Practical Uses of Advanced Rotordynamics Tools to Ensure Trouble-free Operation of a Gearbox.

by

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ABSTRACT

The intent of this case study is to illustrate how rotor dynamics analysis can become an effective tool to improve rotor stability. Analytical method, such as undamped planar critical speed map is used to evaluate the vibration characteristics of a gearbox.

Currently, advanced rotor dynamics software provides greater capability in generating and analyzing rotor models. By removing undesirable instability sources and ensuring reliable separation margin, successful rotor-stability improvement is validated.

This case illustrates a rotor dynamics analysis applied on a high speed pinion of a speed increasing gearbox, which was exhibiting high vibration during operation. Analytical results predicted rotor instability due to the coincidence of the seven times operating speed and its fourth natural planar frequency. Based on recent investigation, this phenomenon is inherent to gear design, and can be controlled by adding or removing weight on the non-drive end of the high speed pinion without major modifications on the gearbox.

Thanks to the rotor dynamics analysis model, the cause of the vibration was found and the gearbox redesigned, avoiding expensive down time to the users.

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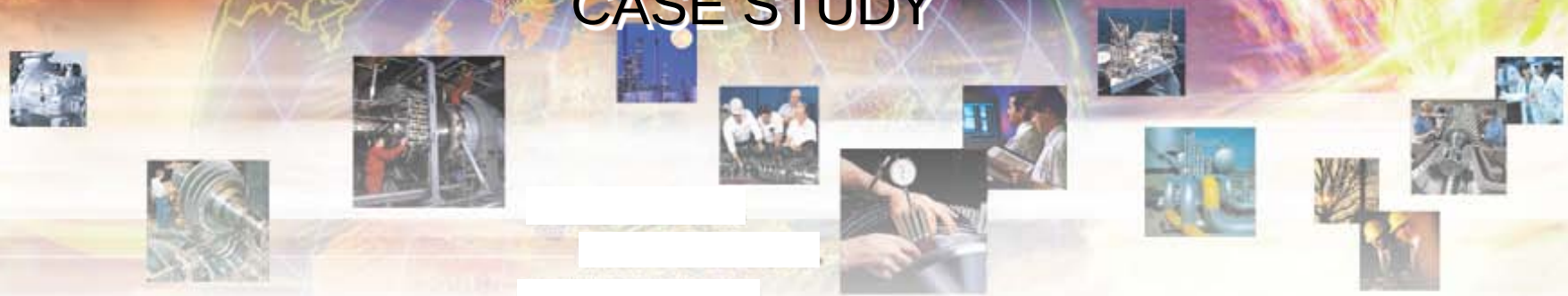
CASE STUDY



