

Survey About **D**eterioration of **C**oncrete **T**ies Due to **A**brasion against **R**ail-way **B**allast

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Design of Concrete Crossties (Session 3)

1310 Yeh Center Atrium

University of Illinois at Urbana-Champaign

Background & Motivation

Objectives

Survey Methodology

Survey Outcomes

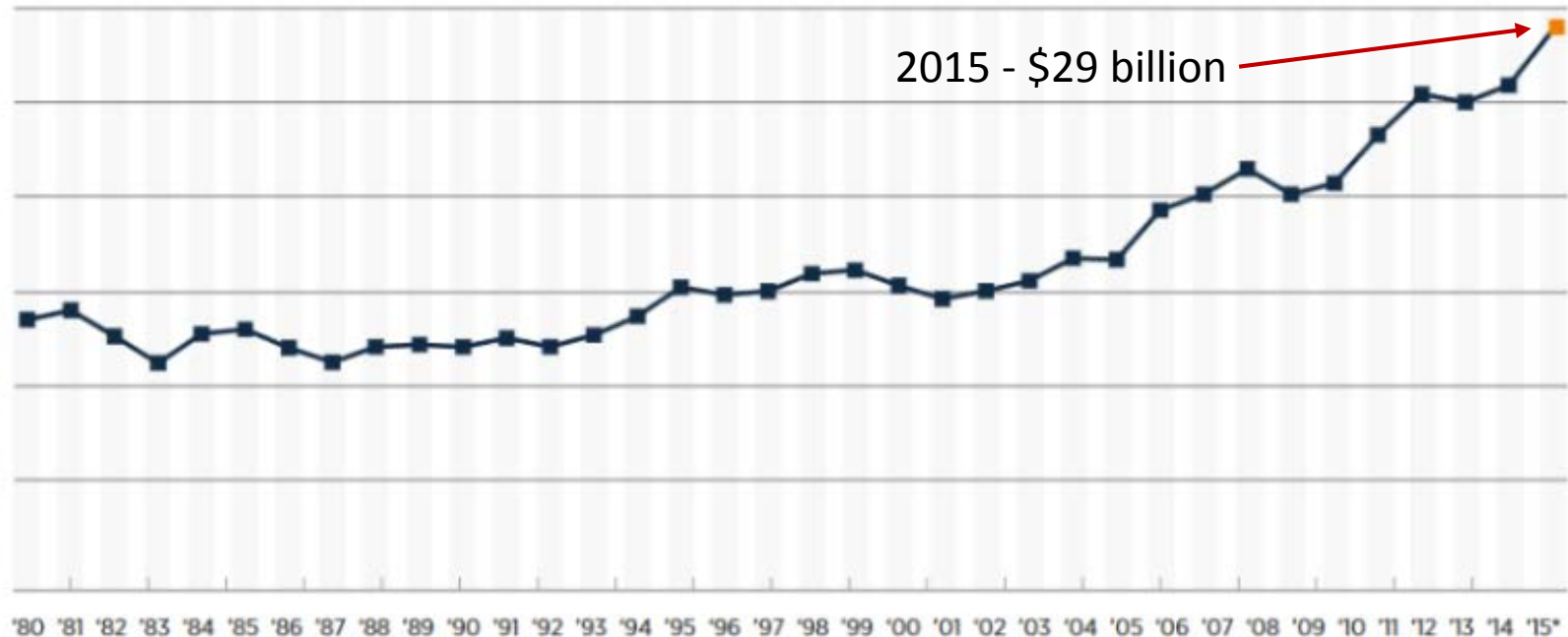
Research Strategy Proposed

Conclusions

Growth and Increased Investment of Freight Railroads

Past 35 Years Statistics

Source: 2015OutlookReport - AAR

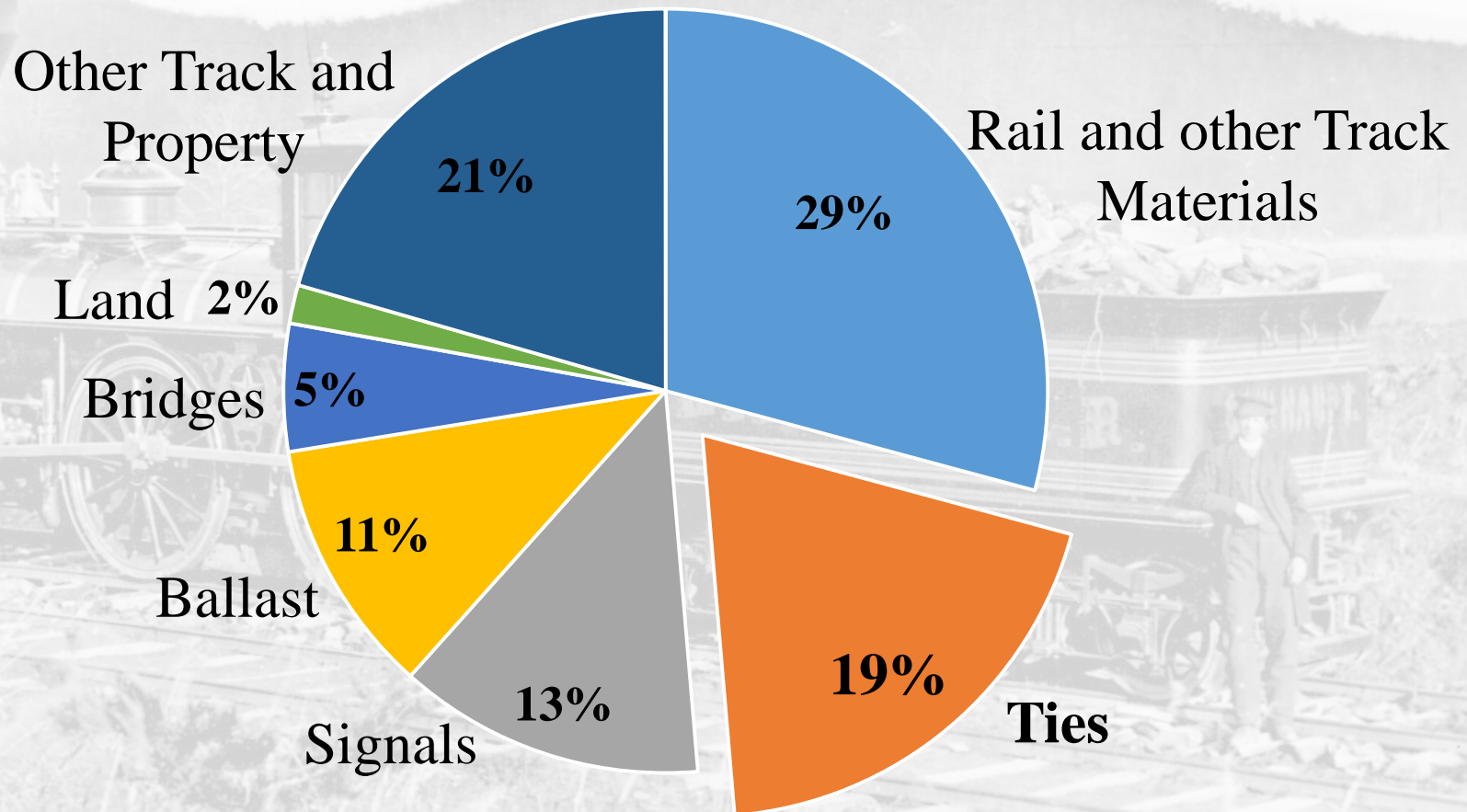


1980

\$575 billion

2015

Growth and Modernization of Railroads Track and Property (\$9.3 billion)



