TECHOLOGY DIGEST

Timely Technology Transfer — 02-022

Body-Mounted Brake Rigging Efficiency Losses in Service

by Fred Carlson

Summary

A study, completed by Transportation Technology Center, Inc. on body-mounted brake rigging efficiency losses in revenue service, shows that loaded brake ratios of 9 percent (at 50-psi brake cylinder pressure) dropped to about 8.2 percent after 75,000 miles of service, stabilizing at that point. The cars, built in 1997, were given brake shoe force tests when new at the factory and again after 75,000, 185,000, and 240,000 miles of service.

The brake rigging under study was the commonly used rod-through type. The cars were Thrall Avalanche® 110-ton rapid discharge coal hoppers belonging to the Southern Companies.

The implications of this study are important when severe grade braking is considered. To balance a 3-percent grade with train brakes alone, an operating brake ratio of about 9 percent is required. On the cars in the study, with a 90-psi brake pipe pressure, the brake ratio could be achieved with a 20-psi brake pipe reduction when the cars were new. After the loaded brake ratios dropped to 8.2 percent (at 50-psi brake cylinder pressure), the brake pipe reduction required to balance the same grade would increase to about 22 psi. That would only leave a further 4-psi service brake reduction available to slow or stop the train without an emergency application. This implies that the Association of American Railroads' loaded brake ratio range could be increased from 11-13 percent to 12–14 percent to offset body-mounted brake rigging efficiency losses.

Four of the 12 cars in the study were equipped with bushings that were coated with a low-friction material. The bushings were installed in all of the body and truck levers on these cars. The purpose was to see if low-friction bushings would increase the as-built rigging efficiency and reduce rigging efficiency losses in service. These bushings proved to be of minimal value, since they increased installation expenses, provided only minor improvement in rigging efficiency, and showed significant wear after 240,000 miles of service.

Suggested Distribution:

- ☐ Car Department
- ☐ Planning & Analysis
- ☐ Safety

Work performed by Transportation Technology Center, Inc.
a subsidiary of the Association of American Railroads

INTRODUCTION

The body-mounted brake rigging efficiency study was done under the Advanced Brake Actuation AAR Strategic Research Initiative. The goal of the study was to promote the development of new concepts in brake rigging design to:

- Increase brake rigging efficiency and maintain higher efficiency through the life of the car,
- Reduce brake shoe force variations within a car, and
- Reduce tapered brake shoe wear.

Twelve coal hoppers from Southern Companies have been the subjects of a braking study since they were built in the fall of 1997. The loaded and empty brake ratios were measured at the factory, and again three times thereafter, at intervals of approximately 50,000 to 75,000 miles of service. The cars were delivered as four-unit drawbar-connected cars with body-mounted rod-through brake rigging. All four units of one four-unit car had bushings coated with a low friction material. These bushings were installed in the body and truck levers. The bushings were intended to increase the brake rigging efficiency and to reduce the efficiency loss over time.

The cars are Thrall Avalanche® coal hoppers, with the following details:

- Gross rail load: 286,000 pounds
- Empty weight: 50,800 pounds
- 50 percent empty/load equipment
- Rod-through brake rigging
- Lever ratio: 8.21415
- Theoretical loaded brake ratio at 65-psi brake cylinder pressure: 11.3 percent

The brake-rigging diagram of the car is shown in Figure 1.

TEST RESULTS

The 12 test cars ran as three 4-unit drawbar-connected cars until 2000, when the cars were split into single unit cars. This involved rebuilding the car ends where the drawbar was mounted. During the rebuild, some of the vertical end levers (11.875″×10.125″ levers in Figure 1) were inadvertently flipped, which caused a reduction in the braking forces on that end of the car. This was not noticed until the fourth test, when the levers were corrected. Table 1 lists the results of the initial factory test and the three field tests. All brake ratios were measured at 50-psi brake cylinder pressure. All readings were taken after the rigging was rapped.

The new loaded car rigging efficiency is about 79.8 percent (given by the actual brake ratio divided by the theoretical brake ration). The rigging efficiency reduced to about 71.9 percent after 75,000 miles of service.

