor

- Bill Moorhead
 - Will act as member of UIUC/RaiITEC project team
 - Role will include assisting students, faculty, and staff in building relationships with the transit sector and pursuing answers to focused questions
 - Already visited campus for preliminary project discussions and general site visit
- David Staplin
 - Will serve in External Advisor Role (FTA requirement)
 - At two year point in project, will author report on how well we achieved project objectives
 - Final external advisor report will be included in our final report released to FTA

Impact of FTA-Funded Project

- Fact based design of crossties and fastening systems in the US specific to rail transit applications
 - Non-iterative process
- Lower life cycle costs → Greater chance of success
- Strong industry support → Rapid adoption of findings
 - Both in recommended practices and new components
- Training of future rail transit engineers
 - Industry is provided with two deliverables; report and trained students
- Encouraging additional faculty to pursue railway research
- *Establish foundation for follow-on research*

Initial FTA Project Progress

- Attendance at APTA 2015 Rail Conference in Salt Lake City
- Project Coordination Meetings
- Initial Loading Environment Work (Xiao Lin)
- Development and Distribution of International Tie and Fastener Survey (Xiao Lin)
- Development of Field Experimentation Plan (Aaron Cook and Matt Csenge)
- Meetings with MetroLink and NYCT Regarding Field Testing
- Literature Review



RailTEC Students in NY (Taken Day of Proposal Award Announcement)



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 - MetroLink (St. Louis, Mo.)
 - TriMet (Portland, Ore.)
 - Pandrol USA
 - Rail Product Solutions (RPS), Inc.
 - LBFoster
 - GIC Inc.
 - Hanson Professional Services, Inc.
 - Amtrak

FTA Industry Partners:



New York City Transit



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