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Analysis of Wheelset Removals

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Summary

An analysis of freight car repair data for wheelset removals has been conducted as part of the Association of American Railroads' (AAR) Strategic Research Initiatives (SRI) Program. Information from this analysis was developed to guide research activities to improve safety and extend wheel life. The AAR is focusing significant research efforts on extending wheelset life through the development and testing of improved wheel and rail profiles, improved suspension systems, improved brake systems, and high performance wheel steels. This analysis of data from the AAR's Car Repair Billing (CRB) database was used to ensure that research is being focused appropriately.

Wheelsets represent the largest category of freight car maintenance expense in 2008, accounting for 51 percent of all CRB freight car maintenance dollars. A wheelset is defined as two wheels, two bearings, and an axle. Condemnable wheels are the highest specific cause of the wheelset being removed, accounting for 77 percent, followed by bearings at 23 percent, and less than 1 percent attributed to axles.

For wheelset removals from wheels specifically, tread damage, such as shelling and spalling, represents the highest cause of removal at 67 percent. Tread damage is commonly manifested as a high impact wheel identified through the use of wheel impact load detector systems. Wear accounts for 27 percent of the wheel related wheelset removals. Of these, high flanges and thin flanges account for 66 percent and 25 percent of the condemnable wheels, respectively.

Many of the SRI projects currently underway are intended to increase wheel life through improvements in wheel tread fatigue life and/or improvements in wheel wear characteristics, which are the largest sources of wheelset removals.



INTRODUCTION

As part of the AAR’s SRI program to prevent wheel failures and extend wheel life, an analysis of freight car repair data has been conducted to ensure that research is being focused appropriately. Data from the AAR’s CRB database was used to determine the specific causes for mechanical repairs and wheelset removals. Then, Universal Machine Language Equipment Register (UMLER) was used to examine the data based on car type. Wheel-related SRI projects are briefly summarized.

BACKGROUND

The AAR maintains the CRB database so that freight car maintenance facilities can receive reimbursement from car owners for repairs made in accordance with AAR standards. Repairs made by the car owner, or by a second party under a privately contracted maintenance agreement, do not appear in CRB. The data contained in CRB has been shown to approximate half of all freight car maintenance based on the number of Single Car Brake Tests reported through CRB compared to the number reported through UMLER. Therefore, in many cases, percentage values derived from CRB data are applicable to the entire industry.

If a wheel, bearing, or axle is found to have an AAR condemnable defect, the entire wheelset is removed and replaced with another wheelset. So, in terms of tracking maintenance costs, the most logical unit is the wheelset. However, CRB data is entered according to the specific problem (Why Made Code, WMC) with a particular component of a wheelset, such as a wheel or bearing. This method of tracking is beneficial in terms of identifying the issues related to specific components, but does not easily provide a direct way of identifying the cause for wheelset removal.

For much of the analysis described in this *Technology Digest*, more sophisticated queries of the CRB database were used to tie together WMC’s for components to determine a primary removal cause for each wheelset. For example, a particular wheelset may have both a condemnable bearing and a condemnable wheel. In this case, the wheelset would be categorized as a removal for a bearing related cause because a typical bearing failure is more serious than a typical wheel failure.

ANALYSIS OF REPAIR DATA

Conventional wisdom in the railroad industry says that the majority of freight car repairs are focused on wheelset replacement. Figure 1 confirms this notion by showing the percent of all 2008 CRB repair costs associated with major mechanical categories. Wheelset replacement comprises just over half of all freight car repair costs. Brake systems, which can have a direct influence on wheelset life through overheating of wheels and wheel sliding, account for an additional 20 percent of repair and maintenance costs.

