FIELD TESTS OF AIR DRIED AND BOULTONIZED CROSSTIES TO COMPARE IN-SERVICE PERFORMANCE

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INTRODUCTION

In the middle of 1989, CSXT began a wood crosstie (tie) test to compare the in-service performance of air-dried and boultonized ties. Mr. Randy Wingard and Mr. Archie Arthur were the primary movers in the Chessie System Engineering Department in the development and implementation of this important test.

The three objectives of this test were to compare in measurable terms the difference in crosstie life or performance between:

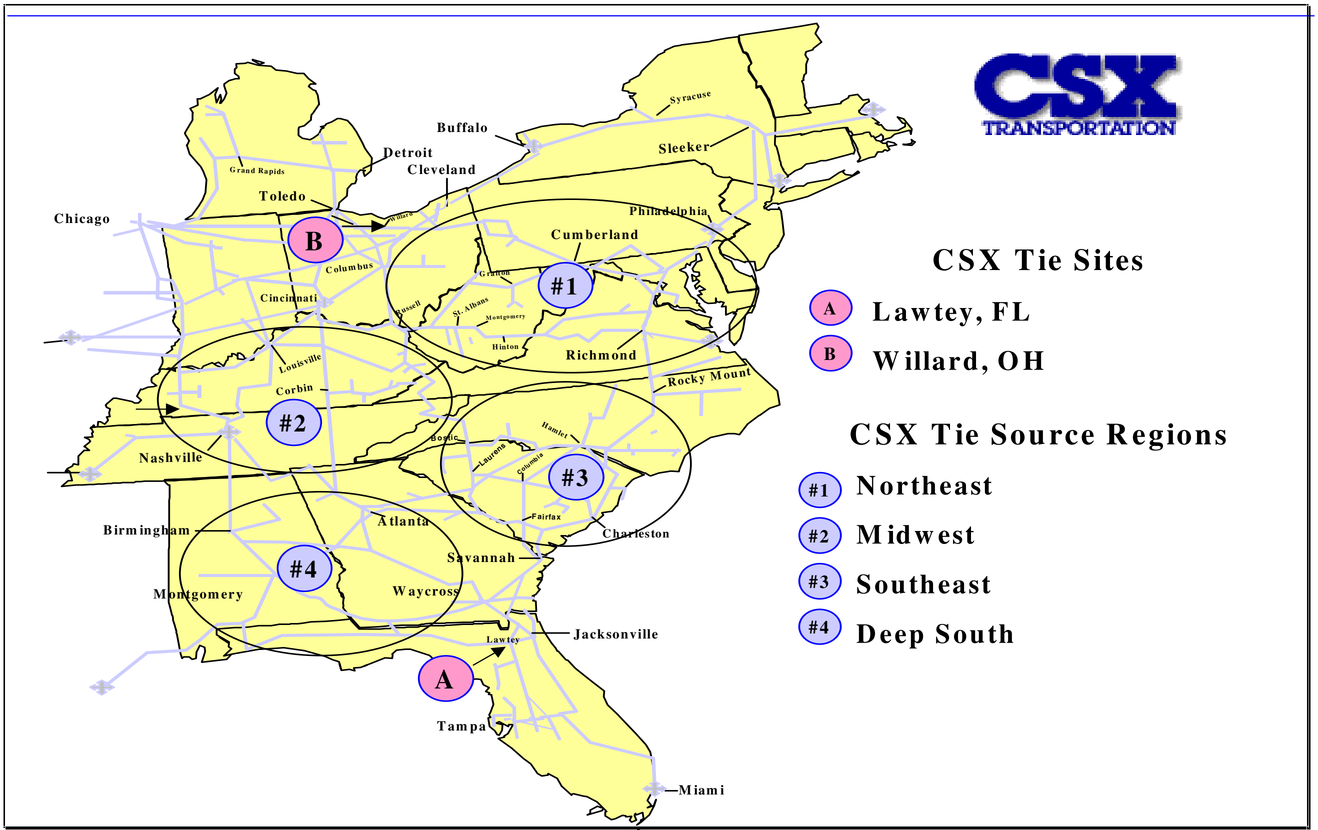
1. Air Dried vs. Boultonized Treatment Process.
2. Overall Performance of Northern vs. Southern Territory.
3. Species Comparison of Northern (Appalachian) Oaks vs. Southern Oaks.

In order to make valid comparisons the number of variables needed to be minimized to the three objectives being measured in this test. Crosstie life and performance will change with annual tonnage, degree of curvature, rail weight and type, grade, wheel loads, track deflection, and many others.

To measure the difference between air dried and boultonized treatment an equal number of crossties were processed within a regional geographical area using each of the two methods. With the “green” crossties coming from the same area if not the same tie cutter it was believed that initial wood quality would be nearly identical for both treatments. If you hold the wood quality constant, you can now measure the difference in treatment types.

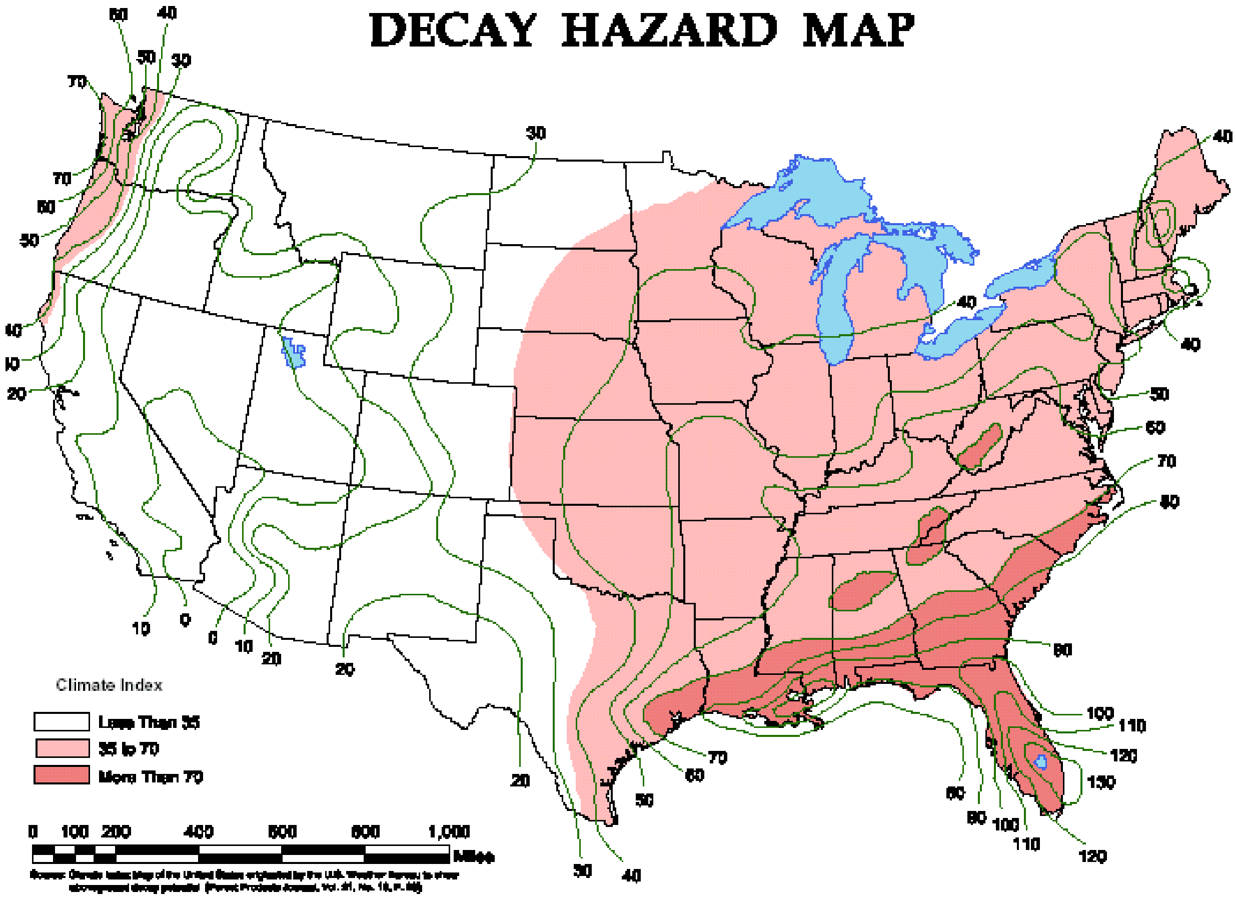
For the difference in territory, a Southern test site was selected in Lawtey, FL were it has a decay hazard of around 110 as developed by the U.S. Weather Bureau. The Northern test site was Willard, OH with a decay hazard of around 45. The location of the test sites are shown in Figure 1**.** The decay hazard map is shown in Figure 2**.**

