TECHNOLOGY DIGEST
TD-08-042
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Teardown Results of Coal Cars Identified by Truck Performance Detectors

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Summary

Transportation Technology Center, Inc. has developed algorithms to identify poorly performing cars using truck performance detectors (TPD). As a result, five cars were selected for inspection to determine their condition. Four of the five had undergone a rebuild program and one was scheduled for a rebuild. Inspection and analysis of the TPD data showed that all five cars were poor performers.

The performance of the rebuilt cars significantly changed after rebuild occurred. The most likely cause was rotational resistance issues. All four of the rebuild program cars had constant contact side bearings with incorrect setup heights. Additionally, Car 228 had an improper repair, which added further to the high rotational resistance.

Since this inspection, the four rebuilt cars have been repaired and returned to service. The repairs included properly adjusting the constant-contact side bearings and correcting any improper repairs. The most recent warp index history data from TPDs shows that the performance of these cars has greatly improved.

By using the new algorithms to monitor cars and identify poor performers, they can be removed from service, inspected and repaired, improving the overall condition of the fleet and reducing the total stress on infrastructure.

This work was tasked by the Association of American Railroads as part of its Strategic Research Initiatives Program.

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BACKGROUND AND INTRODUCTION

Transportation Technology Center, Inc. (TTCI) has been tasked by the Association of American Railroads, as part of its Strategic Research Initiatives Program, to:

- Identify poorly performing cars and trucks
- Focus maintenance actions on specific car and truck components
- Support predictive car maintenance planning processes

As part of this initiative, TTCI has developed algorithms to identify poorly performing cars passing TPDs. These algorithms were used to develop a list of poorly performing cars. The results of the inspection and teardown of five of the cars identified are presented here. The cars are coal cars and four of them went though a rebuild program. The fifth one is scheduled for rebuild.

TRUCK PERFORMANCE DETECTORS

TPDs identify cars having poor curving performance. TPDs measure vertical and lateral forces using instrumented cribs on reverse curves, and, from the data, certain metrics are developed based on criteria found in Chapter XI of the Association of American Railroads' *Manual of Standards and Recommended Practices*.[1]

Two of these metrics developed by TTCI are Warp Index[2] and Gage Spread Force,[3] which when used together can determine a car's performance. Figure 1 shows the warp history of the five cars inspected. Warp Index is defined as a percentage of how warped a truck becomes while traveling though a curve.

Figure 2 shows the gage spread force history of the same five cars. Gage Spread Force is defined as the lateral force input into the track structure.

These figures show that there was a significant deterioration in performance after July 2005, thus the cars were identified as poor performers and were selected for inspection.

