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Research and Test Department

SURVEY OF WOODEN CROSSTIE TESTS
VOLUME I

Report No. R-744

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AAR Technical Center
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13. ABSTRACT

In order to avert possible loss of valuable information, this survey was undertaken to compile a central listing of all wooden crossties tests which have previously been or are currently being performed by railroads or laboratories in the United States.

Records on 305 tests were located and abstracts have been written on each test. These are compiled and listed on the computer at the Association of American Railroads Technical Center in Chicago, Illinois.

Additional information on any individual test may be obtained by contacting the railroad or laboratory originating the test.

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Canadian Pacific LTD, Montreal, Quebec

Consolidated Rail Corporation, Philadelphia, Pennsylvania

CSX Transportation, Inc., Jacksonville, Florida

Illinois Central Railroad, Chicago, Illinois

Norfolk-Southern Railway, Atlanta, Georgia

Soo Line Railroad, Minneapolis, Minnesota

Southern Pacific Transportation Co., San Francisco, California

Union Pacific Railroad, Omaha, Nebraska

Burlington Northern Railroad, Overland Park, Kansas

EXECUTIVE SUMMARY

The testing of various species of wooden crossties, preservatives, seasoning and treatment methods on a variety of track environments began as early as 1900 on U.S. and Canadian railroads.

Contact with chief engineers of the major class one railroads, both the U.S. and Canadian Forest Products Laboratories, the American Wood Preservers Association, the Railway Tie Association, the National Technical Information Service and the Transportation Research Information Service resulted in locating records on 305 individual tie tests.

An abstract has been prepared for each test describing the objectives, test site location, test variables, current status and persons to contact. These abstracts are on file at the Research and Test Department-Technical Center, AAR, 3140 South Federal Street, Chicago, Illinois 60616, along with complete descriptions and results, where available, for each individual test.

1.0 INTRODUCTION

The Association of American Railroads/Railway Tie Association Ad Hoc Committee on Wood Tie research was desirous of locating and compiling a listing of all wooden cross tie tests which have been conducted on U.S. and Canadian railroads or by laboratories or agencies involved in wood research. It was felt that because of railroad mergers and personnel changes in engineering and purchasing departments, any data which might have been collected following a tie test installation could become lost or destroyed. Since there is no singular listing of all the wooden tie tests, it was also the desire of the committee to compile this information to be housed at a central location for ready reference and use by anyone interested in learning the results of a particular test. The decision was made to list the tests on the computer at the Technical Center, AAR, in Chicago, Illinois. Entry to the list can be made by the use of keywords which pertain to wood crosstie installations, i.e., species, preservative, method of treatment, seasoning method, etc. Appendix E contains a discussion of the AAR crosstie test database.

Contact with all major railroads was made to determine what tests they had in track and to secure the inspection records each railroad had in its file. Similar inquiries were made of various laboratories and agencies engaged in wood research. Unfortunately, it was found that several railroads which have test installations no longer keep records on them and, in fact, have destroyed test files during a transfer of engineering office-locations. Most of the railroads contacted no longer monitor the tests because of personnel shortages. Many of the inspection results were last recorded as far back as ten years and have not been updated.

Should additional information be desired by the reader, it can be secured from the AAR Technical Center in Chicago or the railroad contact person shown on the abstract listing. Any conclusions are solely those of the writer and may differ from the railroad property doing the testing. None of the tests were observed by the writer.

2.0 DATA ANALYSIS

A total of eighteen railroads and four wood research organizations were contacted. Test records were received from nine railroads and three of the research organizations. Railroads providing data were ATSF, Conrail, CSX, IC, N-S, SP, UP, CP and CN. Additional data was provided by the U.S. Forest Products Laboratory, Forintek, formerly Canadian Forest Products Laboratory, the American Wood Preservers Association, and AAR.

A high percentage of the tests reported are no longer in service and only a small percentage of those are being inspected or monitored in some way. This is because most of the railroads do not have the personnel to do this work. Only three roads indicated that they were inspecting some of their tests and were planning to continue only as long as there was sufficient manpower.

Many of the test reports which are listed do not contain enough information from which to draw any conclusions. The reporting railroad either discontinued making inspections and tabulating the necessary data or the details which had been collected have been lost or destroyed. In many cases, the test was conducted and visually inspected with no detailed information recorded. Because of this lack of data, this report will be confined to summarizing those tests which contain sufficient information from which to draw some conclusions.

Data will be classified by groups such as species of wood tested, preservatives and treatment, seasoning methods, and track hardware. Where possible, correlation of similar variables from various sites will be made.

3.0 WOOD SPECIES

It seems safe to say that all species of wood in the United States and Canada, which are acceptable for use as crossties, can be treated with a wood preservative in an effort to protect them from decay organisms.

In the early days of railroading, however, ties were used untreated. There were no preservatives or treating facilities available. Species such as white oak, black locust, black walnut and cypress were used untreated by railroads East of the Great Plains. Railroads in the West used Douglas Fir, Larch, Redwood and Lodgepole pine to a large extent.

In the eastern portion of the U.S., white oak was the preferred species because of its abundance, natural durability and resistance to mechanical wear. Quoting from a report written by W. J. Burton, assistant to Chief Engineer, Missouri Pacific Railroad Company, "Beginning with the earliest construction in 1851, track ties were of white oak. With untreated white oak, the average life prior to 1900 was somewhere around eight years, being greater on the lines in Kansas, Nebraska and Colorado than on those in Arkansas or Louisiana. It is probable that the early white oak ties averaged greater life than the white oak of later years, partly because the latter came more from the low lands and partly because of increasing traffic, speeds and wheel loads." (1)

Other species in use untreated exhibited similar characteristics of durability and furnished approximately the same length of service. Appendix A, taken from USDA Forest Products Laboratory General Technical Report FPL-229, lists the comparative resistance of heartwood to decay of various species.

Early railroads did not actually test wood species before their use. They used a product that was relatively cheap with all the necessary requirements to support rails and with a seemingly inexhaustible supply. One of the earliest tests to evaluate a species which had not been used for crossties was placed in track in 1910 on the Southern Pacific using five varieties of Eucalyptus. This test was installed and monitored by the Forest Products Laboratory, Madison, Wisconsin, as follows:

Final report on test of Eucalyptus Ties.

Ties consisted of five varieties.

1. Blue Gum or Eucalyptus Globulus, marked by one notch one nail.

2. Red Gum or Eucalyptus Rostrata, marked by two notches and two nails.

3. Sugar Gum, or Corynocalyx, marked by three notches and three nails.

4. Gray Gum, or Tereticornis, marked by four notches and four nails.

5. Red Ironbark, or Sideroxylon, marked by five notches and five nails.

These ties were placed in track May 18, 1910, on Section 17, just west of Madrone, from Engineers Station 967 plus 74.3 to 971 plus 99.9.

The track in which these ties were placed was rock ballasted in August 1909, new 90# CS rail having been laid in February 1909.

Variety No. 5, or Sugar Gum, were procured from L. D. Purdy of Berkeley, California in the form of logs 10 to 24" in diameter and 8' long of which there were 100 pieces, same being cut from trees in December, 1909 and were sawn into 7" x 9' ties at West Oakland, January, 1910, making 111 ties. These ties were placed from Engineers Station 970 plus 54.3 to Engineers station 970 plus 57.3.

Balance of ties were procured from Mr. Robert Main of Corona Del Mar Ranch at Goleta, California being hewn ties and were cut during February and March 1910, more particularly described as follows:

Variety #1.

Blue Gum (E. Globulus) 11 trees were cut, making 40 ties, 35 of these ties from first growth, 35 year old trees and 5 ties from second growth about 11 years old. All were placed in track, from Engineers station 971 plus 28.3 to 971 plus 99.9.

Variety #2.

Red Gum (E. Rostrata) 11 trees were cut making 40 ties, trees being 38 years old; 38 of these ties being placed in track between Engineers stations 970 plus 57.3 and 971 plus 28.3.

Variety #4.

