Taking the guesswork out of managing resonance issues using FEA

When a machine running speed matches with a resonant machine frequency, excessive resonance vibrations can be created.

Resonance has been responsible for some of the most spectacular failures in industry, from common site components such as motors and pumps through to massive structures such as bridges (see Tacoma Narrows Bridge).

In rotating equipment, resonant frequency events can occur as a result of natural balance variations, **making resonant frequency concerns an ever present risk**.

Whilst detectable by vibration analysis stopping the problem permanently isn't always easy.

Altering the machine to change the resonant frequency, without engineering understanding, can be "hit or miss", where the changes may not be effective or even can make things worse.

The alternative to "hit or miss" is using **Finite Element Analysis (FEA)** to test many possible modifications and determine the most effective and practical.

The challenge

ALS was approached by a client with a newly installed underground ventilation fan that could not be operated at the operating speed due to excessive vibration. The inability to utilise the ventilation fan was impacting production as a lack of airflow reduced the number of haul-trucks permitted underground.

ALS was approached to perform onsite investigations of the cause of the excessive vibration and to provide recommendations to overcome the problem.

The approach

ALS developed a work scope that included both site testing and FEA. Site testing provided real-world data for a thorough understanding of machine behaviour under the expected range of operating conditions. Subsequent FEA would allow multiple different modifications to be tested to ensure that the final recommendations achieved the required objectives.

Site results

A bump test performed on the fan structure revealed a clear resonance at 22.8 Hz.

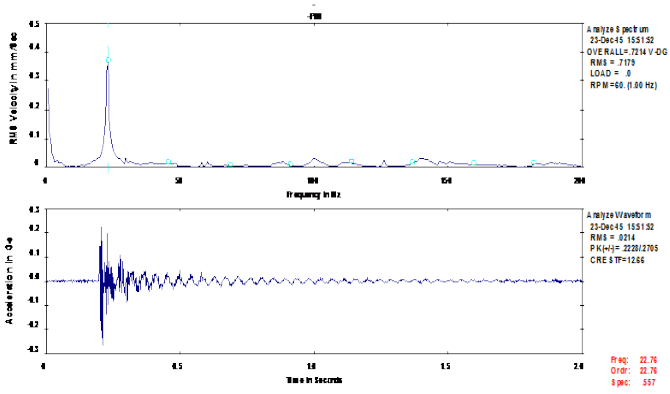

Figure 1: Bump Test Spectrum and Waveform

Multichannel data-acquisition revealed that the resonance related to a whole body horizontal vibration mode, resulting in specific distortions of the motor support structure, fan casing and mounting skids.

FEA results

With this information gathered onsite, ALS set about constructing a finite element model to test a number of different structural modifications aimed at altering the resonant frequency.

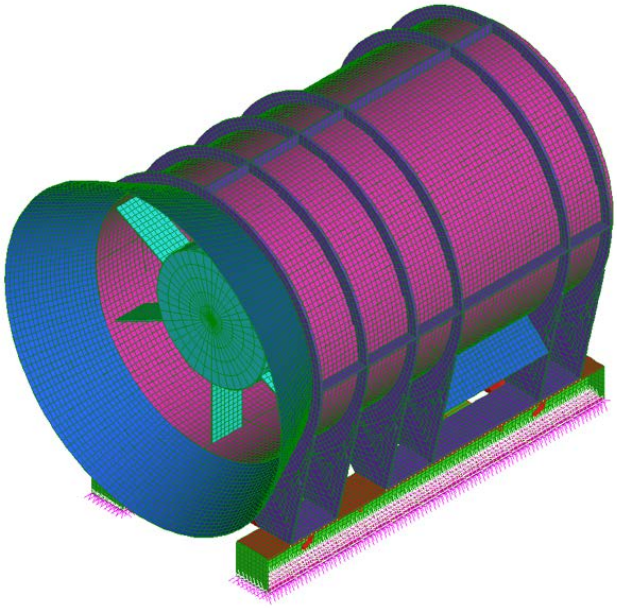

Figure 2: Ventilation Fan Finite Element Model

The final solution was designed in three stages to meet immediate and future performance requirements.

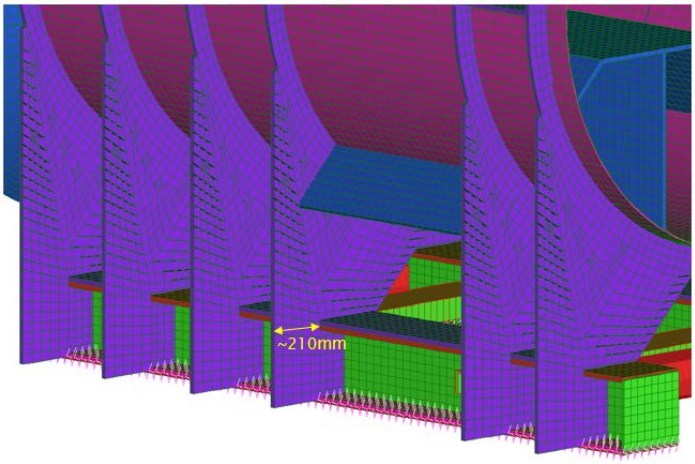

Figure 3: Finite Element Model Showing Stage 1 and 2 Modifications

The outcomes

After implementation of stages 1 and 2, ALS attended site to perform, ALS attended site to perform further services only to find fan already operating at low vibration levels and not requiring any further improvement in balance state.

Figure 4: Modified Underground Vent Fan Structure

The return of the ventilation fan to service, essential to proper mine performance, allowed for immediate returns in mine productivity.

Our reliability team

The above solution demonstrates the broad capability that ALS brings to bear to manage vibration problems.

From:

- Efficient vibration analysis, to
- High end consulting engineering services such as FEA, and
- Affiliated services such as machine balancing

ALS has solutions for understanding and solving all of your vibration issues in a cost effective manner.

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