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GRMS (Track Gauge Strength) Application in 2010

Overview

Technology has impacted almost every thing we do in the railway industry today. This includes how we measure track condition. Computers, laser optical measurement and the digital age have created the opportunity to collect amazingly accurate and detailed data about track condition for every foot of track. In fact, there are developing measurement systems that have the capability to collect and process terabytes of data, — a magnitude of data that is running ahead of our ability to transfer, process and store it. Technology has tremendously advanced the railroad's ability to optimize track maintenance and safety, and to respond to changing track conditions.

Figure 1. Hi-rail track gauge-strength measurement vehicle (also measures track geometry and rail wear).

One of the more significant track technologies developed within the past 30 years is Gauge Restraint Measurement Systems (GRMS), which measure and quantify track gauge strength. The origins of GRMS are based in AAR research work that was done to understand the response of track to loadings by various car types. This development work followed about 20 years after the initial development, introduction and acceptance of automated track geometry measurement systems.

Over the next 25 years, development and application of GRMS allowed the FRA to make an 11-page addition to the Track Safety Standards (section 213.110) providing for an "alternative" method of inspecting and responding to minimum safety conditions as they relate to rail

fastening systems and crosstie inspections. Unlike other minimum thresholds that exist within the TSS 213 standards, GRMS introduced a measure of "performance" that was unique.

From its introduction, GRMS (or more generically, track gauge-strength measurement) has had both its strong industry supporters, as well as some who have viewed it as just another "four-letter word". Frequently, track gauge-strength measurement has not been fully understood. Sometimes it has been misapplied or utilized ineffectively. This article will try to address what it is, what it is not, how it is being used today, and its potential value to the industry.

What is GRMS?

Measurement of track gauge strength is essentially a measure of how effectively the crossties and fasteners resist an active gauge-widening load (see Figure 1). GRMS systems, whether hi-rail or rail car mounted, load the ties and fasteners through the railheads with a non-destructive, uniform vertical and lateral loading.

Figure 2. Loaded gauge and geometry measurement at load axle of GRMS test car.

The system measures the change in gauge caused by this load, and reports the results. The measure that is used to determine relative track gauge strength is Gauge Widening Projection (GWP). GWP requires the input of two gauge measurements, loaded and unloaded gauge, for every foot of track, and an accurate measure of the GRMS vertical and lateral loading. GWP provides a standard measure of how track performs against gauge-widening forces. This measure of track gauge strength also provides exception reporting of locations in track that may need maintenance or repair. GWP is best viewed as a measure of reserve gauge strength. GWP can also be used to generate estimated tie replacement plans on the basis of relative reserve gauge strength, using reasonable assumptions for weak tie clusters and typical tie replacement rates (see Figure 3).

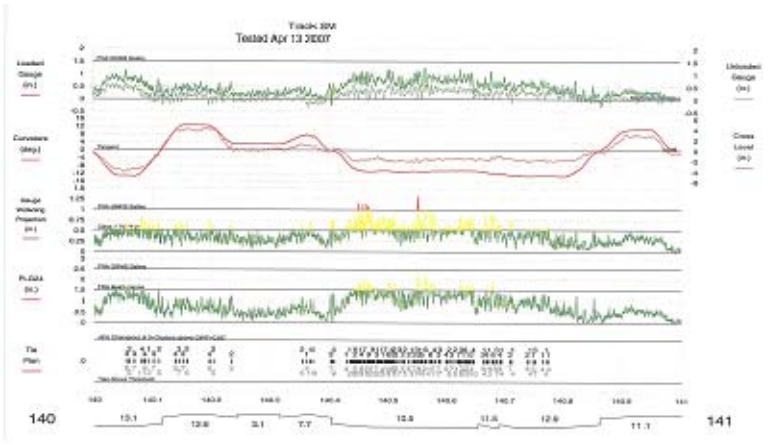

Figure 3. Estimated tie replacement plan using GWP threshold of 0.55", cluster length of 3 ties in a row exceeding GWP threshold, and 45% estimated replacement rate.

What GRMS is not!