Gray Gum, (E. Tereticornis) 10 trees were cut making 41 ties from trees 33 years old. 35 of these ties were aid in track from Engineers station 967 plus 90.3 to 968 plus 54.3.

Variety #5.

Red Ironbark (E. Sideroxylon) 4 trees were cut making 11 ties from trees 35 years old, nine ties being placed in track between Engineers station 967 plus 74.3 and 968 plus 90.3.

During the first three months of service these ties split considerably but thereafter no further change was noted. Varieties No. 1, 2, 4 and 5 which were hewn two faces were in poor shape when installed, while variety No. 3 the sawed ties were in good shape.

All these ties remained in service without special attention until December 1914 when three of variety No. 5 were removed because of shattering. Balance of variety #5 were removed in May, 1917. No further change was made until may, 1919 when all varieties were removed.

Of these ties variety No. 3 gave most satisfaction but this was evidently due to the fact that they were sawed ties from large trees while other varieties were from small trees being hewn ties.

The wood in four varieties of these ties did not show decay except in the sapwood but checked badly so that track spikes had an insecure hold, and had they been on curved track would have been removed several years ago.

The experiment shows that gum tree ties are not satisfactory in this nine year test.

A number of imported species and varieties have been tested, particularly at times when for one reason or another, there appeared to be a shortage of timber for crossties in the U.S. In a report published in 1920, the author Albert W. Buel, consulting Engineer, writes, "Attempts to develop a railway tie supply from the tropical and semi-tropical forests have failed. Yet, there is good reason to believe that in this very field is to be found one of the most immediate and most significant possibilities in the use of tropical hardwoods. In a special report of the committee on ties of the American Railway Engineering Association, made some months ago at the request of the Railroad Administration, the unsatisfactory condition of our tie supply and its probable future was fully discussed. At the present rate of consumption, the report says, the standing timber in the United States would be exhausted in thirty years, but due to the increasing value and similar causes affecting consumption, the present supply supplemented by new growths will last at least fifty years. During this period, however, the cost of ties will increase continually, quality will decrease, and more and more difficulty will be experienced in supplying the demand. For these reasons, the development of additional sources of supply is of prime importance." (2)

Obviously our timber supply for crossties has continued to be adequate up to the present time and, according to U.S. Forest Service projections, will continue to be sufficient for the next thirty to fifty years. The greatest amount of testing of imported species occurred in the 1970's when a number of South American woods were offered to the railroads.

Tests of Brazilian woods were installed on the Chessie System and on the Southern Railway system. Ties from Belgian Congo and Ecuador have also been tested. Some of these imported ties remain in track today, however they are not being monitored and no figures are available as to their success or failure. There have been no reports in the last seven or eight years of interest by the railroads in imported ties.

In reading the reports of recent tests that have been located, none of the railroads or agencies were found to be testing the ability of the wood to perform as a crosstie in an untreated state until late 1986 when a group of untreated white oak and Ekki (Laphina alata), an African species were installed for evaluation on Conrail's South Fork, Pennsylvania test track.

Conrail believes that it is necessary to evaluate the economic feasibility of decay resistant species both from the U.S. and foreign sources. Ekki, also called Azobe, is a very dense African hardwood and while it can be treated, needs to be tested under high speed heavy tonnage conditions to determine its natural durability in an untreated state. This and the untreated white oak test will be inspected regularly until conclusions can be drawn.

4.0 PRESERVATIVES AND TREATMENT

The treatability of various woods is determined by the actual structure of wood cells and vessels making up the substrate. Penetration of a preservative can be either longitudinally by means of aligned vessels or tangentially through openings or pits that lead from one cell to the adjoining cell and through the cell walls themselves. These openings or pits have an internal membrane that may, in certain heartwoods, come in contact with the opening and effectively block passage of preservatives, thereby causing poor treatment. Another such condition results from natural crystalline occlusions occurring in the living cell that also blocks the passage of preservative in the heartwood vessels of some species. Appendix B, taken from USDA Forest Products Laboratory General Technical Report FPL-15, lists the treatability of heartwood of various species.

While there has not been a lot of testing done on untreated species, the results of our survey show that a large number of different species have been tested after impregnation with a wood preservative of some kind. Following the introduction of Creosote in the late 1800's, many other wood preservatives were formulated and virtually all of them were tested in crossties. These include chromated zinc chloride, pentachlorophenol, borax, KP resin, asidbar, copper napthanate, zinc-meta-arsenite, Boliden salt, chromated copper arsenate and various types of petroleum. Many different solvents have also been tested in solution with Creosote and Pentachlorophenol. The greatest number of the tests located in the survey were concerned with evaluating the ability of a specific preservative to protect various species of wood used as crossties under a myriad of track conditions.

Reports of some representative tests are as follows:

Performance of Douglas Fir Ties Treated with 47-53 Creosote Fuel Oil Solution

Purpose

To determine the service life of Creosote treated Douglas Fir ties installed in curved track.

Material Treated

100 Douglas Fir ties were treated with a solution of 47 percent Creosote and 53 percent fuel oil to a final net retention of 8.55 pounds per cubic foot of wood.

Installation

The ties were installed out of face on a 2^0 curve under 130# rail in March, 1932. Ballast was crushed rock. Eight rail anchors per 39 foot rail section were used. Location was East from MP 759 near Clackamas, Oregon, on the Portland Division of the Southern Pacific Transportation Company. This test was last inspected in 1974. Annual tonnage was 26 MGT.

Conclusions

Ninety four percent of the ties were removed from track in 42 years mainly because of plate cutting and checking. Based on the chart for determining probable service life of crossties developed by J. D. McClean, USDA Forest Products Laboratory and assuming the test ties would have been completely removed in 1978, the average life for these ties is calculated to be 35 years. See Appendix B.

Performance of Douglas Fir Ties Treated With Borax in Petroleum Oil

Purpose

To determine the service life of Douglas Fir ties treated with a Borax-Petroleum solution and installed in curved track in Oregon.

Material Treated

100 Douglas Fir ties were treated with 0.45 pounds per cubic foot of Borax and 6.4 pounds per cubic foot of heavy petroleum distillate.

Installation

The ties were installed out of fact in a 2^0 curve under 130# rail in March 1932. Ballast was crushed rock. Eight rail anchors per 39 foot rail section were used. Location was East from MP 759 near Clackamas, Oregon on the Portland Division of the Southern Pacific Transportation Company. This test was last inspected in July, 1958. Annual tonnage was 26 MGT.

Conclusions

Ninety six percent of the ties had been removed from track by 1957, principally because of plate cutting and splitting. Using the probable service life chart in Appendix B and assuming the balance of the ties would only last until 1958, the average life for these ties is calculated to be 21.4 years.

Performance of Douglas Fir Ties Treated With Borax-Petroleum Solution

Purpose

To determine the service life of Douglas Fir ties treated with a Borax-Petroleum solution for installation in tangent track in California.

Material Treated

100 Douglas Fir ties were treated with 0.42 pounds per cubic foot of Borax and 4.95 pounds per cubic foot of heavy petroleum distillate.

Installation

These ties were installed out of face in tangent track under 110# rail in sand ballast. Location was at the East end of the station at Garnet, California on the Los Angeles Division. Data of installation was May, 1931. Annual tonnage was 33 MGT. Final inspection and report was made in March, 1948.

Conclusions

Ninety six percent of the ties had been removed by the date of the final inspection indicating an average life to that time of 15.1 years. Plate cutting and splits were the primary causes for removal. It is interesting to note that these Borax treated ties in Southern California were in sand ballast while the previously described ties with similar treatment were in Oregon in crushed rock ballast. The Oregon installation had approximately 6 years longer service life. Borax treatment, however, did not give the long life received from creosote petroleum treatment.

Performance of Douglas Fir Ties
Treated With 70/30 Creosote Fuel Oil solution

Purpose

To determine the service life of Douglas Fir ties located with 70/30 Creosote Petroleum solution and installed in tangent track.

