Wood Tie Life: Part I Average Tie Life

In a conventional mile of railway track, there are approximately 3,250 crossties, spaced, on the average, 19½ inches apart. Although each of these ties experiences approximately the same level of loading and the same range of environmental conditions, differences in wood, treatment and support will result in a difference in the life of these ties. Even if all of the ties are installed at the same time, they will not all fail at once. Rather, they will fail in accordance with a statistical distribution about a "mean" or "average" value. This average value can be used as a guide to determine the "life" of the tie in track.

The average life is a function of several factors, including track and traffic characteristics and environmental conditions. Over the years, there have been attempts to define, in broad terms, the average life of ties as a basic function of the traffic density of the track. This is necessary, at a minimum, in order to allow for the differences in failure modes of the ties, and in particular the differences between mechanical failure modes at higher-traffic densities and environmental failure modes at lower-traffic densities (See *RT&S*, May 1988, p. 12).

Using data acquired between 1934 and 1957, early researchers developed the relationship between average tie life and traffic density presented in Figure 1 (1). This showed that under light-traffic loadings, an average tie life of 50 years was achieved (yards and sidings had an average tie life of 60 years). Under high-traffic densities, however, this life dropped to less than half of these figures (1).

Subsequent analysis (See Figure 2) of tie-life data taken during 1978 shows a very similar trend, with low-density tracks having an average tie life of over 40 years, and high-density tracks having an average life of just over 20 years (2). Once again, there appears to be a difference in the tie-failure mechanism associated with high- and low density types of track.

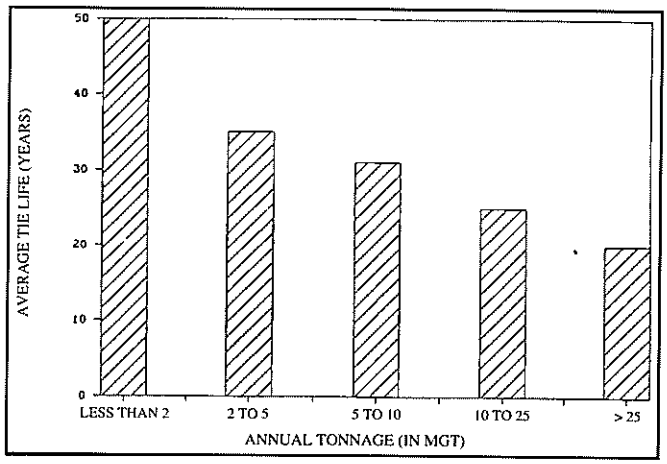

Figure 1 — Average tie life (data from 1934 to 1957)[1]

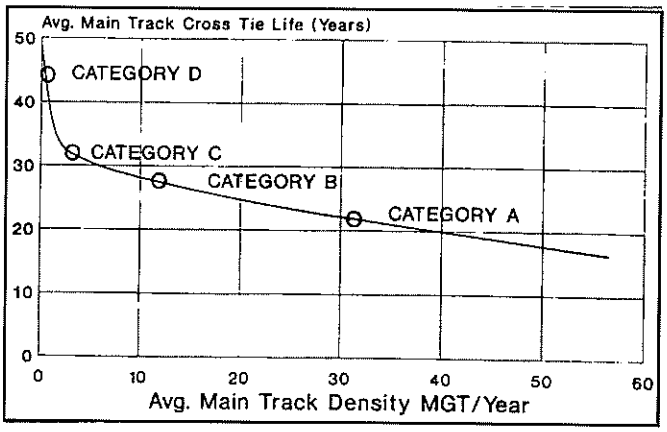

Figure 2 — Tie life versus tonnage, from 1978 industry statistics[2]

Environmental effects

More recent data on a moderately-high-density track show a similar average tie life. In this case, detailed analyses of several sites on a 20 MGT mainline in the northeastern United States showed a distribution of tie failures corresponding to an average tie life of between 25 and 30 years (3). This figure appears to be consistent with the average tie life obtained for that tonnage level in Figures 1 and 2.

The preceding data allow for the development of a relationship between average tie life and annual traffic density. However, the effect of other parameters on average tie life is not as well defined. These other parameters include curvature, axle load, ballast condition, as well as

a range of track and traffic parameters, which affect the load distribution on the crosstie. In addition, the variation in environment has been found to play a strong role in tie life, particularly on the moderate- and light-density lines where the primary modes of tie failure are environmentally related.

This environmental effect was recently illustrated by examining the average tie life in different geographical and climatic regions of the United States. The U.S. was divided into three distinct zones, based on "decay hazard" (Figure 3). The average tie life in the Eastern region was found to be 46 years; the Southern region, 30 years; the Western region, 51 years (4). Such a broad categorization of climatic conditions can result in differences in average tie lives of a factor of 1.5 or greater. This suggests that environmental factors have a significant effect on the average life of ties in track.

Considering these effects, it is possible to estimate the average tie life as a function of at least several key factors. However, the average tie life does not give the actual distribution of tie failures in track. Rather, it defines the point about which these failures are distributed. The distribution of tie failures about this average value will be presented in Part II.

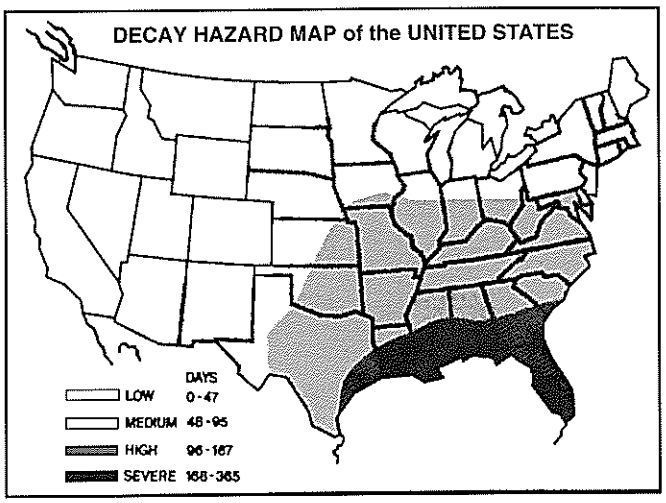

Figure 3 — Environmental effect map[4].

References

(1) Code, C. J., "Crossties: What is the Average Life?" *Railway Track & Structures*, December 1962.

(2) McIlveen, E. R., Roney, M. D., Lake, R. W. and Raymond, G. P., "The Road Cost Maintenance Model, " Canadian Institute of Guided Ground Transport Report 80-16, March 1981.

(3) Davis, D. D. and Chow, P., "Tie Condition Inspection: A Case Study of the Failure Rate, Modes, and Clustering, " Bulletin of the American Railway Engineering Association, Bulletin 723, Volume 90, December 1989.

(4) Russell, Allen, "Tie Decay-Underrated Factor," *Railway Track & Structures*, August 1986.