RTA TieReport #1

Update on Wood Tie Life: Part 1

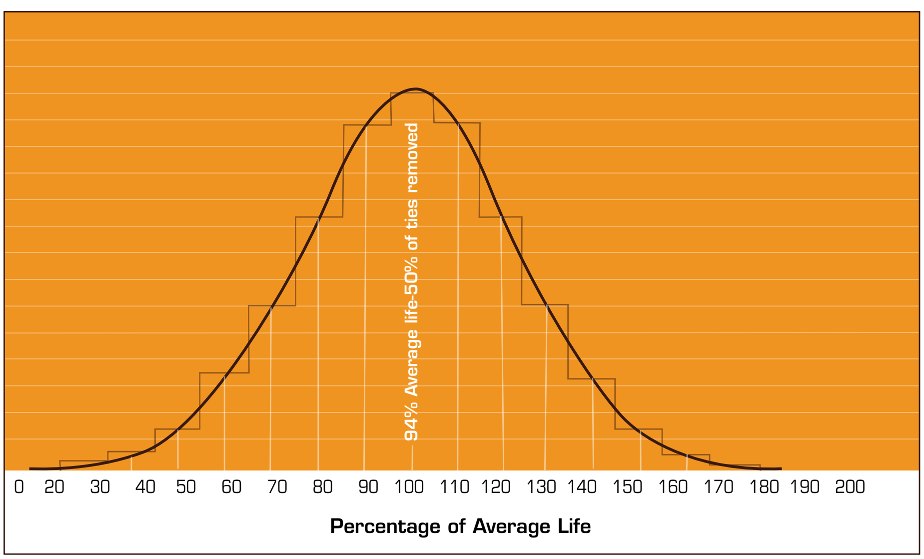
Wood crossties represent the predominant type of tie in use in North America. The life of the wood crosstie will vary significantly based on track, roadway, traffic and environmental conditions [1,2]. This TechNote will present the most current experience of wood crossties life as a function of such key parameters as track curvature, environmental conditions, and traffic density.

The lives presented here are for conventional creosote-treated hardwood crossties with cut-spike fasteners. This system represents the dominant tie and fastener system used on North American freight railroads. The effect of alternate, non-conventional fastener types, such as elastic fasteners, and treatments will be presented in a later TechNote.

These tie lives are calculated based on the RTA's SelecTie model as calibrated to tie lives reported by several major US Class 1 railroads. While other wood tie life models have been developed over the years [1,3] the SelecTie model has been found to represent a realistic assessment of conventional wood tie life in North American freight railroad service.

It should be noted that ties, even when installed at the same time under identical operating conditions, do not all fail at once. Rather, there is a statistical distribution of tie failure and hence replacement, around an "average" tie life, as shown in Figure 1 for wood ties with cut spike fasteners.

Figure 1: *Factors that Affect Tie Life*



Frequency curve showing successive percentage tie replacements for 10 percent intervals of average life. Symmetrical form- Original taken at 94 percent.

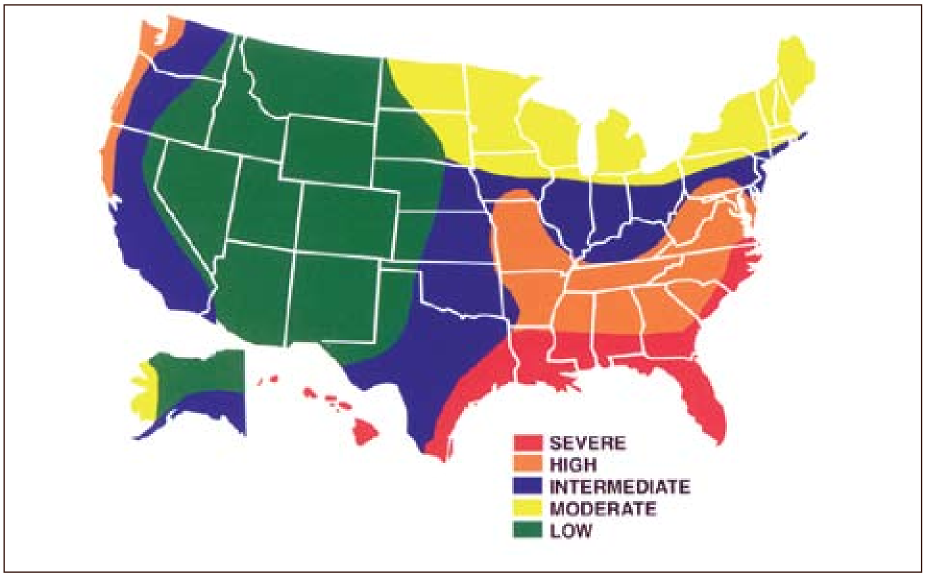
Such statistical distribution curves have been developed by the USDA Forest Products Laboratory [4] and the Association of American Railroads [5]. This average tie life model is a convenient reference value to use, and as such can be related directly to the key track, traffic, and environmental parameters that reflect tie life variability. As can be seen in Table 1, Tie Life is related to a range of track, traffic and environmental factors.

