

A Cost-Benefit Analysis of Creosote-Treated Wood vs. Non-Treated-Wood Materials

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Introduction

Creosote-treated wood products have been a vital part of our nation's physical infrastructure for more than a century. Because they are so cost effective, wood products such as railway ties, cross ties, and bridge timbers, utility poles, and marine and foundation piling that are pressure-treated with creosote continue to be the materials of choice for many industrial, commercial, and governmental end users.

Method of Economic Comparison

Wood products treated with creosote or other preservatives, and products made from alternative materials such as steel, concrete, or plastic, all have specific advantages and disadvantages in particular end use situations. End users (or specifiers) evaluate alternative materials' costs and benefits to determine which offers the most cost-effective choice for specific needs. Creosote-treated wood continues to be widely regarded as the most cost-effective material in the vast majority of circumstances. This paper focuses upon the economic advantages offered by creosote-treated wood vs. non-wood alternative materials.

Creosote-Treated Wood Market

Each year, approximately 91 million cubic feet of wood products are treated with creosote to protect them from infestation and decay and greatly prolong their useful lives. The most significant wood products treated with creosote include railway ties and timbers, electric utility poles, and marine and foundation piling.

By virtue of their ability to resist some of the most challenging conditions of decay and physical abuse, creosote-treated wood products are often installed in aquatic environments. For purposes of this paper, aquatic environments are defined broadly to include not only uses in or over water, but also within the general proximity of water, such as for roads, railroads, and utility lines that follow coasts or rivers. An estimated 15% of creosote-treated wood products, or approximately 12 million cubic feet, are installed within such aquatic environments.



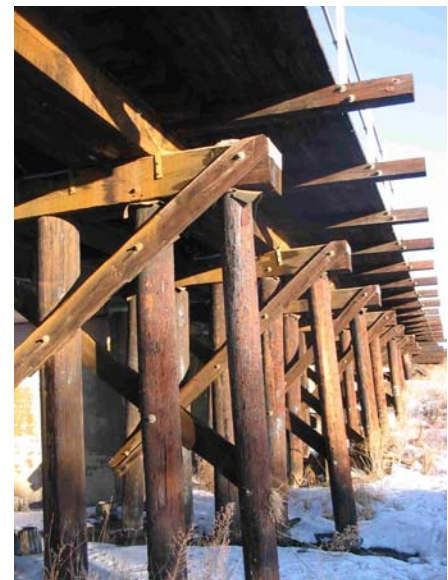
¹ The author has worked in or with the wood preserving industry for approximately 25 years in positions including plant engineer, corporate environmental manager, Chairman of the American Wood Preservers Institute Government Affair Committee, and, as a consultant, has written numerous papers related to the economics and environmental behavior of treated wood. This paper relies heavily on the paper "Economics of Treated Wood Used in Aquatic Applications," dated March 8, 2006 and written for the Western Wood Preservers Institute. That paper is available at www.wwpinstitute.org under the link for Aquatic Issues. Some tables from that paper have been updated to develop data more specifically directed to creosote-treated wood products.

Product Longevity

The U.S. Navy obtains typical service lives for creosote-treated pilings of at least 20 years and probably approximately 40 years.² The piling industry estimates that marine pilings will last about 75 years in northern areas and 40 years in southern areas of the U.S.³ The U.S. Class 1 Railroads similarly find a typical service life of approximately 40 years. The U.S. Forest Service estimates that treated timber bridges last 50 years or longer.⁴ Treated wood utility poles have been shown to provide useful lives of 75 years and longer.⁵ Such service is better than or at least the same as, what can be expected from alternative materials. This longevity means that creosote-treated wood products not only offer lowest installed cost, but also lowest life-cycle cost.

Railroad Uses

Clearly, the railroad industry is the largest user of creosote-treated wood. Railroads continue to choose creosote-treated crossties and related products because they provide unsurpassed cost-effective performance. Wood crossties form a part of the complex railroad system. Wood can flex repeatedly with minimal fatigue. It can absorb severe impact with limited damage, as results when a railcar derails. Such impacts shatter concrete ties. Ties, by being placed horizontally at the ground line, experience the most severe biological decay hazard with extended or continuous moisture and abundant oxygen. The service life can exceed over 50 years and when taken out of service crossties can be recycled to industrial boilers as fuel. Ten percent of railroad trackage is estimated to be located in aquatic environments. Creosote-treated crossties typically cost approximately \$28 each or \$7.50 per cubic foot.



