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Assessing Constant Contact Side Bearing Performance for a Bulkhead Flatcar

by Darrell Iler and Russell Walker

Summary

Track tests and modeling studies, conducted by Transportation Technology Center, Inc. (TTCI), indicate that several styles of constant contact side bearings (CCSBs) installed on a bulkhead flatcar provide improved performance in combined issues of curving, vertical load equalization, and high-speed stability. Ultimately, the long/extended travel* design was selected as the required equipment to simplify the side bearing selection mandates that are set in the *AAR Office Manual* Rule 88.

TTCI conducted these tests on behalf of the Association of American Railroads' Equipment Engineering and Mechanical Research committees (EEC/MRC) in response to reducing the stress state of the railroad. As of January 2001, the railroad industry has adopted a directive stipulating that all interchange railcars that are new (or cars that have been re-built, given extended service, or increased gross rail load) must be equipped with long-travel CCSBs in accordance with *AAR Office Manual* Rule 88. 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 bulkhead flatcar, TTPX81550, at the Federal Railroad Administration's Transportation Technology Center (TTC). A standard double roller was not tested. Only: long-travel, long-travel roller assist, long-travel shear, and standard-travel roller assist CCSB designs were evaluated. The double roller side bearing was not tested since the industry does not typically use this device. Tracks used at TTC included the Wheel-Rail Mechanism loop with the dynamic curve section and the Transit Test Track. Tests were performed with the railcar and track in good condition and properly adjusted CCSBs; thus, results presented in this report only apply to car performance under similar conditions.

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

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INTRODUCTION AND CONCLUSIONS

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 a rail cars' overall 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 a bulkhead flatcar. AAR subsidiary Transportation Technology Center, Inc. (TTCI) performed the tests and evaluated the results using methods outlined in Specification M-1001, Chapter XI of the AAR's *Manual of Standards and Recommended Practices*.

Cars with significant service mileage and broken-in trucks were desired to minimize anomalous effects caused by new equipment. Additionally, the EEC wished to use CCSBs that had a period of usage as well. However, for testing purposes, there was not a controlled method of selecting "used" CCSBs since 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 tests were 100-ton ASF Ride-Control cast in 08-75 with a standard suspension. The trucks received a Class 1 reconditioning in 1991 and had accumulated 91,000 service miles since that time. The lightweight and load limits were 81,200 and 181,800 pounds, respectively. Car length is 68 feet over strikers with truck centers of 48 feet. Side bearings were tested without lubrication and center bowls were left in dry condition as received. In loaded tests, the bulkhead flatcar was laden with concrete blocks resulting in a center of gravity at the normal location.

The following side bearing designs were selected:

- Standard-travel Constant Contact with Roller Assist (STRA).
- Long-travel Constant Contact (LT).
- Long-travel Constant Contact with Roller Assist (LTRA).
- Long-travel Shear Constant Contact (LTS).

CHAPTER XI PERFORMANCE

Car tests were performed loaded and empty using Chapter XI criteria in steady state curving, spiral negotiation, and dynamic curving. High-speed stability testing was performed with the car empty, using 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. Table 1 summarizes the results.

Table 1. Chapter XI Performance Summary

	STRA	LT	LTRA	LTS
Empty Spiral	Met	Met	Met	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	Met	Met	Met	Met
Empty Hunting Curve	Met	Met	Met	Met
Empty Hunting Tangent	Met	Met	Met	Met

Each of the side bearing choices performed well. The best performance in dynamic curving occurred using long-travel designs (Figure 1). Figure 2 shows a similar trend in spiral negotiation where the long-travel designs offered slightly better wheel loading, but all designs performed well. Unlike stiffer cars, curving issues will not challenge this car design because of its flexibility.

Hunting tests were performed on both curved and tangent track. Results from both regimes were similar with respect to Chapter XI criteria. Figure 3 provides comparative results on the performance trends for the side bearings tested. Some long-travel designs exhibited less control at higher speeds than others; this has a strong correlation to the value of pre-load in the design. Those with the highest pre-load provided the most high-speed stability

