Effect of Material Quality on Ballast Life

Recent attention has been focused on the issue of ballast material quality and the behavior of ballast under traffic loading. Previous *Tracking R&D* articles (*RT&S* Jan. 1987, Aug. 1988) have addressed studies relating to the sources of ballast fouling and the development of improved ballast tests. Moreover, a recent AAR study[1] presented several ongoing research studies in the area of ballast quality and its effect on the life of the ballast in track.

In order to provide an indication of fouling of the ballast, defined as the filling of the voids or ballast open areas by fines, the percentage of materials passing a No 4 sieve is studied. When this value approaches the range of 20 percent, the ballast can be considered to be approaching its fouling limit.[1] Fig. 1 presents the results of gradation measurements on a U.S. mainline railroad ballast field test that has been in place for three years.[1] As can be seen in this figure, for a dolomite ballast material, the percentage of ballast passing the No. 4 sieve has increased each year, indicating that the ballast is in fact degrading under traffic. By the third year, approximately 5.0 percent of the ballast material passed through a No. 4 sieve. Similar behavior was observed under two other test ballasts, a slag and a quartzite. However, the rate of degradation of these two stronger ballasts was less than that exhibited by the weaker dolomite ballast in Fig. 1. By using these measures of degradation, and the limits defined above, it is possible to project the life of ballast materials under the type of traffic loadings encountered in the test zone. However, as in the case of many such tests, several years worth of data are often required before meaningful projections can be made.

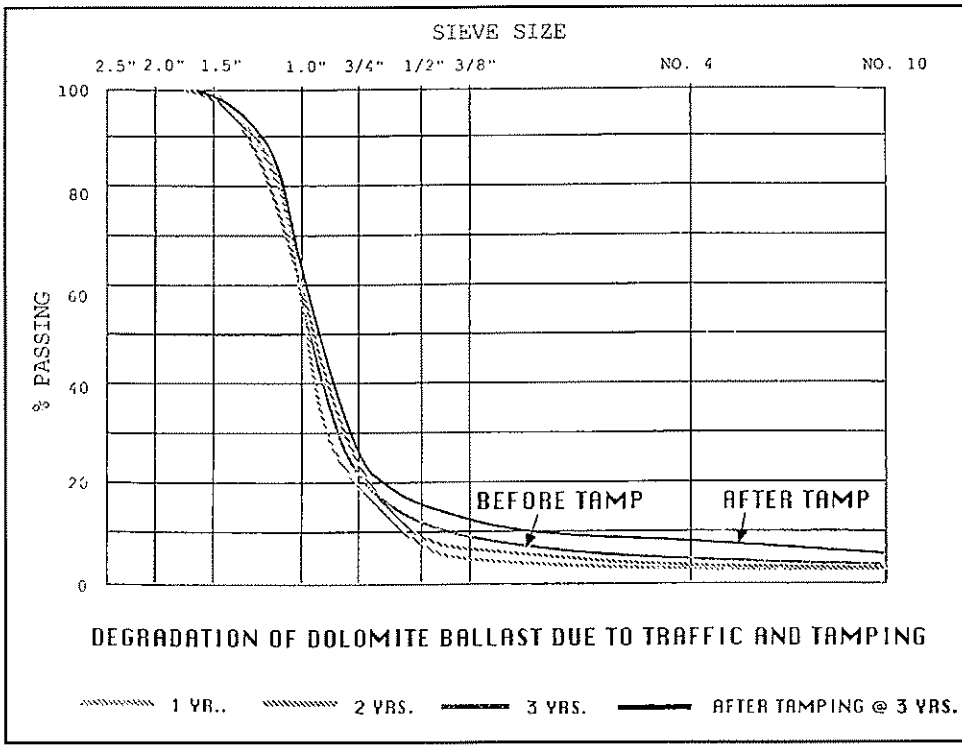

Figure 1 — Ballast Breakdown at Railway Test Site

As part of this test activity, the ballast gradation was also measured before and after tamping of the dolomite ballast. This is also illustrated in Fig. 1. As can be seen, the effect of a single tamping cycle in the third year was to increase the percentage of ballast passing the No. 4 sieve from 5.0 percent to 8.5 percent. This may be considered a significant increase and suggests that frequent tamping of ballast such as dolomite can, in fact, significantly affect the overall life of the ballast in track.

These results suggest that ballast strength rather than simply ballast gradation has a significant effect on the life of the ballast in track. Using the recently developed ballast abrasion number,[2] which is equal to the LA abrasion value, plus five times the Mill abrasion value, the relative effect of ballast strength and ballast gradation (using AREA gradation ranges) was examined.[1] These results are presented in Fig. 2.

As may be seen in Fig. 2, the effect of the ballast strength as defined by the abrasion number is significantly greater than the effect of the ballast gradation as defined by the AREA gradation number. In fact, as noted in the figure, the effect of ballast gradation on the ballast life, in track, is relatively small. However, varying the abrasion number from 25 (very good ballast) to 65 (relatively poor ballast), can result in an increase in ballast life from under 300 MGT to almost 1200 MGT.[1,2]

Examination of the overall economics of ballast as a function of its strength (abrasion number) results in the behavior presented in Fig. 3. In this case, the equivalent annual cost of the ballast (average annual cost) increases as the strength of the ballast decreases. However, while this increase is relatively small for moderate-density track (25 MGT or less), it increases dramatically for high-density track. Thus, in the case of 75 MGT annual tonnage track, the annual cost per mile for a poor ballast (abrasion number of 65) is more than double that of a good ballast (abrasion number of 25). Noting that the cost of the ballast material itself can be less than half of the overall costs,[3] this suggests that purchase of premium ballast material in fact may be justified, particularly for high-density mainlines.

