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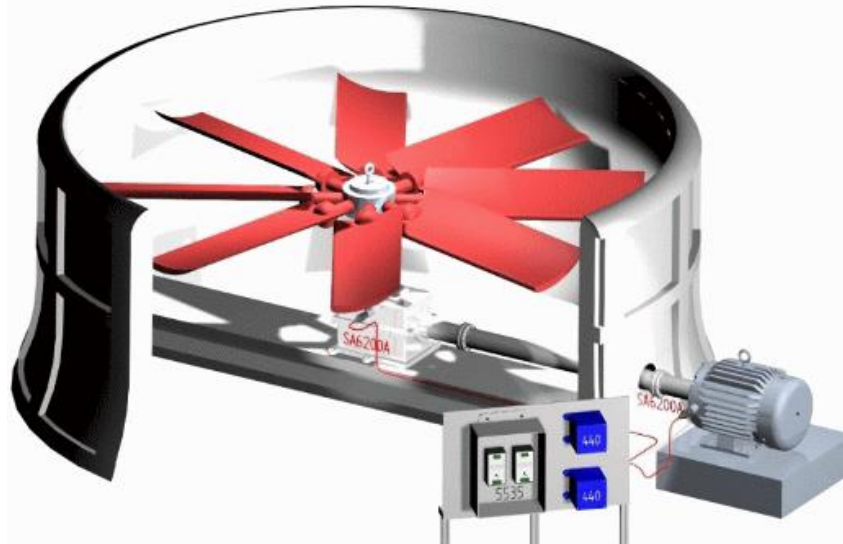
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Case Study on Failure of Gearbox of Cooling Tower Fan in Cement Mill

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Equipment Details:

- Equipment : Cooling Tower Fan
- Equipment Tag : CTF-2
- Motor Rating : 160kW, 1485 rpm
- Gearbox : Paharpur Geareducer
- Gear Ratio : 12.98
- Gear Shafts : Input, Intermediate Gear & Output



Problem Description:

- High vibration was experienced on the motor of the cooling tower fan with the entire structure vibrating.
- The Mechanical manager of the site decided to perform shaft alignment as routine alignment check was due on the fan.
- Vibspectrum was requested to carryout the alignment prior to vibration check.

Alignment Results:

As Found



As Left



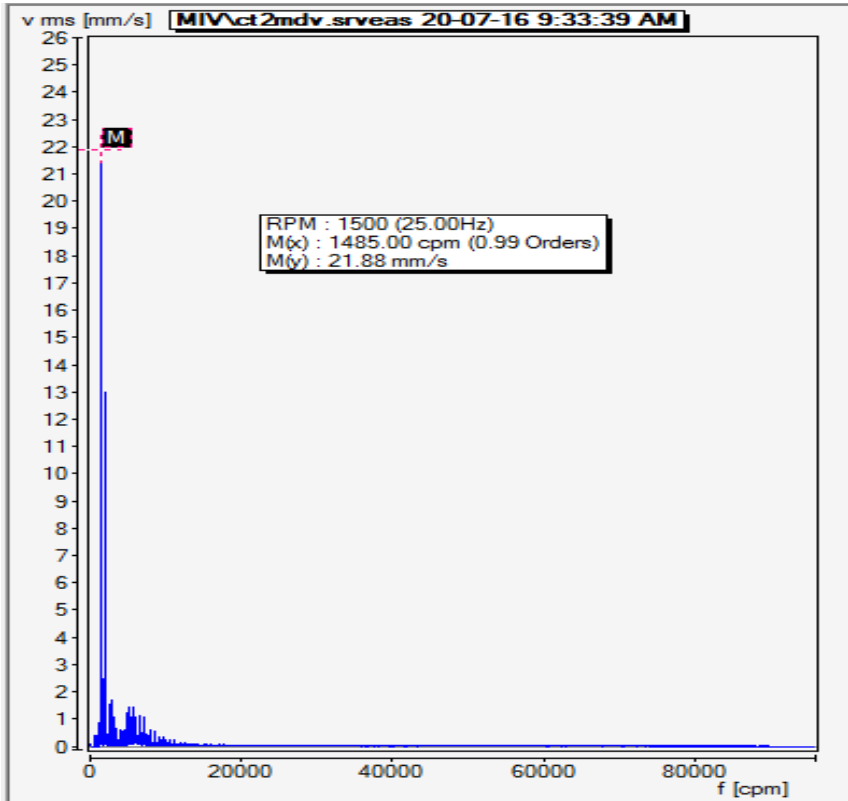
- The results indicated the spacer coupling between the motor and gearbox shaft was misaligned.
- The correction was performed in the vertical axis and brought to acceptable limits but in the horizontal axis, the correction wasn't possible as the motor was bolt bound in one direction.