Concrete ties

The Growing Demand

Advantages of concrete ties

Durable

Robust and reliable

Need less maintenance

Have a high flexural capacity

A longer life time compared to timber ties

Commonly installed track sections subjected to heavy traffic

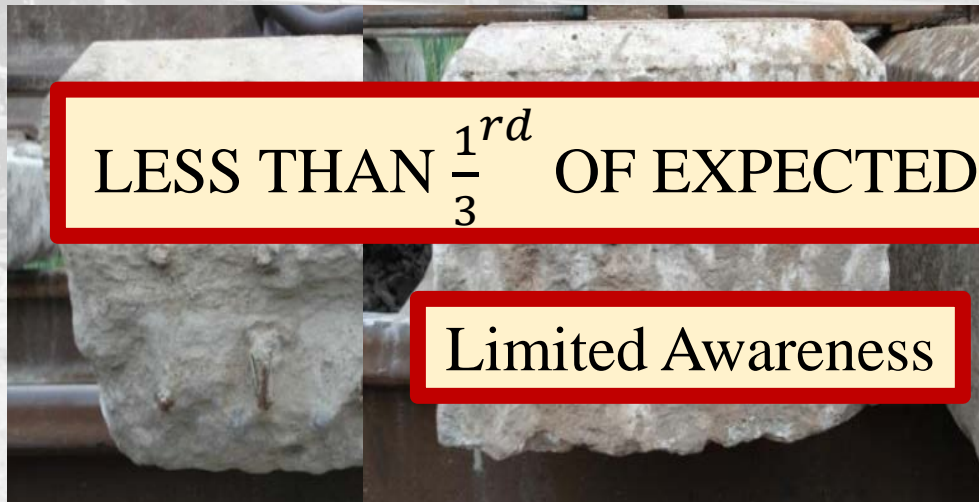


6.5% of Market Share

Contradicting and Questioning the Durability, Reliability and Robustness of Concrete Ties

Northbound CSX Transportation (CSX) train **derailed** on the Metro-North Railroad
July 18, 2013
Bronx, New York

NTSB investigation identified partially abraded prestressed concrete ties



LESS THAN $\frac{1}{3}^{rd}$ OF EXPECTED LIFETIME

Limited Awareness

Outline

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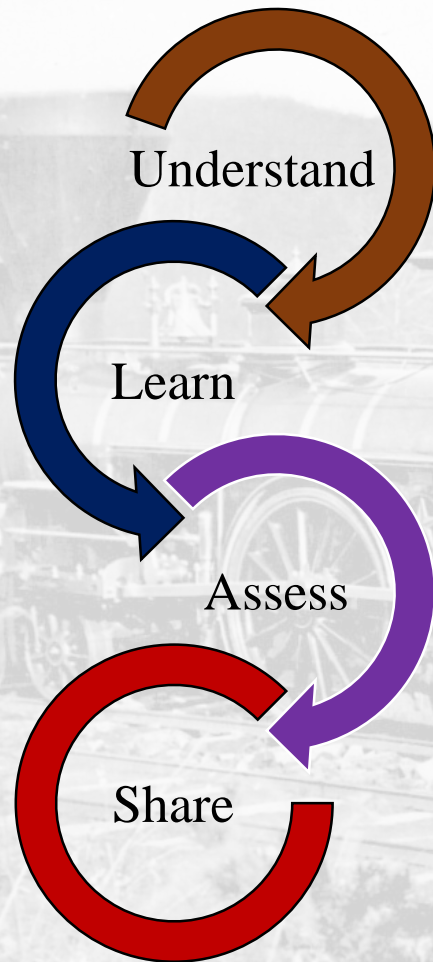
Survey Methodology

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Research Objectives



Conduct a Survey

Where?
Why?
How?