Installation

The ties were installed out of face in tangent track under 110# rail in Dome* ballast. Location was MP 749 to MP 750 near Dome, Arizona on the Tucson Division of the Southern Pacific Transportation Company. Data of installation was January, 1935. Annual gross tonnage was 33 MGT. Final inspection was April, 1963.

Conclusions

Ninety three percent of the ties had been removed by the data of the final inspection. The balance of the ties were described as being so badly split, shattered, checked or plate cut that it is estimated they will be replaced within the next year. The average service life of the test was 16.8 years based on the prediction chart for tie service life in Appendix B.

While the four tests described above represent only a very small percentage of the total number of tests and were treated in

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* Dome Ballast is ballast obtained from the quarry at Dome, Arizona.

the 1930's, they are among the few tests which had final reports documented. Inspection and reporting were discontinued on a very high percentage of the tests listed in the appendix and thus no conclusions can be determined by the writer. It is suggested that the railroad conducting the test be contacted if further information is desired by the reader.

5.0 SEASONING METHODS

In order to satisfactorily (pressure) inject a preservative into a wooden crosstie, it is necessary to remove the moisture from the cells within the wood. The preservative replaces the water in the cells and protects the wood from decay.

The oldest method of drying or seasoning wood prior to treatment is stacking in the open with sufficient space between the pieces to allow air movement and thus evaporate the moisture. This is a very effective means of drying crossties but requires considerable time due to the size of the piece of wood involved. It becomes necessary to purchase the ties a number months ahead of when they are required for use in the track.

The majority of the test identified in this survey were treated after a period of air seasoning ranging from 4 to 14 months depending upon the species of wood being used and climatic conditions at the drying site. Other methods of drying ties include Boultonizing, vapor drying, shed drying and controlled air seasoning.

The Boultonizing process consists of boiling the green ties in the creosote solution while under a vacuum for a period ranging from 8 to 16 hours until the moisture content is sufficiently low enough to permit adequate treatment; generally about 50 percent. Water removed is captured and measured during the process. Regular creosote treatment follows the drying period. Total time to condition and treat the ties ranges from 18 to 22 hours.

Vapor drying of crossties is accomplished by subjecting green ties to a hot solution containing a drying agent such as Xylene which creates organic vapors that boil off the water from the ties. This heating period usually takes from 10 to 12 hours. A vacuum period of approximately two hours follows the drying and the regular treatment cycle occurs thereafter. Total time for the entire drying and treating process is about the same as for Boultonizing; from 18 to 22 hours.

Shed drying is actually air drying by stacking the ties under a roofed structure to keep rainfall off of the ties. This method has been tried in only a few locations where rainfall is heavy. Additional cost is required to construct and maintain the sheds in the storage yard. It is reported, however, that drying time is substantially reduced and fewer surface checks are experienced.

Controlled air seasoning also uses a roofed structure with the addition of large fans which are used to circulate air through the tie stacks periodically. As with shed drying, additional cost for construction and maintenance is necessary. This method is not in general use, but has been tested by at least one railroad in the past. Unfortunately, no record of results is available for inclusion in the list of tests.

One railroad kept very good records on the comparison of Boultonizing, vapor drying and air seasoning. The results of their test after seventeen years in track estimate average service for vapor dried ties at 18.3 years, Boultonized ties at 17.5 years, and air seasoned ties at 21.0 years. These averages were determined from the "Estimated Average Life" table published in the AREA Proceedings, (9), after calculating the percent of ties remaining in the test.

Several other railroads continue to use each of these major methods of seasoning; air drying, vapor drying or Boultonizing; but have not reported tie conditions or have no records from which additional conclusions can be drawn. The reader may, by using the keywords for any of these methods, locate the railroads which have conducted any tests and make contact with the appropriate party for further information.

6.0 TRACK HARDWARE TESTS

Historically, the cut spike has been used to fasten rail to the wooden crosstie. During the last 10 to 15 years, however, several other types of fasteners have ben developed and tested to be used in place of cut spikes. Tests have been installed using elastic spikes and screw spikes. Some of the fasteners which were originally developed for use with concrete ties have been modified for use on wooden ties. Compression clips, Pandrol clips, TR&D rigid blot down fasteners, DE clips, Portec Curv/Bloc and McKay Safe Lok fasteners are among those which are currently being tested.

These newer fastening systems are being tested in curved track in an effort to retain better gage. Holding gage has consistently been a problem when using cut spikes due to movement and thus loosening in the spike hole.

The railroads testing these fasteners do not record the performance of individual ties, but do make periodic inspections of the installation and note the condition of the track at that time. Most of the tests were installed in the late 1970's or early 1980's and no conclusions have been reached. Reports of recent inspections, however, indicate satisfactory performance toward correcting the condition for which the test was installed. Test conducted with the AAR Decorator vehicle showed that several premium fasteners have significantly superior resistance to gage widening than conventional, cut spike, track.[10]

Another problem relating to hardware used on wooden ties is that of tie plate cutting. Basically, two methods have been tried in order to eliminate this condition. Tests using longer than normal tie plates or 16 gauge galvanized steel wear plates ranging in length from 14" to 18" directly under standard tie plates have been installed. Either of these plates will help to distribute the load over a larger area of the rail bearing portion of the tie and thus reduce the possibility of the plate cutting into the tie. Pads made of rubber and plastic have also been tested under standard steel tie plates.

Tests have been conducted using inserts made of plastic or very durable hardwood plugs inserted into holes bored into the tie under the tie plate. If the plate begins to cut into the tie; these plugs will provide a support into which the plate cannot cut.

End splitting of wooden ties has been a problem which has initiated some testing. An early method to control end splitting was the use of the anti-splitting iron formed into a C or S shape and driven on edge into the end of the tie. The shape of the device enabled it to hold the grain of the wood together and reduce the possibility of a split. It was found, however, that ties do continue to dry and shrink while in track permitting the irons to loosen and drop out of the ends. Because of this, many railroads have discontinued the usage of irons. They have instead tested other types of hardware in order to control splitting.

Steel dowels are driven into a pre-bored hole a few inches from the end and their fluted shape prevents the tie from splitting. If a split has started, it can be squeezed together and application of the dowels will prevent it from opening. One railroad reported the testing of stainless steel bands placed around the end of the tie in an effort to control splitting. This was done in 1957, but no records were kept as to their effectiveness.

A product which has been developed recently is the nail plate. This is a piece of galvanized steel with a cross section slightly smaller than the end of a tie. Many elongated holes are punched into the piece to form teeth. It is driven into the end of the tie and prevents splitting from occurring. It was first tested on the Milwaukee Road and considered very successful after 16 years.(11) Based on the results of this application, nail plates are finding widespread usage currently.

7.0 MISCELLANEOUS TESTS

Many tests have been conducted which do not come under the previous groupings. They were initiated to correct or alleviate a particular problem occurring with the tie. Included in these tests are incising and kerfing to reduce surface checking, the use of bituminous and petroleum coatings to protect against weathering, laminating two or more smaller pieces of timber together with glue or dowels to form a full size or larger tie, and the use of wood chips bounded together to form a crosstie.

Several railroads and treating companies have tested the practice of incising crossties prior to seasoning in an effort to reduce the quantity and size of surface checks which can extend beyond the treated zone after installation in the track. It has been found that incising reduces the stresses which normally occur in a tie when it is drying. It has been felt that the majority of tie splitting develops during air seasoning prior to treatment. One test reports, however, that checks in unicised ties continue to grow in number and severity long after installation in track. It has also been reported that incised ties are more sound than the unincised. Many small checks are present but fewer large checks are noticeable.(3) The incision also provide for better penetration of the preservative into the tie averaging up to as much as 0.5 pounds more preservative per cubic foot of wood than in ties which were not incised.

Another method which has been tested to prevent the development of large surface checks is that of kerfing. Saw cuts or kerfs 0.16" wide and from 2 to 2 1/2 inches deep were made in the side surfaces of several species of ties. The center line of the sides of the ties was not used as a kerfing position since checks in the kerfs could possibly line up and cause a lateral split to occur. For this reason, the kerf position was staggered. After air drying, it was found that there was a considerable reduction in the number and severity of checks. They had been diverted from the top surface of the tie to the side areas. In order to restore bending strength to the tie, it was necessary to glue splines into the kerf.(4) While this method was successful in removing the checks from the top surface of the tie, it would obviously be considerably more expensive than incising due to the need for additional machining, gluing and handling.

