Lateral Ballast Resistance

Last month's Tracking R&D examined factors that affect the ability of the track structure to resist buckling. One such track parameter is the lateral strength of the track structure, and, in particular, the lateral resistance of the tie in the ballast. This lateral-resistance parameter has been found to be of importance, not only in the area of track buckling, but also in the ability of the track to maintain its lateral geometry (its alignment) over time and traffic.

While earlier testing of lateral resistance had focused on the strength of a length of track, often in the form of a panel test (*RT&S*, July 1986, p. 23), most recent efforts have focused on testing the lateral resistance of a single tie — often using a field-deployable test fixture. Through the use of such a fixture, researchers have determined that an adequate representation of the lateral track resistance (for the purposes of quantifying track-buckling behavior) can be obtained by testing three randomly-selected ties in a 50-foot section of track (1).

The corresponding lateral resistance of the track has been found to fall into three broad categories: Strong, medium and weak, as illustrated in Figure 1. These categories, which are defined by the shape of the resistance curve obtained by single-tie lateral push tests, vary as to the magnitude of the maximum, or peak, resistance value (F_P) and the value of the limiting resistance value (F_L). As can be seen in Figure 1, both strong- and medium-resistance track have a distinct peak value which decreases, or "softens," to a reduced limiting value. However, in the case of the weak track, the two values are equal, with a constant (and low) lateral-resistance value. (These three categorizations of the lateral-track resistance correspond to the three categories of track-buckling resistance discussed in last month's Tracking R&D.)

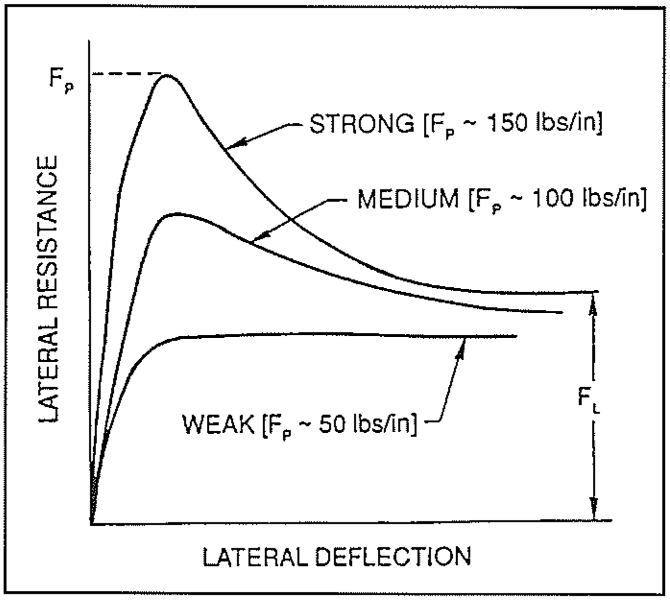

Figure 1 — Lateral resistance of track: Single-tie test results (1).

Track disturbance

Another phenomenon associated with the lateral resistance of the track is the effect of a disturbance to the track, such as the type caused by track maintenance.

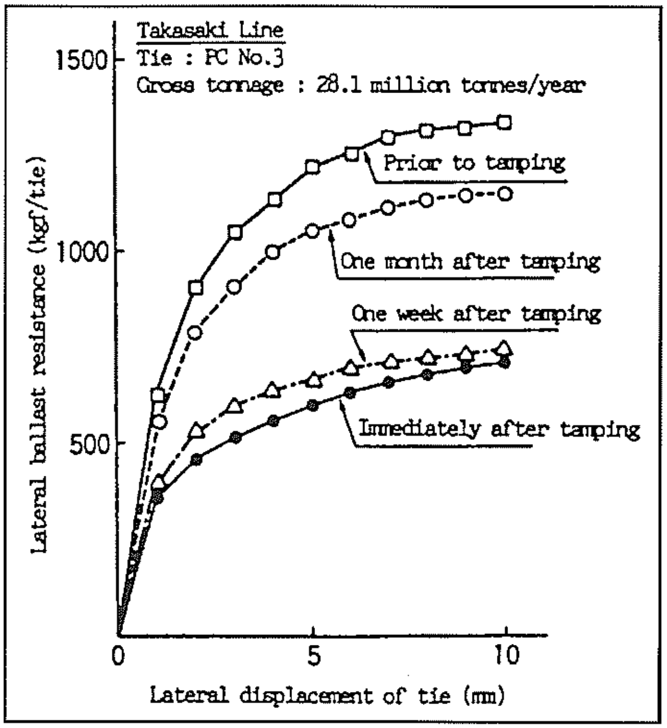

Figure 2 — Characteristics of lateral ballast resistance (3). Note: 1kgf = 2,000 lbs.

Such an effect is illustrated in Figure 2, which shows that tamping reduces the lateral resistance of the ballast to less than half of its original value. Furthermore, it shows that even after the passage of over two million tons of traffic (one month after tamping), the track had not reached its fully-consolidated (pre-tamped) state.

