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ON THE VALUE OF CREOSOTE TREATING OF TIMBER CROSSTIES TO THE CANADIAN RAILWAYS

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Introduction

Every year, Canadian railways replace around 2 million crossties in track to maintain safe and reliable infrastructure for the growing business of handling Canada's domestic transportation needs and a bulk export business that is critical to the economy. These crossties are pressure-treated to a retention of 7 lbs. per cubic foot or refusal in the white oaks with 50/50 preservative (which is a creosote-petroleum oil solution)[1] . This ensures [1]they have the service durability needed to withstand the rigours of supporting trains carrying up to 14,000 tons of products in an environment that varies from hot to severe cold, and from wet to dry.

Historical Context

It was always so that the Canadian railways used pressure treated crossties in track. The original crossties laid were typically a first growth, rough hewn timber with tight growth rings. In spite of this, these ties succumbed to environmental decay, such as splitting and rot and required replacement. In 1921, Canadian Pacific Railway was replacing 2 million crossties per year (1), double today's rate of tie replacement. That year, the decision was made to adopt pressure treated creosoted ties and in 1922 CPR added half a million creosoted crossties to the 1.9 million untreated ties that were laid in track. It was seen early on that the creosoted ties had better dimensional stability and less tendency to split. In 1923, CPR laid 1.4 million creosoted ties to only 1.1 million untreated ties. The positive results of the treated ties led to a steady shift to creosote ties. In 1951, only 100,000 untreated ties were purchased, the last year they were specified, save for 1956, when an unplanned demand exceeded the stock of air dried ties and 100,000 untreated ties were again purchased. By 1962, there were only 200,000 untreated crossties remaining in CPR main tracks. In 1961, CPR estimated (1) that the average service life of untreated ties installed between 1918 and 1922 had been 10 years, while those installed after 1941 had lasted 12 years on average. The equivalent life for creosoted ties was established at 32 years.

Why Ties Fail

Ties are marked for replacement at the end of their useful service life for a number of reasons. Canadian Railway Track Safety Rules (2) define a defective tie as one that are either:

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[1] 50/50 preservative = P3 (AWPA standard for creosote-petroleum oil solution)
P3 is made up from:
50% P1/P13 = standard for coal tar creosote
50% P4 = standard for petroleum for blending with creosote.

(1) Broken through;
(2) Split or otherwise impaired to the extent the crossties will allow the ballast to work through, or will not hold spikes or rail fasteners;
(3) So deteriorated that the tieplate or base of rail can move laterally more than ½ in. relative to the crossties; or
(4) Cut by the tieplate through more than 40% of the tie's thickness.

But what causes a tie to split and separate, to have the plate cut through the tie or to be unable to hold spikes? For most ties, properly dried and treated, failure is the result of a long progression of mechanisms. New oaks, maples and other mixed hardwoods have more than adequate bearing capacity to withstand life under a tieplate even in the heaviest tonnage lines. Those under joints receive some extra pounding that foreshortens their lives, but the rail acts as a beam on an elastic foundation and the load is distributed to roughly 11 adjacent ties. Usually the demise of a crosstie is the joint result of mechanical wear, moisture buildup and decay. It starts as the top surface of the exposed crosstie is subjected to the drying effects of the sun, while the remainder of the tie is encased in rock ballast. This causes radial shrinkage of the crosstie that opens up checks. In the meantime, mechanical action is causing the tieplate to abrade and tie fibres are being rolled to the edges of the plate. This progresses to a slight depression in the plate area. Moisture seeps into this depression around the edges of the plate, through the spike holes and through the checks in the tie's surface. Wet wood is not as strong as dry wood and the plate cutting progresses. Meanwhile the checking in the tie is deepening into splits. When these splits progress below the protective creosote layer, they expose untreated wood. With the right combination of moisture and temperature, decay sets in and fungal spores begin their task of boring into the cellulose fibres. CPR has found that decay can be seen within 5 years (3). But here is where the failures of treated vs. untreated ties diverges.

