A Few Thoughts on the Treatment of Railway Ties.

By Edwin Winfield, Transportation Student, Canadian Pacific Railway.

In Canadian Railway and Marine World for November the writer saw a statement to the effect that it was not considered economical to chemically treat ties until they cost a certain amount. As he has been somewhat interested in the subject, particularly since seeing the experimental plant at the Forest Products Laboratory in Montreal, this statement set up a train of thought which will find expression in this brief analysis of the matter. It is hoped the views presented may prove of interest to the railway community.

It is evident that there is one big question in the matter, and that concerns dollars and cents. We have before us a tie, and what we want to know concerning it is, if the tie were treated before being put in the track, would we be further ahead financially, in the final analysis, than if it were put in untreated? In order to answer this question in such a way that we can feel our answer to be correct and based on good reasoning, we have to make a study of all the contributing factors; then, having done so and summarized the results of our enquiries along different lines, we are in a position to answer it.

Before proceeding, let us examine this treating proposition and see just what the treating is supposed to accomplish and how it does it. It is not supposed to add strength to resist mechanical wear, or make the tie physically stronger; it is supposed to make the tie better able to resist decay. Decay of wood is but the work of bacteria and fungi, which low forms of life, with a few exceptions, are unable to attack the living tree, but certainly thrive on the dead timber. They eat away the wood fibre, and the wood becomes rotten; it has decayed. Heat, air, food and moisture are necessary for the fungus to keep on living. If moisture could be kept out of the wood entirely, the fungus would die, but this is a difficult matter. If a poisonous substance is injected into the wood, the fungus dies. The ideal tie preservative, then, is one wherein a poisonous substance can be made to penetrate far into the wood. Having thus penetrated, it should adhere closely to the wood fibres and cells, act to the exclusion of moisture, and be not easily washed out of the wood, with cost right in proportion to results.

It is well known, particularly to those of us who have made a study of the thing from behind a track shovel or tamping bar, that ties in the track are rendered useless in one of two ways. These are: (1) Failure caused by the tie starting to decay, which softens it and renders its powers of resistance to wear and tear less. (2) Failure caused by wear and tear, as "rail-sawing," re-driving of spikes, splitting, crushing of fibres, etc., without decay having set in.

Our first line of enquiry deals with the causes necessitating the removal of the tie from the track. It will be at once appreciated that there will be many factors contributing to the result of our enquiry along this particular line, among which may be mentioned the kind of ballast, spacing of ties, volume of traffic, drainage, climatic conditions, etc. Just at this point, though, let us assume that in a stretch of track where conditions as above are similar, we have ties made from two or three kinds of wood. On observation, it will likely be found that one kind of tie has always to be taken out, not because it is smashed and crushed through the effects of the wear and tear of traffic in itself, but because it has become so badly decayed that it could not stand this wear and tear at all. On the other hand, another kind may have a tendency to split and sliver, while quite sound as to decay; a third kind may be so crushed and cut, while not decayed at all, that its removal is imperative.

Suppose a tie which we may designate as tie A, is always found to fail from wear, and it thus fails before decay has set in. Evidently, it would not pay to treat that tie; treating it would not prolong its life, as it is worn out before it decays anyway. But suppose tie B is always found to have its failure due to decay in the first instance. We are not in a position to state that it would pay to treat that tie; we are able to say that it might pay to treat it. On the testimony of the roadmaster and some of the section foremen, it is determined that tie B has an average life of seven years in the piece of track we are considering. Another man comes along and produces facts and figures to show that if that tie had been treated with creosote, it would not have decayed, under identical track conditions, for 14 years. It is agreed though, as the result of experience, that the tie, (thus treated or not) would wear out, under those track conditions, in 12 years, 2 years before it would have to be removed because of decay. It is stated that it would cost to treat the ties, in the quantity we want them, 36c each, and we are then in a position to find out if it would pay to treat the tie as follows, also knowing the untreated tie costs 80c in the track.

