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Incidence of Asymmetric Wheel Flange Wear in Revenue Service

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Summary

Data from wayside wheel profile monitoring devices suggests that asymmetric wheel flange wear is widespread in the North American car fleet. It confirms data from the Association of American Railroads' (AAR) Car Repair Billing, which suggests that wheelsets rejected for Why Made 60 code (thin flange) are worn asymmetrically and confirms limited maintenance observations taken from 134 cars in a particular car fleet and reported in previous *Technology Digests*.

The car repair billing data and data from wayside wheel profile monitoring devices shows that the incidence of asymmetric wheel flange wear is reducing the life of wheels in high mileage cars that are not prone to having wheels removed due to high impact loads.

The root cause for asymmetric wheel flange wear is suggested to be the action of truck brake rigging and the resulting contact of brake shoes on the wheel tread. The widespread nature of asymmetric wheel flange wear, independent of car and, seemingly, truck type, helps to substantiate this hypothesis as the brake rigging and brake shoes are a common factor to all cars observed with asymmetric wheel flange wear.

The Transportation Technology Center, Inc. (TTCI) has been tasked to support the Advanced Technology Safety Initiative (ATSI) through the AAR Strategic Research Initiatives (SRI) Program. The asymmetric wheel flange wear problem was identified by car owners who requested ATSI to investigate the problem. TTCI is also tasked under the AAR SRI Program to develop design concepts for an integrated freight car truck (IFCT); IFCT design concepts will include means to address the problem of asymmetric wheel flange wear.

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Introduction

The incidence of asymmetrically worn wheel flanges on the wheelsets of a particular series of 134 cars has been reported in a series of *Technology Digests (*TDs) under AAR's SRI Program.[1,2,3] This has led to an investigation into the incidence of wheels with asymmetrically worn flanges in the North American car fleet. An asymmetric flange wear metric for wayside wheel profile measurement devices (WPMD) has been developed to support this work. This TD reports on the development and nature of this metric and the suspected incidence of asymmetrically worn wheelsets in North America.

Car Repair Billing Data

Initially, AAR's Car Repair Billing (CRB) data was referenced to establish the incidence of asymmetric wheel flange wear, generally, in the North American fleet. The analysis of this data was inconclusive. Many wheelsets with wheels condemned for Why Made (WM) 60 code (thin flange) reference the opposing wheel as WM 11 (mate wheel). Associated finger gage readings record the worn wheel as 9 (condemnable) and the mate wheel as 0 (with no wear). The 45 percent frequency of a zero reading of the mate wheel (520 out of 1,149) for 2010 Q2 CRB data suggests either:

- The wheel was measured correctly and that asymmetric wheel wear is widespread
- The carman visually estimated the thickness of the flange of mate wheel as being substantially unworn without applying the gage
- The wheel was not measured or estimated and the carman recorded a zero reading

The large number of zero readings could severely skew the histogram of differences in finger gage readings.

Figure 1 shows the frequency of the 2010 Q2 CRB data. It suggests that wheels most likely to be condemned for WM 60 (thin flange) are subject to asymmetric flange wear. These conclusions would be tempered if the 45 percent of zero readings mentioned above are indeed erroneous, and it could suggest an opposite conclusion.

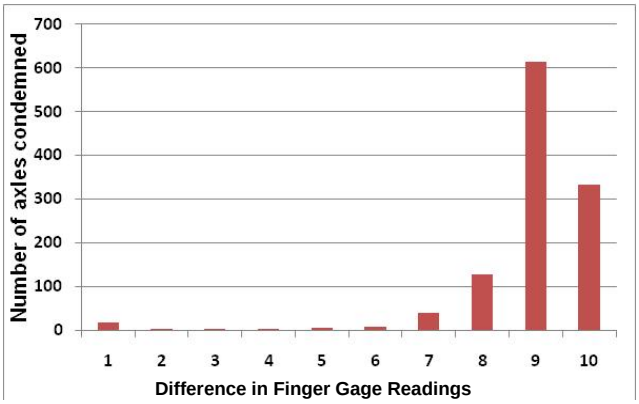

Figure 1. 2010 Q2 CRB Data for Wheels Condemned for WM 60

Metric Development

In order to remove uncertainty on this issue, reference was then made to WPMD data. A metric was developed during this investigation that would identify wheels with the potential of being condemned for asymmetric flange wear. Figure 2 illustrates this metric graphically.

