ANNUAL CHARGES FOR RAILWAY TIES.*

FACTORS governing the annual cost of maintaining any tie are: (*a*) First cost in track. (*b*) Annual interest and tax rate. (*c*) Life of tie. The first cost of the tie consists of three main charges, some of which may be still further subdivided. The three main charges are: (1) First or wood cost of tie, including foreign freight, preservatives and mechanical protection. (2) Labor and other costs of putting ties in the track. (3) Overhead supervising charge. The sum of these is the cost of the tie in track.

On the first cost of the tie there is a tax charge and an interest charge. In our calculations we assume a tax rate of 1 per cent. on value and an interest rate of 6 per cent., making a total of 7 per cent. Any other rate can be used.

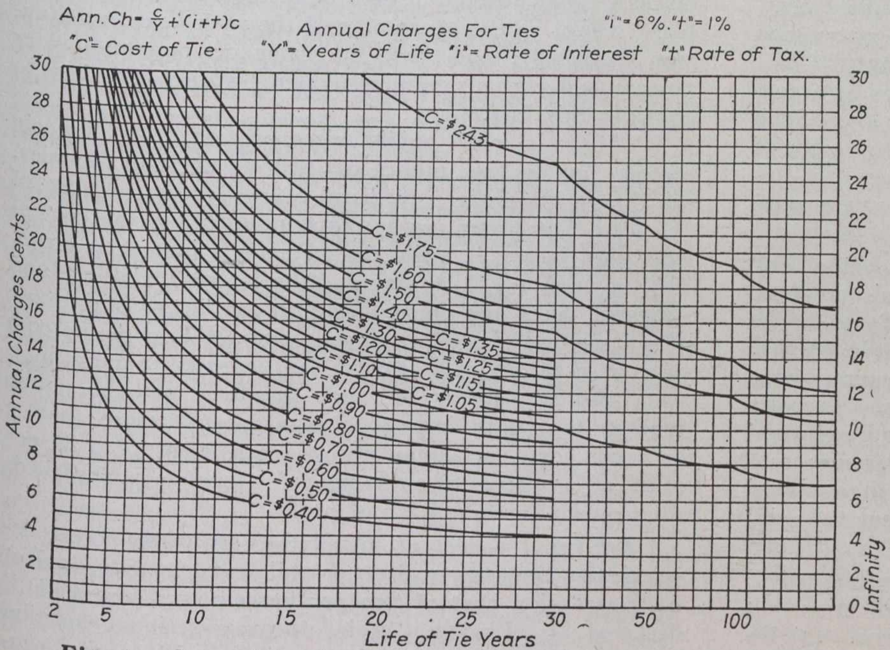

Fig. 1.—Computing Curve for Annual Charges of Railway Ties.

The annual maintenance charge for all ties is the sum of annual interest and tax on first cost of all ties in track and of the replacement cost in track of all ties removed.

Over a series of years the replacement accurately determines the average life of all ties. If one-tenth of all the ties is replaced each year the average life is running at the rate of 10 years. If one-twelfth is replaced the average life is running at the rate of 12 years. If one-eighth is replaced, the average life is running at the rate of eight years. If in 10 years as many ties have been replaced as the total in service, the average life is 10 years, irrespective of variations in different years.

The annual maintenance cost can be expressed by the formula:

$$A = \frac{C}{Y} + C\,(i + t)$$

A = Annual maintenance charge.
C = First cost of tie in track.
Y = Average years of life determined by number of removals.
i = Rate of interest on investment.
t = Tax rate on investment.

*From a paper by Harrington Emerson and T. T. Bowen, read at the annual meeting of the American Wood Preservers' Association, January 19-21, 1915.

By means of the above formula the diagram, Fig. 1, has been constructed for solving instantly as to a single tie or classes of ties, all ties for a year or series of years, the fundamental question of the relation existing between: First cost of tie; life of tie; annual cost of maintenance.

Three distinct problems may be solved with this diagram: Fixed annual cost with first cost and duration of life, both variable.

To illustrate: Take the horizontal $0.15 line of annual charge as the standard annual cost. Along this line there are numerous intersections with the curved lines of first cost and the vertical lines of duration. Therefore, if ties are kept up on an allowance of $0.15 per tie per annum, there are many solutions as follows:

First cost.	Duration, years.	Annual cost per tie.
$0.40	3.2	$0.15
0.60	5.5	0.15
0.75	7.6	0.15
1.00	12.5	0.15
1.25	20.0	0.15

But we may take another problem, namely that of first cost fixed, but annual cost and time variable.

First cost.	Duration, years.	Annual cost per tie.
$1.00	2	$0 57
1.00	3	0.403
1.00	4	0.32
1.00	5	0.27

First cost, $1.00; 2 years' duration.

Interest	$0.07
Annual cost	0.50
Total	$0.57

Finally, we can assume an average standard life, say 15 years, and determine first cost and annual costs.

First cost.	Duration, years.	Annual cost per tie.
$0.40	15	$0.0546
0.60	15	0.0820
0.75	15	0.1025
1.00	15	0.1366

The first illustration given here, that of fixed annual cost with varying duration and first cost, is by far the most valuable of the three. This solves definitely the economic question of the value of tie treatment.

Suppose a tie without treatment costs $1 in the track and lasts 10 years. How much may be spent for treatment to prolong its life to 18 years? The annual cost of $1 tie lasting 10 years is $0.17. The intersection of the $0.17 horizontal line with the 18-year vertical line falls on the $1.35 curved line of first cost. Therefore, it will pay to spend $0.35 for chemical treatment or mechanical protection, or both, on the $1 tie to prolong its life from 10 years to 18 years.

The diagram also illustrates graphically, by the steepness of the curves, the great economy in prolonging the life of ties that ordinarily last but a few years.

It is, of course, understood in this theoretical diagram and tables that tie maintenance is a continuous performance; that nothing takes place suddenly and that there are great individual variations.

The advantage of the cost formula used is its extreme simplicity. The conclusions it forces on us are, however, not invalidated by any other formula, however complex.