TECHOLOGY DIGEST

Timely Technology Transfer — 02-003

Link Support System Brake Rigging

by Fred Carlson and Jerry Malachowski*

Summary

Initial results of tests performed on the Link Support System brake rigging modification have shown a significant reduction in tapered brake shoe wear, an increase in brake rigging efficiency, and a reduction in brake shoe force variations. The Link Support System is the first design submitted for the Association of American Railroads' (AAR) Advanced Brake Rigging Project. The Advanced Rigging Project has the goal of promoting the development of advanced brake rigging designs that will:

- Reduce the brake shoe force variation within a given car;
- Increase brake rigging efficiency, and reduce the loss of efficiency as the brake rigging ages; and
- Reduce the occurrence of taper worn brake shoes.

The Link Support System consists of standard body mounted rigging adapted to make use of a link support and guide member. This combination of components guides the brake beam in a horizontal configuration, regardless of brake beam end extension wear. The brake beam is prevented from drooping, which can cause the top of the brake shoe to wear more than the bottom as the top of the brake head tilts closer to the wheel tread. The Link System also reduces the frictional losses between the brake beam and the side frame pocket, thereby increasing the rigging efficiency and reducing the brake shoe force variations from side-to-side on the same brake beam.

One set of equipment is installed on a car and currently under test at the Federal Railroad Administration's Facility for Accelerated Service Testing (FAST) near Pueblo, Colorado. Two other sets are installed on coal hopper cars in revenue service.

Suggested Distribution:

❑ Mechanical Department

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

INTRODUCTION

The AAR Advanced Brake Rigging project was initiated to promote the development of new brake rigging designs that could:

- Reduce the brake shoe force variation within a given car;
- Increase the brake rigging efficiency, and reduce the loss of efficiency as the brake rigging ages; and
- Reduce the occurrence of taper worn brake shoes.

The Link Support System, developed through a consortium of Schaefer Equipment Inc. and YSD Industries, is the first brake rigging design submitted to TTCI under the project. Schaefer Equipment manufactures forged brake rigging components including levers, through-rods and bottom-rods, clevises, brake rod hardware, and assemblies. YSD Industries manufactures freight car equipment, including brake beams, boxcar doors and roofs, load dividers, running boards, and outlet gates.

The system is currently under test on one car running in the FAST train at the FRA's Transportation Technology Center (TTC), and on two cars in revenue service with the Gainesville Regional Utilities that are operating on the CSX Railroad. The FAST car is intended to provide a rough shock and vibration environment, but this car is subjected to very few brake applications. The revenue service test provides most of the useful data regarding rigging efficiency, tapered brake shoe wear, and uniform brake shoe forces.

SYSTEM DESCRIPTION

The Link Support System attaches link members between extra holes of a longer truck through-rod and the outer ends of modified brake beam center struts. This arrangement guides the brake beam and allows it to stay in a horizontal configuration regardless of brake beam end extension wear. The beam is prevented from the drooping that would normally cause uneven shoe wear as the top of the brake head moves closer to the wheel tread. It also reduces the frictional losses between the brake beam and the side frame pockets, thereby increasing the rigging efficiency and reducing the brake shoe force variations from side-to-side on the same brake beam. It does this by keeping the end extensions aligned with the side frame unit guides. Exhibit 1 shows the system as it was installed on the FAST car, and Exhibit 2 illustrates how the Link Support System aligns the brake beam end extensions within the side frame unit guides.

