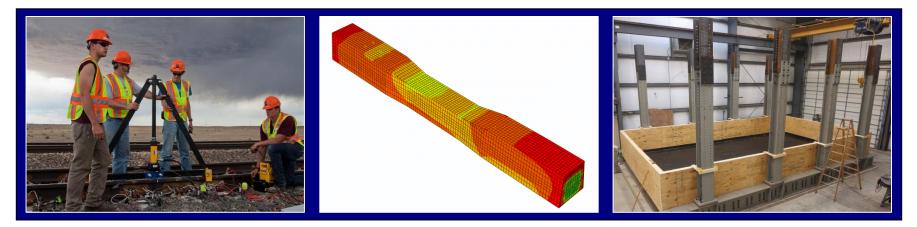
### UIUC FRA Concrete Tie and Fastener BAA October 2013 Program Update



### FRA Tie and Fastener BAA - Industry Partners Meeting Incline Village, NV 7 October 2013

Marcus S. Dersch, J. Riley Edwards, Ryan G. Kernes, Bassem O. Andrawes, David A. Lange, and Daniel Kuchma



## Outline

- Program-Level Update (Tie Program)
- Project-Level Update (FRA BAA)
  - Overall Status
  - Budget Review
  - Final Report Planning
  - Path Forward
  - Future Meetings
  - 2014 Symposium
- Questions
- Discussion



