Scheduling Rail Testing

Testing rail for internal fatigue defects is a critical element of any track-inspection program. Between 1982 and 1988, rail-caused derailments accounted for over 25% of the total number, and 40% of the total cost of track-caused derailments (*RT&S,* Oct., p. 11). Since many, if not most, of these rail-caused derailments were associated with defects that are *not* detectable by eye, the importance of an effective rail-testing program is immediately apparent.

One area of research aimed at improving the effectiveness of rail inspection is that of improving rail-testing schedules in order to make the test frequency (and corresponding test effectiveness) more responsive to the actual defect growth behavior in the rail. This approach, presented in an earlier Tracking R&D (*RT&S,* Jan. 1987, p. 12), has been the thrust of research by the Association of American Railroads and the Federal Railroad Administration[1].

More recent research performed by the Transportation Systems Center has attempted to combine the crack growth behavior of rail defects with the detection capabilities of conventional (ultrasonic) test equipment in order to relate the frequency of rail testing to traffic and track (and in particular rail crack growth) characteristics[2].

Test intervals

By relating the ability of the rail to tolerate "damage," or fatigue cracks, to the ability to detect the cracks, it is possible to determine the rail testing interval that will minimize the risk of a rail defect growing undetected until it fails in service.

As can be seen in Figure 1, the strength of the rail—its ability to withstand service loadings without failing—decreases during the period of crack growth (increasing defect size), until failure, caused by the reduced strength of the rail due to the presence of the defect, occurs. Since the period between detectable defect size and failure is relatively short (approximately 40 to 50 MGT), it is necessary to schedule rail inspections on a frequent basis[3].

However, even if a test is scheduled within the 40- to 50-MGT interval, it is not certain that the defect will be detected. This is particularly true during the early portion of crack growth, when the rail defect size is below 30%. As can be seen in Figure 2, the probability that a defect will be detected varies from 30% (or less than one in three) when the defect is small (10% of head area) to greater than 80% when the defect exceeds 30% of head area.

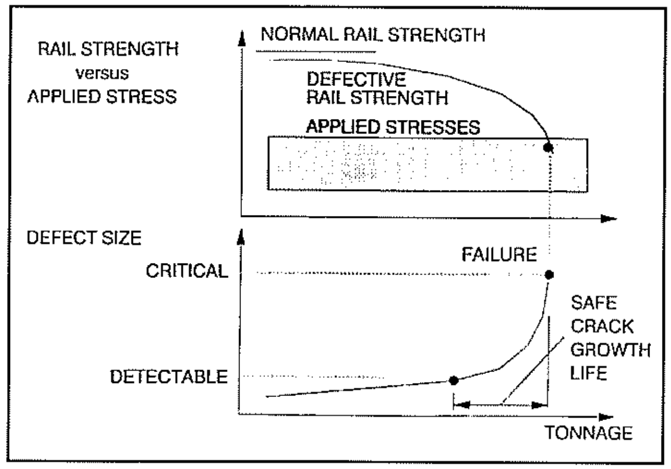

Figure 1 — The effect of crack growth on rail integrity[2]

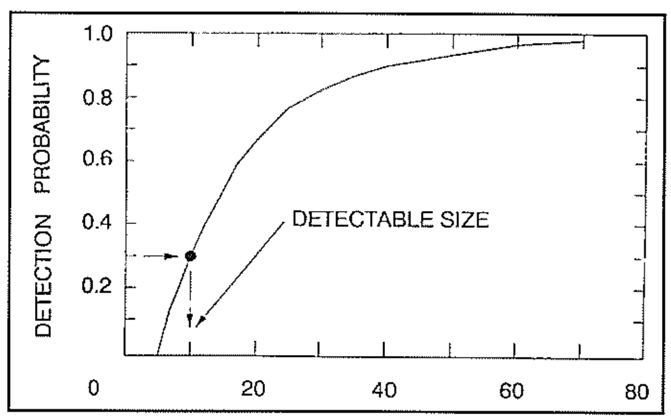

Figure 2 — The detectable size (percent of railhead area) of detail fractures[2]

To insure that the majority of the defects are detected before the rail breaks, it may be necessary to schedule multiple inspections during the period of crack growth. This must also be related to the actual defect growth rate, or frequency of defect occurrence, of the rail being inspected.

Scheduling curve

One approach to relate this information and develop an effective rail testing schedule, is to develop a master scheduling curve, which includes the total number of defects per mile, the interval between rail tests and the number of defects detected since the previous test[2]. Making use of defect-growth and detection-probability data, the interval between rail tests (in MGT) is developed as a function of the most recent defect history, in terms of defects (both detected and service) per mile. Thus, if the total defect count for a segment of track is known, the interval between rail tests can be determined directly.

Figure 3 compares the results of applying this inspection approach with actual inspection practices on three U.S. railroads. As can be seen in this Figure, there are two distinct patterns or groupings, one which corresponds closely with current practice on these railroads, and one which recommends an inspection frequency of approximately half the current practice. There is also a small group of data points where the recommended test interval is more frequent than the current practice.

By using an improved approach, railroad maintenance officers can more effectively schedule their rail testing programs in light of their rail conditions, operating practices and traffic patterns. This, in turn, can lead to an increased number of detected rail defects, and, if properly carried out, a decrease in rail-caused derailments.

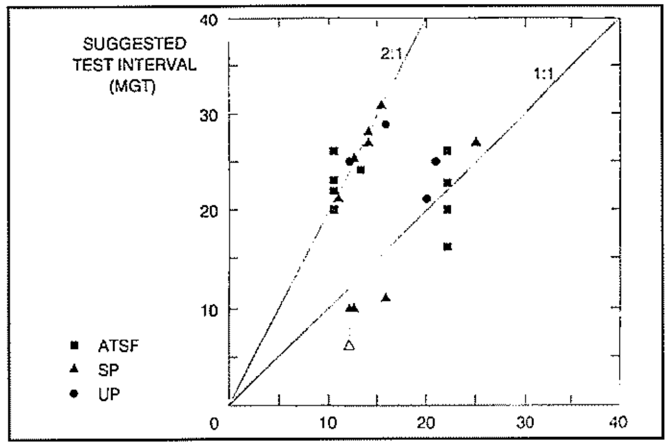

Figure 3 — The actual test intervals (in MGT) of three Class I railroads[2]

References

(1) Davis, D. D., Joerms, M. J., Orringer, O., and Steel, R. K., "The Economic Consequences of Rail Integrity," Third Heavy Haul Railway Conference, Vancouver, B.C., October 1986.

(2) Orringer, O., "Self-Adaptive Guide for Scheduling Rail Inspection in Service, " International Conference on Residual Stress in Rails: Effects on Rail Integrity and Railroad Economics, Kracow, Poland, April 1990.

(3) Orringer, O. et. al., "Crack Propagation Life of Detail Fractures in Rail," Department of Transportation Report DOT/ FRA/ORD-88/13, October 1988.