# *Effects of Tamping on Ballast Degradation*

Degradation of the ballast is usually a result of the breakdown of the ballast particles as they are subjected to a combination of mechanical and environmental factors. The causes of ballast breakdown include:

- —Repeated traffic loading, and in particular heavy-axle-load-traffic loading, including the effect of mechanical abrasion and overloading of the ballast particles.
- —Weathering, including the effect of freeze-thaw, thermal effects, water, water slurries and acid rain.
- —Handling at the quarry, during transport and during unloading or dumping.
- —Maintenance activities, including tamping.

Research carried out by the Association of American Railroads has shown that the effect of tamping on the generation of ballast fines can be significant (1). Since tamping represents the most common of the maintenance techniques used by railways to restore and maintain the vertical geometry of the track structure, this is of particular importance to railways in planning their ballast maintenance programs.

### *In-track tests*

In a series of in-track tests at the Transportation Test Center, the effect of tamping on ballast degradation was studied through the use of ballast boxes located under the ties (1). By monitoring the gradation of the ballast materials before and after tamping, the effect of the tamping operation (and the number of tamping squeezes) was evaluated. Figures 1 and 2 present the gradations of the two ballasts tested — an AREA No. 3 limestone ballast (Figure 1) and an AREA No. 4 granite ballast (Figure 2).

As can be seen in these Figures, there is a distinct and measurable change in the gradation for both materials after being subjected to 10 and 20 tamping squeezes each, with the number of finer particles increasing significantly in both cases. In the case of the softer, limestone ballast, there is a significant increase in the percentage of ballast passing sieves one-inch and less, with a significant amount of material passing the "fine" 3/8-inch, 1/4-inch, No. 4 and even No. 10 sieves. Note that the recommended gradation for AREA No. 3 ballast has no materials passing sieves of less than 1/2-inch (2).

In the case of the harder, granite ballast, while the actual percentage of finer materials is noticeably less