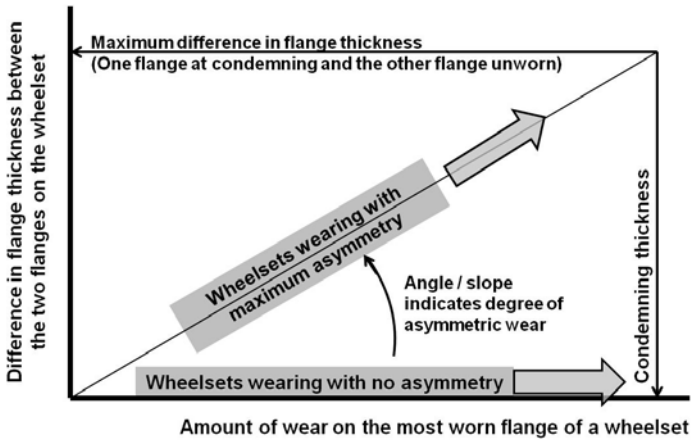

Figure 2. Graphical Depiction of Asymmetric Wear Metric

The amount of flange wear on the wheel with the most worn flange on a wheelset is plotted against the difference in flange wear between the two wheels of that wheelset. Wheelsets wearing at the limit of asymmetry (i.e., those with no flange wear on one wheel of a wheelset) will lie on an axis where the ratio between the above two parameters is unity.

Wheelsets wearing perfectly symmetrically will have zero difference in flange wear and will lie on the horizontal axis, as Figure 2 shows. The ratio between these two measurements provides a measure of the degree of asymmetry and can be used as an early indication that asymmetric flange wear is occurring prior to reaching or nearing condemning limits.

Service Data

Wheel profile data for one month was obtained from four wayside WPMD sites. It amounted to 783,694 valid wheelset records from 84,617 cars. Then, the data was segregated according to car series, owner, etc. The resulting data is discussed below.

Data from the extended fleet of the 134 cars first identified with asymmetric wheel flange wear:[1]

Figure 3 shows the data for axle 2 of all coal cars in this fleet passing the WPMD. Data for axle 4 is similar. Figure 4 shows data for axle 1, and the data for axle 3 is similar to this data. The data includes repeats of the same car passing the detector; some cars passed it five times and some just once.

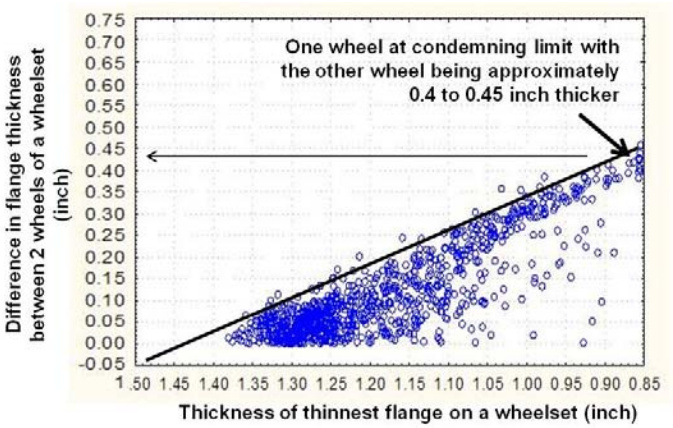

Figure 3. Plot of difference in flange thickness across axle 2 versus thickness of thinnest flange for a specific series of coal cars passing the WPMD

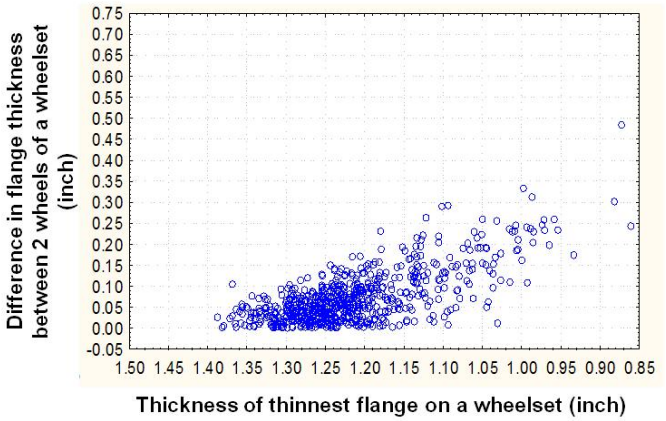

Figure 4. Plot of difference in flange thickness across axle 1 versus thickness of thinnest flange for a specific series of coal cars passing the WPMD

The data:

- Exhibits the anticipated characteristics depicted in Figure 2
- Confirms maintenance records that this car series is subject to asymmetric wheel flange wear[1]
- Shows wheels reaching condemning flange thickness on one wheel generally have a mate wheel with a flange thickness of 0.45-inch greater than condemning (i.e., 1.3 inches thick, or approximately 0.1-inch less than nominal for a wide flange wheel)
- Shows there are few evenly worn wheelsets reaching the condemning limit
- Shows flange wear between wheels on the same wheelset is generally even until one wheel wears to a thickness of about 1.1 inches, after which wear becomes asymmetric
- Shows flange wear is less severe on axles 1 and 3; this was observed from maintenance records and attributed to car orientation under loaded operation.[1] Because the majority of these cars are new (± 3 years old) and receiving their first wheel change, the fact that there is a difference in performance between wheelsets in positions 1 and 3 versus 2 and 4 is also unsurprising

Data from another coal operator:

Data from another coal operator using cars from a different car builder shows the same trends but with wear on opposing diagonal positions in the car.

This latter observation suggests that the brake rigging of the latter car supplier is asymmetric in the opposite sense to that observed on the cars first inspected.[1]

Data from covered hopper and box cars:

Data from a series of covered hopper cars and from a series of box cars shows the same trends that the coal cars show.

Data from tank and intermodal cars:

Data from a series of tank cars is similar (Figure 5); however, the incidence of wheels reaching condemning for WM 60 (thin flange) would seem to be less.

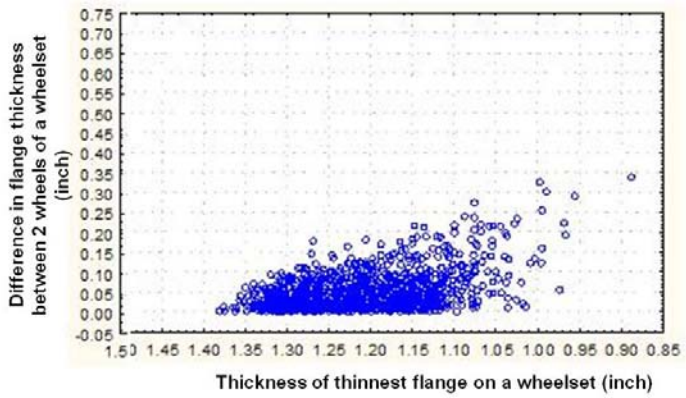

Figure 5. Plot of difference in flange thickness across axle 1 versus thickness of thinnest flange for a specific series of tank cars passing the WPMD

Data for intermodal cars is similar to that for tank cars and similar comments apply.

Conclusions

WPMD data confirms both the limited maintenance data obtained in previous studies[1] as well as CRB data presented in this TD:

- Most wheelsets condemned for WM 60 are observed to have asymmetrically worn flanges.
- Few wheels reach the WM 60 condemning limit with equal wear on each wheel flange.
- Asymmetric wheel flange wear appears to be widespread in the North American car fleet.

These observations suggest that, particularly, rod-through brake rigging, introducing lateral forces to the brake beam and brake shoe abrasion are a dominant root cause for asymmetric wheel flange wear, as this rigging type predominates in the North American fleet and brake shoes are used universally.

- CRB data is substantially correct when indicating that the mate wheel has zero wear; this wear is probably of the order of 0.1 inch for a wide flange wheel; 0.1 inch is slightly greater than one reading on a finger gage.
- High impact wheels reduce the incidence of asymmetrically worn wheels and WM 60 wheel change outs as the wheels are rejected before flanges wear thin.

Recommendations

It is recommended that the influence of brake shoe contact on the wheel tread be considered as a problem widespread in the North American car fleet and that solutions to the problem be pursued.

Asymmetrically worn wheels have the potential to:

- Reduce vehicle hunting thresholds
- Increase the stress state of the track
- Increase fuel consumption

Consequently, means should be sought to eliminate asymmetrically worn wheels, which might include:

- The introduction of criteria to remove asymmetrically worn wheels from service; these wheels being detected at wheel profile monitoring devices
- Removing the cause for asymmetrically worn wheels through the design and application of:
  - Improved brake shoes
  - Improved truck brake rigging

An earlier TD suggests the ideal means to introduce improvements is to consider short-term alterations to the brake shoes and introduce recommended changes in conjunction with recommended rigging changes in the proposed design for an integrated freight car truck currently being developed under the AAR SRI freight car truck project.[4]

References

1. Tournay, Harry, et al. October 2010. “Asymmetric Flange Wear: Data Analysis,” *Technology Digest* TD-10-034, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, Colo.
2. Tournay, Harry, et al. October 2010. “Asymmetric Flange Wear: Inspection and Teardown Results,” *Technology Digest* TD-10-035, Association of American Railroads, Transportation Technology Center, Inc., Pueblo, Colo.
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