Vibration Spectrum:

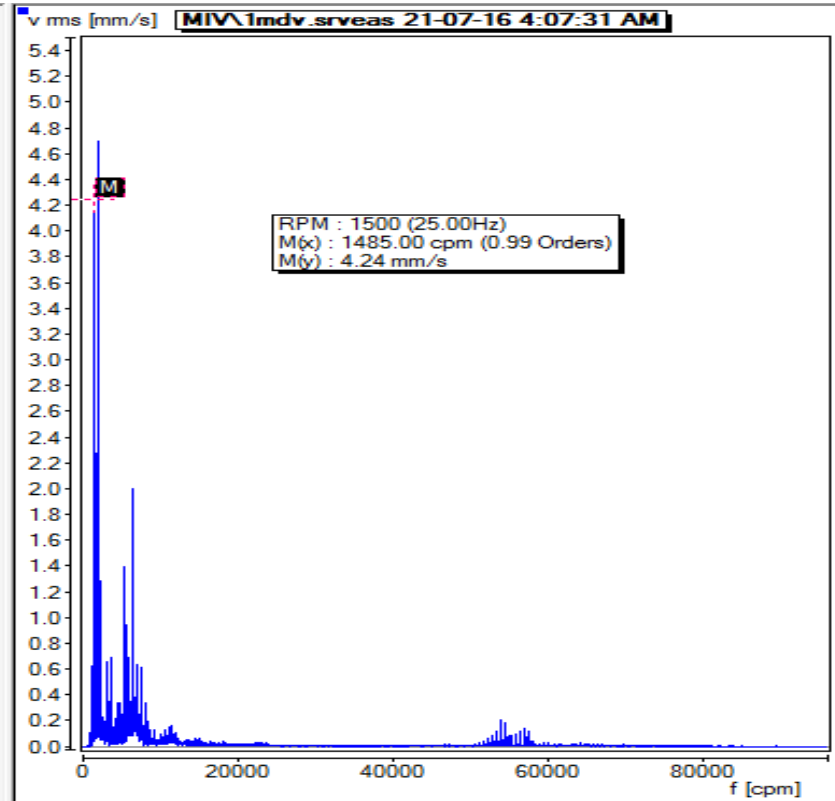
- The machine was run at full speed after the alignment correction.
- High vibration still persisted on the motor with predominant 1x peak vibration of motor rpm.
- Long cable was laid to capture the vibration on the gearbox and the spectrum was dominated by 1x running speed of the motor rpm.
- Balancing was advised to reduce the high 1x amplitude.
- It was decided to add weight on the coupling for balancing the 1x frequency amplitude.

Vibration Spectrum after Balancing:

Before Balancing



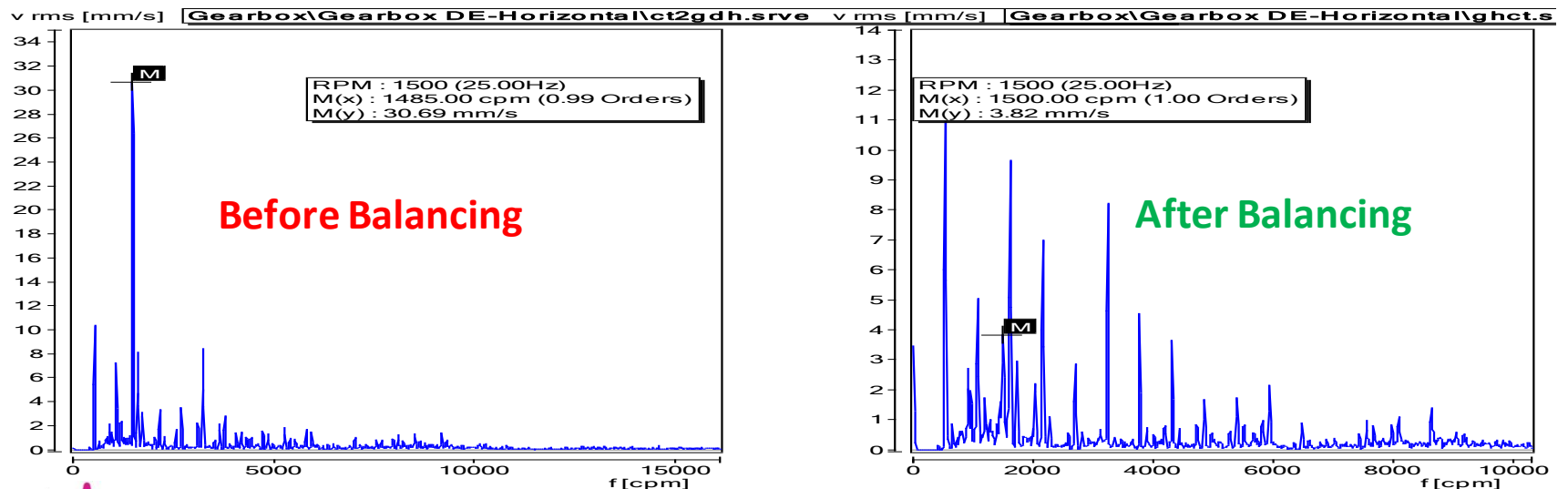
After Balancing



- The coupling balancing was performed and the vibration levels on motor reduced from 21mm/s to 4.24mm/s RMS.

High Vibration on the Gearbox:

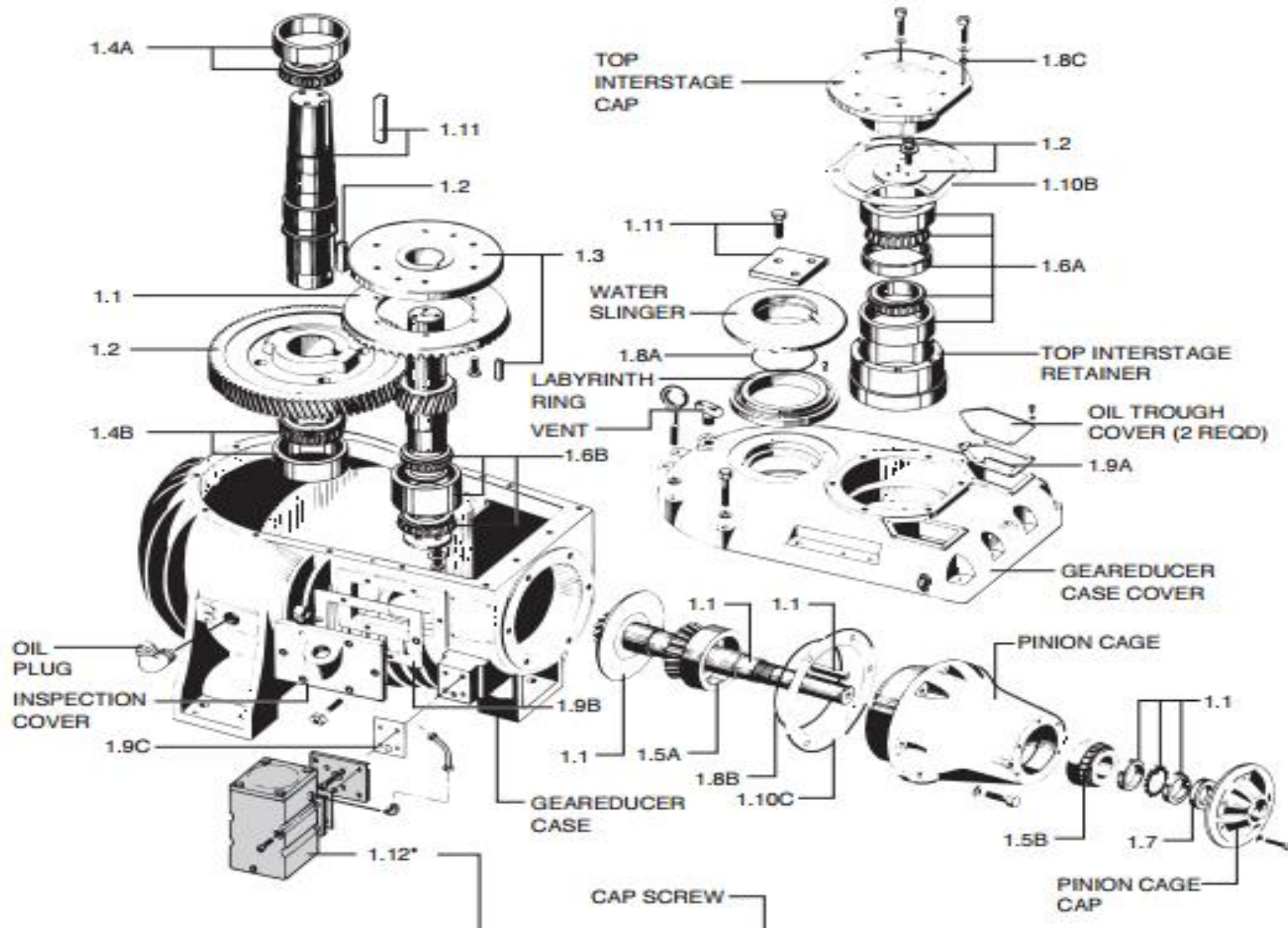
- The vibration on the motor side reduced but the vibration on the gearbox was still above acceptable limits.
- The high vibration was dominated by 1x peak of motor rpm and hence again balancing was advised with sensor mounted on the gearbox input shaft.