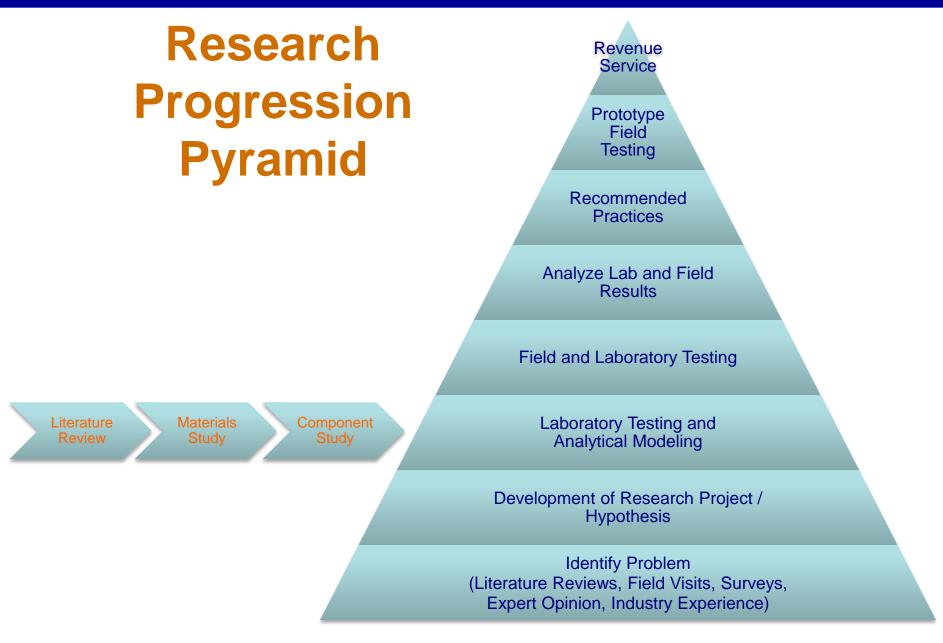


# **Program Vision**

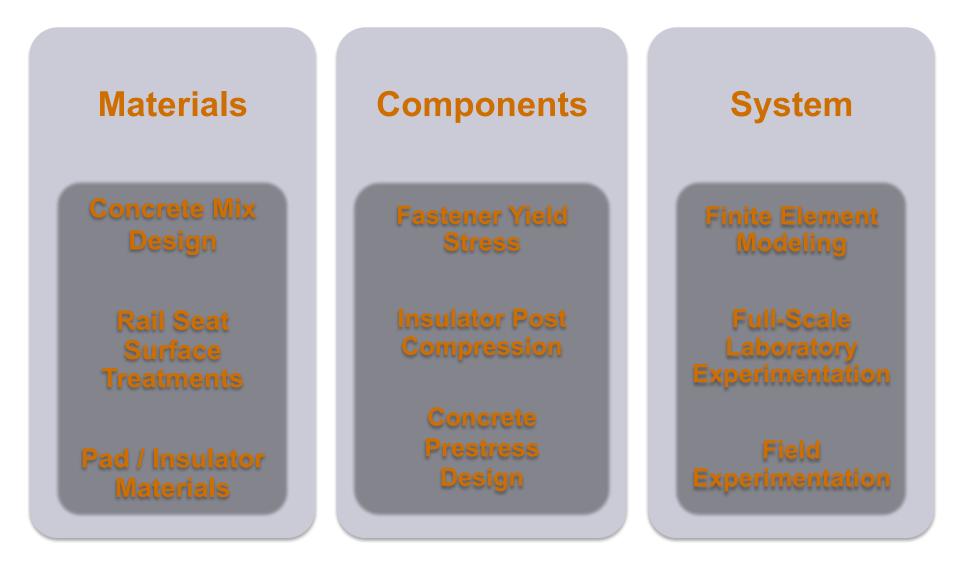
Investigate real-world engineering challenges related to concrete crossties and fastening systems, serving the railroad industry and University, while developing strong leaders

# **Program Objectives**

- Solve real-world design and performance challenges associated with concrete crossties and fastening systems
  - Projects 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
- Meet railroad industry and University objectives (which can be divergent in nature)
  - Strive to have more "basic" projects on the applied → basic research continuum
- Foster student interest in the subject, training future leaders in the fundamentals of railway engineering



### **Concrete Crosstie and Fastener Research Levels (and Examples)**



### **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) and GIC Ingeniería y Construcción (Crosstie Design)
- **NEXTRANS** Region 5 Transportation Center (RSD)
- National University Rail (NURail) (Fastening System Wear and Fatigue)
- CN Fellowship in Rail Engineering (RSD)









National University Rail Center



U.S. Department of Transportation

Federal Railroad Administration

## **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** Begin Improved FRA Tie and Fastener BAA (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 Summer Interns and Graduate Research Assistants for Amsted RPS and FRA Tie and Fastener BAA Projects (Matthew Greve and Kartik Manda)

**2013 Fall** – Hired Graduate Research Assistant for FRA Tie and Fastener BAA Project (Andrew Scheppe and Matthew Csenge), FRA BAA Modification #3 Awarded

#### UIUC FRA Tie BAA – Program Update Meeting – October 2013

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Year	Conference / Meeting	Papers	Presentations	Posters
2009	AREMA	1	1	
	IHHA	1	1	0
2010	TRB	1	1	0
	AAR Research Review			1
	JRC	1	2	0
	AREMA	1	1	
2011	TRB	1	0	1
	IHHA	3	0	2
	AAR Research Review			1
	JRC	0	2	0
	WCRR	2	0	2
	AREMA	1	1	
2012	TRB	1	1	1
	AAR Research Review			1
	JRC	2	6	0
	WRI		1	
	PCI	1	1	0
	AREMA	1	1	
	ACerS Concrete Conference	0	0	1
	TRB	2	2	0
	IHHA	6	6	1
	AAR Research Review			4
2013	JRC	3	8	0
	WRI		1	
	AREMA	1	1	
	WCRR	4	1	3
	Tot	al 33	38	18
	2009 2010 2011 2012	2009AREMA IHHA2010TRB AAR Research Review JRC AREMA2010TRB IHHA2011AAR Research Review JRC WCRR AREMA2011TRB IHHA 	2009 AREMA 1   IHHA 1   TRB 1   AAR Research Review 1   AREMA 1   ARR Research Review 1   AREMA 1   AREMA 1   AREMA 1   AREMA 1   IHHA 3   2010 AREMA   IRC 0   VCR 2   AREMA 1   IHHA 3   2011 ARR Research Review   JRC 0   WCRR 2   AREMA 1   TRB 1   AAR Research Review 2   2012 WRI   PCI 1   AREMA 1   ACerS Concrete Conference 0   TRB 2   IHHA 6   AAR Research Review 2   2013 JRC 3   WRI AREMA 1	2009 AREMA 1 1   TRB 1 1   2010 ARR Research Review 1 1   2010 JRC 1 2   AREMA 1 1 1   2010 JRC 1 2   AREMA 1 1 1   Z011 TRB 1 0   IHHA 3 0 2   AREMA 1 1 1   TRB 1 0 2   WCR 0 2 0   AREMA 1 1 1   TRB 1 1 1   AREMA 1 1

