



RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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**

2014 Symposium Sponsors



WVCO Railroad Division

Dear 2014 Symposium Attendee,

Welcome to Champaign-Urbana, IL and the Department of Civil and Environmental Engineering (CEE) at the University of Illinois at Urbana-Champaign (UIUC). UIUC is home to the Rail Transportation and Engineering Center (RailTEC), and we look forward to you meeting the students, staff, and faculty that work within RailTEC. We are pleased that you have chosen to attend the 2014 Symposium and hope you will actively participate in discussions and engage your fellow attendees throughout the event. Our primary objective in organizing the 2014 Symposium was to facilitate the transfer of technology and knowledge as well as to further domestic and international communication and collaboration on the design and performance challenges and solutions for crossties and fastening systems. We are hopeful that you will enjoy the technical presentations, research discussions, and technical tours of voestalpine Nortrak in Decatur, IL and the new RailTEC Research and Innovation Laboratory (RaIL) here at UIUC.

We would like to provide specific recognition to Amsted RPS for their ongoing support of research and testing here at UIUC since 2009. Financial support from Amsted RPS has been foundational in allowing us to build a program in crossties and fastening systems, and we are very grateful for our partnership with them. We would also like to thank the Federal Railroad Administration (FRA) for their sponsorship of concrete crosstie and fastening system research at UIUC under the High Speed and Intercity Passenger Rail Broad Agency Announcement (BAA) program. Additionally, we sincerely appreciate the ongoing research support from the Association of American Railroads (AAR), NURail, GIC Ingeniería y Construcción, and IntegriCo Composites. Without these organizations and the many other individuals and organizations that frequently provide input and guidance for our research we would not be able to conduct research and host an event such as this.

If there is anything that our team can do to make your stay at UIUC more enjoyable, please do not hesitate to contact one of the faculty, staff, or students within RailTEC.

Sincerely,
Bassem O. Andrawes
Christopher P.L. Barkan
Marcus S. Dersch
J. Riley Edwards
Ryan Kernes
Daniel Kuchma
David A. Lange
Conrad Ruppert, Jr.



<http://ict.illinois.edu/railroad>

2014 Symposium Overview and Featured Events

TUESDAY 3 JUNE

Registration (Yeh Center Atrium, 1st Floor)	7:00am	-	5:00pm
Light Breakfast	7:00am	-	8:00am
Opening Remarks	8:00am	-	8:30am
Technical Session	8:30am	-	9:30am
Break	9:30am	-	10:00am
Technical Session	10:00am	-	12:00pm
Lunch (UIUC's Beckman Institute)	12:00pm	-	1:30pm
Technical Session	1:30pm	-	3:00pm
Break	3:00pm	-	3:30pm
Technical Session	3:30pm	-	5:00pm
Reception (Murphy's Pub)	5:30pm	-	7:00pm

WEDNESDAY 4 JUNE

Registration (Yeh Center Atrium, 1st Floor)	6:30am	-	5:30pm
Light Breakfast	6:30am	-	8:30am
Technical Tour Departs (see page 12)	7:15am	-	12:00pm
RTA Technical Tour Departs (see page 12)	8:30am	-	12:00pm
Lunch (Illinois Terminal - City View)	12:00pm	-	1:30pm
Technical Session	1:30pm	-	3:30pm
Break	3:30pm	-	3:45pm
Technical Session	3:45pm	-	5:30pm
Reception (UIUC's Memorial Stadium)	6:00pm	-	7:00pm
Keynote Dinner & Speech (Memorial Stadium) Joseph Smak (Amtrak & AREMA)	7:00pm		

THURSDAY 5 JUNE

Light Breakfast	7:00am	-	8:00am
Technical Sessions	8:00am	-	10:15am
Closing Remarks	10:15am	-	10:30am
Start of AREMA Committee 30 Meeting	11:00am		

Symposium Locations

Newmark Civil Engineering Laboratory

Yeh Student Center - All Technical Sessions will be held in 1310 Yeh Center unless otherwise noted
205 N. Mathews Avenue - Urbana, IL 61801