Figure 1



CSX
TRANSPORTATION
CSX Tie Sites
A Lawtey, FL
B Willard, OH
CSX Tie Source Regions
#1 Northeast
#2 Midwest
#3 Southeast
#4 Deep South
Buffalo
Syracuse
Sleeker
Detroit
Cleveland
Grand Rapids
Toledo
Chicago
Philadelphia
Cumberland
Columbus
Cincinnati
Grafton
Russell
St. Albans
Montgomery
Hinton
Richmond
Louisville
Corbin
Rocky Mount
Hamlet
Nashville
Laurens
Columbia
Fairfax
Charleston
Birmingham
Atlanta
Savannah
Montgomery
Waycross
Jacksonville
Lawtey
Tampa
Miami

Figure 2


DECAY HAZARD MAP
Climate Index
Less Than 35
35 to 70
More Than 70
0 100 200 400 600 800 1,000
Miles

The third objective of looking at how the species or wood growth affected performance, crossties from four geographically different areas, Tie Source Regions (TSR), were used in this test. Each crosstie from each TSR was given a unique number and has been followed since it was installed. Although, CSXT does buy green crossties of other materials than oak, this test was limited to only oak. Since green crossties are usually not transported far for treatment, it was believed that the Northeast (NE) and Midwest (MW) TSRs would represent northern (Appalachian) oaks and the Southeast (SE) and Deep South (DS) TSRs, the southern oaks. The data has been collected and aggregated for each area separately. The four TSRs geographical areas are shown in Figure 1.

The basic parameters for this test are that it is comprised of nearly 1,200 crossties, from four different geographical areas each producing 75 crossties using two different treatment methods and installed at two different locations on the CSXT system.

All plants followed CSXT treatment guidelines which are in general agreement with AWPA Treatment Specifications. Test crossties were selected at random. There was no difference between a test crosstie and one that was going into any railroads maintenance program. The typical blend of railroad ties is 35% mixed hardwood and the remaining 65% being 35 to 40% white oak and 60 to 65% red oak. In this test, only white and red oaks were selected. A percentage comparison of standard versus test ties is shown in Table 1.

Table 1: Comparison of CSX standard species blend versus test site.

	Mixed Hardwood	White Oak	Red Oak
CSX Standard	35%	23 to 26%	39 to 42%
Test Ties	0%	35 to 40%	60 to 65%

TEST SITE COMPARISON

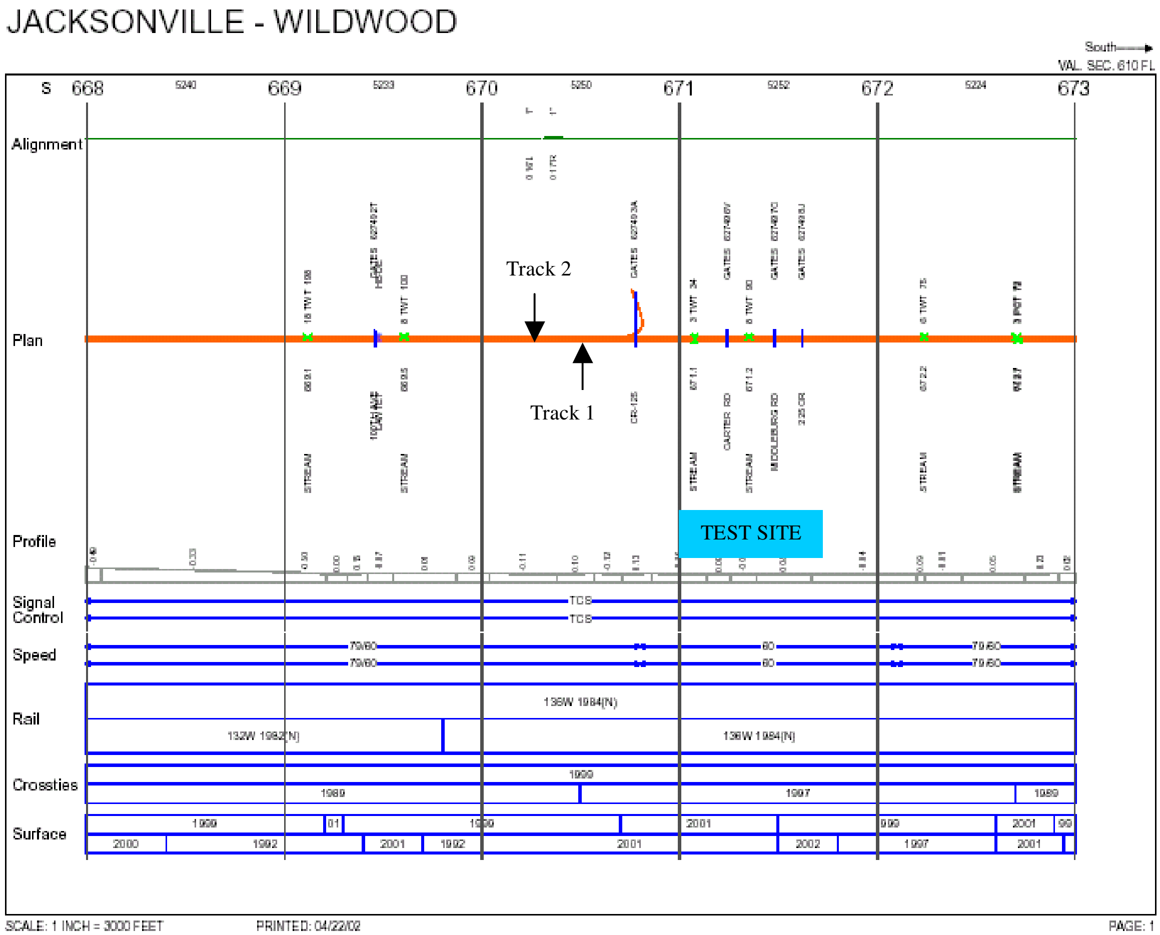
The test site comparisons are shown in Table 2. Within the limits set by CSXT these were the closest two sites in terms of geometry, rail, train speed, and tonnage. Tonnage details are explained later.

Table 2: Test site comparisons.

	LAWTEY, FL.	**WILLARD, OH.**
MILEPOST LOCATION:	S 671.0 to 671.5	BG 197.9 to 198.8
LENGTH OF TEST SITE:	0.5 Miles	0.9 Miles
TRACK NUMBER:	1	2
TYPE OF RAIL:	New 136-lb. CWR	New 132-lb. CWR
DATE INSTALLED:	1984	1963
GEOMETRY:	Tangent	Tangent
GRADE:	Almost Flat	- 0.37
SIZE OF TIE:	7” x 9” x 8’6”	7” x 9” x 8’6”
LAST TIMBERED:	Aug. 24, 1989	May 15, 1989
TIMBERING GANG:	15T77	15T76
PREVIOUS TIE CYCLES:	1979	1982 & 1985
LAST SURFACING:	1989 & 1992	1991 & 1993
TRAIN SPEED: PSN/TV/FRT/UT	79/60	79/70/60/50
EST. TOTAL MGT ON TIES: AS OF JUNE 2001	208 MGT	330 MGT
DECAY HAZARD INDEX:	110	45
DECAY HAZARD RATIO:	2.4	1