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### **Conference Accomplishments** (FRA Tie and Fastener BAA Only)

- TRB 2013 → 1 Spoken Presentations and 1 TRR Publication Accepted
- IHHA 2013 → 4 Spoken Presentations, 1 Poster, and 5 Technical Papers
- JRC 2013  $\rightarrow$  5 Spoken Presentations and 2 Papers
- WRI 2013  $\rightarrow$  1 Spoken Presentation in Plenary Session
- AREMA 2013 → 1 Spoken Presentation and 1 Paper
- WCRR 2013 → 1 Spoken Presentation, 3 Posters, and 4 Technical Papers
- TRB 2014 → 1 Spoken Presentation (more potentially to come)
- JRC 2014 → 4 Abstracts Submitted

## **Journal Articles**

Journal	Торіс	Lead Author	Status
ACI Materials	RSD Mechanisms	Zeman	In Press
Trans. Research Record	Rail Seat Pressures	Rapp	In Press
Jourtan of Trans Eng.	Rail Seat Pressures	Shurpali	Final Version Submitted
ASTM	SSART Abrasion	Shurpali	Under Development
JRRT	SSART and LSART	Kernes	Draft Version Submitted
EJSE	Field Testing	Grasse	Under Development
JRRT	Modeling	Shin/Chen	Draft Version Submitted
	ACI Materials Trans. Research Record Jourtan of Trans Eng. ASTM JRRT EJSE	ACI MaterialsRSD MechanismsTrans. Research RecordRail Seat PressuresJourtan of Trans Eng.Rail Seat PressuresASTMSSART AbrasionJRRTSSART and LSARTEJSEField Testing	ACI MaterialsRSD MechanismsZemanTrans. Research RecordRail Seat PressuresRappJourtan of Trans Eng.Rail Seat PressuresShurpaliASTMSSART AbrasionShurpaliJRRTSSART and LSARTKernesEJSEField TestingGrasse

## Research Team (May 2013)



### **Current Tie and Fastener Research Coverage**

Load distribution through rail stress analysis Kartik Manda

Mechanistic behavior of insulator Brent Williams Load quantification Brandon Van Dyk/ Andrew Scheppe

