TECHNOLOGY DIGEST
TD-16-020
©JUNE 2016
TIMELY TECHNOLOGY TRANSFER

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

Review of Tread Conditioning Brake Shoe Service Test Results

Scott Cummings

Summary

A survey by Transportation Technology Center, Inc. (TTCI) indicated that five out of six revenue service tests saw improvements in wheelset life by using tread conditioning brake shoes compared to high friction composition (HF comp) shoes. TTCI surveyed 10 car owners of large fleets (six Class I railroads and four private car owners) to obtain details regarding revenue service testing of tread conditioning brake shoes. This effort was conducted as part of the Association of American Railroads' (AAR) Strategic Research Initiative on Improved Brake System Performance.

One test that involved a simultaneous evaluation of two different types of tread conditioning brake shoes found improved brake shoe life, but no improvement in wheel life for either type of tread conditioning brake shoe compared to the control HF comp shoes. Another test evaluated wheel wear and did not find a large difference attributable to different brake shoe styles. In combination, the six reported tests span a wide range of conditions and are a good representation of the North American freight railroading environment with respect to service and route characteristics and car types (flatcars, coal cars, covered hopper cars, box cars, and articulated double stack cars).

Tread conditioning brake shoes are generally marketed as a way for car owners to improve the service life of wheelsets and brake shoes — two items of considerable expense for car owners. The industry has been exploring tread conditioning brake shoes as a means of improving wheel life for about 20 years, but little has been published on test results until now.

TTCI was not involved in the design, execution, or analysis of any of the tests described in this *Technology Digest*. Accordingly, TTCI is neither endorsing nor discrediting the tests described herein.

Please contact **Scott Cummings (719) 584-0739** with questions or concerns regarding this *Technology Digest.* E-mail: scott_cummings@ttci.aar.com.

INTRODUCTION

Transportation Technology Center, Inc. (TTCI) distributed a survey regarding revenue service testing of tread conditioning brake shoes and summarized the responses as part of the Association of American Railroads (AAR) Strategic Research Initiative on Improved Brake System Performance. Five of the six tests found sufficient benefit from the tread conditioning brake shoes to affect a purchasing change. TTCI was not involved in the design, execution, or analysis of any of the tests described in this *Technology Digest.*

BACKGROUND

Wheelset and brake system components represent substantial maintenance costs for car owners. Figure 1 shows the cost contribution of various components in the industry's 2013 running repair cost totaling $1.2 billion.[1]

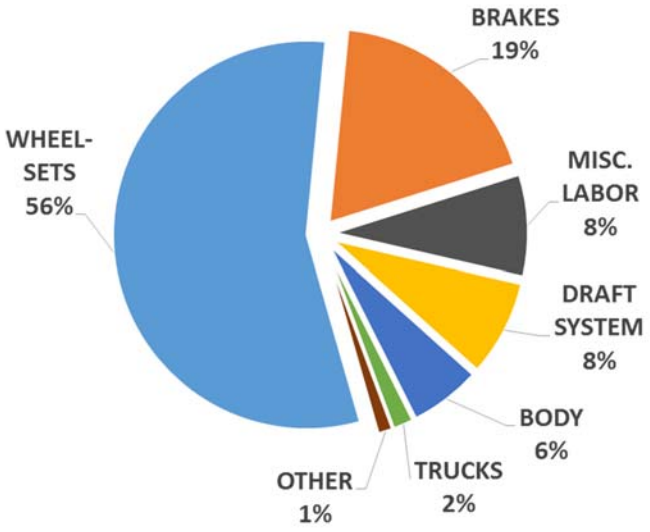

Figure 1. Mechanical Repair Spending[1]

Tread conditioning brake shoes are often marketed as a way for car owners to improve the service life of wheelsets and brake shoes. The North American freight railroading industry has been interested in tread conditioning brake shoes since at least 1996.[2] In addition to the AAR specification for high friction composition (HF comp brake shoes,[3] a specification for tread conditioning brake shoes was adopted in 2008.[4]

Many revenue service tests have been conducted, but there is little publically available information describing the tests and their results. This *Technology Digest* partially remedies that situation by summarizing six revenue service tests of tread conditioning brake shoes.

For any revenue service test, minimizing the influence of non-test variables is critical to obtaining results relevant to the test variable. Test design, data collection, and data analysis methods can have a large influence on the conclusions. TTCI neither endorses nor discredits the tests described herein, but simply provides a platform for results to be shared.