Coatings of tar or bituminous products have also been tested as a means of reducing moisture fluctuations in ties an thereby reducing the enlargement of checks. Tests have been conducted by the AREA and the Canadian Forest Products Laboratory at Ottawa as well as by several railroads.

A test of particular interest on which detailed records were kept is the one conducted by the Canadian Forest Products Laboratory. Forty eight 6" x 8" x 8" hard maple (acer saccharum Marsh) ties were supplied by the Canadian National Railway. The ties were treated in two steps. First, the treating schedule was regulated to result in deep penetration of creosote at light retentions and then a second treatment was given by injection of undiluted coal tar or a mixture of coal tar and creosote. Mixtures used were 80 percent coal tar with 20 percent creosote and 60 percent coal tar with 40 percent creosote. One group was treated with creosote only to be used as controls.

The purpose of the two step treating cycle was to improve the possibility of bleeding of preservative from the tie that would provide the advantages of a protective coating which would form after the tie was exposed to the weather in the track. The treating schedule was, therefore, regulated to result in deep penetration of the creosote for maximum preservative effectiveness followed by the second light treatment of the protective mixture which would have a tendency to bleed freely upon exposure to the sun.

After treatment the ties were exposed to weathering by being placed several inches apart on an asphalt surface at the laboratory. The ties remained undisturbed for four years during which period they were examined periodically. The ties were not placed in track because they were not pre-drilled. Six inspections were made during the four year period. Treating data are shown in Exhibit 1. Results of the examinations are shown in Exhibit 2 and Exhibit 3.

The bar graph shows a comparison of the various groups in which the extent of bleeding was based on an arbitrary evaluation in which "zero" denoted a perfectly dry tie and "100" denoted a totally wet surface.

The following conclusions were drawn at the end of the four year period:

1. The treatment of 100 percent creosote followed by 100 percent coal tar exuded a sufficient amount of preservative to produce protective coatings on the ties between six and twelve months following treatment.

2. The other three treatments did not cause sufficient bleeding to be considered satisfactory for the formation of protective coatings.

3. The injection of two to three pounds per cubic foot of coal tar resulted in heavy bleeding.

4. Bleeding of the ties appeared to be a function of the proportion of coal tar employed in the second step of treatment. The higher the proportion of coal tar the greater the tendency to bleed.(5)

Exhibit 1.

Two-Step Treating Data for Maple Cross-ties

(creosote followed by protective mixture)*

Charge	Protective Material Employed	*Average Retention, PCF		Remarks Following Treatment
		Creosote	Protective Mixture	
1	nil------------	8.57	nil)	These ties formed the control group and were not treated with protective mixture.
2	nil------------	5.72	nil)	
3	nil------------	5.27	nil)	
Lowry Process				
4	coal tar--------	4.10	2.90	Ties had dirty, dripping tops, sides were clean.
5	coal tar--------	4.75	2.07	All ties were clean and dry.
6	coal tar--------	5.75	2.05	Ties were moist and shiny.
Lowry Process				
7	80 tar/20 creosote	7.65	1.35	Ties were clean but slightly moist.
8	80 tar/20 creosote	5.45	2.02	Ties were clean with some wet shiny patches.
9	80 tar/20 creosote	6.17	2.32	Ties were shiny and greasy.
Full Cell Process				
10	60 tar/40 creosote	9.07	1.82	Two ties were coated with a dry sludge.
11	60 tar/40 creosote	6.47	1.80	Two ties were coated with a dry sludge.
12	60 tar/40 creosote	5.05	4.72	Charge was steamed. Ties had a shiny surface.

* The protective material was coal tar or coal tar and creosote mixture.

Exhibit 2.

Annual Ratings for Checking and Bleeding of Cross-ties Over 4 Years of Exposure.

Preservative Treatment[1]	A						B						C						D					
Date of Inspection[2]	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Avg. No. Checks per tie in the groups of 12 each.....	1.7	1.6	1.6	1.8	2.0	1.9	2.0	2.0	2.0	1.8	1.8	1.8	2.6	2.5	2.6	2.4	2.5	2.7	2.2	2.1	2.0	2.2	2.3	2.3
Total Area bleeding[3]	10	5	10	10	0	0	1125	950	740	540	293	190	396	320	240	205	106	91	183	160	132	149	114	102
Avg. Area of ties bleeding·	1.0	0.4	0.4	0.5	0	0	94	79	61	45	25	16	33	27	20	17	9	8	15	13	15	13	10	9
No. ties showing wet surfaces..................	3	1	2	2	0	0	12	12	6	8	8	6	6	6	7	9	8	8	4	8	8	9	9	8

1 Preservatives:
- A = Creosote
- B = Creosote followed by coal tar
- C = Creosote followed by 80 coal tar + 20 creosote
- D = Creosote followed by 60 coal tar + 40 creosote

2 Dates of Inspection:
1. May 30, 1962
2. August 3, 1962
3. July 22, 1963
4. June 30, 1964
5. June 8, 1965
6. June 22, 1956

3 The area bleeding was an estimate of the percentage of upper surface which had a liquid creosote or tar covering. The average was the sum of all such areas in a group divided by the number of ties in the group

