

Improving the Economics of Bulk-Commodity Service — S2E Standard Car Truck

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Summary

An Association of American Railroads' Strategic Research Initiative has demonstrated that a Standard Car Truck improved suspension system (S2E) can provide economic savings in typical eastern and western railroad service. Tests conducted under this program compared the performance of a conventional three-piece truck with an S2E truck in a baseline aluminum coal car loaded to 286k.

Compared to a baseline conventional three-piece truck, the S2E truck demonstrated the following performance results:

- 60 percent reduction in lateral curving forces
- 60 percent reduction in incremental curve resistance
- 15 percent reduction in tangent resistance
- Improved high-speed stability
- Improved vertical dynamics for loaded cars
- S2E did not meet Chapter XI criteria in Yaw and Sway above 60 mph

Criteria used to determine savings are described in the Bulk-Commodity Freight Truck Specification developed for this program by Transportation Technology Center, Inc. Performance goals were identified to reduce costs associated with vehicle and track maintenance, energy consumption, worn truck components, and car availability.

The intended applications are double-stack cars used for transporting general merchandise as well as bulk-commodity cars.

Suggested Distribution:

- Car Department
- Planning & Analysis
- Equipment/Rolling Stock
- Intermodal
- Mechanical



TTCI
Transportation
Technology Center, Inc.

Work performed by
a subsidiary of the Association of American Railroads

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INTRODUCTION

Tests indicate that an improved suspension system can provide lower rolling resistance and reduce lateral forces. These tests were conducted by TTCI as part of an Association of American Railroads' Strategic Research Initiative to improve the economics of bulk-commodity service.

The performance of the S2E truck was measured using methods described in a Bulk-Commodity Freight Truck Specification developed specifically for this program. Two identical baseline cars were used for these tests. Both are modern lightweight aluminum coal cars as shown in Exhibit 1. One was empty and one was loaded to 286,000 pounds.



Exhibit 1. Base Car Used in Evaluating Suspension Types

TRUCKS TESTED

Baseline Truck

The baseline truck was a Barber S-2-HD of 125-ton design. Snubbing is by four steel friction wedges, each resting on one B-355 outer and one B-356 inner coil spring. Side bearings are Miner TCC 4500 constant-contact design. The truck uses 38-inch wheels and has a secondary coil spring suspension. Each side has one D5 outer coil and one D6 inner coil in parallel with a dual rate spring package consisting of the following:

- Six B-291 main coils
- Six B-297 top coils in series with main coils
- Six B-298 intermediate coils in parallel with main coils

In the empty condition, the dual-rate spring group is soft for the first 1 inch of travel because the top coils are in series with the parallel combination of main and intermediate coils.

S2E Truck

The S2E is the latest in the line of Barber stabilized trucks from Standard Car Truck Company. This design has 50-286 dual rate spring groups to provide maximum roll stability for empty and loaded cars. To optimize high speed and roll stability, Barber 945-SW split wedges are utilized to provide warp stiffness and damping. Pedestal shear pads, designated 945-SW, improve curving performance. The trucks are also equipped with Barber bowl liners and Miner TCC 4500 constant contact side bearings.

TWIST-AND-ROLL TEST RESULTS

The twist-and-roll test measures the ability of a car to negotiate cross level perturbations. Because the truck center spacing of the high sided gondola car (40 feet, 6 inches) is very close to the wave length of the perturbations, the car is excited in pure roll mode. Consequently, twist-and-roll is a difficult test for this car. The S2E truck reduced loaded car vertical dynamics as shown in Exhibit 2.

