EVALUATION OF EXISTING LOADING ENVIRONMENT IN NORTH AMERICA FOR IMPROVED CONCRETE SLEEPERS AND FASTENING SYSTEM

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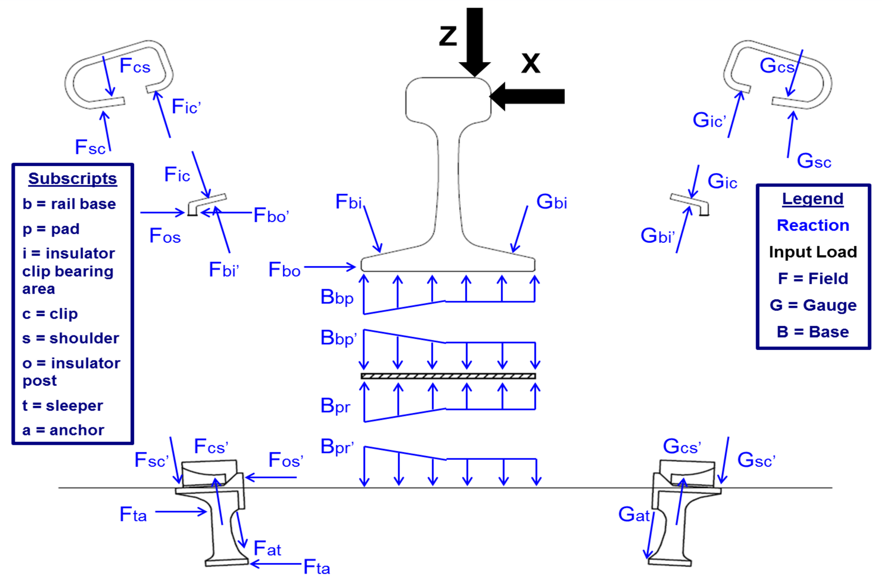
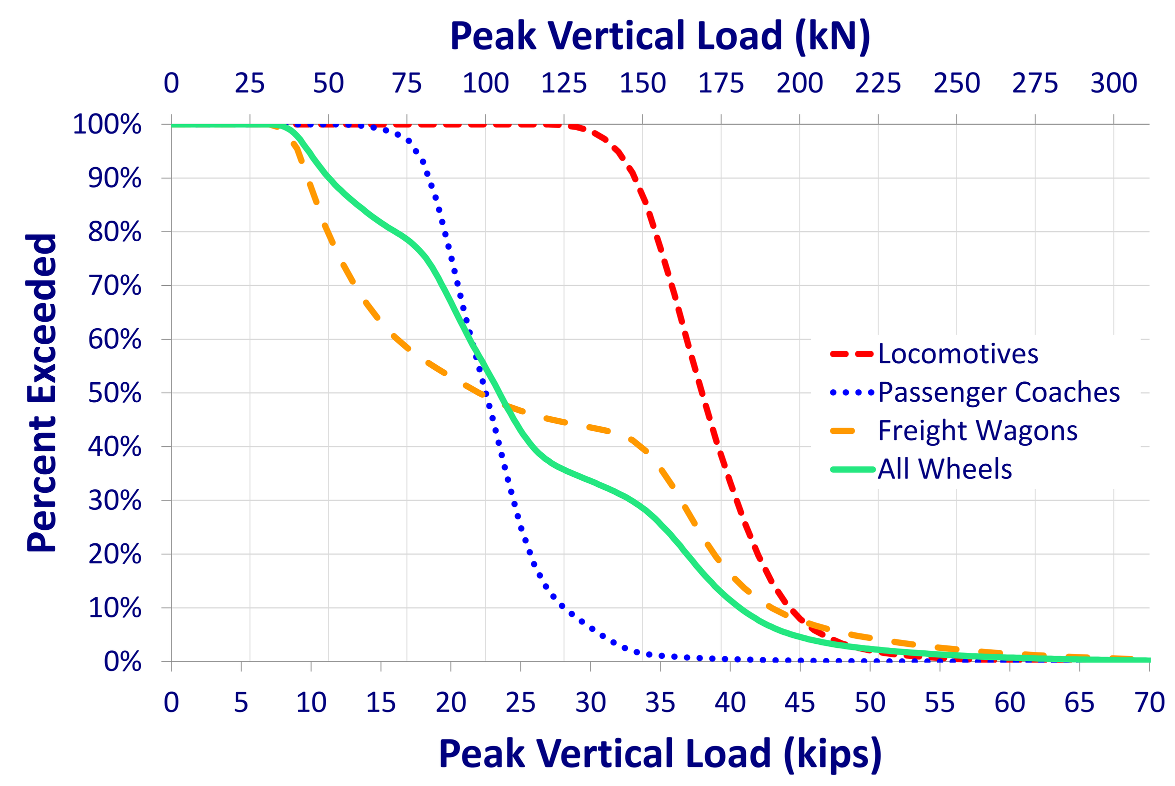
INTRODUCTION

