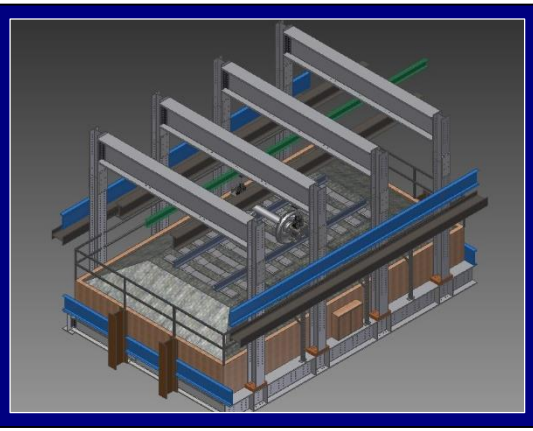
# Introducing RailTEC's Research and Innovation Laboratory (RAIL)



**FRA Tie and Fastener BAA - Industry Partners Meeting**

**Colorado Springs, CO**

**2 April 2014**

Riley Edwards, Marcus Dersch, and Ryan Kernes

U.S. Department of Transportation
Federal Railroad Administration

RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

# 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

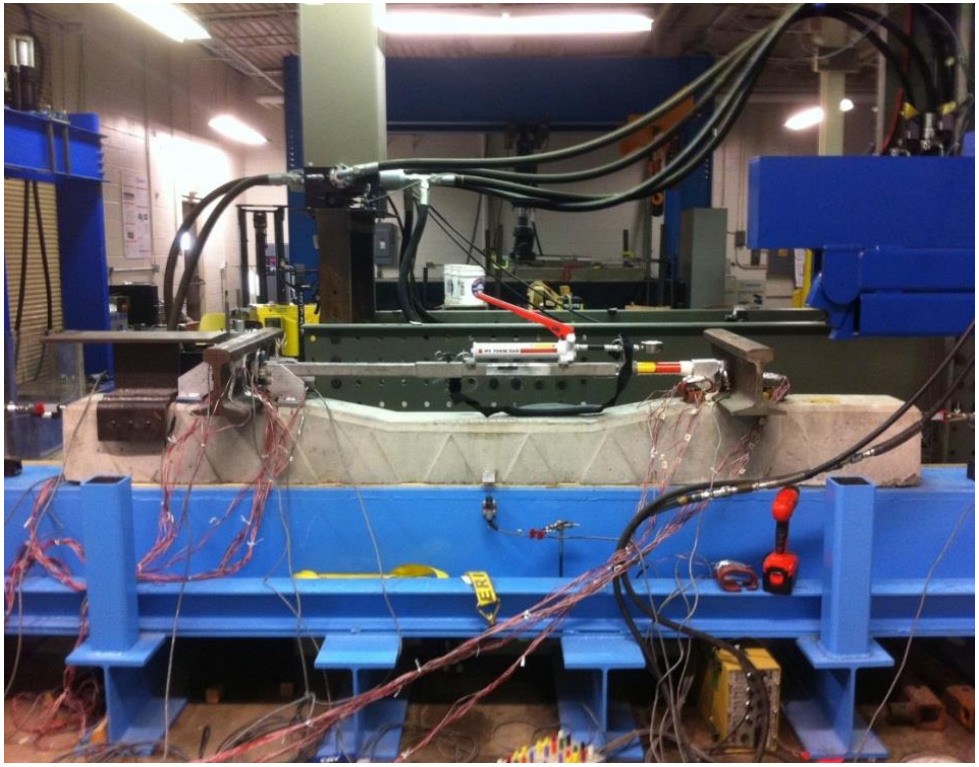
# Pulsating Load Testing Machine (PLTM)

- 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)