U.S. railroads' use of alternative materials has been only for limited situations. For example, concrete, which costs approximately \$41 per tie, has been found to offer advantages in the curving segments of heavy haul railroads where its weight and rigidity help to keep the rails in place. Concrete ties, however, have very different mechanical properties, such as in flexibility, that mean they cannot safely be inserted into sections of rail with wood ties. Concrete railroad beds require more ballast rock and heavier rails than wood railroad beds but slightly fewer ties are required. A mile of new track using creosote-treated wood crossties costs approximately \$236,000. A mile of new track using concrete crossties costs about \$308,000, approximately 30% more than with wood ties.

² Smith, April 2006, Comments Regarding The Economic And Alternative Materials Sections Of: "Treated Wood In Aquatic Environments: Technical Review And Use Recommendations" Stratus Consulting, October 2005, prepared for the WWPI.

³ Pile Durability, Timber Piling Council web site at <http://www.timberpilingcouncil.org>.

⁴ Michael Ritter, 1990, Timber Bridges: Design, Construction, Inspection, and Maintenance, USDA Forest Service. See <http://www.fs.fed.us/na/wit/WITPages/timberbridgespub.html>.

⁵ Wood Pole Life Span. What You Can Expect. Andrew Stewart, Engineering Data Management, reported in Wood Pole Newsletter, Volume 20, 1996.

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The methods and technologies for use of concrete crossties are still developing. Although concrete crossties have been utilized by the railroads in limited situations for at least the last two decades, problems continue to be discovered. For example, significant problems with the rail fasteners have recently developed causing some early failures in heavy haul track structures. Excessive abrasion in the rail seatings and fastener and concrete failures continue to create performance problems.⁶ Given the 40 to 50 year intended product life, the U.S. railroads have chosen to continue their heavy reliance on creosote-treated wood crossties while also investigating alternative crosstie technologies.

The Railway Tie Association (RTA) reports that for crosstie replacements (that is crossties replaced into existing track as part of maintenance) during 2005, approximately 96% of ties used were wood and 4% were concrete and that 95% of ties purchased for all purposes in 2005 were wood.⁷

A detailed comparison of the costs of creosote-treated wood crossties with concrete, plastic, and steel crossties was recently completed for the RTA.⁸ This evaluation considered the varying life expectancies for creosote-treated wood crossties in dry (western), moderate (northern), and wet (southeastern) climates, for low, moderate, and high annual tonnage rates, and for straight and curved track. Creosote-treated wood tie life was estimated to range from a low of 19 years for wet climate, high tonnage, curved track to a high of 50 years for dry climate, low tonnage, straight track. Creosote-treated wood crossties consistently provided significantly lower railway costs ranging from approximately 57% to 86% of alternate materials in the dry and moderate climates and slightly lower to slightly higher costs ranging from 83% to 113% of alternate materials in wet climates. However, the recent trend to dual treat crossties with borate and creosote is expected to result in significantly longer life in wet climates for very little added cost.⁹ Thus, creosote-treated wood crossties can be expected to provide lowest overall cost even in the wet climate of the southeastern U.S. and with overall cost savings relative to alternate materials approximately as estimated by this author for projected savings.

Steel and plastic crossties have found limited use by the railroads. These ties cost approximately \$65 each, compared to \$28 for creosote-treated crossties. These materials offer flexural qualities more similar to wood so that the railroads have been experimentally interspersing such ties into an otherwise wood crosstie system. However, the installed cost for such ties is at least 50% more than creosote-treated wood crossties. In addition some railroads have experienced fastener problems with the steel ties. A mile of new track using steel or plastic ties costs approximately \$356,000.

The U.S. railroads mostly use creosote-treated crossties to replace decayed, worn, and/or damaged ties. They install approximately 20 million equivalent ties per year at a cost of approximately \$580 million for all uses and \$72 million for aquatic environment uses. The installed cost of these ties amounts to approximately \$1.5 billion overall and \$190 million for aquatic uses annually. Compared to the alternative materials, creosote-treated crossties allow the U.S. railroads to save approximately \$615 million overall and \$76 million in aquatic application areas annually.