...the abrasion problem occurs

By providing a research strategy

Frame the academic curiosity in the current need of
industry

Outline

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Conducting a Survey to Understand

Preparing a list of questions



Deciding the target population & Collecting their contact information



Email exchanges, phone conversations, and personal interviews

Target Population

Experts who have conducted and/or are already conducting research on related topics

Railroad Associates

Association of American
Railways (AAR)

AREMA Committee 30

Transportation Technology
Center, Inc. (TTCI)

Consulting Firms

Bowman, Barrett, & Associates
Esca consultants, Inc.

Prestressed & Precast Industry

GIC

Precast Concrete Manufacturers'
Association (PCMA)

Railroad Manufacturers

AMSTED RAIL

Academia

The University of New
Mexico (UNM)

Western New England
University (WNE)

University of Illinois at
Urbana-Champaign
(UIUC)



Outline

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Learning from the Survey Conducted

Documentation and analysis of the obtained answers



Scientific quantification of the verbal survey outcomes

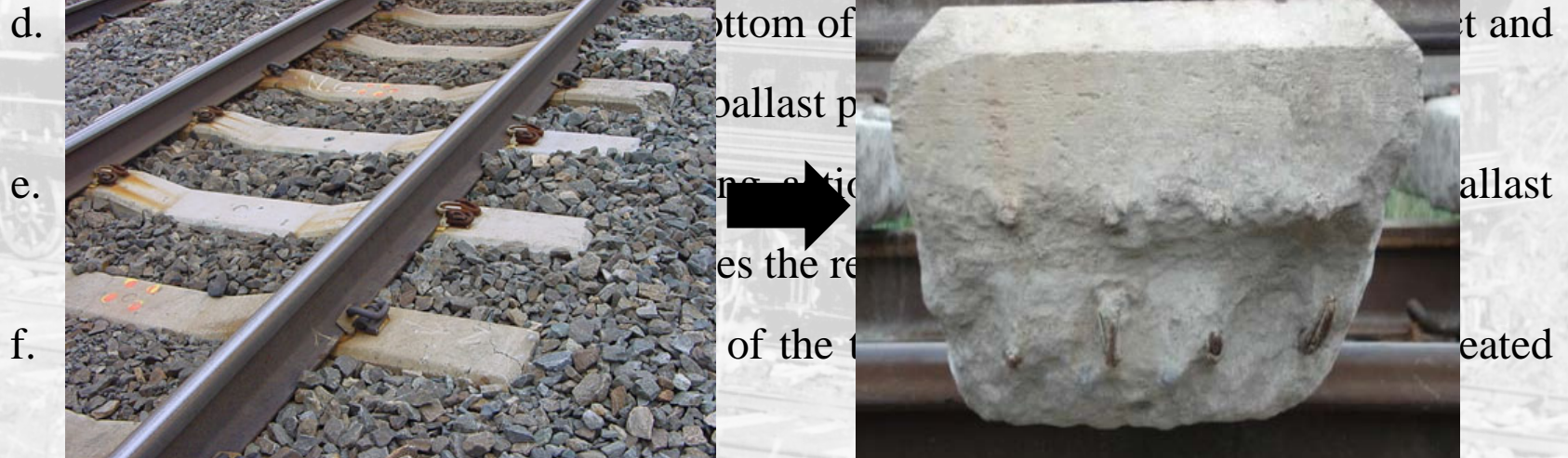
**Definitions of
Abrasion**

Uncertainty

**Contributing
Factors**

Definitions of bottom surface abrasion of concrete ties

- Wear of concrete ties on the sides and bottom skin against ballast and fines accumulated on the track due to friction.
- Interaction or the rubbing action between bottom surface of concrete cross-ties and ballast particles causing relatively high contact stresses which results in the loss of material and finally failure
- Concrete tie abrasion is presumably due to sufficiently high enough contact stresses between tie and ballast resulting in failure on the bottom surface.