- The design of concrete sleepers and fastening systems is largely dependent on the type and magnitude of loads traveling through the track superstructure
- Many efforts have been undertaken to quantify wheel loads, but limited research has been conducted to understand how the wheel loads are transferred to the underlying infrastructure
- The University of Illinois at Urbana-Champaign (UIUC) is conducting a study to understand the demands placed on the track structure to improve the design of concrete sleepers and elastic fastening systems



WHEEL LOAD QUANTIFICATION

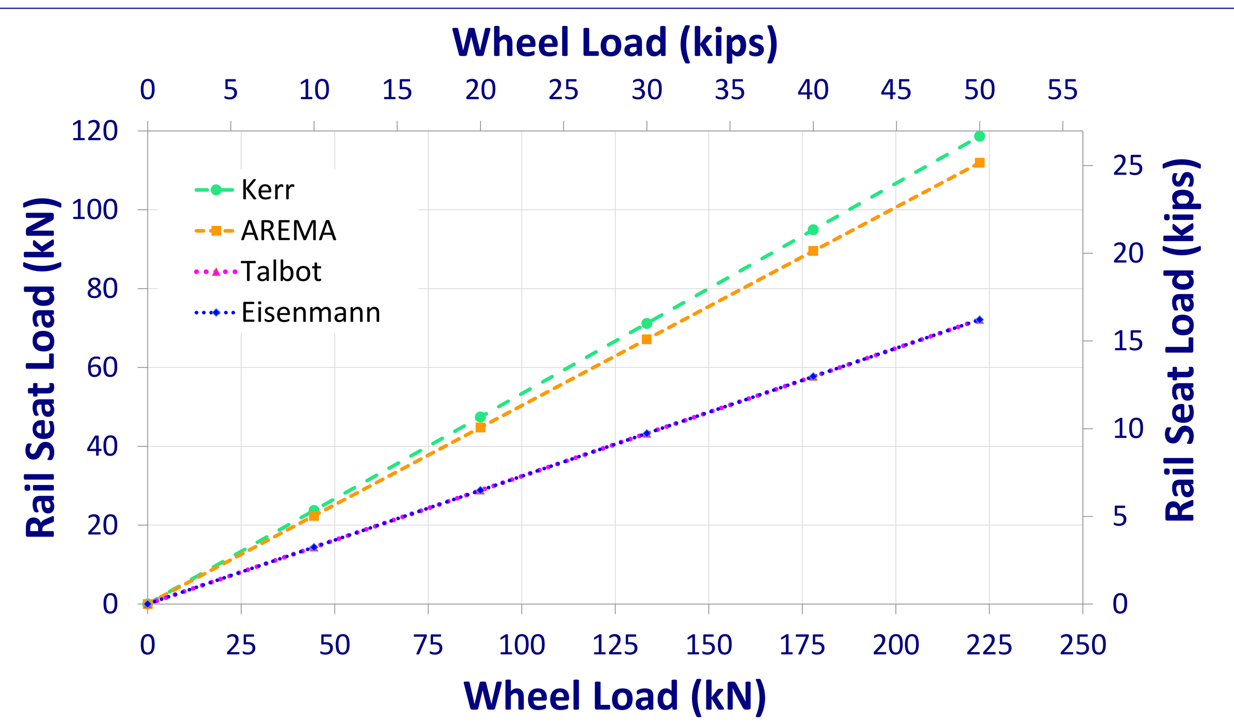
- The wheel impact load detector (WILD) is a useful tool for collecting and analyzing loading data entering the track
- Vehicle type and its associated static load provides a baseline for the expected total wheel load
- Increasing speed minimally increases the most common magnitudes of wheel loads
- Traffic composition and other site-specific parameters play a significant role in the distribution of the load environment
- Seasonal effects in load minimally affect the majority of the wheel load distribution
- Wheel condition, especially as it relates to wheel irregularities, is a significant factor in determining expected loads entering the track structure
- Impact loads become more severe at higher speeds



