Continuous Measurement of Track Gauge Strength

In 1988, inadequate track geometry was responsible for approximately 40% of all track-caused derailments (*RT&S,* Oct., p. 11). Of these, a significant number were directly associated with inadequate gauge strength (defective or missing ties and/or fasteners). Several major research efforts have aimed at quantifying and developing a means to measure the strength characteristics of track in which the gauge-holding strength of the ties and/or fasteners is found to be inadequate for the traffic carried.

In one such effort, initiated in 1979 by the Association of American Railroads and the Federal Railroad Administration, controlled lateral and vertical loads were applied continuously to the track structure by a special test vehicle. This prototype test vehicle, dubbed the "DECAROTOR," measured the loaded gauge of the track under lateral loads of between 4,000 and 8,000 pounds, and vertical loads of between 5,000 and 15,000 pounds (1, 2, 3). By comparing measurements of the loaded gauge with those of the unloaded gauge, a dynamic gauge-widening measurement was obtained. That measurement was directly associated with the gauge "strength" of the track.

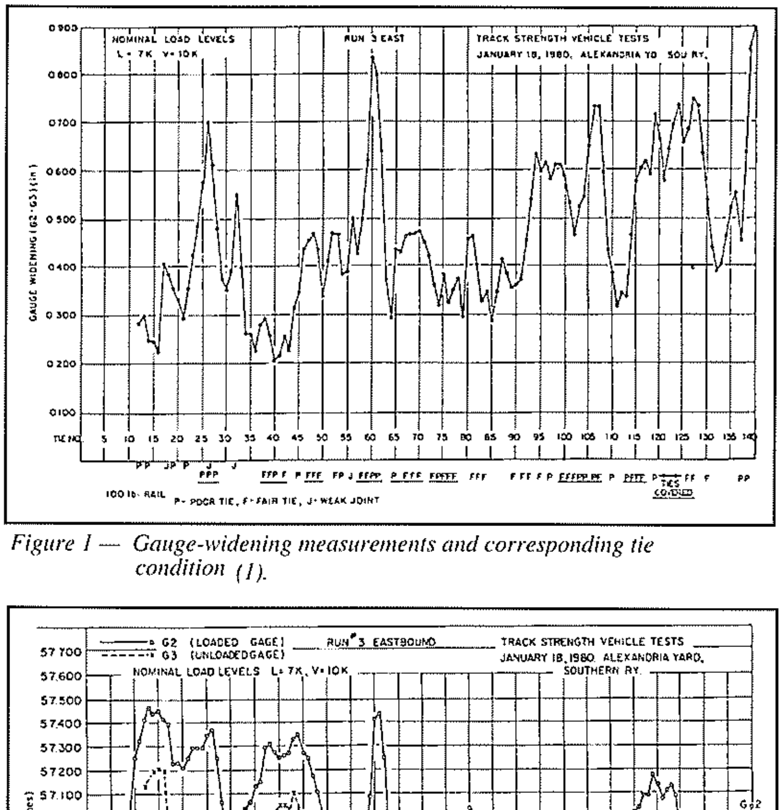

Figure 1 — Gauge-widening measurements and corresponding tie condition (1).

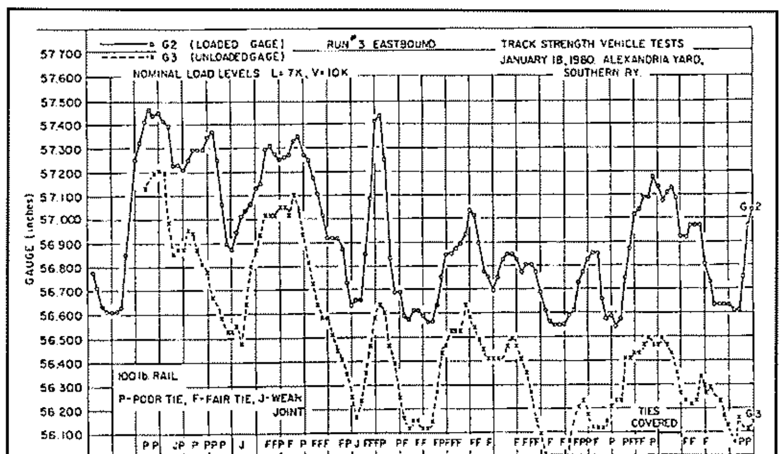

Figure 2 — Comparison of loaded- and unloaded-gauge measurements (1).

Detecting weak spots

Several sets of field tests carried out using the DECAROTOR indicated that the vehicle could locate "weak spots" in the track structure without causing additional damage to the track. Dynamic gauge widening and corresponding loaded- and unloaded-gauge measurements were taken for a 200-foot section of track, and the condition of the ties in the test zone were noted. As can be seen in Figures 1 and 2, a correlation between dynamic gauge widening (net gauge widening) and clusters of ties in poor or fair condition (based on visual evaluation of the ties) was observed.

This research program showed that this approach was conceptually feasible. Subsequent research focused on developing improved measurement systems and more reliable indices of gauge strength. In a program currently under way, the Department of Transportation's Transportation Systems Center developed a special "load-applying axle" that can be mounted on a conventional freight car in place of a normal axle, and can apply a controlled lateral (gauge-widening) load to the track (4).

The split-axle system

By measuring the loaded track gauge, the unloaded track gauge and the applied lateral forces, this "split-axle" system calculates the "compliance" of the track, which is a measure of the strength of the track structure. It also calculates a Gauge Reserve Index (GRI) which relates the initial unloaded gauge of the track to the risk of wheel drop under severe train-loading conditions (which, in turn, is related to the dynamic or loaded gauge of the track). By monitoring these two parameters, this system allows for the identification of weak spots in the track structure, and gives a measure of the strength of the tie/fastener systems.

