

The work described in this document was performed by Transportation Technology Center, Inc., a wholly owned subsidiary of the Association of American Railroads.

Key Findings:

- The wheelsets in cars with disabled brakes show no wear advantage on the flange or tread at this point in the test.
- Additionally, braking does not appear to have a negative effect on tread surface condition yet based upon visual appearance.
- More of the wheels from braked cars had no visible damage compared to the wheels from cars with disabled brakes.

Revenue Service Test of Cars with Disabled Brakes: Interim Results

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[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. The test includes appropriate control groups to compare performance.

Wheel wear and tread surface damage have long been thought to be heavily influenced by the abrasive contact and heat developed through tread braking. This test is intended to allow quantification of these effects and thereby provide direction for future wheel/brake research.

Nine of the 12 well car wheelsets were removed after less than 150,000 service miles, most for high impact loads. Five of these nine wheelsets were from the trucks with disabled brakes. Inspections were conducted on two of the wheelsets removed from trucks with disabled brakes and tread damage was found on the wheels, indicating that substantial heating from tread braking is not necessary to produce tread damage. The other removed wheelsets were not available for inspection at the time of their removal.

An inspection of the five coal hoppers with disabled brakes and five identical cars operating in the same unit train was conducted after approximately 110,000 service miles on the wheelsets. No wheelsets have been removed yet due to wheel-related causes. Braking does not appear to have a negative effect on wear or tread surface condition yet based upon visual appearance.

The Federal Railroad Administration (FRA) granted an enforcement discretion for these eight cars to operate in revenue service with disabled brakes until July 2020 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. New wheelsets were used to eliminate the influence of pre-existing conditions.

WELL CARS

By selecting 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.

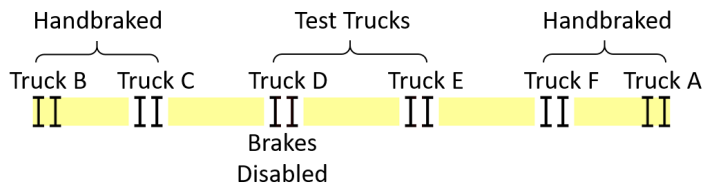


Figure 1. 5-Unit articulated well car nomenclature

The well cars used in this test are operating on their normal routes, typically in Canada. New 38-inch wheelsets were installed in the D and E trucks of these cars for this testing. The three well cars re-entered service and began their test in October 2016. All three cars had accrued between 149,000 and 197,000 service miles as of July 2018, the most current available mileage at the time of this report. As of September 2018, five of six wheelsets with disabled brakes and four of six wheelsets with normally operating brakes had been removed as detailed in sequential order in Table 1.

Table 1. Wheelset removals from well cars (red rows = braked trucks, blue rows = disabled brakes)

Car	Axle	Braked	Removal WMC*	Date	Mileage
W3	8	Yes	L=65, R=11	3/5/17	53,000
W1	8	Yes	L=65, R=11	3/24/17	50,000
W2	7	Yes	L=11, R=65	6/6/17	77,000
W3	6	No	L=61, R=61	6/16/17	72,000
W1	5	No	L=11, R=65	12/22/17	137,000
W1	6	No	L=65, R=11	1/19/18	146,000
W1	7	Yes	L=65, R=65	1/19/18	146,000
W2	5	No	L=65, R=11	1/19/18	136,000
W3	5	No	L=11, R=80	2/27/18	143,000

* 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, 80 = Scrape, dent, or gouge more than 1/8 inch deep

Car W3 was inspected in February 2018, just prior to the removal of the wheelset in axle position 5 with disabled brakes.

Figures 2 and 3 show the condition of the tread of the left and right wheels of this wheelset, respectively.

