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Effects of Long-Term Inactivity on Railcar Bearings

Inactive Bearings

Failures in railcar wheel bearings can result in catastrophic derailments like the East Palestine, OH incident on February 3, 2023. Many factors affect bearing performance, including long periods of inactivity as bearings sit idle in railyards or sidings. According to the NTSB incident report, the East Palestine train derailment was caused by a bearing that had two previous long periods of inactivity where the bearing sat idle for 565 days and then again for 216 days. Could inactivity contribute to lubricant degradation in which the grease separates and becomes less effective?

To answer this question, the University Transportation Center for Railway Safety (UTCRS) at the University of Texas Rio Grande Valley (UTRGV) teamed with the National Transportation Safety Board (NTSB), MxV Rail, and CSX Transportation to study bearings pulled from freight cars that have not moved for extended periods (6–36 months). This multi-year project started in 2023 and is ongoing; however, the first round of tests already produced interesting findings–not only about bearing damage, but about the methods needed to detect the damage. This research is in progress with preliminary findings.

Experiment

The first round of the project began with CSX locating freight cars that had not moved in three years and removing ten bearings. The bearings were pulled and shipped using special protocols to avoid any rotation that could redistribute the grease inside before they reached the test labs at UTCRS. Some bearings were opened immediately at UTCRS for inspection while others were left assembled for performance testing on a laboratory test rig.

During testing, UTCRS monitors both temperature and vibration. Temperature rise is the primary method railroads use to identify failing bearings using Hot Bearing Detectors (HBDs) mounted on the side of the tracks. Vibration is an alternative measure that is more sensitive and corresponds directly to mechanical damage of bearing components.

The first performance test was initially planned for 100,000 miles (161,000km) with speed and load gradually increased to final values of 66 mph (106 kph) and 34,400 lbs (153 kN) load per bearing, which closely approximates the maximum conditions seen in normal freight car service. The test rig spun four bearings at a time on a single axis: two bearings pulled from service, plus two freshly assembled healthy (defect-free) bearings for comparison. The pulled bearings are designated L7 and R7 in the figures.

At the beginning of the test run, higher than normal torque was required to start rotation. After starting, bearing R7 quickly showed signs of abnormality including sparks emitting from the seal after only 163 mi (262 km) and a dislodged seal after 6,731 mi (10,832 km). The seal event was accompanied by a brief spike in temperature that, notably, quickly subsided. After the seal was dislodged, the bearing leaked grease at irregular intervals (Figure 1).

Starting around 36,000 miles (58,000 km), the abnormal bearing showed vibration levels that were above the

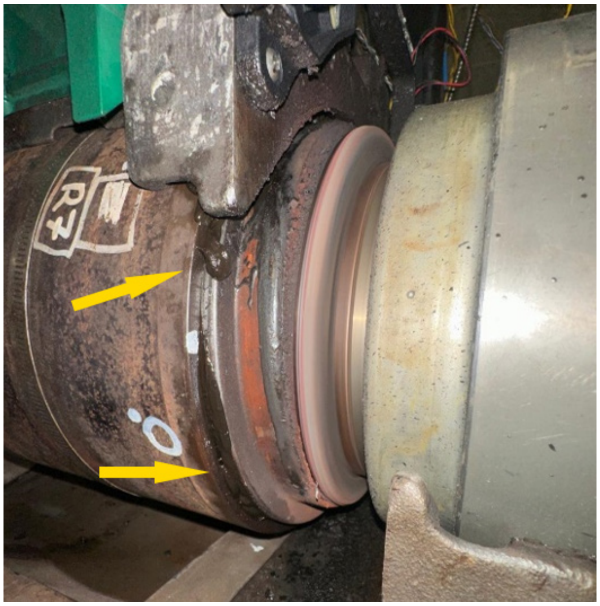

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Figure 1: Bearing R7 releasing grease after its seal dislodged.

established threshold for a normal bearing, and continuously increasing, indicating progressing damage. However, the temperature rise above ambient conditions showed no abnormality. The operating temperatures remained far below the 170°F (94°C) above ambient limit typically set for HBDs – they were usually below 50°F (28°C) above ambient and not significantly different than the healthy bearings.

Finally, the test was terminated early at 93,554 miles (150,561 km) due to impending failure: bearing R7 began *indexing* under full load. Normally, the inner ring of the bearing (the *cone*) grips the spinning axle and rotates with it, while the outer ring (the *cup*) is stationary and held in place by a bearing adapter. Indexing is a condition in which internal friction is so high that the outer ring moves, scraping against the bearing adapter that is supposed to hold it stationary. If continuous, this a dangerous condition requiring termination of the lab test.

After the test, both pulled bearings were opened and inspected. Figures 2 and 3 show cones from bearings L7 and R7, respectively. Consistent with the vibration measurements, R7 showed large areas of *spalling*, meaning flaking of metal off the surface. More importantly, one of the cones in R7 had a fracture across its entire width, as shown in Figure 4. In rail service, this could cause the cone to lose its grip on the axle, rapidly leading to overheating and catastrophic failure.


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Figure 2: The inner ring (cone) raceway of bearing L7, showing no signs of damage.


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Figure 3: The inner ring (cone) raceway of bearing R7, showing severe damage over a large area.


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Figure 4: Fractured cone in bearing R7. This fracture could cause the cone to lose its grip on the axle, leading to indexing and catastrophic failure.

Conclusion

The first sample included ten bearings, where two were subjected to long duration tests. A much larger sample is needed before definite conclusions can be drawn about the prevalence of compromised bearings on railcars that have been inactive for long periods of time. Nevertheless, the first sample included bearings that showed definite signs of moisture entry, and one of the two bearings tested exhibited severe damage that within 94,000 miles progressed far beyond industry standards for safe operation. Remarkably, there was no temperature indication of a problem, while vibration monitoring detected an issue about 57,500 miles before the end of the test, demonstrating its efficacy in bearing condition monitoring.

About This Project

This study was funded by the US Department of Transportation under Award No. 69A3552348340. The views presented here are those of the authors, and should not be attributed to the USDoT, NTSB, or industry partners for the project. The complete project report is available upon request. For the report or other information, please contact UTCRS at railwaysafety@utrgv.edu or (956) 665-8878. The center website is railwaysafety.utrgv.edu