PLTM in New RaIL Facility at UIUC

# 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

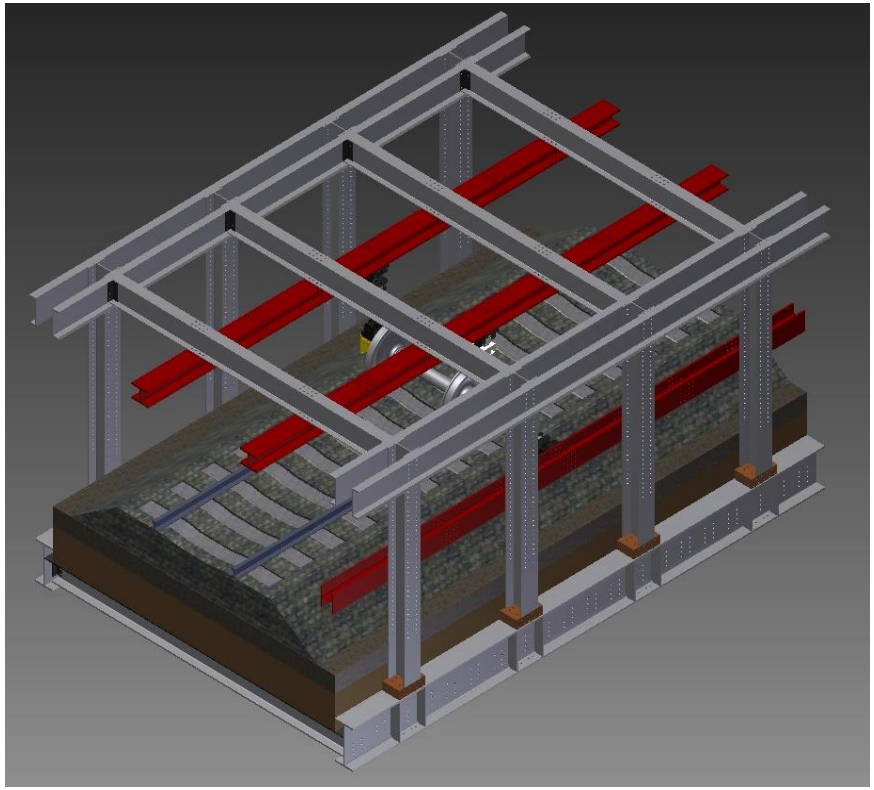


# Static Tie Tester (STT)

- 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

ILLINOIS

TTX

Amsted RPS
An Amsted Rail Company

CN

HANSON

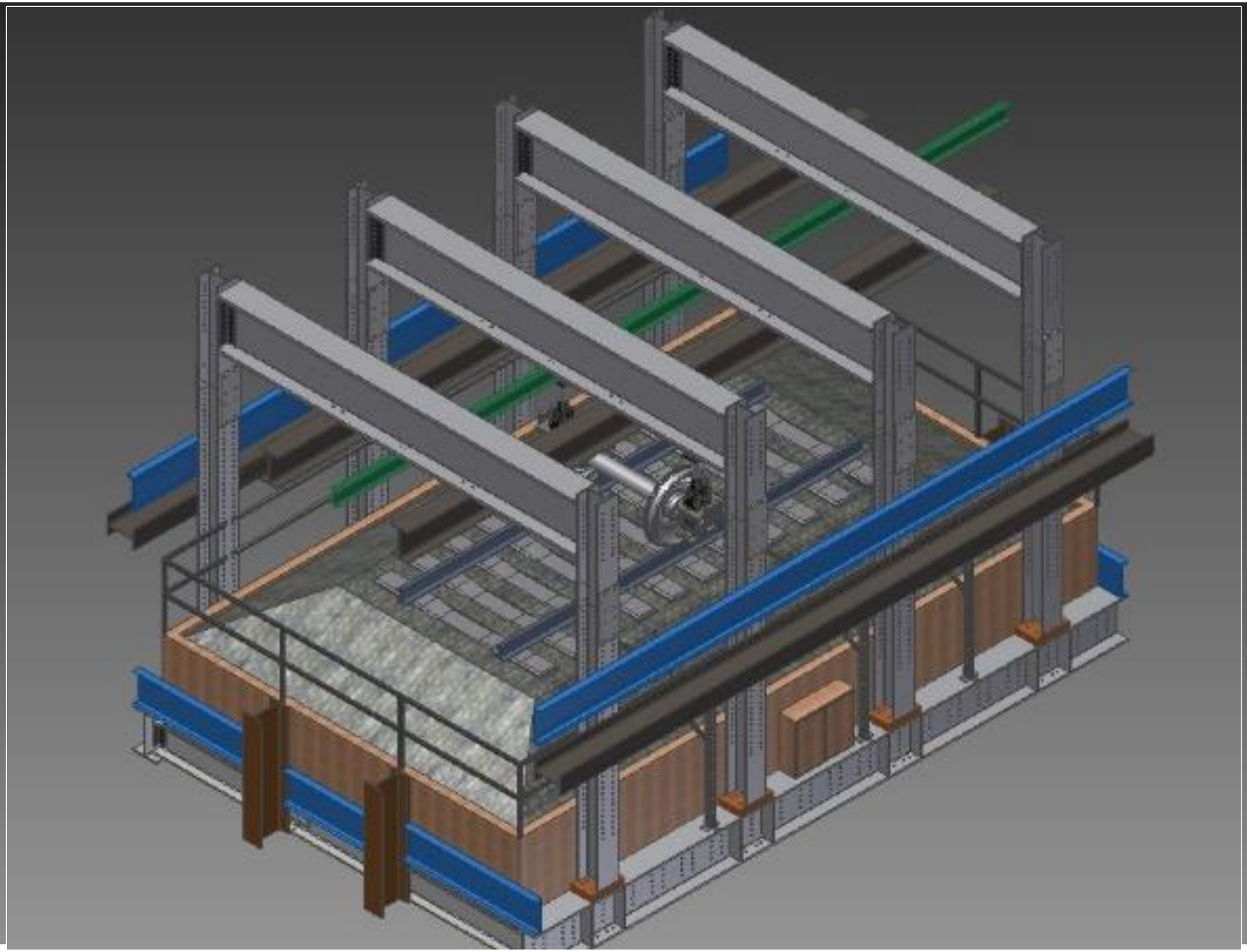
U.S. Department of Transportation
Federal Railroad Administration

