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Revenue Service Test Initiation of Cars with Disabled Brakes

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Summary

Transportation Technology Center, Inc. (TTCI) is investigating the effects of tread braking on wheel wear and tread damage by monitoring the performance of three articulated 5-unit well cars and five coal hopper cars with disabled brakes operating in otherwise normal revenue service conditions. After less than a year in service for this test, four of the twelve well car test wheelsets have been removed for high impact loads; three of these four wheelsets were from the control group located in trucks with normally functioning brakes. An inspection was conducted on the one wheelset removed from a truck with disabled brakes and shelling was clearly visible on the tread of both wheels. The other three wheelsets were not available for inspection. The coal cars have only been operating with disabled brakes for a short time and have not generated significant results yet.

The Federal Railroad Administration (FRA) granted an enforcement discretion for these eight cars to operate in revenue service with disabled brakes for up to three years as part of this test. Trains moving these cars must contain a sufficient number of cars to maintain at least 95 percent operational brakes. The brakes in the D truck of the three well cars were disabled along with the entire brake system of the five coal hoppers. The test includes appropriate control groups to compare performance. New wheelsets were used for the test group and the control group to eliminate the influence of pre-existing conditions.

Although the ability to control train speed is a fundamental aspect of railroad operations, the manner in which braking occurs could potentially be adjusted to promote wheel longevity. Without an understanding of the effects of tread braking on wheel wear and tread damage, it is difficult to evaluate potential improvements. This test is critical to providing direction for future wheel/brake research.

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INTRODUCTION

TTCI facilitated a test involving three multi-unit articulated well cars and five coal hopper cars operating in revenue service with disabled air brakes to determine the effects of tread braking on wheel wear and tread damage. Comparisons of the wheel wear patterns, wear rates, and tread damage will be made between wheels with disabled brakes and wheels operating in the same trains and/or same cars with fully functioning air brakes.

Background and Motivation

The formation of wheel shell defects is a rolling contact fatigue phenomenon driven by the repeated loads on the wheel-rail contact patch as the wheel rotates. Wheel tread surface fatigue damage in the presence of elevated temperatures is known as thermal mechanical shelling (TMS). Increased wheel temperature from tread braking has multiple competing effects on the TMS process including decreased fatigue resistance, decreased modulus of elasticity, and relief of beneficial compressive residual stresses.[1,2] The number of wheels exposed to temperatures high enough for TMS can potentially be reduced by as much as 88 percent by reducing wheel temperature variation.[3]

Wheel wear rates and patterns can be affected by contact with the brake shoe. Asymmetries in the brake rigging of typical cars can force the brake shoes to shift laterally with respect to the wheels and begin the process of asymmetric wheel wear.[4] Wheel wear due to tread braking is also a potential contributor to the hunting issues associated with loaded grain cars.[5]

Although the wheel shelling and wear issues related to tread braking could be addressed with changes to components (such as the brake rigging designs and brake shoe properties) or operating practices (such as the use of dynamic braking), it is not clear how much effect any such changes would produce, and thus it is difficult to cost justify or rank order such changes. It is possible that the abrasive action of the brake shoe, in some limited durations and at proper levels of force, may act to extend rather than shorten wheel life.[6] This test is critical to shedding light on these issues and providing direction for future wheel/brake research.

Enforcement Discretion

It was necessary to obtain permission from the FRA to operate cars in revenue service with disabled brakes. Upon request, FRA elected to issue an enforcement discretion to allow this test to proceed subject to some conditions, such as requiring that all handbrakes be fully operational.[7] FRA also required that the trains be operated with at least 95 percent operational air brakes. A total of eight cars (three well cars and five coal hopper cars) are permissible in service with disabled air brakes for up to three years as part of this test.

Well Cars

By selecting 5-unit articulated well cars for this test, an ideal comparison can be made between the wheels in the D truck with brakes disabled and the wheels in the E truck with fully functioning brakes; the mileage and routing will be identical and the load conditions will be similar. Figure 1 shows that each of these cars is equipped with two handbrakes: one that activates the brakes on the A and F trucks and one that activates the brakes on the B and C trucks. The test wheels in the D and E trucks are not affected by handbrake applications.

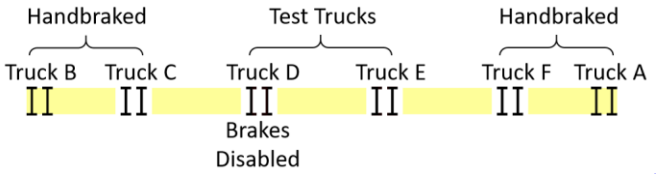

Figure 1. 5-Unit Articulated Well Car Nomenclature

The well cars used in this test are operating on their normal routes, typically in Canada. This should accelerate the test results due to the historically short wheel lives of articulated well cars in this environment. One study of tread damage in Canada found 75 percent of the inspected wheelsets from this car type had service lives of three years or less.[8] Figure 2 shows a photo of one of the well cars.

Figure 2. One of the 5-Unit Articulated Well Cars Used in This Test

To disable the brakes on these cars, special brake beam wear liners were welded into the side frames on the D trucks to restrict the motion of the brake beams and prohibit contact between the brake shoes and the wheels. Figure 3 shows the brake disabling method for the well cars.

New 38-inch wheelsets were installed in the D and E trucks of these cars for this testing and initial wheel

profiles were captured with a MiniProf device. The three well cars re-entered service and began their test in October 2016. All three cars had accrued between 54,000 and 63,000 service miles as of May 2017, the most current available mileage at the time of writing. As of July 2017, one of six wheelsets with disabled brakes and three of six wheelsets with normally operating brakes had been removed as detailed in sequential order in Table 1.