The Uncertainty of Abrasion

Biggest concern and the top pressing factor

According to the experts, there exists limited awareness about

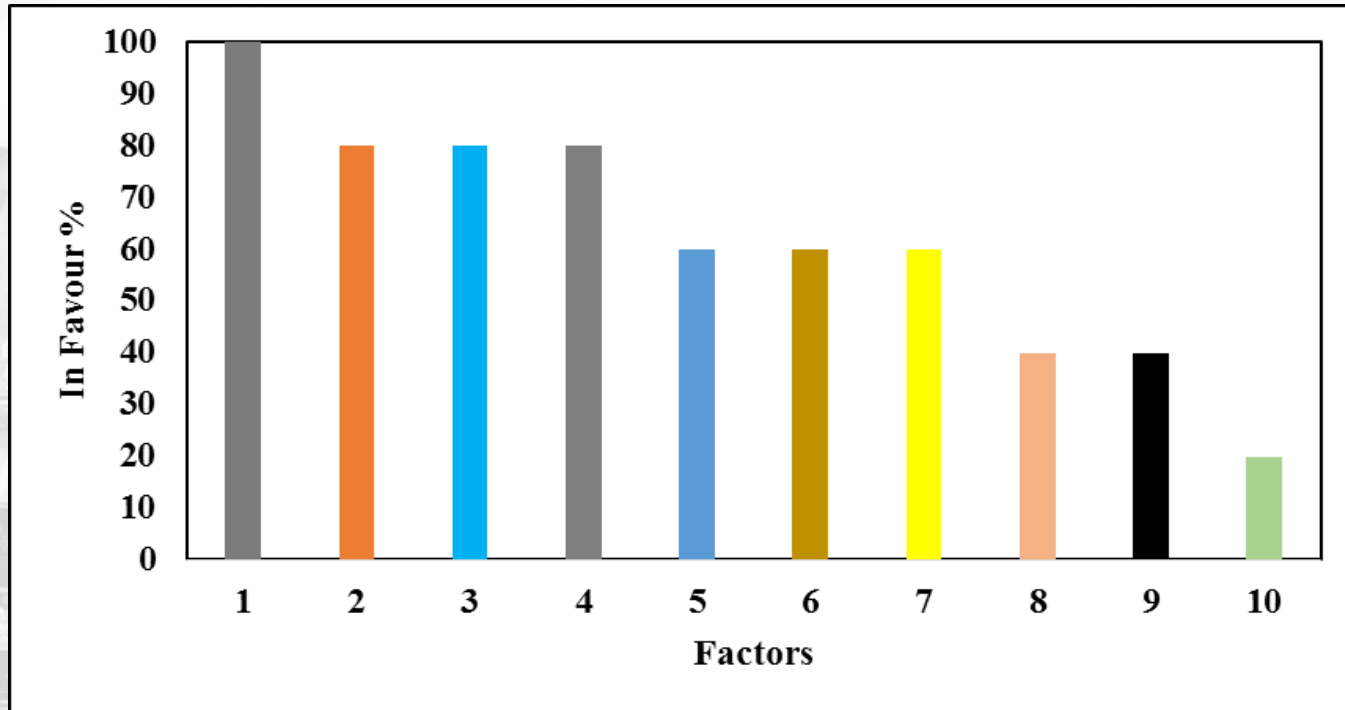
What is the severity of the abrasion problem

How common it is throughout the network

How it could be prevented through design

Why this problem starts

Factors Contributing to Abrasion



- | | |
|-----------------------------|---|
| ■ 1 Material of the Ballast | ■ 6 Relative Displacement b/w Tie and Ballast |
| ■ 2 Material of the Ties | ■ 7 Track Discontinuities |
| ■ 3 Drainage | ■ 8 Weather/Temperature and Humidity |
| ■ 4 Geometry of the Ties | ■ 9 Subgrade |
| ■ 5 Contact Forces | ■ 10 Fabrication |

Outline

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Survey Outcomes

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Objectives of Research Strategy

