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SRI-1A Wheel Profile Service Test on Coal Cars

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Summary

Transportation Technology Center, Inc. has designed a new wheel profile to improve vehicle curving performance and to reduce the wear-in period of wheels. Named SRI-1A,* the new profile was designed under the Association of American Railroads' Strategic Research Initiatives Program.

The second service test of the SRI-1A wheel profile is being conducted using 10 coal cars operating on the West Virginia route of Norfolk Southern Railway. This route has many sharp curves. For the purpose of comparison, five of the ten cars are equipped with the SRI-1A profile wheels and the other five cars are equipped with the AAR-1B profile wheels.

This *Technology Digest* reports the service test results up to about 50,000 loaded miles of operation.

In this test, the SRI-1A profile wheels produced lower average gage spreading force (GSF) than the AAR-1B profile wheels during the first 8,000 miles of loaded operation. The GSF values for the two profile designs were similar for the data collected around 28,000 and 50,000 miles of loaded operation.

After 8,000, 28,500, and 50,000 miles of loaded operation, the SRI-1A wheels produced 27-, 21- and 16-percent less wear, respectively, compared to the AAR-1B wheels. The SRI-1A wheels also produced a more evenly distributed wear pattern.

The symmetric pattern of wheel flat locations observed at 50,000 miles of loaded operation indicates those flats were likely initiated by wheel slide due to inappropriate braking. There were no clear indications that the surface defects were directly related to the wheel profile types.

Service test results indicate that the wheel profile design reduced the initial wear-in period of the wheels.

Inspection of the wheels on the test cars will be continued until wheel replacement occurs in order to evaluate the economic benefits of the SRI-1A wheel profile.

Larger scale revenue service tests are being planned. The tests are expected to involve multiple car types and longer distance operating routes.

*The SRI-1A profile was previous named the TTCI-1A profile.



INTRODUCTION

Under an Association of American Railroads’ Strategic Research Initiatives project of improving wheel and rail life, Transportation Technology Center, Inc. (TTCI) developed a new wheel profile, named SRI-1A. TTCI designed the new wheel profile to improve vehicle curving performance and to reduce wear-in period of wheels, compared with the current standard AAR-1B profile. Figure 1 shows the differences in contact features between the AAR-1B and SRI-1A profiles when contacting a typical worn profile from the high rail in a curve. TD-06-023¹ and TD-08-025² describe development background and previous service test results using a five-unit intermodal car for this profile.

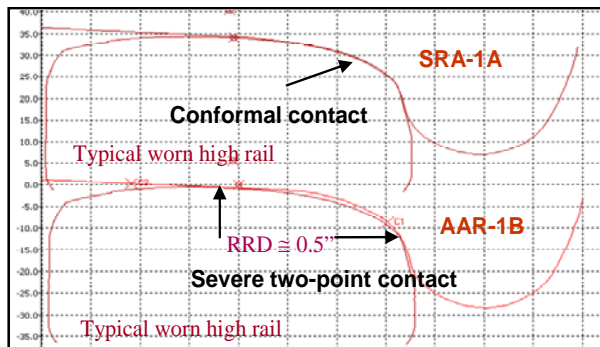


Figure 1. Contact features of the SRI-1A and the AAR-1B wheel profiles

TTCI, with support from Norfolk Southern and Progress Energy, Inc., is conducting a wheel profile performance test on coal cars to evaluate the performance of the SRI-1A wheel profile in coal service. The test began in October 2006 and has resulted in an average accumulation of 50,000 loaded miles in revenue service through October 2008.

SERVICE TEST DESCRIPTIONS

Ten 110-ton capacity PGNX coal cars (Figure 2) are being used in this test. For the purpose of comparison, five of the ten cars are equipped with the SRI-1A profile wheels and the other five cars are equipped with the AAR-1B profile wheels.



Figure 2. Coal Car used in the Wheel Profile Test

The West Virginia route that these test cars are traversing contains many sharp curves. Average loaded miles are estimated at 400 miles per trip. The train operating speed is generally below 50 mph; consequently, vehicle stability is not a concern.

The curving performance of the loaded test cars is assessed using the data from a truck performance detector (TPD) installed at Eggleston, West Virginia, on this route.

The test cars have been inspected four times, at approximately 0, 8,000, 28,500, and 50,000 miles of loaded operation, to measure wheel profiles for comparing wear rate and to document wheel surface conditions to establish contact fatigue differences between the two wheel profile types.