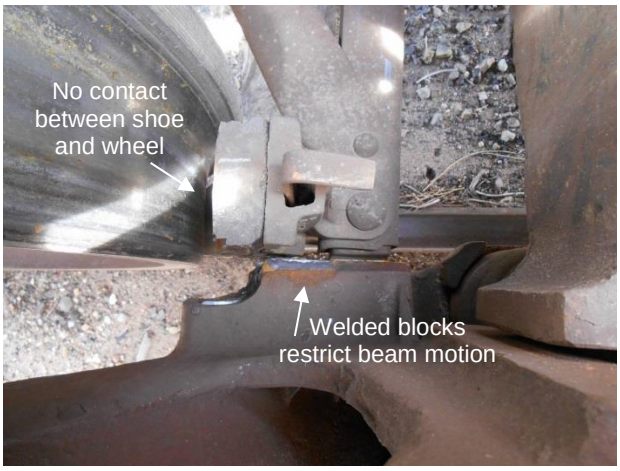

Figure 3. Brake Disabling Method for Well Cars

Table 1. Wheelset Removals from Well Cars

Car	Axle	Braked	Removal WMC*	Date
W3	8	Yes	L=65, R=11	3/5/17
W1	8	Yes	L=65, R=11	3/24/17
W2	7	Yes	L=11, R=65	6/6/17
W3	6	No	L=61, R=61	6/16/17

** Why Made Code: 11 = Removed in good condition, account of associated repairs, 61 = High impact wheel from 80 kips to less than 90 kips, 65 = High impact wheel 90 kips or greater*

Car W3 was inspected on June 8, 2017, just prior to the removal of non-braked wheelset in axle position 6. Figure 4 shows an example of the shelling found on both wheels of this wheelset. Wheel profiles captured on this car with a MiniProf device show typical early wear patterns on both braked and non-braked wheels: discernable wear on the flange and tread with little or no wear in the flange root. Likewise, data from wayside Wheel Profile Monitoring Systems (WPMS) for all three well cars also shows similar wear levels for the braked and non-braked wheels in terms of flange height, flange thickness, and tread hollowing. As additional mileage accumulates, more detailed wear analysis will be reported in a future *Technology Digest (TD)*. The three wheelsets removed from trucks with normally operating brakes were not available for inspection by test personnel.

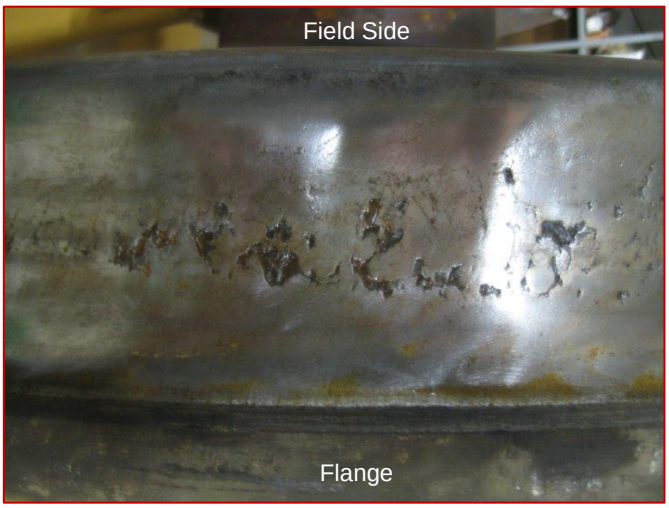

Figure 4. Tread Shelling Found on Both Wheels of a Wheelset with Disabled Brakes

Coal Hopper Cars

A total of 10 coal hopper cars are also undergoing testing to evaluate the effects of tread braking. Five of these cars have disabled brakes, and the other five cars have fully functioning brakes and will act as a control group. Each of the ten test cars received new 36-inch wheelsets at the start of the test and initial profiles were measured with a MiniProf device. Figure 5 shows an example of the hopper cars. These cars were built in 2012 with a typical light weight of 49,200 pounds and a gross rail load capacity of 286,000 pounds. They are equipped with M-976 trucks and rod-through-bolster body mounted brake rigging with high friction composition brake shoes. Inspection of the trucks showed them to be in good condition on all ten test cars. The coal cars began service testing in early July 2017. By the end of the first month of testing, they had completed approximately 10,000 miles on their standard route between the Powder River Basin in Wyoming and a power plant in Georgia.

Figure 5. One of the Coal Hopper Cars Used in This Test

Because of the need to keep the handbrakes fully functional on these cars, a different method was used to disable the brakes. Figure 6 shows an example of the device that was used to hold the cut out cock in the off position, thereby disabling any air brake applications

while still allowing normal handbrake operation and a functional brake pipe to allow other cars in the train to charge, apply, and release their brakes.

Figure 6. Air Brake Cut Out Method for Coal Hoppers

CONCLUSION

Revenue service testing is underway involving three multi-unit articulated well cars and five coal hopper cars with disabled brakes. The objective of the test is to evaluate the effects of tread braking on wheel wear patterns, wear rates, and tread damage. The FRA has issued an enforcement discretion to allow these eight cars to operate in service with disabled brakes.

After approximately 60,000 service miles, four out of twelve test wheelsets have been removed from the well cars for high impact loads. Three of these four wheelsets were removed from trucks with normal braking. The wheelset removed from a non-braked truck was inspected immediately prior to removal and showed clearly visible shelling on the tread of both wheels. The other removed wheelsets were not available for inspection.

Preliminary results are not yet available from the coal hopper test cars due to their later test start date.

TTCI will continue to monitor wheel life, impact loads, and WPMS data from these test cars and provide updated results in future TDs.

ACKNOWLEDGEMENTS

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