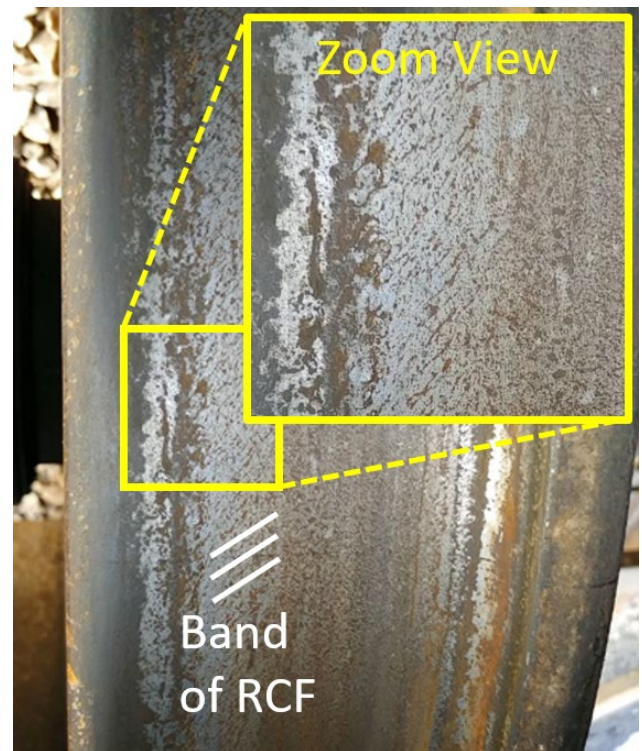


Figure 2. Tread condition of Car W3 Wheel L5 at time of removal



Figure 3. Tread condition of Car W3 Wheel R5 at time of removal

Both wheels show that wheel tread damage can form without substantial thermal input from tread braking. Wheel L5 had a band of rolling contact fatigue (RCF) cracks, also known as ‘heat checks’² or ‘scuffing.’³ RCF cracks are commonly found on the surfaces of wheels and rails and are the result of large stresses at the wheel/rail contact patch, rather than thermal input. In some cases, RCF damage can lead to wheel shells. Wheel R5 had several well-developed (but non-condemnable) shells in the tread surface and had produced impact loads as high as 66 kips prior to removal.

Wheel profile data was collected on these cars, but statistical comparisons were difficult due to small sample sizes, inconsistent service mileages between the cars, and relatively short wheel lives. There was not an obvious wheel wear penalty on the wheelsets in the braked trucks. The car owner has stated that the mileages for these wheelset removals are shorter than typically expected. A brake pressure sensor was recently installed on one of the test cars to enable quantification of brake applications.

COAL HOPPER CARS

A total of 10 coal hopper cars also are 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 act as a control group. Each of the 10 test cars received new 36-inch wheelsets at the start of the test. These cars have 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 high friction composition brake shoes. The coal cars began service testing in early July 2017 and operate on a standard route between Wyoming and Georgia.

The coal hoppers were inspected in September 2018 after approximately 110,000 miles since test initiation. Wheel profile measurements and visual inspection of the wheels, trucks, and brake systems were conducted by TTCI personnel. The brake system cut-out cock of each car was verified to be in the intended position. No abnormal truck wear conditions were noted. Figure 4 shows the categorization of the tread conditions for each wheel in the test. It is noteworthy that the braked cars had more wheels with no visible tread damage compared to the cars with disabled brakes. The treads of some of the wheels showed minor damage that typically extended around much of the circumference. This damage is thought to be due to some combination of RCF and/or continuous spalling.³ This type of damage is labeled “Shells” in Figure 4. Figure 5 shows an example. Two wheelsets showed evidence of spalling from

wheel slide damage at a discrete circumferential location and are labeled “Spalls” in Figure 4. One wheelset from one of the braked cars was removed after approximately 90,000 miles for a bearing issue.