Source: Amtrak – Edgewood, MD (November 2010)

RAIL SEAT LOAD CALCULATION METHODOLOGIES

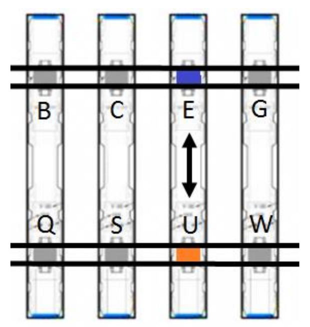
- The wheel load is distributed over several sleepers, both in front of and behind the wheel
- How the wheel load is distributed greatly affects the magnitude of load entering the rail seat, other components of the sleeper and fastening system, and the track substructure
- Many analytical methods have been developed to estimate the magnitude of rail seat loads given a particular wheel load
- Given a consistent set of parameters (sleeper spacing, track modulus, and rail size), four of these methods were compared (see figure on right)

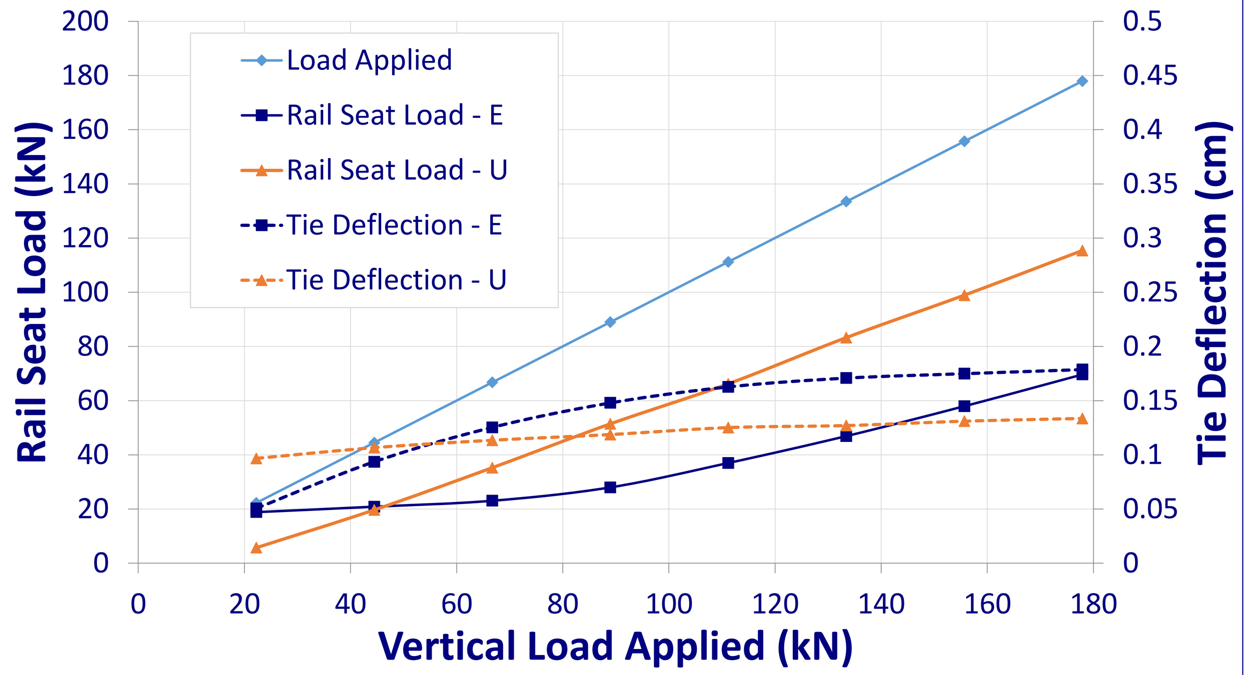


QUANTIFYING DEMANDS ON THE TRACK STRUCTURE

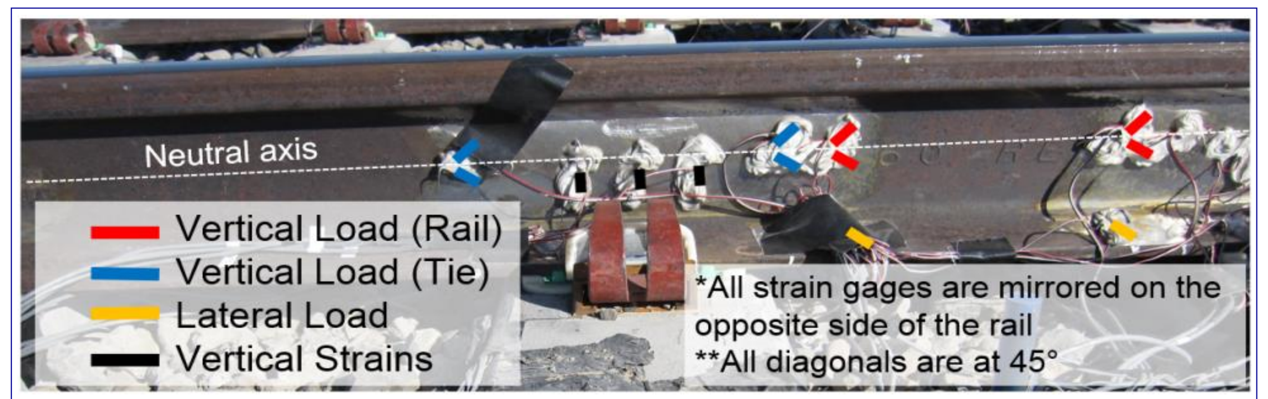
a) Instrumentation was deployed in the field to quantify the vertical wheel and rail seat loads

b) Additional instrumentation was deployed to quantify the load magnitudes at various other interfaces and components

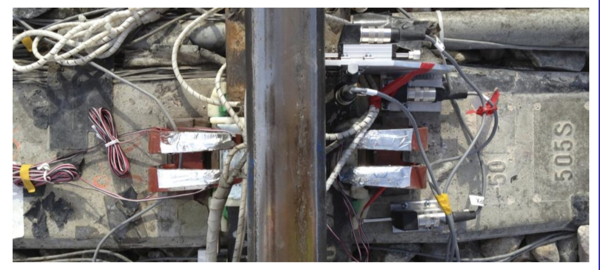




- Rail seat load and sleeper displacement vs. wheel load as measured on concrete sleeper track at the Transportation Technology Center (TTC) in Pueblo, CO, USA



(a) Strain gauge configurations to quantify vertical and lateral rail loads, vertical rail seat load, and vertical strains in the rail



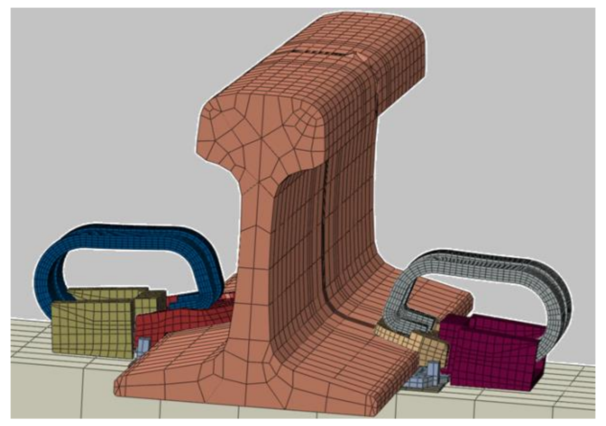
b) Additional Instrumentation at TTC

CONCLUSIONS

- The wheel impact load detector (WILD) data can be used to characterize the loading environment at the wheel-rail interface
- Actual rail seat loads measured in the field can vary as individual sleeper support conditions vary but track modulus remains constant
- Therefore, current analytical calculation methodologies lack the ability to consistently and accurately predict the rail seat loads
- Additional work in the field and lab is required to better quantify the demands at various fastening system components

FUTURE WORK

- Data from other technologies (instrumented wheel sets, train performance detectors, etc.) will be analyzed to determine their feasibility in characterizing the actual loading environment
- The finite element model will be further validated and refined with additional experimental results
- The validated FEM will be used to perform parametric studies to better understand the demands at various components as parameters (support conditions, fastener materials, sleeper spacing, etc.) are changed
- This improved understanding will be used to aid in the development of a mechanistic design process for the concrete crosstie and elastic fastening system



University of Illinois crosstie and fastening system FEM

Full-Scale Railway Engineering Research Facility, UIUC, USA

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Amsted RPS Amsted Rail · Union Pacific · BUILDING AMERICA · BNSF RAILWAY · AMTRAK · GIC · HANSON · LBFoster CXT Concrete Ties