ROTORDYNAMIC ANALYSIS OF A CENTRIFUGAL FAN

Objective

To assess the flow induced vibration characteristics of a radially backward curved centrifugal fan under various operating speeds, using FSI technique and assess its operating safety.

Challenges

- Choosing the appropriate boundary conditions.
- Ensuring proper contact between shaft and rotor.
- Mapping of flow induced load on to the walls of fan blade

FEA Model

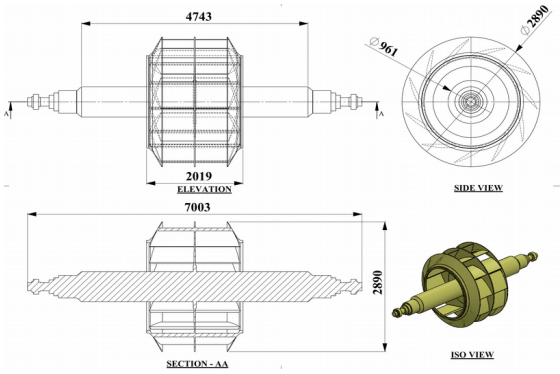

Fig 1: Geometry – Centrifugal Fan

Fan Type	Double Suction Radial Fan
Fan Impeller size (OD)	2748 mm
No. of blades	11 (On each side of centre plate)
Blade type	Aerofoil
Fan Speed	950 rpm
Fan total weight	42900 kg (without motor)
Bearing Type	Spherical Roller
Vibration limits	2.5 mm/s

Table 1: Fan specifications

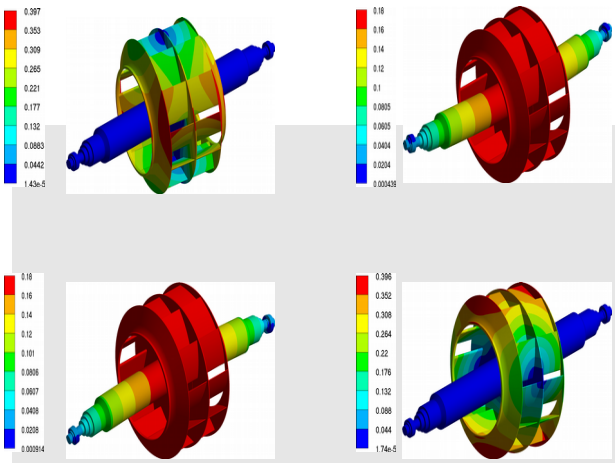

Fig 2: 1st Four Mode shapes

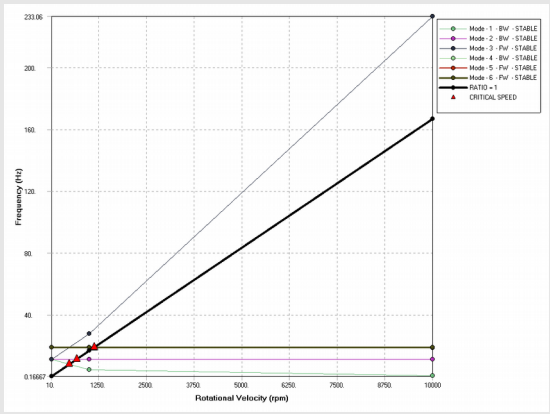

Fig 3: Campbell Diagram

Approach

Rotordynamic analysis is used to study the vibrational behaviour of a rotor shaft system. The vibrational behaviour of Induced Draft(ID) Fan impeller (Fig 1) of a typical 300 MW power plant subjected to dynamic flow load is assessed in this case study. The fan specifications are as shown in Table 1. RANS based turbulent flow model was used to resolve the flow field near the blade and shaft region of the fan. The force exerted by the flow were mapped onto the blades to assess the vibration characteristics of the fan under such dynamic load conditions. Bonded contact region is defined at the interface of rotor and shaft. The bearings are provided at both ends of the shaft. Bearing properties are assumed to be axisymmetric and the stiffness is specified. The rotational velocity of rotor is varied from 10 rpm to 10,000 rpm. Harmonic analysis using FEA code was applied to predict Natural frequency and mode shapes (Fig 2) for the first 6 modes. Results of Natural frequency and mode shapes were extracted at different rpm to generate the Campbell diagram (Fig 3). From the Campbell diagram, critical speeds of the ID fan were identified at various operating conditions. The results obtained from the simulation were found to be in good agreement with the analytical values mentioned in design values.

Conclusions

The critical speeds of given system under dynamic load conditions were predicted by performing flow coupled with modal analysis and plotting the Campbell diagram. The results indicates that the operational speed is away from the critical speed and hence the operating conditions of fan can be considered safe. However in harmonic analysis results the vibration amplitude peak was 5 mm/s, whereas the OEM specified vibration limit is 2.5 mm/s. If the condition of resonance is met, the fan would vibrate beyond the allowable limits.

Benefits

- Natural frequencies and mode shapes can be predicted.
- Critical speeds within or near the operating range can be identified.
- Vibrations under dynamic loading can be predicted.

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