Transports Canada Transport Canada
Développement Development

Radial Axle Freight Car Trucks Generate Savings

The word "truck" applied to railroad equipment would appear incongruous to many. Although the term may conjure up visions of highway trailers riding on flatcars, it is, in fact, used to describe the wheel assembly under each end of a rail car.

The standard (conventional or three-piece) truck holds two wheel sets parallel to each other and provides no mechanism to steer the wheels around curves. The wheels, therefore, approach a curve at a large angle of attack forcing the flange (the raised guiding edge) of a steel wheel against the rail and producing lateral force on the rail. Over time, these forces accelerate wheel and rail wear in curved track, resulting in frequent maintenance problems. Heavy haul railroads, moving coal and other bulk commodities in 100-ton cars in 100-car unit trains, experience higher rates of wear of wheels and curved track because of the greater lateral force generated by each car and because of the number of repeated occurrences.

Another deficiency of conventional trucks is their lack of stability when empty cars are moved on tangent track. They tend to oscillate from rail to rail or "hunt."

Solution

The problems associated with conventional rail-car trucks have inspired the search over many years for an improved truck that would reduce wheel and rail wear. One of the solutions proposed, to which Canadian researchers have devoted considerable development effort over the last several years, has been the radial axle steering-arm truck. Since the mid-1970s the Transportation Development Centre (TDC) of Transport Canada, in cooperation first with Canadian National (CN) Railways and more recently with Canadian Pacific (CP Rail), have researched the benefits of radial axle trucks. The TDC's investment to date totals about $500,000 (Canadian), which has been matched dollar for dollar by the railroads involved.

Early research sponsored by CN concentrated on the radial axle steeringarm truck known as the DR-1. This research identified the major factors that control tracking performance and interaxle lateral and yaw stiffness. To compensate for these factors, the DR-1 consists of a steering device fitted onto a standard three-piece truck. This device is made up of two C-shaped cast-steel arms, one on each side of the bolster, as shown in Figure 1, which increase interaxle lateral stiffness by maintaining the side-frame alignment. This improves tangent track performance by greatly reducing the truck's tendency to hunt and thus permits much higher operating speeds. Typically, the safe operating speed for empty cars may be increased from approximately 45 — 50 mph to 60 — 65 mph.

Interaxle yaw stiffness is achieved by elastically coupling the wheel sets to each other through the truck side frames. This allows longitudinal movement of the axle under the control of the resilient pads, which in turn permits the radial positioning of the wheel sets in the frame. This radial positioning in a curve increases the flange-free contact zone between the wheel and the rail, greatly reducing wear.

Testing

Initially, laboratory and short-term in-service performance evaluations were performed on new truck designs by CN and CP Rail in cooperation with the TDC. As experience was gained, small numbers of the most promising designs were placed in revenue service to quantify the expected benefits. For purposes of comparison, control cars equipped with standard three-piece freight car trucks were placed in service at the same time. All test cars were fitted with new wheels and the new wheel profiles were recorded.

Periodic wheel profile measurements and angle-of-attack measurements, which determine the radial position of the wheel set in a curve, were taken to quantify curving performance; and high-speed tangent track tests were performed to quantify the critical or hunting speed of the trucks and determine a safe operating speed.

In August 1986, the Association of American Railroads (AAR), in cooperation with British Columbia Railway (BC Rail), CN, CP Rail, the National Research Council (NRC) of Canada, and TDC, conducted a large-scale test program on BC Rail's Tumbler Ridge branch line that serves unit coal trains in northeastern British Columbia. The test program compared the performance of a 100-car unit coal train equipped with standard trucks with that of a 100-car train with radial DR-1 trucks. A number of parameters, including energy consumption and rail wear, were evaluated during the tests of the two truck types.

Benefits

Reduction of wheel wear, particularly flange wear, was the first and most obvious benefit derived from the use of radial trucks. The dramatic improvement in wheel wear obtained with the radial trucks is shown graphically in Figure 2, which clearly indicates that the amount of wheel metal loss was considerably less for the radial axle trucks than for the standard trucks. These results, obtained by CP Rail, indicate that radial axle truck wheels exhibited approximately 25 percent of the flange wear and 70 percent of the tread wear that developed on the control cars. These are two of the factors that led to improved wheel-set economics for cars equipped with radial axle trucks.

