TECHNOLOGY DIGEST

Timely Technology Transfer — 02-023

Assessing Constant Contact Side Bearing Performance for a Short Covered Hopper

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Summary

Track tests and modeling studies indicate that long-travel* constant contact side bearings (CCSBs) installed on a short covered hopper provide the best overall performance in combined issues of curving, roll control, vertical load equalization, and high-speed stability. CCSBs generally performed well in comparison to double rollers in loaded truck turning resistance tests.

Transportation Technology Center, Inc. (TTCI) on behalf of the Association of American Railroads' Equipment Engineering and Mechanical Research Committees conducted these tests in response to reducing the stress state of the railroad. The Equipment Engineering Committee has recommended to the Technical Services Working Committee that after January 1, 2003, all new cars and cars that are rebuilt, cars given extended service, or increased in gross rail load, in accordance with AAR Office Manual Rule 88, be equipped with long-travel CCSBs. The rest of the fleet will be considered after that date. The test plan called for both track testing and modeling of four railcar styles. In addition, six separate car designs were exclusively modeled.

This *Technology Digest* focuses on tests performed on a short covered hopper, BNSF409040, at the Federal Railroad Administration's Transportation Technology Center (TTC). A standard double roller was evaluated along with three general CCSB designs: long-travel, standard-travel roller assist, and a non-metal capped version. Tracks used at TTC included the wheel-rail mechanism loop, with the dynamic curve section, and the transit test track. Test requirements mandated the use of railcars and track in good condition; thus, results presented in this report only apply to similar conditions.

Short, Covered Hopper, BNSF409040

* Throughout this *Technology Digest*, the reference "long-travel" is equivalent to extended travel or any device with 5/8-inch of travel.

Suggested Distribution:

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

Work performed by Transportation Technology Center, Inc.
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INTRODUCTION

The North American rail industry has made a concerted effort to reduce the stress state of the railroads. Constant contact side bearings (CCSBs) are an integral part of improving the overall performance of railcars. In 2002, the Association of American Railroads' (AAR) Mechanical Research Committee (MRC) and Equipment Engineering Committee (EEC) approved a test plan to begin evaluating general styles of CCSBs. The tests included loaded/empty curving, dynamic curving, limiting/bunched spirals, and empty high-speed stability on a short covered hopper. The tests were performed and results evaluated using methods outlined in Specification M-1001, *Manual of Standards and Recommended Practices*.

Cars with some accumulation of service mileage and broken-in trucks were selected to minimize anomalous effects caused by new equipment. Additionally, the EEC wanted to use CCSBs that had a period of usage. However, for testing purposes, there was not a controlled method of selecting "used" CCSBs because these devices are worn by cyclic action that is independent of mileage. For this reason, new CCSBs were supplied by manufacturers and "pre-cycled" to help minimize break-in anomalies. Wheel profiles used during the test included AAR-1B for all curve tests, and 100,000-mile profiles (KR wheels) for high-speed stability tests.

TEST SETUP

Trucks used during testing were 110-ton Barber S-2-D cast in 06-98 with a standard suspension (seven D5 outer, and four D5 inner and inner-inner coils). The lightweight and load limits were 57,100 and 228,900 pounds, respectively. Car length was 40 feet over strikers with truck centers of 29.5 feet. Side bearings were tested without lubrication, and truck center plates were left in dry condition as received. The car had accumulated more than 60,000 service miles prior to testing. In loaded tests, the hopper was filled with sand to test with the center of gravity close to the normal location.

The following side bearing designs were selected:

- Double Roller (DR)
- Standard-Travel Constant Contact with Roller Assist (STRA)
- Long-Travel Constant Contact (LT)
- Standard-Travel Non-Metal Constant Contact (NM)

CHAPTER XI PERFORMANCE

The car was tested loaded and empty using Chapter XI criteria in steady state curving, spiral negotiation, and dynamic curving (Exhibit 1). Empty car high-speed stability testing up to 60 mph was performed using high-mileage wheel profiles. An unstable car at speeds below 60 mph does not meet high-speed stability criteria.

A closer look at the performance in empty dynamic curving revealed that two side bearing designs (non-metal and double-roller) could not complete the test, and the best performance occurred with the long-travel design (Exhibit 2). However, note that all side-bearing designs exceed the 1.0 L/V criteria. Exhibit 3 is a demonstration of the loaded dynamic curving performance. Note that the vertical load approached or fell below Chapter XI limits of 10 percent, when standard travel CCSB designs were used.

Hunting tests were performed in both curved and tangent track. Results from both regimes were similar with respect to Chapter XI criteria. Exhibit 4 provides comparative results on the performance trends for the side bearings tested. In this case, all CCSB designs provided sufficient control to maintain stability.