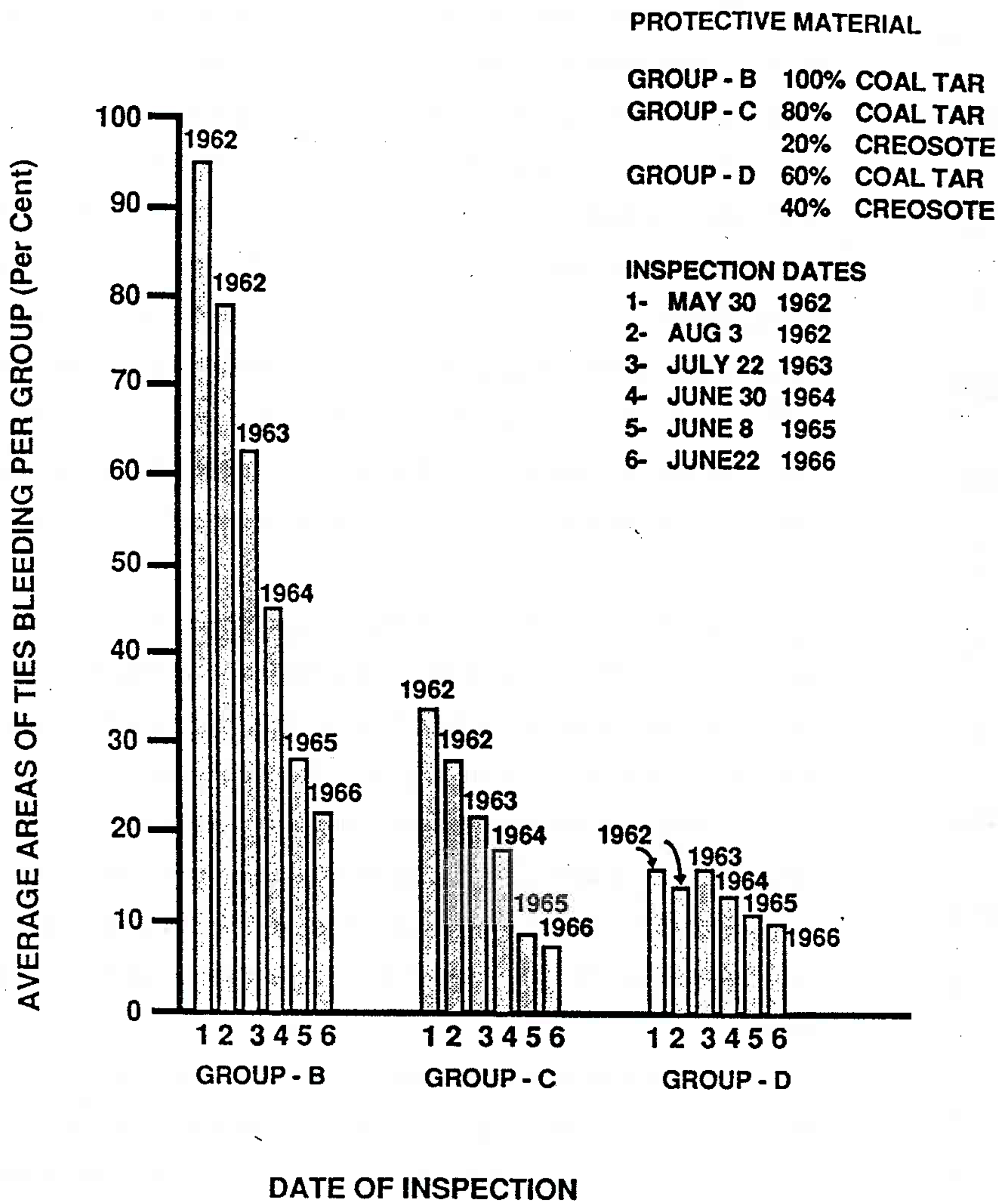

Exhibit 3. Results of Inspection for Bleeding of Cross-ties Over 4 Years of Exposure.

Obviously, additional expense is necessary to employ the method described and the individual railroad would have to weigh this extra cost against their need for protection from checks.

During the late 1960's and early 1970's, some tests were conducted to determine the feasibility of making a wider tie by using smaller timbers held together with screw type fluted 1/2" steel dowels. The intent was to fabricate a tie with a wider base which could be placed on thirty inch centers and compete with the concrete tie. It was also felt that this practice would permit utilization of smaller timber which, in some areas, was more readily available than timber required for solid sawn ties.

Laminated ties were also formed using two pieces of 3 x 6" or 4 x 6" x 8'6" based and then dowelling a top board of 4 x 8" or 3 x 8" cross section for a finished tie seven inches thick with an 8 inch wide face and 12 inch wide base.

Several combinations of wood species were used in making these ties. Commonly oak, hickory and mixed hardwoods were used for the top piece with yellow pine as the base pieces, although many were made of all hardwood. A few were made entirely of pine.

As with most of the tests located, no detailed records were kept of these tests but a few railroads who reported the installation of this type of tie advised that they were performing very satisfactorily in track. There have been no reports of the timbers separating and very little plate cutting has been observed after ten years of service.

Another type of laminated tie which has been tested by one railroad is constructed of several laminations which have been glued together with a phenolresoreinol resin glue. A total of thirty-two ties were fabricated in a laboratory. Sixteen ties were made with five dressed laminations, each the full width and length of the tie. The following pattern was used:

Top lamination	yellow birch	7/8" thick
Second lamination	jack pine	1 5/16" thick
Third lamination	jack pine	1 11/16" thick
Fourth lamination	jack pine	1 5/16" thick
Bottom lamination	jack pine	1 11/16" thick

The remaining sixteen ties were fabricated from on-inch lumber of random widths and lengths. Scarf joints were made in many of the laminations to obtain the required length of eight feet and the material was edge-glued to make up the full width of the ties. All pieces were dressed on four sides. The ties consisted of a top lamination of yellow birch 7/8" thick.

All of the thirty-two ties were incised on tops and bottoms and were pressure treated with 50/50 creosote petroleum solution. Thirty-two solid sawn jack pine ties were installed as controls. Installation was made in 1948 and 1949 at two locations. The last inspection was made in 1975. The performance rating and service life are shown in Appendix D.

After twenty-seven years in track, the laminated ties were in much better mechanical condition than the solid control ties.(6)

Some testing has also been conducted using a reconstituted composite wood tie fabricated from wood chips and resin. This mixture is placed in a mold and formed into a solid piece under heat and pressure. A longitudinal support member is placed in the center of the tie for reinforcement.

The wood chips are made from crossties which have been removed from the track. The original concept for this type of tie was to provide usage for crossties removed from track. The disposition of used tie has become an increasingly difficult problem for the railroad industry since burning has been outlawed by most states and solid waste landfills are being filled and closed.

In addition to tests installed on several railroads in the late 1970's, a test was also placed in the track at the Transportation Test Center at Pueblo, Colorado. Between 1976 and 1982, approximately 700 million gross tons (MGT) of heavy axle load traffic ran over these ties. In 1982, the ties were removed from the track for inspection.

The inspection revealed that forty-seven percent of the apitong wood reinforced and seventeen percent of the steel reinforced ties had broken through vertically under the rail seat; also twenty percent of the wood reinforced and thirty-five percent of the steel reinforced ties had delaminated to various degrees. In comparison, none of the sawn softwood ties and less than two percent of the sawn hardwood ties used for controls had been condemned during the same test period.

Data showed no significant difference between reconstituted ties and conventional ties in their ability to resist plate cutting. However, the composite ties that had delaminated also had substantial plate cutting.(7)

Two of the railroads which have installed the composite wood tie report horizontal and vertical breaks which are causing delamination and breakage under the tie plate area. They believe, however, that if improved engineering is applied to the initial technology used in developing this type of tie, a viable alternative to the conventional wood tie is possible.

An additional experiment involving the fabrication of crossties from several small pieces of wood glued together was conducted by the USDA Forest Products Laboratory in Madison, Wisconsin.

Crossties were made by the Press-Lam process in which logs are cut into veneers, dried and glued together into timbers of crosstie size. Two studies were completed to evaluate the Press-Lam processing and performance of crossties.

In April 1973, sixteen ties were produced, six of which were placed in Conrail track near Orrville, Ohio and the remaining ten were tested in the laboratory. Eventually, seven of these were placed in a yard track for observation. The second study consisted of fabricating twenty-five full-sized ties made from four foot long veneer instead of full tie length material. All ties were tested for bending stiffness. Nine were retained at the laboratory for bending strength and sheer strength determinations and sixteen were sent to a treating plant for preservative treatment. Of these, eight ties were placed in BN track near Moline, Illinois, four were placed in a yard track and four were placed in the FAST loop at the Transportation Test Center, Pueblo, Colorado.

Inspection in 1979 indicated that all ties were performing very well in the track. There has been no report of their condition since that time. The laboratory tests indicate that Press-Lam ties were not significantly different from solid-sawn ties in physical properties.

The viability of this product, however, most likely will depend upon the economies of manufacture rather than performance characteristics.(8)

8.0 FUTURE TESTING

A few railroads have indicated a renewal of interest in establishing test sites for testing any new developments relating to the wooden crossties as well as other track components. BN, Conrail, Santa Fe and Norfolk-Southern are all involved and have specified certain personnel to be responsible for monitoring new tests and any earlier tests which are still in track on which conclusions have not been drawn.

9.0 SUMMARY

While it was not possible to secure information about all of the wooden crosstie tests that have been installed because of mergers, personnel changes and testing policies on various railroads, we are fortunate to have located a sufficient number of tests which can be examined by the reader. By making contact with the railroad or institution initiating the test, information can be gained that will provide the reader with details that will enable him to determine if new testing of a particular product or condition should be undertaken.

10.0 REFERENCES

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9. American Railway Engineering Association, Report of Committee 3-Ties, "Method of Determining Approximate Average Life of Ties in Track," Proceedings, p. 808, Volume 35, 1934.

10. Reinschmidt, A. J., Choros, J., Shafarenko, V. M., Track Gage Characteristics as Measured from a Moving Vehicle on Mainline Track, Report R-561, Association of American Railroads, November, 1983.

