Rail Fatigue – When to Relay

As we had noted in January's "Tracking R&D," the rail replacement criteria for mainline tangent and shallow-curved CWR track has been shifting towards fatigue defect occurrence. Not only does this require the monitoring of the fatigue defects, but it also necessitates determining a proper point in time for relaying the rail based on the defects formed.

In monitoring fatigue defects in track, it is apparent that strings of rail (as opposed to individual defect sites) do not *suddenly* fail in fatigue. Rather, there is a gradual increase in the number of fatigue defects that occur as tonnage accumulates over the trackage. This rate of defect occurrence has been shown to follow a probability distribution (see Fig. 1). The figure does reveal that the rail experiences more defects per mile per year as it remains in track over a longer period of time under accumulating tonnage.

The decision when to remove the rail from mainline service and sell it, scrap it, or cascade it to a less severe operating environment is not a simple one since, as mentioned, the rail does not just fail. Such a decision must have an economic as well as a technical side.

Individual rail defects are normally replaced in track by welding in plugs and not by removing strings of rail from track. Thus, the costs associated with the increasing number of fatigue defects must be considered.

Recent research activities have predicted defect occurrences in mainline track using both fatigue analyses and actual defect history, and by examining the associated costs to determine the optimum time for removing rail from service. Such an analysis[1] presents some of the costs associated with rail fatigue defects in track. They include the cost of: rail flaw inspection, which increases as the number of defects increase and the inspection interval decreases; replacing the rail at defect sites, in-service defects and their repair or replacement, and derailments associated with defects that are not found in time.

Other costs that may enter the analysis include train delay costs because of inspection and repair. When these are compared with the cost of new rail and the value of the old rails, either as relay rail or scrap rail, then an optimum relay point can be determined.

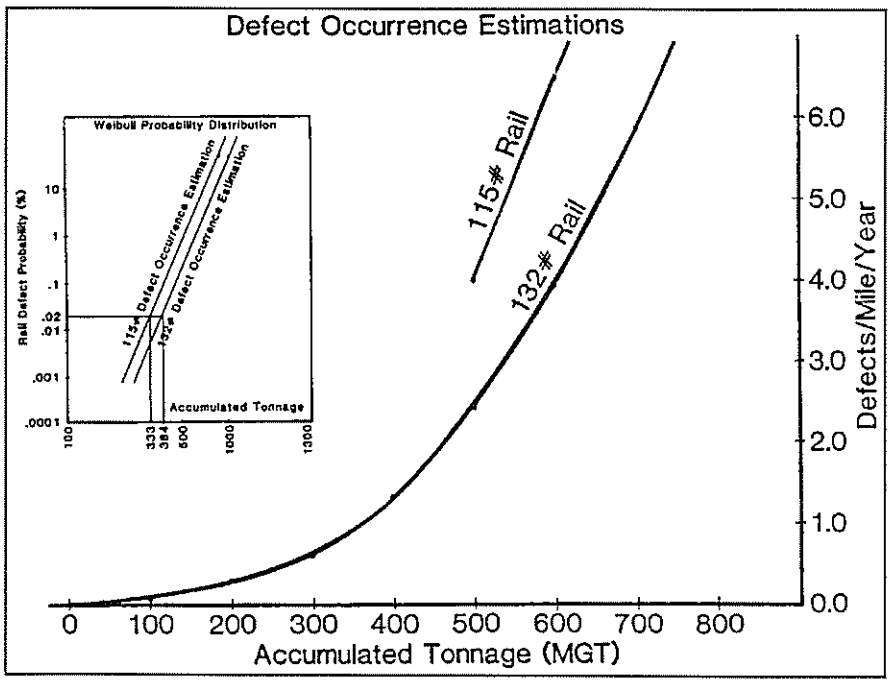

Figure 1 — Defect Occurrence Estimations

Where needed important!

One of the factors that strongly influences the time at which rail is removed is the need for that rail elsewhere. Thus, for railroads with many light secondary and branch lines, rail is often cascaded from mainline trackage before the rail defect problem is significant. In such a case, the value of the rail as relay rail is very high. Conversely, for railroads with few secondary or branch lines — and thus very little need for relay rail — the value of the rail as relay rail is low. The rail then will tend to remain in track as long as is practically and economically possible.

In most cases, however, there is a balance between the need for relay rail, either on the original railroad or for sale, that establishes a practical value of removing the rail from mainline track.

Moreover, when the rail is removed from mainline track for secondary use, its expected life in years will still be quite significant since the rate of tonnage accumulation on branch lines will be much less.

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While research is still pushing ahead, some early results indicate that an economic rail replacement point is reached when the defect rate is between 2 and 6 defects per mile per year.[1,2] The actual replacement point depends heavily on factors such as relay value, the probability of the defect causing a derailment, and the discount rate used in the analysis, among other assumptions. In addition, such operating characteristics as traffic loading — that is, distribution of wheel loads — and annual tonnage will seriously affect the analysis. However, the concept of determining an optimum time for rail replacement based on technical and economic criteria is one that must be examined further as railroads strive to improve operations and reduce costs.

1. Wells, T. R., "Rail Performance Model: Evaluating Rail." 1983 AREA Annual Technical Conference.
2. Wells, T. R. and Gudiness, T. A., "Rail Performance Model: Technical Background and Preliminary Results," MR Report R-474, May 1981.