Table 1: Tie Life Factors

Traffic Characteristics	• Traffic Density or Tonnage (Annual MGT) • Axle Load • Speed • Traffic Type
Track Geometry	• Curvature • Grade
Track Type and Condition	• Rail Section (weight) • Welded Rail (CWR) vs. Jointed Rail • Fastener Type • Ballast/Track Support
External Factors	• Environment (climate, temperature, humidity, decay hazard) • Biological factors (termites, fungi, etc.) • Wood type (e.g., hardwood vs. softwood)

Of these factors, three can be considered to be the dominant factors for conventional wood tie, cut spike track:
- Tonnage
- Curvature
- Environmental Conditions (Decay Hazard) [Figure 2]

Figure 2: Decay Hazard Map of U.S.



The first two factors directly affect the rate of mechanical degradation of the ties. The third factor directly affects the rate of decay of the tie.

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The actual mode of failure, mechanical vs. decay, is a function of the severity of the service environment (tonnage, curvature, etc.) and the rate of decay or environmental degradation (which also includes biological degradation such as through termite infestation, etc.). On average, the distribution of failure between mechanical and environmental decay is illustrated in Figure 3 [1,6]. However, This distribution can change significantly as a function of the parameters noted above. This can be seen in the following Figures.

Figure 3: *Tie Failure Distribution by Defect Mode. (Mainline Case)*

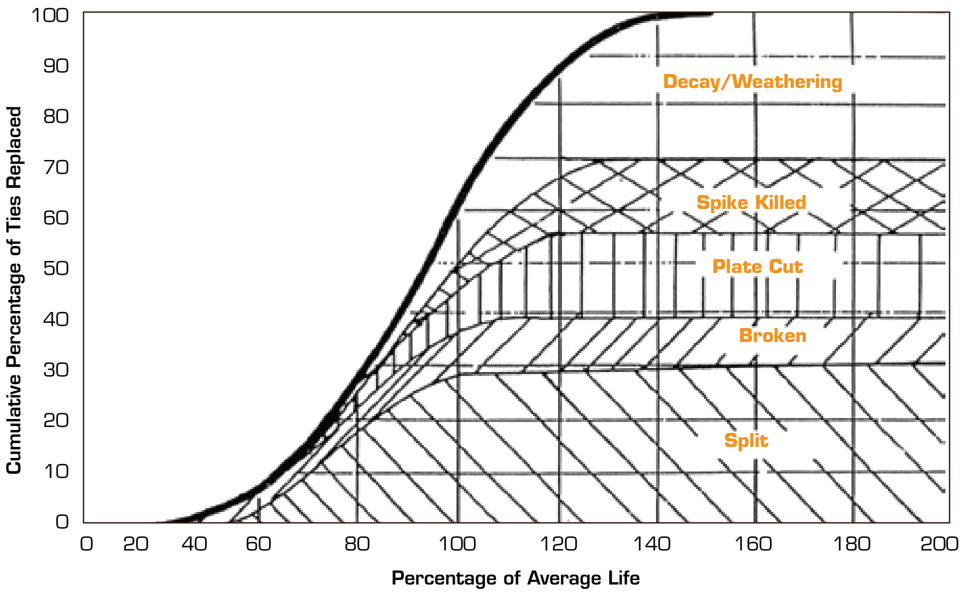

Figure 4: *Curvature Sensitivity*

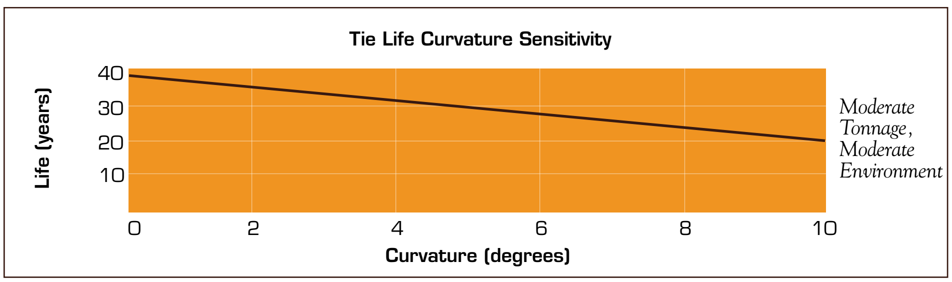

Figure 4 presents the sensitivity of tie life to curvature, defined in degrees of curvature.