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11.0 APPENDICES

APPENDIX A

COMPARATIVE RESISTANCE OF HEARTWOOD TO DECAY

USDA FPL Note 229

TABLE 10-2 Comparative Resistance of Heartwood to Decay

Resistant or very resistant	Moderately resistant	Slightly or non-resistant
Baldcypress (old growth)	Baldcypress (young growth)	Alder
Catalpa	Douglas-fir	Ashes
Cedars	Honeylocust*	Aspens
Cherry, black	Larch, western	Basswood
Chestnut	Oak, swamp chestnut	Beech
Cypress, Arizona	Pine, eastern white	Birches
Junipers	Pine, longleaf	Buckeye**
Locust, black	Pine, slash	Butternut
Mesquite	Tamarack	Cottonwood
Mulberry, red		Elms
Oak, bur		Hackberry
Oak, chestnut		Hemlock
Oak, Cambel		Hickories
Oak, Oregon white		Magnolia
Oak, post		Maples
Oak, white		Oak (red and black species)+
Osage-orange		Pines (most other species)++
Redwood		Poplar
Sassafras		Spruces
Walnut, black		Sweetgum**
Yew, Pacific		Sycamore
		Willows
		Yellow-poplar

APPENDIX B

TREATABILITY OF HEARTWOOD OF VARIOUS SPECIES USDA FPL-15 PUBLICATION

Method of Application

The two main features of a preservative treatment are the preservative use and the method of applying it. The results will also be affected by the treatability of the species selected (table 1).

Table 1. - Treatability of heartwood of various species

Group 1. - Heartwood least difficult to penetrate

Softwoods	Hardwoods
Bristecone pine (Pinus aristata).	American basewood (Tilla americans).
Pinyon pine (P. edulis).	Beech (white heartwood) (Fagua granditolia).
Redwood (Sequoia sempervirens).	Black tupeio (blackgum) (Nyssa syivatica).
	Green ash (Fraxinus pennsylvanica var. lanceoiata).
	Pin cherry (Prunus pensylvanica).
	River birch (Betula nigra).
	Red oaks (Quercus spp.).
	Slippery elm (Ulmus tulva).
	Sweet birch (Betula lenta).
	Water tupelo (Nyssa aquatica).
	White ash (Fraxinus americans).

Group 2. - Heartwood moderately difficult to penetrate

Softwoods	Hardwoods
Baldcypress (Taxodium distichum).	Bigtooth aspen (Populus grandidentata).
California red fir (Ables magnifica).	Black willow (Salix nigra).
Douglas-fir (coast) (Pseudotsuga menziesli var.menziesli).	Chestnut oak (Quercus montana).
Eastern white pine (Pinus atrobus).	Cottonwood (Populus spp.).
Jack pine (P. banksiana).	Mockernut hickory (Carya tomentosa).
Loblolly pine (P. taeda).	Silver maple (Acar saccharinum).
Longleaf pine (P. palustria).	Sugar maple (A. saccharum).
Ponderosa pine (P. ponderosa).	Yellow birch (Betula lutes).
Red pine (P. resinosa).	
Shortleaf pine (P. echinata).	
Sugar pine (P. lambertiana).	
Western hemlock (Tsuga heterophylla).	

Group 3. - Heartwood difficult to penetrate

Softwoods	Hardwoods
Eastern hemlock (tauga canadensis).	American sycamore (Platanus occidentalis).
Engeimann spruce (Picss engeimannii).	Hackberry (Calis occidentalis).
Grand fir (Ables grandis).	Rock elm (Ulmus thomsal).
Lodgepole pine (Pinus contorta var. latifolla).	Yellow-poplar (liriodendron tullifera).
Noble fir (Ables procera).	
Sitka spruce (Picea sitchensals).	
Western larch (Larix occidentalis).	
White fir (Ables concolor).	
White spruce (Picee gisuca).	

Group 4. - Heartwood very difficult to penetrate

Softwoods	Hardwoods
Alpine fir (Ablee lasiccarpa).	American beech (red heartwood) (Fague granditolia)
Corkbark fir (A. lasiocarpa var. arizonics).	American chestnut (Castanea denista).
Douglas-fir (Rocky Mountain) (Pseudotsuga menziesil var. glauca).	Black locust (Robinia pseudoscacis).
Northern White-cedar (Thuja occidentalis).	Blackjack oak (Quercus marilandics).
Tamarack (Larix laricina).	Sweetgum (redgum) (Liquidambar styraciflua).
Western redcedar (Thuja pilcata).	White oaks (Quercus spp.).

APPENDIX C

Average service life prediction chart for tie service life (from USDA Wood Hand Book #72)

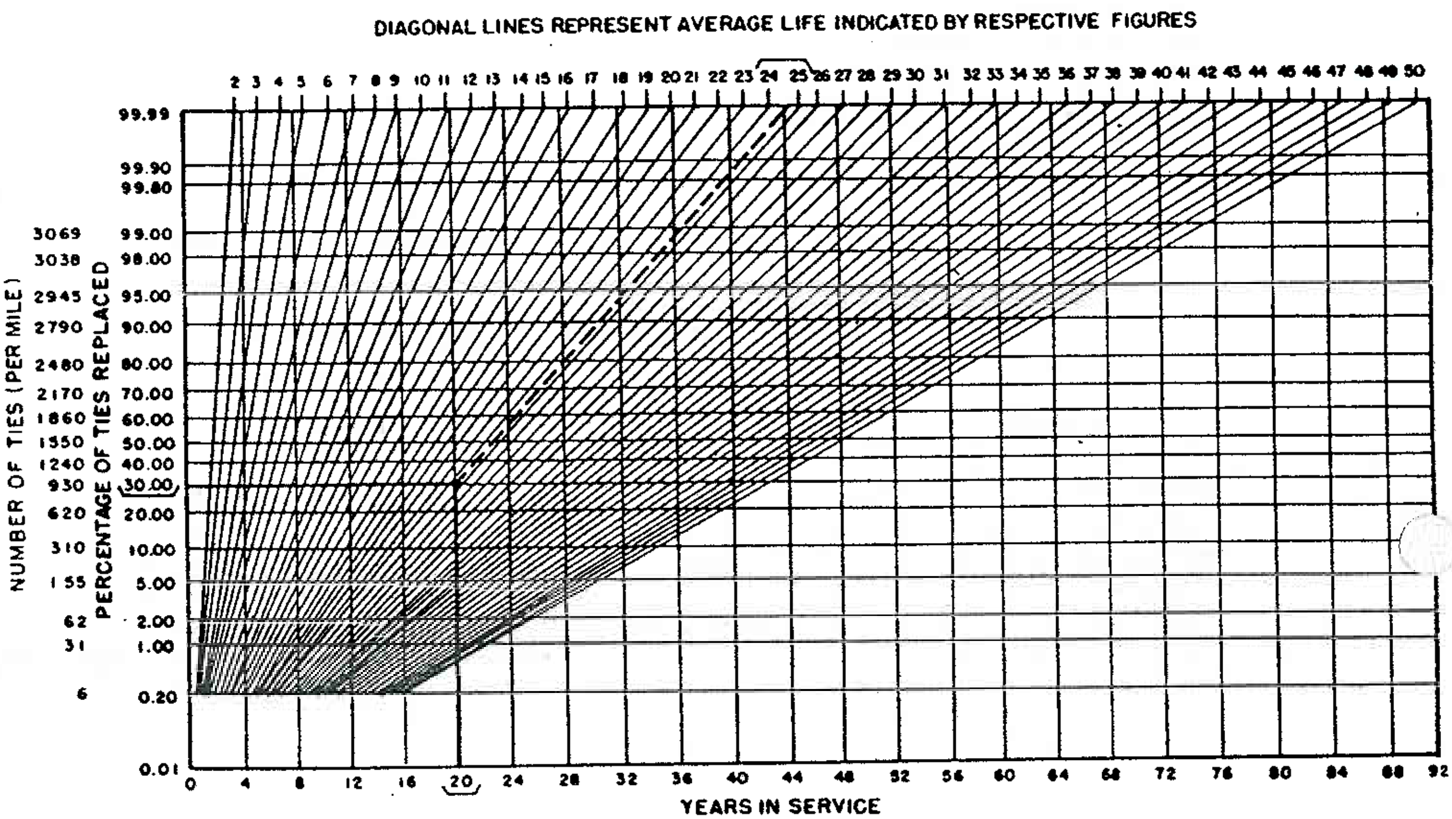

Chart for determining the probable average life of ties from the percentage replaced in a given time. To use the chart find the percentage-renewal figure at the left, follow this line horizontally until it intersects the vertical line corresponding to the number of years the group of ties has been in service, then follow the nearest heavy diagonal line to the upper edge of the chart where the probable average life of the group of ties in years will be found.

