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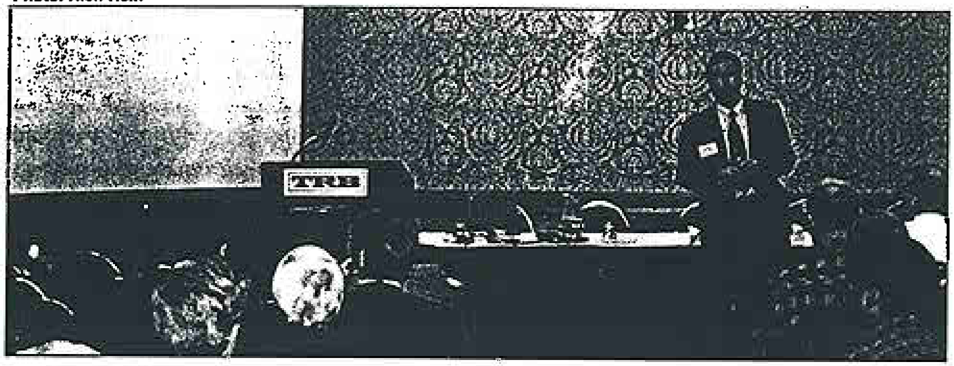

The Next Progression In Treated Wood Tie Technology:

The Engineered Hybrid Wood Crosstie

Editor's Note: On Jan. 13, 1999, RTA Executive Director Jim Gauntt made a presentation to attendees at the 78th annual meeting of the Transportation Research Board in Washington, D.C. A breakout session on "Alternative Tie Designs and Fasteners," sponsored by the Committee on Railroad Track Structure Systems Design, included presentations from the AAR's Rafael Jimenez on alternative tie performance at FAST and from several plastics and steel-based tie researchers. Committee members, and in particular, session chairman Harry Bressler of Burke-Parsons-Bowlby Corporation, had seen the need to educate the audience on the technological advancements in treated wood ties by focusing on "alternative" wood-based materials. RTA, in conjunction with AREMA Committee 30 On Ties Chairman Don Gallery and tie expert Dave Webb, prepared the paper. The following is Gauntt's edited narrative of that paper which outlines that wood remains the material of choice for railroads because of the "progressions" that the industry has created in wood tie technology and how these progressions continue with engineered hybrid wood crosstie and timber alternatives. While it is clear that the solid sawn treated wood crosstie will remain the dominant material for track construction, these new products illustrate how the wood industry continues to develop new tie and timber technologies for track applications.

The treated wood crosstie has come a long way since untreated hand-hewn ties were first installed by railroads more than 150 years ago. These untreated ties, which were replaced every six to eight years, progressed into a solid sawn product in the 1920s that remains the cornerstone of modern railroad track construction. Even with the advent of some of the alternative tie materials in the late 1970s, solid sawn treated wood crossties still retain a 93-94 percent market share of all tie materials purchased and installed in the United States and Canada. There are reasons for this. The wood crosstie has undergone a history of technological "progressions" that have enabled it to perform under increasingly stringent operating conditions.

The first progressions in the technology for wood crossties came fairly early. In order to extend the life of wood crossties and make their use more economical, the preservative creosote began to be used to pressure treat ties. In fact, the first commercially viable treating plant was constructed by the L & N Railroad in 1875. That particular plant utilized a full cell process, or Bethel method, for pressure preserving hand hewn ties with creosote. Today, creosote remains the exclusive preservative used to pressure treat the ties manufactured for the railroad industry.

Progression occurred in wood treating technology by changing the process to an empty cell method, or Rueping-Lowry process, that allowed less preservative to be used, reducing costs. That, along with the advent of small mechanized sawmills, led to the rapid development of the solid sawn treated wood crosstie industry in the early part of this century.

These progressions in production, quality control and preservative treatment that we now reflect on as if they were a form of natural evolution, were actually based on careful research—planned and executed for the benefit of railroads. It is these economic and technological progressions that have made it possible for the treated wood crosstie to retain its 93-94 percent market share.

From a performance perspective, the reason for wood's dominance is that preservative treatment, and improved manufacturing processes, created a product capable of 35-plus years of service in mainline track. Today, in U.S. Class I railroads, the system-wide average life for pressure treated wood crossties continues to exceed 35 years, even with significantly increasing traffic density, loadings and speed.

The "wood" crosstie provides this kind of performance without the luxury of being "homogenous." There are several species that are utilized for solid sawn tie material. These include the oaks, mixed hardwoods—northern and southern groups—southern yellow pine, certain other softwood species both in eastern and western groupings, and Douglas fir. Each of these materials has a regional specificity and properties that have engendered its use by certain railroads.

In the process of developing engineering data for AREMA Committee 30, RTA developed a table of material properties for each solid sawn species and engineered wood. These are published in the Tie Guide and include both RTA performance specifications and treatment specifications of the American Wood-Preservers' Association. Also included is a directory of each approved wood species by grouping and geographical region. As a template to assist railroad engineers in material comparisons, the Tie Guide tables include allowable dimensions, density, weight, moment of inertia, section modules, modules of elasticity, modules of rupture, railseat compression data, surface hardness data, static bending data, stiffness under load, a flexibility factor and lateral resistance.

Understanding that there is an enormous base of knowledge about solid sawn wood tie physical properties helps one to look to the next "progression" in wood ties, "the engineered hybrid wood crosstie." Development of engineered hybrid wood ties and timbers has occurred for two primary reasons. The first is to find ways to improve wood's performance in the track by enhancing its physical properties. The second is to extend the timber resource where necessary and possible.