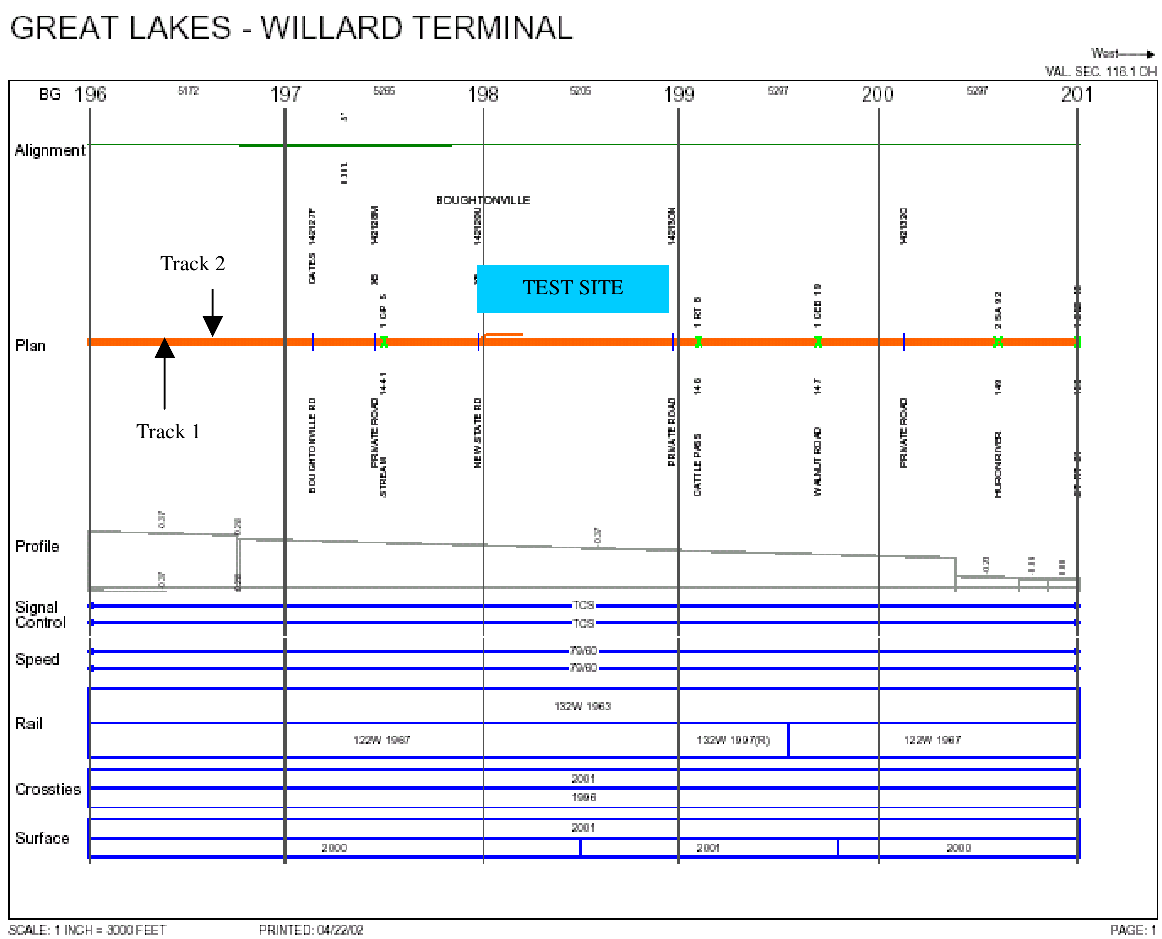
This information and other details are shown graphically for Lawtey, FL. In Figure 3 and Figure 4 for the Willard, OH test site.

Figure 3



JACKSONVILLE - WILDWOOD
South
VAL. SEC. 610 FL
S 668
669
670
671
672
673
Alignment
Plan
Track 2
Track 1
Profile
TEST SITE
Signal Control
TCS
Speed
79/60
60
Rail
136W 1984(N)
132W 1982(N)
136W 1984(N)
Crossties
1999
1989
1997
1989
Surface
SCALE: 1 INCH = 3000 FEET
PRINTED: 04/22/02
PAGE: 1

Figure 4


GREAT LAKES - WILLARD TERMINAL
West
VAL. SEC. 116.1 OH
BG 196
197
198
199
200
201
Alignment
Plan
Profile
Signal Control
Speed
Rail
Crossties
Surface
Track 2
Track 1
TEST SITE
BOUGHTONVILLE
TCS
79/60
132W 1963
122W 1967
132W 1997(R)
2001
1996
2000
SCALE: 1 INCH = 3000 FEET
PRINTED: 04/22/02
PAGE: 1

WHY IS THIS TEST IMPORTANT?

The budget for the installation of ties is usually the railroads single largest budget item. A small improvement in tie performance or tie cost can produce substantial savings. Yet, today only around 20% of all ties are produced using the boultonizing process. To be truthful, when this test was set-up one conclusion was already predicted. Mr. Arthur just knew that a boultonized tie was inferior. After twelve years in track and twelve years of test results, Mr. Arthur now concludes that a well processed boultonized tie is as good as air dried. With that leap of faith, it then becomes an issue of dollars and cents. Does the holding cost for a green tie at 30 days for boultonized versus 10 to 12 months for air dried offset the higher energy cost to process a boultonized tie for 24 hours versus 8 hours for air dried?

As an industry it has been reported that the monthly inventory carrying costs were about $1.4 million in 1998 and rose to $1.54 million in 1999 and early 2000. This is an annual industry carrying cost of $18.5 million. The industry has been installing around 14.1 million ties annually: Class 1 replacement at 10.1 M, Class 1 in addition at 0.5 M, regional and short lines at 3.5 M. The carrying cost per tie is then calculated to be $1.31. As outlined in Treatment Methods a boultonized tie requires 20 to 24 hours to treat compared to around 8 for air dried. This added cycle time for boultonizing does require additional energy which will largely offset this $1.31 per tie carrying cost. Since, most treatment plants are set-up for the processing air dried ties, a true comparison is at best difficult.

I can still remember that the Illinois Central Railroad Engineering Department had a standard drawing for ties based on rail section. Drawing No. 23.36 was for 112 & 115 LB. rail and showed how the tie was to be bored before treatment. A 7/16" diameter hole for soft-wood ties and a ½" hole for hardwood on 6 ¼" centers length wise and 3 ½" width wise. Today a tie is a tie is a tie, one tie fits all, and buying them is often a Purchasing function and not Engineering. In today's vernacular, this is six-degrees of separation between the sawmill and consumer.

The question often raised is will the Railroads, whether it be Engineering, Purchasing, or Finance, be able to make precise plans for tie production requirements? The answer is an unequivocal, NO! The use of a dedicated boultonized plant or production line will reduce the six-degrees to three or four degrees of separation with the associated bottom line savings.

TEST SITE TONNAGE

As with any field test, you attempt to hold as many factors as possible constant. Although not a perfect match for tonnage or traffic mix, the Lawtey, FL and Willard, OH sites were the two sites available that did give the best overall match. It was a requirement by CSXT Engineering that the test be installed on double track.

From the start of the test in mid 1989 until 1998 the tonnage at Lawtey was around 40 MGT annually compared to 50 MGT at the Willard site. The Lawtey site was running about 80% of the tonnage seen on the Willard site. With the breakup of Conrail and the construction of full double track from Willard to Chicago, IL this comparison changed dramatically. The tonnage at Lawtey modestly increased to 53.5 MGT while Willard more than doubled to 136.2 MGT in year 2000. Lawtey now only represents only 40% of the tonnage at Willard. Although a significant change, this has not been fatal to the test or the test results. To date all failed crossties have been attributed to splitting and decay. However, one would expect to start seeing crosstie plate cutting at the Willard site in future inspections due to this increase in tonnage.

As shown in Table 3 “Crosstie Test Site Annual Tonnage” the total tonnage on the test site track number 2, east bound for Sterling, is likely to be around the 330 MGT shown as the total for east bound movements. Since tonnage is not kept by track number this is not an exact amount. Trains at Willard are being operated by the traditional method of right-hand-running so it should be representative. Trains at Lawtey are operated on a left-hand-running so that trains headed north to Baldwin which typically would be operated on track number 2 are, in fact, operated on the test site track number 1. Therefore, the total of 208 MGT is probably representative for this test site. This makes the overall tonnage at this test site, to date, about one-half of the Willard site.