APPENDIX D

PERFORMANCE RATING AND SERVICE LIFE OF GLULAM TIES

Test Lot[1] No.	Year	No. of Ties Rated	Checking (inches) Average	Plate Cutting (inches) Average	Ties with end splits %	Service life (a/R) Max. 27/100
			Glulam Ties			
1448	1969	16	1.0	0.8	0	
	1971	16	1.0	0.9	18	
	1973	16	1.1	1.0	18	
	1975	16	1.2	1.2	19	27.0/100
1450	1970	16	0.8	0.4	19	
	1972	16	0.8	1.0	19	
	1975	15	0.6	0.9	13	26.9/94
			Control Ties			
1447	1969	10	2.1	2.5	70	
	1971	10	2.5	2.6	80	
	1973	10	2.4	2.6	80	
	1975	5	-	-	-	20.9/50
1449	1970	14	3.1	2.1	79	
	1972	4	-	-	-	
	1975	3	-	-	-	24.3/18

[1] Lots 1447 and 1448 - 16 each installed near North Bay, Ontario in 1949.
Lots 1449 and 1450 - 16 each installed near St. Lazare, Quebec, 1948.

APPENDIX E

CROSSTIE TEST DATABASE

For each crosstie test found an abstract was written to summarize the test information. Data from each abstract was entered into a database on AAR's mainframe computer in Chicago. Exhibit 4 is an example abstract.

The use of a database to store the information allows AAR to expand the current entries or add more entries as data becomes available. The data can be analyzed in several ways. One can list entries by title, author, railroad, location, or keyword. The keywords are generally the test variables. Exhibit 5 is a listing of current keywords or subject terms contained in the database.

The database will be maintained by AAR for use by AAR and RTA members. Procedures will be developed for outside access to the database by members. Several standard report options will be available to the user. Obtaining information via the standard reports will not require any knowledge of the database program or its operations. Exhibit 6 shows a currently available "report" from the database listing the title, abstract, and keywords of all entries having the keyword "spacing."

This database can be a useful tool in crosstie research. It can provide background on products, processes and ideas tested in the past or present. It can provide ideas for future work or provide proof that some ideas may not work.

In order for the database to be truly useful it must be comprehensive and current. Contributions from all wooden

Exhibit 4. Tie Database Abstract

AAR_ID	291
RR_ID	WP-131
ENTRY_DATE	7/21/1988
START_DATE	010167
END_DATE	010186
TEST_PROGRESS	C
TEST_TITLE	TIE CONDITION AT DES PLAINES: A PROGRESS REPORT
AUTHOR1	D.D. DAVIS
AGENCY_NAME	A.A.R.
SPONSORING_NAME	A.A.R./R.T.A./C&N.W. R.R.
STATION_BEGIN	IL DIVISION; W. B. TRACK
MILES_BEGIN	MP 13.9
STATION_END	?
MILES_END	MP 15.1
CITY	DES PLAINES
STATE	IL
COUNTRY	U.S.A.
DESCRIPTION	?
MGT	30
NUM_OF_TIES	3400
CON_NAME	D.D. DAVIS
CON_TITLE	SENIOR RESEARCH ENGR
CON_ADDRESS	3140 S. FEDERAL ST.
CON_CITY	CHICAGO
CON_STATE	IL
CON_ZIP	60616
CON_PHONE	(312) 567-6748

========================<ABSTRACT>============================

A TEST SECTION OF TIES WAS INSTALLED IN 1967 BY THE AAR, RTA, AND C & NW RAILROAD. THE PRUPOSE OF THIS JOINT PROJECT WAS TO EVALUATE THE PERFORMANCE OF VARIOUS CONFIGURATIONS OF CROSSTIE SIZES AND SPACINGS. EIGHT SECTIONS WERE INSTALLED IN THE TEST. THIS PROGRESS REPORT DISCUSSED THE RESULTS OF SUBJECTIVE AND OBJECTIVE TRACK/TIE CONDITION SURVEYS MADE DURING 1986. OBSERVATIONS AND TRENDS HAVE BEEN NOTED. TIE BEARING AREA PER UNIT LENGTH OF TRACK APPEARS TO BE A KEY PARAMETER. TIE CROSS-SECTION, LENGTH, AND SPACING CAN EACH AFFECT TIE FAILURE RATES AND MODES.

==

DOWEL-LAMINATED
TIE SPACING
CROSSTIE
CROSSTIE LENGTH
CLUSTERING
FAILURE RATE

==

crosstie researchers are needed. Towards that end we wish to thank the following organizations for their contributions.

LIST OF SPONSORING NAMES AND COUNT OF EACH

A.A.R/R.T.A./C&N.W.R.R.	(1)
A.T.&S.F. RWY CO.	(30)
ASSOCIATION OF AMERICAN RAILROADS	(2)
B & O RAILROAD	(10)
BOSTON & MAINE R.R.	(1)
C.N. RWY	(18)
C.P. RAILWAY	(14)
CENTRAL OF GEORGIA R.R. CO.	(1)
CHESSIE SYSTEM	(4)
CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC R.R., CHICAGO, IL	(2)
CONRAIL	(31)
EASTERN FOREST PRODUCTS LABORATORY	(1)
FOREST PRODUCTS LAB.	(1)
ILLINOIS CENTRAL R.R., CHICAGO, IL.	(2)
INDIANAPOLIS, COLUMBUS AND SOUTHERN TRACTION CO., INDIANAPOLIS, IN.	(1)
KOPPERS CO. INC. PENNSYLVANIA R.R.	(1)
L AND N RWY CO., CHESSIE SYSTEM	(4)
N-S RWY SYSTEM	(12)
NORTHERN PACIFIC RAILWAY CO.	(1)
PENN-CENTRAL TRANSPORTATION CO.	(4)
PENNSYLVANIA R.R.	(3)
S.P. TRANSPORTATION CO.	(59)
SEABOARD COAST LINE R.R.	(3)
SOUTHERN PACIFIC R.R. CO., SAN FRANCISCO, CA.	(1)

SOUTHERN RAILWAY SYSTEM	(4)
THE DETROIT AND MACKINAC R.R., DETROIT, MI.	(1)
U.P. RAILROAD CO.	(72)
VARIOUS WESTERN RAILROADS	(1)
WHEELING & LAKE ERIE R.R.	
(NOW N-S & NORFOLK-WESTERN R.R.)	(2)
MISSING	(6)

Exhibit 5. List of Database Keywords

KEYWORDS	KEYWORD_ID
1% PENTA-BURNER FUEL	1
2% PENTA-BURNER FUEL	2
2% PENTA-PETROLEUM	3
24 + BURNER FUEL OIL	4
25-75 CREOSOTE-FUEL OIL	5
25-75 CREOSOTE-HEAVY FUEL	6
25-75 CREOSOTE-PETROLEUM	7
3 APR 6	8
3% PENTA SOLUTION	9
3% PENTA-PETROLEUM	10
30-70 CREOSOTE-FUEL OIL	11
30-70 CREOSOTE-PETROLEUM	12
4% PENTA-PETROLEUM	14
44-56 CREOSOTE-FUEL OIL	15
47-53 CREOSOTE-FUEL OIL	16
5% PENTA	17
5% PENTA PETROLEUM	18
50-50 BIENFAIT CREO.PETRO	19
50-50 CREO-AROMATIC OIL	20
50-50 CREOSOTE-COAL TAR	21
50-50 CREOSOTE-PETROLEUM	22
50-50 CREOSOTE-FUEL OIL	23
50-50 CREOSOTE-HEAVY FUEL	24
57-43 8DCREOSOTE-FUEL OIL	25
5 APR 6	26
60-40 CREOSOTE COAL TAR	27
60-40 CREOSOTE-PETROLEUM	28
70-30 CREOSOTE COAL TAR	29
70-30 CREOSOTE-PETROLEUM	30
75-25 CREOSOTE-PETROLEUM	31
80-20 CREOSOTE COAL TAR	32
ABANDONMENTS	33
AFRICA	34
AFTER TREATMENT	35
AIR DRYING	36
AIR SEASONING	37
ALBERTA JACK PINE	38
ANTI-CHECKING	39
ANTI-CHECKING IRON	40
ANTI-SPLITTING	41
ARKANSAS GAS-OIL	42
ARTIFICIAL SEASON IN OIL	43
ARTIFICIAL SEASONING	44
ASIDBAR	45
ASPHALTIC CRUDE OIL	46
AWPA GRADE 1 CREOSOTE	47
BALLAST TYPE	48
BEECH	49
BELGIAN CONGO HARDWOOD	50
BETHEL PROCESS	51
BIENFAIT CREOSOTE	52
BIENFAIT TAR	53
BIENFATE LIGNITE CREOSOTE	54
BIRCH	55
BIRD TIE PADS	56
BLACK OAK	57
BORAX	59
BORING	60
BOULTON PROCESS	61