Because GWP provides very good information about the performance of crossties and fasteners, it provides a very good perspective on track's ability to hold gauge. A track that does not have very many GWP exceptions might be assumed to not need very many crosstie replacements, but not necessarily. Although track that is found to have poor gauge-holding ability through GRMS measurement probably needs new ties, track that exhibits good track gauge strength does not necessarily mean that no ties are needed.

Crossties are replaced for many reasons. Gauge-holding ability is an important one, but it is not the only reason. For example, ties that have significant plate cutting may exhibit reasonable gauge-holding strength, but still need to be replaced due to differential or depth of plate cutting. GRMS testing, and the measurement of GWP, in particular, does provide very good information about gauge strength and the potential need for replacement crossties, but in and of itself, is not enough to provide a detailed tie replacement plan.

Any estimate of replacement ties generated from the performance-based measurement of track gauge strength needs to be fully verified by field inspections. GRMS-based track gauge-strength measurements, alone, should not be used to presume that no crossties need to be replaced.

Common Use of Track Gauge Strength Measurement in North America

In 2009, there were approximately 75,000 miles of track that was tested for track gauge strength on North American rail properties. Only a fraction of those miles (less than 2,000 miles) were tested to support the use of the alternative inspection standards allowed by *Track Safety Standards, Subpart D, Section 213.110*. Most of the gauge strength testing is being done to provide "additional information" about the track condition — information such as weak track locations that may need prompt attention.

Figure 4. Using a PTLF to validate a GWP exception.

Some Class 1s have adopted the thresholds established by the GRMS 213.110 standards for follow-up inspections and repairs, recognizing that this information helps them to find and fix the weaker locations in track. The key measurements that are available are:

- Unloaded Gauge. This measure of track gauge is most similar to the gauge measurement taken by a trackman in the field.
- Loaded Gauge. Measured near the non-destructive load-axle where the GRMS load is applied. Loaded Gauge is almost always a larger measurement of track gauge than would be measured by the typical geometry car. It is reasonable to expect about ¼" wider gauge

for strong track when compared to a geometry car that is applying a very large vertical load, but usually very small lateral load to the track structure.

- Gauge Widening Projection. GWP is a measure of the reserve gauge holding strength of the crossties and fasteners. Essentially GWP is measuring the track's ability to hold good gauge against wheel forces that are trying to spread gauge. GWP is verified with a PTLF delta gauge (4,000 lb loaded gauge less unloaded gauge) reading of 5/8" or more.
- Projected Loaded Gauge (PLG). PLG is an extrapolation or estimate of what gauge might be under a (very uncommon) 24,000-pound lateral and 32,000-pound vertical load. PLG has limited value to the track inspection process outside of supporting the GRMS alternative standard inspection and cannot be verified by track maintenance crews. When PLG exceptions are measured, they are always at the same location as an easily verifiable gauge and GWP exception.

Most railroads that are using GRMS testing vehicles for measurement of track are adding only Loaded Gauge and GWP to their normal track geometry parameters of inspection. This provides additional information about their track strength and helps them focus maintenance attention on the weakest gauge location in track.

Value of track gauge strength testing in North America

Figure 5. Spike-killed ties with plate cutting at a GWP exception.

Over the past 10 years, there have been more than 500,000 miles of track tested with GRMS measurement. The rigorous conditions of heavy haul freight, or the challenging budget constraints for shortlines, continue to challenge track maintenance mangers every day.

More than 125 railroads in North America, including all Class 1s and many shortline and regional railroads, have been using track strength measurement. Most users test track annually, and in some cases, multiple times annually over certain sections of track.

The principle value and common exceptions found by GRMS testing has been:

- To provide additional information about gauge strength condition of track that is not found by geometry cars or regular hi-rail inspections.
- To focus on the weakest gauge conditions in order to provide effective utilization of maintenance resources.

- To find gauge strength exceptions, such as spike-killed ties (see Figure 5), broken spikes in curves or broken screw spikes in turnouts (see Figure 6) that frequently are not found by geometry cars or hi-rail inspections.To find fastener problems on concrete ties.
- To provide comparative track gauge strength information to support tie replacement plans.
- To improve safety.

Figure 6. Broken screw spikes in a high-speed turnout.

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