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Asymmetric Flange Wear: Data Analysis

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Summary

Transportation Technology Center, Inc. (TTCI) has analyzed wheel removal data from a fleet of 134 coal cars. This data suggests a pattern of asymmetric wheel flange wear on the wheelsets: one flange of a wheelset wearing to condemning limits while the opposing flange remains substantially unworn; this wear occurs on diagonally opposing wheels of each truck in a car.

This *Technology Digest* (TD) reports on the data analysis conducted, and it is the first of three TDs relating to the wheel performance of this car series. The other two TDs report on:

- The results of teardown inspections of two cars experiencing asymmetric wheel flange wear
- Possible root cause for this wear and remedies

Investigations continue into the root cause of asymmetric wheel flange wear, particularly in regard to asymmetric wheel flange wear in the North American car fleet in general. Results of these investigations will be reported in future TDs.

TTCI has been tasked to support the Advanced Technology Safety Initiative (ATSI) through the Association of American Railroads' (AAR) Strategic Research Initiatives (SRI) Program. The asymmetric wear problem was identified by car owners who requested ATSI to investigate the asymmetric wheel flange wear 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

TTCI has been tasked to support the ATSI through the Association of American Railroads' (AAR) Strategic Research Initiatives program. A number of car owners have reported through the ATSI that they have experienced a larger than expected incidence of wheel flange wear. An analysis of truck hunting detector (THD) data suggested that these cars might be exerting a larger lateral force on one rail of a THD site than the other, indicating poor tracking performance on tangent track. One particular car owner provided maintenance data, the opportunity to inspect cars in service, and two cars for teardown inspections conducted at the Transportation Technology Center (TTC), Pueblo, Colorado.

This TD reports on the findings from the data analysis. Two subsequent TDs will describe:

- The results of teardown inspections of two cars experiencing asymmetric wheel flange wear
- Hypotheses made as to the root cause for this wear

Investigations and further analyses into the root causes for abnormal wheel flange wear in general, and asymmetric wheel flange wear in particular, continue with findings to be published in future TDs.

DATA ANALYSIS

Wheel removal data per Why Made (WM) code was obtained for a set of 286,000-pound coal cars introduced into service in 2005.[1] These cars, operated by Mitsui Rail Capital, were equipped with AAR M-976 trucks and had run approximately 400,000 miles at the time of analysis. This data (Figure 1) indicates:

- Only 35% of wheels have been removed to date.
- 82.4% of these wheelsets have been removed for WM 60 (thin flanges).
- Only 10.6% of wheels have been removed for WM 65 (tread defects).

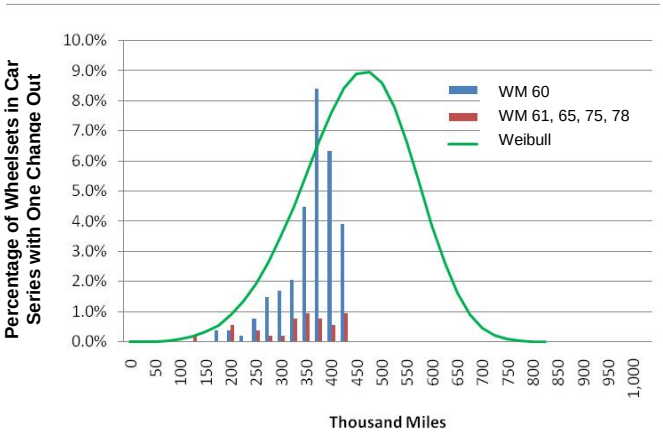

Figure 1. Percent of Removals by Why Made Code versus Weibull Projection

A Weibull projection of the data available to date suggests an average wheel life of 503,000 miles may be anticipated; this projection will be updated as further data becomes available. This data was compared with currently available data (Figure 2).

In 2002, a TTCI wheel life survey was made of three trains: one train operating with 263,000-pound cars without M-976 trucks and two trains operating with 286,000-pound cars equipped with M-976 trucks, which indicated average lives of approximately 300,000 miles (depicted in Figure 2 as *Data processed in 2002*).