Beckman Institute

405 N. Mathews Avenue - Urbana, IL 61801

Illinois Terminal

45 E. University Avenue - Champaign, IL 61821

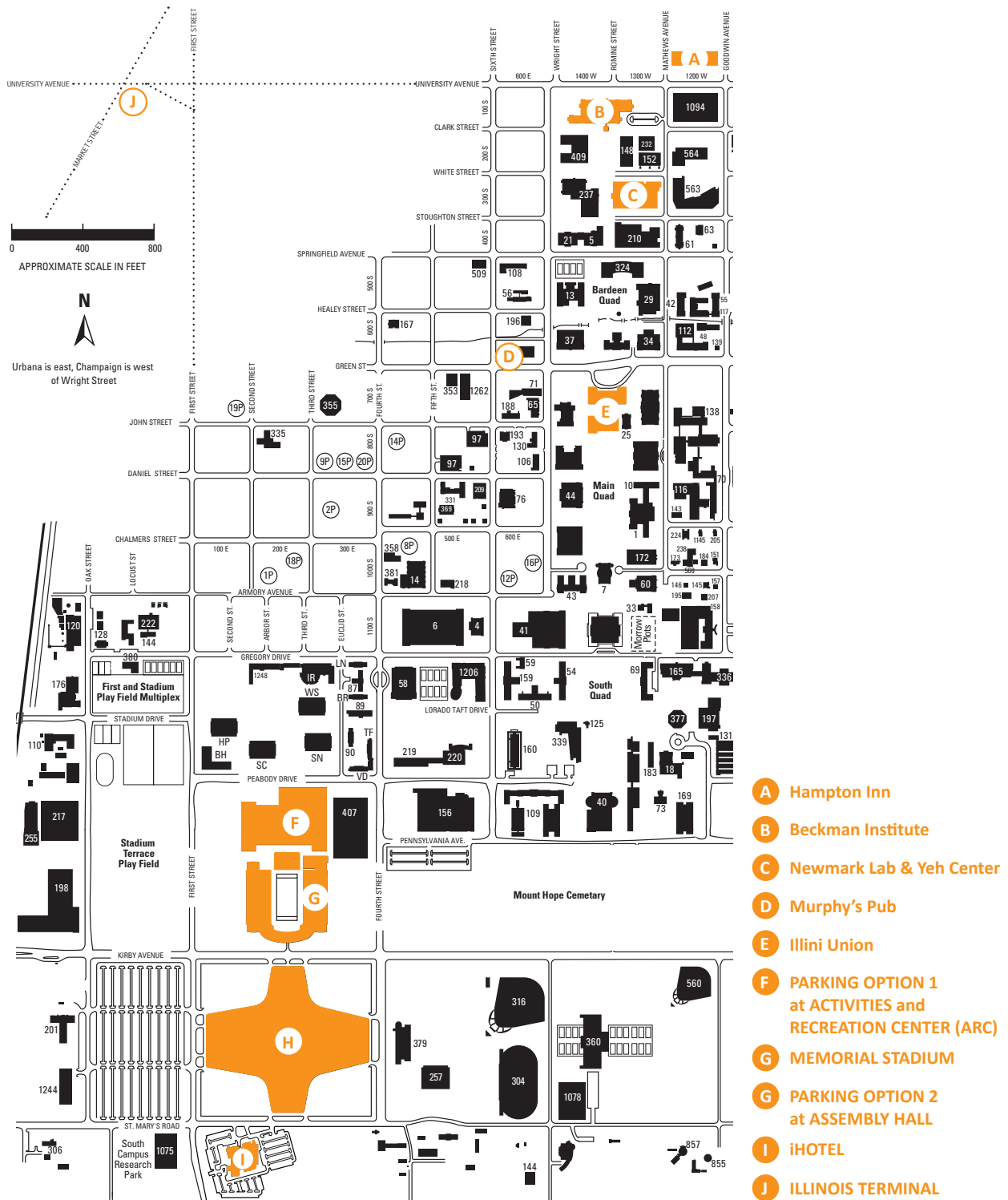
Memorial Stadium

1402 S. 1st Street - Champaign, IL 61820

Murphy's Pub

604 E Green Street - Champaign, IL 61820

UIUC Campus Map



Parking: Parking on campus is extremely limited. We do have a small number of parking passes for \$20 daily, available through the registration website.

Attire: The recommended dress for the conference is “business casual”.

Conference Contacts:

Riley Edwards: 931-624-4623, jedward2@illinois.edu (conference director)

Marcus Dersch: 812-779-1750, mdersch2@illinois.edu (program development)

Angie Stanford: 217-300-8544, astanfrd@illinois.edu (conference registrar)

<http://ict.uiuc.edu/railroad/Crosstie>

Spoken Presentations

TUESDAY 3 JUNE

- 7:00 Registration/Continental Breakfast (Yeh Center Atrium, First Floor)
- 8:00 Safety Briefing and Introductory Remarks - Riley Edwards
UIUC Civil and Environmental Engineering (CEE) Department Welcome - Associate Head Liang Liu
UIUC RailTEC Welcome - Executive Director and Professor Chris Barkan
Federal Railroad Administration (FRA) Welcome - Cam Stuart
Recognition of Amsted RPS - UIUC Research Sponsor
Overview of Symposium Objectives - Riley Edwards

Track 1: Concrete Crossties and Fastening Systems Track

- 8:30 Panel Discussion (Session 1-1)**
Session Moderator: Marcus Dersch - University of Illinois at Urbana-Champaign

