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Auto Parts Boxcar Ride Quality Investigation

by Ken Rownd

Summary

An auto parts boxcar with poor ride quality performance was evaluated for ride quality by Transportation Technology Center, Inc. (TTCI), a subsidiary of the Association of American Railroads (AAR). Modification of this car's suspension and replacement of one axle resulted in improved performance.

The boxcar selected was a 60-foot car GTW 309621. General Motors provided the car and selected it due to parts damage and because poor performance was measured by wayside detection. The empty car was shipped to the Federal Railroad Administration's Transportation Technology Center (TTC) near Pueblo, Colorado, for investigation as part of the AAR's Advanced Freight Car Truck program. This program is examining auto parts performance issues in railroad service. The GTW car had a traditional freight suspension.

GTW 309621 Auto Parts Car

The suspension and car arrived at TTC in an extremely worn state. As-received tests measured high-speed instability at 35 mph on tangent track. The suspension was systematically upgraded to acceptable condition with stability tests conducted for each improvement. TTCI addressed the following items: wheel profiles, center bowl condition, friction shoes, column wear plates, roller bearing adapters, and constant-contact side bearings.

Two features of this car were not acceptable per AAR interchange rules. The truck center bowl rim was rubbing on the car body at one end of the car, and all the constant-contact side bearings were collapsed or broken. These items affect performance and are also the result of poor performance. High-speed instability quickly damages frictional interfaces on the car and in the suspension. The wheel profiles were acceptable per AAR interchange rules, but were a factor in the instability as well. The suspension interfaces were extremely worn. Rebuilding these suspension elements proved to have little effect on the measured performance. This is significant because shopping the car for repair would likely have resulted in rebuilding the suspension and side bearings and keeping the wheels as-received. The outcome would be a marginal improvement to ride quality.

Stable performance was achieved with higher pre-load constant-contact side bearings and with one wheelset replaced due to wheel tread hollowing. Renewing the truck friction snubbing components had little effect on measured performance.

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INTRODUCTION AND CONCLUSIONS

General Motors has been monitoring the performance of auto parts boxcars by damage and by measurement from wayside detectors. In cooperation with the AAR Advanced Freight Car Truck program, one bad actor car was selected for detailed investigation by TTCI. This car had a traditional freight suspension and constant-contact side bearings (CCSB).

The car arrived with the trucks worn past recommended limits. The wheel condition was acceptable per AAR interchange rules. Some hollowing of the wheel tread surfaces was noted especially in Axle 2. The CCSB were collapsed and ineffective.

Investigation of the as-received car demonstrated the following:

- The as-received car was unstable at 35 mph.
- Rebuilding the truck frictional interfaces had little effect on performance.
- Using TTCI wheels (with profiles intended to excite instability) raised the speed of unstable performance to 45 mph.

With the TTCI wheels, the following effects on car stability were noted from renewing the CCSB:

- Instability was reached at 57 mph with the 4,500-pound preload CCSB.
- Stable performance to 75 mph was achieved with the 6,000-pound preload CCSB.
- Instability was reached at 55 mph with the 6,000-pound preload CCSB and the as-received wheels.

Changing only Axle 2 to the TTCI wheel profile had the following effect for CCSB variation:

- Instability was reached at 70 mph with the 6,000-pound preload CCSB.
- Car stability was achieved at 75 mph with the 8,000-pound preload CCSB.

METHODOLOGY

The GTW 309621 auto parts car was tested for high-speed stability performance on tangent track. Tests were repeated for each vehicle upgrade. The car arrived with good wheels, failed CCSB, and worn truck components. In addition, the truck center bowl rim was rubbing on the car body at the B-end location.

Stability performance is defined by calculating the highest standard deviation of lateral car body acceleration over 2,000 continuous feet of operation (out of 6,000 feet total) on tangent track. The AAR, *Manual of Standards and Recommended Practices* AAR, M-1001, Chapter XI freight car certification requires this value to be less than 0.26. AAR M-976, the truck specification for 286,000-pound gross rail load cars, requires this value to be less than 0.13. In practical test application, the speed increment to go from the M976 criterion to the Chapter XI criterion is small. Vehicle stability is lost once the value exceeds 0.13.