Also, a survey is in process of wheel life under another series of coal cars equipped with AAR M-976 trucks and indicated as *Other operator* in Figure 2. Interestingly, although only 20 percent of wheels from 120 cars have been removed after approximately 450,000 miles, results show:

- An average wheel life in excess of 600,000 miles is predicted by the Weibull analysis.
- The majority of removals to date have been for WM 65, high impact wheels (HIW) and not for thin flanges.

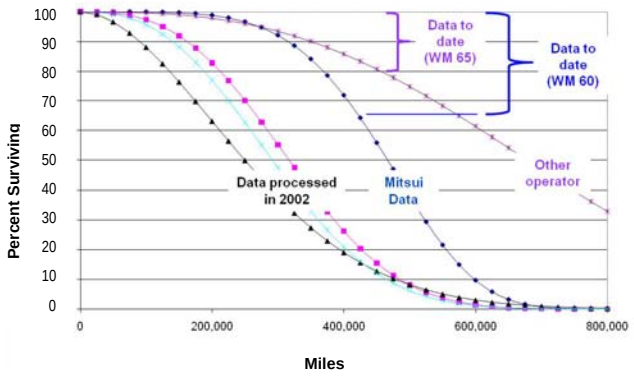

Figure 2. Wheelset Survival Curves

An analysis of the data with respect to position in the car (Figure 3) shows thin flange removals.

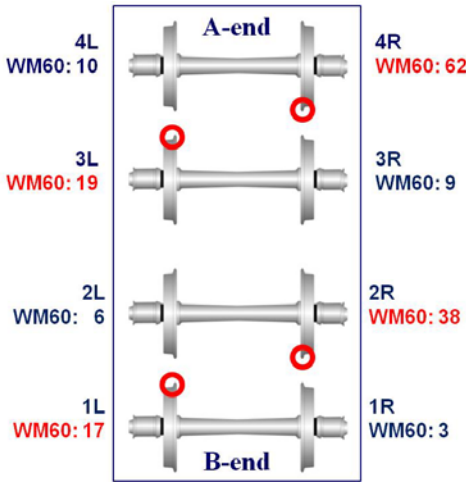

Figure 3. Distribution of Removals for WM 60 (thin flanges) within the Cars According to Wheel Position

The wheelset removal data shows that thin flange removals:

- Predominate in positions 4R, 3L, 2R, and 1L within the car
- Occur more frequently on axles 4 and 2, suggesting that the car operated more often with the A-end leading
- May occur infrequently in the other wheel positions within the car

Figures 4 to 7 show the WM 60 (thin flange) data in histogram form for the wheels on each of the four diagonals in the car. Again, it is obvious that removals in positions 4R, 3L, 2R, and 1L within the car predominate.