SURVEY

The following survey was distributed to a total of 10 entities that own large fleets of railcars. This group included six Class I railroads and four private car owners. The survey requested information related to revenue service testing as follows:

1. Shoe types tested?
2. Were other components tested during the same brake shoe test? If so, please include a brief description.
3. Test start date and end date, if complete.
4. Car details.
   a. How many cars?
   b. Car type?
   c. Build date (and rebuild date if applicable)?
   d. Light weight and load limit?
   e. Truck type/style?
   f. Body mounted brake rigging or truck mounted brakes
5. Service details.
   a. Typical annual mileage and/or typical mileage during the test?
   b. Manifest service or primarily in unit train(s) with other test cars?
   c. Other details about service environment?
6. Regarding the wheelsets used in the test, were they:
   a. New material at the beginning of the test, or
   b. All re-profiled at the beginning of the test, or
   c. Pre-existing under the test cars and in various conditions at the beginning of the test?
7. What criteria were used to evaluate performance? (e.g., Weibull analysis of wheel life, average wheelset mileage or age at removal, average brake shoe mileage or age at removal, etc.)
8. How did the analysis handle brake shoe changes on the test cars that occurred during the test? (e.g., all wheels censored when first brake shoe on the car was changed, etc.)
9. What were the results? (e.g., survival plot with 95 percent confidence intervals, average wheelset mileage at removal, etc.)
10. What were the conclusions? (e.g., no statistically significant difference in wheel life attributable to brake shoe type, 20 percent improvement in wheel life when using a certain shoe type, etc.,)
11. Did the test result in a cost-benefit to affect a purchasing change?

RESULTS

Four of the surveyed entities provided details regarding a total of six unique revenue service tests (referred to here at Tests A through F. Table 1 shows details regarding the six revenue service tests. In this table, brake shoes are noted as HF comp or as one of two different styles of tread conditioning brake shoes (TC-A or TC-B).

Table 1. Test Details

Test	A	B	C	D	E	F
Brake Shoes Tested	HF comp, TC-A	HF comp, TC-A	HF comp, TC-A	HF comp, TC-A	HF comp, TC-A, TC-B	HF comp, TC-A
Control Car Quantity	Historical values	Historical values	680	200	100	52
Test Car Quantity	30	360	120	200	100 cars TC-A 100 cars TC-B	52
Car Type	Coil Steel Flatcars	Steel Coal Hoppers	Aluminum Coal Gondolas	Grain Covered Hoppers	Boxcars	Five-Unit Articulated Double Stack Well Cars
Brake Rigging Type	Body mounted	Truck mounted	Truck mounted	Body mounted	Body mounted	Truck mounted
Test Initiation Year	2003	2004	2000	2008	2012	2008
Test Duration	2 years	2 years	3 years	7 years	3.5 years	7 years
Typical Annual Mileage	60,000 mi.	90,000 mi.	95,000 mi.	65,000 mi.	25,000 mi.	100,000 mi.
Car Age at Beginning of Test	3 years	20 years	New	4 months	New	New
Wheelset Condition at Beginning of Test	Service worn	Service worn	New	Service worn for 4 months	New	New
How were brake shoe replacements handled?	Replaced in kind	Replaced in kind	Not addressed	Continued to monitor data after test shoes were changed out after approximately 2 years	Replaced in kind. Wheel and brake shoe life was censored when a different type of shoe was applied to the car.	Replaced in kind. Wheel and brake shoe life was censored when a different type of shoe was applied to the car.
Test Criteria	Wheelset miles to removal	Impact load data and wheelset miles to removal	Wheel wear, maintenance records for brake shoes and wheelsets, and impact loads	Impact load data, maintenance data for wheelsets	Survival data for wheels and brake shoes	Survival data for wheels and brake shoes
Finding	60% improvement in wheelset life	26% improvement in wheelset life	54% reduction in wheelset costs, 82% reduction in wheelsets removed for shelling or impact loads, little change in wheel wear	Reduction of 25 shelled wheels in first 2 years of test. After 6 years, test cars had saved 250 wheels.	Improved brake shoe life, no improvement in wheel life	Improved brake shoe life and improved wheel life
Purchasing change?	Yes	Yes	Yes	Yes	No	Yes

Combined, these six tests span a wide range of condition, and are a good representation of the North American freight railroading environment with respect to service and route characteristics and car types.