Analysis of wheel replacements for the test population shows that the mean mileage traveled between wheel removals for any cause was 185,000 miles for radial axle trucks compared with 152,000 miles for standard trucks—an improvement of more than 20 percent. This substantial drop in wheel removals for radial trucks demonstrates the effectiveness of the radial action in reducing wheel flange contact with the rail during operation and thus decreasing wear.

Results of energy consumption tests performed on dry track over two sections totaling 15 miles showed energy savings ranging from 12 to 24 percent for the DR-1-equipped train compared with the train with standard trucks.

The Witness Groove Method, a rail wear measurement tool developed by the NRC to determine rail wear after only a few passages of a train, indicated that on dry track the radial trucks produced rail wear savings of approximately 25 percent compared with the standard trucks. This represents a substantial increase in rail life. For example, rail located on a tight curve and subjected to heavy loadings may have a useful life of only 5 to 7 years. Use of radial axle trucks can extend this life by about 2 years. The number of years of extra life depends on the curvature of the track and the weight and volume of traffic.

The cost of a standard truck is about $8,000 (Canadian). The incremental cost for a radial axle truck (either as a retrofit or as additional cost on a new truck) is about $2,250 to $3,000 (Canadian). This increased capital cost is the prime reason that railroads have taken a conservative approach to investing in this new equipment. Because the life of freight cars (including the trucks) generally averages 30 to 35 years, the railroads want to be convinced that the initial capital investment is justified by the benefits.

Because the measurable benefits are greatest for heavy haul railroads, they have been the first to make significant investments in radial axle trucks. In western Canada, CN and BC Rail are jointly operating approximately 800 cars equipped with DR-1 radial axle trucks in unit coal trains. CP Rail is currently conducting a large-scale evaluation program in its Pacific Region using a 100-car unit sulfur train equipped with radial trucks.

For more information contact Douglas W. Dibble, Senior Development Officer, Transportation Development Centre, Guy Favreau Complex, 200 Dorchester Boulevard West, Suite 601, West Tower, Montreal, Quebec H2Z 1X4, Canada; or R. R. Mayes, Director-General, Research and Development, Transport Canada, Ottawa, Ontario K1A 0N5, Canada.

Suggestions for "Research Pays Off" articles are welcome. Contact Nancy A. Ackerman, Editor, TR News, *Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 (telephone 202-334-2972).*

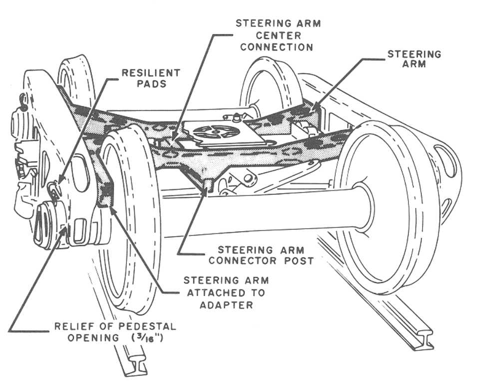

FIGURE 1 General arrangement of truck equipped with DR-1 steering assembly.

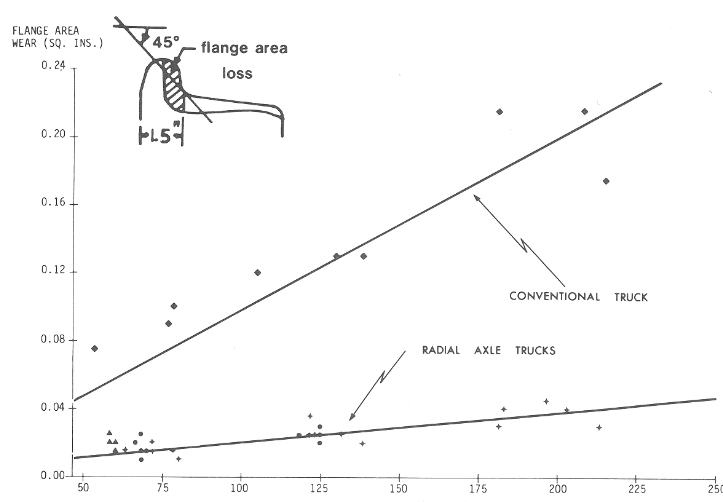

FIGURE 2 Loss of wheel flange cross-sectional area versus mileage.