National University Rail Center - NURail
USDOT-RITA Tier I University Transportation Center

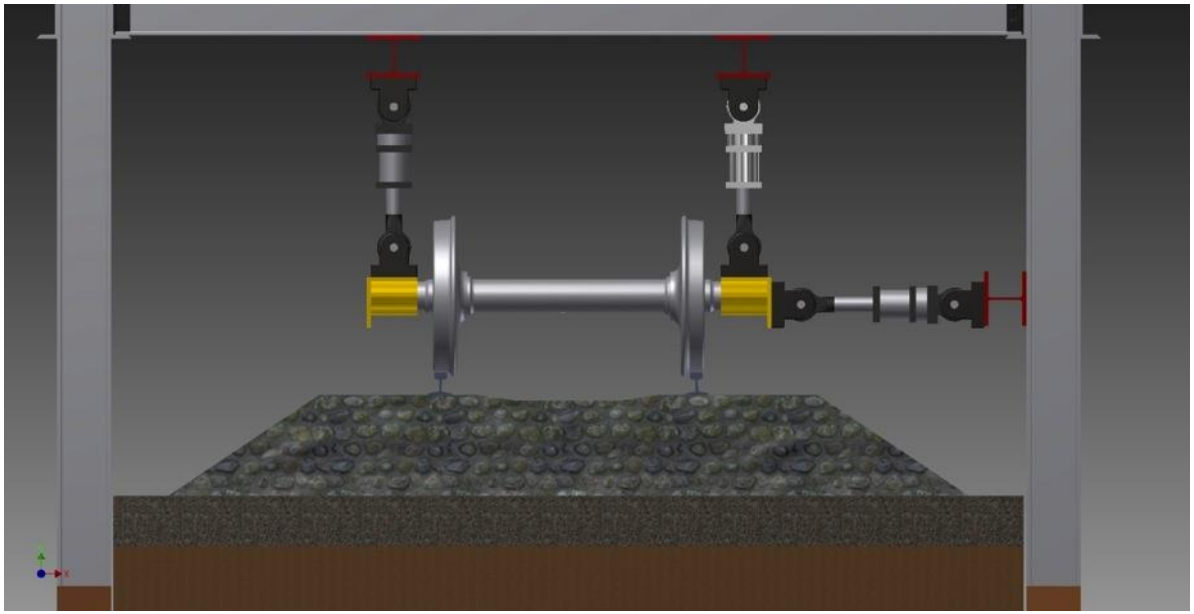
# Full Scale Track Bed: Mission and Objectives