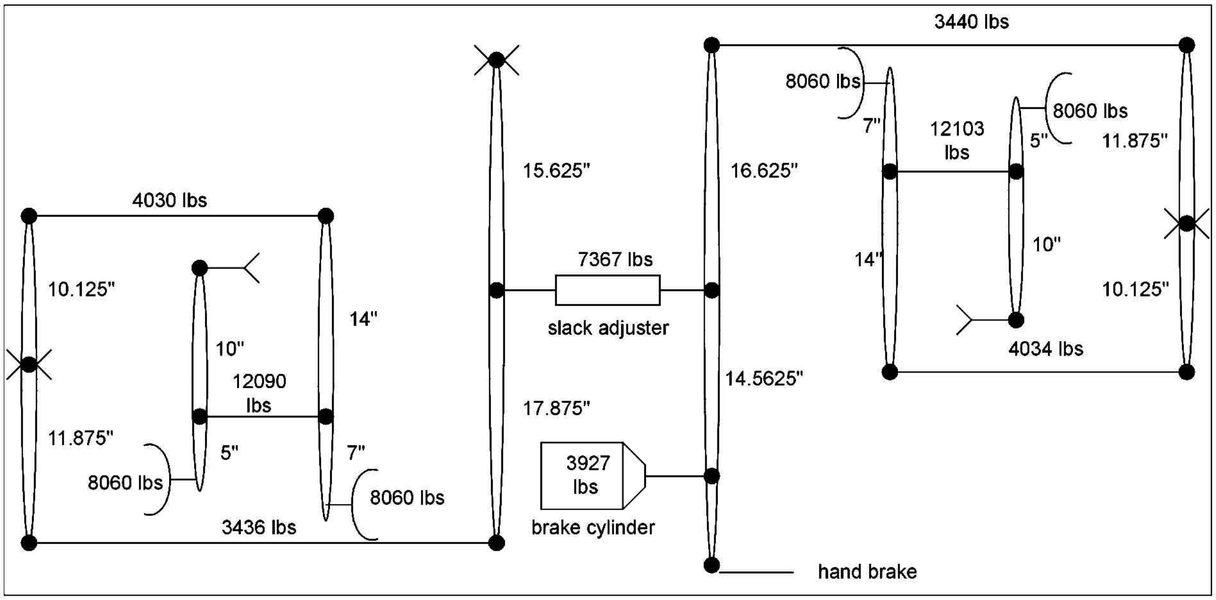

Figure 1. Rod-Through Brake Rigging on Test Cars

Table 1. Loaded Brake Ratios of Test Cars

		Loaded Brake Ratios - percent				
	Average Mileage	**0 (new)**	**73,057**		**184,825**	**239,443**
Un-bushed levers	JHMX 97378	9.2	7.9	4-unit Cars Split into 12 Single Cars	Not tested	Not tested
	JHMX 97379	9.5	8.0		Not tested	Not tested
	JHMX 97380	9.1	8.4		Not tested	Not tested
	JHMX 97381	8.8	8.5		7.8 *	8.2
	JHMX 97402	8.2	7.7		8.3	8.3
	JHMX 97403	8.8	8.1		6.2 *	8.3
	JHMX 97404	8.9	7.3		6.0 *	Not tested
	JHMX 97405	8.9	9.1		7.4 *	8.0
	Average	***8.93***	***8.13***		***8.3 (7.16)*****	***8.2***
Bushed	JHMX 97542	8.8	8.0		7.4 *	7.9
	JHMX 97543	9.1	8.9		7.1 *	8.2
	JHMX 97544	9.1	8.7		Not tested	Not tested
	JHMX 97545	8.8	8.6		7.7 *	Not tested
	Average	***8.95***	***8.55***		***7.4 ****	***8.05***

* The brake ratios listed are low due to the incorrect vertical end lever installation made when the cars were rebuilt as single units. This was discovered during the May 2002 tests. Cars 97404 and 97545 are suspected of having a wrong lever orientation, but this cannot be confirmed since these cars were not tested in 2002.

** The average for the non-bushed cars is for the known good cars only, and the average for all cars in the group is in parentheses.

TEARDOWN INSPECTION

Two trucks, one from a car equipped with lever bushings and one without bushings, were disassembled to inspect the brake components. No abnormal wear patterns were found in any of the rigging pins, lever holes, brake beam end extensions, brake beam struts, or in the plastic brake beam wear liners. However, the low-friction coatings in the bushings were flaking off or worn off to the point where little of the original coating remained. Figures 2 through 5 show some of the wear conditions found.