⁶ Jim Gauntt, RTA, Personal communication, 3 December 2007.

⁷ Jim Gauntt, Wood Ties Dominate 2005 Installs, Crossties, September/October 2006, Pg 12-16.

⁸ Allan Zarembski, Development of Comparative Cross-Tie Unit Costs and Values, August 2006.

⁹ RTA R&D Briefing: Borates as Pre-Treatment Preservative Enhancers, undated. Available from <http://www.RTA.org>.

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Creosote-treated wood crossties offer significant advantages, beside lower cost, over concrete, steel, and plastic crossties. Their lighter weight allows greater ease of handling and flexibility in crews and equipment. The wood crossties lower mass and greater resiliency means the ties provide a dynamic pad that attenuates impact loading. This reduces wear on rails and other structural components and also reduces noise and transmission of vibration to structures near the right of way. Wood provides electrical isolation, an important factor for track signaling. No other alternative material can match these qualities.¹⁰

Railroad track systems utilizing creosote-treated wood crossties not only provide the most cost-effective design, but also offer long term proven performance. Improvements in treatment technology, such as pretreatment with borate, and in-track maintenance treatments are expected to further extend, and thus lower the life-cycle cost, of treated-wood crossties. Concrete ties will probably continue to hold a portion of the market, but performance problems make them unsuitable as broad-scale replacements for wood crossties. Plastic crossties, which are actually composites of recycled and virgin plastic reinforced with steel, remain an emerging technology approaching similar in-track performance to wood, but without long-term proven performance and at much higher cost and with dependency on high-cost, imported petroleum and steel. Further, the raw material supply and manufacturing base for plastic would require many years, probably decades, to ramp up capacity to replace creosote-treated wood. Steel crossties introduce problems to signaling due to their conductivity and, although available for many decades, have never earned significant market share due to inferior cost and performance compared to wood.

Marine and Freshwater Market

Creosote-treated piling, timber, and lumber are used to construct and maintain docks, piers, dolphins, bulkheads, and retaining walls in applications serving marine end users ranging from freight terminal operators, the U.S. Navy, municipalities owning docks and marinas, and transit districts. The facilities may be in salt, brackish, or fresh water bodies. For simplicity, these are all called “marine” in the rest of this paper. All uses are obviously in aquatic environments. Private and smaller commercial docks, piers, and related structures are not considered within this market for the purpose of this paper.



Approximately 1.2 million cubic feet of creosote-treated wood are used annual in the U.S. for marine applications. Although material costs range widely depending on the product, an average cost of creosote-treated wood is estimated to be approximately \$14 per cubic foot with an installed cost (including labor, equipment, etc.) of approximately \$77 per cubic foot.

¹⁰ A. M. Zarembski, Wood Crosstie Benefits, undated, available from <http://wwpinstitute.org>.

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Two projects using creosote-treated wood and alternative materials of concrete and/or steel, one in the smaller range and one larger, have been evaluated for costs and those costs averaged to estimate the market savings offered by creosote-treated wood. Creosote-treated wood costs less than similar structural members of concrete or steel. Treated wood can often be installed at lower cost due to lower weight, the fact that it floats, and the ease of field modifications. On a whole project basis, projects using treated wood are approximately one half the cost of the same projects using concrete or steel. Additionally, for many installations, the flexibility and ability to absorb shocks, the natural taper that increases friction capacity, and no need for additional corrosion protection make creosote-treated wood the preferred choice for pilings.

The value of creosote-treated wood products sold to the marine market is approximately \$16 million per year. The installed cost of this material is approximately \$93 million per year. The cost of the same projects using alternate materials would be approximately \$182 million annually. The availability of creosote-treated wood products allows the marine market to save approximately \$89 million each year.

Utilities Market

Treated wood continues to be the choice material for utility poles and cross arms in electrical transmission and distribution and communication services. While products treated with creosote represent 10% to 15% of the utility treated wood market, some companies find that creosote treatment is preferable due to their unique situations. Most utilities continue to select treated wood because it is the most cost effective in comparison to alternatives of concrete, steel, and fiberglass. An estimated 5% of utility poles are installed in aquatic environments.