Table 3: Crosstie Test Site Annual Tonnage

Year	***From***	***To***	***Prefix***	***From***	***To***	***East***	***West***	***Total***	***Notes***
1989	STERLING	WILLARD	BG	155.5	204.22	12.16	14.56	26.72	1
1990	STERLING	WILLARD	BG	155.5	204.22	21.56	26.95	48.51	
1991	STERLING	WILLARD	BG	155.5	204.22	20.19	25.83	46.02	
1992	STERLING	WILLARD	BG	155.5	204.22	23.24	28.53	51.78	
1993	STERLING	WILLARD	BG	155.5	204.22	24.82	29.93	54.75	
1994	STERLING	WILLARD	BG	155.5	204.22	25.79	30.87	56.66	
1995	STERLING	WILLARD	BG	155.5	204.22	24.17	30.55	54.72	
1996	STERLING	WILLARD	BG	155.5	204.22	25.72	31.28	57.00	
1997	STERLING	WILLARD	BG	155.5	204.22	27.81	33.11	60.91	
1998	STERLING	WILLARD	BG	155.5	204.22	24.61	31.64	56.25	
1999	GREENWICH	WILLARD	BG	193.1	204.22	38.36	45.66	84.02	
2000	B'GHTONVILLE	WILLARD	BG	193.69	204.19	62.21	74.06	136.27	2
	TOTALS					330.64	402.97	733.61	

Year	*From*	*To*	*Prefix*	*From*	*To*	*East (South)*	*West (North)*	*Total*	*Notes*
1989	BALDWIN	STARKE	S	652.3	678.4	16.08	10.37	26.45	1
1990	BALDWIN	STARKE	S	652.3	678.4	23.44	14.55	37.98	
1991	BALDWIN	STARKE	S	652.3	678.4	24.27	15.37	39.65	
1992	BALDWIN	STARKE	S	652.3	678.4	24.37	16.95	41.32	
1993	BALDWIN	STARKE	S	652.3	678.4	23.83	16.99	40.81	
1994	BALDWIN	STARKE	S	652.3	678.4	27.20	17.56	44.75	
1995	BALDWIN	STARKE	S	652.3	678.4	28.62	18.41	47.03	
1996	BALDWIN	STARKE	S	652.3	678.4	28.72	18.48	47.20	
1997	BALDWIN	STARKE	S	652.3	678.4	28.34	19.46	47.80	
1998	BALDWIN	STARKE	S	652.3	678.4	27.57	19.16	46.73	
1999	BALDWIN	STARKE	S	652.3	678.4	27.36	18.71	46.07	
2000	LAWTEY	STARKE	S	669.71	677.06	31.93	21.83	53.76	2
	TOTALS					311.72	207.83	519.56	

Notes:

1) Prorated for start of test.

2) Divided by same % as last year.

MEASUREMENTS

Critical to the test was the necessity of identifying each tie over time. The method developed was to install a metal tag with the geographical region (TSR) and unique tie number imprinted on it. To avoid damage and to further help identification the tag was recessed in a circular hole. One hole identified the tie as an air dried sample and two holes a boultonized sample tie.

The ties were randomly installed in a regularly planned tie renewal. The distribution varied from next to each other to as many as ten (10) non-test ties between. Therefore, each tie could be identified with a metal tag, one or two holes for treatment process, and number of ties between test ties. After 12 years in track all ties can still be located. New metal tags have been added to some ties. The tags had been damaged through the various surfacing operations or routine maintenance activities.

When CSXT added double track from near Willard, OH to Chicago it did affect the Willard test site. A new power cross-over was installed in the existing double track at Willard. A total of 29 ties were removed from the air dried NE sample and 28 ties from the air dried SE sample. These ties were not reinstalled and have been lost to the test.

The tie was divided into five (5) unique areas for measurement purposes. The end of each tie or field end was one area. Between the rails, the tie was divided into thirds; north center, center, and south center. If you had one long crack or check it would be tabulated as a single value in the center. However, you were permitted to fill out any or all three of the sub-areas. Each crack or check was measured as to width, length, and depth. After much discussion it was felt that most cracks took the shape of a knife edge or “V”. We felt that a reduction of one-half would more accurately portray the area volume of loss. Besides an accurate measurement, comments were permitted as to light, medium, or heavy checking. No volume loss was assigned to these comments. In this way you could view the performance of a single tie in time as it goes from say no comment in 1993 to medium checks in 1997 to an area loss of 4.5 cubic inches in 2001. The other comments permitted were OK, Failed, MD for mechanical damage, CB for center broken, and KH for knot hole. Although not part of the study there did seem to be a relationship between knot holes and failed ties.

FAILED TIE LIMITS

From a measurement standpoint what is a failed tie? I'm not aware of any measurement number or limit that identifies the point were a tie goes from being called a good tie to one that is failed and should be removed from track. It appears that a number around 300 to 400 cubic inches loss in area is when these tie inspectors went from a good to failed tie. With these main line ties having a total volume of 6,426 cubic inches a loss of 300 to 400 is only 5 to 6% of the total.

WHITE VERSUS RED OAK TREATMENT

With hindsight always being 20/20, I mention the issue of white and red oak treatment to reinforce that this was not a test objective. Maybe, it should have been. Mr. Arthur's solution, along with others, is to state that the railroad should not use white oaks in the south where there is a high decay hazard. Problem solved.

White oaks are an integral part of the ties at the Lawtey, FL test site with it's decay hazard of 110. One could argue that the high failure rate is due to the higher than standard number of white oaks in the sample: 25% standard versus 35% test ties. As we continue to follow and monitor the test ties we will check to see if we develop a non-standard Forest Products failure curve.

PROCUREMENT POLICIES

Based on Mr. Arthur's recall from 1989, the following is CSXT's procurement policies for wood crossties at that time. These are very similar to then current AREMA specifications.

PROCUREMENT – Types of wood accepted

TA Species – Oak, both red and white

TC Species – Ash, beech, birch, cherry, gum, locust, mulberry, hard maple, and black walnut

TD Species – Elm, hackberry, soft maple, sassafras, and white walnut

TEST TIE PROCUREMENT – Types of wood accepted

TA Species – Oak, both red and white (ONLY)

SIZES

Main Lines:

No. 5 = 7” x 9” x 8’6” with a minimum 8” face

No. 4 = 7” x 9” x 8’6” with a minimum 7” face

No. 4 = 7” x 9” x 8’6” with a minimum 7 ½” face, maximum of 20% per car

No. 3A = 7” x 7” x 8’6” maximum of 20% per car, if face is under 6 ½” No. 2

Side Track:

No. 3 = 6” x 8” x 8’6” with a minimum face of 7” and no wane

No. 2 = 6” x 8” x 8’6” with a maximum of 1” wane and maximum of 20% sq. accepted

Also, accepted saddlebacks outside the tie plate area having a minimum 4 ½” face, a maximum of 20% per car.

Sledrunners with not less than ½” the thickness of face on which appear and not more than 3” from the end of the tie was also accepted.

TEST TIE SIZES

Main Lines:

No. 5 = Approximately 80%

No. 4 = The balance of around 20%

STACKING – Air Dried

All ties were stacked German method with 9 across and 1 perpendicular at the end, except at the Midwest plants.

Ties at the MW plants were straight stacked, lumber style.

INSPECTION

1. Any rot in the crosstie was never accepted.
2. Holes outside the rail bearing area of a size less than a width of ¼” and depth of less than 3” were accepted.

3. Holes inside the rail bearing area of a size less than a width of ½" and depth of less than 3" were accepted.
4. Knots inside the rail bearing area of a diameter larger than 1/3 the width of surface on which it appears were not accepted.
5. Shakes which are a separation of rings were accepted if they were not more than 1/3 the width of the crosstie.

INCISING

1. All crosstie were incised.
2. If more than 10% of the teeth were broken on the inciser head it was not accepted.
3. Incising teeth were 9/16" long and needed a minimum penetration of ½" to be acceptable.

ACCEPTANCE

1. Borings were taken from every charge.
2. 80% of every 20 borings must have 65% penetration of annual rings treated on Oak and total annual rings penetrated on mixed hardwoods.
3. Total sapwood must be treated on White Oak crossties.

BOULTONIZED

1. Ensure that ties being treated "green" have been cut within the last 30 days to obtain a uniform moisture content.
2. The frequency of shipments from any given green tie source is a measure of this 30 day policy.

TREATMENT METHODS

Mr. Arthur makes the point that treatment of crossties is an art rather than a science. The quality of treatment depends largely upon the right decisions by the Plant Supervisor. He must ensure that proper treating cycles are implemented.

Air Seasoning

Air seasoning is the time-honored method of seasoning crossties prior to treatment. The cost of handling, capital equipment requirements and energy required are minimal. However, it is time consuming. Leaving the grading skids or the incising machine the crossties are stacked into air seasoning units or ricks. A rick will consist of approximately 45 to 55 ties. Each tie in a layer is separated from the tie on either side by an air space of about 2 inches. Each layer is separated from adjacent layers by forming a zig zag, V type of layering commonly referred to as the German Stacking Pattern or by 2 x 2 inch spacers, lumber style. The ricks are then carried to the seasoning yard where they are stacked in tiers for air seasoning.

