Construction Loads for Plastic/Composite Ties

Richard Reiff – TTCI
Mahmood Fateh – FRA
Background

♦ Railroad user reports of damaged plastic ties
  ▲ Handling
  ▲ Installation
  ▲ Early reports suggest up to 20%

♦ Railroads handle, transport, and insert plastic ties in the same manner as wood ties

♦ Some damage “hidden”
  ▲ Some failures occur after several years in track
Project Overview

♦ FRA funded work to improve safety

♦ Objectives
  ▲ Determine loads plastic ties are subjected to during handling and installation
  ▲ Compare with existing AREMA qualification tests
  ▲ Initiate efforts to revise current tests or identify new testing procedures

♦ Major Tasks
  ▲ Survey users of plastic ties to identify areas of concern
  ▲ From survey results develop approach and test plan
  ▲ Instrument three plastic ties for field testing
  ▲ Measure forces during handling, distribution, and installation
  ▲ Summarize results
    ─ Compare and suggest screening tests needing changes
What was Found

♦ Activities exceeding current screening loads
  Impact loads (dropping)
  Installation loads
  ▲ Short duration – insertion bending (< 10 seconds)
  ▲ Longer duration – nipping bending (> 10 seconds)

♦ Activities applying moderate loads
  Spiking impacts
Results of Railroad User Surveys

♦ Key areas where damage was reported as an issue
  ▲ Possible damage during handling at manufacturers plant
  ▲ Damage due to forklift tabs
  ▲ Dropping of ties during unloading
  ▲ Spiking and tie plate hold down installation
  ▲ Insertion bending

♦ Issues identified, but beyond current scope and budget
  ▲ Possible inadequate bending strength requirements
  ▲ Accelerated fatigue tests
  ▲ Accelerated aging tests
  ▲ Improved base stock quality control
Instrumented Plastic Tie

♦ Plastic Tie Samples – donated by TieTek, BNSF
   - Not previously done for this purpose
   - Calibrated using AREMA standard practices
     ▲ Center bending and rail seat bending configurations
   - Calibration shows linear load vs. strain
     ▲ Ties “remain bent” for a time after initial load

Strain gages bonded to bottom of tie, prior to wire hookup.

Example of strain gage wiring at tie center. Gages were protected under tape.
Typical Calibration Curve
One curve developed for each of 12 strain gage locations
Damage during Handling and Shipping

♦ In plant handling issues
  ▲ Stacking
  ▲ Fork lift damage
  ▲ Bouncing

♦ Stacking and handling protocol received from supplier
  ▲ No issues (< 20% maximum calibration strain)
  ▲ Forklift damage — training
Unloading Issues

♦ Simulated by drop tests
  Replicate unloading from cars
  Same process as followed with wood ties
  Preferred method to scatter ties
  ▲ Improves efficiency during installation

Configuration 3 end view – full load dropped on instrumented tie.
Unloading Issues

- Configuration producing worst case bending strains
  - Push tie off forklift
  - 2- to 5-foot drop in increments
Micro strain bending produced at various locations on the tie

Summary of center bending loads for tie being struck by full load (configuration 3)
Summary – Drop Test Worst Case Bending

♦ Results for 4-foot drop
Exceeds typical AREMA center bending load of 10,000 pounds
Impact generates approximately 16,500-pound center bending load
  ▲ Projected load at 9,350 micro strain
  ▲ Location depends on tie orientation at impact

♦ Suggested solutions:
Impact screening test needed
Or, change unloading methods

Full weight of a standard tie, dropped center of instrumented. Drop 5 (48")

![Graph showing micro-strains vs. center bending force](image-url)
Installation Tests

- Similar data collection – cables on 25-foot tether
- Insertion variables
  - Install tie with great care
  - Jam tie vertically and bend against rail
- Spiking variables
  - Tie end nipping
  - Spiking variations
- Cooperative effort from CSX: Richmond, VA maintenance shops
  - Nordco TRW Tie Inserter
  - Nordco CX Spiker
  - R&R ties in yard tracks
Tie being pushed in place, bent under near rail
Tie Insertion
Typical Time History of Center Bending Strains during Installation
Peak Event No. 6 (-15,622 micro strain)

Time (seconds)

Microstrain

-14,000
-12,000
-10,000
-8,000
-6,000
-4,000
-2,000
0

0 10 20 30 40 50 60 70 80 90 100

0 -2000
-4000
-6000
-8000
-10000
-12000
-14000

TIE1TOPR. TOP RIGHT. (UE)
Rail Seat Bending during Tie Insertion

♦ Results still under evaluation

♦ Calibration data for rail seat bending
   ▲ 0 to 7,000 pounds produced
     ─ 0 to 3,000 micro strain

♦ Insertion data under full bending
   ▲ Shows 0 to 12,000+ micro strain
   ▲ Linear extrapolation suggests load ~28,000-30,000 pounds
   ▲ Severe rail seat bending may no longer be linear
     ─ Additional tests, analysis ongoing
Tie Nipping and Spiking
Time History – Nipping and Spiking

Top – Center Bending Peak Event No. 7 (13,796 micro strain)  
Bottom – Rail Seat

Microstrain

Time (seconds)
Results – Worst Case Center Bending during Tie Insertion and Nipping

♦ Event 5 – Peak during nipping (10,600 pounds)
♦ Event 6 – Peak during installation (11,800 pounds)
Summary

♦ Activities producing bending in excess of normal AREMA test
   Equivalent load for AREMA center or rail seat bending test configuration
   Dropping over 4 feet
   ▲ Impact load, short duration < 0.1 second
     – 16,500-pound impact to tie center
   Pushing tie against rail during installation
   ▲ Short duration — < 5 seconds
     – 11,800 pounds — center bending
     – >> 10,000 lb? — rail seat bending — results under review
   Tie nipping and spiking
   ▲ Duration 10+ seconds
     – Nipping with center grips – 10,600-pound center bending
     – Rail seat during spiking – no high bending loads
Implementing Results

♦ Path Forward
  ▲ Complete insertion tests on second railroad/machine
  ▲ Summary report and recommend follow on efforts
  ▲ Coordinate with AREMA Committee 30

♦ Future work identified (2011 – pending funding)
  ▲ Develop or modify laboratory screening tests
  ▲ Demonstrate new tests
  ▲ Recommendations for AREMA 30 guidelines

Other issues regarding plastic ties
  ▲ Fatigue life/tests
  ▲ Weathering resistance
  ▲ Accelerated aging
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