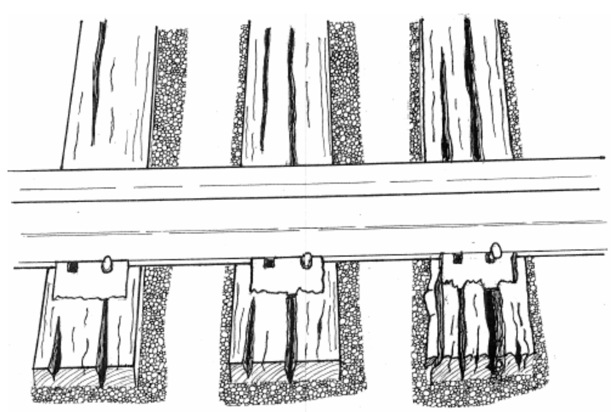

Figure 1 Illustration (from left to right) of the Progression of Deterioration in a Timber Crosstie

In an untreated tie, the effect of sun and ultraviolet radiation dries the tie surfaces rapidly and the splitting progresses rapidly. At the same time, the fungal colonies multiply in the favourable moist surface environment. In both treated and untreated ties, failure is usually caused because of the breakdown of biologically weakened wood fibres by mechanical abrasion under the tieplate and working of the spikes. This occurs slowly at first, but as a bathtub depression in the plate occurs, the mechanical action is enhanced, as is the presence of moisture. The abrasive breakdown of the plate area them progresses to a crushing action and a shearing delamination of the rings in a wedge shaped area under the tieplate. Alternatively, the tie may continue to split, particularly those not properly air dried. When the split opens to allow the wedging action of ballast particles, or the split progresses through a spike hole, failure can also occur.

In a well treated hardwood tie, if takes around 30 years before decay and moisture profoundly influence its strength. In an untreated tie, this occurs after year 5. Even in treated ties in mainline track, decay can be seen. Studies by the Association of American Railroads (4) identified 60-70% of the ties in a test section of the former New York Central mainline as having predominantly failed due to decay. Equivalent surveys on CPR and Norfolk Southern identified that 40-50% of the ties that had failed in higher tonnage lines had failure primarily influenced by natural causes. This increased to 97% in very light tonnage lines, where mechanical failures were concentrated in the sharp curves and at joints.

The Economic Cost

The above comparison of service lives invites the question: "What if tie treatment had not been available?" The most current estimates of tie service lives from CPR's planning group have pegged the value of treated crossties at:

- 29 years average service life in high density core lines;
- 37 years average service life in primary main lines;
- 43 years life in feeder lines;
- 60 years life in branch lines.

This is a very large service life improvement over the years when ties were only available untreated. Could CN and CPR have risen today to economically viable private corporations with extensive US properties and an integral role in Canada's exports without the benefit of wood treatment? A financial post audit would likely say no. If the Canadian railways still had an average life of 11 years for crossties, they would have required an annual tie program in the range of 7 million crossties annually. In addition to the strain on Canada's forests, this would have cost the industry an additional $600m per year in tie renewal costs. This is roughly equivalent to the total of any annual free cash that Canadian railways generate annually today, and considerably more than has been netted in the past. $600m in additional costs annually would have been just under double the annual capital cost of infrastructure maintenance, effectively negating the prospect of prospering as enterprises independent of government assistance.

Where did the value of creosote treatment go? Canada's 1967 National transportation Act favoured shippers, and the lion share of the saving has gone to a long trend of lower fright rates per ton-mile carried. This has helped to even the disadvantage Canadian farmers and industries have in shipping their goods greater distances to port. Lower freight rates have made Canada more competitive in selling coal, grain, potash, lumber, automobiles and other manufactured goods in the global marketplace.

So in addition to the benefits of creosote treatment in reducing the demand for tree harvesting for crossties, modern creosoting can be attributed, along with modern rail steelmaking with making railways economically viable to the benefit of Canada's position as a major exporter to the world.

But what of the waste when a crosstie must one day discarded? Canadian Pacific Railway disposes of all of its treated wood through co-generation facilities for energy recovery, where the ties are burned at a heat that is high enough to meet government environmental standards.

Could we live with less creosote? The Canadian railways, in particular Canadian National have over 3 million concrete ties in track, which are economically viable in heavy tonnage lines. You would also find steel ties in regular use in tunnels and turnouts. The Canadian railways are active in tests of Parallam lumber, reconstituted ties, plastic ties, and Borate treated ties encapsulated with smaller amounts of creosote, and are encouraging emerging Canadian suppliers of rubber and asphalt ties. There are higher cost alternatives, but creosote treated timber ties have been the backbone of the rail system and continue to support the Canadian economy.

References

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