CURVING PERFORMANCE

Gage spread force (GSF) is defined as a half of summation of lateral forces on four wheels of a truck. It indicates truck curving performance and the force that pushes the two rails apart in a curve. Poor curving performance results in high GSFs. Figures 3, 4, and 5 show the average GSF results in three periods: (1) first 8,000 miles, (2) one month of TPD passes, around 28,500 miles, and (3) one month of TPD passes, around 50,000 miles. The SRI-1A profile produced a lower average of GSF values than the AAR-1B profile for the first 8,000 miles. The GSF values were similar for both profiles for the 28,500 and 50,000 miles of data.

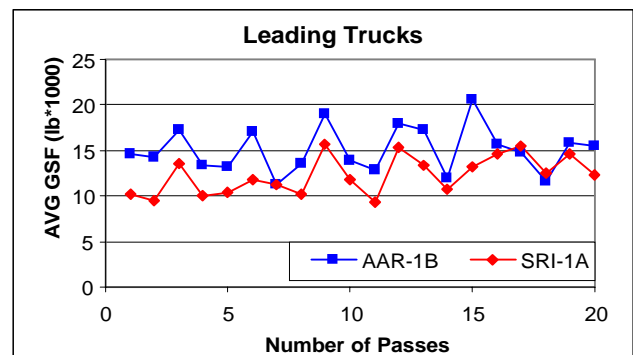


Figure 3. GSF in the First 0 to 8,000 miles of Loaded Operation

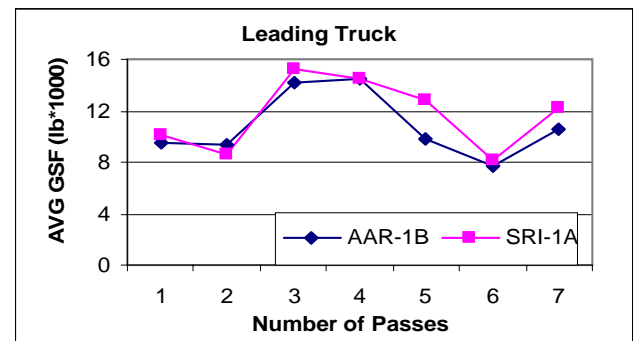


Figure 4. GSF around 28,500 miles of Loaded Operation

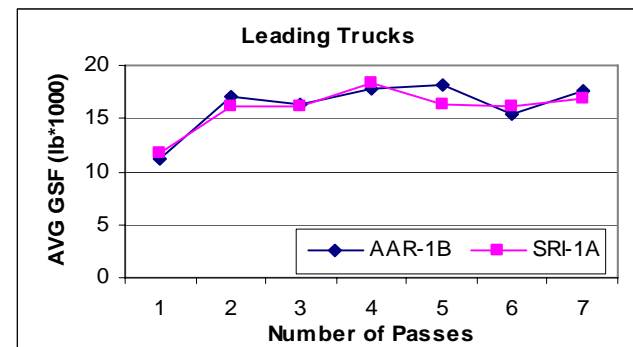


Figure 5. GSF around 50,000 miles of Loaded Operation

WHEEL WEAR AND WEAR PATTERN

Wheel wear is calculated by comparing each worn wheel profile with the unworn profile. The difference in cross sectional area equals the amount of wear (Figure 10 shows an example). Figure 6 shows that the SRI-1A wheels wore 27-, 21- and 16-percent less compared with the AAR-1B wheels, after approximately 8,000, 28,500 and 50,000 miles of loaded operation, respectively.

Notice that less wheel wear indicates less energy consumed at the wheel/rail interface, potentially resulting in reduced rail wear and fuel consumption.

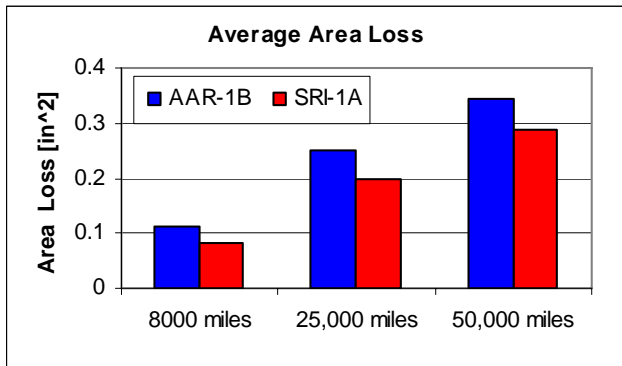


Figure 6. Average Wheel Cross Sectional Area Loss of the Coal Cars being Tested

Figure 7 shows comparable data from the five-unit intermodal car test (reported in TD-08-025). The wheels on the coal cars experienced 25-percent more wear compared to those on the five-unit car at the corresponding mileage for both profile types. The higher wheel wear rate on coal cars is presumed to be due to the heavier axle load and sharper track curvature experienced by the coal cars. However, the SRI-1A profile wheels experience generally less wear than the AAR-1B profile wheels in both tests.

