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Preliminary Evaluation of T-18's Gage Restraint Measurement System Tests

SUMMARY

The Office of Research and Development of the Federal Railroad Administration (FRA), with the cooperation of the Union Pacific Railroad (UP), conducted a series of tests to determine if the new Gage Restraint Measurement System (GRMS) vehicle, T-18, can successfully test at 50 miles per hour (mph). The use of a deployable axle on the T-18 has virtually eliminated the risk of wide gage derailment by removing the split axle from the running truck, thus allowing the vehicle to test at higher speeds. Test speeds up to 35 mph are standard for GRMS vehicles owned by various railroads and private companies that provide service to the railway industry. Parameters that were important to successfully test at 50 mph were evaluated during the test along with the detection of any gage widening defects as described in the FRA Track Safety Standards.[1] The ability of the load control system to maintain the preset loads within acceptable limits and the unloaded gage measurement system accuracy at higher speeds were the basic concerns. Detection of the same number of defects and the location of these defects at the two test speeds were the parameters used to evaluate GRMS ability to properly test track at higher speeds. Figure 1 shows the T-18 with the deployable split-axle in the test position.

Results from the testing indicated that the vehicle could test at 50 mph while detecting track defects found at the standard test speed of 35 mph. The applied loads, especially the vertical load, had a higher standard deviation at the higher speed but were within the variation limit of the T-6 GRMS, the truck mounted split-axle. Although a higher variation existed on the loads, this should not preclude the testing at 50 mph since the new formulation for gage widening ratio (GWR)[2] will take into account both the measured vertical and lateral loads. The accuracy of the mechanical unloaded gage measurement system is a concern, but since a laser unloaded gage measurement system is scheduled for installation on the T-18, this is not expected to prohibit to 50 mph testing. Further evaluation and data analysis are planned to obtain a better understanding of T-18's capabilities and limitations at 50 mph operations.

Figure 1. T-18 Vehicle Ready for Testing.

BACKGROUND

Under a mutual agreement, FRA and UP conducted a gage widening test on the Alexandria subdivision using FRA's T-18, the new GRMS vehicle with a deployable split-axle. UP was interested in evaluating the gage strength of a track section from Alexandria to Iowa Junction, LA, to explore the possibility of using a GRMS vehicle for track inspection under the current track safety standards. FRA needed to further evaluate the T-18's performance and demonstrate to the industry the use of the modified technology (i.e., the deployable split-axle). Further, FRA and UP were concerned with the limitation of the test speed of the GRMS vehicle, 35 mph, and were interested in exploring the possibility of higher GRMS testing speeds.

T-18 tested the UP line from Alexandria, LA, to Oberlan, LA, at 35 and 50 mph and conducted repeatability runs for a track section between Milepost (MP) 620 +0 and 622 +2928. On March 10, 2006, the repeatability runs from 20 to 50 mph were conducted, while the 35 and 50 mph runs were conducted on March 11, 2006. The order of testing was from MP 610 to 623 first at 35 mph and then from MP 623 to 652 at 50 mph. This testing order provides data to evaluate any effects or to observe if the T-18 permanently damages the track at higher speeds.

VEHICLE ASSESMENT AND DATA ANALYSIS

All systems on the T-18 during the 50 mph tests performed very well with minimal noticeable difference in the ride quality.

Table 1 shows the average test loads during these tests. Comparison of the standard deviation of the applied loads, Figure 2, indicates if the system can maintain the test loads within acceptable limits.

Table 1. Average Applied Loads.

Speed	Left Lateral	Right Lateral	Left Vertical	Right Vertical
(mph)	(kips)	(kips)	(kips)	(kips)
20	7.03	7.17	19.62	21.70
30	7.02	7.19	19.52	20.43
30	7.01	7.19	19.56	20.48
40	7.02	7.18	19.52	21.59
50	7.03	7.21	19.43	20.33
50	7.00	7.20	19.42	21.45

Figure 2 shows that the lateral load standard deviation doubled from 20 mph to 50 mph, but 30 and 50 mph runs are consistent. The vertical loads show the similar standard deviation increase with the exception of the second 50 mph run.

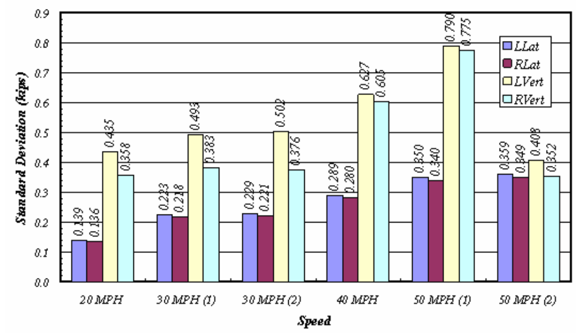

Figure 2. Standard Deviation for the Applied Loads as a Function of Test Speed.

This increase is probably due to dynamic affects at higher speeds. The standard deviation for this run is similar to the 30 mph run and at least one half of the first 50 mph run. This does not seem to be indicative of the trend noted in the lateral loads and vertical loads from other runs. The other item addressed was the difference in the standard deviation between left and right vertical loads; the left is always higher than the right.

This difference is probably due to curving forces or dynamic loading since at higher speed it seems to be less apparent.

All applied loads seem to be within an acceptable range as compared to T-6 test loads, especially when the calculation of gage strength parameters (with the new GWP formulation) will take into account the actual measured loads.

