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Constant Contact Side Bearing Environment

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Summary

TTCI has completed data collection and reduction for use in the newly published specification for constant contact side bearings (M-948, Manual of Standards Recommended Practices). Beginning in 2003, the Association of American Railroads (AAR) Mechanical Research Committee and the Transportation Technology Center, Inc. (TTCI), Pueblo, Colorado, a wholly owned subsidiary of the AAR, selected three rail car types to provide railroad environment information related to the performance of constant contact side bearings (CCSBs). The intent of the study was to develop a lab testing procedure for CCSBs using the displacements that a side bearing experiences in coal and intermodal service. The three cars tested were a refrigerated boxcar running with high-speed intermodal traffic, a coal hopper, and a single unit well car.

The following are the observations and conclusions from this test:

- All three test cars performed well in the combined 25,000 miles of testing because of their excellent condition and maintenance.
- CCSBs vertical fatigue cycles measured in the field are at or below the test requirements in M-948.
- CCSBs longitudinal cycles (hunting) occurred less often than the new test requirements of M-948 (making the specification challenging).
- Results from the service test show that the M-948 inputs are more severe. CCSBs meeting M-948 should therefore provide improved service performance for most types of cars under normal service conditions.

Having accumulated approximately 14,000 miles, the refrigerated boxcar was the primary source of M-948 data. In that period only one 2.3-mile region demonstrated any unfavorable vehicle performance. During this incident the recorded hunting values were measured at 0.38 g standard deviation while traveling at 65 mph. This information was used to provide validation for the inputs used in an M-948 laboratory test procedure, which in the final version, is a challenging specification for typical CCSBs. Meeting the requirements of the specification should provide confidence that these CCSBs will provide years of satisfactory performance.

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TTCI Transportation Technology Center, Inc.

Introduction

In 2003, the Transportation Technology Center, Inc. (TTCI), Pueblo, Colorado, began a series of tests on three cars known to experience high mileage in an effort to ascertain the environment experienced by constant contact side bearings (CCSBs). Each of the cars was instrumented with GPS equipment and instrumented to measure bolster rotation (CCSBs longitudinal sliding), car body roll in the center bowl (CCSBs vertical cycles), lateral accelerations at each end, speed, and global position. The focus for the instrumentation was the inputs into the CCSB. It was anticipated at the time that the services would also be a challenging factor in CCSB performance; this, however, was not realized in all cases. The cumulative mileage from colleted data was over 25,000 miles for the three cars.

Following testing, data was analyzed using peak valley counting, FFT, and phase analysis methods for both the accelerations and the displacements. This Technology Digest (TD) documents the applicable findings from the data. This information was used as a reference to establish testing limits used in the recently published M-948 specification in the AAR Manual of Standards and Recommended Practices.

76-Foot Refrigerated Boxcar

In 2003 the tests began on a 76-foot refrigerated boxcar owned by Tropicana and used to ship orange juice in high-speed traffic lanes from Tampa, FL to Los Angeles, CA (Figure 1).

Figure 1: 76-foot Refrigerated Boxcar from Tropicana

This service was selected as potentially being more challenging for side bearings since the Tropicana cars frequently ran at high speeds (60-70 mph). The route was traversed three times between Tampa and Los Angeles as depicted in Figure 2. The car is equipped with ASF Super Service Ride Master trucks using Lord primary suspension pads and A-Stucki SSB-5000 side bearings. Tropicana does an exceptional job of maintaining their railcar fleet, which proved beneficial on the wear and tear of components like trucks and CCSBs.

Because of the exceptional maintenance, only a small percentage of the boxcar performance inputs were considered challenging for CCSBs.

Figure 2: Path of Tropicana Boxcar Measured by GPS

Autoflood Coal Gondola

The next car tested was an Autoflood coal hopper owned by Southern Power and used in service lanes between the Powder River Basin, WY and Juliette, GA (Figures 3 and 4).

Figure 3: Southern Power's Autoflood Coal Hopper

Figure 4: Route Traveled by Southern Power's Hopper

The hopper was equipped with ASF Super Service Ride Master trucks using the Pennsy Adapter Plus primary suspension pads and Miner TCC-IV CCSBs. The car was in excellent condition and looked new. It originally came equipped with standard travel side bearings, which were replaced with the TCC-IV design and run for one round trip before collecting over the road (OTR) data.

