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IMPACT FORCES MEASURED OVER A 62-DEGREE CROSSING,

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Summary

Impact forces of more than twice the static wheel load were measured over a 62-degree crossing diamond at the Transportation Test Center's Facility for Accelerated Service Testing (FAST). Both 100-ton (263,000 lb) and HAL (315,000 lb) cars produced these high impacts at a speed of 40 mph. The impacts increased linearly with speed. The HAL car produced impacts that were about equal to those for a 7 or 8 mph higher speed with the 100-ton car. Therefore, HAL cars will most likely lead to faster degradation of crossings if speeds are not reduced.

Instrumented wheel sets were used to measure impacts in the 62-degree crossing. Analysis shows that the impacts will most likely be higher in higher-angle crossings due to a larger effective gap at the flangeway. The worst case is a 90-degree crossing.

Testing of additional crossings is needed in order to quantify the relationships between crossing angle, speed, and impact forces. Additional testing will be performed as more crossings are made available to the FAST program.

This work was performed to monitor the performance of frogs and special trackwork under heavy axle loads as part of the Frog Performance Experiment at FAST.

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INTRODUCTION AND CONCLUSIONS

62-DEGREE CROSSING IMPACT FORCE MEASUREMENTS

Wheel impacts on a 62-degree crossing (Exhibit 1) were measured using instrumented wheel sets. Measurements were made using a 100-ton (263,000 lb) car and a heavy axle load — HAL — (315,000 lb) car at the Facility for Accelerated Service Testing (FAST).

Exhibit 1. 62-degree Three-Rail Crossing

Exhibit 2 summarizes the impact force data. Each data point represents the average of 16 measured impacts. At zero speed, the static wheel loads are plotted. The impact forces increase linearly with speed. As expected, the impacts under the HAL car are significantly higher than those under the 100-ton car.

The increase in impact force due to the HAL car is roughly equivalent to a 7 or 8 mph increase in speed. At 40 mph, the average impacts are more than twice the static wheel load for both cars.

The maximum impact measured under the 100-ton car was 96.1 kips. For the HAL car, it was 117.8 kips. Both maximums were measured at 40 mph.

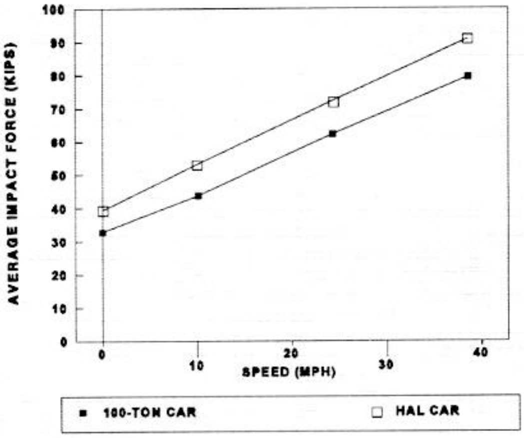


Exhibit 2. Average Impact Forces

Exhibit 3 shows a typical force time history for a single 38-inch wheel on a HAL car through the crossing. Note that the instrumented wheel measures a distinct impact at each of the two frogs. These impact forces are only for a 62-degree three-rail bolted crossing. Crossings of different angles or designs are likely to experience different impact levels. Different amounts of wear may also affect the impact levels. At the time this test was conducted, there was about 1/8 inch of batter at the gaps in the frogs.

The test train ran over the crossing at speeds of about 10, 25, and 40 mph. After the passes, the train was turned and three passes were made in the opposite direction at the same speeds. The instrumented wheel set data was sampled at a frequency of 512 Hz with 200 Hz filtering. There is also some mechanical filtering of the impacts due to the wheel mass between the gages and the wheel tread.

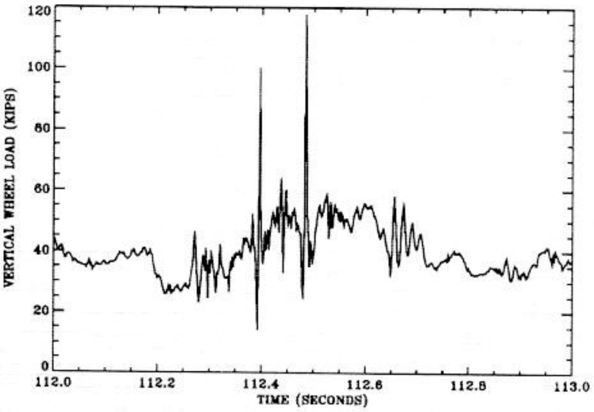


Exhibit 3. Wheel Force Time History

EFFECT OF CROSSING ANGLE

Crossing angle affects wheel/flangeway gap interaction in the following three ways:

1. At 90-degree crossings, both wheels of a wheel set negotiate the flangeway gap at the same time, causing simultaneous impacts on both wheels.