Figure 3 illustrates the use of this split-axle system in identifying such weak spots. As can be seen in this Figure, locations C and D, which have spikes and plates removed on three and four ties, respectively, are clearly identifiable using the GRI measurement.

This measurement system has also been used to quantify the strength of newly-timbered track. As can be seen in Figure 4, the compliance or strength of the newly-timbered track is noticeably better than the "as-is" track with no new ties. (It should be noted, however, that there is no significant difference in GRI because the unloaded gauge of the as-is track was better than that of the section with new ties.)

The results of these tests, together with those of the earlier DECAROTOR tests, indicate that there exists the potential for measuring the gauge-holding strength of the track through the use of this type of load-applying/measuring system. Noting that research in other areas has likewise shown a benefit in measurement of geometry parameters under loads representative of actual traffic conditions (*RT&S*, Nov. 1988, p. 15), it appears that measurement of track geometry, in general (and gauge in particular), can provide a meaningful indication of not only track geometry, but also of the strength or load-carrying ability of the track.

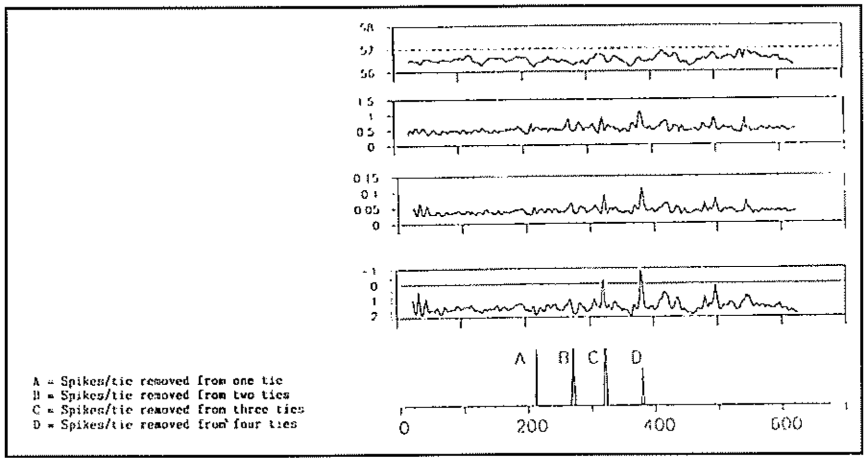

Figure 3 — Test data from artificially degraded track (4).

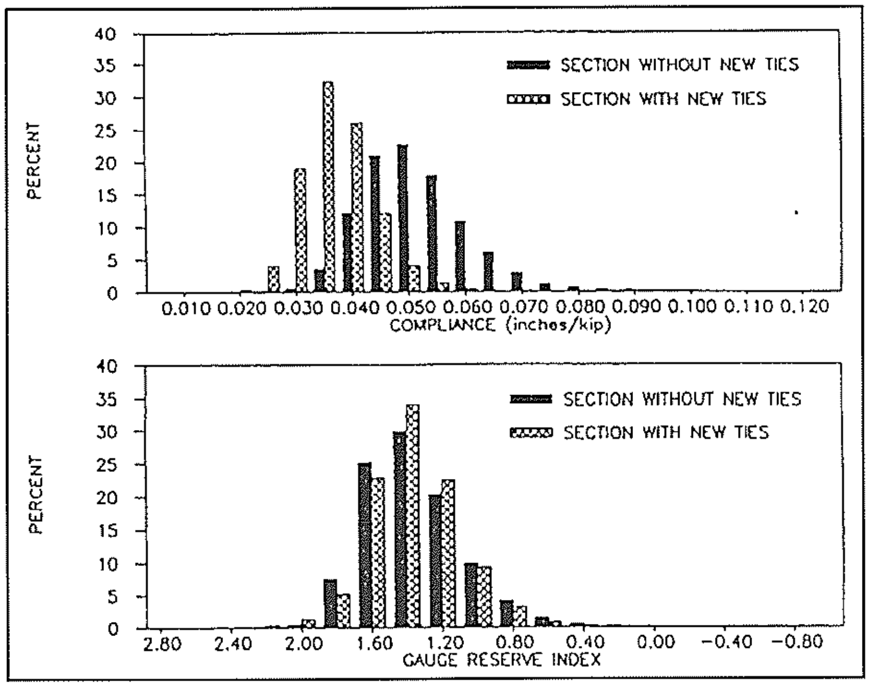

Figure 4 — Comparison of recently-maintained track with "as-is" track (4).

References

(1) Zarembski, A. M., McConnell, D. P. and Lovelace W. S., "New Car for Measurement and Evaluation of Gauge Widening Resistance of Track," Bulletin of the American Railway Engineering Association. Bulletin 678, Volume 81, March 1980.

(2) Zarembski, A. M. and Choros, J., "Field Evaluation of Mainline Quality Track Using a Track Strength Test Vehicle," Bulletin of the American Railway Engineering Association, Bulletin 680, Volume 82, November/December 1980.

(3) Zarembski, A. M., "On the Feasibility of Continuous Measurement of Track Gauge Restraint," Rail International, July/August 1980.

(4) Coltman, M., Dorer, R. and Boyd, P., "The Development of Automated Survey Techniques for Evaluating Tie and Rail Fastener Performance," American Society of Mechanical Engineers, Applied Mechanics Rail Transportation Symposium, 1988 (AMD-Vol. 96/RTD-Vol. 2).