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Evaluation of Truck Warp Misalignment

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This Technology Digest (TD) supports TD-07-006, which describes inspection and maintenance procedures for poorly performing cars identified by truck performance detectors (TPDs). It details a means to evaluate the warp misalignment of a truck, an identified cause for poor curving performance. This process of measurement is not included in the overall inspection and maintenance TD because it is complex, difficult to conduct, requires skilled personnel, and consequently, is not recommended as part of the regular evaluation process. It is, however, documented because it may be useful in examining poor performers using TPDs that might otherwise show no cause for poor performance.

Summary

TPDs identify cars having poor curving performance. Data collected is used for planning appropriate maintenance actions that reduce inspection and maintenance costs.

In order to prove TPD effectiveness and to develop appropriate inspection and maintenance processes for car owners, poorly performing cars were identified by TPDs and subsequently sent to Transportation Technology Center, Pueblo, CO, where they were inspected, tested, and torn down.

One cause of poor performance was identified to be truck warp misalignment. In turn, causes for warp misalignment are low truck warp restraint or a truck that has high warp damping and becomes locked in a warped condition.

This TD describes means to measure and repair truck warp misalignment and supports TD-07-006 and TD-06-009 outlining, respectively, overall inspection and maintenance procedures and detailed issues associated with the truck/carbody interface.

Experience gained from this process has enabled the development of procedures to guide inspectors in the identification of car subsystems and components requiring maintenance. Component suppliers' and Association of American Railroads' (AAR) performance limits are used where applicable. Where limits do not exist, but are desirable, suggestions are made. Inspection and maintenance experience in response to TPD identification is, to date, limited. In addition, poor performance has been observed to result from a combination of subsystem and component condition and functionality as well as car type. Consequently, recommended condition limits and maintenance actions are often qualitative. It is envisioned that individual car owners will use these recommendations as guidelines for developing inspection and maintenance processes most appropriate for their fleets and operating conditions.

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BACKGROUND AND INTRODUCTION

As part of AAR's Strategic Research Initiatives Program, Transportation Technology Center, Inc. (TTCI) was tasked to develop inspection and maintenance procedures for cars identified as poor performers by TPDs.

TTCI developed algorithms to identify poorly performing cars using TPDs.[1,2] The relationship between these algorithms and the physical condition of the equipment needs to be established for effective car identification and maintenance.

TTCI conducted 23 inspections and teardowns of cars identified by TPDs. Of these, 16 cars were initially inspected and partially torn down at railroad maintenance facilities. Two coal cars were brought to the Transportation Technology Center for detailed inspection, test, and teardown.[3,4] Another five coal cars were inspected and partially torn down at another railroad maintenance facility.[5] Experience from these activities has been used to compile this and other reports listed under references.

TD-07-006 outlines overall inspection and maintenance procedures for identifying and rectifying causes for poor curving performance.[6] Identified causes for poor performance include:

- Low truck warp restraint
- Truck warp misalignment

Low truck warp restraint has been reasonably addressed in TD-07-006. The detection of truck warp misalignment is, however, more problematic. Friction wedges can lock with the truck in a warped condition. They can, in turn, unlock, as a consequence of:

- Vehicle/track interaction
- During carbody lift at inspection as:
  - Rotational resistance at the truck/carbody interface is relieved.
  - They release when the carbody weight is relieved.

In addition, the relationship between truck warp misalignment and truck warp restraint is that of frictional hysteresis.[7,8,9,10] This implies that there are a number of possible warp deflection angles that trucks can take up depending on their load histories and the residual loads between wheel and rail.

Nevertheless, measurement of truck warp misalignment can, on occasion, assist in understanding poor performance, especially when used in conjunction with observations of:

- TPD data in curves of opposite sense
- Observed asymmetric wheel flange and tread wear[6]

This TD details means to measure and repair truck warp misalignment.

MEASUREMENT OF TRUCK WARP MISALIGNMENT

The truck should firstly, and preferably, be measured in-place under the carbody. A number of passes in a yard should be made rolling the car back and forth on tangent, level track in order to best align the wheelsets. The car should then be stopped, without brakes, and the wheelsets' alignments measured.