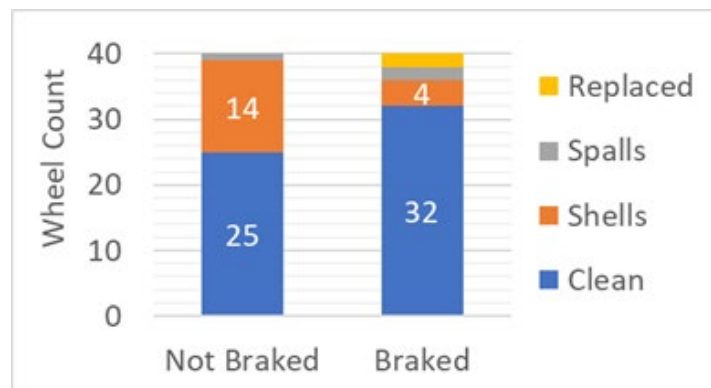


Figure 4. Visible tread surface condition

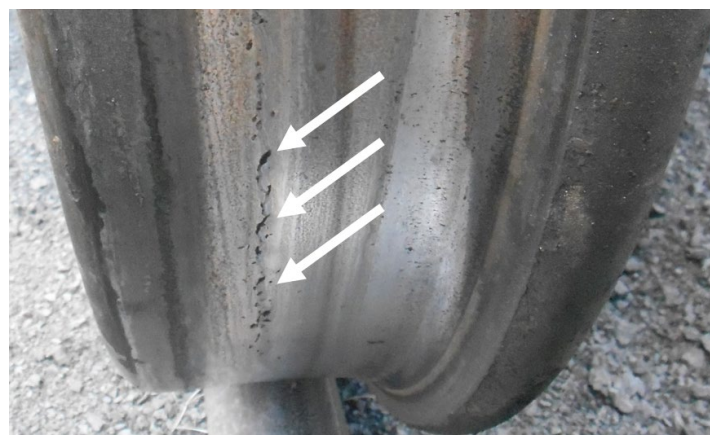


Figure 5. Example of the minor tread damage that can be found on coal car wheels

Wheel transverse profile measurements were collected with a Miniprof™ instrument and overlaid with the associated profile data that was collected at the test initiation to determine wheel wear. In this manner, the area loss was calculated for each wheel and segregated into flange wear and tread wear. Figure 6 shows these results and indicates that tread braking has not caused an increased wheel wear rate at this point in the test. Figure 7 shows the average wheel wear in terms of flange height and flange width. These results show that relatively little wear has accumulated and further confirm no wear penalty from tread braking at this point.

Data from wheel impact load detectors is periodically monitored for these cars. At this point in the test, none of the coal hopper wheels have exceeded 80 kips impact load.

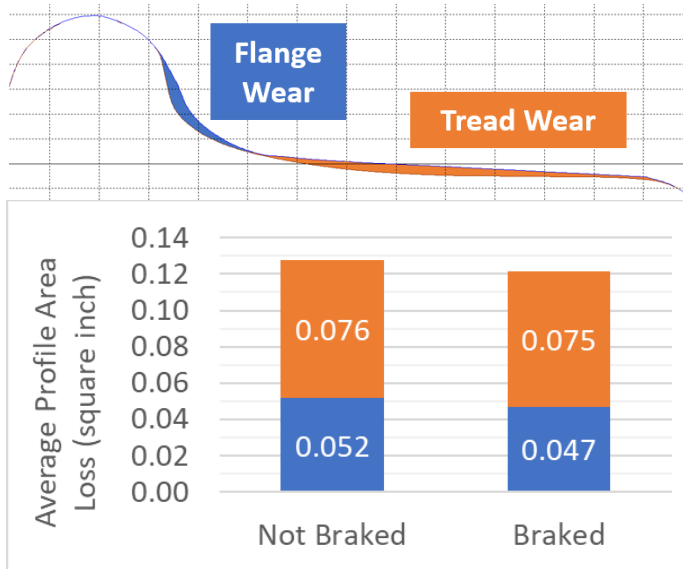


Figure 6. Wear area loss results for coal hopper cars segregated by wheel flange and tread

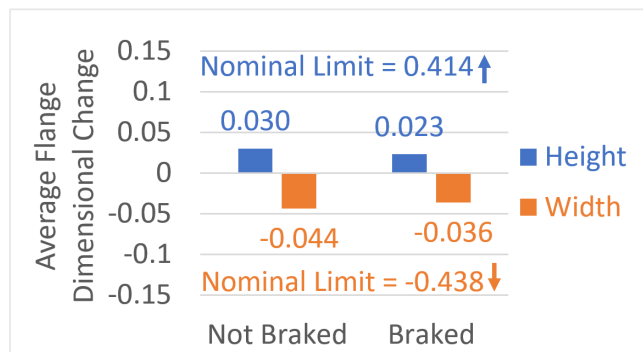


Figure 7. Flange height and width wear results for coal hopper cars

CONCLUSIONS

After approximately 150,000 to 200,000 service miles, nine out of 12 test wheelsets have been removed from the well cars, most for high impact loads. Four of these wheelsets were removed from trucks with normal braking and the other five wheelsets were removed from trucks with disabled brakes. Two of wheelsets removed from trucks with disabled brakes were inspected immediately prior to removal and showed visible tread damage. The other removed wheelsets were not available for inspection around the time of their removal.

Preliminary results from the coal hopper test cars indicate relatively little wheel wear after approximately 110,000 miles of service. At this point in the test, there is no wheel wear penalty evident from tread braking. In addition, there are more wheels from the control group of cars with no visible tread damage (32) compared to wheels from the disabled brake cars (25).

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

ACKNOWLEDGEMENTS

This testing would not be possible without cooperative effort from Norfolk Southern Railway, TTX Company, BNSF Railway, Canadian National Railway, and Southern Company. The original inspiration for this project and partial funding for the 52 new wheelsets used in the test came from the Wheel Defect Prevention Research Consortium, a group that disbanded in 2016.

References

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