High Vibration on the Gearbox (Contd..):

- After balancing with gearbox sensor as reference, the 1x amplitude of gearbox reduced from 30mm/s to 3.24mm/s RMS.
- The overall vibration was still high with the entire structure vibrating.
- On closely studying the spectrum, we found out that the predominant peak of vibration was now at 540cpm and multiple harmonics.
- Further analysis was carried out to identify the source of 540 cpm frequency vibration.

Paharpur Gearbox:

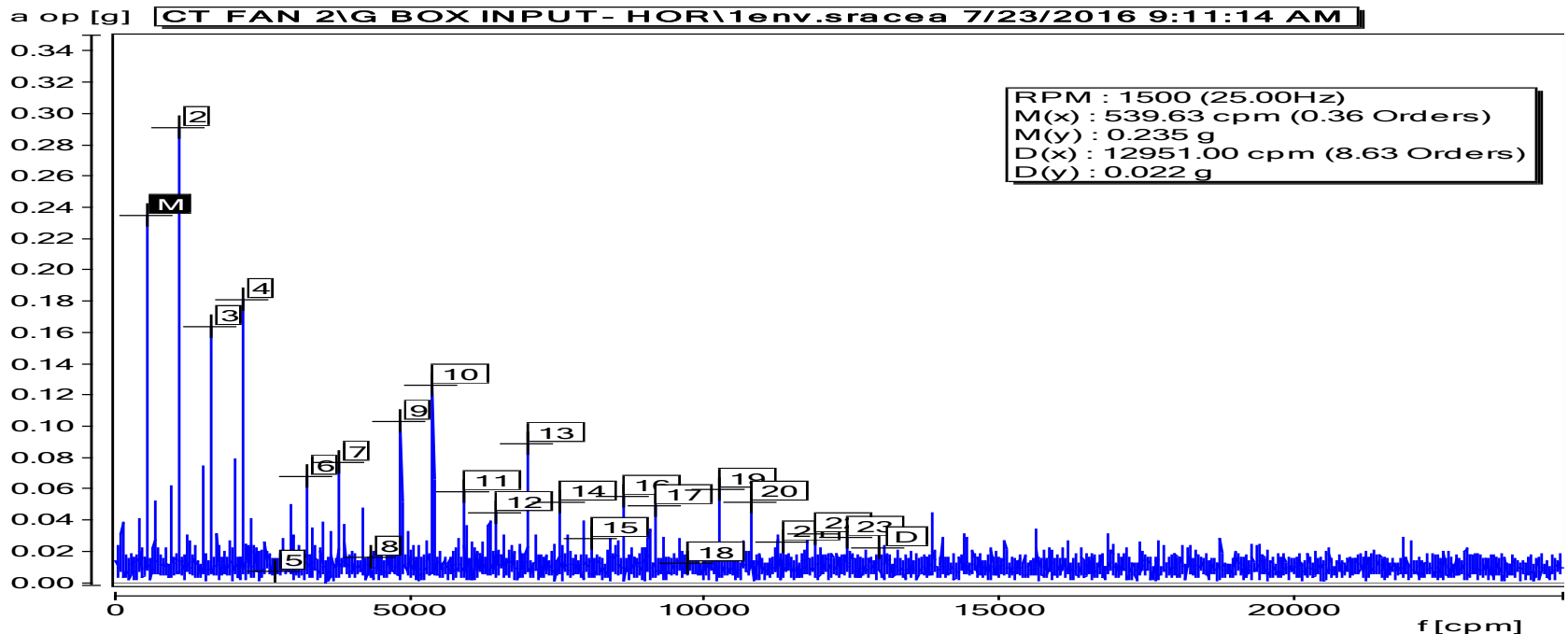


Gearbox Stages and its speeds:

Input Speed, N1	-	1485 RPM
No. of Teeth on Input Pinion	-	21
No. of Teeth on Intermediate shaft Gear	-	58
Speed of Intermediate Shaft, N2	-	540 RPM
No. of teeth on Intermediate shaft Pinion	-	20
No. of Teeth on Output Shaft	-	94
Speed of Output Shaft, N3	-	115 RPM
Gearmesh Frequency for 1 st Gearset	-	31185 CPM
Gearmesh Frequency for 1 st Gearset	-	10800 CPM

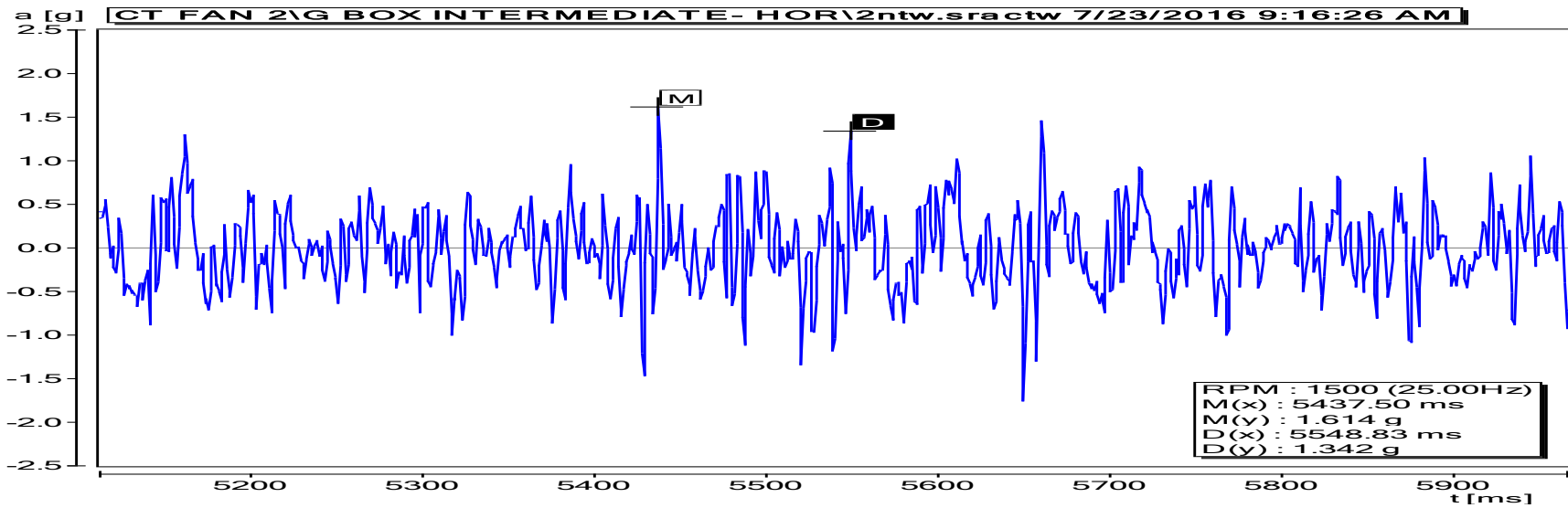
Gearbox Failure??:

- The new peak of vibration suggested a possible gear failure and on thorough study of the spectrums, the peak 540cpm was co related to the intermediate gear speed.



Time waveform:

- The time waveform obtained on the gearbox indicated peaks distinctively spaced at 540cpm.



- The sound profile from the cooling tower was compared with that of a healthy cooling tower gearbox and suggested clear impacts.
- Hence based on the above findings it was concluded to inspect the gearbox.