There are four basic truck/wheelset orientations possible in a typical 2-axle truck, corresponding to different positions of the wheelsets with respect to each other (Figures 1 through 4). These can be determined and measured using a 10-foot straight edge or lasers as follows:

1. A straight edge is placed across the backs of the wheelsets on one side of the truck. It may be necessary to make this measurement on the other side of the truck as well, depending on the type of alignment orientation seen.
2. Close attention must be paid to determine the wheelset orientations prior to starting. Figure 1 shows the wheelsets parallel to one another and perpendicular to track center, and therefore the straight edge will seat properly on the flange backs with little or no clearance.

   Misalignments shown in Figures 2 and 3 reveal both similarities and differences. In each figure, the two wheelsets are parallel to one another; however, Figure 2 shows the wheelsets angled to track center with little to no lateral offset between them, whereas Figure 3 reveals the wheelsets perpendicular to track center with substantial lateral offset between them. Figure 4 shows radial misalignment and the straight edge contacting both wheelsets with gaps on either wheel. This was covered in TD-07-006.[6] When feasible and applicable, the straight edge must lay flush against the back(s) of a wheel(s). It may be possible to make a measurement against the face(s) of a wheel(s), but care must be taken to ensure that there is not any metal flow visible.

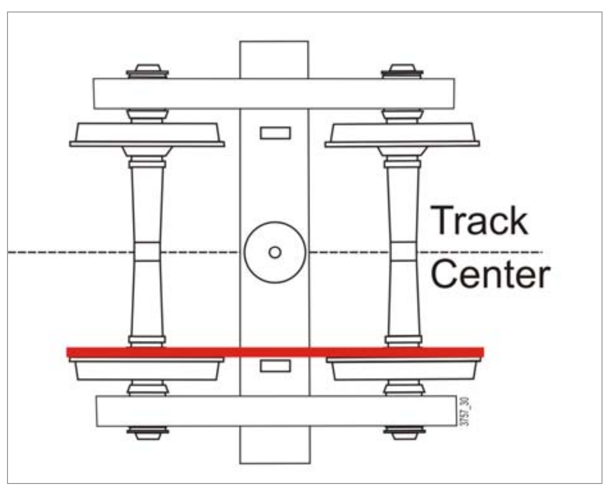

Figure 1. Parallel Wheelset Alignment, No Warp

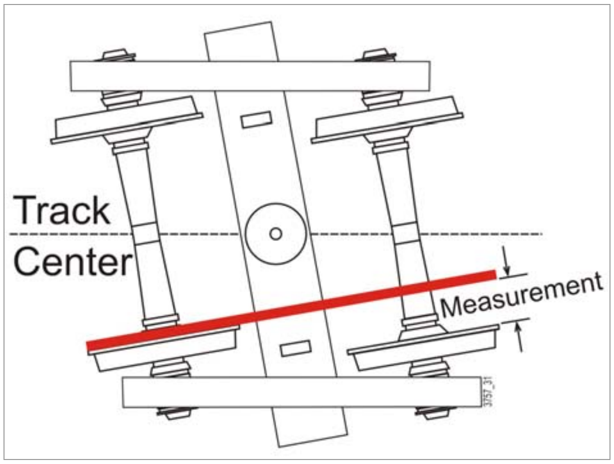

Figure 2. Truck Warp (No Radial Misalignment)

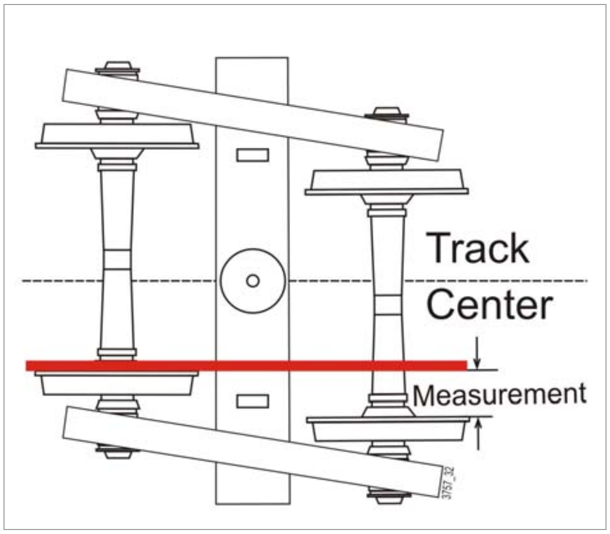

Figure 3. Truck Warp (No Radial Misalignment)