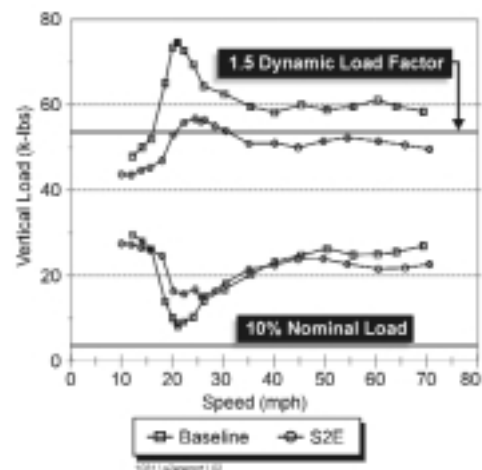


Exhibit 2. Maximum and Minimum Vertical Wheel Loads in Twist-and-Roll Tests in Loaded Car

PITCH-AND-BOUNCE TEST RESULTS

The pitch-and-bounce test regime measures the ability of the car to negotiate vertical profile deviations. Poor performance results in suspension bottoming and high vertical track loads. The pitch-and-bounce test is performed loaded. The car's truck center spacing is very close to the wave length of the track perturbations; therefore, the car is excited in an almost pure bounce mode of vibration.

Exhibit 3 compares the performance of the baseline and S2E truck. Vertical loads were smaller for the S2E truck up to 65 mph. Above 70 mph the 1.5 dynamic load factor goal was exceeded for both trucks.

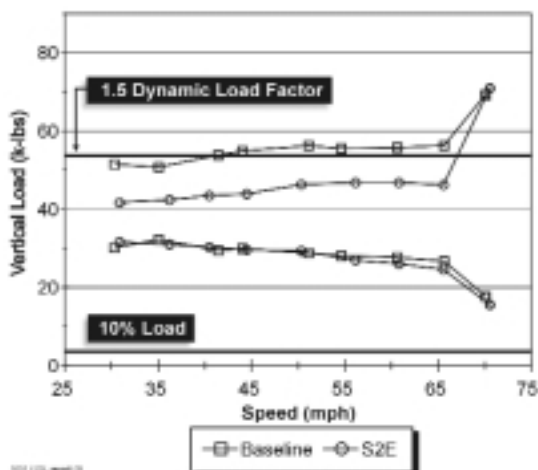


Exhibit 3. Vertical Wheel Load Performance in Pitch and Bounce Tests

YAW-AND-SWAY TEST RESULTS

The yaw-and-sway test measures the ability of a car to negotiate laterally misaligned track. Poor performance results in high lateral track loads. The yaw-and-sway test is only performed in the loaded condition. The base car met yaw-and-sway criteria; however, the S2E exceeded Chapter XI criteria above 60 mph.

CONSTANT CURVING TEST RESULTS

The constant curving test measures a car's ability to negotiate well maintained track curves. Poor performance increases costs associated with derailment and track maintenance. Exhibit 4 compares lead wheel and truck side lateral forces in several curves. The S2E truck reduced average lateral curving forces by 60 percent.

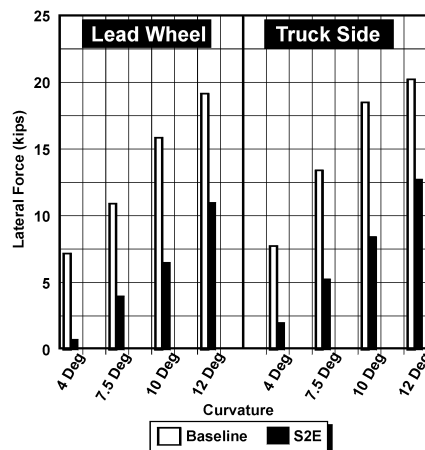


Exhibit 4. Lateral Wheel Load Performance in Constant Curve Tests

DYNAMIC-CURVING TEST RESULTS

The dynamic-curving test combines cross-level and gage deviations on a 10-degree curve. The cross-level deviations are similar to those installed in the twist-and-roll test section. As observed in the twist-and-roll test, vertical dynamic loads were reduced for the S2E truck when compared to the base truck.