Approximately 328,000 creosote-treated utility poles, or 8,400,000 cubic feet of creosote-treated wood, are sold to the utility market annually. Approximately 16,000 poles, or 420,000 cubic feet, are installed in aquatic environments.

The annual value of creosote-treated poles sales to the U.S. utilities is approximately \$148 million overall and \$7 million in aquatic areas. The installed cost of these poles is approximately \$262 million overall and \$13 million in aquatic areas, annually.

A representative pole for the utility market is considered to be the class 4, 45-foot long pole. The installed cost of this pole is typically approximately \$800. Comparable costs for poles of other materials are \$1,650 for fiberglass, \$1,370 for steel, and \$1,750 for concrete. Compared to steel, the least cost alternative, the utilities are saving approximately \$187 million overall and \$9 million in aquatic applications annually by using creosote-treated wood instead of the non-wood alternatives.

Widespread installation of electric transmission or distribution lines underground is not a cost-effective alternative to overhead systems using wood poles. Following a major ice storm in 2002, the North Carolina PUC¹¹ studied this option and concluded, “replacing the existing



¹¹ North Carolina Public Staff Utilities Commission News Release, November 21, 2003. Obtained from the North American Wood Pole Coalition at <http://www.woodpoles.org/documents/undergroundpressrelease.pdf>.

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overhead distribution lines ... with underground lines would be prohibitively expensive.” They further concluded that although some improvement in reliability in the face of abnormal weather could be obtained, that “is offset by a 58% increase in repair time, as underground faults require specialized repair crews to locate the faults, dig up the area around the fault, and repair the cable.”

Utilities tend to continue use of treated-wood poles for reasons other than cost. Wood poles are easier to climb. Wood’s naturally low conductivity reduces electrocution hazard. Wood can more easily be repaired or field modified. Utility industry comments to the EPA by the Utility Sold Waste Activities Group stated: ***“The most critical factors in an electric utility’s selection of materials for transmission and distribution poles are safety, reliability, and functionality. Treated wood poles are superior to the alternatives in all three categories, and they are more cost-effective.”***¹²

Unit Cost Comparisons

The cost comparisons discussed in the above sections address complete system comparisons, reflecting designs that are optimal for each type of material. Additionally, the unit costs were developed to reflect the large buying power of major industrial companies. The unit costs in the following table represent typical unit costs to contractors¹³ to obtain and install the materials. These costs are not directly comparable to those used elsewhere in this paper to develop market impacts, but do provide a direct illustration of comparative unit costs.

Typical Unit Costs for Treated-Wood and Alternate Materials

| MATERIAL | Material Cost | Installed Cost | Cost Units |
|---|----------------------|-----------------------|-------------------|
| Driven Foundation Pilings | | | |
| Creosote-Treated Wood, 12#, up to 40-feet, 12” butt, 8” tip | \$9.95 | \$15.60 | /l.f. |
| Concrete, Precast, Prestressed, 40-feet, 12 | \$10.55 | \$16.28 | /l.f. |
| Pipe Piles, 12-inch dia., no concrete fill | \$23.00 | \$31.44 | /l.f. |
| Crossties | | | |
| Creosote-Treated, 7 x 9 x 8’-6” | \$43.00 | \$67.48 | /each |
| Concrete, 8’-6” | \$93.50 | \$114.79 | /each |

¹² USWAG, 2005. Comments of the Utility Sold Waste Activities Group on the Notice of Availability of the Preliminary Risk Assessment for Wood Preservatives Containing Pentachlorophenol Re-registration Eligibility Decision.

¹³ Means Building Construction Cost Data 2007, Reed Construction Data, Inc.