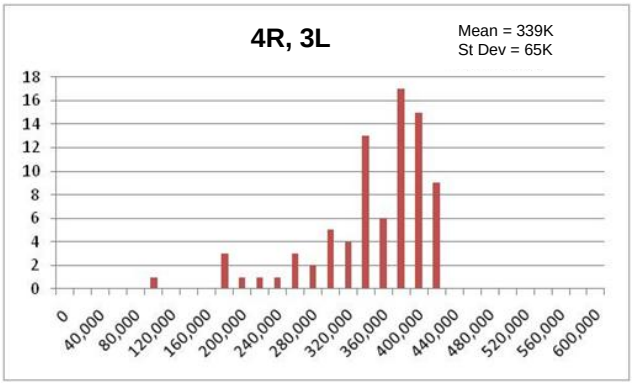

Figure 4. WM 60 Removals in Positions 4R and 3L

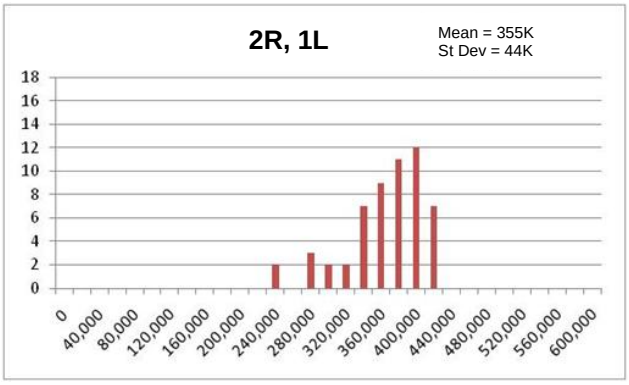

Figure 5. WM 60 Removals in Positions 2R and 1L

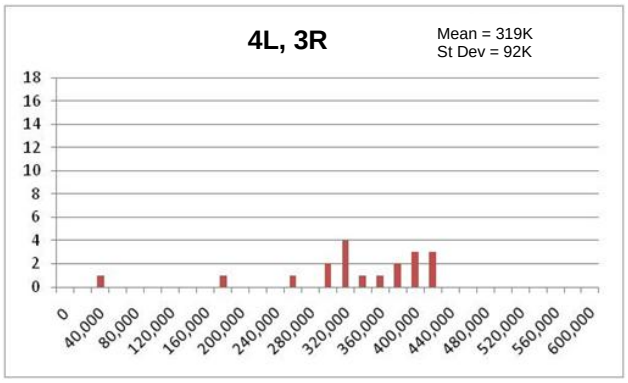

Figure 6. WM 60 Removals in Positions 4L and 3R

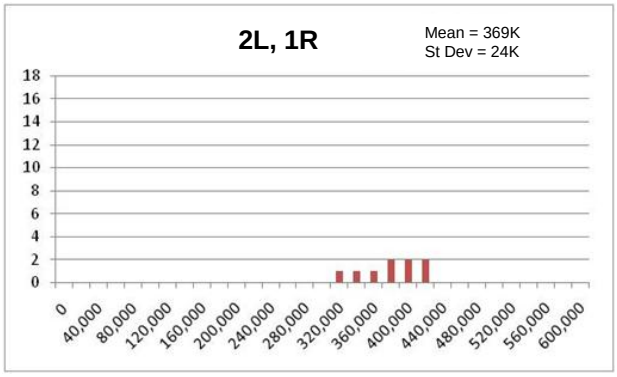

Figure 7. WM 60 Removals in Positions 2L and 1R

It should also be noted that wheels are being rejected for thin flanges commencing, typically, after approximately 200,000 miles. Currently, average mileages before rejection are approximately 350,000 miles, but are anticipated to increase as predicted by the Weibull analysis.

Of further interest is the removal data segregated according to WM code and axle position (Figures 8 through 11). Here it can be seen that the next dominant mode after WM 60 (thin flange) is WM 65 (HIW). This mode dominates on axle 4 which, when considering the flange wear dominance of axle 4, is the predominant lead axle in the car. It might suggest that if the flange wear problem is solved, the next removal mode will be HIW and that HIW are mainly associated with lead axles in the car.