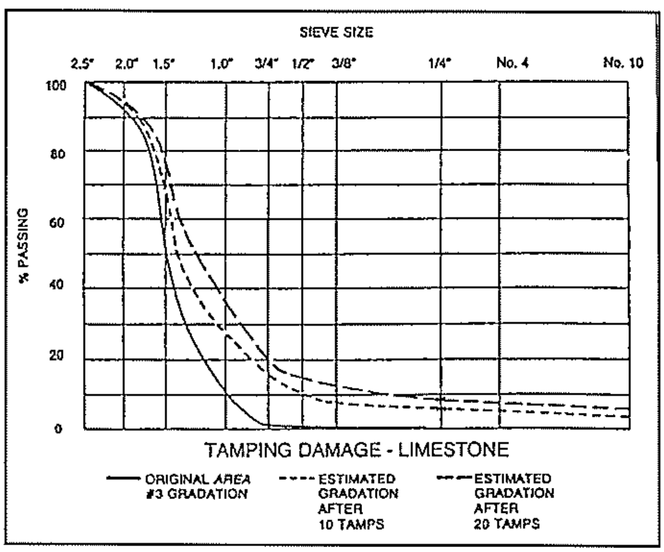


*Figure 1 — Limestone gradation before and after tamping[1].*

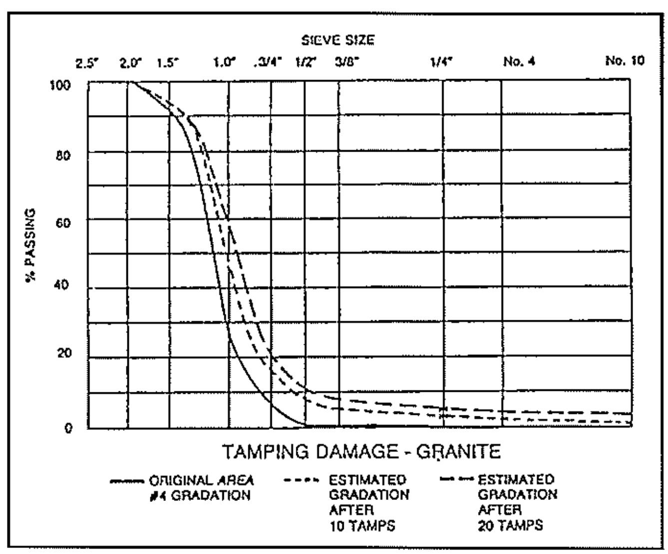


*Figure 2 — Granite gradation before and after tamping[1].*

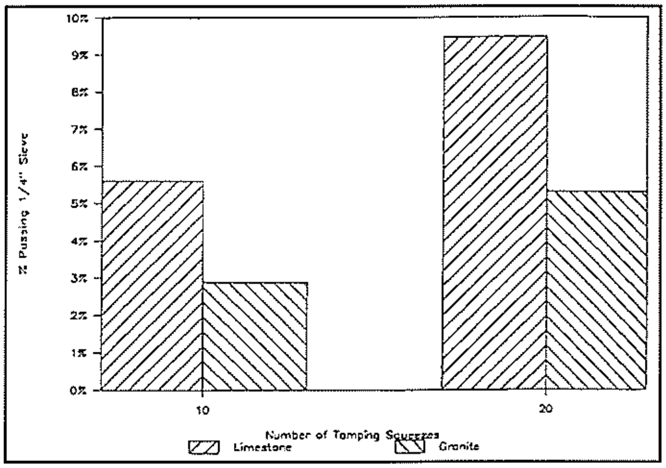


*Figure 3 — Damage done by number of tamping passes.*

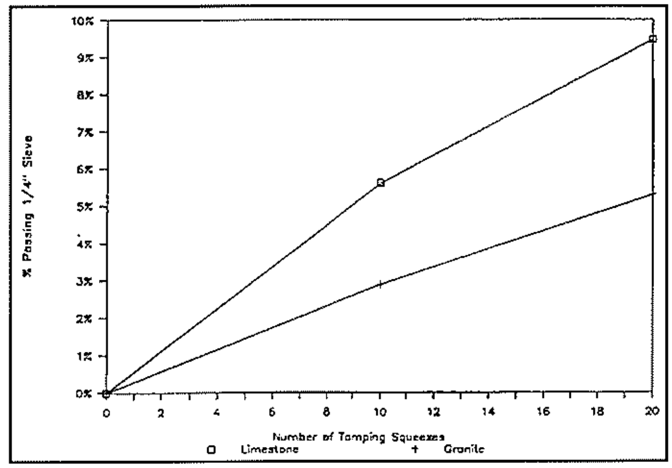


*Figure 4 — Another view of the effect of tamping on ballast [1].*

than that of the limestone, there remains a significant amount of materials passing through the ¼-inch, No. 4 and No. 10 sieves. Again, the recommended gradation for AREA No. 4 ballast has no materials passing sieves of less than ⅜-inch (2).

This difference between materials is more clearly illustrated in Figure 3, which shows the amount of fines (passing ¼-inch sieve) generated by tamping in both the limestone and granite materials. The harder granite material appears to produce approximately 40% to 50% less fines than the softer limestone material. In both cases, however, the measurable amount of fines is beyond what is permitted under AREA ballast gradations.

Figure 4 presents the results of these tests in a somewhat different format. Again focusing on the amount of ballast passing the ¼-inch sieve (unacceptable for both AREA No. 3 and No. 4 ballasts), it can be seen that there is an almost linear relationship between the number of tamping squeezes and the percentage of fine ballast particles. It may be inferred from this that tamping damage is cumulative, with an increasing amount of fines being built up as the ballast remains in track and is subject to periodic and ongoing maintenance (tamping).

Since ballast fouling represents one measure of ballast life (3), degradation can be related to ballast life as well. Noting that one definition of fouled ballast for a uniformly graded ballast is that which contains 20% to 25% fines (3), it can be seen that this type of ballast damage can result in a direct shortening of the life of the ballast in track. This, in turn, must be taken into account by track-maintenance officers, as they plan maintenance activities and weigh the trade-offs between the various maintenance and cleaning techniques.

## References

(1) Chrismer, S. M., "Track Surfacing with Conventional Tamping and Stone Injection," Bulletin of the American Railway Engineering Association, Bulletin 728, Volume 91, December 1990.

(2) American Railway Engineering Association, 1990 Manual for Railway Engineering, Chapter 1.

(3) Klassen, M. J., Clifton, A. W. and Watters, B. R., "Track Evaluation and Ballast Performance Specification," Transportation Research Board, January 1987.