Concrete Crosstie and Fastening System Successes, Challenges, and Research Needs

Steven Ashmore (Union Pacific Railroad)
Mike Brown (Transportation Technology Center, Inc. (TTCI))
Erik Frohberg (BNSF Railway)
Jose Mediavilla (Amsted RPS)
Cam Stuart (Federal Railroad Administration (FRA))

- 9:30 Break

- 10:00 Fastening System Design Priorities (Session 1-2)**
Session Moderator: John Bosshart (BNSF Retired)

Summary of Union Pacific's Fastening System Design Priorities
Steven Ashmore (Union Pacific)

The Effect of Fastening System Design on the Occurrence of Rail Seat Deterioration
David Herron (Pandrol Limited)

Lateral and Vertical Load Path - Summary of Field Results
Brent Williams and Matthew Greve (University of Illinois at Urbana-Champaign)

Development of a New-Generation Dowel and Screw Combination
Brandon Van Dyk (Vossloh Fastening Systems, GmbH)

Basic Properties of Thermoplastic Polyurethane Materials Used in Rail Pads
Jeff Degross (BASF)

Spoken Presentations

12:00 **Lunch** - Beckman Institute - 5th Floor
405 N. Mathews Avenue - Urbana, IL 61801

1:30 **Concrete Crosstie Design Priorities (Session 1-3)**
Session Moderator: Scott Tripple (Pandrol USA)

Concrete Ties - The Amtrak Experience
Al Cloutier (Amtrak)

Case Study of a Concrete Tie Base Wear Site with Implications for
Crosstie Performance
Ted Sussmann (Volpe Center)

Investigating Factors That Affect Air Entrainment During Fabrication
of Concrete Railroad Ties
Kyle Riding and Mohammed Albahtiti (Kansas State University)

Mechanistic Design of Crossties and Fastening Systems -
An Overview
Andrew Scheppe (University of Illinois at Urbana-Champaign)

3:00 **Break**

3:30 **Concrete Crosstie and Fastening System Modeling
(Session 1-4)**
*Session Moderator: Bassem Andrawes
(University of Illinois at Urbana-Champaign)*

Railroad Concrete Tie Failure Analysis
Hailing Yu (Volpe Center)

Finite Element Modeling of Concrete Crossties and
Fastening Systems
George Chen (University of Illinois at Urbana-Champaign)

I-TRACK - Analytical Tool for the Analysis of Track Behavior
J. Riley Edwards (University of Illinois at Urbana-Champaign)

5:00 **Adjourn Technical Session**

5:30 **Social Hour** - Murphy's Pub
604 E Green St., Champaign, IL 61820

7:00 **Dinner on your own** (see page 13 for suggested restaurants)

Spoken Presentations

WEDNESDAY 4 JUNE

- 6:30 Registration/Continental Breakfast (Yeh Center Atrium, 1st Floor)
- 7:15 Technical Tour Departs (Via Charter Bus) *Schedule on pg. 12*
- 8:30 RTA Technical Tour Departs (Via Charter Bus) *Schedule on pg. 12*
- 12:00 Railway Tie Association (RTA) Welcome - Jim Gauntt
Illinois Terminal Welcome - Tom Costello - Champaign-Urbana Mass Transit District (CUMTD)
2014 Symposium Sponsor Recognition

Track 2: Timber Crosstie Track

- 1:30 Timber Crossties and Tie Treatment (Session 2-1)** 1310 Newmark
(concurrent with Session 1-5)
Session Moderator: Jim Gauntt (Railway Tie Association - RTA)

Wood Tie Industry Economic and Research Overview
Jim Gauntt (Railway Tie Association (RTA))

Creosote Performance and Dermal Skin Effects
David A. Webb (Creosote Council)

Dual Tie Treatment Methodologies Compared
Adam Taylor (University of Tennessee-Knoxville)

Cost Effective Life Extension of Bridge Timbers with Copper Naphthenate and Borates
Jeffery Lloyd (Nisus Corporation)

- 3:15 Break

- 3:30 Timber Crossties and Tie Treatment (Session 2-2)** 1310 Newmark
(concurrent with Session 1-6)
Session Moderator: Jim Gauntt (Railway Tie Association - RTA)

The Newest AWPA Standardized Treatment for Crossties
Tim Carey (Arch Wood Protection, Inc. a Lonza company) ACZA

Copper Naphthenate – A Review and Update
Jeffery Lloyd (Nisus Corporation)

Supplemental In-Situ Treatment of Wood Ties with Borate Rods
Jim Renfroe (Wood Care Systems)

Third Party Audits and Inspections for New Wood Protection Systems
Terry Amburgey (Golden Spike Inspection Group)

Environmental Life Cycle Assessment of Wood Ties Compared to Alternative Tie Materials
Stephen Smith (Stephen Smith Consulting)

Spoken Presentations

1:30 Concrete Crosstie Innovation (Session 1-5) 2311 Newmark
(concurrent with Session 2-1)
Session Moderator: Robert Peterman (Kansas State University)

Tie and Fastener Research at the Transportation
Technology Center, Inc.