Figure 5: *Tonnage Sensitivity*

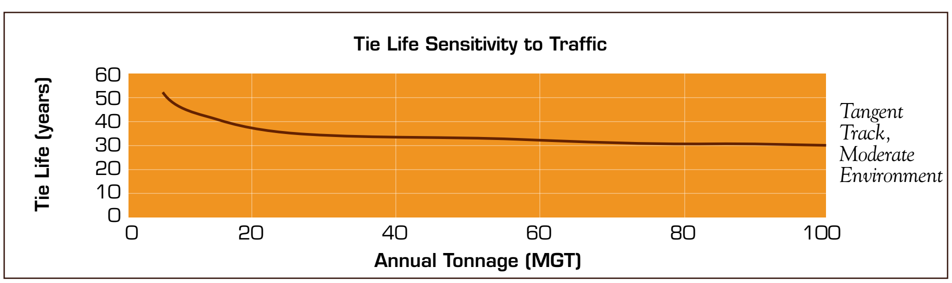

Figure 5 presents the sensitivity of tie life to traffic density, defined in terms of annual tonnage of MGT per year.

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Figure 6: Environmental Sensitivity

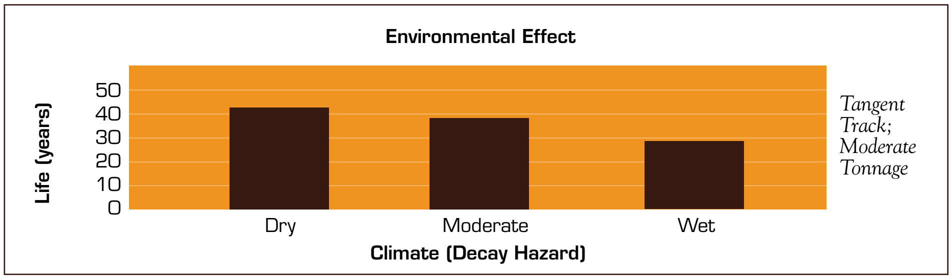

Figure 6 presents the sensitivity of tie life to environmental or climatic condition. This is directly related to the Decay Hazard map presented in Figure 2 and can be simplified as follows:

- "Dry" Climate Track: Representative of Western U.S.
- "Moderate" Climate Track: Representative of Northern U.S.
- "Wet" Climate Track: Representative of Southeastern U.S.

Table 2 presents a tabular summary of tie life by major category [2] as follows:

Annual tonnage:

- Low: 10 MGT per year
- Moderate: 25 MGT per year
- High: 50 MGT per year

Curvature:

- Tangent
- Moderate (defined as 4 degrees)
- Composite curvature (80% tangent and 20% to curves reflect a distribution identified on selected US railway routes)

Climatic condition:

- "Dry" Climate Track: Representative of Western U.S.
- "Moderate" Climate Track: Representative of Northern U.S.
- "Wet" Climate Track: Representative of Southeastern U.S.

Table 2: Wood Tie Life

"Dry" Climate Track	Curve (deg)		
MGT	0	4	Aggregate
10	50	39	47.8
25	40	33	38.6
50	36	28	34.4

Moderate Climate Track	Curve (deg)		
MGT	0	4	Aggregate
10	45	36	43.5
25	38	30	36.2
50	33	26	31.5

"Wet" Climate Track	Curve (deg)		
MGT	0	4	Aggregate
10	34	27	32.8
25	29	22	27.3
50	25	19	24

REFERENCES

1. Zarembski, A. M. and Holfeld, D. H., "On the Prediction of the Life of Wood Cross Ties," American Wood Preservers Association, Annual Conference, Pittsburgh, PA, April 1997.

2. Zarembski, A. M., "Development of Comparative Cross-Tie Unit Costs and Values," Report to the Railway Tie Association, August 2006.

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4. MacLean, J. D., "Percentage Renewals and Average Life of Railroad Ties," Forest Products Laboratory, USDA Forest Service Report No. 866, November 1957 (Reaffirmed 1965).

5. Wells, T. R., "Tie Failure Rate Analysis and Prediction Techniques," Association of American Railroads Report R-515, October 1982.

6. Davis, D. D., and Shafarenko, V., "Tie Condition at Des Plaines: A Progress Report," Bulletin of the AREA, Bulletin 713, December 1987.