Jewell Instruments

Characterization of Dynamic Inclination of Bogie

- **Objectives:** Measure dynamic inclination of bogie
- **Solution:** Jewell Instruments **LSOC**
- **Benefits:** High resolution and ruggedness
- **Results:** Reliable and precise measurements

Overview

In addition to high accuracy & precision accelerometers, rail systems and related equipment often make use of equivalent inclinometers for rail maintenance of way applications, and for measuring dynamic tilt of rail cars. These are aspects of paramount importance when it comes to ride comfort, reliability, and the lifespan of the rail equipment in question. The rail car's bogie is a harsh environment where the bogie's components are exposed to adverse conditions, including high levels of shock and thermal swings. These wear out the components over time.

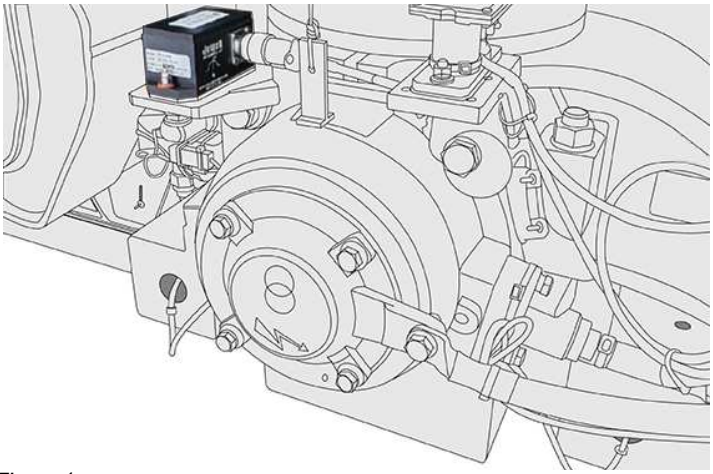

Figure 1

Background Of Issue

A Jewell client required a rugged inclinometer solution to measure the dynamic inclination of a high-speed rail system bogie during operation at varying speeds. This set-up would then monitor and characterize the lateral dynamics of the train and inform a variable to be used on a dynamic simulation system intended to be used as a predictive maintenance model to anticipate the wear and lifespan of critical components.

High levels of shock were expected during operation, so a rugged-yet-accurate product was required. Jewell recommended an LSOC Force balance inclinometer, a fluid damped inclinometer intended for rough applications.

Figure 1 shows the Jewell LSOC mounted to the Rail bogie, where its sensitive axis has been positioned to measure tilt dynamics in the lateral direction relative to the travelling axis of the train (Y axis).

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Project

For this application, several technologies were evaluated. The rough environment, due to shock, vibrations tend to reduce sensors life and more importantly, prevent a clean signal to be delivered by the sensor. Output clipping, and noise are typical drawback of majority of sensors in harsh environments. The rugged nature of the LSOC, along with its fluid dampened sensing element, prevent many of these issues including clipping by attenuating unwanted amplitudes and input frequencies from the input of the sensing element made up of a sensing servo motor.

During operation concerns were brought up regarding high levels of shock applied to the sensor. Shown in Figure 2 where the red traces are the LSOC, and the blue are from a third-party reference inclinometer, You can see in the acceleration chart that there was a series of recurring shock of up to ~15G's (max) impacting the system during operation. From these concerns, it was decided to fill the interior of the LSOC with a free flowing syntactic foam powder to increase longeivity of the sensor, in addition to enhancing the sensors dampening fluid for greater protection and performance.