The oldest reported test began in 2000 and Test D was still in progress during the period of the TTCI survey response. Test durations ranged from 2 to 8 years, and the number of cars involved in the tests was a few as 30 and as many as 800. A good assortment of car types was reported as test subjects; including coal cars, grain covered hopper cars, box cars, coil steel flatcars, and articulated double stack well cars. In some tests, the cars were brand new at the start of the test and equipped with brand new wheelsets. In other tests, the cars were up to 20 years old at the start of the test and began the test with the existing wheelsets. With the exception of the articulated double stacks, all test cars were rated for 286,000 pounds gross rail load with tare weights ranging from 41,000 pounds up to 81,000 pounds. Three of the six tests made use of cars with body mounted brake rigging while the other three tests involved truck-mounted brakes. Likewise, there was an even split of the number of tests in manifest trains versus unit train service. Route characteristics included a wide variety of curvatures, grades, and climates throughout Canada, the United States, and Mexico.

Four of the tests compared the performance of a control group of cars equipped with standard high friction composition brake shoes to the simultaneous performance of one or more test groups of identical cars equipped with tread conditioning brake shoes. Tests A and B used the historical performance of the test cars as the control group and compared the performance of the cars before and after installing tread conditioning brake shoes. None of the tests knowingly involved component differences on the cars other than brake shoes; thereby reducing the chances of confounding mechanical component variables affecting the results.

Maintenance records for brake shoes are reported with the car number, but the specific location on the car for the brake shoe replacement is not reported. This can present a problem for revenue service testing because it is not possible to determine which brake shoe on the car was replaced by a review of the maintenance records for that car. An attempt is made to replace brake shoes in kind, but as a practical matter, this does not always happen. Four of the tests evaluated wheel life according to the style of the original brake shoes applied at the start of the test. Two tests applied a survival analysis technique to censor the wheelset life data for all wheelsets in a car that had a dissimilar brake shoe replacement at the mileage of that replacement. In this way, the wheelset life evaluation of Tests E and F apply specifically to the one style of brake shoe installed on the car at the beginning of the test without any interaction from the effects of other brake shoe styles.

All of the tests evaluated the wheelset life using maintenance records. Some tests included evaluation of wheel performance based on impact load data. Test C looked specifically at wheel wear differences that could be attributed to the different brake shoes. Tests E and F included an assessment of brake shoe life based on maintenance records.

Although Test E found improved brake shoe life with tread conditioning brake shoes, it did not find improved wheel life for TC-A or TC-B compared to the control HF comp shoes. The other five tests found sufficient improvement in wheelset life to cause the car owner to begin (or continue) purchasing tread conditioning brake shoes for their cars rather than HF comp shoes.

Although TC-A brake shoes were involved in all six tests reported to TTCI, TC-B brake shoes were only involved in Test E. It should be noted that tread conditioning brake shoes have evolved throughout the span of time covered by the tests described in this report.

CONCLUSION

A survey of results from six unique revenue service tests of tread conditioning brake shoes showed wheelset life improvement in five of the tests involving flatcars, two types of coal cars, covered hoppers, and articulated double stack cars. The car owners recognized sufficient benefit from the tread conditioning brake shoes in these five tests to begin (or continue) purchasing tread conditioning brake shoes rather than HF comp shoes. The sixth test involving low annual mileage boxcars found improved brake shoe life, but did not find improvements in the life of wheelsets for either of two different types of tread conditioning brake shoes. One test that evaluated wheel wear did not find a large effect due to brake shoe type.

REFERENCES

1. Car Repair Billing Database. Railinc. Cary, NC. 2013.
2. Stagl, Jeff. “Technology Update: Tread-Conditioning Brake Shoes.” *Progressive Railroading*. Nov. 2008. http://www.progressiverailroading.com/csx/article/Technology-Update-Tread-Conditioning-Brake-Shoes--18557
3. *AAR Manual of Standards and Recommended Practices.* Section E. Brakes and Brake Equipment. “Brake Shoe, High Friction Composition or Metal Type.” Specification M-926. Adopted 1965. Last Revised 2006.
4. *AAR Manual of Standards and Recommended Practices.* Section E. Brakes and Brake Equipment. “Brake Shoe, High Friction Tread Conditioning–High Capacity.” Specification M-997. Adopted 2008.