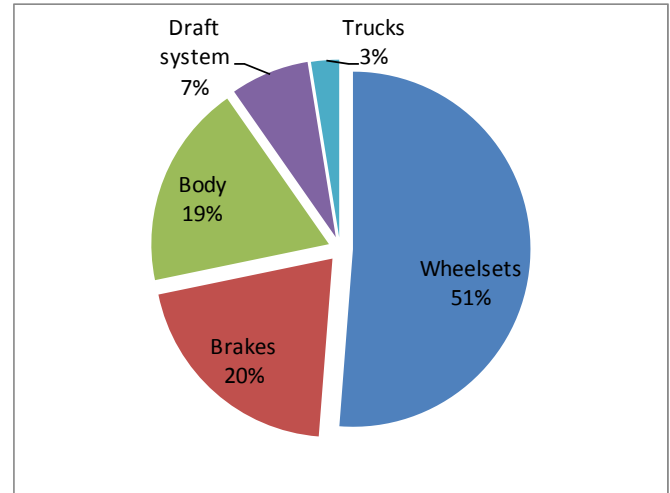


Figure 1. Freight Car Repairs¹

Figure 2 shows the components primarily responsible for wheelset removal. As stated earlier, this analysis gave precedence to bearings over wheels, so a wheelset with both a condemnable bearing and a condemnable wheel is shown in the bearing category. Even with this precedent, wheels are the primary component causing the removal of 77 percent of wheelsets. In Figure 2, the “Other” category includes causes such as WMC 25 “Owner’s Request.”

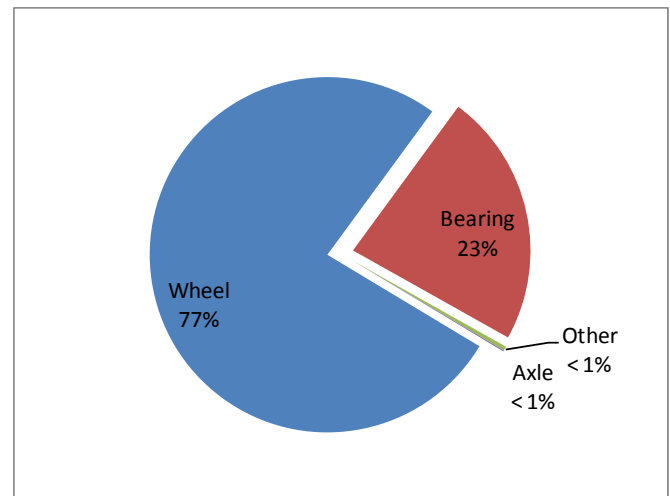


Figure 2. Breakdown of Causes for Wheelset Replacement¹

Figure 3 shows that tread damage (67 percent) and wheel wear (25 percent) are the most common wheel related causes for wheelset replacements. Here, the “Other” category covers a variety of small population causes such as WMC 7 “Obsolete Material,” WMC 13 “Attention Required as Directed by Early Warning Letter,” and WMC 68 “Rim Cracked or Broken.”