Mike McHenry (Transportation Technology Center, Inc. (TTCI))

Report from a Sleeper Manufacturer - Standardised Concrete Ties
and Rail Fastening Systems in Austria

Hermann Gruber (SSL - Schwellenwerk und Steuerungstechnik Linz GmbH)

Innovative Sleeper Design With Under Sleeper Pads as an Efficient
Method to Reduce Railway Induced Vibration Propagation

Arnold Pieringer (RAIL.ONE GmbH)

Network Effects and Cost of Railroad Crosstie Maintenance
and Replacement

Alexander Lovett (University of Illinois at Urbana-Champaign)

3:15 Break

**3:30 Concrete Crosstie Materials Technology and
Quality Assessment (Session 1-6)** 2311 Newmark
(concurrent with Session 2-2)
*Session Moderator: Mike McHenry
(Transportation Technology Center, Inc.)*

A Quality Control Bond Test for Prestressing Wires

Robert Peterman (Kansas State University)

Efficacy of Laboratory Pre-tensioned Prism Specimens in Predicting
Transfer Lengths of Real Concrete Railroad Ties

Naga Narendra Babu Bodapati (Kansas State University)

Development of an Automated Transfer Length Measurement
System for Quality Control of Railroad Cross-Tie Production

Terry Beck (Kansas State University)

Monitoring Crosstie Behavior and Crosstie/Ballast Interaction

Tim Stark (University of Illinois at Urbana-Champaign)

The Abrasion Resistance of Concrete for Concrete Railway
Crosstie Applications

Emily Van Dam (University of Illinois at Urbana-Champaign)

5:30 Adjourn Technical Sessions

5:45 Charter bus available to transport to social hour and dinner

(Continued on next page)

Spoken Presentations

6:00 **Social Hour** (UIUC Memorial Stadium
1402 South 1st Street, Champaign, IL) See page 4 for parking information and directions

Enter Stadium at Gate 16 on the West Side, take elevators to the 6th floor to the 77th Club

7:00 Keynote Dinner and Presentation
Joseph Smak
Senior Director of Track Maintenance and Compliance at Amtrak
Current President and Chairman of the Board of Governors of AREMA

9:00 Charter busses available to transport to Yeh Center and Hotels

THURSDAY 5 JUNE

7:00 Registration/Continental Breakfast (Yeh Center Atrium, 1st Floor)

Track 3: Composite Crossties and Track Inspection

8:00 Composite Crossties (Session 3-1)

Summary of Current State of Practice for Composite Crossties
Rich Lampo (U.S. Army Engineering Research & Development Center)

8:30 Inspection Technologies for Crossties and Fastening Systems (Session 3-2)

Session Moderator: Cam Stuart (FRA)

Utilization of System-wide Automated Wood Tie Inspection Data
Greg Grissom and Todd Euston (GREX)

Condition Assessment of Concrete Ties With Nondestructive Impact
Velocity and Echo Measurements
Paul Fisk (NDT Corporation)

Approaches to Assess Concrete Tie Damage Using Ultrasonic Scans
*John Popovics and Suyun Ham (University of Illinois
at Urbana-Champaign)*

Machine-vision-based Evaluation of Concrete Tie Degradation in High
Speed Applications
Jeff Henderson (ENSCO)

10:15 Final Closing Remarks

10:30 Adjourn Symposium

11:00 Start of AREMA Committee 30 Ties Meeting

Poster Presentations

Analysis of the Shear Behavior of rail Pad Assemblies as a Component of the Concrete Sleeper Fastening System

Thiago Bizarria do Carmo, Christopher P. L. Barkan, J. Riley Edwards, Bassem O. Andrawes, Ryan G. Kernes, University of Illinois Urbana-Champaign (UIUC)

Quantification of Concrete Sleeper and Elastic Fastening System Demands Utilizing Concrete Sleeper Rail Contact Area

Matthew Greve, Chris Rapp, Marcus Dersch, J. Riley Edwards, Christopher P.L. Barkan, University of Illinois Urbana-Champaign (UIUC); Jose Mediavilla, Amsted RPS; Brent Wilson, Amsted Rail, Inc.