TTX Single Unit Well Car

The last car tested was a TTX single unit well car shown in Figure 5.

Figure 5: TTX Single Unit Well Car

This car traveled in service lanes frequented by intermodal traffic, however it did not get utilized in the dedicated "Z" trains which travel under priority conditions at high speed (up to 70 mph) coast-to-coast. Figure 6 shows the routes that data was retrieved from. Gaps in the paths were caused by loss of power (solar) or equipment malfunctions. Essentially no significant data results were collected and thus were not used in developing the M-948 specification.

Figure 6: Route Traveled by TTX's Single Unit Well Car

The well car was equipped with ASF 70-ton Ride Control trucks and Miner TCC-III long travel side bearings. The car had acquired 532,000 miles before being used in the OTR test. The wear condition was appropriate for the mileage and it was preferred to leave the car in as-is condition for the test.

Data Results for M-948

Considering the available data set the most notable observation is the absence of any challenging inputs into the CCSBs from the three cars. It was anticipated that plentiful high-speed instability events would give an indication of the frequencies and amplitudes that CCSBs experience while in railroad service. Those cycles would then be modeled when developing inputs to be used in a laboratory test to evaluate the CCSBs. Instead all three cars produced few OTR inputs that would challenge the newer designs of CCSBs. In a positive light this is good news since recently there have been many advances in railcar components like trucks and side bearings that provide better car dynamic performance.

Vertical CCSB Cycles

Service data from the three cars was analyzed for the vertical displacements imparted to CCSBs. Table 1 provides the cycle counts measured in the vertical direction as compared to those published in the M-948 specification.

Table 1: Vertical Cycle Counts Measured in OTR Tests and Required in the M-948 Specification

Amplitude (in)	*OTR Counts*	*M-948 Counts*
0.125	2,841,318	1,200,000
0.250	140,966	240,000
0.375	24,215	40,000
0.500	6,551	10,000
0.625	2,591	2,500

The counts (at normal frequencies of 0.1 to 2.5 Hz) at the lower amplitude range are not particularly challenging to typical side bearings so the difference in counts at 0.125 inches is not significant. The M-948 input requirements do increase the cycles in the mid ranges, which should make lab testing more conservative. In addition, the inputs can be imparted in a time frame that is more compressed than that measured in revenue service, which again facilitates a more conservative test.

Longitudinal CCSB Cycles

As stated earlier the available data demonstrated little issue with poor car performances. Reasons for this result are related to good car conditions and operating speeds. The refrigerated boxcar made three trips between Tampa and Los Angeles totaling 14,000 miles. In one of those trips, the leading truck (B-end) experienced high-speed instability continuously for over 2 miles. Figure 7 shows the traces from this event.

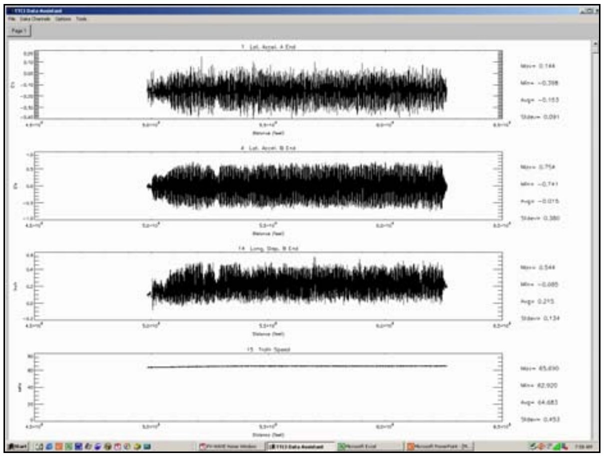

Figure 7: Accelerations and Displacements Recorded on Three Miles of Track near Willcox, AZ

To provide some measure of the type of inputs used for the M-948 service test a further analysis of this singular event is provided below. M-948 requires that for 37-hours and 20-minutes, CCSBs be subjected to hunting cycles that combine both a vertical and lateral displacement. The vertical cycle (peak-to-peak) is 0.125 inches at 3.0 Hz in phase with longitudinal cycles of 0.25 inches at the same frequency. When comparing this to the segment of data above there are some interesting correlations. Figure 8 shows the Fast Fourier Transform (FFT) of the filtered (FIR filter at 10 Hz) displacement signals from the boxcar; note that the frequency in both cases is about 3.0 Hz.