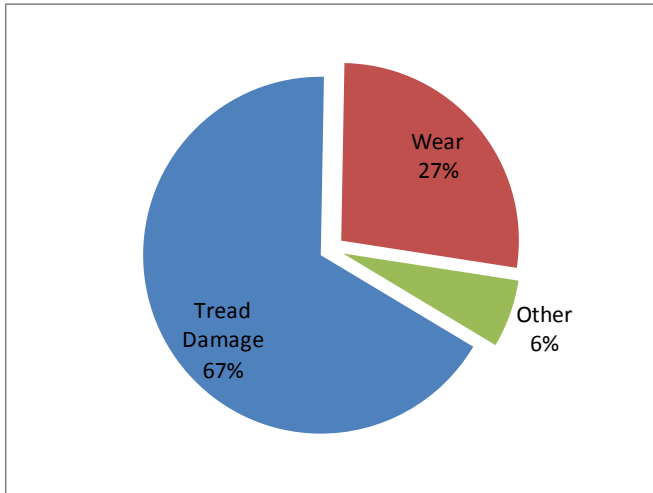


Figure 3. Breakdown of Wheel Causes for Wheelset Replacements¹

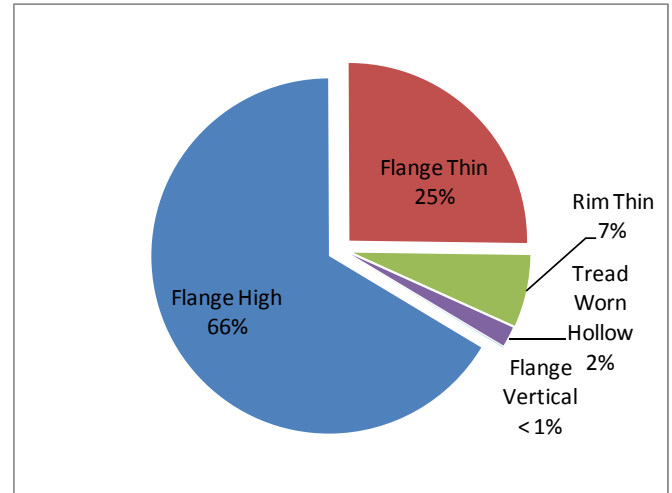


Figure 5. Breakdown of Wheel Wear Causes for Wheelset Replacements¹

Figure 4 shows more detail about the causes of wheel tread damage. The “High Impact” category contains both causes related to wheel impact load detector (WILD) data: WMC 61 and WMC 65. Inspections have shown that nearly all high impact wheels exhibit wheel tread damage in the form of shelling or spalling.²

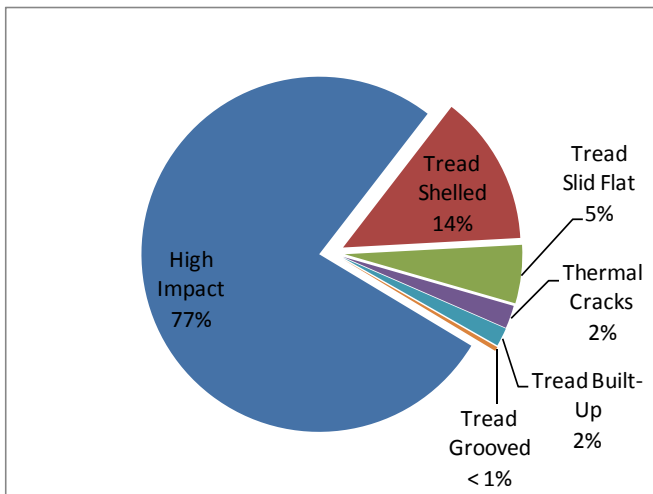


Figure 4. Breakdown of Wheel Tread Damage Causes for Wheelset Replacements¹

Figure 5 shows more detail about the causes of wheel wear. WMC 64 “Flange High” (66 percent) is sometimes viewed as a desirable cause for wheelset removal because it requires the wearing of a large amount of wheel tread material and thus is a generally an indicator of long wheelset life. Conversely, WMC 60 “Flange Thin” (25 percent) requires far less material wear and can be indicative of wheelset or truck misalignment issues.

WHEELSET REPLACEMENTS BY CAR TYPE

The wheelset removal data was also examined in relation to car type by cross-querying UMLER with data from the CRB database. The accuracy of using CRB data as an estimate for industry-wide repairs on a car-type basis is unknown. It is possible, and perhaps even likely, that not all car types have an equal percentage of repairs reported to CRB. Nevertheless, it may be useful to examine the relationship between car type and wheelset replacement using the available data.

Figure 6 shows the number of wheelsets removed in 2008 per car type.^{1,3} While covered hoppers have the most wheelset removals of any car type, this is also the most populous type of car in North American freight operations. Figure 7 shows the data normalized by million car miles to remove the effect of car population and usage.^{1,3}