Exhibit 1. Link Support System Installed on the FAST Car

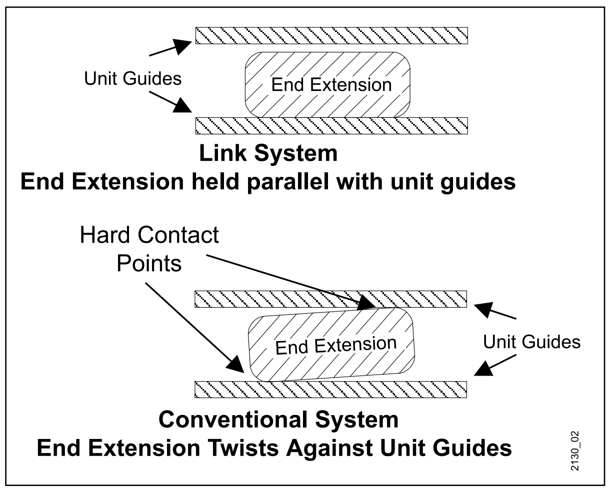

Exhibit 2. Binding Mechanism of End-Extension/ Side Frame Interface

REDUCTION OF TAPER WEAR

A brake shoe typically wears more at its top. When the shoe reaches the condemning limit of 3/8 inch, a considerable amount of friction material can remain on the bottom of the shoe. Initial results from revenue service tests of the Link Support System indicate that it provides a significant reduction in taper wear. The brake shoes in this test were about half worn after 51,000 miles of service. However, these test cars will need more service history before conclusive results can be reported. Exhibit 3 shows the shoe thickness difference, top-to-bottom, on the two test cars and the standard control car.

The reduction in taper wear has a direct economic consequence in the number of brake shoes used per car over a given period of time. The data in Exhibit 4 shows that, compared to the standard car in this test, the link cars have an average taper wear that is less than 1/10th the original condition and an estimated brake shoe life improvement of 44 percent.

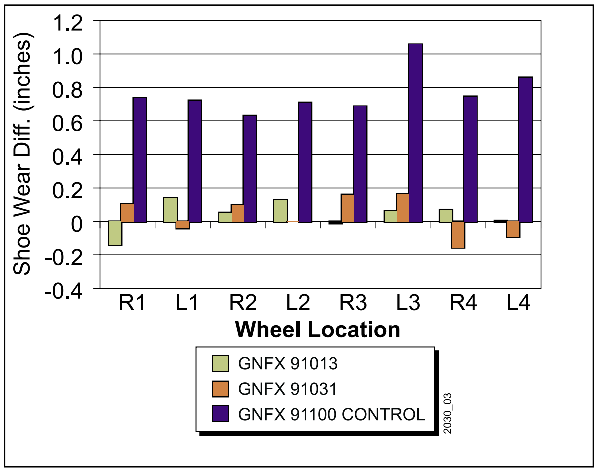

Exhibit 3. Brake Shoe Taper Wear on Two Revenue Service Test Cars Versus One Standard Control Car

Exhibit 4. Taper Shoe Wear and Estimated Shoe Life Data for Cars in Revenue Service Test

Car	Taper Shoe Wear – inches			Estimated Shoe Life in 1,700-mile Round Trips
	Max.	Min.	Avg.	
GNFX 91013 Link	.111	.007	.060	62 trips 105,400 mi
GNFX 91031 Link	.110	.009	.074	56 trips 95,200 mi
GNFX 91100 Standard	1.155	.727	.886	41 trips 69,700 mi

BRAKE SHOE FORCES

The brake shoe forces were measured on the two revenue service test cars before and after the application of the Link Support System. The forces were recorded both before and after tapping the rigging. Exhibit 5 shows the results.

Car 91013 has lower total shoe force because it was tested with the empty/load equipment set for empty, while Car 91031 was set for loaded position. The higher efficiency of the Link Support System is indicated by the higher untapped forces measured using the Link Support components, and the smaller spread between untapped and tapped readings. In the original unloaded condition, the standard brake systems on GNFX 91013 had untapped brake shoe forces that were 70 percent of the tapped forces. After the Link Support System was installed, the untapped shoe forces improved to 82 percent of the tapped forces. Similarly, the untapped shoe forces improved from 76 to 85.5 percent on the loaded car, GNFX 91031. In both cases, the force difference was reduced by over 40 percent.