Exhibit 1. Chapter XI Performance Summary

	DR	STRA	LT	NM
Empty Spiral	Met	Met	Met	Met
Empty Curving	Met	Met	Met	Met
Empty Dynamic	Not met	Not met	Not met	Not met
Loaded Spiral	Met	Met	Met	Met
Loaded Curving	Met	Met	Met	Met
Loaded Dynamic	Not met	Not met	Met	Not met
Empty Hunting Curve	Not Met	Met	Met	Met
Empty Hunting Tangent	Not Met	Met	Met	Met

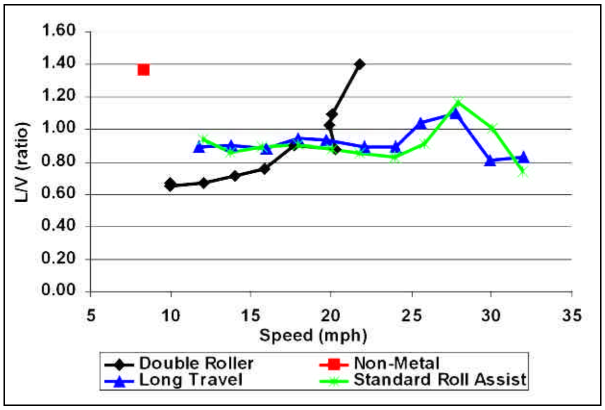

Exhibit 2. Empty Dynamic Curve Performance

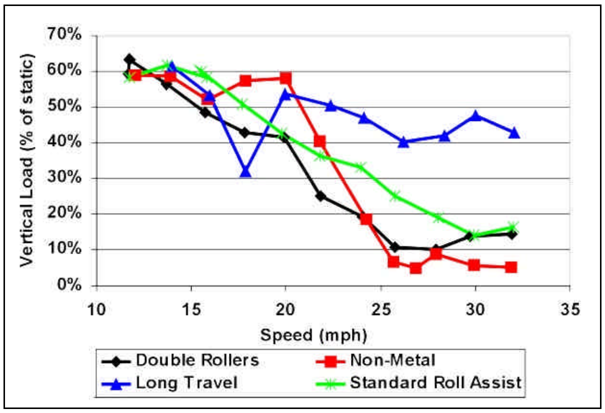

Exhibit 3. Loaded Dynamic Curve Performance

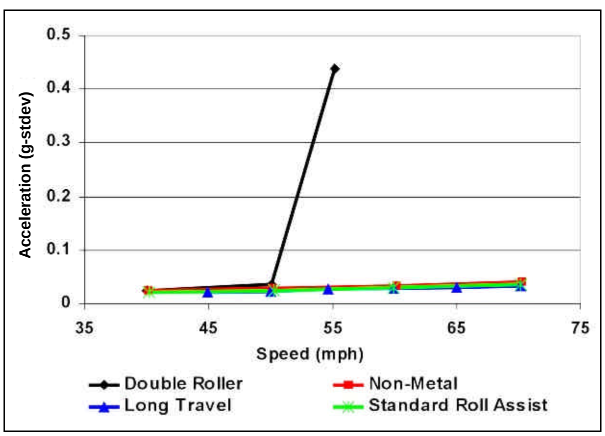

Exhibit 4. High-Speed Stability Performance

TRUCK TURNING MOMENT

It is known that CCSBs potentially contribute to an increase in the truck turning resistance on a given railcar. At issue may be how much this contribution is. During curving tests, data was collected to allow turning-moment calculations to be made and truck-warp measurements to be analyzed. Results show the long-travel CCSBs had slightly higher truck turning resistance values (10-35 percent) than the double rollers. This hopper has a short truck center and, with respect to truck rotation, more easily negotiates track spirals. As the truck negotiates the spiral, the interface between the side bearing and car body will experience minimal loads using double rollers versus loads derived from the preload in a CCSB design. The final outcome when negotiating curves will be a slightly higher truck turning value when using CCSBs than with double rollers.

VERTICAL LOAD EQUALIZATION

Long-travel CCSBs provide better vertical load equalization in spirals when cars are torsionally stiff and have medium to long truck centers. Sufficient vertical load is vital for controlling L/V ratios and flange climb derailments. In spirals, the entire car system must respond to maintain vertical loads safely. From a vertically suspension perspective, a railcar is a series of springs including the suspension, CCSB, and car-body torsional stiffness.

The short covered hopper experienced reduced benefit due to the short truck centers. Our measurements found CCSB designs provided lower vertical loads compared to rollers (Exhibit 5) in *empty* car tests (1,500 pounds). This is due to the minimal side bearing travel needed to negotiate the track twist (1 inch/20 feet) given the short 29.5-foot truck centers (car-body experiences less twist). In *loaded* tests, long-travel side bearings provided similar vertical load equalization to a double roller in a track twist rate of 1 inch per 20 feet.