The ties are air seasoned for various periods of time, depending on species, seasoning yard conditions, the time of year they go into stack, the ability of the species to withstand decay, and lastly the history of past practice.

It is general practice to air season oak ties 10 to 12 months whether they went into stack in September or January. In this period of time the moisture content will have dropped from as initial level of 80% to an average of 50 to 55%. The outer inch of wood will be at a much lower moisture content than the center.

Boultonizing

As the Boultonizing “art” was practiced for oak and hardwoods crossties up through the 1960’s it was the most misused of all the artificial seasoning methods. Most often, it has been used in the past to process partially air seasoned ties. This resulted in severe checking and splitting. Furthermore, it was not the practice to separate the layers of ties on trams so the hot creosote reached only the outside ties and the ends of other ties on the trams. When a tie is Boultonized properly it will have low moisture content and good treatability.

The ties to be Boultonized are loaded onto trams with every layer separated from adjacent layers by 2 or more stickers at least 3/8” thick. After the cylinder is charged, hot creosote is pumped in until the tops of the ties are covered. The next two steps are conducted almost simultaneously. A vacuum of 20 to 22 inches mercury is pulled on the cylinder and steam is turned into the heating coils or to an external heat exchanger to bring the creosote oil up to the Boultonizing temperature as rapidly as possible. As the hot creosote oil transfers some of its heat to the ties the temperature of the ties increases to the boiling point of water and the moisture in the ties begins to vaporize. This vapor passes up through the creosote bath and into the vacuum line to a condenser. This water is collected and measured. The Boultonizing period is continued until the total water collected is sufficient to reduce the moisture content to the desired level. Twenty to twenty-four hours may be required to Boultonize oak crossties.

Following the Boultonizing it is normal to empty the cylinder of oil and draw a short vacuum. This will evaporate additional moisture. The ties are then ready for pressure treatment.

Pressure Treatment

Charges of crossties are always treated using what the industry labels as the “Rueping – Empty Cell” cycle. After the cylinder is charged with 500 to 750 ties, loaded on trams, the cylinder door is sealed. The air pressure in the cylinder is increased to a level of 25 to 40 pounds-per-square-inch (psi) for oak and up to 60 to 70 psi. for mixed hardwoods. This air not only fills the space surrounding the crossties but also enters into the wood and fills the cell cavities within the wood structure. By holding the initial air pressure on the cylinder when preservative is pumped into the cylinder the air is trapped in the cell cavities. After the cylinder is filled with the creosote additional solution is pumped into the cylinder to increase the pressure to a level of 180 to 200 pounds psi and held steady. There is only one place for this additional creosote to go and that is into the wood cells. The pressure is maintained at this level for a period of 3 ½ to 4 hours for oaks and up to 6 hours for others until the desired injection of creosote into the wood is achieved. The pressure should be maintained on the charge of ties until the flow to the cylinder has practically stopped. This assures the most complete penetration into the wood.

After the pressure phase of the cycle is complete the creosote in the cylinder is returned to the supply tank. A 22 inch vacuum is then drawn on the cylinder for 30 minutes to one hour. As the pressure in the cylinder is reduced from the 180 to 200 pounds down to the vacuum level the air that was originally trapped in the cells of the wood expands and forces some of the excess creosote injected into the ties out of the wood. This leaves the cell walls coated with creosote rather than leaving each cell cavity filled with creosote.

Following the vacuum period the drips are recovered and returned to the supply tank and the treating cycle is complete.

Typically, a treating plant can process 3 charges of air dried ties in a 24-hour period. In the same time period only 1 charge of boultonized ties can be processed.

CSXT Treatment Specifications

1. Oak ties monitored to ensure moisture content below 50 to 55%.
2. Mixed hardwoods not to have more than 35 to 40% moisture content.
3. Oak ties treated to 7 pounds retention.
4. Mixed hardwoods treated to 8 ½ pounds retention.
5. Average seasoning cycle for oaks from 10 to 12 months.
6. Average seasoning cycle for mixed hardwoods from 4 to 6 months depending upon time of year.
7. Pressure cycle for air dried oak ties from 3 ½ to 4 hours.
8. Pressure cycle for air dried mixed hardwoods from 3 to 3 ½ hours.
9. Boultonized treatment for oaks, 16 to 18 hours for moisture removal and then standard treating cycle.
10. Boultonized treatment for mixed hardwoods, never allowed.
11. Initial air pressure for oaks 25 to 40 pounds psi.
12. Initial air pressure for mixed hardwoods from 40 to 70 pounds psi.
13. Creosote pressure from 180 to 200 pounds for all species.
14. Temperature from 180 to 210 degrees Fahrenheit.

PICTURES

As part of the overall report an extensive set of pictures were taken. At Lawtey a total of 96 pictures were taken and 85 at Willard. Table 4 is the picture log for the Lawtey, FL test site and Table 5 for Willard, OH.

It shows the picture number on that roll, crosstie number, and a brief description of the subject of the picture.

Due to space requirements only a selected few pictures are enclosed in this report. These are shown in bold and italics in Tables 4 and 5. All pictures can be made available through CSXT and the authors.

Table 4: Picture Log For Lawtey, FL

LAWTEY, FL TRACK # 1

S 671.0 to 671.5, March 2001

	FIRST ROLL # 036753		THIRD ROLL # 036797
Picture #	Description	Picture #	Description
1	Your survey team	1	MW 2 fair tie
2	***Looking south, milepost 671 north end***	2	MW 71 failed hollow tie
3	Same	3	MW 71 same
4	NE 124	4	MW 181 failed hollow tie
5	Typical tag, 2-holes for boultonized	5	MW 181 same
6	NE 124 5/8" center split	6	MW 216 north end plate on tight
7	NE 150 1/2" center split	7	MW 216 south end plate off 1/16"
8	NE 147 hollow tie	8	MW 216 overall view of a good tie
9	NE 147 hollow tie	9	MW 217 north end plate off 1/8"
10	NE 102 good tie	10	MW 217 south end plate failed
11	NE 119 bad tie	11	MW 217 overall view
12	NE 119 bad tie	12	MW 168 failed hollow tie
13	NE 115 good tie	13	MW 168 same
14	NE 133 bad tie	14	MW 168 same
15	***NE 133 hollow tie***	15	MW 206 hollow failed tie
16	NE 295 3/8" tie plate movement	16	MW 206 same
17	NE 295 1/4" off end plate	17	MW 184 north end plate off