Exhibit 6. Example Database Report Listing Abstracts Related to Tie Spacing.

***************************************TITLE***************************************
DOWEL LAMINATED WOOD CROSSTIES

============================ABSTRACT============================
THIS TEST WAS INSTALLED TO EVALUATE THE PERFORMANCE OF 7''X10''X8'6'' AND 7''X12''X8'6'' LAMINATED WOOD CROSSTIES FABRICATED FROM 2 PIECES OF 7''X5'' OR 7''X 6'' OAK TIMBERS FASTENED WITH STEEL DOWELS. THE 12'' TIES ARE INSTALLED ON 30'' CENTERS AND THE 10'' TIES WERE INSTALLED ON 25'' CENTERS. RACOR STUDS, BIRD TIE PADS AND CUT SPIKES WERE USED IN THE INSTALLATION. ANNUAL GROSS TONNAGE IS ?
#######################################<KEYWORDS>################################
BIRD TIE PADS
DOWEL-LAMINATED
RACOR STUDS
STEEL DOWEL
TIE SPACING
****

***************************************TITLE***************************************
DOWEL LAMINATED CROSSTIES

============================ABSTRACT============================
THIS TEST WAS INSTALLED TO EVALUATE THE PERFORMANCE OF DOWEL LAMINATED TIES COMPARED TO SOLID SAWN TIES. 240 TIES, 6''X12'' IN CROSS SECTION, WERE MANUFACTURED FROM 6X6X8'6'' OAK TIMBERS USING FOUR STEEL DOWELS PER TIE. THE TIES WERE INSTALLED ON 30 INCH CENTERS. 50 NO. 3 TIES WERE INSTALLED ON EITHER END OF THE TEST SECTION ON 20 INCH CENTERS. ANNUAL TONNAGE IS ?
#######################################<KEYWORDS>################################
DOWEL-LAMINATED
OAK TIES
TIE SPACING
****

***************************************TITLE***************************************
EXPERIMINTING WITH DOWEL-LAMINATED CROSSTIES

===========================ABSTRACT==
THESE TIES WERE FABRICATED FROM TWO PIECES OF 6X7X8' 6'' TIMBERS TO MAKE A 12'' TIE. THEY WERE THEN INSTALLED ON 30'' CENTERS, THE SAME AS CONCRETE TIES. 24 TIES WERE FABRICATED AND, FOLLOWING AIR SEASONING, WERE TREATED WITH 60-40 CREOSOTE COAL TAR SOLUTION. THREE DOWELLING PATTERNS WERE USED; 4,5 AND 7 DOWELS. ANNUAL TONNAGE IS 25 MGT.
##<KEYWORDS>################################
60-40 CREOSOTE COAL TAR
AIR SEASONING
DOWEL-LAMINATED
RED OAK
TIE SPACING
TIE SIZE
****

***************************************TITLE***************************************
PERFORMANCE OF DOWELLED CROSSTIES

===========================ABSTRACT==
THIS TEST WAS INSTALLED TO EVALUATE THE PERFORMANCE OF A TWO PIECE DOWELLED TIE. TIES WERE MADE OF 6''X7''X9' TIMBERS FASTENED TOGETHER WITH 5 DOWELS FORMING A 12''X7''X9' TIE. THE TIES WERE INSTALLED OUT OF FACE ON A 30'' CENTER. ANNUAL TONNAGE IS 22 MGT.
##<KEYWORDS>################################
DOWELLED TIE
TWO-PIECE TIE
TIE SPACING
TIE SIZE
****

TITLE
SIXTH PROGRESS REPORT OF COOPERATIVE RESEARCH ON WOOD TIES OF THE RAILWAY TIE ASSOCIATION AN

===========================ABSTRACT==
THE PURPOSE OF THIS TEST WAS TO ASCERTAIN CRITERIA FOR THE MOST EFFECTIVE SYSTEM FOR SUPPORTING RAIL OF VARIOUS SECTIONS ON WOOD RAILWAY TIES, TAKING INTO ACCOUNT TIE SPACING, LENGTH, AND SIZE OF CROSS SECTION. THE INVESTIGATION COMPRISED TWO STAGES: AN ANNALYTICAL STUDY TO DETERMINE THE EFFECT OF DIFFERENT TIE SIZES AND SPACINGS ON THE RAIL SUPPORT, AND A LABORATORY STUDY USING REPEATED LOADINGS AND SIMULATED TRACK CONDITIONS TO CONFIRM THE ANALYTICAL WORK. ALSO, A FIELD TEST WAS MADE ON C & NW'S W.B. TRACK. THE RAIL IS 115-RE CONTINUOUS WELDED, LAID NEW AT THAT TIME. ALL OF THE OLD BALLAST WAS UNDERCUT AND REPLACED WITH NEW GRADE CRUSHED QUARTZITE BALLAST. 8 DIFFERENT ARRANGEMENTS OF TIE SIZE, SPACING, AND LENGTH WERE INCLUDED IN THE INVESTIGATION. MEASUREMENTS WERE INITIATED WITH THE INTENTION OF REPEATING THEM FROM YEAR TO YEAR TO OBTAIN DATA ON 3 DIFFERENT PARAMETERS: TRACK SETTLEMENT, TRACK MODULUS, AND TRACK PROFILE AND CROSS LEVEL. ANNUAL TONNAGE IS 25 MGT.

##<KEYWORDS>################################
WOODEN CROSSTIES
TIE SPACING
TIE SIZE
CROSSTIE LENGTH
CROSS SECTION
QUARTZITE BALLAST
TRACK SETTLEMENT
TRACK MODULUS
TRACK PROFILE/CROSS LEVEL

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TITLE

TIE CONDITION AT DES PLAINES: A PROGRESS REPORT

==============================ABSTRACT===

A TEST SECTION OF TIES WAS INSTALLED IN 1967 BY THE AAR, RTA, AND C & NW RAILROAD CO. THE PURPOSE OF THIS JOINT PROJECT WAS TO EVALUATE THE PERFORMANCE OF VARIOUS CONFIGURATIONS OF CROSSTIE SIZES AND SPACINGS. EIGHT SECTIONS WERE INSTALLED IN THE TEST. THIS PROGRESS REPORT DISCUSSES THE RESULTS OF SUBJECTIVE AND OBJECTIVE TRACK/TIE CONDITION SURVEYS MADE DURING 1986. OBSERVATIONS AND TRENDS HAVE BEEN NOTED. TIE BEARING AREA PER UNIT LENGTH OF TRACK APPEARS TO BE A KEY PARAMETER. TIE CROSS-SECTION, LENGTH, AND SPACING CAN EACH SFFECT TIE FAILURE RATES AND MODES.

##<KEYWORDS>################################

DOWEL-LAMINATED

TIE SPACING

TIE SIZE

CROSSTIE

CROSSTIE LENGTH

CLUSTERING

FAILURE RATE

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