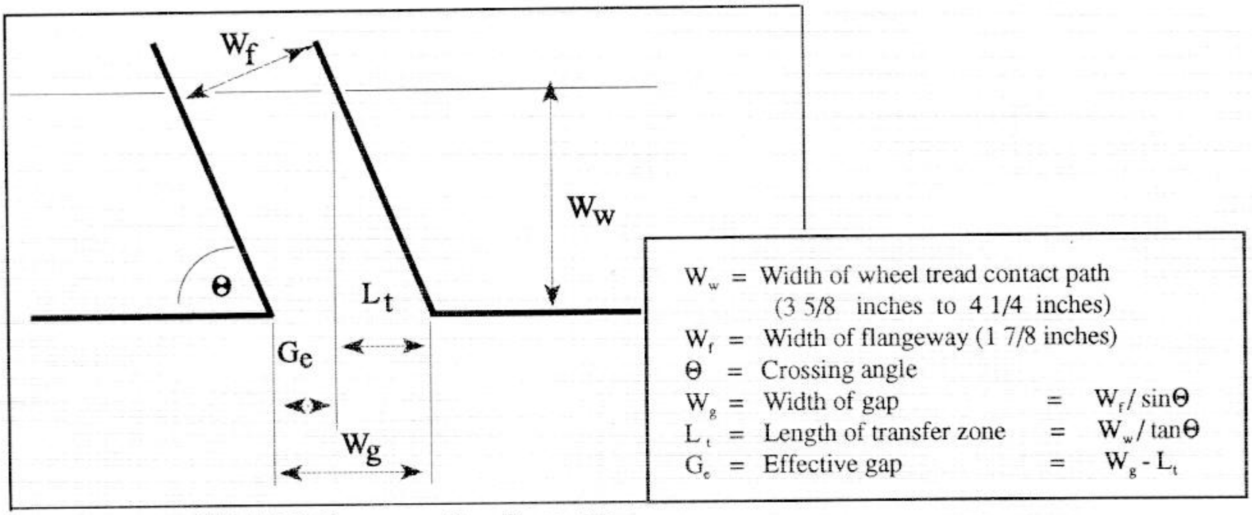
2. At crossings between 90 and about 60 degrees, each wheel crosses an effective gap. The transition from one running surface to the next while crossing the flangeway is not continuous. This causes an impact on the downstream end. The geometry for this case is shown in Exhibit 4.

3. At crossing angles less than about 60 degrees, the wheel is in contact with at least one running surface at all times. The lower the angle, the longer the transfer zone.

Because a wheel set might not be centered while negotiating a crossing, there are minimum and maximum possible tread contact bands given standard wheel set and flangeway dimensions. The minimum possible tread contact width occurs on the wheel in contact with the guard rail. The maximum possible tread contact width occurs on the opposite wheel.

For a 1 7/8-inch flangeway, a wheel width of 5 1/2 inches, and the maximum allowable flange back to flange back distance of 53 3/8 inches, the minimum and maximum possible contact bands are 3 5/8 inches and 4 1/4 inches, respectively. The effective gap, using this range of wheel tread contact width, is shown in Exhibit 5 for different crossing angles. A negative gap shows that the wheel may be in contact with both sides of the gap at the same time. The wheel transfers weight from one side of the gap to the other without losing contact at angles lower than approximately 60 degrees. One would expect that the larger the effective gap, the larger the impact force at the frog due to a particular wheel. Therefore, realignment to reduce crossing angle may prolong crossing life. Further testing is needed to quantify this relationship.

The 62-degree crossing over which force data was collected was donated by CSX Transportation. It was built by the Conley Frog and Switch Company with Bethlehem 136 fully heat-treated rail. After the original running rail failed due to rail end batter and cracking, AAR personnel fabricated new running rail from NKK 136 RE head-hardened rail and rebuilt the crossing. The rebuilt crossing had accumulated about 15 MGT of traffic at the time of data collection.



W_w = Width of wheel tread contact path (3 5/8 inches to 4 1/4 inches)
W_f = Width of flangeway (1 7/8 inches)
Θ = Crossing angle
W_g = Width of gap = $W_f / \sin\Theta$
L_t = Length of transfer zone = $W_w / \tan\Theta$
G_e = Effective gap = $W_g - L_t$

Exhibit 4. Flangeway Gap Geometry

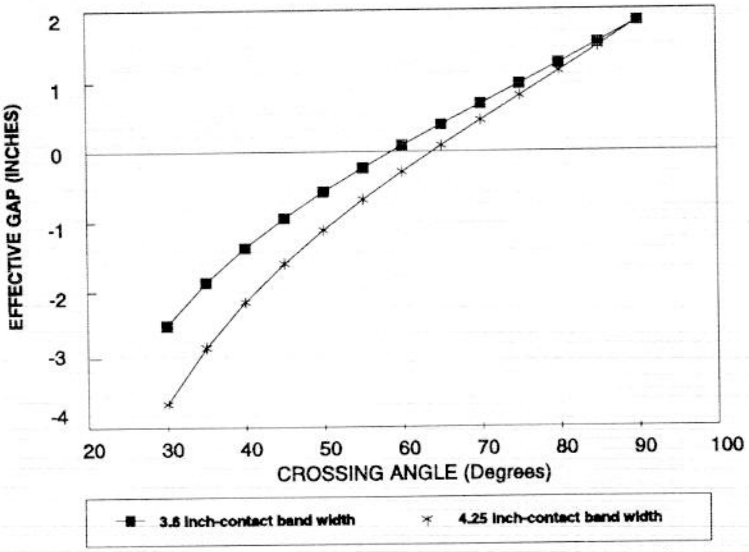


Exhibit 5. Effective Gap for Various Crossing Angles

Note: Contact Joseph LoPresti at (719) 584-0589 or Duane E. Otter at (719) 584-0594 with questions or comments about this document.

A MORE DETAILED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, WILL BE AVAILABLE AT A LATER DATE THROUGH THE DOCUMENT DISTRIBUTION CENTER, CHICAGO TECHNICAL CENTER, 3140 SOUTH FEDERAL STREET, CHICAGO, ILLINOIS 60616. PHONE: BETTY J. VAUGHAN (312) 808-5421. A REPORT LIST IS AVAILABLE UPON REQUEST.