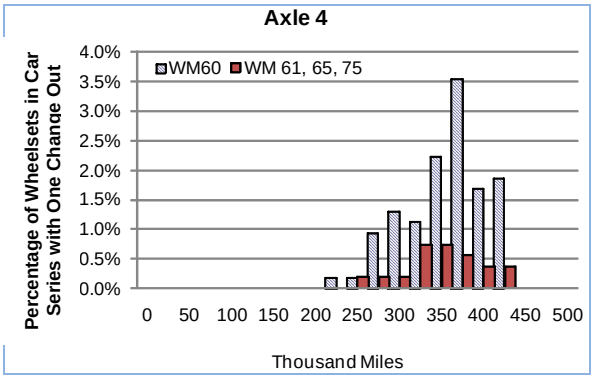

Figure 8. Axle 4 Wheelset Removal Data by Why Made Code

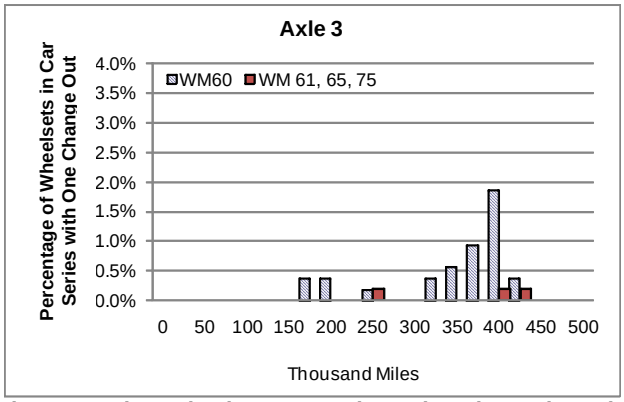

Figure 9. Axle 3 Wheelset Removal Data by Why Made Code

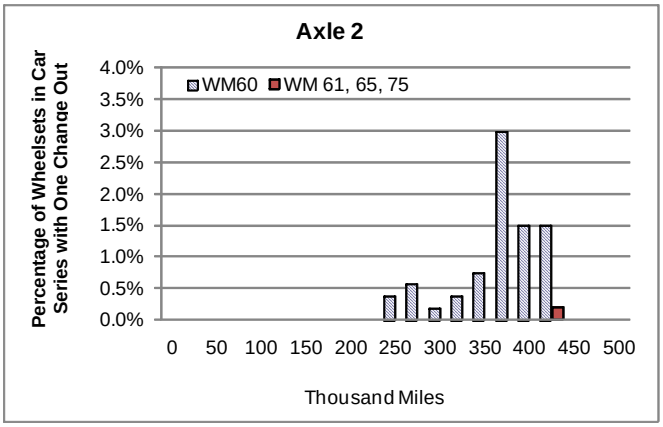

Figure 10. Axle 2 Wheelset Removal Data by Why Made Code

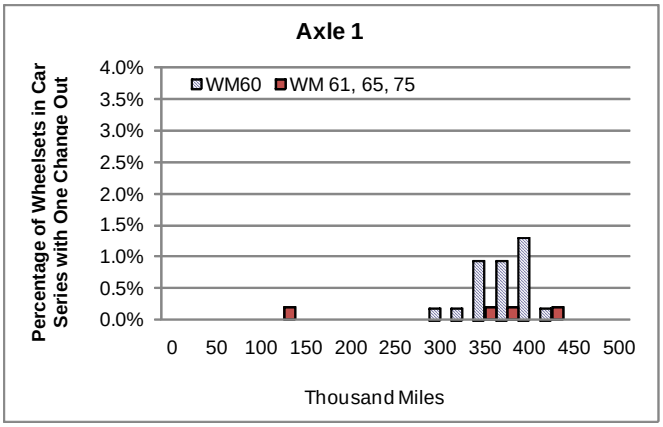

Figure 11. Axle 1 Wheelset Removal Data by Why Made Code

CONCLUSIONS

The results presented in this TD support the following conclusions:

- A particular form of wheel flange wear, asymmetric flange wear, has been observed on a set of 134 coal cars.
- Asymmetric wheel flange wear:
  - Occurs on diagonally opposed wheels in each truck
  - Is associated with particular diagonals within the trucks and car
  - Appears to predominate on axles 4 and 2 of these cars
  - Appears to be related to specific cars in the fleet exhibiting premature wheel failure
- The next dominant removal code is WM 65 (HIW), occurring predominantly on axle 4, suggesting that if the flange wear problem is solved, the next factor to limit wheel life will be that of tread damage.
- Asymmetric flange wear may not be endemic to all coal cars fitted with M-976 trucks; another fleet is experiencing higher wheel life with the majority of removals to date being associated with tread defects; reasons for this difference may be associated with differences in:
  - Operating conditions
  - Component detail including:
    - Brake rigging, brake shoes
    - Adapter pads, constant contact side bearings, and center plates

NOTE

This TD is the first in a series of three TDs related to asymmetric wheel flange wear; the other two TDs address the results of teardown inspections and the formulation of hypotheses to explain the root causes for the observed phenomena.

ACKNOWLEDGEMENTS

TTCI thanks Mitsui Rail Capital for providing performance data for this analysis.

REFERENCE

1. Railinc. 2008. *Car Repair Billing Data Exchange*, Cary, North Carolina.