Effect of Axle Load on Geometry Measurements

Measurement of track geometry, through the use of automated track inspection vehicles, is a well-established technique that is used by virtually all major North American railways. However, the proper axle loading for these track geometry vehicles still remains an area of discussion and analysis.

While it is well established that the deflection of the track is related to and varies with the applied loading[1], the question of whether geometry defects behave in a similar manner is still the subject of active research. In fact, while existing standards generally require the measurement of geometry defects "under load," the exact magnitude of this load is undefined.

One recent research program has addressed the relationship between measured track geometry defects and the corresponding axle load of the measurement vehicle.[2,3] In addition, it attempted to measure the change in key geometric parameters as a function of applied vehicle loading by using track-mounted (wayside) instrumentation.

Three measurements

This research study examined the variation in two key track geometry parameters: gage and cross-level as functions of applied wheel load. A section of class 3 track, with bolted rail, evidence of rail movement and some surface bent joints was used for this test. The applied vehicle wheel loads ranged from minimal (300 lb.) to 33,000 lb. for the wayside comparisons. The corresponding geometry vehicles had wheel loadings up to 20,000 lb.

Fig. 1 and Fig. 2 present the results of three sets of track geometry measurements, for gage and cross-level respectively, over the 250 test site. These measurements compare the unloaded (static) geometry, geometry measured by a light axle load measurement vehicle (R-3 with a wheel load of 4,000 lb.), and geometry measured by a heavy axle load test vehicle (T-6 with an axle load of 20,000 lb.). While it is clear that both the light and heavy measurement vehicles detected the presence of geometry defects, and in fact appeared to follow the same "signature," the actual magnitude of the measured defects varied. This is particularly true at several of the maximum defect points, such as at station 7 in both figures. The largest variations between the heavy and the light geometry measurements over this test site were found to be 0.4 in. in gage (Fig. 1) and 0.5 in. in cross-level (Fig. 2).

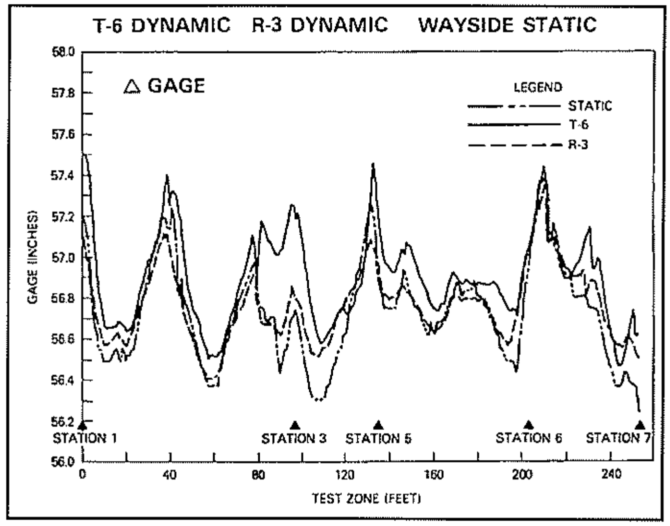

Figure 1 — Gage Comparison

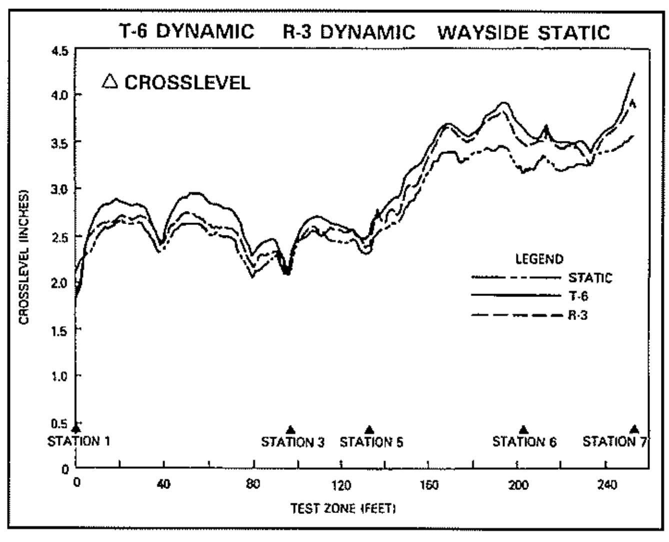

Figure 2 — Crosslevel Comparison

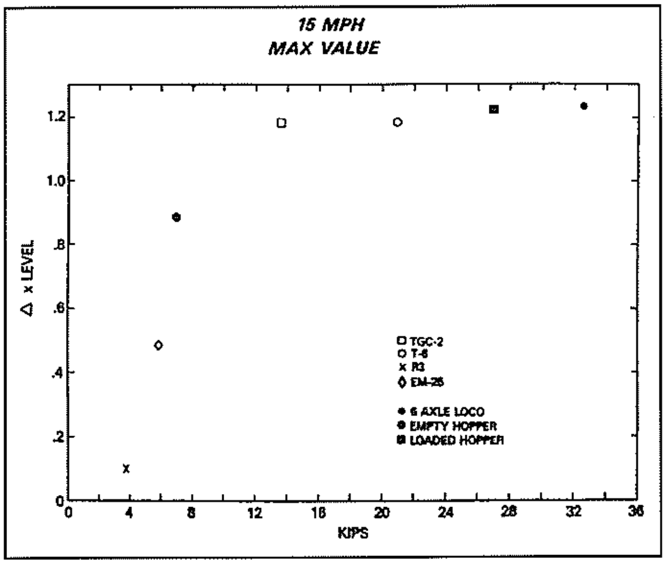

Figure 3 — Crosslevel Comparisons at 15 MPH.

These variations appear to correspond directly to the difference in axle loads of the inspection vehicles. Thus, while it appears that either type of inspection vehicle (light axle load or heavy axle load) can detect the presence of geometry defects, the potential exists for a difference in actual measured value.

Wayside measurements

To directly examine the effect of varying wheel loads on the change in track geometry, wayside measurements were used[2]. Fig. 3 presents one such comparison, for cross-level (x-level) taken at a specific measurement station (station number 7). Note that the vertical axis of this graph represents the change in cross-level from the unloaded measurement value at that fixed track location. As can be seen clearly in this figure, there is a significant difference in the measured geometric parameter between the lighter classes of vehicles and the heavier classes of vehicles with a cut-off appearing to exist at the 14,000 lb. wheel load level. This corresponds to the onboard geometry measurements presented in Fig. 2 and noted above. However, for vehicle loadings above this level, the cross-level measurements (Fig.1) appear to be relatively constant. A similar trend was observed for the gage measurement[2,3], although with greater variation, perhaps associated with the different curving behavior (and corresponding lateral loading) of the test vehicles.

While this test represents only one set of track and operating conditions, and thus may not be readily extrapolated to all track geometry measurement conditions, it does suggest that there is an effect due to the measurement vehicle, and its corresponding loading of the track, which can influence the magnitude of the measured track geometry defect.

References:

1. Hay, W. W., *Railroad Engineering* John Wiley & Sons. New York, 1982.
2. Ensco. Inc., "Final Report for Heavy/Light Test," Federal Railroad Administration DTFR53-85-C-00012. June 1986.
3. Moser, T., "Light Heavy Tests," Presentation made to AREA Committee 2, Philadelphia, PA, January 1986