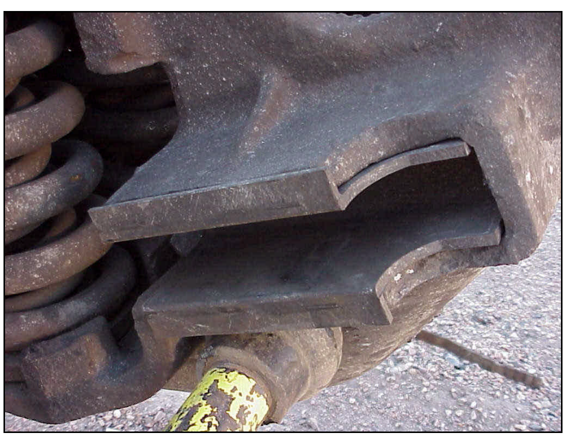

Figure 2. Brake Beam Pocket with Plastic Wear Liner showing Smooth Wear Surfaces with No Gouges or Ridges — Car 97405

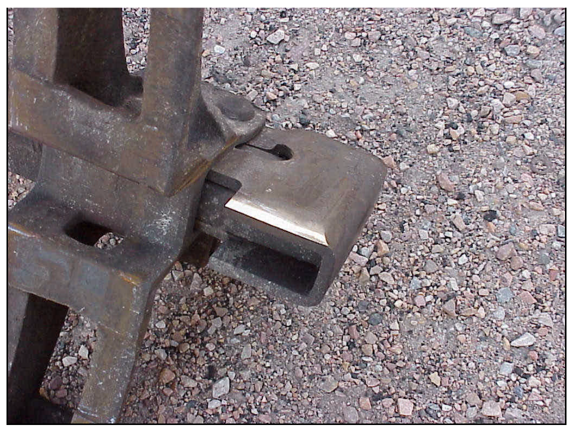

Figure 3. Brake Beam End Extensions Showing Typical Normal Wear Patterns — Car 97405

Figure 4. Bushed Brake Beam Live Lever from Car 97542.
The Low friction coating still remaining is impregnated with rust particles, and much of the coating has been worn away after 226,000 miles.

Figure 5. Live Truck Lever showing almost no wear after 240,000 miles — Car 97405

DISCUSSION

The initial installation of the low-friction bushings in the brake levers was a tedious and expensive proposition. Because of the tight tolerances required, the holes had to be reamed to final size prior to pressing the bushings into the levers. While the initial shoe force tests showed a marginal improvement, the durability of the bushings and their performance after 240,000 miles of service cannot justify the original cost.

Four of the eight un-bushed cars tested in 2002 showed a reduction in braking ratio from 9.0 percent to about 8.2 percent. The cars with the bushings performed worse with two of the four cars dropping to about 8.0 percent. This represents about a 10-percent loss in total braking capacity. Most, if not all, of this efficiency degradation happened in the first 75,000 miles of service, and the brake ratios have remained somewhat stable since that time. And because there was no abnormal wear or other obvious defective components, it may be assumed that normal wear and tear will reduce the brake ratio of a car with body-mounted brake rigging from the current AAR loaded brake ratio range of 11 to 13 percent at 64-psi brake cylinder pressure to about 9.9 to 11.7 percent.

The importance of correct lever orientation cannot be overemphasized. The vertical end levers on these cars have similar top and bottom pin-to-pin dimensions (11.875″×10.125″). So when the cars were rebuilt as single unit cars, it was easy for the levers to be applied in the inverted position. Doing so had a significant effect on the brake ratio of the truck on that end of the car. Take as an example car 97403, which had the vertical end sill lever inverted on the B-end of the car. Table 2 shows the results before and after the lever was reinstalled correctly.

Table 2. Effect of Inverted Lever on Brake Ratios

	A-end (percent)	B-End (percent)	Car (percent)
Inverted B-end Lever	8.17	5.75	7.15
Lever Corrected	8.36	7.89	8.27

CONCLUSION

The implications of this study are important when severe grade braking is considered. To balance a 3-percent grade with train brakes alone, an operating brake ratio of about 9 percent is required. On the cars in the study, with a 90-psi brake pipe pressure, this brake ratio could be achieved with a 20-psi brake pipe reduction when the cars were new. After the loaded brake ratios dropped to 8.2 percent (at 50-psi brake cylinder pressure), the brake pipe reduction required to balance the same grade would have increased to about 22 psi. That would only leave a further 4-psi service brake reduction available to slow or stop the train without an emergency application. This implies that the AAR loaded brake ratio range could be increased from 11-13 percent to 12-14 percent to offset body-mounted brake rigging efficiency losses.

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