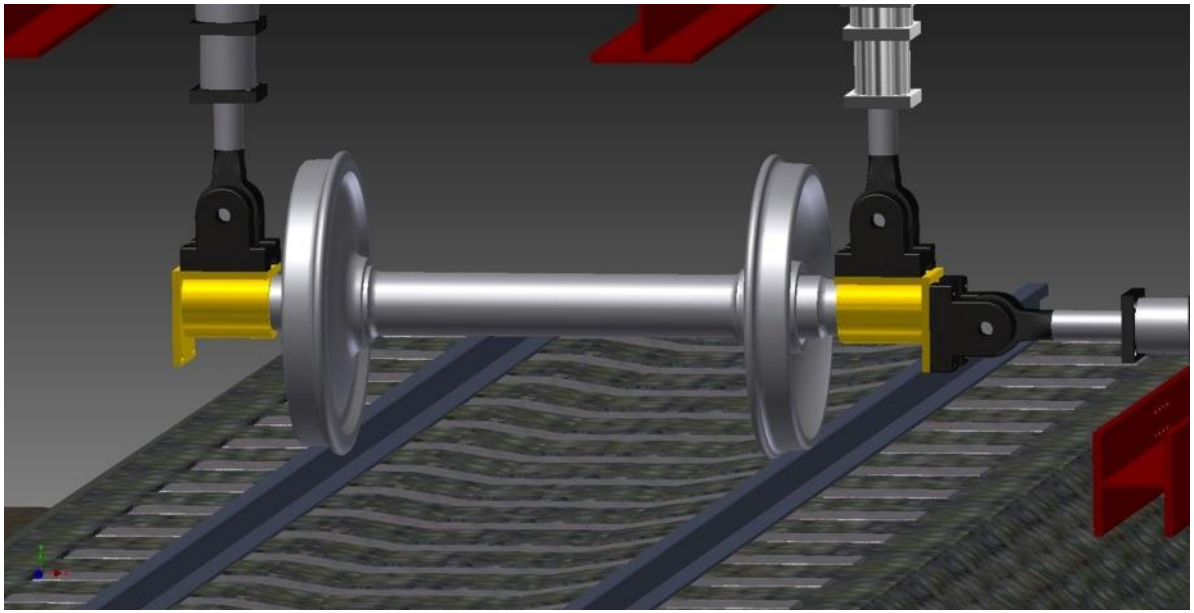
- **Mission:**
  - Design and execute a laboratory frame to accommodate representative full-scale track experimentation to improve the understanding of crosstie and fastening system component response and performance
- **Objectives:**
  - Improve upon existing full-scale crosstie and fastening system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

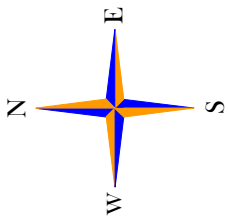
# Construction Timeline and Path Forward