Investigate

Relevance of abrasion of prestressed concrete ties

Identify

Top concerns of precast designers, manufacturers, and railroads

Factors causing abrasion

Individual contribution of the factors

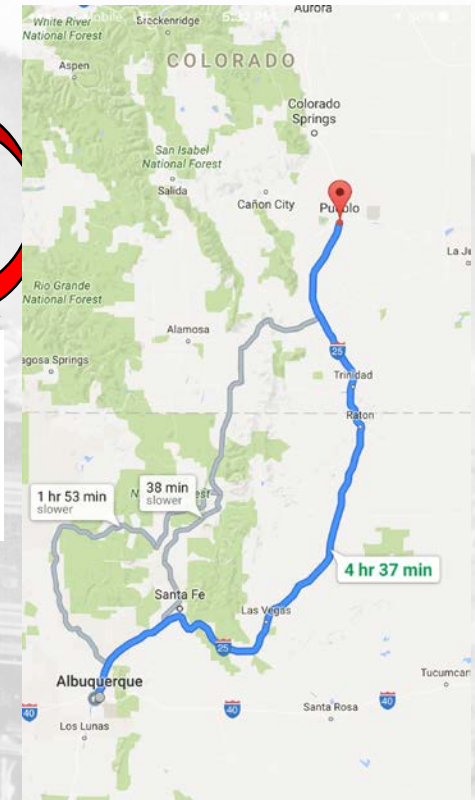
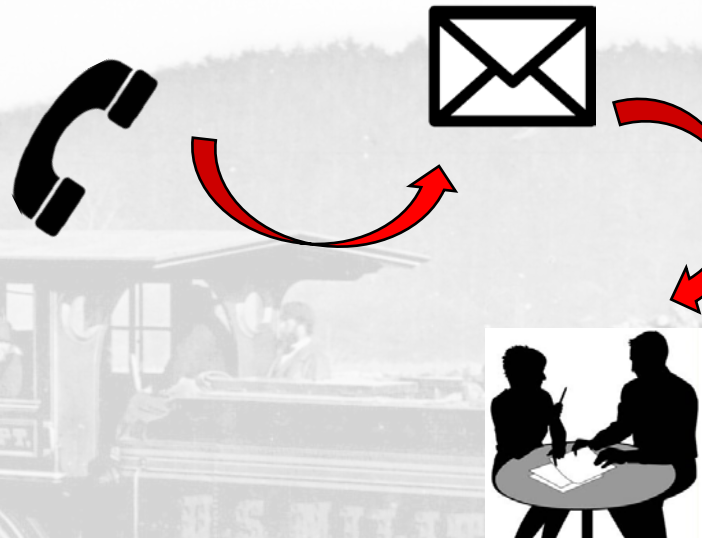
Increase