18 NE 295 overall

19 NE 254 center split

20 NE 254 7/8" center split

21 NE 296

22 NE 296 failed east end

23 At Carter Road, milepost S 671.24

24 Same

SECOND ROLL # 036696

1 SE 199 bad tie

2 SE 199 hollow on west end

3 SE 199 same

4 SE 217 good tie

5 SE 207 north end split & end plate

6 SE 207 souuth end split & end plate

7 SE 47 bad tie

8 SE 57 bad tie

9 SE 57 same

10 SE 31 typ. Center split

11 SE 31 3/4" center split

12 SE 2 north end plate off

13 SE 2 south end plate off 1/4"

14 SE 2 overall view

15 MW 54 hollow failed tie

16 MW 54 same

17 MW 67 average tie

18 MW 17 note failed at knot hole

19 MW 17 same

18 MW 184 south end plate off

19 MW 184 overall view

20 MW 196 fairly good tie

21 MW 153 north end plate

22 MW 153 south end plate off 1/4"

23 MW 153 overall view of failed tie

24 MW 153 same

FOURTH ROLL # 036789

1 DS 253 bad tie

2 DS 245 good tie

3 DS 259 failed tie

4 DS 252 failed tie

5 DS 238 good tie

6 DS 286 north plate off 1/4" on bad tie

7 DS 286 south end plate off 1/2"

8 DS 286 overall view

9 DS 286 overall view of failed tie

10 DS 283 good tie

11 DS 228 good tie

12 DS 232 good tie

13 DS 132 failed at tie plate

14 DS 132 overall view

15 DS 132 failed hollow tie

16 DS 79 good tie

17 DS 130 north plate off 1/16"

18 DS 130 south plate off

19 DS 130 overall view

20 MW 73 north end plate off

21 MW 73 south end plate almost off

22 MW 73 overall view

23 MW 56 failed hollow tie

24 MW 56 same

20 DS 115 failed tie

21 DS 106 good north end plate

22 DS 106 south end plate off 1/8"

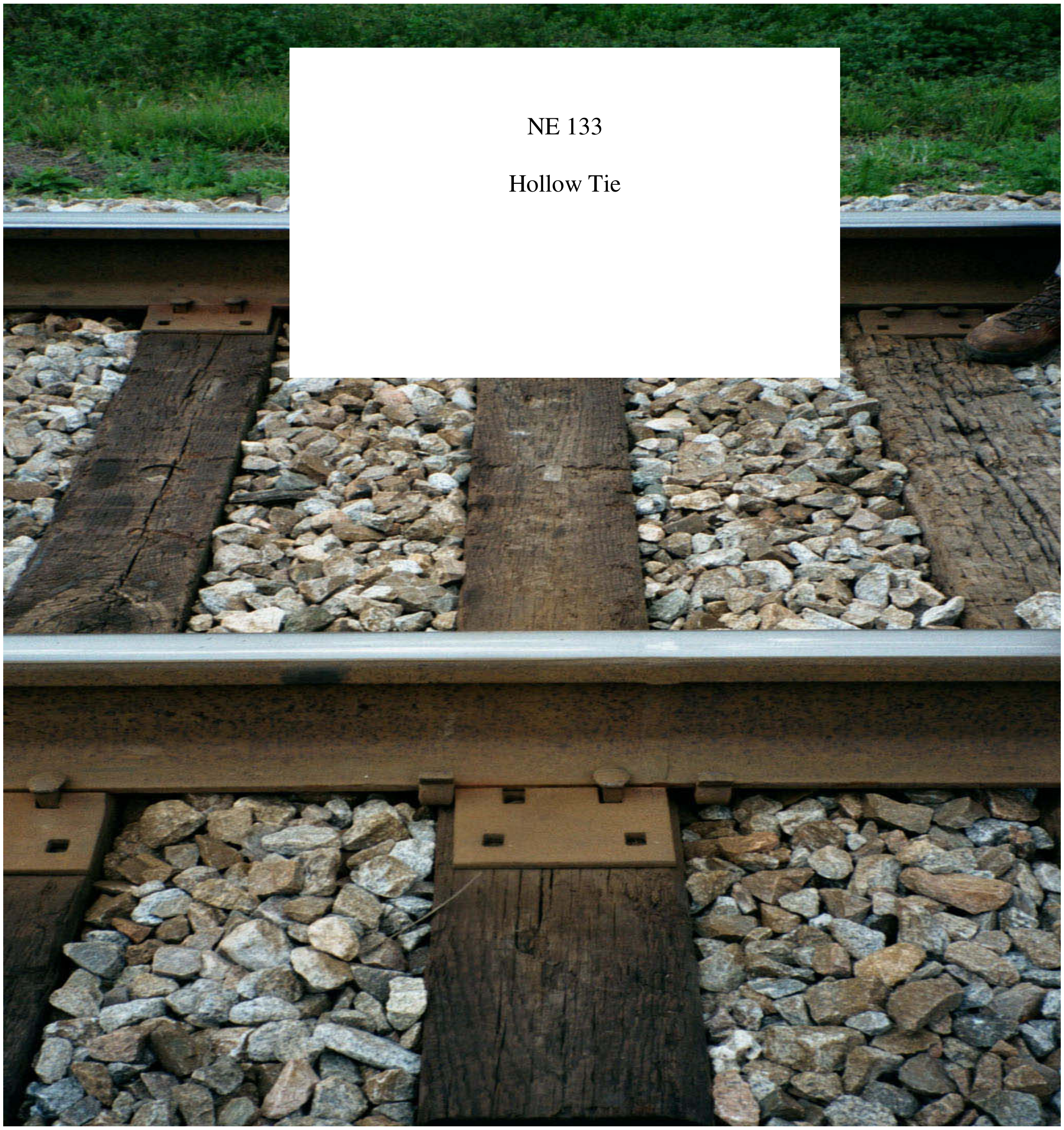
23 DS 106 overall view of good tie

24 Tie test looking North @ South end

Picture 1

Looking South, Milepost 671 North End

Picture 2

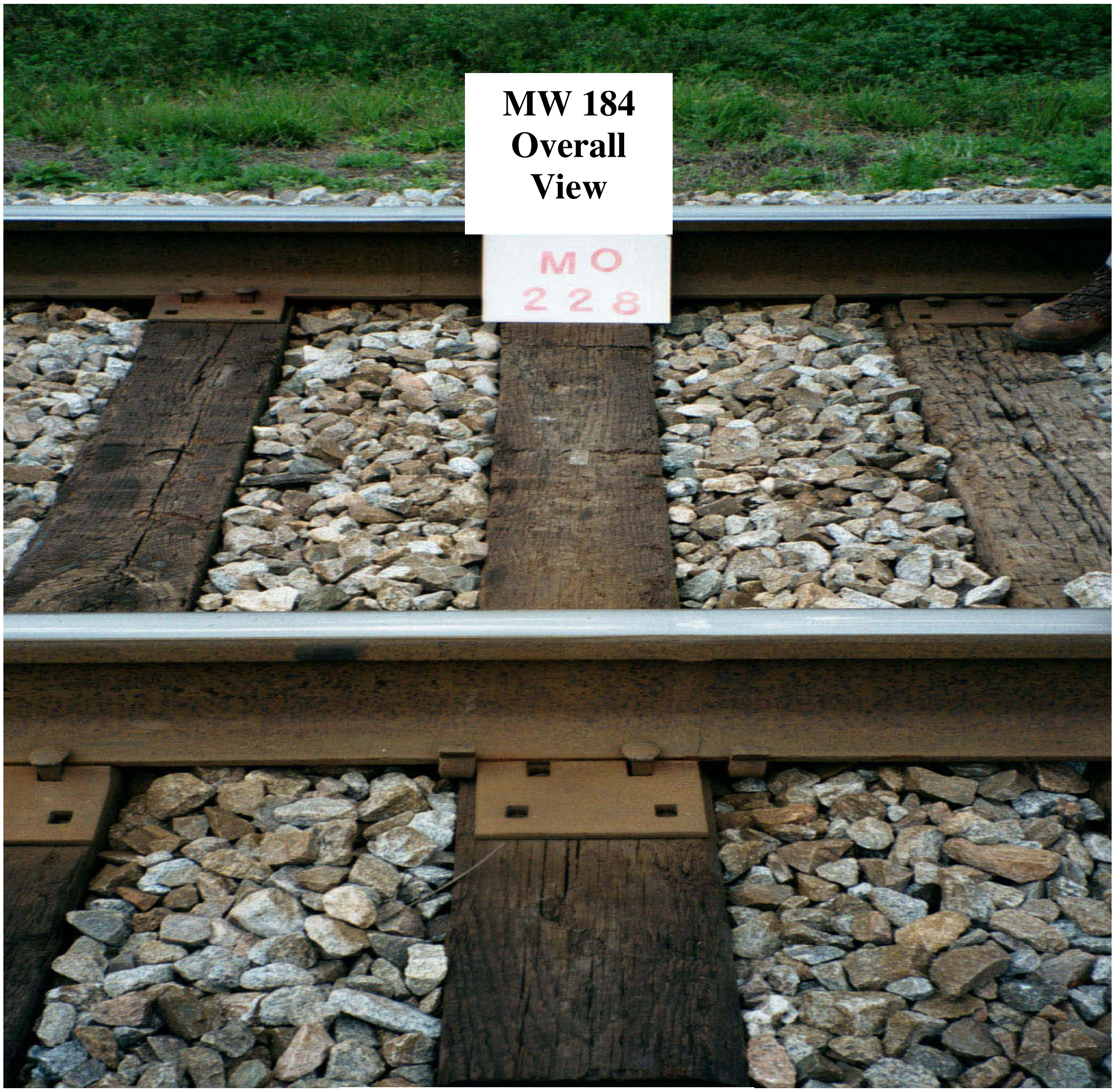


NE 133 Hollow Tie

Picture 3

SE 217 Good Tie

Picture 4



MW 184 Overall View

Picture 5

DS 228 Good Tie

Picture 6

Tie Test Looking North From South End

Table 5: Picture Log for Willard, OH

WILLARD, OHIO TRACK # 2

BG 198 to 199, March 2001

FIRST ROLL # 184725		THIRD ROLL # 184666	
Picture #	Description	Picture #	Description
1	Test site looking East From West end	1A	DS 37 good tie
2	***Same, note milepost BG 199***	2A	DS 65 on left & DS 14 R
3	Same, note milepost BG 199	3A	DS 16
4	Typical old & new tie tag for "291"	4A	DS 16 5/8" center split
5	Two holes for a Boultonized Tie	5A	DS 16 1" center split
6	Typical field weld	6A	DS 16 north end split & off plate
7	Rubber flangeway road crossing	7A	DS 16 south end good plate
8	Typ. Timber & asphalt road crossing	8A	DS 15 on right & MO 10 L
9	MW 248 good tie	9A	NE 43
10	MW 267	10A	NE 43 1/4" center split
11	MW 267 split south end	11A	NE 43 1/2" south end split
12	MW277	12A	NE 24 on left & GS 19 R
13	MW 277 center split	13A	NE 24 good south end plate
14	MW 241 good tie	14A	NE 15 good tie
15	MW 247 center & end split	15A	NE 173
16	MW 247 1/2" center split	16A	NE 173 3/8" center split
17	MW 247 3/4" end split	***17A***	***NE 173 large south end split***
18	MW 289	18A	NE 152 on right & NE 197 L
19	MW 289 good north end plate	19A	NE 152 with correct number
20	MW 289 1/4" off south end plate	20A	NE 169 on left & NE 212 R
21	***MW 123 good tie***	21A	NE 212 3/8" north end split

22 MW 123 corner off on north end plate

23 MW 123 corner off on south end plate

24 MW 81 good tie

SECOND ROLL # 184718

1A MW 110 center split

2A MW 110 north end plate

3A MW 110 south end plate

4A MW 142 south end plate

5A Typical equipment

6A Same

7A Same

8A Same

9A Same

10A MW 100 & MW 130 on right

11A MW 148 & MW 85 on right

12A MW 105 center & end split

13A MW 105 3/8" center split

14A DS 177 center split

15A DS 177 3/4" center split

16A DS 177 south end split

17A DS 157 good tie

18A DS 211 center, DS 202 R & DS 159L

19A DS 163

20A DS 163 good north end plate

21A DS 163 3/8" off north end plate

22A DS 204 center break

22A SE 84

23A SE 84 large north end split

24A Typical pandrol plate

FOURTH ROLL # 184669

1A SE 98

2A SE 98 several center splits

3A SE 98 north end split & plate off

4A SE 98 south end split & plate off

5A SE 88

6A SE 248 on right & SE 288 L

7A SE 257

8A SE 270

9A SE 270 1/2" north end split

10A Looking west at east end of site

11A Same, note milepost BG 198

12A SE 245

13A SE 245 typical south end plate

23A DS 50

24A DS 50 3/16" off south end plate

Picture 7