Geometrical Feature Variation of Pre-stressing Reinforcement Wire in Concrete Ties

Mark Haynes, Kansas State University (KSU)

Tensioned Pullout Test Used to Investigate Indented Pre-stressing Wire Splitting Characteristics and Possible Prevention

Joseph Holste, Kansas State University (KSU)

Framework of an Integrated Railroad Track Maintenance Planning Model

Alexander Lovett, Tyler Dick, Conrad Ruppert, Chris Barkan, University of Illinois Urbana-Champaign (UIUC)

Non-destructive In-place Condition Assessment Technologies for Damage in Concrete Ties

John S. Popovics, Suyun Ham, University of Illinois Urbana-Champaign (UIUC)

Attenuation of Vibrations in Fresh Concrete

Kyle Riding, Ahmad Ghadban, Mohammed Albahtiti, Kansas State University and David Lange, University of Illinois Urbana-Champaign (UIUC)

Derailment Prevention - Concrete Tie & Fastener Research

Cam Stuart, Federal Railroad Administration (FRA)

Evaluation of Existing Loading Environment in North America for Improved Concrete Sleepers and Fastening Systems

Brandon J. Van Dyk, Conrad J. Ruppert Jr., Andrew Scheppe, Christopher T. Rapp, J. Riley Edwards, Marcus S. Dersch, Christopher P. L. Barkan, University of Illinois Urbana-Champaign (UIUC)

Improved Concrete Crosstie Fastening System Insulator Design

Brent A. Williams, J. Riley Edwards, Ryan G. Kernes, Christopher P. L. Barkan, University of Illinois Urbana-Champaign (UIUC)

RailTEC and Railway Tie Association (RTA) would like to welcome you to the Symposium Technical Tour. RailTEC would like to extend our appreciation to voestalpine Nortrak Inc. for hosting the technical tour at their facility in Decatur, IL. Specifically, we would like to thank Sean Betty, Perry Nuernberger, and David Millard at voestalpine Nortrak Inc.

Wednesday 4 June 2014 (Morning)

6:30-7:00 Symposium Attendees that are not on the RTA Field Trip Assemble at Yeh Center (Conference Venue) for Breakfast
 7:15 Busses 1 and 2 (non RTA Field Trip Attendees) Depart Yeh Center
 8:30 Bus 3 (RTA Field Trip Attendees) Depart Yeh Center

Bus 1 (non-RTA Field Trip Attendees):

7:15-8:15 Travel from Yeh Center to voestalpine Nortrak Decatur
 8:15-9:30 voestalpine Nortrak Decatur Tour
 9:30-10:30 Travel from voestalpine Nortrak Decatur to RailTEC Research and Innovation Laboratory
 10:30-11:30 Tour RailTEC Research and Innovation Laboratory
 11:30-12:00 Travel from RailTEC Research and Innovation Laboratory to Illinois Terminal
 12:00 Arrive at Illinois Terminal in Champaign, IL for lunch

Bus 2 (non-RTA Field Trip Attendees):

7:15-7:45 Travel from Yeh Center to RailTEC Research and Innovation Laboratory
 7:45-8:45 Tour RailTEC Research and Innovation Laboratory
 8:45-9:45 Travel from RailTEC Research and Innovation Laboratory to voestalpine Nortrak Decatur
 9:45-11:00 voestalpine Nortrak Decatur Tour
 11:00-12:00 Travel from voestalpine Nortrak Decatur to Illinois Terminal
 12:00 Arrive at Illinois Terminal in Champaign, IL for lunch

Bus 3 (RTA Field Trip Attendees):

8:15-9:15 Light Breakfast and Registration
 9:15-9:45 Travel from Yeh Center to RailTEC Research and Innovation Laboratory
 9:45-10:30 Tour RailTEC Research and Innovation Laboratory
 10:30-11:00 Travel from RailTEC Research and Innovation Laboratory to UIUC Wood Engineering Laboratory
 11:00-11:40 UIUC Wood Engineering Laboratory Tour
 11:40-12:00 Travel from UIUC Wood Engineering Laboratory to Illinois Terminal
 12:00 Arrive at Illinois Terminal in Champaign, IL for lunch

Notes:

Steel toed boots are required for all technical tour locations. Please plan accordingly when packing for this trip. Hard hats (with RailTEC logo) and safety glasses will be provided to conference attendees as a gift for attending the conference.

Non-US Citizens:

A portion of the technical tour takes place on the US Army Corps of Engineers facility that houses the new RailTEC Research and Innovation Laboratory. All non-US Citizens that submitted their passports by the requested deadline (1 May 2014) MUST bring their passport on the day of this tour (Wednesday 4 June 2014).

US Citizens:

You MUST bring a state ID (driver's license) on the day of the tour in order to access the new RailTEC Research and Innovation Laboratory (Wednesday 4 June 2014).