Investment in wood product research has led to several wood-based alternatives to the solid sawn timber tie. These products combine wood fiber with structural adhesives and polymeric fibers to create structurally efficient products for the railway industry. The advantages of these hybrid wood products include strength characteristic "adjustability," size "adjustability" and longer lengths, timber resource extension by species diversification and the use of smaller diameter trees. Additional advantages include improved treatability—hybrid materials are significantly easier to treat than some solid sawn species. And furthermore, the realization of "just-in-time" inventory is possible with some hybrid products. For example, when waiting for track materials to be cut, air-dried and processed, these products can be treated just after their production.

Referring to "adjustable" strength—there are a variety of factors that create the ability to change the engineering properties in these hybrid wood products. There are choices in species, adhesive selection, and a variable curing process that in some production methods increase the density of the base material. Direction and orientation of the wood fibers can also be altered for different performance characteristics.

In the area of size flexibility, the industry is at a point where essentially any specified size is possible. We are also at a point where almost any specified length is possible. The limitations on this usually come down to the size of the building that engineered laminated products are manufactured in, and/or shipping/handling considerations. It is simply important to note that the laminated product's size is not limited to the size of the tree that is cut, which mean that smaller trees can be utilized. It also means that, because of the engineering that is built into the curing processes and the adhesives and fibers that are chosen, wood species that railroads typically don't specify for use can be utilized.

Referring to treatability—laminated wood products are easily treated. Shorter pressure cycles can be used to achieve preservative penetration in the product. And, less preservative is required to provide the most effective level of protection. For example, when parallel-strand-laminated ties were manufactured for testing on the FAST project in Pueblo, they were treated on a six-hour pressure cycle. Utilizing only six pounds of creosote per cubic foot of wood, 100 percent penetration was achieved. In a solid sawn situation, one would see significantly longer pressure cycles. So, the "treatability" factor is an advantage when it comes to the penetration of preservatives into the product and the processing time.

And then, "just-in-time" inventory; the ability to get it when it is needed has become extremely important in some rail construction projects. The engineered and laminated products that will be illustrated are produced with dry wood. That means that the product, once it's produced, is ready for treatment immediately. There's no need to wait for it to be air-dried, and no steaming is required in the pressure treating process. There have been reports that custom size treated timber and tie orders have been on the job in as little as three weeks. Contrast that production time with solid sawn materials and one can see benefits particularly in bridge and other time-sensitive construction projects.

There are some disadvantages to the hybrid wood products. Initial product costs are less than competitive for certain mass applications of the product. And, a lack of field experience with some of the hybrid products has slowed use by some railroads.

There are five different types of hybrid engineered wood for railroad application. Glued-laminated wood products, dowel-laminated wood products, parallel-strand laminated wood products, fiber-reinforced, glued-laminated wood products and fiber-wrapped solid sawn wood ties.

Glued-laminated ties and timbers are really not that new. In fact, in 1948 the Burlington Northern put glued-laminated ties in track in the state of Washington. These ties were just pulled out of track last year. That's a 50-year service life.

Several railroads have experimented with glued-laminated ties and timbers for the greater part of this century. More recently, in RTA and AAR-sponsored research in the FAST project under heavy axle load testing, southern yellow pine has shown remarkable performance as a glued-laminated tie material. Weatherproof adhesives are used to manufacture laminated products that can then be cut into any size of almost any length. And, since hybrid wood ties are essentially the same product and the same size, track transition and maintenance is simplified—wood replaces wood.

Dowel-laminated ties and timbers have also been investigated for a number or years in the Union Pacific Des Plaines test site. Results show that dowel lamination, by producing a larger wood product, could provide improved performance over the current 7x9 sizes. In the RTA and AAR research at FAST under the Heavy Axle Load program, there are dowel-laminated test ties that have been in place over 423 million gross tons of traffic with no failures.

The new kid on the block is parallel-strand-laminated ties. These utilize thick veneers that are peeled from the log, clipped into strands, and then combined with waterproof adhesives in a microwave curing process. Parallel-strand laminated test ties are in place at FAST and have experienced 167 million gross tons of traffic. Of course, parallel strand material has also been used in many structural industrial applications.

Fiber-reinforced laminated wood is the next grouping. Glued lamination, plus the addition of polymeric fibers, increases the strength of the same size member up to 50 percent. It is excellent material for bridge work and other high-strength applications. The technology also improves the wear properties in the rail/plate bearing area of ties. Dr. Habib Dagher at the University of Maine is building a new facility to do additional research on this product.

This process involves using "aligned" high-tech fibers covered with a polyester or vinylester surface. In the particular case of laminated wood products, one can use a very thin lamination of this high-tech fiber material in the bottom glue line of the lamination process. Utilizing this technology allows jobs to be completed using wood members that otherwise would have to be 50 percent larger.

A presentation on fiber-wrapped ties is to follow, so I won't go over that now.

So, what is around the next bend for hybrid engineered wood products? There will probably be increased use of hybrid engineered wood ties and timbers in "tight" time frame projects. Where there is a need for larger timbers, there will be increasing use. Also, there will likely be increased use of hybrid engineered wood products where larger size or longer lengths in solid sawn timber has become prohibitive for either cost or availability. Where specific strength characteristics need to be "designed in" for certain applications, there will be increased use as well. Thank you for allowing me the opportunity to review the next progression in treated wood tie technology—The Engineered Hybrid Wood Crosstie. §