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# Initial Performance Evaluation of Lightweight Trucks Under Heavy Axle Loads at FAST

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**Summary**

Early results of this study indicate that lighter weight trucks provide acceptable performance for 315,000 pound cars, while providing significant potential savings in operating costs.

In 2002, a consortium of suppliers, ABC-NACO, Standard Steel, and Timken, collaborated to produce a lighter weight truck for 315,000-pound cars. These trucks with 36-inch wheels, were installed under three cars for testing at the Facility for Accelerated Service Testing (FAST) at Transportation Technology Center (TTC), Pueblo, Colorado in 2002. Two of the cars completed 63,000 miles of service and the third 48,000 miles. The cars were loaded to 315,000 GWR for all miles.

Initial results include:

- Wheel wear and wheel surface conditions are similar to those of the 38-inch wheels under the rest of the cars in the train.
- Curving performance of the cars is similar to the rest of the cars in the train.
- No unusual truck component wear was observed.
- 63,000 miles is early in the expected life of trucks. Further evaluation is needed before drawing any firm conclusions.
- Braking and thermal capacity testing is not scheduled until the second half of 2005.

North American railroads have made great strides toward increasing productivity, but in the face of constant pressure from competing modes of transportation, the effort must continue. An economic analysis conducted by Transportation Technology Center, Inc. (TTCI), Pueblo, Colorado, indicates that under some circumstances, 315,000-pound cars equipped with 36-inch wheels and lighter trucks, may be more economical than 263,000 and 286,000-pound cars equipped with 36-inch wheels, or 315,000-pound cars equipped with 38-inch wheels and typical (larger, heavier) trucks. The improved net-to-tare ratio offered by car/truck combinations can help offset the increased track maintenance costs associated with the operation of heavier cars.

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## INTRODUCTION

Among the many benefits of the Heavy Axle Load (HAL) Program at FAST is the ability to evaluate the performance of experimental components under carefully controlled conditions. The components tested are usually track components, but rolling stock components are also evaluated. An economic analysis conducted by TTCI in 2001 led to a new test of a lighter-weight trucks for 315,000-pound cars.

## ECONOMICS

The analysis indicated that under some circumstances, 315,000-pound cars equipped with 36-inch wheels and lighter trucks, may be more economical than 263,000 and 286,000-pound cars equipped with 36-inch wheels, or 315,000-pound cars equipped with 38-inch wheels and larger, heavier trucks. The improved net-to-tare ratio offered by this car/truck configuration (Table 1) can help offset the increased track maintenance costs associated with the operation of heavier cars.

| Car GWR (1,000 pounds) | 263 | 286 | 315 | 315 |
|---|---|---|---|---|
| Car Type | Steel/ Aluminum | Steel/ Aluminum | Steel/ Aluminum | Steel/ Aluminum |
| Wheel Diameter (inches) | 36” | 36” | 36” | 38” |
| Tare Weight (pounds) | 44,122 | 44,112 | 46,180 | 48,580 |
| Payload (tons) | 109.4 | 120.9 | 134.4 | 133.2 |
| Net-to-Tare Ratio | 5.0 | 5.5 | 5.8 | 5.5 |

**Table 1 Car Types and Weights**

The truck sets shown in Figure 1, with their lighter castings, shorter bearings and axles, smaller diameter wheels, and shorter wheelbases weigh about 1,200 pounds less than the typical truck set currently in operation at FAST with 315,000 pound cars.

Removing 1,200 pounds from the weight of each freight car truck produces a total weight reduction of 2,400 pounds per car. This weight reduction allows the car to carry an additional 2,400 pounds of lading while keeping gross weight constant. In unit-train coal service, this allows the same net tonnage to be carried with fewer train trips producing a cost avoidance in the areas of track maintenance, car capital and maintenance, locomotive capital and maintenance, and fuel and crew expenses. For a typical lightweight aluminum coal gondola in unit-train service, the annual cost avoidance is between the range of $290 and $380 per year depending on specific route and service characteristics. On a net present value basis, this results in $2,500 to $3,200 net cost avoidance over the life of the car. A route with higher curvature and gradients results in higher levels of cost avoidance.

**Figure 1: Lightweight Test Truck**

## TEST RESULTS

The trucks have been closely monitored since their introduction in 2002 into the FAST/HAL train. Primary areas of interest are 1) component durability and maintenance requirements, 2) failure modes (if any), 3) vehicle curving performance, and 4) the effect of heavy braking on the lighter wheels. Earlier trucks designed for 315,000-pound cars (39-ton axle loads) had larger diameter wheels and axles, and larger castings than trucks designed for 263,000 or 286,000-pound cars to withstand the heavier loads. The components have performed satisfactorily during years of service under double-stack cars and at FAST, but with the weight penalty noted above. Testing at FAST was needed to ensure that the lighter components performed at least as well.

## COMPONENTS

The smaller diameter of the wheels, 36 inch compared to 38 inch, results in a contact stress increase of about 2.3 percent, and less thermal mass to absorb and dissipate the heat generated by braking. Wheel wear and condition of the test cars are being monitored and compared to patterns seen at FAST on 38-inch wheelsets. MiniProf ™ measurements are taken at regular mileage intervals and compared to baseline profiles. Figure 2 summarizes wheel wear statistics for the test wheels, and a comparable sample of 38-inch wheels after similar mileage. The average flange wear for the 36-inch wheels is slightly higher and the average tread wear is slightly lower than the 38-inch wheels. But, with the sample size and variability, it can not be said that the means are statistically different.

