Crosstie/Ballast Pressure Measurement and Analysis

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INTRODUCTION

It has been desirable for years to develop a reasonably simple, accurate, and reliable method to directly measure the average vertical pressure magnitudes and distributions at the crosstie/ballast interface in railroad trackbeds. Quantifying the magnitudes and relative distributions of pressures at the crosstie/ballast interface are important inputs for trackbed engineering design and analysis aspects. The pressures produced by millions of load applications ultimately affect the long-term performance of the track by reducing the service lives of the component materials and layers. Many of the assumptions used today in trackbed design were based on analytical methods, which have never been verified by direct measurement. This research looks to perform that task.

RESEARCH OBJECTIVES

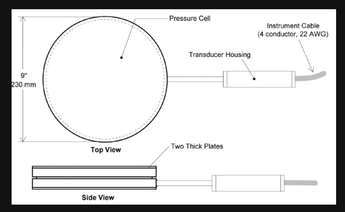
- Determine the Applicability of Granular Material pressure cells to measure vertical pressures at the crosstie/ballast interface for typical revenue traffic
- Evaluate the effect of recessing the pressure cells within the bottom of timber crossties
- Develop a procedure to subsequently install the pressure cells for accurate measurements
- Determine the effect of tamping and relative ballast consolidation on pressure magnitudes
- Determine the effect of accumulated tonnage over time (18-month period)
- Compare the pressure magnitudes recorded with wheel/rail forces (from WILD)
- Determine the relative distribution of pressure along the footprint of a crosstie

INITIAL ATTEMPTS

TTI Railroad – Paris, KY & Norfolk Southern Flatrock, KY


Geokon Model 3515

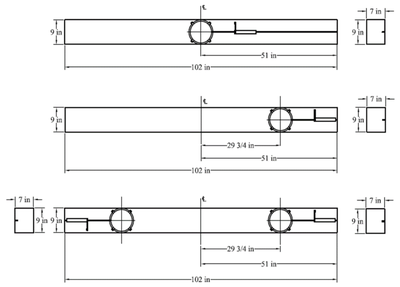
Granular Material Pressure Cell

NEW METHODOLOGY

Routing Copper Naphthenate Timber Crossties

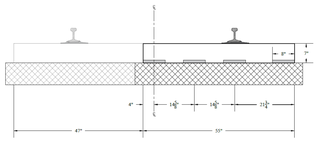
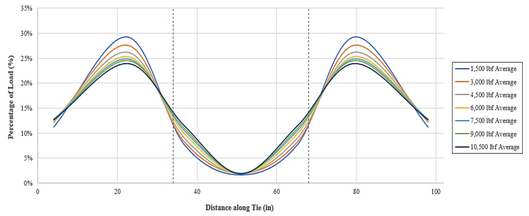




LABORATORY CALIBRATION

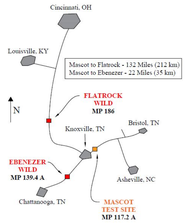

- Created a simulated trackbed designed to minimally resist lateral movement
- Vertical deflections were in the range of 1/3-inch
- Near-perfect correlation between measured and applied stress

LABORATORY EXPERIMENTS

IN-TRACK INSTALLATION

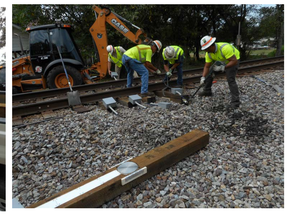
Norfolk Southern – Mascot, TN

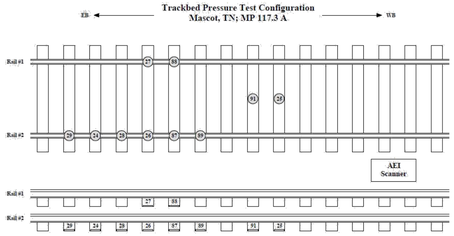
The Mascot test site is located on a mainline track with 136 RE continuous welded rail secured with cut spike fasteners to wood ties. Ties are positioned on 20 in.- (500 mm)- centers and each tie is box anchored. The track support consists of standard NS mainline granite ballast on a well-seasoned roadbed. The site is on a horizontal tangent with a 0.25% vertical grade eastbound ascending. The track annually carries 37 MGT (33.6 MGT) of traffic, with a maximum train speed of 45 mph (72 km/h).

Protecting Electrical Components


NS Personnel Handling the Instrumented Crossties

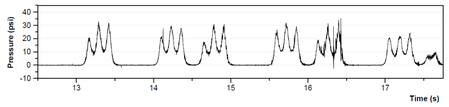
Test Section



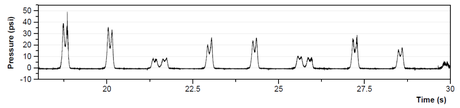
DATA ACQUISITION


PRESSURE MEASUREMENTS

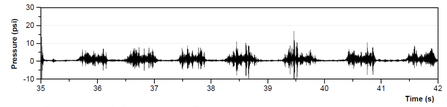
Typical Series of Locomotives



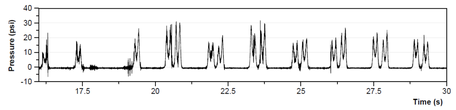
Typical Series of Intermodal Cars



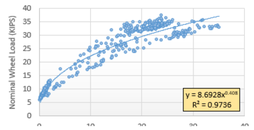
Typical Series of Empty Cars

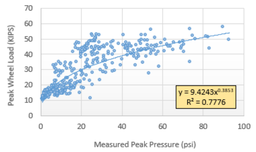


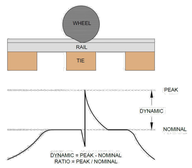
Typical Series of Loaded Cars

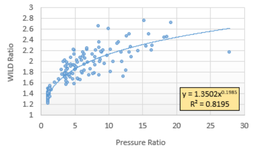


WILD COMPARISONS









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Rose, J.G. Clarke, D.B. Liu, L. and T.J. Watts. "Application of Granular Material Pressure Cells to Measure Railroad Track Tie/Ballast Interfacial Pressures". Transportation Research Record: Journal of the Transportation Research Board, 2018. 2671: In Press.

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