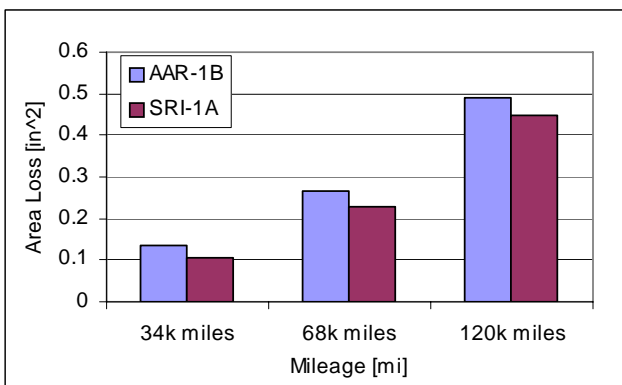


Figure 7. Average Wheel Cross Sectional Area Loss for the Five-Unit Intermodal Car Tested

Figure 8 compares wheel wear in terms of the wheel flange height and the wheel flange width at 50,000 miles of loaded operation. The SRI-1A wheels produced 28- and 22-percent less average wear in wheel flange height and wheel flange width, respectively, compared to the AAR-1B wheels. The wheel flange heights were measured at the taping line of the

wheels. The flange widths were measured at 0.59 and 0.63 inch from the wheel flange tip, respectively, for the AAR-1B and the SRA-1A wheels. This is because of the differences in the original flange height. Again, as shown, the SRI-1A profile wheels also experienced less wear in these two terms than the AAR-1B profiles.

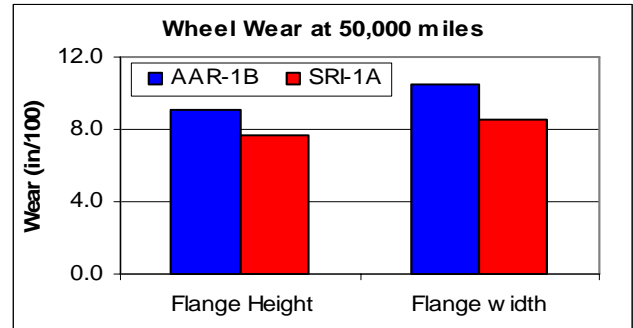


Figure 8. Average Wheel Flange Face and Wheel Tread Wear

Figures 9 and 10 show the wear patterns measured after 8,000 and 50,000 loaded miles of operation. The SRI-1A wheels showed a more even wear pattern across the wheel profile. This is because the profile experienced a more conformal contact pattern than the AAR-1B wheels when new; conformal contact is considered to result in improved curving, reduced truck warp, and more even wheel wear.

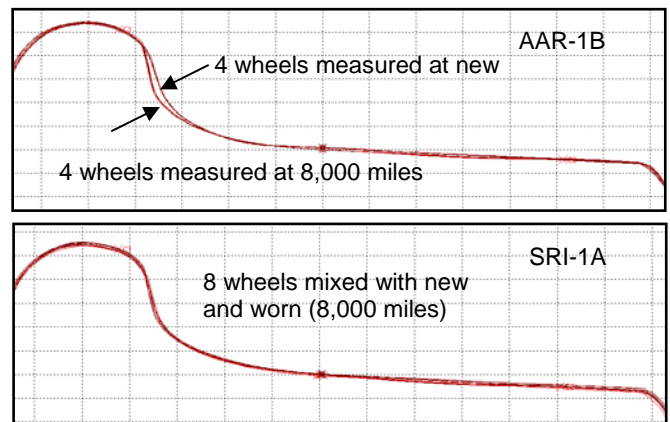


Figure 9. Typical Wear Patterns of the AAR-1B and the SRI-1A Wheels after 8,000 Miles of Loaded Operation