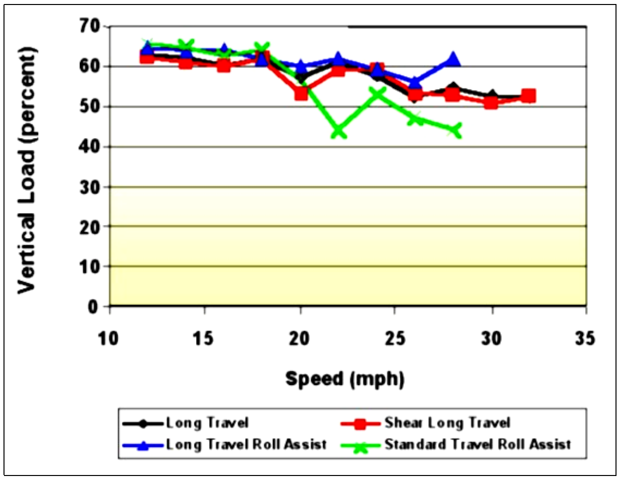

Figure 1. Loaded Dynamic Curve Performance

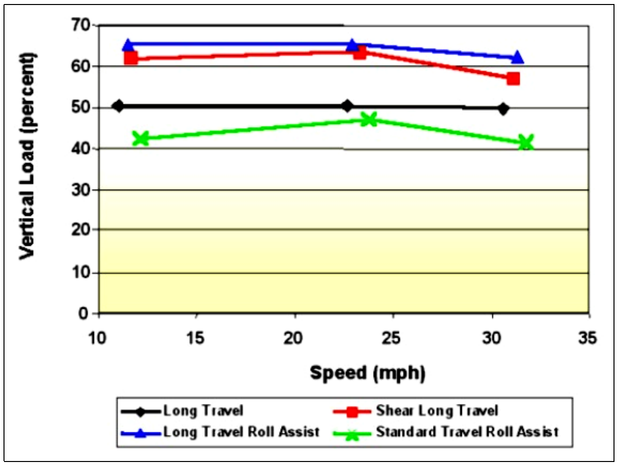

Figure 2. Empty Spiral Performance

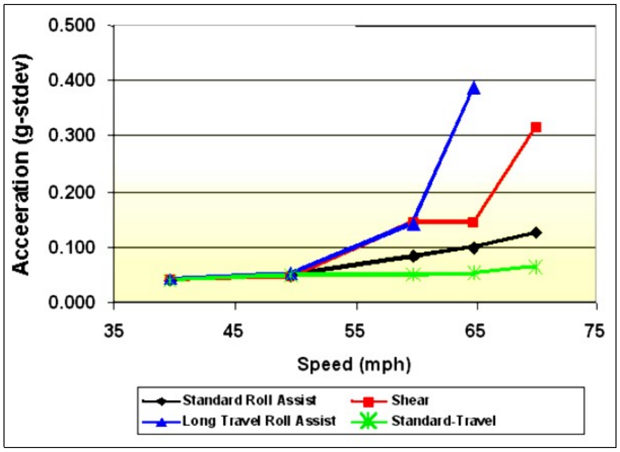

Figure 3. High Speed Stability Performance

TRUCK TURNING MOMENT

It is known that CCSBs can potentially increase truck-turning resistance on a given railcar — at issue is how much. During curving tests, data was collected to allow turning moment calculations to be made and truck warp measurements to be analyzed. Since the car was not tested with double rollers, there is no comparative data. The recorded values displayed a strong correlation to pre-load with the assumption that any binding in the standard travel design will result in higher truck turning moments. The flexibility of the car also allows for better truck turning performance. In previous tests, it was demonstrated that when a car significantly bears down on the side bearing it would increase resistance in truck rotation. This was the case in a torsionally stiff car, like a tank car, that has medium to long truck centers. By comparison, the flexibility of the bulkhead flat car is more responsive to pre-load than the style of CCSB.

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 to control L/V ratios and flange climb derailments. From a vertical suspension perspective, a railcar can be thought of as a series of springs representing the suspension, CCSB, and car body torsional stiffness. In spirals, the entire car structure must respond properly in order to maintain vertical loads safely.

The bulkhead flatcar experiences a benefit in vertical loading when using long-travel CCSB designs, as illustrated in Figure 4. Results showed that long-travel CCSB designs provided higher vertical wheel loads compared to standard travel CCSBs (Figure 4) in empty car tests (2 kips). In loaded tests, long-travel side bearings provided 1 to 2 kips more vertical load equalization in a track twist rate of 1 inch/20 feet.