Test Site Looking East From West End
(Note Milepost BG 199)

Picture 8

MW 123 Good Tie

Picture 9

**DS 211 Center,
DS 202 Right
and DS 159 Left**

Picture 10

NE 173 Large South End Split

Picture 11

SE 248 on Right
SE 288 on Left

Picture 12

Looking West at East End of Site

PREVIOUS TEST RESULTS

The ties have now been examined four times. At installation in 1989 a report was made that all ties had been installed and met CSXT standards. Few defects were noted. Some minor checking was noted even at this initial stage. The first follow-up was in October 1993. It again showed no failed ties. A summary for all air-dried and boultonized ties is shown in Table 6.

Table 6: 1993 Test Results

Year 1993	Mean (M) in cu. in.	Standard Dev. (SD)	M + 2SD
All Air dried Ties	7.764	8.487	24.738
Tie Source Regions			
NE	4.080	4.680	13.439
MW	6.143	7.990	22.122
SE	10.876	9.509	29.893
DS	9.959	9.013	27.985
All Boultonized Ties	7.863	12.257	32.377
Tie Source Regions			
NE	7.089	10.164	27.417
MW	14.167	17.133	48.432
SE	5.823	9.919	25.661
DS	4.374	7.001	18.376

At this early stage no conclusions were developed. However, the Mid West boultonized tie did have the highest amount of checking at 14.17 cubic inches. This is equivalent to a center tie check of 3/8” wide by 19” long by 4” deep.

A third follow-up was done in October 1997. At Willard, OH we did now have two failed ties and at Lawtey, FL an astonishing 32 after just nine (9) years. At Lawtey in 2001 the number is now 94 or 16% of all ties. All test results will compare current data against this 1997 data.

RESULTS

Objective 1 – Air Dried vs. Boultonized Treatment Process

For the comparison of air dried vs. boultonized treatment that answer is still not clear. At Willard, the percentage of air dried ties with total splits of over 50 cubic inches is 3.3% vs. 4.1% for boultonized. Too small a number or difference to draw any conclusions. The Lawtey numbers for air dried over 50 cubic inches is 39% vs. 38% for boultonized. Overall, nearly the same performance. However, a closer look at the data points out two interesting items:

1. Air dried Deep South TSR ties had 59% more failed ties than any other TSR or treatment type. And, 100% more failed ties than any other air dried TSR.
2. Anticipated future performance of the air dried ties may be worse than the boultonized because of the nearly double number of ties with splits in the 20 to 50 cubic inch range at both test sites. This can be seen in Figures 5 for Lawtey, FL all TSR's and 6 for Willard, OH all TSR's.

Objective 2 – Overall Performance of Northern vs. Southern Territory

Only objective 2 can be answered with any degree of certainty. It is very clear that overall tie performance as measured by either tie life or volume of splits (cracks) is dramatically different in Lawtey than Willard, OH. The overall crosstie life comparison is shown in Table 7.

Table 7: Crosstie Life by Test Site

Location	Crosstie Life
Lawtey, FL	17 yrs.
Willard, OH	30 plus yrs.

Tie life for the different TSRs and treatment types at Lawtey are shown in Table 8.

Table 8: Crosstie Life at Lawtey, FL by TSR

TSR	Air Dried	Boultonized
Northwest	20 yrs.	17 yrs.
Midwest	20	16
Southeast	18	17
Deep South	14	18

Between the 1997 and 2001 survey the data shows that the total number and size of splits at the Willard site has remained either constant or increased very slightly.

Objective 3 – Species Comparison of Northern Oaks vs. Southern Oaks

TSR to TSR performance was based on the total volume of splits in cu. in. and the ranking is as shown in Table 9. With 1 (one) being the best performance and fewest splits.

Table 9: Crosstie Performance Ranking by Treatment and TSR

	Air Dried				Boultonized			
Rank	Willard	(Vol)	Lawtey	(Vol)	Willard	(Vol)	Lawtey	(Vol)
1	NE	579	NE	5,562	NE	724	NE	5,528
2	MW	788	MW	6,149	MW	980	DS	5,587
3	SE	1,236	SE	7,222	DS	1,053	SE	5,809
4	DS	1,397	DS	9,876	SE	1,184	MW	8,013
TOTAL		4,000		28,809		3,941		24,937

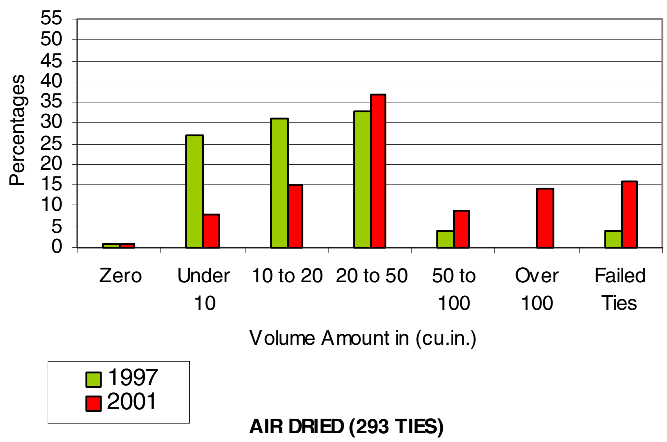
It should be noted that on the boultonized ties in Lawtey the performance from first to third was almost identical with 5,528 cubic inches for NE in first to 5,809 cubic inches for SE in third. Only the MW TSR showed a much poorer performance. The ranking would tend to indicate that the slower growing northern oaks are performing better than the faster growing southern oaks.

