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JOURNAL BEARING LOAD ENVIRONMENT OF A 125-TON COAL HOPPER

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<u>*Summary*</u>

In a recent AAR test, journal bearing load and vibration environment data was collected on a 125-ton aluminum-body coal hopper in unit train service.

Test data was analyzed and compared to data from a 100-ton coal hopper. Results show that the peak vertical bearing loads of the loaded 125-ton hopper were greater than those of the loaded 100-ton hopper. Vertical bearing accelerations were also greater. Lateral bearing accelerations were similar.

Most of the severe impact loads seen by the 125-ton hopper occurred as the test car was traversing crossing diamonds. Based on limited data, there was no clear correlation between peak vertical loads and train speed in this test. This suggests that the bearing load environment cannot be controlled through regulation of speed.

No loads and/or accelerations were measured during the hopper loading or dumping which were more severe than the loads and accelerations which were measured during loaded hopper operation.

Data from this test will be used as a baseline for investigations into the effects and detection of wheel defects, worn truck suspensions, and other irregularities which may affect the journal bearing environment. In addition, data will be used in the development of performance specifications for new bearing designs.

Association of American Railroads
Research and Test Department

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INTRODUCTION AND CONCLUSIONS

Journal bearing load and vibration environment data was recently collected on an in-service 125-ton open-top coal hopper. The purpose was to provide both the railroad and bearing industries real-world data from which performance standards and specifications can be developed for new bearing designs. This data will also be used as a baseline for future investigations into the effects and detection of wheel defects, worn truck suspension, and/or other abnormalities which may affect bearing loads. Analysis of the data shows that the bearing environment of a 125-ton hopper is more severe than that of a 100-ton hopper. Data for the 100-ton hopper was collected from "Journal Bearing Load Environment Test on the Burlington Northern Railroad" (AAR Report No. R-790).

The following statistics were computed from the data collected:

o Loaded 125-Ton Hopper
- Maximum vertical load - 106.4 kips
- Maximum vertical acceleration - > 115.7 g's[1]
- Maximum lateral acceleration - 51.5 g's

[1] The data acquisition system used was capable of measuring a maximum of 115.7 g's vertically; this value was reached in 2 of the 51 bursts of data collected.

o Empty 125-Ton Hopper
- Maximum vertical load - 38.1 kips
- Maximum vertical acceleration - 59.0 g's
- Maximum lateral acceleration - 45.9 g's

The data analysis also shows that most of the severe impact loads occur at crossing diamonds, where one set of tracks crosses another.

No clear correlation exists between peak bearing loads and train speed. This implies that the bearing load environment cannot be controlled through regulation of train speed.

Test Details

Testing was performed with the test car in revenue service in a Detroit Edison unit coal train from late October through mid-November, 1993. This train serves the Monroe Power Plant in Monroe, Michigan, and is loaded at the Bailey Mine in southwest Pennsylvania. The route covers 618 miles of Conrail line approximately every four days.

The test car was an aluminum-body 125-ton coal hopper, equipped for rotary dumping, built in 1970. The car was equipped with 38 inch wheel sets with class G (7x12) journal bearings. Prior to instrumentation of the test car, the wheels were inspected to ensure the absence of any flats or other irregularities which could cause data to be misleading.

Instrumentation of the test car consisted of replacing the standard bearing adapters on the lead axle with instrumented load measuring bearing adapters. Accelerometers for vertical and lateral measurements were mounted to the instrumented bearing adapters. A speed encoder was mounted to the axle.

Data was collected at a rate of 1000 samples per second. Analog low-pass filters with a cutoff frequency of 200 hertz were used to prevent aliasing.

Data Analysis

During data analysis, it was noticed that a large number of the data bursts were similar in that they contained two major impacts. Exhibit 1 shows a segment of left and right bearing load data from one of these bursts. The Exhibit also shows how the load spikes experienced by the bearing adapters could correspond to the rail intersections at a crossing diamond. Load spikes labeled A, B, C, and D correspond to the wheels on the instrumented axle encountering the flange-ways of the crossing track. Also, load spikes were seen on the instrumented axle when the trailing axle of the same truck encountered the same perturbations. These smaller, but significant, load spikes are labeled A', B', C', and D'.

Neither the hopper loading process nor the hopper dumping process could be captured as an isolated data set due to logistics. However, it was determined from the data collected that neither of these events resulted in bearing loads or accelerations as severe as those measured during loaded hopper operation.

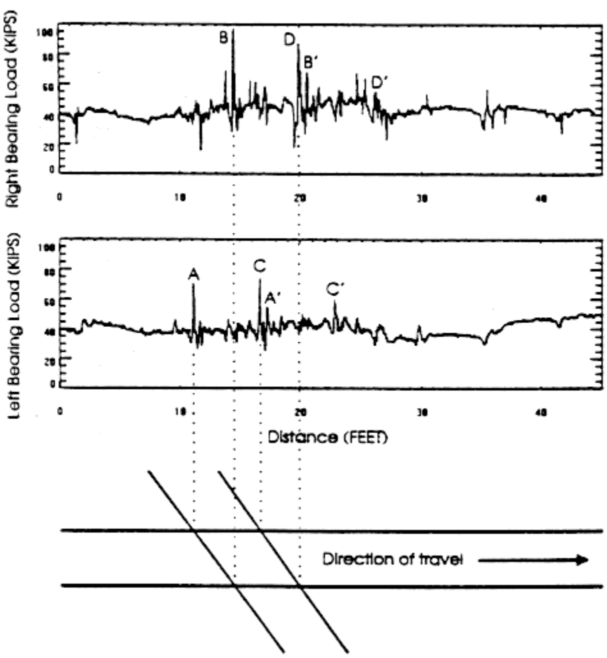

Exhibit 1. Most Bearing Impact Loads Were Caused by a Single Track Structure - the Crossing Diamond.