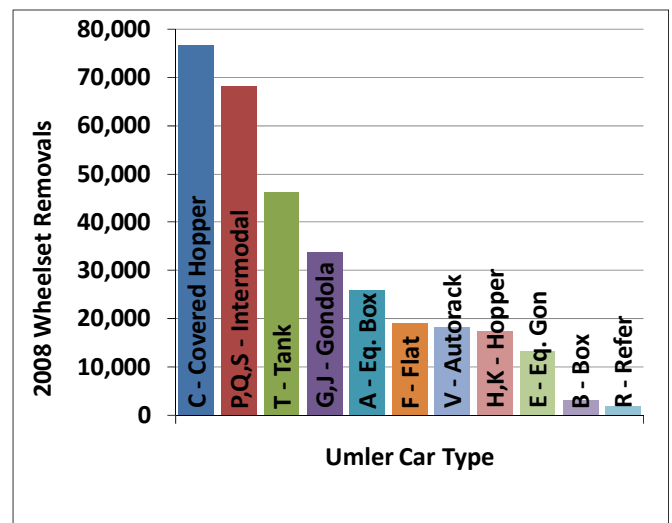


Figure 6. 2008 Wheelset Replacements by Car Type^{1,3}

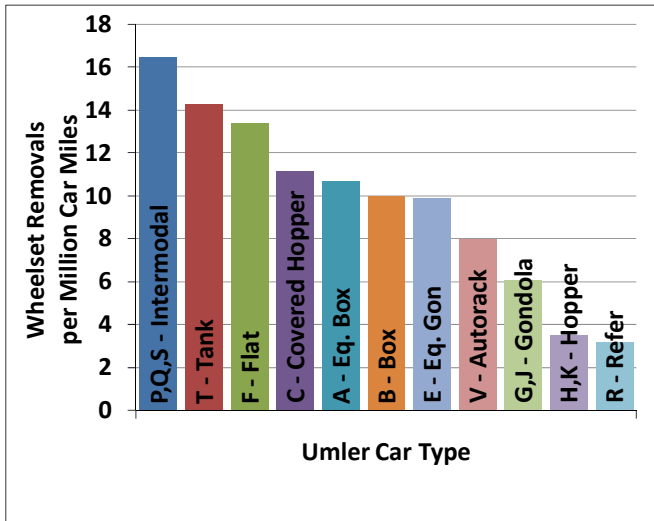


Figure 7. 2008 Wheelset Replacements by Car Type, Normalized by Million Car Miles^{1,3}

The “Intermodal” car type shown in Figure 7 should be considered with caution. These cars can often have 8 or 12 wheelsets in a single car, so their wheelset removals per million car miles is expected to be higher than that of a typical 4-wheelset car.

DIRECTLY RELATED AAR RESEARCH

The AAR has established a number of SRI projects that address the major issues raised in this analysis. The following is a brief summary of current AAR research projects related to extending wheel life:

- SRI 1A “Wheel/Rail Profile Maintenance” — Develop and test the SRI-1A wheel profile which is designed to improve the wear and fatigue characteristics of wheels.
- SRI 1C “Root Causes of Wheel/Rail Rolling Contact Fatigue” — Establish the root causes for wheel and rail rolling contact fatigue and develop measurement strategies to identify conditions for RCF formation as well as vehicle and track design and maintenance strategies to counter RCF on both wheel and rail.
- SRI 2A “Integrated Freight Truck Design” — Develop a truck design with improved curving and hunting stability to reduce wheel wear and fatigue.
- SRI 5A “Improved Brake System Performance” — Develop and test brake rigging designs which provide predictable and well-distributed braking forces to all wheels in a car. (Overheated wheels are particularly susceptible to tread damage.)
- SRI 8C “Strategies to Prevent Heavy Axle Load Wheel Failures” — Develop and test high performance wheel steels designed to resist wheel tread fatigue and wear.

CONCLUSION

Replacement of wheelsets is the major freight car maintenance expense item, accounting for 51 percent of all freight car maintenance dollars in 2008. Wheels are the primary cause of wheelset replacements, accounting for 77 percent of the wheelsets replaced in 2008 while bearings and axles accounted for 23 percent and less than 1 percent of wheelset replacements, respectively.

Tread damage, such as shelling and spalling, is responsible for 67 percent of the wheel-related wheelset replacements. Tread damage is commonly manifested as high impact wheels identified through the use of WILD systems. Wear accounts for 27 percent of the wheel-related wheelset replacements. Of these, high flanges and thin flanges account for 66 percent and 25 percent of the condemnable wheels, respectively.

FUTURE WORK

The AAR is focusing significant research efforts on extending wheelset life through the development and testing of improved wheel and rail profiles, improved suspension systems, improved brake systems, and high performance wheel steels. All these projects aim to increase wheel life through improvements in wheel tread fatigue life and/or improvements in wheel wear characteristics, which are the largest sources of wheelset removals.

REFERENCES

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