Test Result Backup

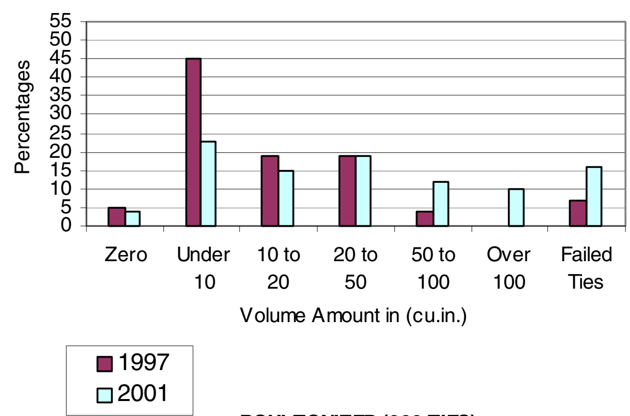
Literally, hundreds of man hours have been used and hundreds of thousands of measurements gathered at the two test sites. The two figures of performance, Figures 5 and 6 at the two sites for all TSRs is just a small sample of the total amount of results available. Additional results will be forthcoming through venue’s like this or by special arrangement with CSXT and the authors.

Figure 5

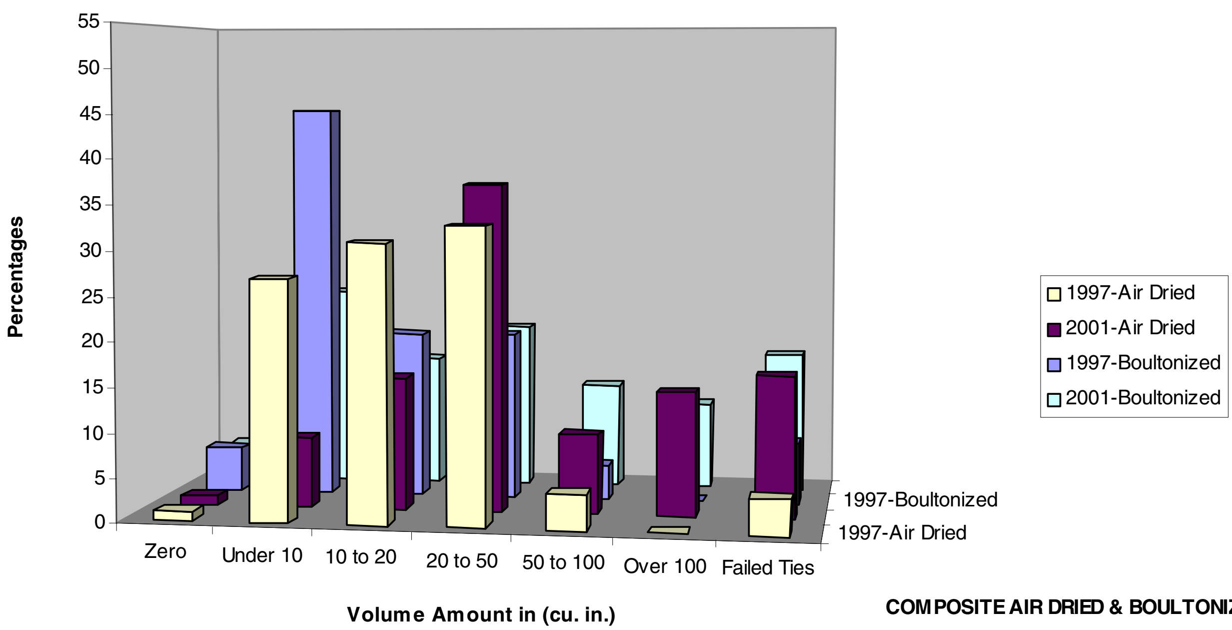
Lawtey, FL All Tie Source Regions



AIR DRIED (293 TIES)



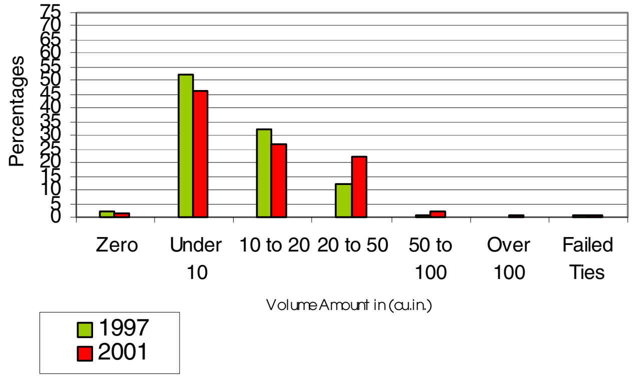
BOULTONIZED (293 TIES)



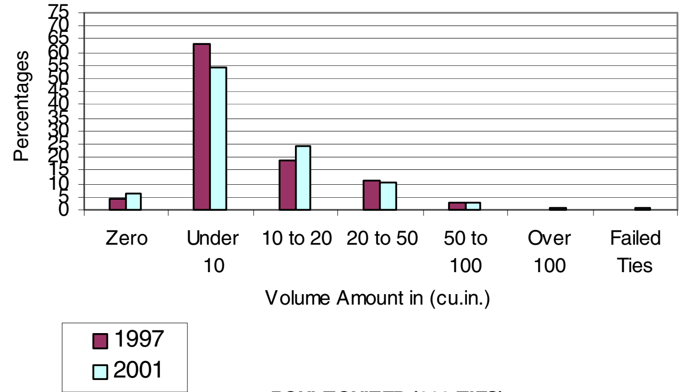
COMPOSITE AIR DRIED & BOULTONIZED

Figure 6

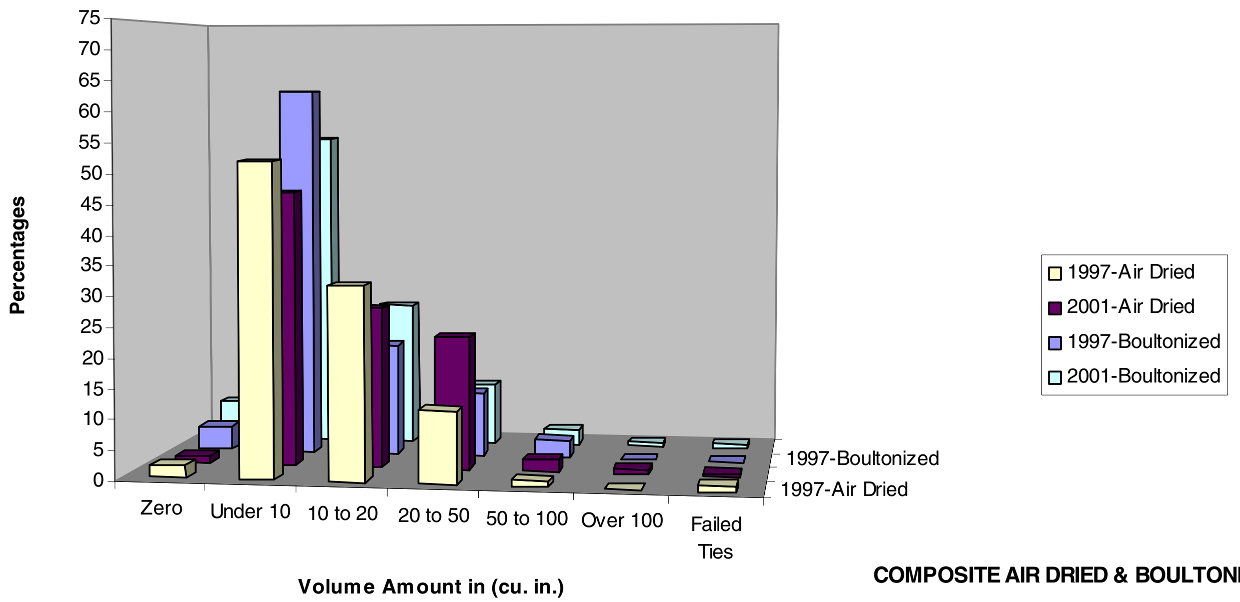
Willard, OH All Tie Source Regions



AIR DRIED (293 TIES)



BOULTONIZED (293 TIES)



COMPOSITE AIR DRIED & BOULTONIZED

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