Sustainability and resilience of prestressed concrete ties

Components in the Research Program

1. Extended survey

2. Field Testing



FAST Facility at the TTCL, Pueblo, CO



3. Laboratory testing



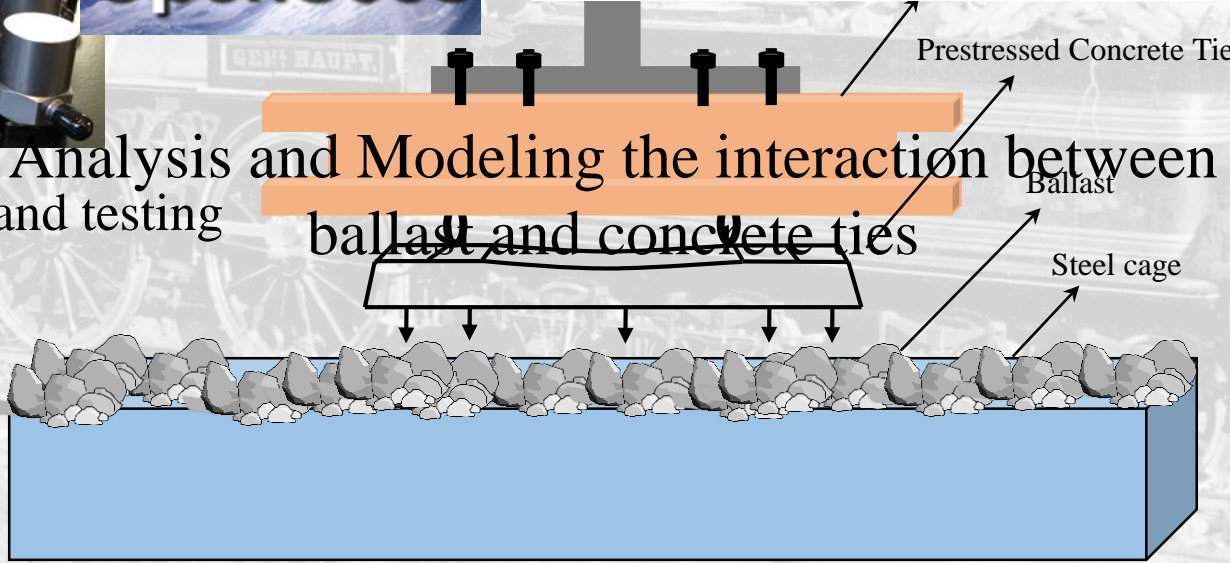
4. Analysis and Modeling



OpenSees

ABAQUS

Smart sensing and testing



SHARE

- **Increasing the awareness** of the abrasion problem and **eliminate industry concerns** on prestressed concrete ties
- Constant feedback, input and guidance from **AREMA Committee 30** (Ties), **NURail Center** and the Transportation Research Board (**TRB**) Rail Safety IDEA Board.
- This research will disseminate all the findings with **industry and academia**.
- The findings will be submitted to the **TRB Annual meeting** and **AREMA Annual Conference**

CONCLUSIONS

- Recently, concrete ties have deteriorated earlier than their expected life time
- Survey of experts identified that concrete abrasion problem is of interest but uncertain
- Survey of experts identified the definition of bottom abrasion of concrete ties
- The survey conducted has obtained main factors contributing to abrasion
- Research strategy has been proposed to assess the severity of abrasion

