

Summary of Current State of Practice for Composite Crossties

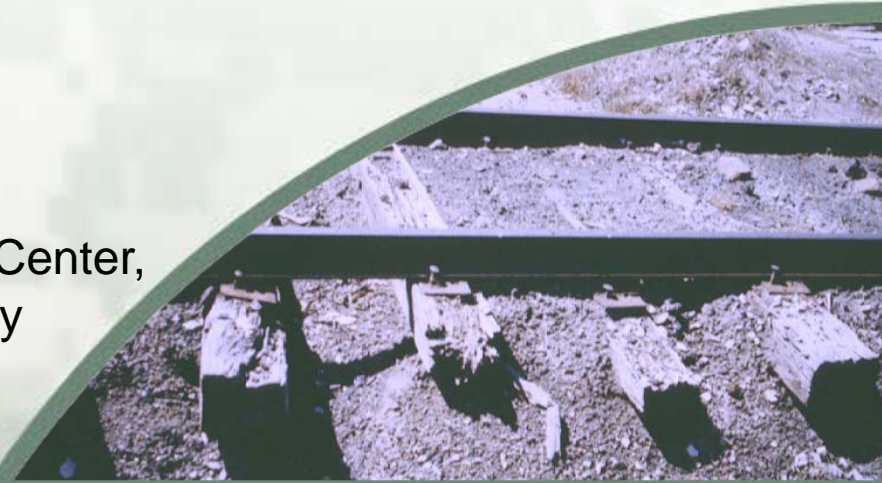
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**US Army Corps
of Engineers®**



Background

- **Roughly 175,000 Miles Of Track In U.S.**
- **Average 10-15 Million Ties Replaced Annually**
 - ▶ Laid End-to-end, 15 Million Standard Ties Would Stretch Almost 24,000 Miles!
- **Army Has Approximately 2,000 Miles Of Track**
 - ▶ Over 10,000 turnouts!!



Wood is Traditional Tie Material

- When Railroads First Developed in U.S., Had Abundance of Trees Available
- Useable Mechanical Properties -- Works Well
- Long-time History of Performance



Drivers to Investigate Alternatives to Wood Ties

- **Increased Wheel Loads (32 Tons → 39 Tons) Per Axle**
 - ▶ Wood Ties Wear Out Faster
- **Changing Environmental Regulations Directed at Chemically Treated Wood**
 - ▶ Manufacture / Use of New Ties
 - ▶ Disposal of Old Ties
- **Concerns of Lesser Quality of Present Day Wood Ties**
- **Rising Cost of Wood**
- **Large Number of Trees Needed to Meet the Demand for Replacement Ties**

WOOD ROTS



Badly Deteriorated Wood Cross-ties

Wood requires chemical treatments to resist rot and insect attack.

Advantages of High-Density Polyethylene Based Recycled Plastic Composite Ties

Attractive Substitute for Wood Ties Because:

- ▶ Diverts waste plastics from landfills
- ▶ Inherently resistant to moisture, rot and insects without poisonous chemical treatments
- ▶ Also recyclable
- ▶ Lower lifecycle costs
- ▶ Comparable strength to wood
- ▶ Can be intermingled with wood ties for tie maintenance activities

Development of First Recycled-Plastic Composite RR Ties

- **Mid-1990's – Realizing the Need for a Reinforced Product, Two Independent Groups Began Developing Composite Ties Based on Glass-Fiber Reinforced High-Density Polyethylene (HDPE)**
- **Established Performance Target Goals**
 - ▶ Minimum Flexural Modulus of 170,000 psi
 - ▶ Maintain gage within +1/4-inch under 39,000 lbf (static) vertical load and lateral load of 24,000 lbf
 - ▶ Installation using standard techniques, equipment, and fasteners
- **Similar Weight and Dimensions To Wood --**
approximately 190-220 lbs per 7 inch x 9 inch x 8-1/2 foot long tie

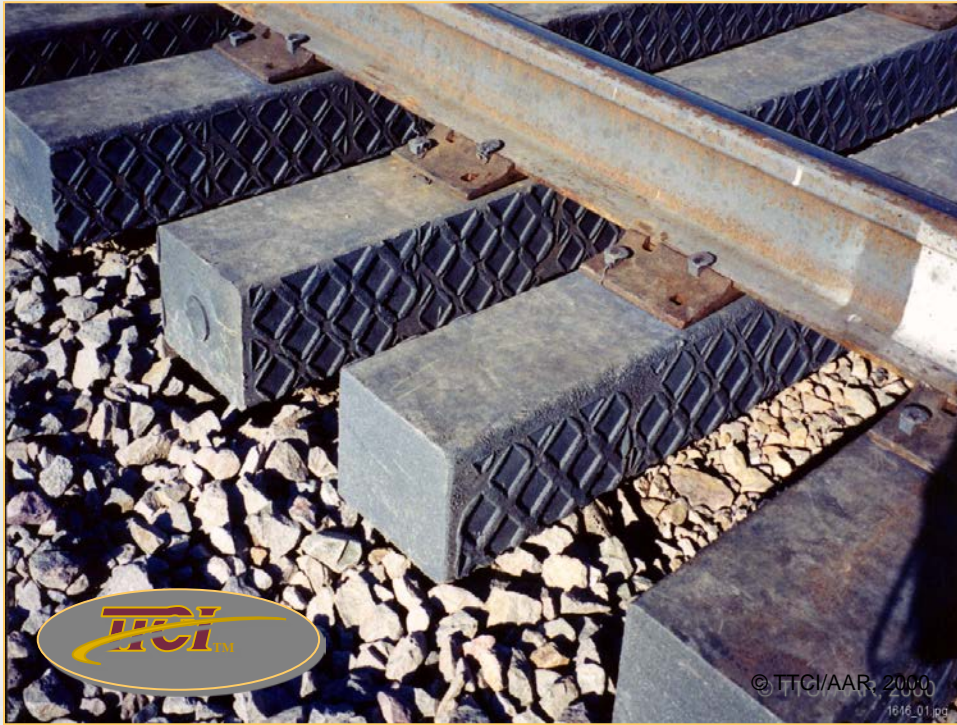
Tests at Facility for Accelerated Service Testing (FAST)