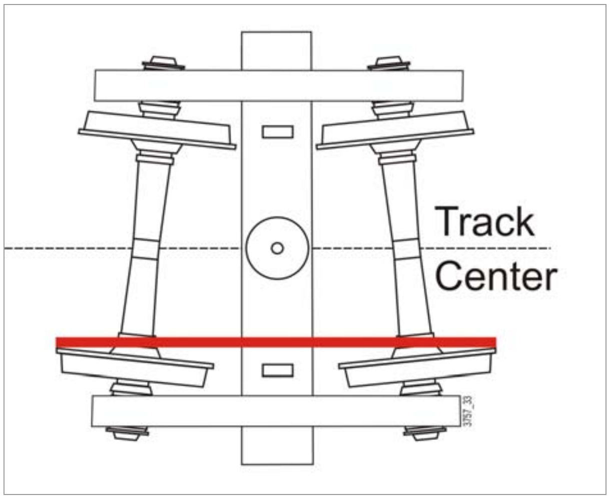

Figure 4. Radial Misalignment (No Warp)

3. Figures 2 and 3 can be reduced to a single measurement as an indication of truck warp misalignment, using a clearance measurement developed from a square truck (Figure 1) to compare against.

4. The mean of the measurements made on one and the other side may reduce the effects of differences in wheelset tolerances (e.g. back-to-back distances between flanges).

   If the warp measurement exceeds 3/8 inch (roughly 5 mrad), there is cause for concern, particularly if the flanges of the wheels that are aligned closer to the gage corner of a rail are more worn than the flanges on the opposing wheels. The truck may require further inspection.

5. The radial alignment of the truck should be measured.[6]

6. If there is appreciable radial misalignment (beyond 3/16 inch, roughly 2.5 mrad) and the clearances in the pedestals allow and the car in question is a light car, an attempt may be made to lever the wheelsets into a more parallel alignment and steps 1 to 4 repeated.

   Continued indication of excessive warp is cause for concern.

7. The carbody may be carefully and slowly lifted at this stage to establish whether the frictional contact at the truck/carbody interface or that in the friction wedges releases the warp misalignment in the truck.

8. Steps 1 to 6 may then be repeated to measure any changes.

   Continued indication of excessive warp or release from the warped state is cause for concern, particularly if backed by evidence of asymmetric wheel wear and poor TPD performance.

9. The bolster should be lifted and the truck torn down with careful inspection of, particularly:

   - Truck side frame column guide wear liners
   - Gibs
   - Friction wedge pockets in the bolster
   - Center bowl/plate wear and condition

   Any sign of vastly asymmetric wear to components may indicate a cause for truck warp misalignment.

OBSERVATIONS

By using this very simple technique of measuring and determining truck warp misalignment, a number of questions can be answered about poor curving performance. By measuring truck warp misalignment rather than making speculations, asymmetric truck and wheel wear and the performance seen from TPD data can be better clarified.

By observing the alignment of truck/wheelsets before and after carbody lift, the following can be determined:

- Poor or low warp restraint trucks
- Locked trucks

REPAIR OF TRUCK WARP MISALIGNMENT

Truck warp misalignment is corrected by utilizing one or more of the following:

- Verify that trucks and their components meet AAR *Field Manual* requirements or repair accordingly.[11]
- Replace condemnable friction wedges. It is also considered advisable to replace truck side frame column guide wear liners and friction wedge pocket wear plates to enable bedding-in of parallel surfaces.
- Replace broken, deformed or missing truck springs
- Restore proper frictional contact at the truck/carbody interface.[6,12]

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