AK Car Impact Response Testing to Determine Axlebox Dynamics Due to Rail Profile Irregularities

Impact response testing of the AK car was conducted at the Chullora Workshop on the 22nd of April, 2009. The purpose of this testing was to determine the dynamic response of the axlebox to various force inputs. This understanding of the dynamics will lead to an ability to calculate the magnitude of rail geometry defects from measured acceleration signals. The force inputs were applied at various wheel/rail contact points around the instrumented bogie and the response was measured with the wheels in contact with embedded rail and in contact with soft rubber pads.

Main Results and Conclusions

The testing gave repeatable Frequency Response Functions in the frequency range of interest (10-100Hz). These frequency response functions represent the dynamics of the axlebox due to equal magnitude impulsive forces at the various wheel/rail contact points on the bogie. The specific findings of these tests are;

- The tests conducted on rubber pads show that the response at the axlebox in the 10- 100Hz range, due to equal magnitude force inputs at various wheels, is mostly composed of nearly equal contributions from both wheels on the measured axle (approx. 85%), with a small contribution from the other wheelset on the bogie.
- The tests conducted on embedded rail show that the response at the axlebox in the 10-100Hz range, due to equal magnitude force inputs at various wheels, is mostly composed of contributions from the wheel/rail contact directly below the axlebox (approx. 48%), with additional contributions from the opposite wheel (approx. 32%) and the other wheelset (approx. 20%).
- The magnitude of response on embedded rail is also significantly reduced when compared to the response on rubber pads.
- These results indicate the sensitivity of the response to changes in the support structure stiffness and the importance of taking into account the contributions of the other wheel/rail contacts when calculating the rail geometry from acceleration measurements.
- In all cases the Frequency Response Functions are not flat. This means that the dynamics of the AK car bogie in this range will promote some frequencies of vibration more than others, leading to over/under estimation of the rail profile if double integration of the raw acceleration signal is used to calculate the rail profile without accounting for the dynamics.

Recommendations

Based on these results the following recommendations for further study are made;

- Theoretical and experimental validation of these results should be performed by modelling the dynamics of the AK car bogie and comparisons of measured axlebox signals with accurately measured speeds, rail profiles and low frequency rail dynamic responses.

- The robustness of the rail profile estimates may be increased by calculating the rail profile in wavelength bands, for example in a similar fashion to the third octave rail profile analysis currently used in the CAT profile acquisition software.
- The sensitivity of the response to the support structure dynamics may necessitate the development of a methodology for eliminating the rail response from the displacement estimate or some form of output-only system identification. The purpose of this would be to indentify the properties of the support structure from the acceleration data so that the correct rail model can be applied when calculating the rail geometry from the acceleration signal.