Planning Through Track Geometry – Part I

The ability to identify and forecast the deterioration of the track structure, and to use this information as a basis for maintenance planning can be of great value to a railroad system in its overall track maintenance activities. The concept of an integrated, computer-based track maintenance planning system has been the subject of an earlier *Tracking R&D* (see RT&S, May 1985). It addressed the subject of forecasting maintenance for *all* of the key track components. Here, however, the focus will be on using track geometry data for maintenance planning and forecasting.

The term 'track geometry,' as used here, refers to the measured geometry of the track structure in space and at a given instant of time. The key elements of track geometry include: *surface* or *profile*, which is the vertical deviation of the track; *alignment*, the lateral or horizontal deviation of the track; *gage*, the distance between rails; *cross-level* or *super elevation* on curves, which is the difference in elevation between the two rails; and *twist*, the variation in cross-level.

Monitoring track geometry provides an assessment of the condition of the track when compared with defined track geometry standards. These standards are maximum permissible variations in the geometry of the track for given traffic and operating conditions. And, they can vary significantly for freight or passenger operations.

Track geometry can be checked by hand or eye, or by the use of track geometry cars. The 'manual' technique is by nature a spot method for locating obvious defects or to verify the existence and severity of the defects. The inspection vehicle procedure, which has come into wide use on freight railroads, is an effective technique to uniformly and consistently measure all the track in a network and to evaluate the track geometry of that network. As the employment of track geometry cars increases, and the availability of track geometry data increases correspondingly, the use of such information for the forecasting of track geometry degradation and associated maintenance will also increase in importance.

Three uses

Track geometry data can be used in three different ways, as illustrated in Figure 1.[1] The first is the most basic application of the data: finding exceptions to specific standards. This procedure is designed to locate, for immediate correction, defects that are currently present in the track, including safety defects such as those which exceed FRA track safety standards, or maintenance defects which exceed the railroad's own standards.

The second use is an extension of the first. It provides an assessment of present track condition for planning immediate maintenance activities. It also employs indices, usually referred to as Track Quality Indices (TQI), which are based on the actual geometry measurements. The TQI help maintenance personnel analyze, evaluate and establish priorities for segments of track with a view toward effective marshaling of maintenance resources. Significant research has been devoted to developing suitable TQI. One set is presented in Figure 2.[2] These TQIs are related directly to, and calculated from, geometry car measurements. Numerous other forms of TQI have been developed for both individual track geometry parameters, or combinations of these.

No.	Use	Data Requirement and Analysis	Action and Result
1.	Exception Location	Manual/automatic analysis to provide nature and location of exception.	Correct defect to reduce risk of accident or damage to track or vehicles.
2.	Present Track Condition Assessment	Automatic analysis to provide numerical Track Quality Indices (TQI) for each track segment.	Use in maintenance planning to guide deployment of maintenance effort, thus reducing costs, risk of emergency maintenance.
3.	Prediction of Change in Track Condition.	TQI change over time associated with traffic, track structure and maintenance data.	Use to guide long-term maintenance planning, understand causes of track degradation and evaluation of maintenance effectiveness.

Figure 1 — Uses of Track Geometry Data

The third use of geometry data is that of predicting variations in track for long-term maintenance forecasting and planning. This approach represents an effective technique for predicting changes in all the key track geometry parameters, and consequently forecasting the maintenance required to correct the estimated degradation. Obviously, it offers great potential toward long-term maintenance planning.

Next month's Tracking R&D will discuss further the application of track geometry data for maintenance forecasting.

Variable	Code	Name	Unit
y_1	GAMN	Mean gauge	Inch
y_2	GASD	Standard deviation of gauge	Inch
y_3	GA99	99th-Percentile gauge	Inch
y_4	GA3M	Third moment of gauge	$(Inch)^3/1000$
y_5	GA4M	Fourth moment of gauge	$(Inch)^4/1000$
y_6	XLDV	Standard deviation of crosslevel	Inch
y_7	WASD	Standard deviation of warp	Inch
y_8	WA99	99th-Percentile of warp	Inch
y_9	PRSD	Standard deviation of profile space curve	Inch
y_{10}	PRSM	Standard deviation of short MCO of profile	Inch/1000
y_{11}	PR99	99th-Percentile of intermediate MCO of profile	Inch
y_{12}	ALSD	Standard deviation of alignment space curve	Inch
y_{13}	ALSM	Standard deviation of short MCO of alignment	Inch/1000
y_{14}	BSEL	RMS value of cross-level deviation from balanced superelevation	Inch

Figure 2 — TQI (Track Quality Indices)

References

1. Bing, A. J., "Development of a Track Degradation Modeling Technique", Federal Railroad Administration Report DOT/FRA/ORD-83/12, April 1983.
2. Bing, A. J., "Track Geometry Data for Maintenance Prediction", Paper presented at the ASCE Spring Convention, Las Vegas, Nevada, April 1982.