There is a hole in the track where a good tie must be placed and a good tie must be kept there. Our object is to keep a good serviceable tie in that hole in the track, forever, at the least expenditure in dollars and cents. In order to find out what tie is going to do the business most economically, there must be considered: (a) First cost of the tie in the track; (b) life of the tie; (c) interest value of money; (d) cost of renewal, assumed equal first cost. Now suppose that, having put in a tie, we start a little sinking fund, such that, when it comes time to renew the tie, the accumulation of our contributions to this little sinking fund will pay for the new tie and the cost of putting it in. The yearly expense attached to keeping that hole in the track properly filled, then, will be, first, the yearly interest on the first cost of the tie, and second, the yearly contribution to this sinking fund. The tie which does the business satisfactorily, and for which this sum is the smallest, will be the best tie to use.

Let S be the first cost of a tie. R the amount of $1 in one year; if the interest rate is 5%, R equals $1.05. A be the amount of our annual deposit in the fund. n the number of years the tie lasts.

The yearly interest on first cost is

$SR - S$. A is equal to $S\left(\frac{R-1}{R^n-1}\right)$

The total yearly expense, equal to yearly interest on first cost plus the yearly contribution to sinking fund, is $S\left(\frac{R^{n+1}-R^n}{R^n-1}\right)$

and the tie, treated or untreated, for which this sum is a minimum, is the most economical tie. The cost of treating, of course, is figured into the first cost of the tie.

Interest per year $= SR - S$. Amount of 1st payment in sinking fund at end of n years $= AR^n$; amount of second payment $= AR^{n-1}$ and so on, and the accumulated amount of all our yearly payments

$$= A\left(\frac{R^n-1}{R-1}\right) \quad \therefore A\left(\frac{R^n-1}{R-1}\right) = S.$$

$$\text{or } A = S\left(\frac{R-1}{R^n-1}\right)$$

and total yearly expense = yearly interest + yearly contributions to sinking fund,

$$= SR - S + S\left(\frac{R-1}{R^n-1}\right) = S(R-1) + S\left(\frac{R-1}{R^n-1}\right)$$

$$= \frac{SR^{n+1} - SR^n}{R^n-1} = S\left(\frac{R^{n+1}-R^n}{R^n-1}\right)$$

These calculations, of course, do not take into consideration the changes in price which will doubtless take place between renewals, but on the assumption that increasing values will be approximately proportional, this appears as good a way to investigate the subject as any.

The tie above mentioned costs 80c in the track untreated. It lasts seven years and fails because of decay. It costs 36c to treat it, making its first cost $1.16. It then lasts 12 years and has to be removed because it is worn out. By making use of the above formula we see that the annual expense of keeping the untreated tie in the track is 13.6c, and the annual expense of keeping the treated tie in the track is 11.6c, and hence it is evident that the treatment of the tie in question would be an economical proposition.

Now suppose that we have another tie, of the same wood, but this time a no. 2 tie, instead of a no. 1. Untreated, its life is seven years, it still being rendered useless through decay, and not wear. At first sight it would appear good business to buy no. 2 ties, but more will have to be used and handled. The creosote treatment, with the same amount of creosote injected yer cu. ft. of timber, will keep decay away just as long, but the tie will wear out in nine years. Say the first cost untreated is 70c in the track. If the tie were treated, its first cost would be 70c plus 36c, or $1.06. The annual expense for keeping the hile in the track filled with untreated ties will be 11.9c, and with treated ties it will be 15.4c, so that it would evidently be poor policy to treat this tie as the no. 1 tie was treated.

Suppose that experience has indicated that the use of suitable tie plates would add two years to the life of such a no. 2 tie; that the tie plates cost 30c a pair, and are worth 20c when the tie is done. Would it be economical to treat such a tie with tie plates on it? The net cost of the plates adds 10c to the first cost of the tie, but the annual interest on the tie plates is 5% of 30c, or 1.5c. First cost untreated is 70c plus 10c, or 80c. Its life untreated is still seven years, as it fails through decay; it might last a little longer because of the tie plates, but once it begins getting rotten, nothing will help it much. The annual expense of keeping the hole in the track filled with untreated ties is 13.6c plus 1.5c, or 15.1c. First cost treated tie is 70c plus 36c, or $1.16, and annual expense is 14.7c plus 1.5c or 16.2c.