To further analyze the loads, a 50-foot section of track where substantial loaded gage activity existed was selected. Figure 3 plotted the vertical load (average between left and right), net lateral load, and Lateral/Vertical (L/V) ratio. Figure 4 plots loaded and unloaded gage and change in gage for the same section of track; thus a comparison of all primary measurement channels can be performed.

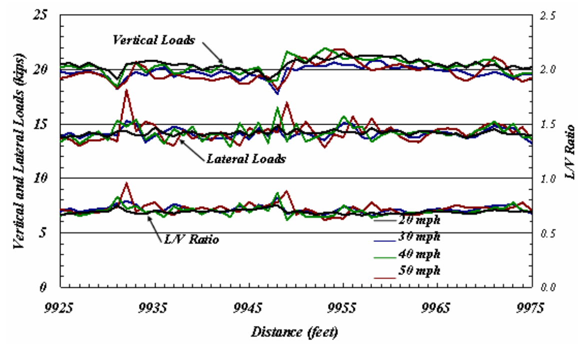

Figure 3. Vertical and Lateral Loads and L/V Ratio Comparisons at 20, 30, 40, and 50 mph.

Figure 3 shows the substantial difference that exists between the lateral loads at 30 mph and 50 mph, approximately a 2 kip increase around the 9932-foot mark. A similar difference is noted at the 9950-foot mark with the 40 mph showing the higher lateral load. The vertical load shows a substantial decrease at both locations with higher lateral load.

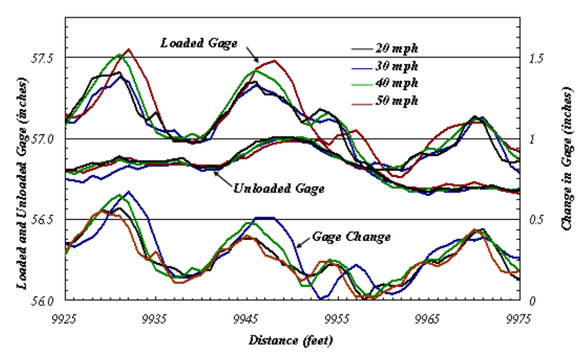

Figure 4. Gage Measurements and Gage Change Comparisons at 20, 30, 40, and 50 mph.

This change in the applied loading, both vertical and lateral, results from a weakness in gage restrain capacity at these two locations, as shown in Figure 4 by the high loaded gage deflection, approximately 1 inch at both locations. The drop in vertical load over these soft spots is consistent regardless of test speed; however, the lateral loads seem to be higher at higher test speed but not consistent at both locations. Further, the trend of increasing lateral load in a soft area is highly unusual based on previous tests with the T-6. One possible explanation for this is that the load control system is over-compensating.

The deflection measurements at these soft spots are within 3/16 of an inch at the maximum location, while the unload gage measurements agree very well over this section.

Table 2 compares the 35 and 50 mph runs from MP 625 to 632. It provides the location of each exception for each run along with the type of exception, GWR or projected loaded gage (PLG), difference in feet, and the magnitude of each exception.

Table 2. Exception Comparisons Between MP 625 and 632 for 35 and 50 mph Tests.

	35 mph			50 mph			Difference	
MP	Feet	GWR	PLG24	Feet	GWR	PLG24	Feet	Value
625				3271	0.77			
625	4449	0.77		4448		58.1	-1	
626	3040	0.82						
627	1588	0.78		1585	0.84		-3	0.06
629	3339	0.79		3347	0.86		8	0.07
630	4054		58.11	4049		58.16	-5	0.05
630	4168	0.89		4165	1.01		-3	0.12
630	4201	0.80		4197	0.86		-4	0.06
360	5175	0.83		5170	0.89		-5	0.06
631	3102	0.78		3107	0.85		5	0.07

Exceptions match for both speeds, except at two locations. The first, GWR maintenance at a value of 0.77 inches, very close to the limit, was noted at 50 mph but not at 35 mph test run; this is probably due to the higher speeds or track response. The second, GWR maintenance, was noted by the 35 mph but not by the 50 mph run. Two different types of exceptions reported at the same location at the two test speeds. At MP 625 + 4449 for 35 mph, it was GWR maintenance, and for 50 mph run, it was a PLG 24 maintenance exception.

Based on the preliminary data given in Table 2, the difference in the calculated reading, with the exception of one, are within 1/16 of an inch, indicating the overall agreement between the two runs is good. The difference in distance between each exception from the two different test speeds is within 10 feet, and this error is probably due to the marking of the MP by the operator. The good agreement in the exception report is an indication that although some differences exist in loading and deflection measured at different speeds, the differences are minor and can be monitored during future testing.

CONCLUSIONS

The following conclusions are based on the review of the preliminary data and on personal observations from the tests:

- Load applications, especially the lateral load control system, should be evaluated to determine if the increase in load at a soft spot is due to load control issues.
- The T-18 system was able to test at 50 mph without any distress to the loading and the data acquisition and presentation system.
- Exception counts and loads should be evaluated as to the magnitude of the value, the difference between location in the track, and the difference between types of exceptions.
- Additional testing and analysis are recommended to evaluate the viability of 1-8 tests at 50 mph.

ACKNOWLEDGMENTS

The tests were conducted under the sponsorship of FRA by ENSCO Inc. UP contributed the track and track personnel to evaluate detected defects.

REFERENCES

1. U.S. Code of Federal Regulations, Chapter 49 Transpiration, Part 213, Track Safety Standards, Section 213.110, Gage Restraint Measurement Systems.

2. "Development of Gage Widening Projected Parameter for the Deployable Gage Restraint Measurement System," FRA, draft report.

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