TECHOLOGY DIGEST

Timely Technology Transfer — 02-021

Assessing Constant Contact Side Bearing Performance for an Aluminum Coal Gondola

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Summary

Track tests and modeling studies indicate that long-travel constant contact side bearings (CCSBs) installed on an aluminum coal gondola provide the best overall performance in combined issues of curving, vertical load equalization, and high-speed stability. CCSBs generally performed well in comparison to double roller side bearings in loaded truck turning resistance tests.

When combining the performance results from all regimes tested, long-travel CCSB designs perform favorably. Other side bearing limitations will be most prominent in dynamic track twist (rock and roll) regimes. Should a railroad have performance problems with empty car rail climbs, 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.

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 EEC has recommended to the Technical Services Working Committee that after January 1, 2003, all new and rebuilt cars, 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 balance 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.

Aluminum Coal Gondola, UP28108

Suggested Distribution:

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

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

INTRODUCTION

The North American rail industry has made a concerted effort to reduce the stress state of the railroads at the vehicle/rail interface. Constant contact side bearings (CCSBs) are an integral part of improving overall railcar performance. 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 an aluminum coal gondola. The tests were performed and results evaluated using methods outlined in Specification M-1001, Chapter XI of the AAR's *Manual of Standards and Recommended Practices.*

This *Technology Digest* focuses on tests performed on an aluminum coal gondola, UP 28108, at the Federal Railroad Administration's Transportation Technology Center (TTC). A standard double roller side bearing was evaluated along with three general CCSB designs: long-travel, standard-travel and a non-metal capped version. Tracks utilized at the TTC included the Wheel-Rail Mechanism (WRM) Loop with the dynamic curve section and the Transit Test Track (TTT). Test requirements mandated the use of railcars and track in good condition; thus, results presented in this report only apply to similar conditions.

TEST SETUP

Trucks used during testing were 110-ton Barber S-2-HD cast in 05-98 with a dual-rate suspension ([6] B-291/297/248, [1] D6, D6A, [2] B355/356). The lightweight and load limits were 43,900 and 242,100 pounds, respectively. Car length is 47 feet over strikers with truck centers of 40.5 feet. Side bearings were tested without lubrication, and truck center plates were left in dry condition as received. The car had accumulated more than 100,000 service miles prior to testing. In loaded tests, the gondola was filled with wood chips in the bottom followed by ballast to raise the center of gravity close to the normal location. The following side bearing designs were selected:

- Double Roller (DR)
- Standard-travel Constant Contact (ST)
- 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). High-speed stability testing was performed with the car empty, with high-mileage wheel profiles at top speeds of 60 mph. An unstable car at speeds below 60 mph does not meet high-speed stability criteria.

Exhibit 1. Chapter XI Performance Summary

	DR	ST	LT	NM
Empty Spiral	Met	Met	Met	Not met
Empty Curving	Met	Met	Met	Met
Empty Dynamic	Met	Met	Met	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

A closer look at the performance in loaded dynamic curving reveals that the standard-travel and double-roller configurations both experienced wheel lift (Exhibit 2). The only side-bearing design that did not fall below the 10 percent threshold was the long-travel design.

Hunting tests were performed in both curved and tangent track. Results from both regimes were similar with respect to Chapter XI criteria. Exhibit 3 provides comparative results on the performance trends for the side bearings tested.

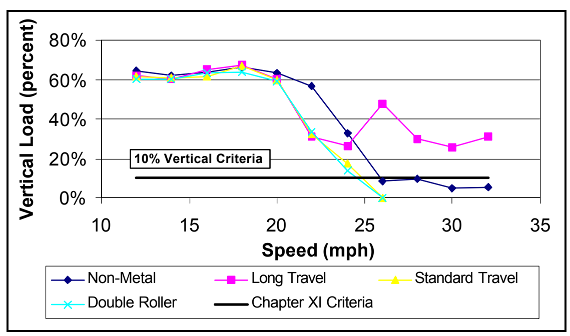

Exhibit 2. Dynamic Curve Test Results

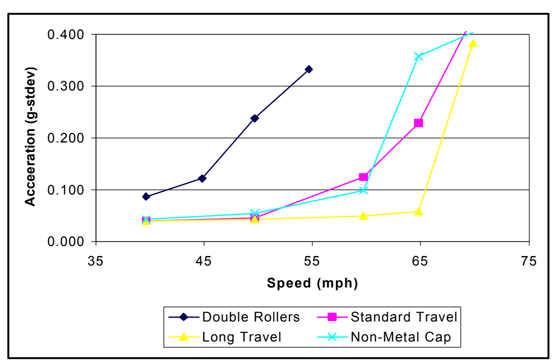

Exhibit 3. High-Speed Stability Tests, 1.5-Degree Curve

TRUCK TURNING MOMENT

It is well 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 similar performance to the double rollers for turning moment in both the limiting and bunched spirals. The mechanism for the difference is thought to be the travel; i.e., when any side bearing goes solid, the body weight carried on the side bearing increases, which raises the truck turning moment at an accelerated rate.

VERTICAL LOAD EQUALIZATION

CCSBs offer another benefit by providing increased capabilities for vertical load equalization in spirals when cars are torsionally stiff and have medium to long truck centers. To control L/V ratios and flange climb derailments, sufficient vertical load is vital. In spirals, the entire car system must respond to maintain vertical loads safely. From a vertical suspension perspective, a railcar is a series of springs including the suspension, CCSBs, and car-body torsional stiffness. Our measurements found that standard and long-travel side bearing designs provided similar results to rollers in empty car tests. This is due to the minimal travel needed to negotiate the track twist (1 in./20 ft) given the relatively short 40-foot truck centers (car-body experiences less twist) and the soft first stage suspension. In loaded tests, long-travel side bearings provided better vertical load equalization in a track twist rate of 1 in./20 ft.