HIGH-SPEED STABILITY TEST RESULTS

The high-speed stability test is conducted to ensure that the empty car does not become laterally unstable at speeds up to and including 70 miles per hour. The base truck became unstable at 60 miles per hour. A worn baseline truck would be unstable at a lower speed. Exhibit 5 compares S2E and base truck performance.

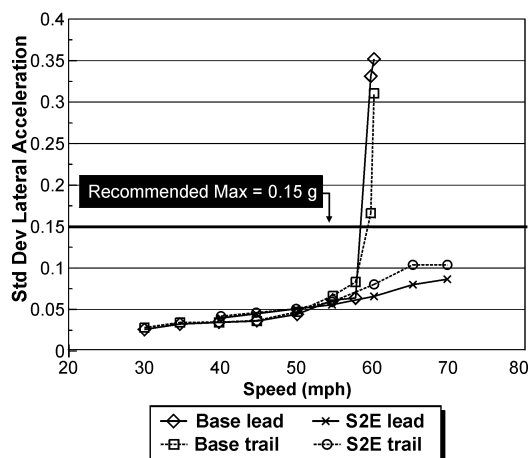


Exhibit 5. High-speed Stability Performance Both Ends of Empty Car



ROLLING-RESISTANCE TEST RESULTS

The S2E truck reduced incremental curve resistance by 60 percent as shown in Exhibit 6. This will reduce wheel wear, rail wear, and fuel consumption. Tangent track resistance was reduced by more than 15 percent. Lower tangent track resistance will reduce fuel costs, wheel wear, and rail wear.

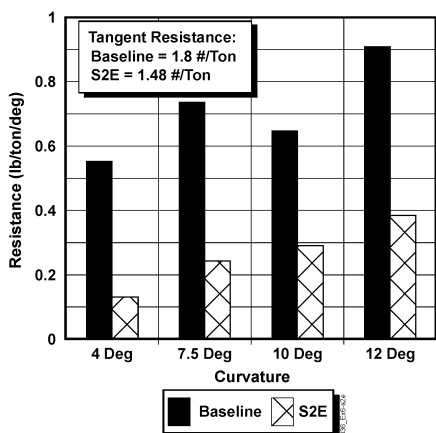


Exhibit 6. Incremental Curve Resistance in Pounds per Ton per Degree of Curve

ECONOMIC BENEFIT DISCUSSION

Exhibit 7 shows the calculated economic benefit per truck per 100,000 miles on typical eastern and western routes. Savings were determined from test results using the following method. Test results were modified by NUCARS modeling to reflect the difference between TTCI test tracks and well-lubricated railroad property. At TTCI, the rail friction is 0.5 while the railroad service friction is 0.31. The modification reduces

the expected savings. The modified results were used in AAR cost models to calculate wheel wear, rail wear, track wear, and fuel consumption on typical routes at 100,000 miles service per year. The same method can be used to calculate savings on any specific route.

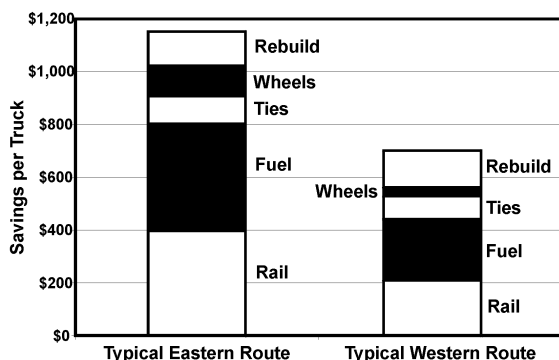


Exhibit 7. Savings for One S2E Truck in 100,000-Miles Service

SUMMARY

The S2E truck performance demonstrates potential to reduce operating costs for bulk-commodity cars through improved suspensions. The Advanced Truck Program offers assistance to designers of new suspensions through modeling support, testing of promising prototypes, and evaluation using cost models.

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