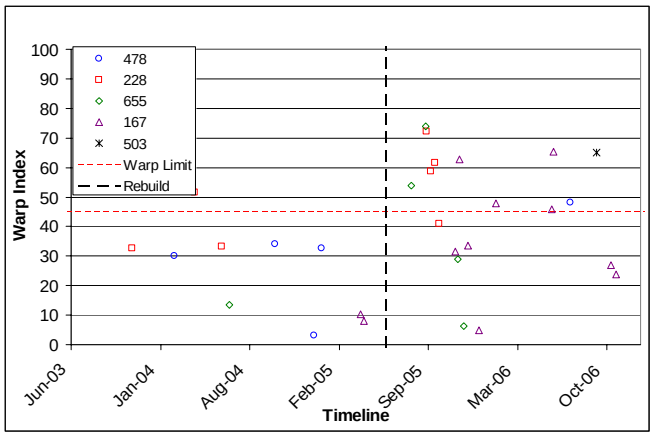

Figure 1. Warp Index History

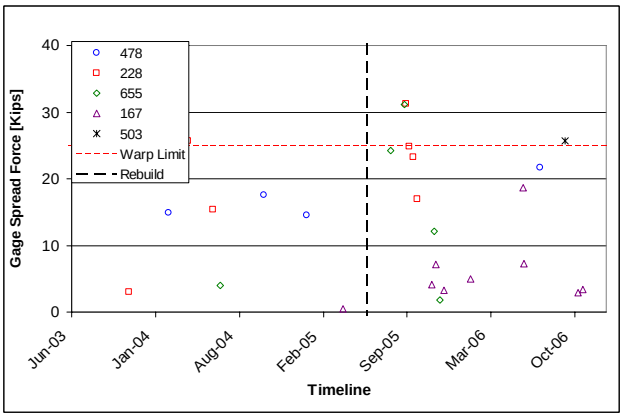

Figure 2. Gage Spread Force History

CAR MAINTENANCE HISTORY

The five cars inspected were segregated into two categories by car maintenance history: (1) cars recently rebuilt (2) cars scheduled for rebuild.

The rebuild program included the following maintenance:

- Carbody rebuild
- M-214 truck rebuild
- Long travel constant-contact side bearings fitted
- New wheels fitted

Four of the five cars went though the rebuild program between July and August 2005 (the fifth was scheduled for rebuild in December 2006).

INSPECTION AND TEARDOWN

Car inspections were performed differently for the two categories of cars because components differ in model and time in component life. For instance, the cars that underwent the rebuild program have long travel constant-contact side bearings, which made the side bearing comparisons with cars scheduled for rebuild impossible. Further, wheel comparisons are not useful from the recently rebuilt cars because they have new wheels. Because of these differences, the inspection results for the two categories are reported in separate sections. Car inspections and teardowns were all performed at the same time in a car shop. The car shop track was measured and determined to be flat and level within 1/2 inch over two car lengths.

Rebuild Program Cars

The four cars that went though the rebuild program were fitted with long travel constant-contact side bearings. These cars were brought into the shop one at a time in the unloaded condition. The constant-contact side bearing heights were measured. Table 1 shows the side bearing heights and car twist of the inspected cars (highlighted measurements are out of tolerance). Car twist is measured by subtracting the side bearing delta from each truck.

Carbodies were then lifted and the trucks were inspected.

Table 1. Constant-Contact Side Bearing Heights

		L	R	Delta	Car Twist
Car 228	A	5 1/16	4 13/16	1/4	1/4
	B	5 1/8	5 1/8	0	
Car 167	A	5 1/16	5 1/16	0	- 1/4
	B	5 3/16	4 15/16	1/4	
Car 655	A	4 7/8	4 15/16	- 1/16	1/2
	B	5 1/8	4 11/16	7/16	
Car 503	A	4 15/16	5 5/16	- 3/8	3/8
	B	5 1/16	5 1/16	0	

Figure 3 shows the polymer elements of the constant-contact side bearings from one of the inspected trucks. A difference in heights can be seen.

Figure 3. Side Bearing Heights

The wheels on these cars appeared to be in near new condition. The truck types are variable damped with narrow wedges, which still looked in good condition from the M-214 truck rebuild.

During the inspection of Car 228, an improper repair to the center plate was discovered. Figure 4 shows the improper repair.

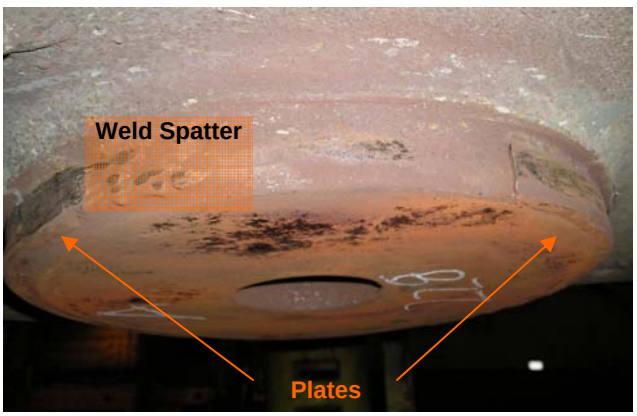

Figure 4. Center Plate of Car 228

The center plate had worn elliptically and two bars had been bent and welded onto the center plate in an attempt to make the center plate once again circular. This improper repair will increase rotational resistance between the center plate and center bowl.