Exhibit 5. Brake Shoe Forces on the Two Test Cars Before and After Installation of the Link Support System

			Total Shoe Force (pounds)	Maximum Force Difference (pounds)	Avg. Diff. Per Beam (pounds)
91013	Un-tapped	orig	10846	341	168
		link	12231	221	95
	Tapped	orig	15413	259	120
		link	14896	205	72
91031	Un-tapped	orig	17976	576	277
		link	18904	404	91
	Tapped	orig	23517	657	182
		link	22102	158	55

Comparing the ratio of the untapped shoe forces for the two systems, it can be seen that the initial brake application will be about 16.6 percent higher empty and 5.1 percent higher loaded when using the link System on these cars. Whether this difference will translate into improved train handling will not be known until an entire train is equipped with Link Systems.

Also, the maximum brake shoe force difference, from the lowest reading shoe to the highest on the same car, is consistently lower with the Link Support System. This force difference has been reduced by 21 percent on the tapped, unloaded car, and by 76 percent on the tapped, loaded car. The loaded car reduction may be unusual, since the maximum force differential between shoes on the original system actually increased after tapping. The average force difference between brake shoes on the same beam has also been reduced. This difference ranged from a 40-percent reduction on the unloaded car to a 70-percent reduction on the loaded car. These numbers tend to indicate a reduced and more controlled level of friction between the brake beam end extensions and the side frame unit guide pockets. This is due to the links supporting the beam in such a way that the end extensions are not twisted in the unit guides, but instead are moving parallel to the guides. The lower tapped brake shoe forces measured with the link indicates that the geometry chosen for these particular levers has caused a lower lever ratio and these will be changed for future applications.

OTHER OBSERVATIONS

The link design includes a jaw end that attaches to the brake beam and provides lateral support for the truck levers. This feature may also be contributing to the lateral positioning of the brake beams. All brake shoes on the link cars were positioned at or near the center of the wheel treads. Some brake shoes in the original rigging were contacting the wheel flange; this condition has apparently been corrected.

ECONOMICS

The estimated payback as a result of the reduced brake shoe usage is shown in Exhibit 6. The payback is based on the assumption of a $150 new-car cost, a $500 cost to retrofit existing cars, and a 15-year system life.

Based on the economic analysis, a retrofitted car running 90,000-miles per year, and a new car running 30,000-miles per year, would achieve payback over the assumed 15-year life of the system.

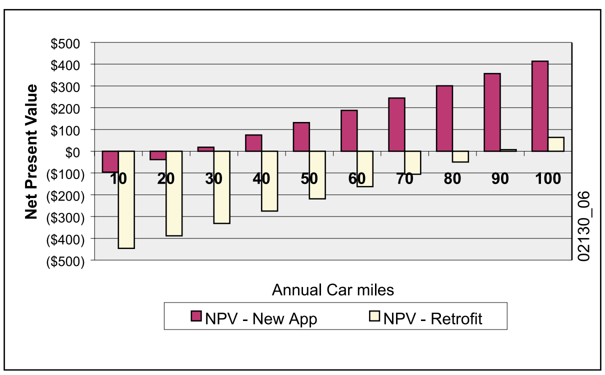

Exhibit 6. Economic Return Based on Annual Car-Miles Assuming a 15-Year Link System Life

CONCLUSION

The Link Support System will undergo additional revenue service testing. However, the results to date show definite promise. So far, the Link Support System has met the goals of the AAR Advanced Brake Rigging Project, in that the shoe force variation within a car has been reduced, the taper wear of the brake shoes has been virtually eliminated, and the rigging efficiency has been increased. This last improvement will be considered significant if the efficiency holds constant for at least 100,000 miles.

FUTURE WORK

Other prototype brake actuation systems will also be tested under the AAR Advanced Brake Rigging Project. As new designs are submitted, they will be tested and the results presented in future *Technical Digests.*

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