Figure 3 illustrates the effect of traffic consolidation on the peak lateral resistance (per tie) for small and large increments of consolidation. As can be seen in this Figure, the average peak resistance increases by over 40% with the passage of 400,000 tons (0.4 MGT) of traffic. For the test track presented in Figure 3, over 6 MGT of traffic was required before the track resistance stabilized at a value approximately 80% higher than the unconsolidated resistance value.

Figure 4 presents the same type of behavior for three different ballast types: Granite, traprock and slag. Although the resistance values for these types of ballast differ noticeably, they all exhibit the same type of consolidation behavior — showing a significant increase in average lateral resistance (shown in lbs/tie) of the order of 70% to 80% of the unconsolidated resistance value. As in the previous Figures, this increase in resistance, or consolidation, took place over a period of traffic ranging from 4 MGT to 8 MGT.

The lateral resistance of the track structure, which plays an important role in the prevention of track buckles and the maintenance of the track geometry, is strongly influenced by the disturbance of the track (through maintenance activities such as tamping) and the level of traffic consolidation. It is because of this effect that slow orders are frequently placed on the track following maintenance — particularly in hot weather — until sufficient traffic passes over the track to restore its strength. However, determining the appropriate level and length of slow orders depends on a good understanding of the lateral strength and resistance of the track structure.

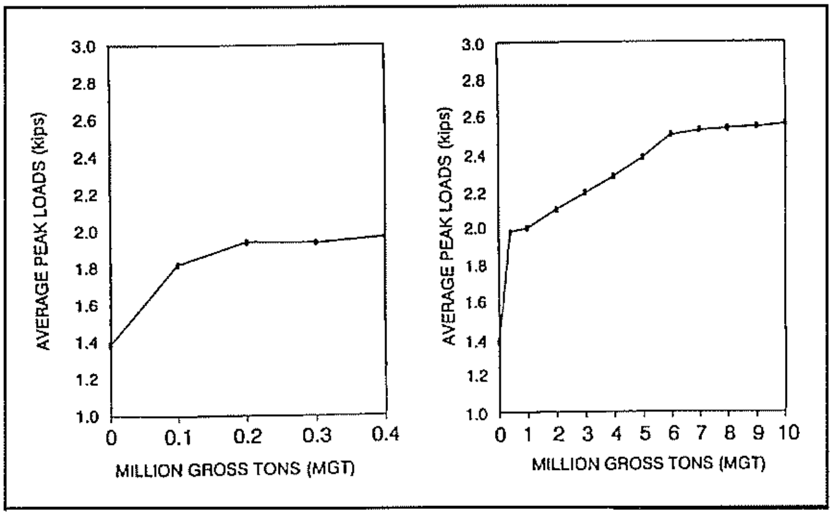

Figure 3 — Effect of track consolidaton on lateral resistance (1).

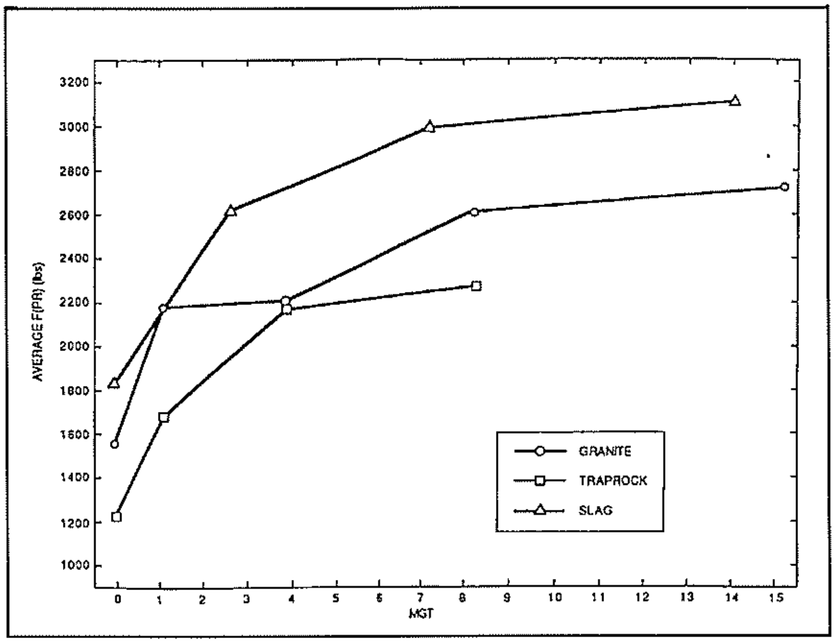

Figure 4 — Consolidaton of differing ballast types (1).

References

(1) Samavedam, G. and Kish A., "CWRTrack Buckling Safety Assurance Through Field Measurement of Track Resistance and Rail Force," Transportation Research Board Conference on Lateral Track Stability, St. Louis, May 1990.

(2) Kish, A. and Samavedam, G., "Dynamic Buckling of CWR Tracks: Theory, Tests and Safety Concepts," Transportation Research Board Conference on Lateral Track Stability, St. Louis, May 1990.

(3) Miura, Shigeru, "Lateral Track Stability: Theory and Practice in Japan," Transportation Research Board Conference on Lateral Track Stability, St. Louis, May ,1990.