Exhibits 4 and 5 are cumulative distributions of the vertical wheel load on the lightest lead axle wheel traversing the spiral. The advantage of this type of plot is to show the overall performance throughout the entire spiral versus a single minimum vertical load measurement. Exhibit 4 compares the empty car vertical load using each type of side bearing. In empty tests, both metal-capped designs and double rollers maintained approximately one ton more load on the light wheel than the non-metal design.

Vertical wheel load results from the loaded car tests are provided in Exhibit 5. Given equal test conditions, the long-travel design provided up to 5,000 pounds more load than other designs.

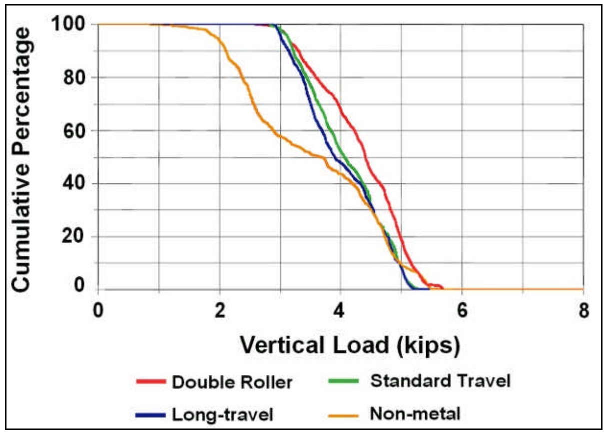

Exhibit 4. Empty Car, Lead Outside Wheel Vertical Load in a Spiral

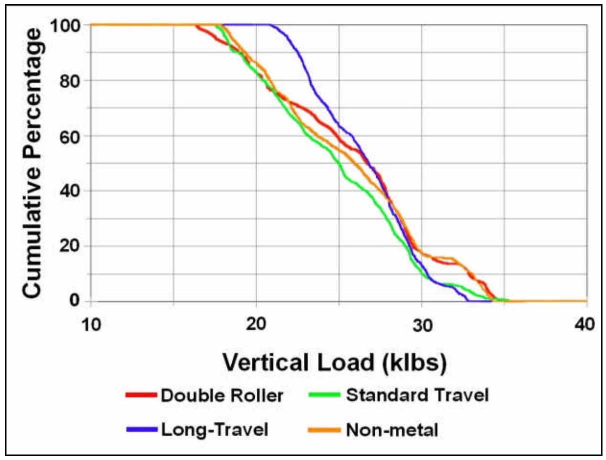

Exhibit 5. Loaded Car, Lead Outside Wheel Vertical Load in a Spiral

MODELING

The model created for this railcar has been tuned and validated with on track test results to provide similar Chapter XI performance trend data. From values produced in modeling, a vertical load plot was constructed to illustrate the performance differences between the various side bearing applications. Exhibit 6 demonstrates the response of the aluminum gondola in spirals. The light blue vertical line indicates the aluminum gondola's performance in the limiting spiral. Results here are in agreement with those presented in Exhibit 4, where the non-metal design consistently provides less vertical load equalization than the other three types.

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 5 to 15 percent higher than the other CCSB styles.

This illustrates the degradation of performance when a car is operated with tight side bearings. This car was selected to conduct degraded component tests (e.g., bad wheels, differential lubrication) to understand performance differences between the same four side bearing styles. This information is published in *Technology Digest* TD 02-014, "Side Bearing Performance under Adverse Conditions."

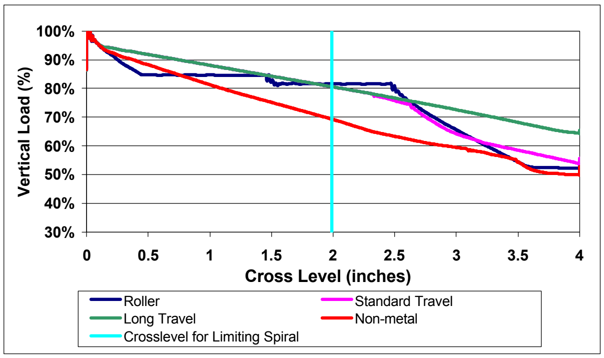

Exhibit 6. Empty Car, Lead Outside Wheel Vertical Load — Modeling Results

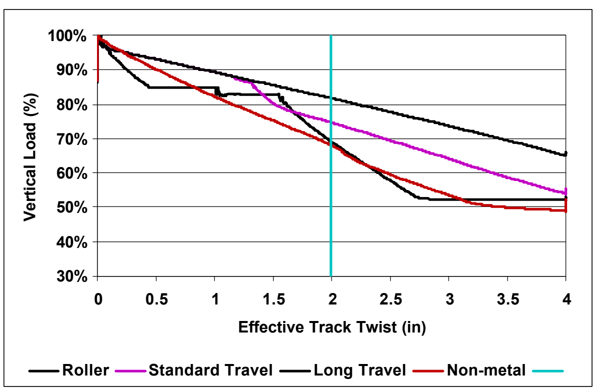

Exhibit 7. Empty Car, Lead Outside Wheel Vertical Load — Modeling Results

CONCLUSION

When combining the performance results from all regimes tested, long-travel CCSB designs perform favorably. Limitations of other side bearing designs are most prominent in dynamic track twist (rock and roll) regimes. Should a railroad have performance problems with empty car rail climbs, 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 approved long-travel designs for use in the aluminum gondola car types. The EEC 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.

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