Champaign-Urbana Recommended Restaurant List

301 Mongolia - Mongolian (stir fry)
301 N. Neil Street, Champaign, IL
217-531-1153

Alexander's Steakhouse
202 W. Anthony Dr., Champaign, IL
217-359-1789

Bacaro - Italian (fine dining)
113 N Walnut St., Champaign, IL
217-398-6982

Biaggi's Ristorante Italiano
2235 S Neil St., Champaign, IL
217-356-4300

Black Dog Smoke & Ale House (casual bar)
201 N Broadway Ave., Urbana, IL
217-344-9334

Courier Cafe
111 N Race St, Urbana, IL
(217) 328-1811

Destihl (gastrobrewpub)
301 N. Neil St, Champaign, IL
217-356-0301
Dublin O'Neil's - Irish Pub
301 N. Neil St., Champaign, IL
217-531-1152

Escobar - Native Latino
6 E Columbia Ave., Champaign, IL
217-352-7467

Great Impasta - Italian
156 Lincoln Sq # D, Urbana, IL
217-359-7377

Kofusion - Asian (sushi)
1 E Main St # 104, Champaign, IL
217-531-1166

Radio Maria - Spanish
119 N Walnut St., Champaign, IL
217-398-7729

Silvercreek (casual fine dining)
402 N Race St., Urbana, IL 61801
217-328-3402

Useful Businesses

FedEx Office Print and Ship
613 South Wright St., Champaign, IL
217-344-2085

Walgreens
407 East Green St., Champaign, IL
217-344-0121

Expresso Royale Cafe
Illini Union Courtyard Cafe, Urbana, IL
217-333-7106

Cocomero (frozen yogurt)
709 South Wright St., Champaign, IL
217-328-3888

Starbucks
503 E Green St., Champaign, IL
217-344-8613

Illini Union Bookstore
809 South Wright St., Champaign, IL
217-333-2050

T.I.S. Bookstore
707 South Sixth St., Champaign, IL
217-337-4900

Cold Stone Creamery
505 E Green St, Champaign, IL
217-367-5555

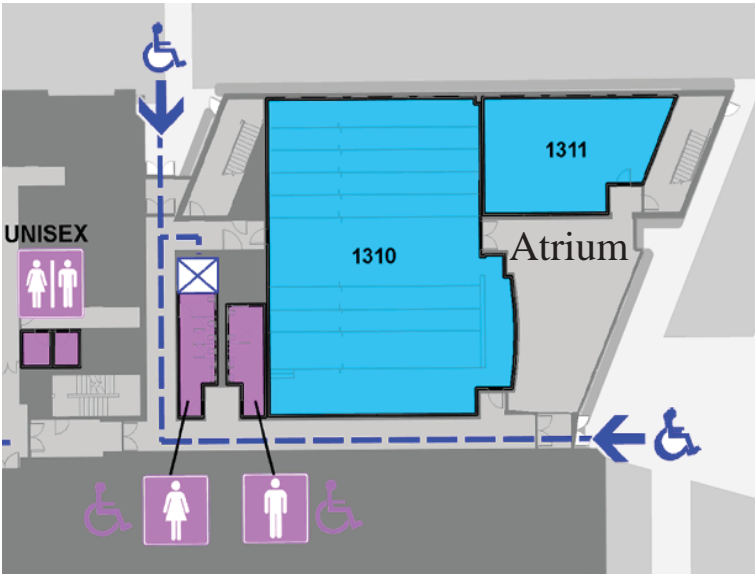
Useful Telephone Numbers

Hampton Inn 217-337-1100
Hawthorn Suites 217-398-3400
iHotel 217-819-5000
Illini Union Hotel 217-333-3030

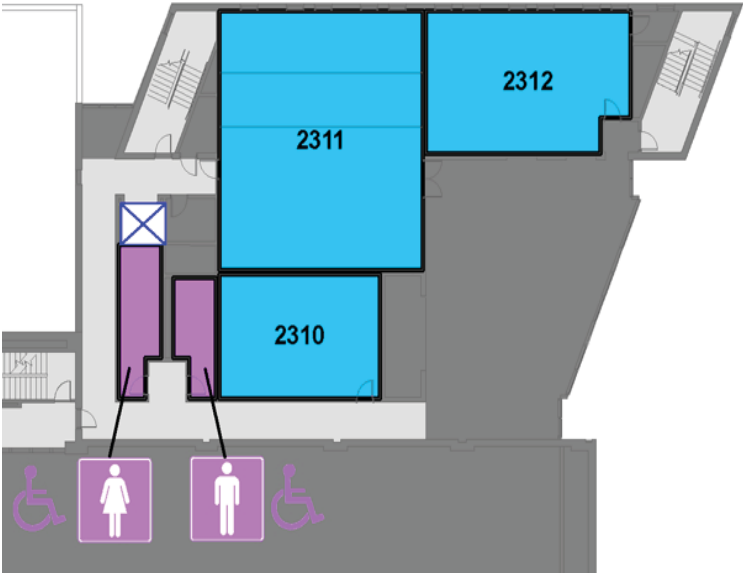
Illini Taxi 217-359-8634
Yellow Cab 217-355-3553
U of I Golf Courses 217-359-5613

Yeh Student Center (Newmark Civil Engineering Lab)