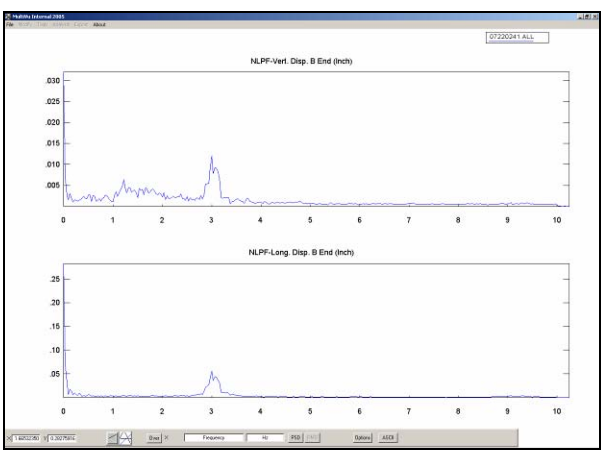

Figure 8: FFT of Boxcar Displacement Channels Demonstrates the Hunting Frequency

A closer look at the actual time history (Figure 9) reveals the phasing of the two displacements and a sample of the amplitudes experienced by the boxcar. In this case the signals are out of phase as compared to the signals specified in M-948 (Figure 10). It does not make a difference if these inputs are in phase or out of phase by 180 degrees as shown, since input to CCSBs is essentially the same either way.

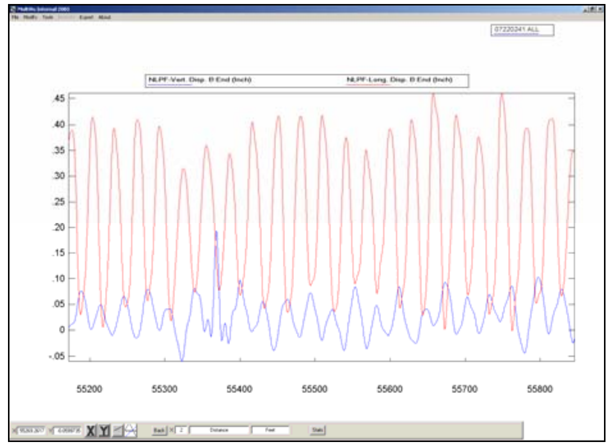

Figure 9: OTR Displacement Cycles Recorded on the Tropicana Boxcar

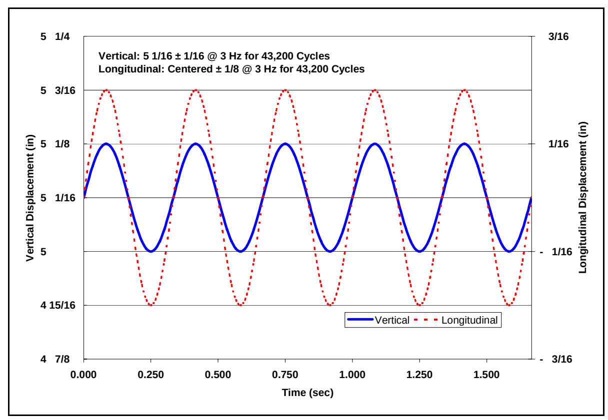

Figure 10: M-948 Hunting Input Requirements for CCSB Lab Testing

Finally, when considering the amplitudes, there are some trade-offs. The amplitudes in M-948 are generally equal (vertical) or smaller (longitudinal) to OTR cycles but the continuous time of the inputs is very different. In OTR tests the boxcar-hunting event lasted 2 minutes where the lab test is conducted continuously over 69 hours (over 37 hours of hunting cycles and the rest of the time in curving cycles).

Conclusion

M-948 is a very severe lab test for the typical side bearings used in service today, meaning that successful candidates should provide many years of good railroad service. OTR test data (where available) provided useful data points to characterize the new lab test inputs. A follow-up Technology Digest will describe the experience of using M-948 to evaluate typical CCSBs.