- **In 1996: Two Plastic Ties Installed in a 5-Degree Curve in the FAST at AAR's Transportation Technology Center, Inc. (TTCI), Pueblo, CO**
- **In 1997: 24 Additional Ties Installed**
- **In 1998: Third Group Installed**
 - ▶ Some With Cut Spikes
 - ▶ Embossing For Increased Lateral Stability
- **Oldest Ties > Billion Gross Tons (MGT) Traffic**

Identified Need for Increased Lateral Stability

- **Newly Installed Wood Or Plastic Tie**
 - ▶ Approx. 1,000 lbf To Push Out
- **With 15 Million Gross Tons Of Traffic**
 - ▶ Wood: 2,500 To 3,000 lbf To Push Out
 - ▶ Plastic: Still About 1,000 lbf To Push Out
- **Newly Installed Plastic Ties With Embossed / Modified Sides**
 - ▶ 4,000 To 6,000 lbf To Push Out

MODIFIED PLASTIC TIES FOR INCREASED LATERAL STABILITY



Engineered Surface To Help Increase Tie Lateral Stability

Plastic RR Ties in Turnout

Crane Naval Surface Warfare Center, IN

- **In Mid-1998 Established a Cooperative Effort to Evaluate Plastic-Composite RR Ties**
 - ▶ Construction Engineering Research Laboratory (CERL)
 - ▶ Crane Naval Surface Warfare Center (NSWC)
 - ▶ Crane Army Ammunition Activity (CAAA)
- **~130 Miles of Track / 925 Turnouts**
- **Chose #10 Turnout on Mainline Track for Demonstration of Plastic Ties in a Turnout**