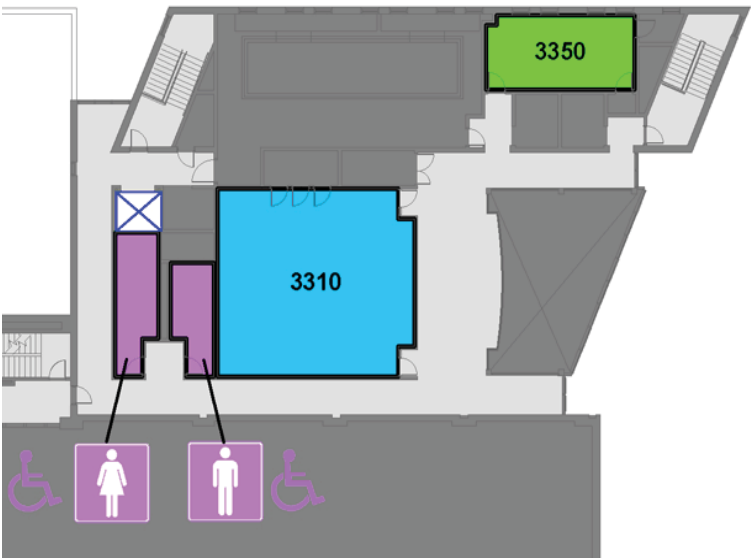
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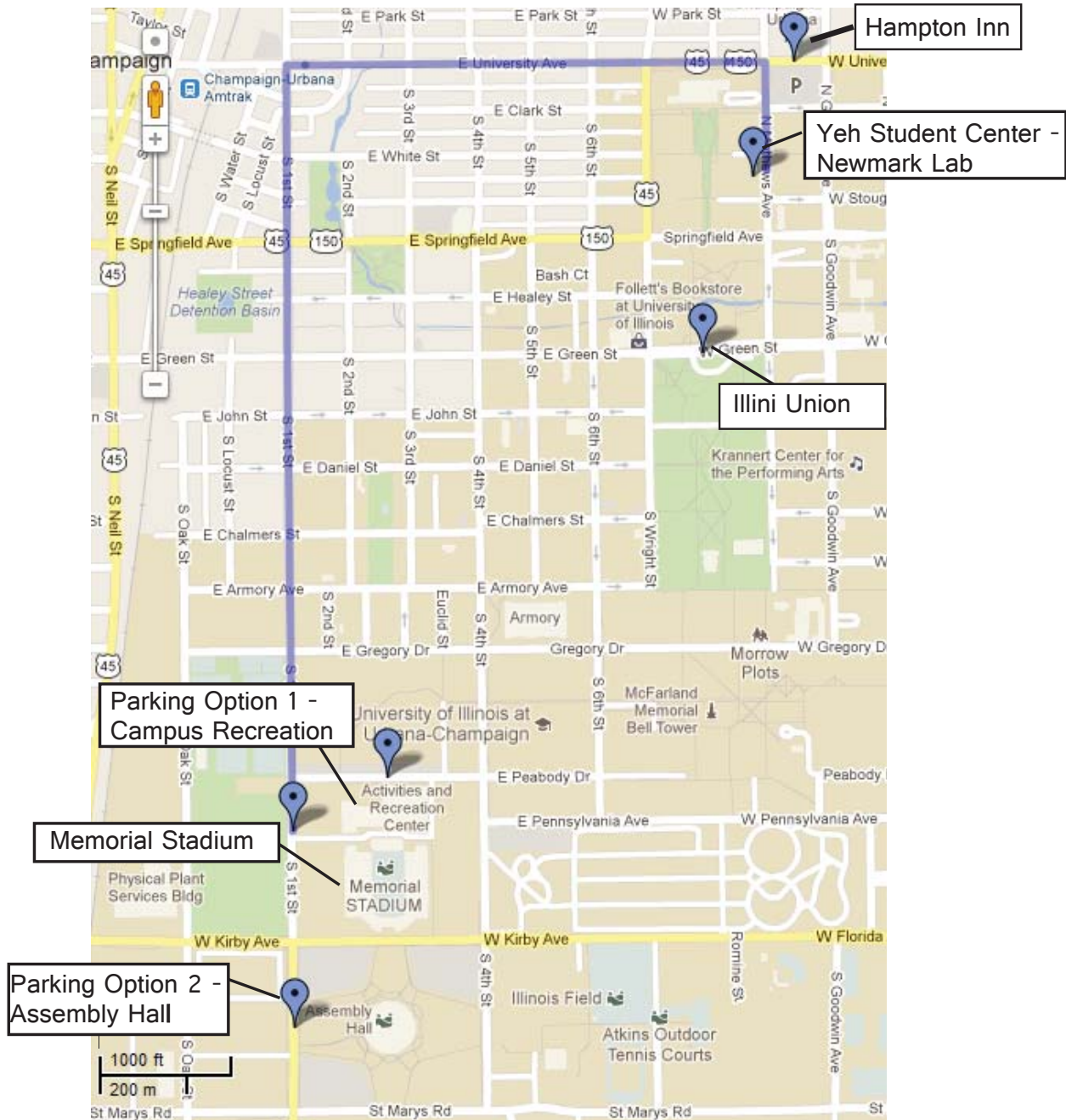
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3RD
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Memorial Stadium Dinner Map - Wednesday 4 June - 6PM