Loaded Hopper Data

The journal bearing load and vibration environment of the loaded 125-ton hopper is more severe than that of the loaded 100-ton hopper. Exhibit 2 shows the peak data values for both of the loaded hoppers.

	125-Ton	100-Ton
Peak Vertical Bearing Load	106.4 kips	75.2 kips
Peak Vertical Bearing Acceleration	>115.7 g's	103.0 g's
Peak Lateral Bearing Acceleration	51.5 g's	50.0 g's

Exhibit 2. Peak Values of the Loaded Hopper Data.

The maximum bearing load of the loaded 125-ton hopper was 41 percent greater than that of the loaded 100-ton hopper. This value represented an increase of 179 percent from the empty 125-ton hopper.

The maximum vertical bearing acceleration of the loaded 125-ton hopper was at least 12 percent greater than that of the loaded 100-ton hopper. The 115.7 g vertical acceleration full scale maximum of the data acquisition system was exceeded in 2 of the 51 bursts of data collected during loaded hopper operation. The peak vertical bearing acceleration of the loaded 125-ton hopper increased by 96 percent from the empty 125-ton hopper.

The maximum lateral bearing acceleration of the loaded 125-ton hopper was only 3 percent greater than that of the loaded 100-ton hopper. And, the peak lateral bearing acceleration increased by 12 percent from the empty to loaded hopper.

Vertical bearing loads for the loaded 125-ton hopper remain within +/- 5 kips of the static bearing load more than 98 percent of the time. Exhibit 3 shows vertical load distribution data collected during loaded hopper operation. Vertical bearing accelerations stayed within +/- 2 g's more than 98 percent of the time.

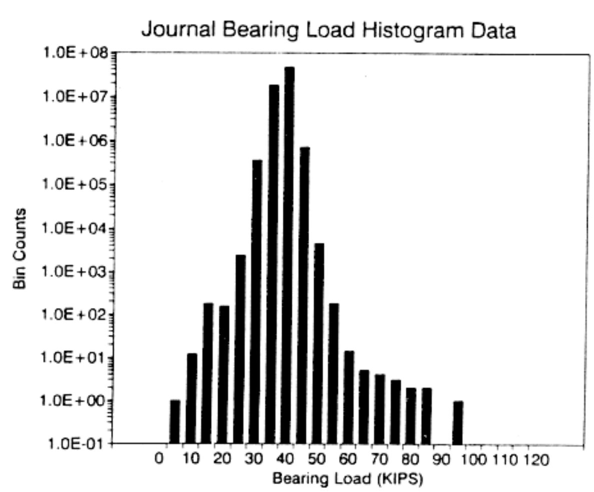

Exhibit 3. Histogram of Bearing Load of Loaded 125-Ton Hopper.

Lateral bearing accelerations stayed within +/- 2 g's more than 99 percent of the time.

Power spectral densities (PSDs) of each of the five-second burst histories were computed and averaged together for each channel. The PSDs show that the power of each of the signals is spread throughout the 200 hertz frequency range.

Most of the bearing load power is below 10 hertz. Exhibit 4 shows the average PSD of the bearing load. Power of the vertical bearing acceleration is concentrated below 5 hertz. And lateral bearing acceleration power is concentrated below 3 hertz.

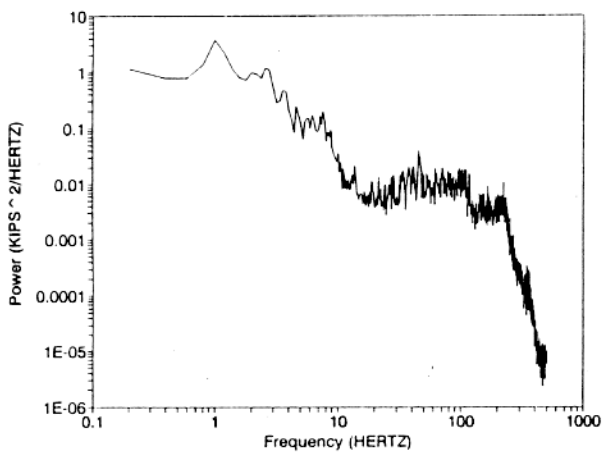

Exhibit 4. Average Power Spectral Density of Bearing Load of Loaded 125-Ton Hopper.

The correlation between train speed and peak bearing load was equal to -0.4 during loaded hopper operation. The statistical validity of the correlation is questionable because there were only eight pairs of data available for the calculation.

<u>Empty Hopper Data</u>

Peak vertical bearing loads of the empty 125-ton hopper were nearly twice those of the empty 100-ton hopper. Peak vertical bearing accelerations of the 125-ton hopper were slightly more than half those of the 100-ton hopper. Peak lateral accelerations were similar for the two hoppers. These peak values are provided in Exhibit 5.

A correlation coefficient of -0.2 was computed from 20 pairs of bearing load and train speed data.

	125-Ton	100-Ton
Peak Vertical Bearing Load	38.1 kips	20.0 kips
Peak Vertical Bearing Acceleration	59.0 g's	103.0 g's
Peak Lateral Bearing Acceleration	45.9 g's	51.0 g's

Exhibit 5. Peak Values of the Empty Hopper Data.

Note: Contact Kenneth L. Martin at (312) 808-7283 with questions or comments about this document.