Upgrades examined included new friction castings, new column wear plates, new bearing adapters, wheel profile changes, new center plate wear liner, and CCSB changes.

Upgrading the truck frictional interface components did not change the car performance. However, the introduction of new CCSB improved high-speed stability performance. Replacing the as-received wheels with wheels used to test high-speed stability in AAR standard tests also raised the minimum speed of instability.

Figure 1 shows the extremely worn friction shoe and mating column wear plate. Under normal circumstances, these surfaces are flat.

Figure 1. Worn Friction Wedge and Wear Plate

Results: As-received car

Figure 2 shows the standard deviation of lateral acceleration for the as-received car. This value is for 2,000 feet of continuous data. The two solid horizontal lines are at 0.13 (the criterion for high-speed stability in the M-976 truck specification) and 0.26 (the criterion for Chapter XI). This car was not stable at 35 mph.

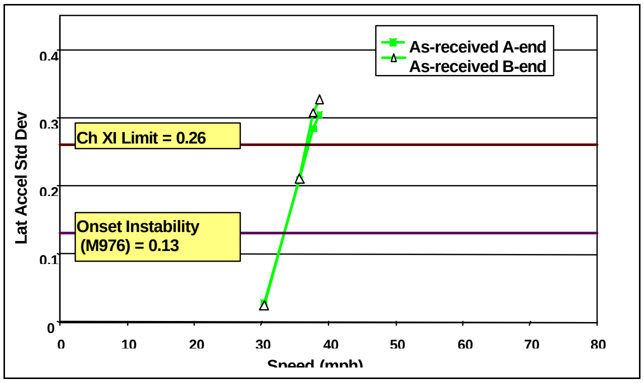

Figure 2. As-received Stability Performance

Results: Rebuilt truck

The as-received car had a worn suspension. To document the effect of restoring the suspension to industry-accepted standards, the following items were replaced with new components.

- Friction shoes
- Column wear plates
- Bearing adapters
- Center bowl liners

Figure 3 compares the performance of the re-built truck to the as-received truck. The stability performance did not change from the as-received condition.

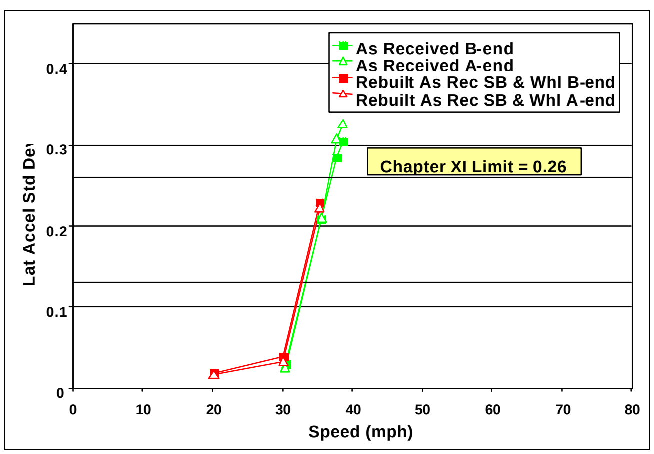

Figure 3. As-received and Re-built Truck

Results: Wheel Profile

The wheel profiles in the as-received car were all within AAR rules. However, replacing these wheels with the TTCI wheels used for high-speed stability tests did improve performance by increasing the speed at which instability was reached from 35 mph to 45 mph. Figure 4 shows the worst as-received wheel profile. This wheel was 2 mm hollow as indicated by the solid blue line. Although hollow tread wheels are not desirable, this wheel is acceptable under current AAR interchange rules. The full flange probably means this wheel hollowing occurred in a short period of time and is likely a result of the car instability.

