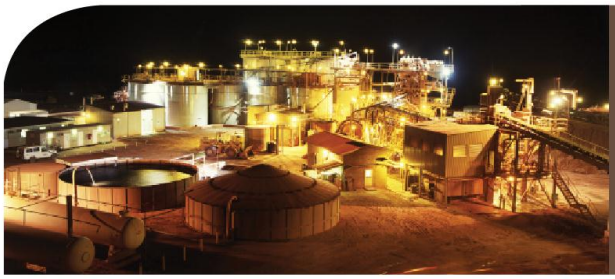
ALS Asset Care



AssetCare Counts #18

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Operational Deflection Shape Analysis Aids Gearbox Vibration Diagnostics

Gearbox vibration condition monitoring is a well-established technique in industry. After the recent replacement of a large mill drive gearbox with an older refurbished unit, vibration levels on all of the measured vibration channels increased markedly. The conventional gear vibration spectra recorded were however observed to be commensurate with gear pairs at the start of their service life. Due to the long history ALS Industrial has with the customer, we were able to retrieve historical vibration data for the particular gearbox in question from our database. It was immediately apparent that the same refurbished unit had similar high vibration levels when it was in service at the customer's site between 2000 and 2006. Towards the middle of 2006, a new gearbox was installed, which immediately lowered the measured vibration levels.

What are the key differences between the two gearboxes? The original gearbox (which exhibits the higher vibration levels) has a casing manufactured from welded plate steel. The newer gearbox has a cast and machined casing. Although it may be anticipated that the welded plate steel casing would respond differently to the structural excitation compared to the cast casing, the client sought confirmation of the cause of the observed high vibration levels.

An ALS engineer went out to site with a high channel count multi-function data acquisition system. Standard condition monitoring data was acquired on thirty channels simultaneously. The gearbox was re-instrumented in different locations to obtain time waveform data from which an Operational Deflection Shape (ODS) could be computed. Ten points on the gearbox casing were selected and instrumented in each of the three Cartesian coordinate directions, resulting in thirty channels of data simultaneously acquired.

From the ODS data (Figure 1), a dominant torsional vibration mode could clearly be identified. It was therefore evident that the gearbox casing was lacking in torsional stiffness. As the casing experiences torsional flex, the meshing gear pairs will experience small relative motion, leading to slight imperfections in the meshing geometry. These imperfections account for the high audible noise levels experienced in the vicinity of the gearbox.

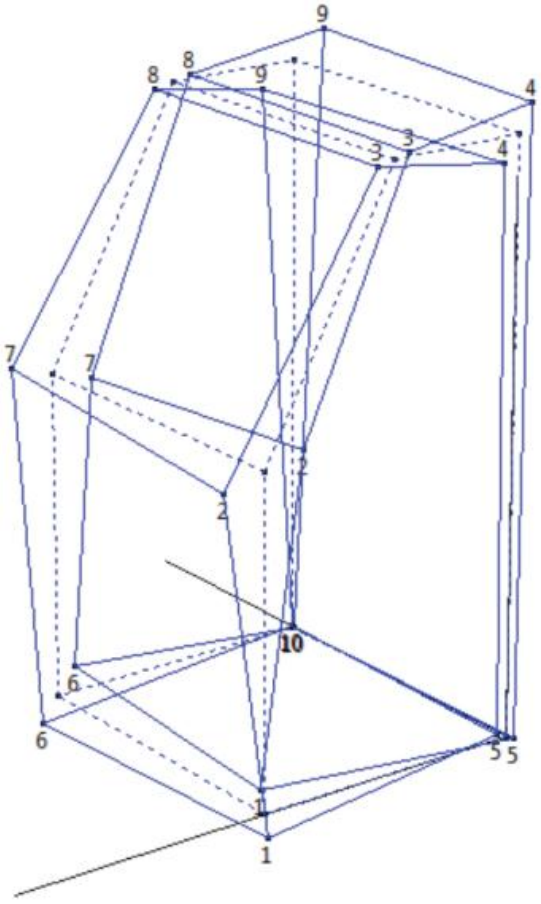

Figure 1 – Gearbox Casing ODS

Due to the marked rise in overall vibration levels observed when the reconditioned gearbox was installed, coupled with the high audible noise levels experienced in the immediate proximity of the gearbox, the client was concerned that this gearbox might not function satisfactorily for a sufficient length of time. Drawing on the dominance of the torsional vibration mode shape exhibited by the gearbox, the primary cause for the high levels of both vibration and noise could be clearly established, backed up by solid experimental evidence as measured in the ODS analysis: the gearbox lacks torsional stiffness. This information may be used to adjudicate the root cause of the vibration issues experienced with the gearbox: a torsional vibration mode is to blame, as opposed to a defect or flaw in the gear teeth.

In this case study ODS analysis was found to be a clear aid in diagnosing an issue experienced with an industrial gearbox, facilitating sound engineering judgement based on reliable information. A defect or flaw in the gear teeth, whether due to manufacturing error or wear, would require replacement of the affected gears, while torsional stiffening of the gearbox casing requires modification to the casing. In this case, replacement of the gears would likely have contributed very little to a reduction in the high vibration levels, whereas modification of the gearbox casing stands would significantly reduce the problematic vibrations. Operational deflection shape analysis has therefore served to pinpoint the cause of the high vibration levels as a structural issue with the gearbox casing.

Due to the size and criticality of the gearbox, modification to the gearbox casing was not an option. Being able to pinpoint the issue with the gearbox prevented expenditure of significant resources on proposed solutions that would not have adequately addressed the root cause of the problem.

The ALS Reliability Engineering group works with clients across Australia to offer advanced vibration diagnostics services.

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