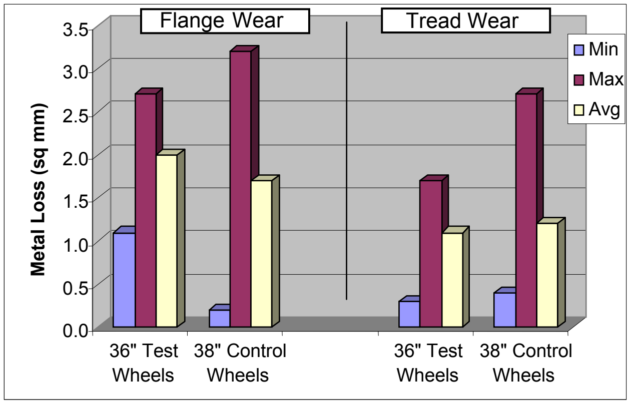


**Figure 2: Wheel. Wear and Condition Tests**

Figure 3 shows wheel surface conditions. The 36-inch wheels are in good condition, similar to typical 38-inch wheels at FAST.


**Figure 3: Wheel Condition Comparisons**

Train operations at FAST do not include extended periods of braking. To validate modeling showing that the 36-wheels have sufficient thermal capacity to withstand extended braking, a 36-inch wheel from one of the test trucks will be tested on TTCI's wheel dynamometer in 2005 when the wheel has reached over one-half of its wear life. Another test will be conducted on a wheel near the end of its wear life (approximately 150,000 miles).

The axles in the test trucks are the same diameter as for typical axles used with 38-inch wheels for 315,000-pound cars. With the diameter being larger than for axles used under 263,000- and 286,000-pound cars, bending stresses are lower, even though the axle load is higher. The smaller diameter wheels and shorter bearings in the test trucks slightly reduce axle bending stresses produced by vertical and lateral loads. In addition, the shorter bearings design should reduce axle flexure and consequently reduce fretting wear between bearing components.

The tested trucks were dismantled in August 2004 and closely inspected. Normal wear was noted on the castings. The bolster gib rotation stops were the only areas showing significant wear. This is typical at FAST, where five-and six-degree curves and their spirals make up 75 percent of the track, and the cars are always loaded. The polymer center bowl liners were in good condition and should provide several more years of service. Figure 4 shows examples of the condition of the components.

**Figure 4: Condition of Lightweight Truck Components after 55,000 Miles**

There were no component failures in any of the test trucks. One car needed maintenance when the vertical portion of the composite bowl liner began to contact the horizontal surface of the body bolster center plate casting, thus increasing the truck turning moment and inhibiting proper steering. This condition was indicated by truck performance detectors at FAST. Clearances governed by center bowl and center plate dimensions caused the problem, the lighter weight truck was not at fault.. To restore proper clearance an additional 1/4-inch-thick horizontal composite liner was added to the center bowls. Side bearing clearance was adjusted accordingly.

## VEHICLE CURVING

As noted above, curving performance of the cars is being monitored through the use of truck performance detectors located at FAST. Figure 5 shows exceedence plots associated with that data. The data was recorded from January 2003 through December of 2004 and includes data for over 4 million passes of typical FAST cars and over 125,000 passes of cars with light weight trucks. Average high-rail lead-axle lateral load in a 5-degree curve for the entire train was 7.5 kips, and for the test cars it was 7.4 kips. All other things being equal, the shorter truck wheelbase and smaller diameter wheels should slightly reduce curving forces. But, the difference is so small relative to other factors affecting curving, that no firm conclusions can be drawn from the small difference measured.

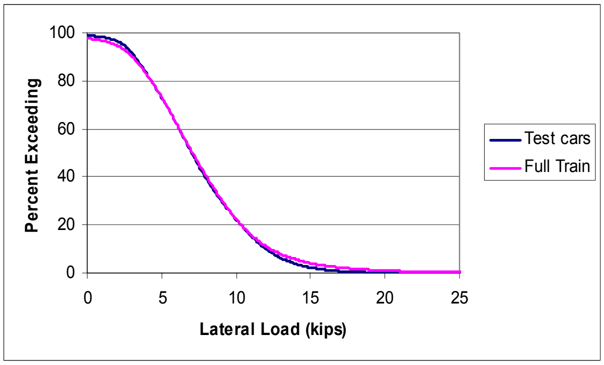


**Figure 5: Performance Detector Exceedence to Lateral Load Plot**

## Summary

Initial test results are promising, but 63,000 miles is very early in the expected life of trucks. At FAST, with the high proportion of curved track (one 5-degree curve is not lubricated); the wheels are approaching 50 percent of their wear life with no problems to date. However, there have been reports of increased problems with 36-inch wheels in revenue service as axle loads were increased from 33 tons to 36 tons. Further evaluation, including braking and thermal capacity of worn wheels, and revenue service testing, is needed before drawing any firm conclusions.

Lighter weight trucks offer the possibility of providing significant cost savings to the railroads. Monitoring of the equipment will continue to ensure that it will perform satisfactorily over an extended period, and that increased failure or maintenance costs do not outweigh the economic benefits.

The Association of American Railroads (AAR) and the Federal Railroad Administration (FRA) fund the FAST/HAL program. The program also benefits from donations provided by AAR member railroads and supply industry. ABC-NACO, Standard Steel, and Timken donated components being tested.