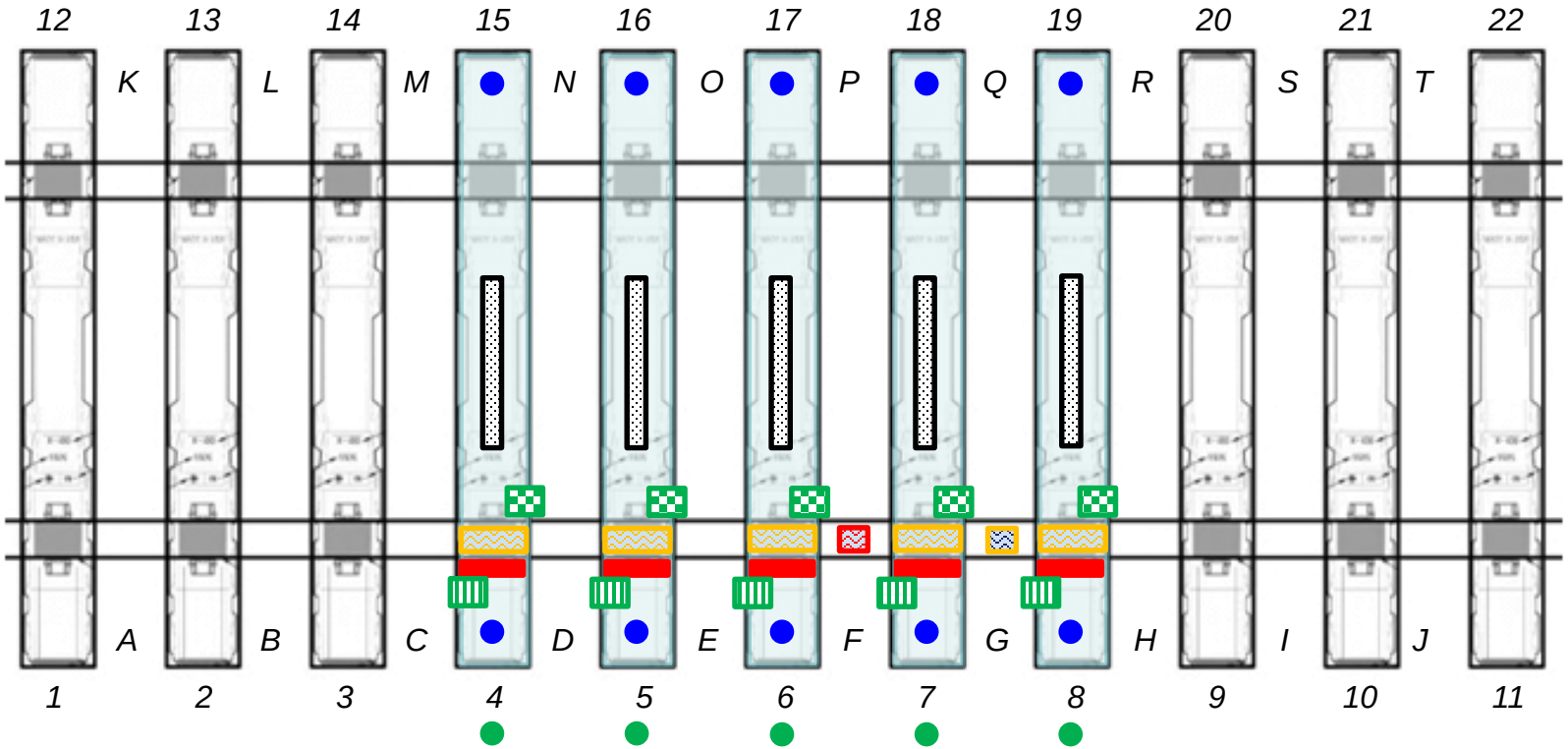
- **Construction**
  - Frame modification and connections → April-July 2013
  - Frame assembly → July-October 2013
  - Track construction → September-December 2013
    - Rail, ballast, subballast, and subgrade supplied by CN
    - Crossties supplied by LBFoster CXT Concrete Ties
    - Fastening systems supplied by Amsted RPS
    - IWS calibrated and provided by TTX
  - Finalize construction and begin shakedown and experimental matrix → January-April 2014
- **Hydarulic Systems Installation**
  - Hydraulic system and actuators purchased from MTS
  - Hydraulic cooling system purchased from BAC
- **Path Forward**
  - Completion of Shakedown → April 2014
  - Completion of experimental matrix → 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)

