TQIs – Part II, Alternatives

Last month's *Tracking R&D* discussed Track Quality Indices, or TQIs, fashioned from the statistical analysis of track geometry data. There are, however, other alternative Track Quality Indices which have been developed by different railroads and research organizations. Several of these types of TQIs are often sensitive to a particular set of vehicle/track responses, and will be discussed here.

The determination of one of these alternative TQIs employs track geometry measurements to calculate instantaneous vehicle accelerations.[1] These are converted to forces, in the vertical and horizontal directions, which relate accordingly to profile and alignment variations. In this approach, the accelerations are calculated from the vehicle mass moving along an imperfect track. There are separate computations for the vertical and lateral accelerations. The effect of super elevation is then introduced into the vertical force calculation. By eliminating the mass of the vehicle, a set of indices are derived for alignment, high rail profile, and low rail profile. These values can be treated individually or combined, if desired into a single TQI.

Direct relation to derailment

A different yet successful approach is one correlating TQI directly with the occurrence of derailments on a particular railroad.[2] This method employs regression analyses to obtain the correlation between various track geometry parameters and derailment occurrence. By then combining the geometry parameters into a single *Track Geometry Rating* having a good correlation with derailment, a safety-based TQI is obtained. The final TGR used has been based on a combination of track twist and alignment.[2] This TGR serves as an additional output value on the railroad's track geometry car, for the evaluation of track condition. An additional relationship between TGR and train slow orders has also been developed employing the same basic approach.

TSC TQIs

Safety-based TQIs are an ongoing part of the Federal Railroad Administration's "Track Safety Research Program for the Development of Track Performance Specifications." This effort emanates from the DOT Transportation Systems Center (TSC) in Cambridge, Mass. In the TSC program, a TQI based specifically on consecutive cross-level variations is being developed. The number of consecutive low joints — for example those with cross-level defects — enters into the calculations, together with the amplitude, or cross-level defect, of the joints.

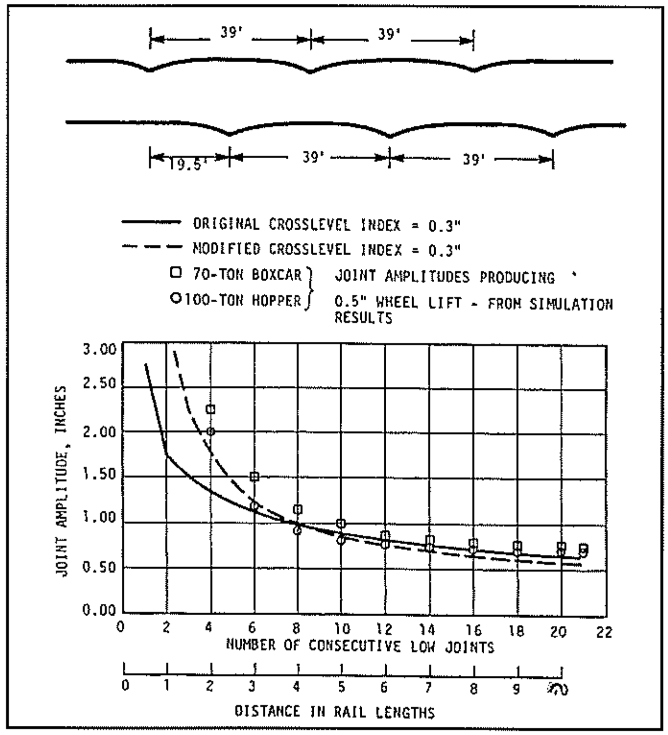

Figure 1 — Permissible Crosslevel Variation vs. Number of Consecutive Low Joints: Modified Crosslevel Index

CLIs

The TSC index does not concentrate just on amplitude, which is the traditional approach to geometry exception as in the FRA's current Track Safety Standards. Rather, the index referred to as the Cross-level Index (CLI), or alternatively as the Cross-level Index-modified (CLIM) is tuned to be particularly responsive to those track geometry defects that excite the traditional low-speed harmonic or 'rock and roll' responses in freight cars. This is particularly true of covered hopper cars with high centers of gravity.

The figure given illustrates how a single CLI value can represent a set of different combinations of consecutive joints and joint defect amplitudes which can result in a vehicle safety condition. The occurrence of wheel lift, as experienced during the "rock and roll" responses described, is the theoretical basis for the setting of the initially suggested CLI values.[3] Though of recent origin, TSC CLIs and CLIMs represent still another safety-based approach to Track Quality Indices.

Appropriate TQIs can thus be established to provide additional correlation between the directly measured track geometry values and different types of undesirable vehicle responses associated with the geometry of the track structure. In this manner, TQIs serve as an additional tool for the maintenance officer in the identification of those track locations requiring necessary maintenance. The same indices can also play an important role in the planning and implementation of the desired maintenance activity.

References:

1. Leshchinsky, D., "Development of A Track Quality Index," Association of American Railroads Report, WP-100, February 1982.
2. Tuve, R. F., "An Application of Track Geometry Data to Track Maintenance Planning on the Southern Railway," Transportation Research Board, January 1980.
3. Weinstock, H., "Vehicle Track Interaction Studies For Development of Track Performance Specifications," British Rail/Association of American Railroads Vehicle Track Interaction Seminar, April 1984.