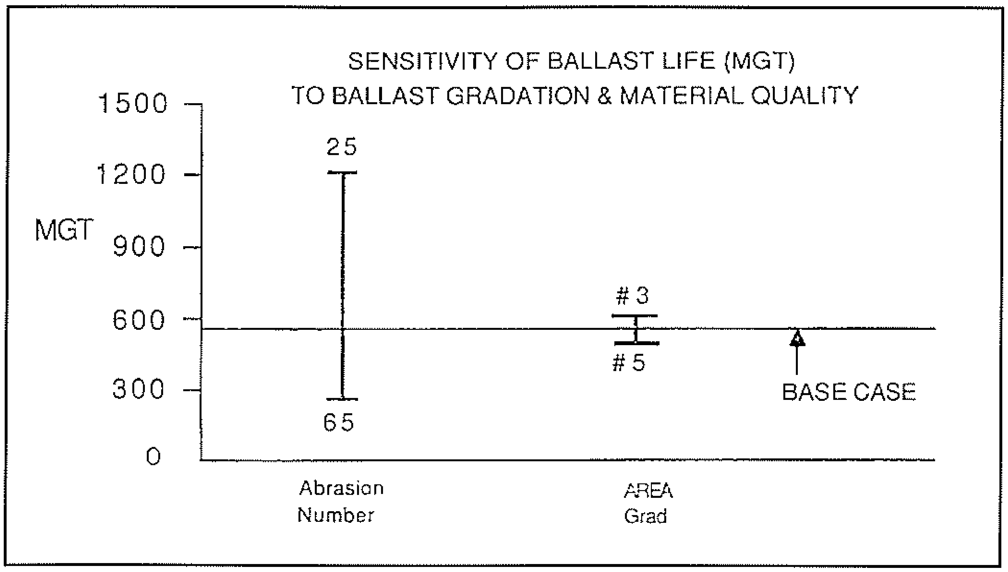

Figure 2 — Effect of Varying Gradation and Material Quality Upon the Projected Ballast Life.

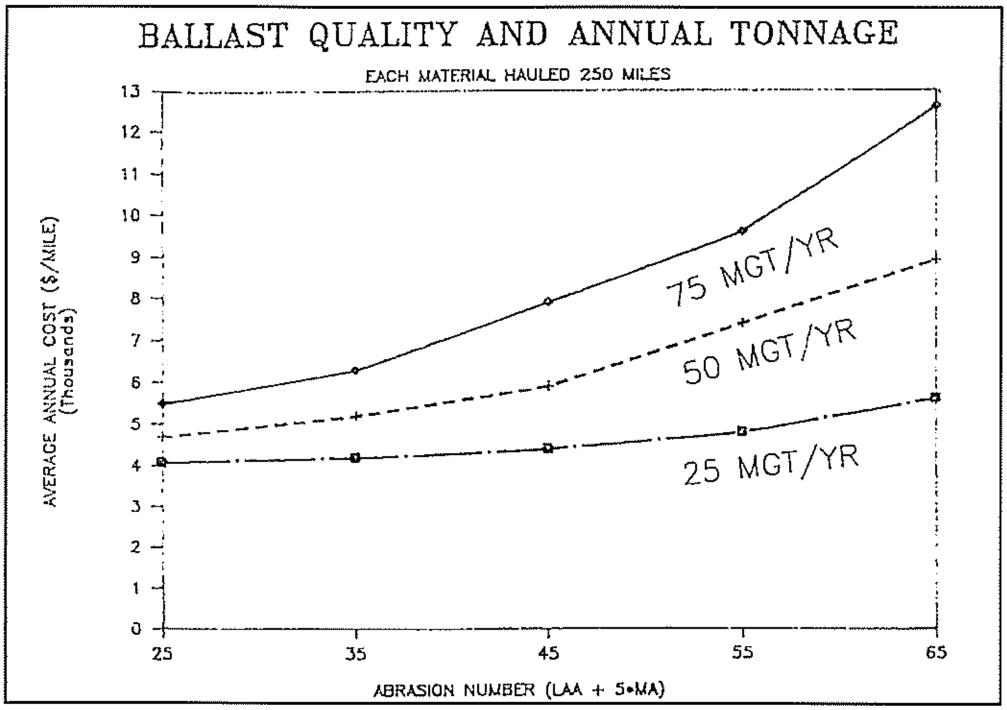

Figure 3 — Cost Comparison of Ballast Quality and Annual Tonnage.

References

1. Chrismer, S. M., "Recent Developments in Predicting Ballast Life and Economics," *Association of American Railroads Report R-700*, August 1988.
2. Klassen, M. J., Clifton, A. W., and B. R. Watters, "Track Evaluation and Ballast Specifications," presented at the 66th Annual Transportation Research Board meeting, Washington D.C., 1987.
3. Burns, D., "M/W Cost Components Part I-Surfacing," *Railway Track & Structures*, April 1987.