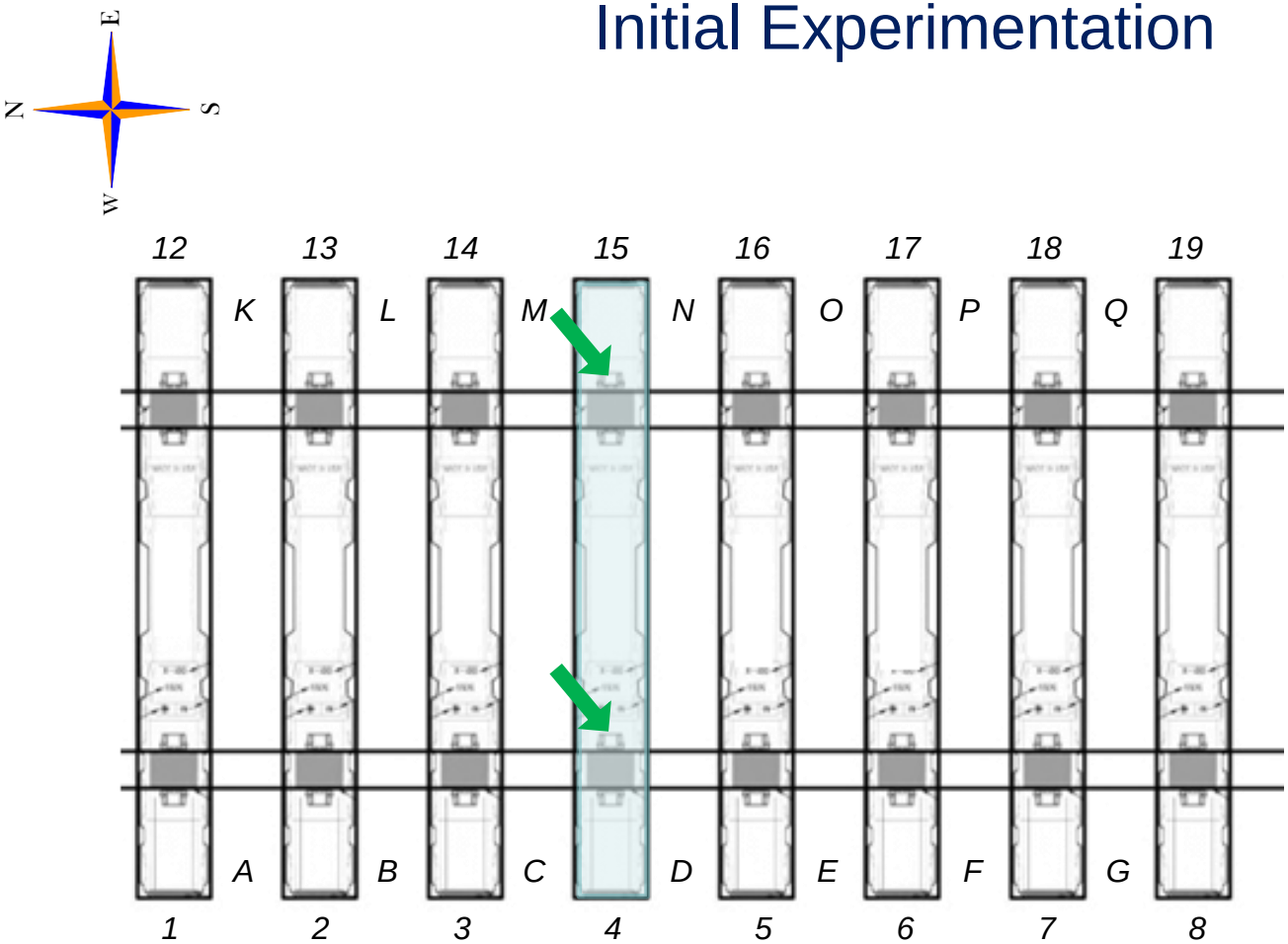
Embedment Gauges

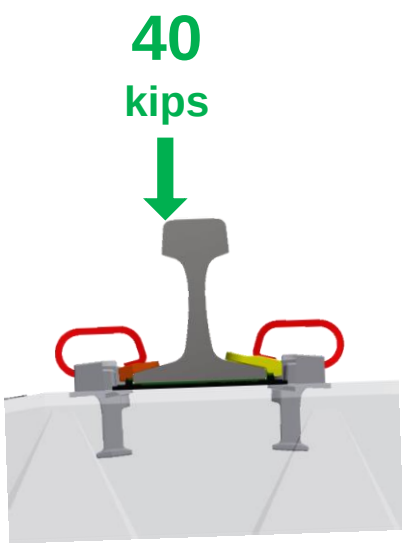
Crosstie Surface Strains

Lateral Crosstie Displacement

Vertical Crosstie Displacement

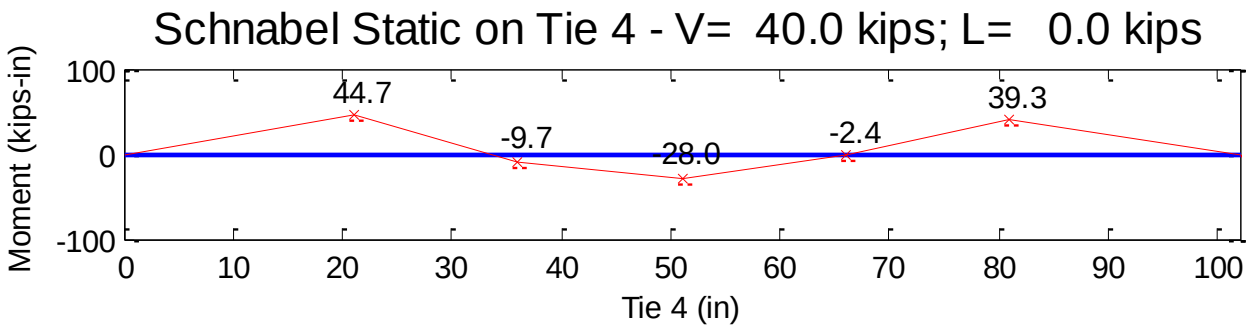
# Initial Experimentation



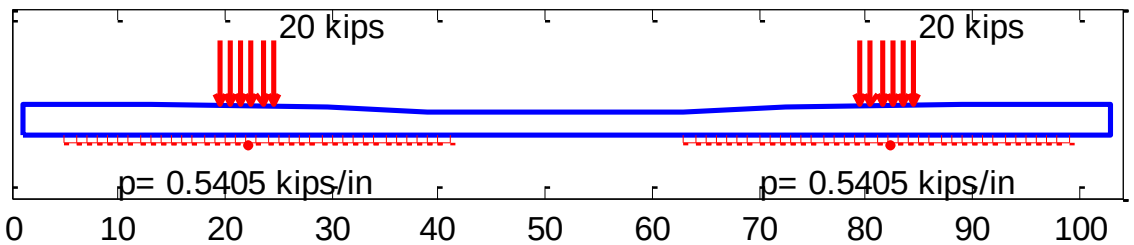



# Preliminary Discussion on Support Conditions

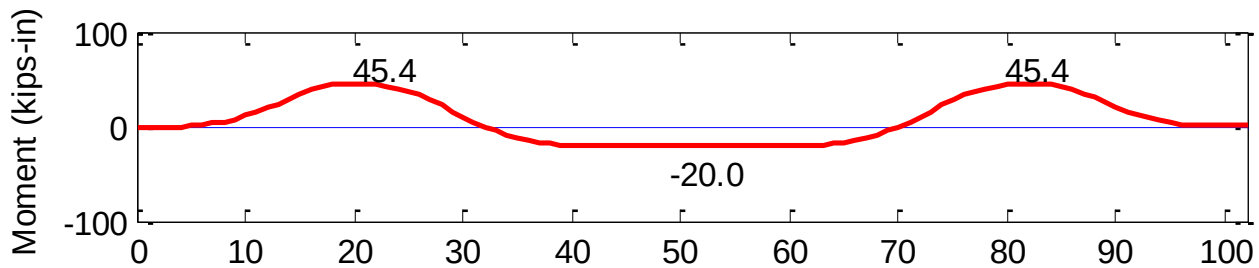
**TEST**




**ANALYSIS**




Load and Support Conditions




Moment Diagram

# 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?

# 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
- Additional appreciation to Tim Prunkard and the entire UIUC Machine Shop for the construction of the frame


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

UNION PACIFIC BUILDING AMERICA®

BNSF RAILWAY

AMTRAK®

Amsted RPS An Amsted Rail Company

GIC GIC INGENIERÍA Y CONSTRUCCIÓN S.A. DE C.V.

HANSON

LBFoster CXT Concrete Ties

CN TTX

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