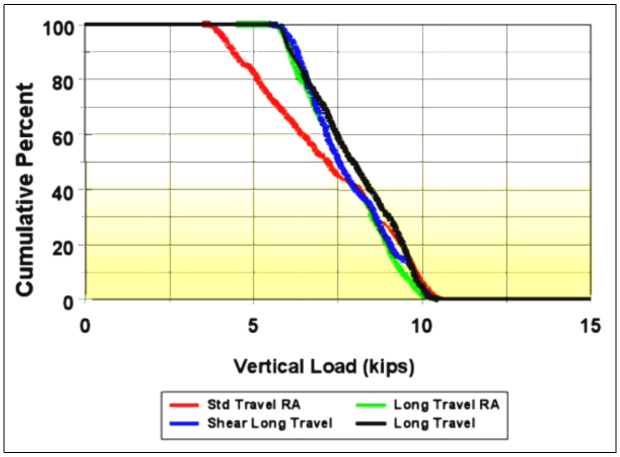

Figure 4. Empty Car — Lead Outside Wheel Vertical Load in a Spiral

MODELING

The model created for this railcar has been tuned and validated with on-track test results. Using model information, a vertical load plot (Figure 5) was constructed to illustrate the performance differences between the various side bearing designs. The figure demonstrates the vertical load equalization performance of the bulkhead flatcar in spirals.

The light blue vertical line in Figure 5 indicates the bulkhead flatcar's performance in the limiting spiral. At this rate of twist, there are only minor predicted differences in vertical wheel load between the CCSB designs modeled. In test data, the double roller was not evaluated and the standard travel design had about 2 kips less vertical load than long-travel designs (40 percent vs. 60 percent remaining vertical load).

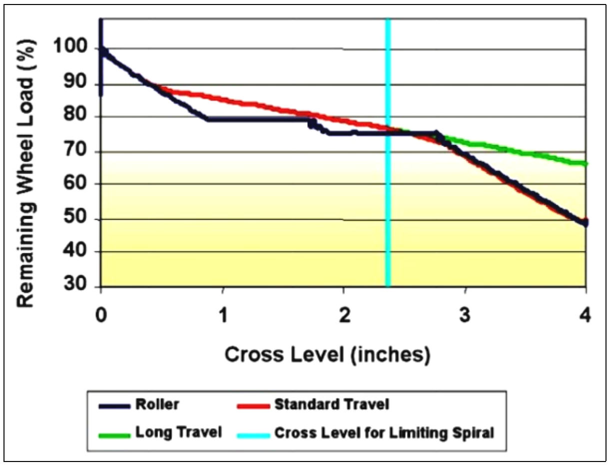

Figure 5. Empty Car, Lead Outside Wheel Vertical Load, Modeling Results

Figure 6 demonstrates the effect of having 1/8-inch tight side bearings. Once again, the light blue line indicates the bulkhead flatcar's performance in the limiting spiral. The long-travel design is predicted to provide a vertical load nearly 15 percent higher than the other CCSB styles. It is imperative that CCSBs be correctly installed and maintained as this illustrates the degradation of performance in spiral negotiation when a car is operated with tight side bearings. This also shows how long-travel designs are more tolerant to the tight condition.

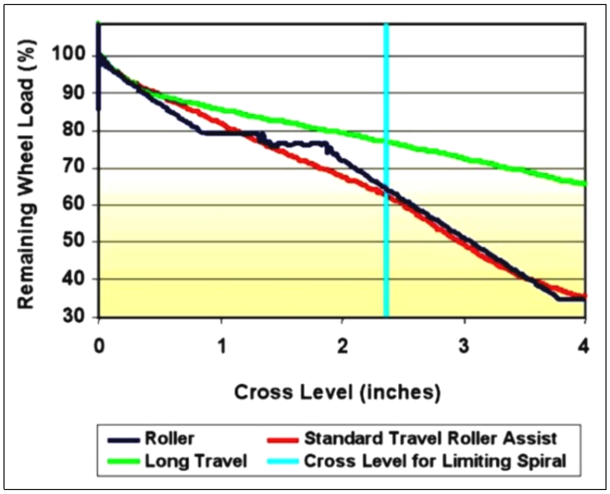

Figure 6. Empty Car, Lead Outside Wheel Vertical Load, Modeling Results 1/8-inch Tight setup

CONCLUSION

When combining the performance results from all regimes tested, long-travel CCSB designs perform favorably. Due to the type of car tested, other side bearing designs also performed well. Though any of the designs tested performed acceptably, the EEC concluded that requiring a long-travel design in cases like this would improve car performance and simplify application guidelines; thus benefiting the industry in the long run. In 2002, the EEC recommended to the Technical Services Working Committee that all new cars (or cars that have been re-built, given extended service, or increased gross rail load) be equipped with long-travel CCSBs in accordance with *AAR Office Manual* Rule 88. The recommendations were adopted effective January 1, 2003.