Car Scheduled for Rebuild

The fifth car, scheduled for rebuild, was inspected at the same time as the other four.

Inspection revealed both high wedge heights and asymmetric wheel wear. High friction wedges are a major cause of truck warp. Figure 5 shows the asymmetric wheel wear.

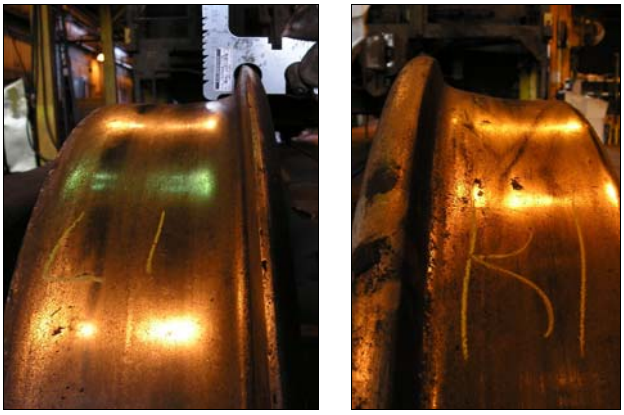

Figure 5. Axle 1 Wheelset on Car 478

There are many causes of asymmetric wheel wear, one being low truck warp restraint. Because the trucks of this car had high friction wedges, this could explain the asymmetric wear.

TRUCK PERFORMANCE SINCE INSPECTION

Since these cars were inspected, the four that went through the rebuild process have been repaired and returned to service. The repairs included properly adjusting the constant-contact side bearing heights and repairing the center plate on Car 228. Figure 6 shows the warp index history of the cars, which indicates that the cars returned to service are performing significantly better.

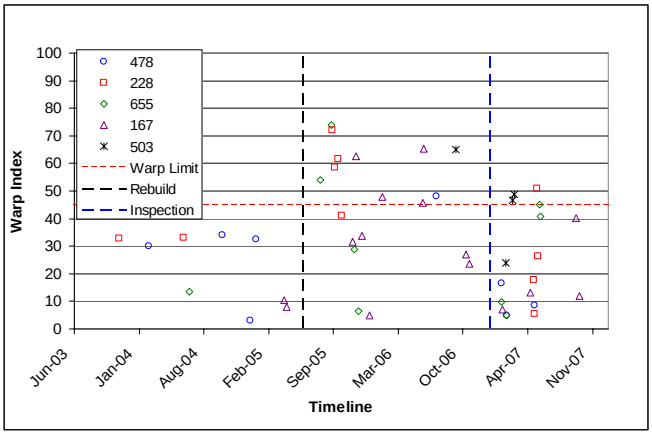

Figure 6. Warp Index History since Inspections

CONCLUSIONS

The performance of the rebuild program cars significantly changed following the rebuild. The quality of the M-214 truck rebuild is not considered the cause of the subsequent poor performance. The most likely cause of poor performance was high rotational resistance. One of the four rebuilt cars, Car 228, had an improperly repaired carbody center plate, which probably added to the rotational resistance. The constant-contact side bearings on all of the rebuilt cars had incorrect setup heights. When the side bearing setup heights are excessively tight, the metal cap can bottom out in the cage and greatly increase the preload, thereby adversely affecting the rotational resistance.

The poor performance of the car scheduled for rebuild was likely caused by low truck warp restraint as a result of high wedges. This low truck warp restraint could also lead to asymmetric wheel wear causing the performance to deteriorate even more.

Since this inspection, the four rebuilt cars have been repaired and returned to service. The repairs included properly adjusting the constant-contact side bearing heights and correcting any improper repairs. The most recent warp index history data from TPDs indicates that the performance of the cars greatly improved.

FUTURE WORK

Monitoring of the cars will continue as they pass wayside detectors to ensure that they are performing properly. Future programs are needed to ensure that once cars are repaired and/or rebuilt, they are operating properly.

REFERENCES

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2. Tournay, H., B. Madrill, and T. Wolgram. March 2007. "The Development of a Truck Warp Index," *Technology Digest* TD-07-13, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, CO.

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