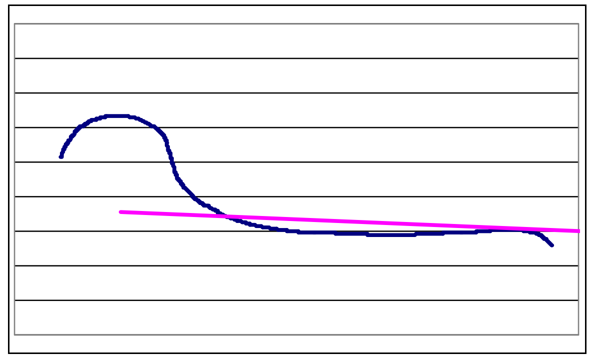

Figure 4. Profile for As-Received Axle 2 (2 mm Hollow)

Results: CCSB Pre-load

The car arrived with collapsed CCSB. These were replaced with new CCSB at 4,500- and 6,000-pound preload. Figure 5 shows the performance at the worst end of the car for each CCSB using the TTCI wheels. Stability at 60 mph was achieved with the 6,000-pound preload CCSB and the TTCI wheels.

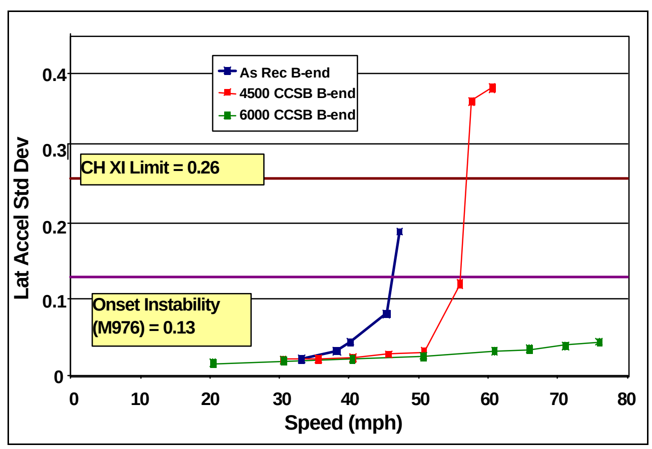

Figure 5. Performance with CCSB Preload Using TTCI Wheels

Results: CCSB and Wheel Profile Interaction

Although the new 6,000-pound preload CCSB made the car stable when using the TTCI wheels, returning to the as-received wheels degraded performance.

Replacing only Axle 2 improved performance, but the car was still unstable at 70 mph. The same wheel combination was stable at 75 mph when 8,000-pound preload CCSBs were installed. Figure 6 shows the performance in each test. Stable performance was achieved at 75 mph with the 8,000-pound preload CCSB.

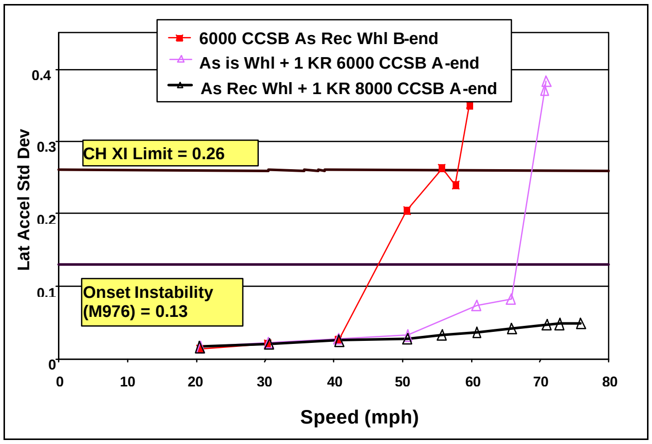

Figure 6. Performance with CCSB, As-received and TTCI Wheel Profiles

CONCLUSIONS

The bad-actor car arrived with worn-out suspension and collapsed side bearings. The wheel profiles were acceptable by industry standards. It is likely that the trucks would have been rebuilt and the side bearings renewed at a railroad shop and the car returned to service. This would result in the car being instable at typical operating speeds.

Replacing the wheels and installing 6,000-pound preload CCSB, or replacing just Axle 2 and installing 8,000-pound preload CCSB would result in stable performance at 75 mph. Without the use of a wayside detector or an instrumented test, the importance of the wheel profile to car performance would not be recognized.

Acknowledgements

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