Gearbox Inspection:

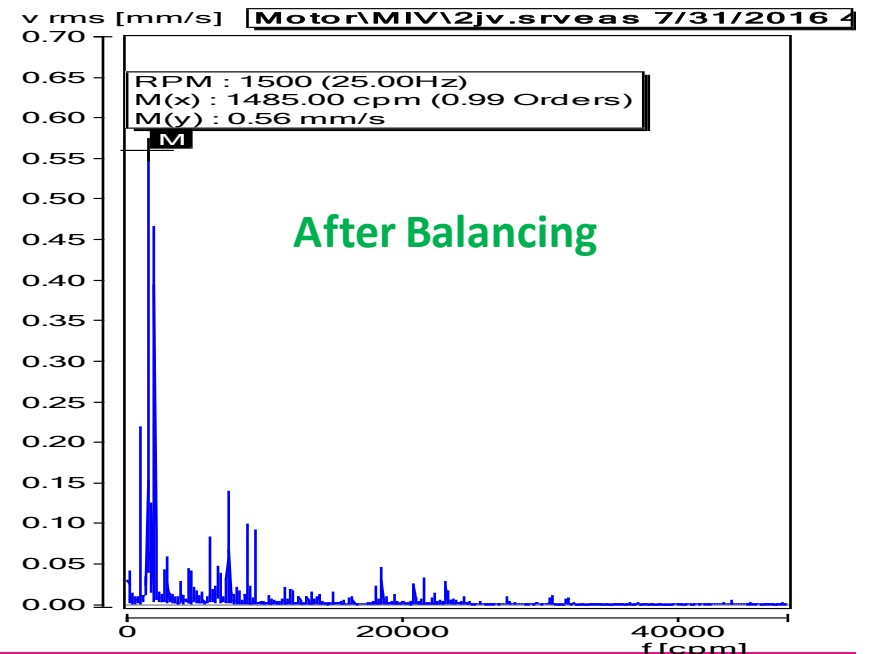
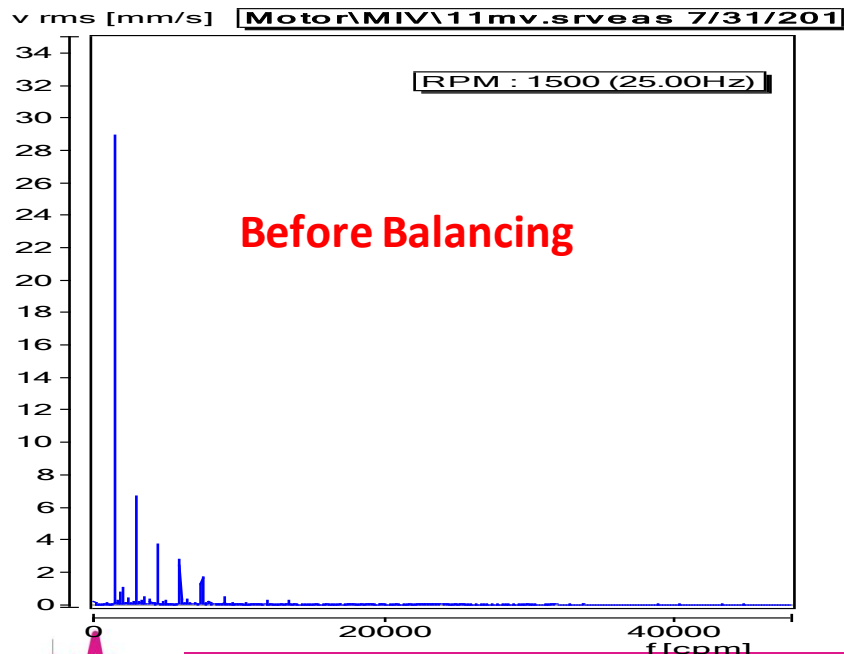
- On inspection, the intermediate shaft pinion was found to be severely damaged.



- The damage corresponds to bending fatigue damage. The probable reasons for this kind of damage are excessive loads or inclusions in the steel.

Vibration spectrum after gearbox replacement :

- After replacement of the gearbox, the initial vibration was still high with 1x peak of the motor running speed.
- Coupling balancing was carried out on both couplings and the vibration values reduced to below 1mm/s RMS.



Conclusion:

- The high vibration on the cooling tower was due to failed gear.
- The probable reason of failure on the gear was due to load on the gear which can be due to misalignment or unbalance.
- Vibspectrum was able to capture the gear fault using techniques as time waveform and sound profile of the gear.
- The timely finding of the gear failure helped Gulf Cement avoid catastrophic failure.
- The machine has been operating smoothly ever since July 2016.

THANK YOU