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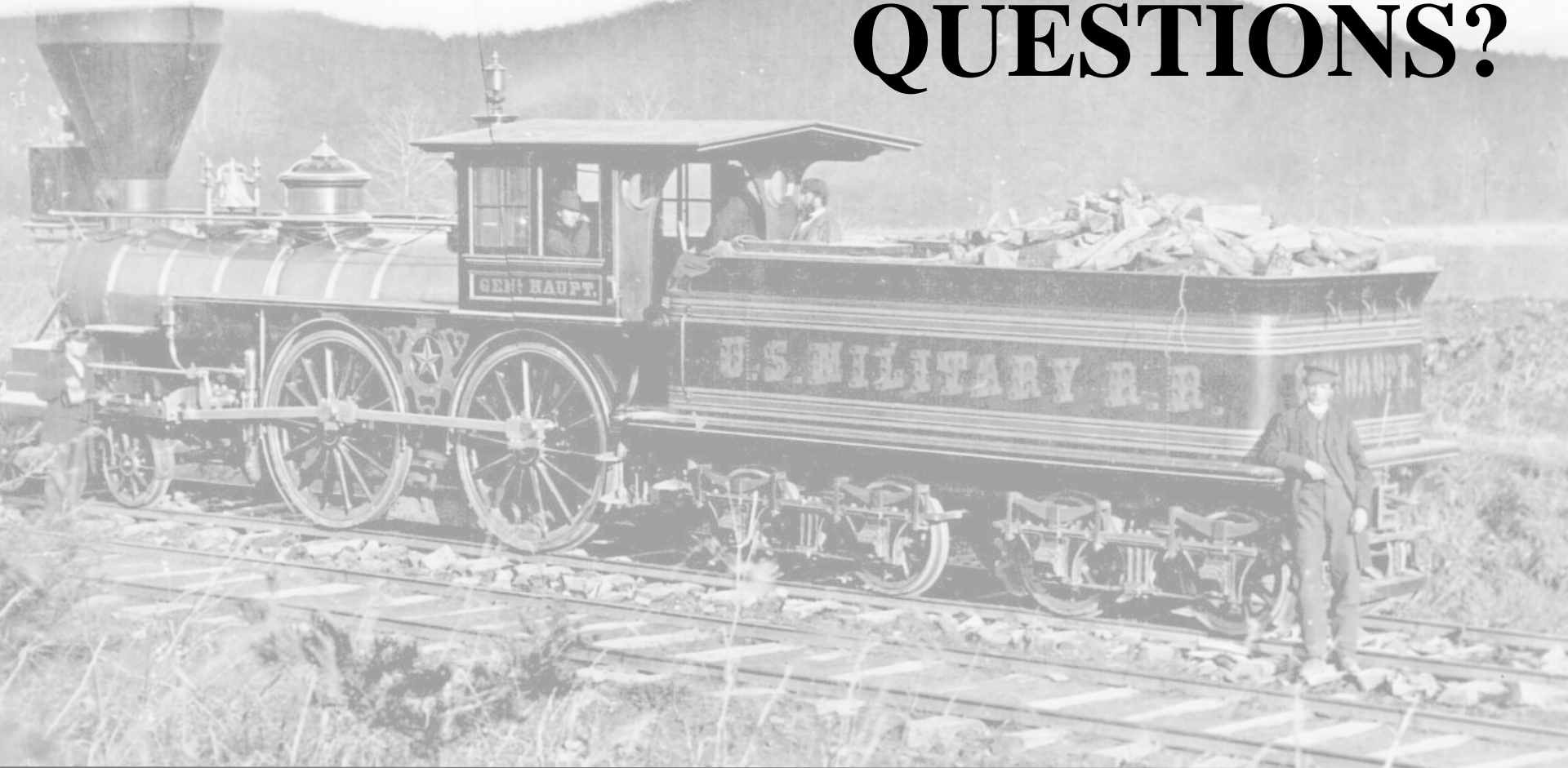


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THANK YOU!

QUESTIONS?





A black and white photograph of a steam locomotive pulling a freight car. The locomotive is on the left, and the freight car is on the right. The freight car is loaded with logs and has "U.S. MILITARY R.R." written on its side. A person is standing on the tracks next to the freight car. The background shows a hilly landscape.

APPENDIX

List of Questions

1. What is abrasion of concrete ties against railway ballast and why does it occur?
2. How much do the following aspects contribute to the cause of the issue?
 - a) Uncertainty
 - b) Economic situation
3. On a scale of 1 – 10, 1 being least problematic, how will you rate the problem of the abrasion of concrete ties against railway ballast?
4. Should the rail road industry be worried about this issue?
5. What according to you is the reason of this abrasion
 - a) Material of the Tie
 - b) Material of the ballast
 - c) Fabrication
 - d) Drainage
 - e) Weather/Temperature/Humidity
 - f) Geometry of the tie
 - g) Contact force
 - h) Relative displacement between tie and ballast
 - i) Subgrade
 - j) Track discontinuities
6. How are the damaged or abraded ties treated? Is there any investigation or are they simply discarded?
7. Do you know of any accidents or problems which occurred because of tie abrasion? If so, please mention
8. Are you aware of any past research or investigation conducted in relation to this topic? If so, could you please provide any related material

Variables?

Constants?

Defining failure?

Time of losing 1mm of cross section?

Sensors?

Data acquisition?

Load range?

What to look for?

Time is the governing factor to decide the failure of the tie?