Environmental Risks

The environmental impacts associated with creosote-treated wood products have been extensively studied and are, therefore, well understood and can be mitigated where necessary. A study of creosote-treated dolphins installed in the Puget Sound area showed that PAH levels in tissue of mussels growing on the treated-wood surface were not elevated and that within just four years, “the most significant environmental response to these structures was the establishment of a diverse and abundant epifaunal [surface attached] community on the piling and the attraction of large numbers of Dungeness crabs, starfish, finfish and other megafauna [larger animals] to what had become an artificial reef.”¹⁴ A study published by the U.S. Forest Service considered creosote-treated crossties in a wetland environment and concluded that no significant migration of PAHs occurred from the ballast into the wetland environment.¹⁵ For cases that users or regulators question whether a specific use of creosote-treated wood might impact an aquatic environment, the WWPI has published a guide, backed by scientific study, to evaluate specific situations.¹⁶ For more detailed evaluation, the WWPI also has a creosote-treated wood model that can be downloaded from their website so that project and environmental data can be entered and evaluated.¹⁷

Environmental impacts of alternative materials are usually presumed to be insignificant, even though they may present risks or potential risks that have simply not been evaluated. For example, galvanized steel releases significant amounts of zinc. Plastic and components of fiberglass release plasticizers that are believed to be endocrine disrupters. Further, plastic remains in the environment for a very long time, breaking into small, floating pieces that have been found in ocean water at up to 10 pounds of plastic for every pound of plankton.¹⁸ Up the food chain, this has resulted in raptors with bellies full of plastic.¹⁹ New concrete may leach constituents that increase the pH of water and/or toxic metals. Old concrete, with jagged points of rebar, cannot be dismissed as a safety hazard to humans and animals alike. The environment is not well served by giving these alternative materials a free pass while restricting creosote-treated wood.

Wood is a renewable resource that is grown, harvested, and manufactured into products in the U.S. Treatment of the products with creosote occurs at facilities in the U.S. At the end of its useful life, creosote-treated wood may be recycled for energy recovery in industrial boilers, thereby reducing reliance on imported fuel and reducing use of limited landfill capacity. Creosote, as well as creosote-treated wood, does degrade naturally over time in the environment. The amount of energy input, and resulting air emissions, to manufacture treated wood is one-

¹⁴ D. Goyette and K. M. Brooks, Addendum Report, Continuation of the Sooke Basin Creosote Evaluation Study, Year Four – Day 1360 and 1540, May 12, 2001

¹⁵ K. M. Brooks, Polycyclic Aromatic Hydrocarbon Migration from Creosote-Treated Railway Ties Into Ballast and Adjacent Wetlands, Research Paper FPL-RP-617, June 2004.

¹⁶ Treated Wood in Aquatic Environments. Available at <http://www.wwpinstitute.org>.

¹⁷ Download model from <http://www.wwpinstitute.org/researchdocs/creosote/creorisk.XLS>.

¹⁸ Plastic in the Plankton, ACF Newsource, available at http://www.acfnewsource.org/environment/plastic_plankton.html.

¹⁹ Assessing and Monitoring Floatable Debris, Oceans and Coastal Protection Division, U.S. Environmental Protection Agency, EPA-842-B-02-002, August 2002. Available at <http://www.epa.gov/owow/oceans/debris/floatingdebris/>.

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quarter to one-tenth that required for concrete, steel, or plastic.²⁰ The environmental arguments in favor of creosote-treated wood are compelling.

Conclusion

The railroad, marine, and utility users continue to buy and install creosote-treated wood products in their systems. They do so because, as the above analysis shows, it is highly cost-effective to do so. For the situations where creosote-treated wood is most cost effective, the savings relative to non-wood alternative materials are large, as shown in the following table.

| U.S. Market Area | Whole Market Annual Savings (millions) | Aquatic Market Annual Savings (millions) |
|-------------------------|---|---|
| Utilities | \$187 | \$9 |
| Railroads | \$615 | \$76 |
| Marine Construction | \$89 | \$89 |
| U.S. Total | \$891 | \$174 |

Substitution of alternative materials does not offer an easy choice nor “solve” a perceived environmental problem, but would create unintended consequences of higher transportation and utility costs and present new environmental issues.

Creosote-treated wood has supported the U.S. infrastructure for the last century as a strong, flexible, environmentally sound, and cost-effective material. Today, it still is all these things.

²⁰ R. A. Sedjo, Wood Materials Used as a Means to Reduce Greenhouse Gases (GHS): An Examination of Wooden Utility Poles, October 2001, available from <http://wwpinstitute.org>.