Mechanistic behavior of rail pad assembly Thiago Bizarria

> Clip stress analysis/ Crosstie structural analysis Sihang Wei

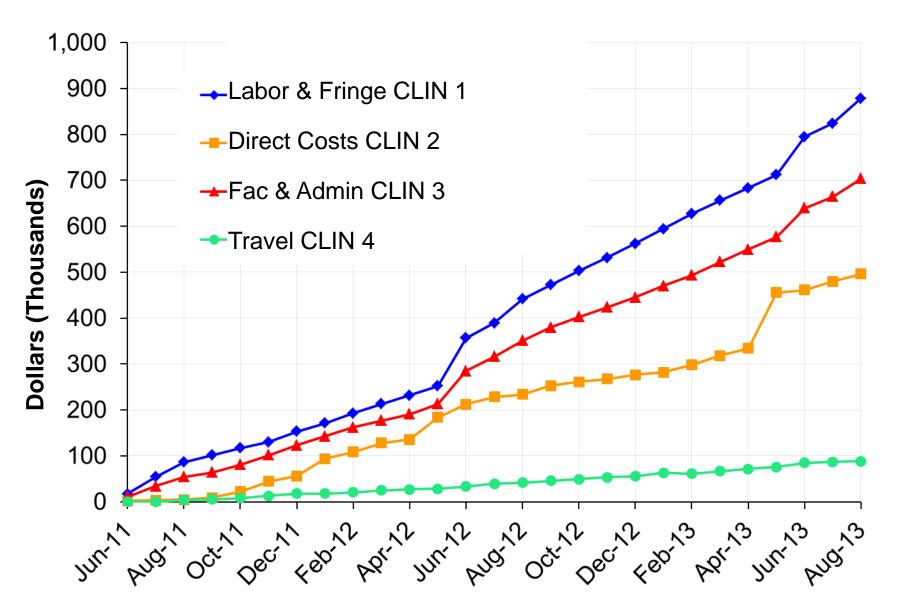
Rail seat pressures Matthew Greve

Other research: Concrete materials (Emily Van Dam), FE modeling (George Chen and Austin Zhang)

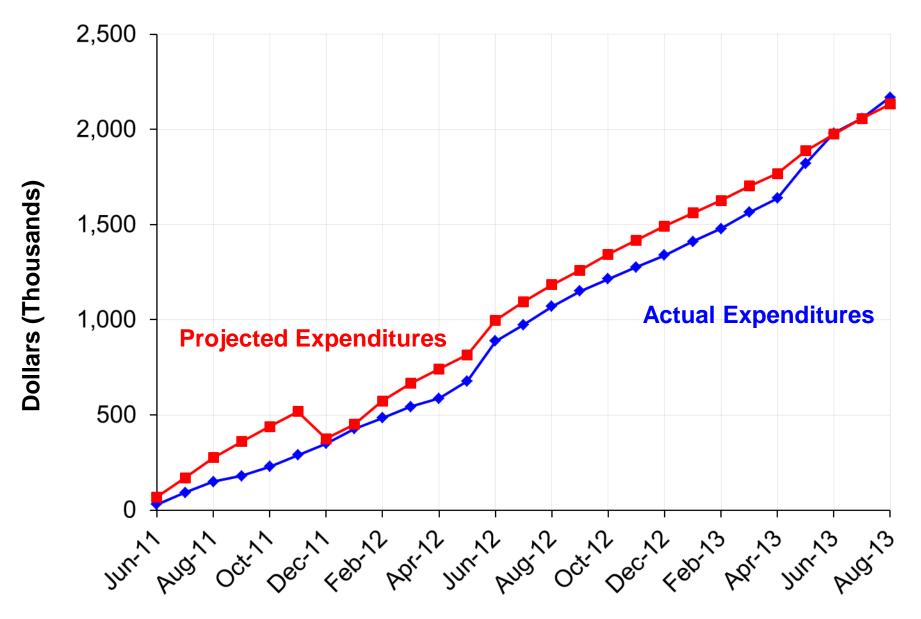
## **FRA Tie and Fastener BAA Status**

- Currently in Month 29 (October 2013) of 43 Months (including modification period of performance extension)
- Financial status through Month 27 (August 2013):
  - Funding Level: \$3,129,348 (incl. both financial mods)
  - Expended: \$2,167,644
  - Remaining: \$961,704 (31%)
- Adherence to Schedule through Month 29 (Oct. 2013):
  - Re-baselined the project in Month 28
  - Critical path items are back on schedule
  - Improved schedule adherence is due to improved coordination between different areas of the project (e.g. modeling and experimental teams)

### **Cumulative Monthly Expenditures and Budgets**



### **Actual vs. Projected Cumulative Total Expenditures**



### Final Report Development - Process

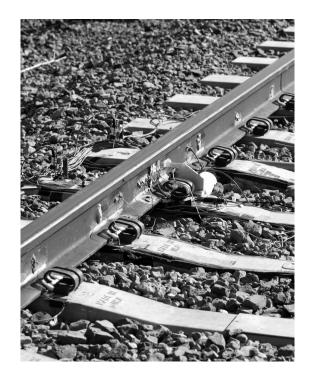
- Chapters Drafted Internally at UIUC by Project Subteams (e.g. modeling)
- 2. Internal Review by Research Engineers and Faculty
- 3. Internal Revision and Rereview
- Chapters (1 to 2 at a time) sent to FRA for Technical Review
- 5. Process repeats until all chapters are reviewed and approved
- 6. Final report released