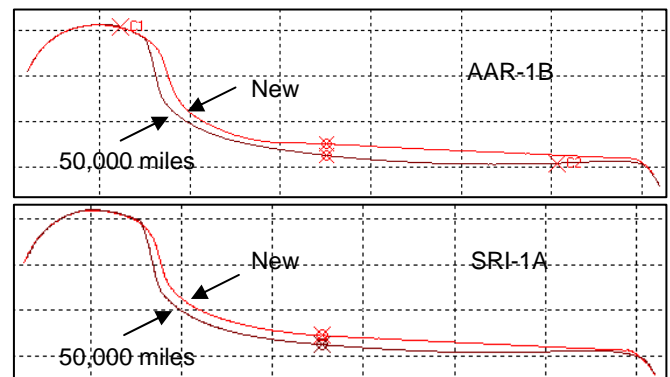


Figure 10. Typical Wear Patterns of the AAR-1B and the SRI-1A Wheels after 50,000 Miles of Loaded Operation

Some AAR-1B wheels experienced asymmetric wear between two wheels on the same axle during the five-unit intermodal car test. The asymmetric wear is evaluated as the difference in the cross sectional area wear between left and right wheels. For the coal cars being tested, the AAR-1B wheels showed a similar level of average asymmetric wear as the SRI-1A wheels at 50,000 miles of loaded operation, as Figure 11 shows. This is possibly due to the coal cars being operated in a relatively short designated route with small variations in track geometries and rail profiles, while the five-unit intermodal car traveled around the country and experienced much larger variations in track geometry and rail profile conditions.

The evaluation of all wheel profiles measured after 50,000 miles of loaded operation shows that these two types of wheels have worn into the similar shapes at this stage of the test, even though they have different amounts of wear.

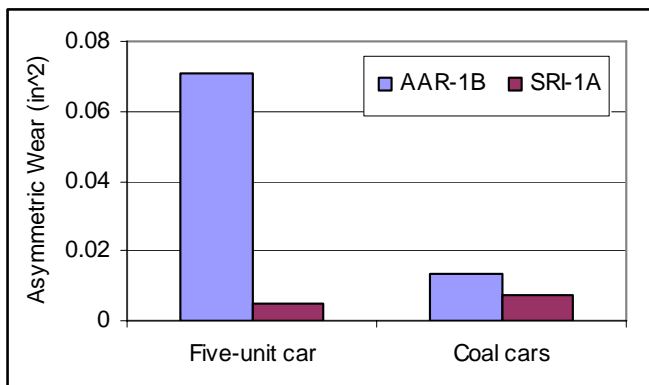


Figure 11. Evaluation of Asymmetric Wheel Wear

WHEEL SURFACE CONDITIONS

After 8,000 miles of loaded operation, all wheel surfaces were in good condition. After 28,500 miles of loaded operation, the wheel surfaces were generally in good condition. A few wheel flats and surface defects were observed. There were no clear indications that the surface defects were related directly to the wheel profile types.

After 50,000 miles of operation, several of the trucks had wheels with flat spots of significant size (Figure 12).

The wheel flats are nearly symmetrically positioned on the wheels mounted on the same axle. This wheel flat pattern indicates the flats were likely initiated by wheel slide due to inappropriate braking.



Figure 12. A Sizeable Wheel Flat

CONCLUSIONS

The SRI-1A wheel profile wheels experienced lower wear rates than the AAR-1B profile wheels and improved curving performance during their initial life. This will result in reduced rail wear and extended wheel life. TTCI recommends that the Equipment Engineering Committee consider implementing this profile as a new design standard.

FUTURE WORK

Inspection of the wheels on these test cars will be conducted annually until wheel replacement occurs in order to evaluate the economic benefits associated with the use of the SRI-1A profile. The TPD data will be monitored twice a year to document force variations between the two wheel profile types.

Larger scale revenue service tests are being planned. The tests are expected to involve multiple car types and longer distance operating routes.

ACKNOWLEDGMENTS

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REFERENCE

1. Wu, H., Madrill, B., and Kalay, S. September 2006. "New Wheel Profile Design and Preliminary Service Test Results." *Technology Digest* TD-06-023, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, Colorado.
2. Wu, H., Madrill, B., and Kalay, S. June 2008. "Service Test Results of a New Designed Wheel Profile." *Technology Digest* TD-08-025, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, Colorado.