FTA Concrete Crosstie Project – Final Update

Prototype Installation at St. Louis Metrolink and CTA Instrumentation

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2019 Industry Partners Meeting
16 October 2019 | Tucson, AZ

U.S. Department of Transportation
Federal Transit Administration

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UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
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FTA-Funded Resilient Concrete Crossties and Fastening System Research Program

Objectives
► Develop resilient concrete crosstie design solutions for light, heavy, and commuter rail transit operators

Methodology
► Quantify concrete crosstie and fastening system demands when subjected to rail transit loading environments

Key Parameters to Quantify
► Loading Environment (lateral and vertical wheel/rail loads)
► Crosstie Bending Moments (rail seat and center)
► Rail Displacements (vertical and lateral)
FTA Project Transit Partner Agencies

(Two Sites; Curve & Tangent)
Field Experimentation Takeaways

► Loading environment is significantly different at each transit mode
  • Design of any infrastructure component should consider this

► Wheel loads exceeded an impact factor (IF) of 3 rarely (<0.05%)
  • AREMA recommends designing concrete crossties with an IF of 3

► The reserve flexural capacity factors of safety ranged from 2 – 6

► This provides an opportunity to optimize not just the crosstie design but track structure
  • “Savings” from reductions in concrete, steel, & handling could be reallocated into resilient materials (under tie pads, ballast mats, etc.)

► Resilient materials could:
  • Reduce maintenance costs (e.g. increase time between tamping, etc.)
  • Reduce urban pollution (i.e. ground borne noise and vibration, etc.)
Final Prototype Design

Original

Prototype
Prototype Casting at CXT: 16 – 18 Oct.

► 22 crossties cast at CXT, Spokane | 8 crossties had internal instrumentation
Sacramento Regional Transit (SacRT) 8-wire tie design experience

- SacRT’s experience with 8-wire tie design brought up as caution during last year’s meeting
- RailTEC team contacted and visited SacRT to learn about their experience and performance of these ties
  - In 2001 during construction for the Phase I South Line project, center crack issues were observed in the 8-wire ties being used
Sacramento Regional Transit (SacRT) 8-wire tie design experience

- Issues caused by severe center-binding conditions of the ties due to contractor practices in the surface leveling of the subballast layer prior to dumping of ballast by high-rail dump trucks
- Around 320 ties were removed from track due to cracking and approximately six (6) were left in track for monitoring.
- After 18 years in service, no additional deterioration has been observed

▶ SacRT currently uses a 12-wire tie design based on supplier recommendation
Prototype Installation at Metrolink
Prototype Installation at Metrolink
Prototype Results – Railseat

- Design Railseat Positive Capacity: **189 kip-in**
- Similar performance between Original and Prototype designs
Prototype Results – Center

- Design Center Negative Capacity: -56 kip-in
- Similar performance between Original and Prototype designs
Prototype Results - Conclusions

► SacRT’s experience and RailTEC site visit
  • Ties have performed well to date
  • Care and understanding on the part of the construction contractor is needed to prevent extreme demand conditions during construction

► Prototype Crossties
  • Perform similar to original design
  • Bending demand well below the design capacities at C and RS
  • Demonstrates that further optimization can be used
  • No issues have been reported with the prototypes to date

► CTA Wheel-Rail loading
  • Successful instrumentation installation
  • Have been able to identify repeat offenders
  • Possible follow-on research
Additional Work – CTA Instrumentation

► Project extension from FTA allowed collection of additional wheel-rail loads at another heavy-rail property

► Objectives
  • Obtain additional data on heavy-rail loading environment and provide relevant information to CTA personnel

► Approach
  • Instrument southbound Red Line with continuous and automated monitoring of revenue service wheel-rail interface loads.

► Project Timeline
  • December 8th, 2018 – Installation of instruments at CTA
  • July 13th, 2019 – Last train data recorded

► Summary of Recorded Data
  • 30,558 trains → 977,856 axles → 1,955,712 wheels
Field Installation
Vertical Loads

Total trains = 30,558
From 12/10/2018 to 07/13/2019
Maximum = 44.8 kips
Minimum = 2.1 kips
Average = 9.2 kips
# Vertical Loads - Maximum Recorded

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Vertical Loads – Mode Comparison

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- When comparing heavy rail properties, demands on CTA are lower than those measured at NYCTA
  - Note: NYCTA site was in a curve

- Similar average loads observed between CTA (heavy rail) and Metrolink (light rail), but much larger extreme values recorded at CTA
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Thank you for your attention!

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Rail Transportation and Engineering Center (RailTEC)

This project is funded by the Department of Transportation’s Federal Transit Administration and supported by the National University Rail Center (NURail), a US DOT-OST Tier 1 University Transportation Center.