Yeh Student Center - Newmark Civil Engineering Laboratory, 205 N. Mathews Ave, Urbana, IL 61801

Memorial Stadium - (Dinner in the 77th Club on 6th Floor - **Enter Stadium at Gate 16 on the West side**) - 1402 South 1st Street, Champaign, IL 61820

Bus Transportation will be provided from the hotels and the Yeh Student Center. If you wish to drive there are 2 parking options:

Parking Option 1 - Campus Recreation (metered spots)
201 East Peabody Drive, Champaign, IL 61820

Parking Option 2 - Assembly Hall
1800 South 1st Street Champaign, IL 61820

Invitation to Join Bi-Monthly Web-Conferences

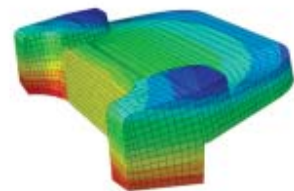
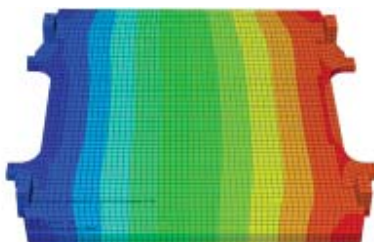
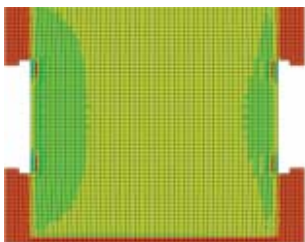


Please consider signing up for bi-monthly web-conferences designed to encourage a dialogue between international institutions interested in the domain of sleepers and fastening systems. Participants include academics, manufacturers, government research centers, and researchers and managers at railways. Web-conferences began in November 2013.

The objectives of the web-conferences are as follows:

- Discuss the objectives of current research efforts that are aimed at concrete sleeper and fastening system design and performance.
- Provide updates on relevant research progress.
- Determine research synergies and opportunities for collaboration.
- Develop action items to increase the depth of our understanding of research progress and performance of components.
- Discuss critical areas for future research.

If you would like to sign up for the email distribution list or you would like to present on one of the web-conferences, please email Riley Edwards at jedward2@illinois.edu.





ANNOUNCING THE NEW
**RailTEC Rail Research
& Innovation Laboratory**
at the Schnabel Geotechnical Laboratory

Rail Transportation and Engineering Center (RailTEC)
Department of Civil and Environmental Engineering
College of Engineering
University of Illinois at Urbana-Champaign



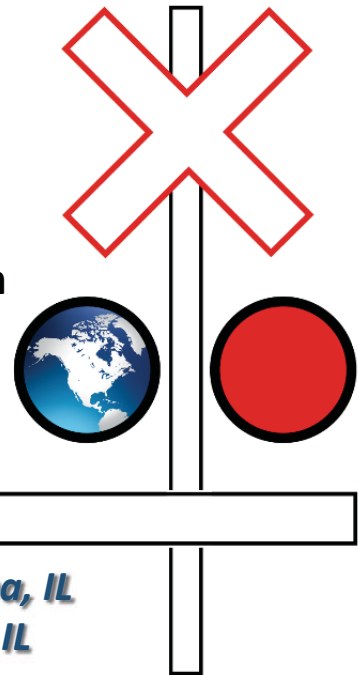
GLXS 2014

Global Level Crossing

Safety & Trespass Prevention Symposium

3-8 August 2014

University of Illinois at Urbana-Champaign



Technical Sessions: 4-6 August in Urbana, IL

Technical Tours: 7-8 August in Chicago, IL

Achieving the “Three E’s” of Engineering, Education & Enforcement and Moving Beyond to Evaluation, Encouragement & Emergency Response



GLXS 2014 will be the principal international conference bringing together engineering, safety, security, human factors, technology experts practitioners, academics and researchers from the global highway, rail, law enforcement and regulatory communities. It provides an opportunity to exchange information, discuss the latest research and share best practices to improve the safety of the at-grade interface between highway and rail systems.

There will be a large exhibition room and space is available

To receive future announcements send a message with your name, email address and “GLXS 2014 Info” in the Subject line to GLXS-2014@Illinois.edu

For more information go to:

<http://go.Illinois.edu/GLXS2014>

Download PDF's of the PPT's

PDFs of Spoken Presentations Available for
Download after the Symposium at:

<http://ict.uiuc.edu/railroad/Crosstie/2014/crossties.php>





<http://ict.illinois.edu/railroad>