U.S. Department of Transportation

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Improved Concrete Crossties and Fastening Systems for US High Speed Rail and Joint Passenger/Freight Corridors

Office of Research and Development Washington, DC 20590



DOT/FRA/ORD-12/XX

Final Report Draft January 2013

### Final Report - Table of Contents (Working Draft)

#### **Executive Summary**

#### Volume 1

- 1. Introduction and Background
- 2. Laboratory Instrumentation Results
- 3. Field Instrumentation Results
- 4. FE Modeling Results and Simplified Design Tool Results
- Mechanistic Design of Concrete Crossties and Fastening Systems
- 6. Conclusions

#### Volume 2

- 1. International Survey Results
- 2. Loading Quantification Document
- 3. Laboratory Instrumentation Plan
- 4. Laboratory Instrumentation Results
- 5. Field Instrumentation
- 6. Field Instrumentation Results
- 7. Modeling Methodology and Development
- 8. Modeling Results (Parametric Analyses) and Conclusions
- 9. Simplified Analytical Model Development and Capabilities
- 10. References
- 11. Abbreviations and Acronyms

### Final Report – Status (October 2013)

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#### <u>KEY</u> Future In Progress Final Review Complete

### <u>Volume 2</u>

- 1. International Survey Results
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- 10. References
- 11. Abbreviations and Acronyms

# Key Highlights Since Tampa (Fall 2012)

- Multiple trips to TTCI including completion of 2nd major field experiment focusing on lateral load path
- Design and construction of full-scale setup
- FE Model advancement and capabilities update
- Establishing dates for and expanding the 2<sup>nd</sup> International Crosstie and Fastening System Symposium
- Chapters for final report drafted/developed
- Strong Conference and Journal Participation (Papers, Posters, and Presentations)
- Students graduated and entering industry

### **Current Focus and Immediate Path Forward**

- Complete processing of May 2013 field data from TTC
- Complete construction and shakedown of full scale laboratory experimental loading frame
- Continue to integrate experimental and modeling efforts
- Complete development and validation of initial multi-tie model utilizing laboratory and field experimentation data
- Document mechanistic design improvements
  - Synthesis of lab and field data
  - Validation of model
  - Review of specifications and identification of gaps
  - Developing vision for path forward

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## **Future Meetings**

- AREMA C-30 and Industry Partners Meetings
  - Lake Tahoe, NV  $\rightarrow$  October 2013
  - − Pueblo, CO  $\rightarrow$  April 2014
    - Half-day overview (if there is interest)
  - Champaign-Urbana, IL  $\rightarrow$  June 2014
    - Co-located with International Symposium
  - − Orlando, FL  $\rightarrow$  October 2014
    - Co-located with C-30 meeting and RTA
- 2<sup>nd</sup> International Concrete Crosstie and Fastening System Symposium, Urbana, IL → 2014
- Program Review Meetings with FRA
  - (Location and Dates TBD)

### 2014 International Crosstie and Fastening System Symposium

Rail Transportation and Engineering Center (RailTEC) University of Illinois at Urbana-Champaign, Newmark Lab, Champaign, IL 61801

### 3 – 5 June 2014

This three day conference will have presentations, discussions and a technical tour that focus on the state of the art in timber, concrete, steel and composite crosstie and fastening system design, performance, research, modeling, and inspection.





## **Acknowledgements**

U.S. Department of Transportation

### **Federal Railroad Administration**

- Funding for this research has been provided by the Federal Railroad Administration (FRA)
- Industry Partnership and support has been provided by
  - Union Pacific Railroad
  - BNSF Railway
  - National Railway Passenger Corporation (Amtrak)
  - Amsted RPS / Amsted Rail, Inc.
  - GIC Ingeniería y Construcción
  - Hanson Professional Services, Inc.
  - CXT Concrete Ties, Inc., LB Foster Company
  - TTX Company
- Specific Acknowledgement of the entire team at UIUC, including the Co-Pis, Research Engineers, and Students

#### FRA Tie and Fastener BAA Industry Partners:

















## **Questions?**

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Ryan G. Kernes Research Engineer rkernes2@illinois.edu