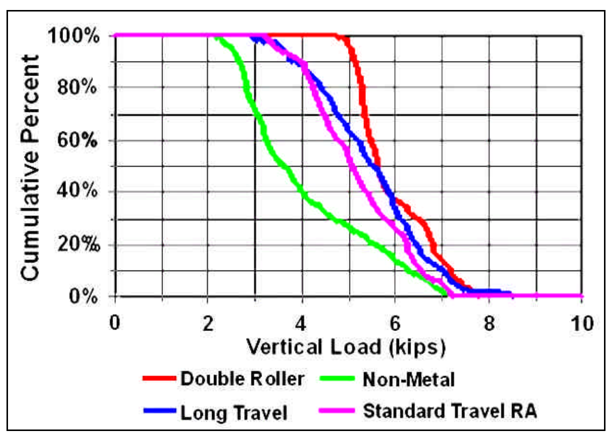

Exhibit 5. Empty Car — Lead Outside Wheel Vertical Load in a Spiral

MODELING

The model created for this railcar has been tuned and validated with on-track test results. Using model information, a similar vertical load plot was constructed to illustrate the performance differences between the various side bearing applications. Exhibit 6 demonstrates the response of the short covered hopper in spirals. The light blue vertical line indicates the hopper's performance in the limiting spiral. Note the non-metal design is predicted to provide less vertical load equalization than the other three types, which was confirmed in test. The dark blue step shaped line illustrates how the double roller can at times provide slightly better vertical loading for reasons previously discussed.

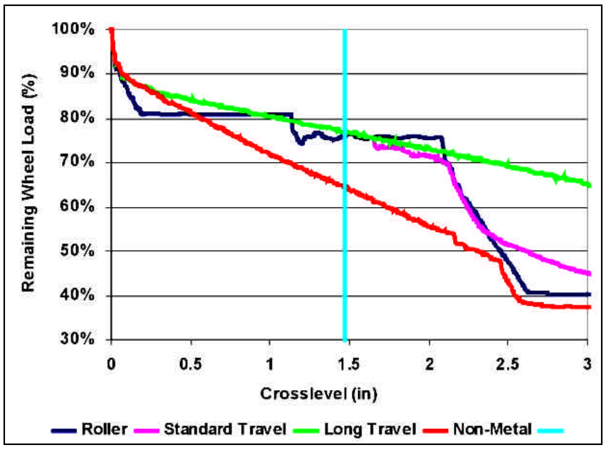

Exhibit 6. Empty Car — Lead Outside Wheel Vertical Load — Modeling Results

Exhibit 7 demonstrates the effect of having 1/8-inch-tight side bearings. The light blue line in this exhibit indicates the performance of the car in the limiting spiral. The long travel design is predicted to provide a vertical load between 20 to 25 percent higher than the other CCSB styles. This highlights the degradation of performance when a car is operated with tight side bearings. Thus, CCSBs must be properly installed and maintained. This also shows how long travel designs could be more tolerant to the tight condition and/or improper installation.

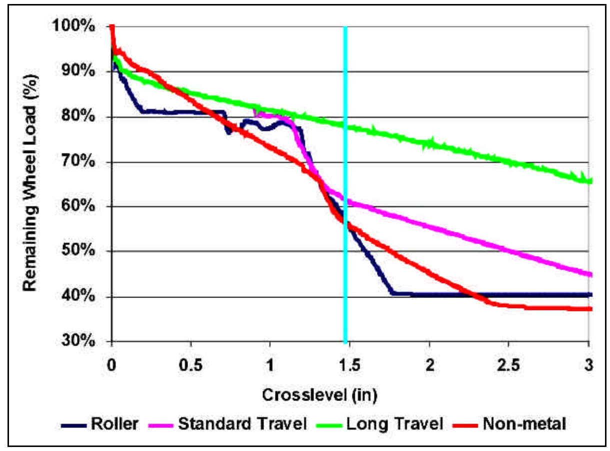

Exhibit 7. Empty Car — Lead Outside Wheel Vertical Load — Modeling Results

CONCLUSION

When combining the performance results from all regimes tested, long-travel CCSB designs perform favorably. Other side bearing designs may have limitations in dynamic track twist (rock and roll) regimes and possibly vertical load equalization under adverse conditions. Should a railroad have performance problems with empty car rail climbing, car-body roll in the truck center plate, or severe spiral negotiation, the long-travel CCSB can provide measured improvements. The application of CCSBs potentially increases truck-turning resistance, but this can be minimized when long-travel styles are used. The EEC has recommended to the Technical Services Working Committee that after January 1, 2003, all new cars, cars that are rebuilt, and cars given extended service or increased in gross rail load, in accordance with AAR Office Manual Rule 88, be equipped with long-travel CCSBs.

Note: Contact Darrell Iler at (719) 584-0546 with questions or comments about this document.
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