Plastic Tie Turnout -- CRANE NSWC



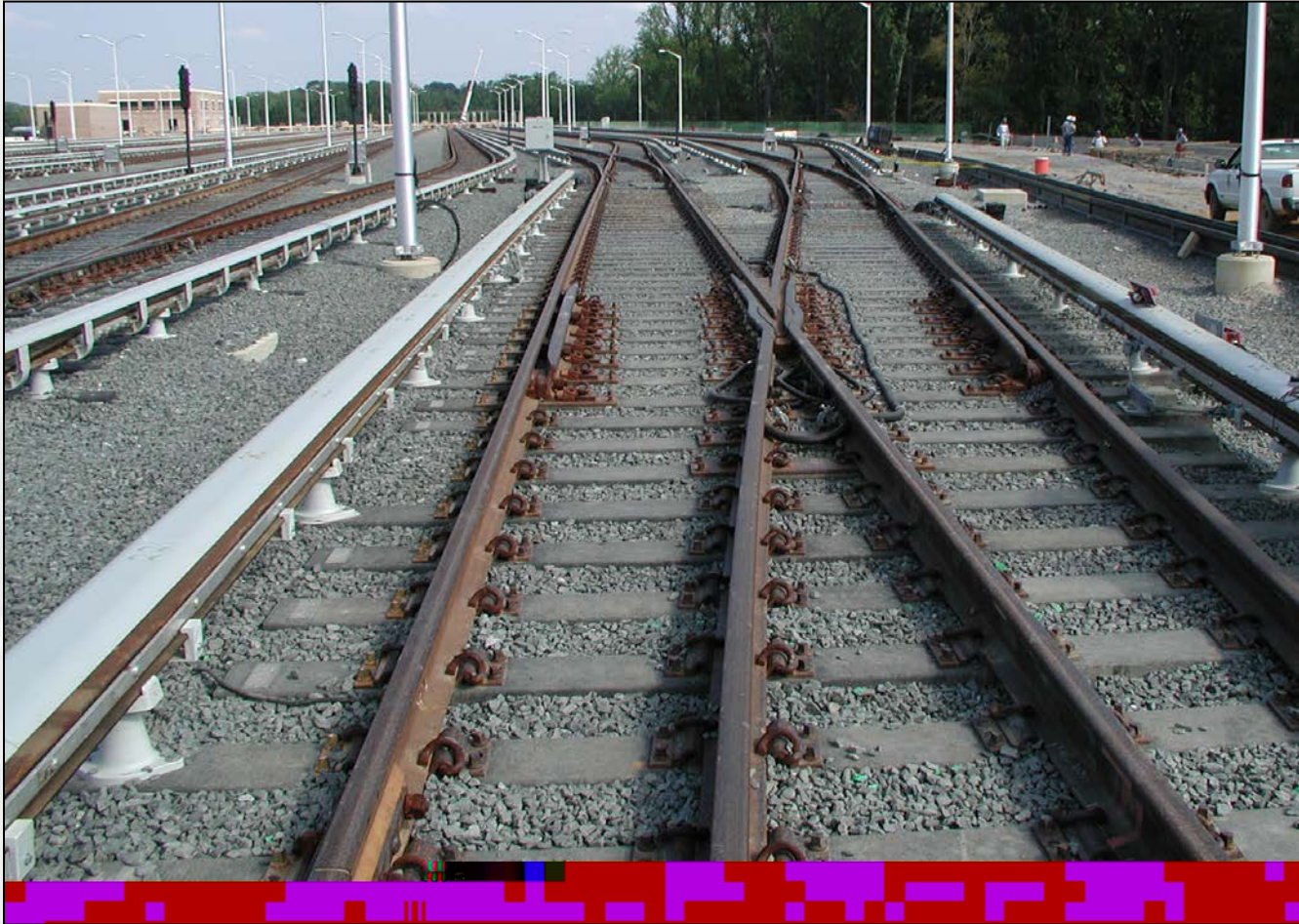
Laying Out SwitchTies

2nd Plastic Tie Turnout -- CRANE NSWC



Second Plastic Tie Turnout Completed June 2002

Switches and Special Track Work



One of Six Plastic Tie Turnouts at Wash D.C. Metro's Yard Facility

Switches and Special Track Work



Now a market growth area for Engineered Composite Ties

Use in Road Crossings



Another Market growth area for engineered composite ties and recycled plastics.

Plastic RR Ties in Transit Track



CTA Has Installed Plastic Ties in Both Elevated & Ballasted Track

Plastic RR Ties in Class 1 Track



Use same installation equipment as for wood ties.

AREMA Guidance on Engineered Composite Ties

- **Under Committee 30 on Crossties**
- **To Develop Minimum Performance Guidance for Engineered Composite Ties**
 - Emphasis on heavy axle load, Class 1 applications
 - Includes both polymeric and wood composites
- **Section 5 on Engineered Composite Ties in of the AREMA Engineering Manuals, Chapter 30, First Published in 2003 Edition**

AREMA Guidance for Plastic Composite Cross Ties

- **Modulus of Elasticity, Min. – 170,000 psi**
- **Modulus of Rupture, Min. – 2,000 psi**
- **Rail Seat Compression, Min. – 900 psi**
- **Single Tie Lateral Push, Min. – 2,000 lbf**
- **Spike / Screw Pullout, Min. – 1,900 / 5,000 lbf**
- **Thermal Expansion, Max. – 7.5×10^{-5} in/in/°F**

Possible Failure Modes

- Meet Minimum Performance Requirements
- Fracture/Cracking
- Tie Plate Cutting
- Fire
- Low Tie/Ballast Interaction
- Creep (increase in gage)
- Stress-Relaxation (loosening of fasteners)
- Deterioration Due to Environmental Exposures

Tie Stiffness / Track Modulus

Oak Ties:	3,160 – 3,240 lbf/in/in
Plastic Ties:	3,190 – 3,430 lbf/in/in



Fracture / Cracking



Cracking at fasteners or tie fracture – can occur during handling or installation procedures

Fire / Combustibility

Switch Heaters



Thermite Welding

Burnt wood tie



Resistance to Environmental Exposures



Exposure to water, diesel fuel, UV-radiation, etc.

Testing of 10-year old composite ties with high tonnage service loading showed NO deterioration of properties.

New Section for Composite Ties for Open Deck Bridges



All plastic composite RR bridge at Fort Eustis, VA

New Section for Composite Ties for Open Deck Bridges

Drivers:

- Declining tie-life and performance from some new (rapid-growth) timber
- Formosan termites
- Higher bridge deck costs, more frequent replacement
- Concrete ties probably not workable
 - ▶ Lack of impact resistance & attenuation
 - ▶ High dead load compared to timber

New Section in 2012 Edition of AREMA Chapter 30

Fire Test Methods

- Concerns with fire in tunnels and open-deck bridges (bridge ties should be at least as fire resistant as timber bridge ties)



Summary / Conclusions

- Technology of engineered plastic composite ties has advanced significantly over the past 2-1/2 decades
- Plastic composites ties are an environmentally friendly and sustainable alternative to treated wood ties
- Engineered composite ties have competitive life cycle costs to wood and concrete
- Manufacturers have come and gone
- Current manufacturers highly focused on quality

Summary / Conclusions

- Current demand for composite ties in excess of current capacity
- International sales for composite ties are also on the rise
- The AREMA engineering guidance needs to be updated to address the higher performing products now available

Questions ???



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