RECYCLED-PLASTIC COMPOSITE RAILROAD CROSSTIES

U.S. railroads replace about 15 million wood crossties each year, and increasing wheel loads are accelerating this deterioration every year. Environmental restrictions on preservative chemical treatments plus higher costs and lower durability have the railroad community interested in alternative materials to wood. Every year over 7 billion lb of high-density polyethylene (HDPE) plastic is molded into consumer product containers, and the vast majority of it ends up in landfills. In the early 1990s, the emerging U.S. plastics recycling industry began experimenting with the idea of fabricating plastic RR ties, and it was quickly determined that it takes more than a tie-shaped block of plastic to duplicate the service performance of a standard RR tie. Plastic ties would have inherent resistance to rot and insects, eliminating the need for chemical treatments, but recycled HDPE by itself lacked the required mechanical properties of wood.

In 1994, researchers from the U.S. Army Construction Engineering Research Laboratory (CERL), Rutgers University, U.S. Plastic Lumber (USPL), Polywood, Inc., and Conrail and Norfolk Southern railroads developed, demonstrated, and patented innovative recycled-plastic composite technologies for use as railroad crossties. First the researchers had to determine which physical and mechanical properties are required to achieve the desired in-service performance, and then they attempted to meet those requirements by incorporating reinforcement fibers into the HDPE to create a composite material. The use of commercially available glass-fibers as a reinforcement is a difficult approach because the high viscosity of molten HDPE results in poor wetting of the glass by the matrix polymer. The resulting fiber-impregnated material is ineffective due to inefficient stress transfer between the matrix and the reinforcement fibers; unwetted pockets of glass fibers act as gross material defects rather than reinforcements. These problems were overcome by either of two innovative techniques: the use of (1) chopped glass fibers recovered from scrap fiber-reinforced polymer composites and (2) recycled waste polystyrene. Using these reinforcements, elastic moduli exceeding 250,000 psi were achieved, compared to an average 90,000 psi for unreinforced recycled HDPE.

Field test installations were conducted by Conrail and Norfolk Southern, including a track section in Conrail's main line between Pittsburgh and Philadelphia. In a related effort, several groups of plastic composite ties were installed in the Facility for Accelerated Service Testing (FAST), a railroad industry test bed at Pueblo, CO; the purpose was to investigate various performance parameters, rail fastening hardware alternatives, and lateral track stability. The oldest ties have so far been subjected to over 500 million gross tons of traffic at heavy wheel loading; there have been no failures of the plastic composite ties, and none show signs of degradation or wear. In December 1998, recycled-plastic composite ties were installed in a turnout (switch) in mainline track at a military munitions center in Indiana — the first application of plastic ties in a turnout.

The longer life expectancy of the plastic ties makes them ideal for hard-to-maintain areas such as turnouts, bridges, and tunnels. USPL is now a licensed manufacturer of recycled-plastic composite RR ties, marketed under the name Duratie, using the Rutgers-developed innovative glass-fiber-reinforced recycled-HDPE technology. The innovative polystyrene reinforcement technology is now being licensed to Polywood, Inc., to manufacture recycled-plastic composite plastic RR ties. After a successful initial test in elevated commuter track, the Chicago Transit Authority has purchased more than 30,000 ties in open bid, and has installed these ties in both elevated and ballasted track. These two types of innovative reinforced plastics technology are now used both in mainline and transit tracks across the U.S., including the Washington D.C. and New York City mass transit authorities. The railroad industry's rapidly growing interest in these plastic composite ties has spurred several other composites manufacturers to compete for a share of the wood replacement tie market. Industry interest has also prompted the American Railway Engineering and Maintenance-of-Way Association (AREMA) to establish a new Subcommittee on Engineered Composite Ties, the purpose of which is to develop engineering guidance for the performance specifications and use of these tie technologies.

As recycled-plastic composite ties become common components in our nation's railroads, they will conserve millions of trees, reduce the leaching of hazardous wood tie preservative chemicals into the environment, and put substantial amounts of the nation's trash to constructive commercial use (thus conserving landfill space). Not insignificantly, these materials will also reduce the railroad industry's track maintenance costs. The rapid acceptance of these innovative composite crossties is especially remarkable considering the traditional and conservative nature of the railroad civil engineering community.

Still more benefits are likely to accrue to the nation from this technological development. Results of a recent study indicate that use of these recycled-plastic materials could help to reduce greenhouse gases in the atmosphere. Furthermore, this same technology could readily be adopted as a very low-cost, high-performance alternative to the more costly composites being tested in the public infrastructure today.

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RECYCLED-PLASTIC COMPOSITE RAILROAD CROSSTIES

Recycled-plastic ties into test track

Plastic composite ties in turnout

Structural plastic lumber in bridge

Waste plastics going to landfill

Eng'd for increased lateral stability

Composite Ties Workshop 2001

Rotting wood crossties

Taking performance measurements

CTA installs plastic composite ties