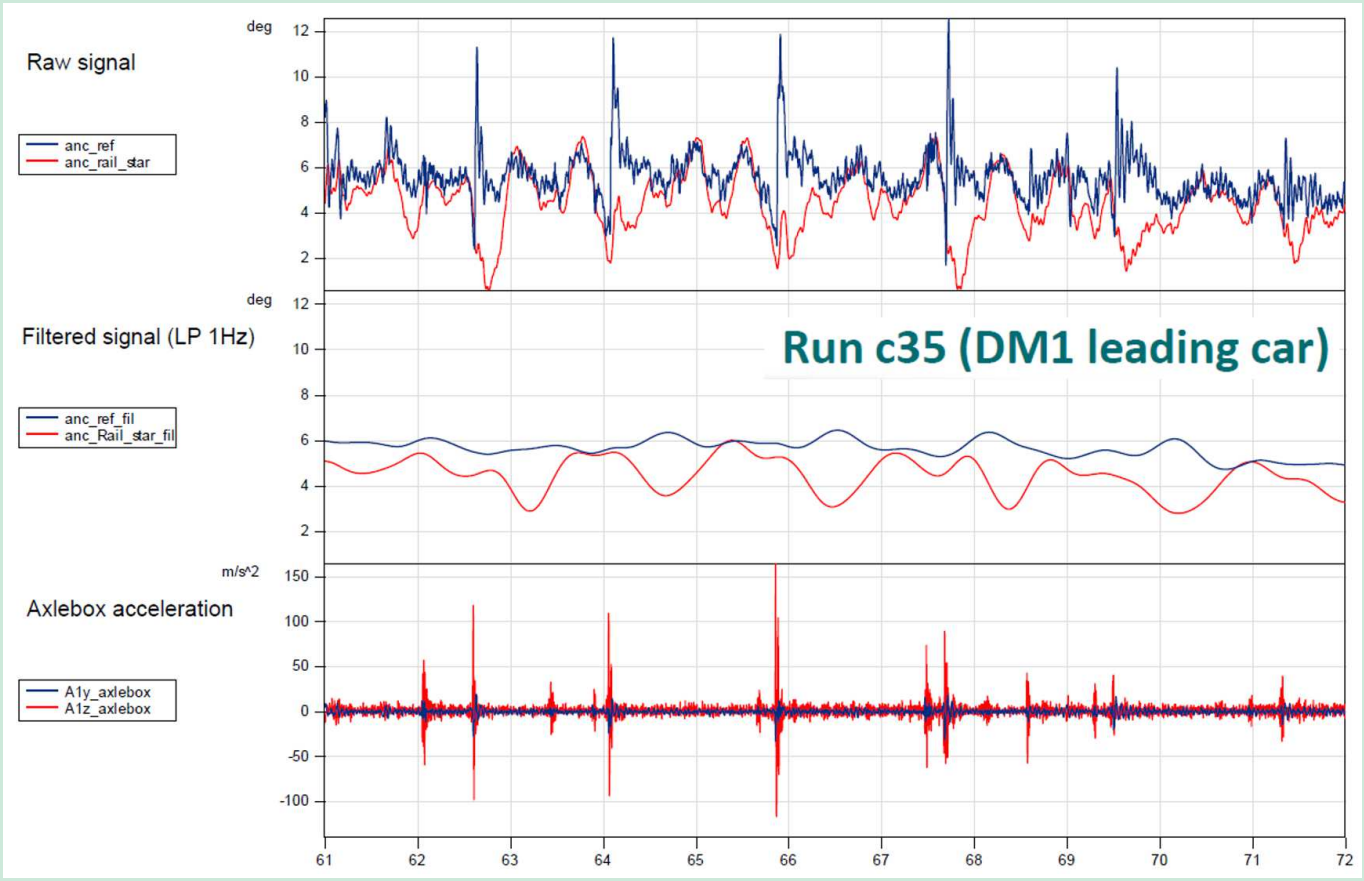

Figure 2

After modification, the customer successfully carried out their bogie dynamics characterization, with accurate and reliable data gained from the LSOC despite recurring levels of shock during the test runs.

The LSOC & our newer, improved LSOX are particularly suited to demanding rail applications, being resistant to impact shocks with a survival rating of 1500g's at 0.5ms (0.5 sine). The products are also available as CENELEC compliant variants.

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