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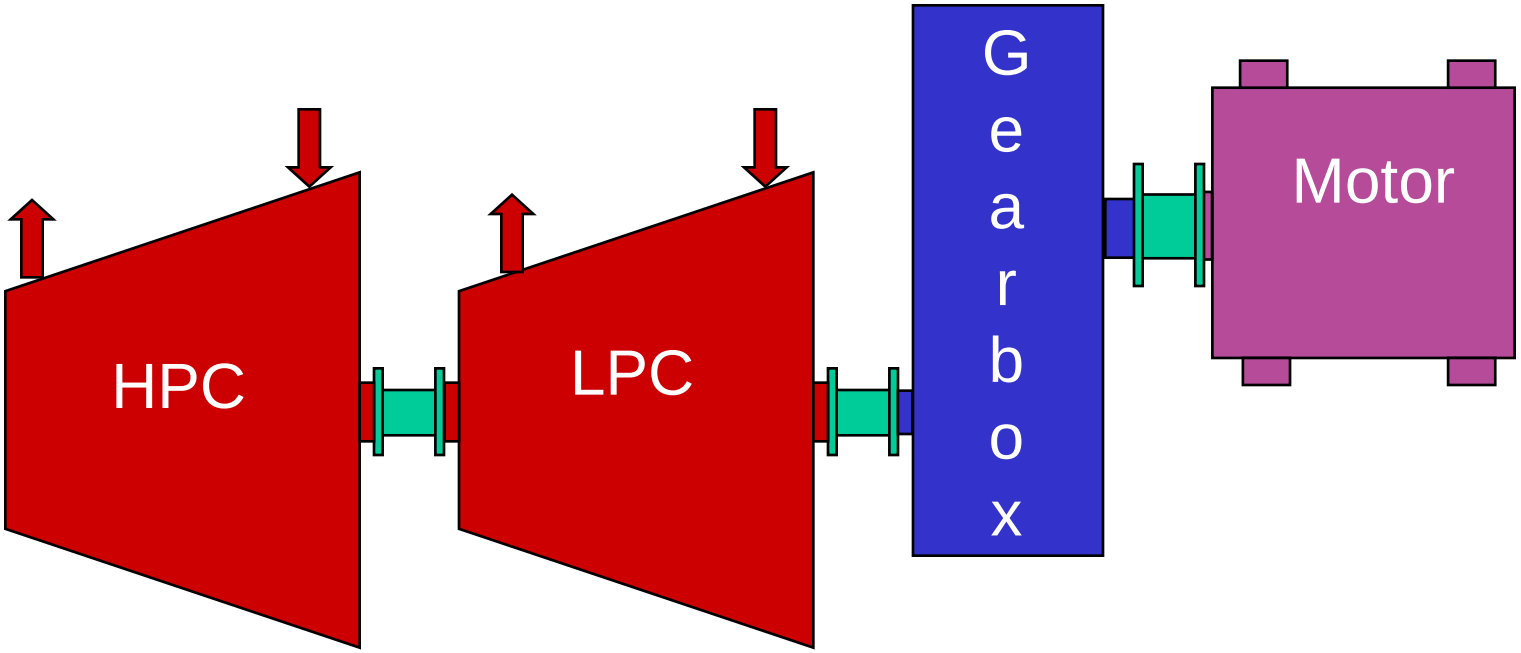
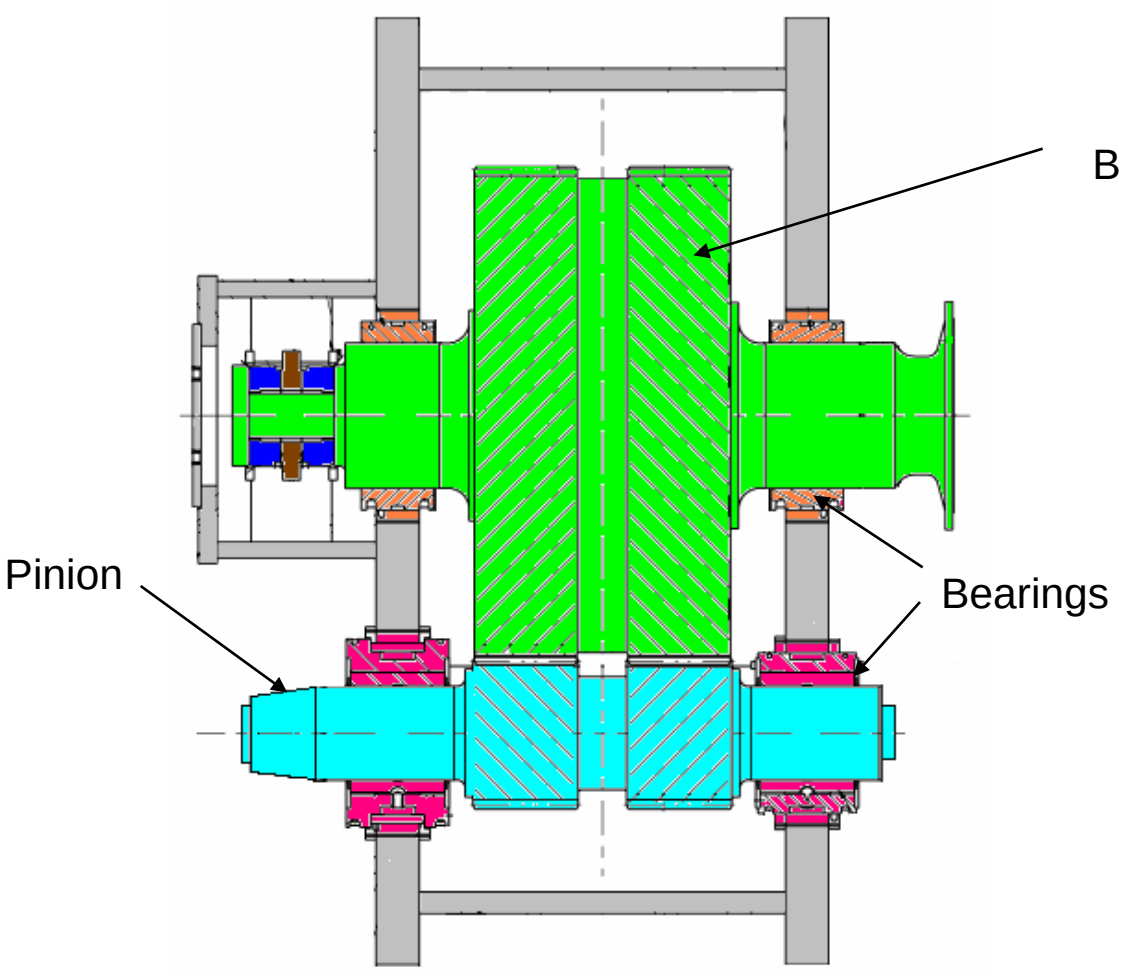
Problem Statement

- The intent of these case study is to illustrate how rotor dynamics by means of analytical methods, such as undamped critical speed map analysis, can improve rotordynamics of a gearbox, ensuring more reliable operation.

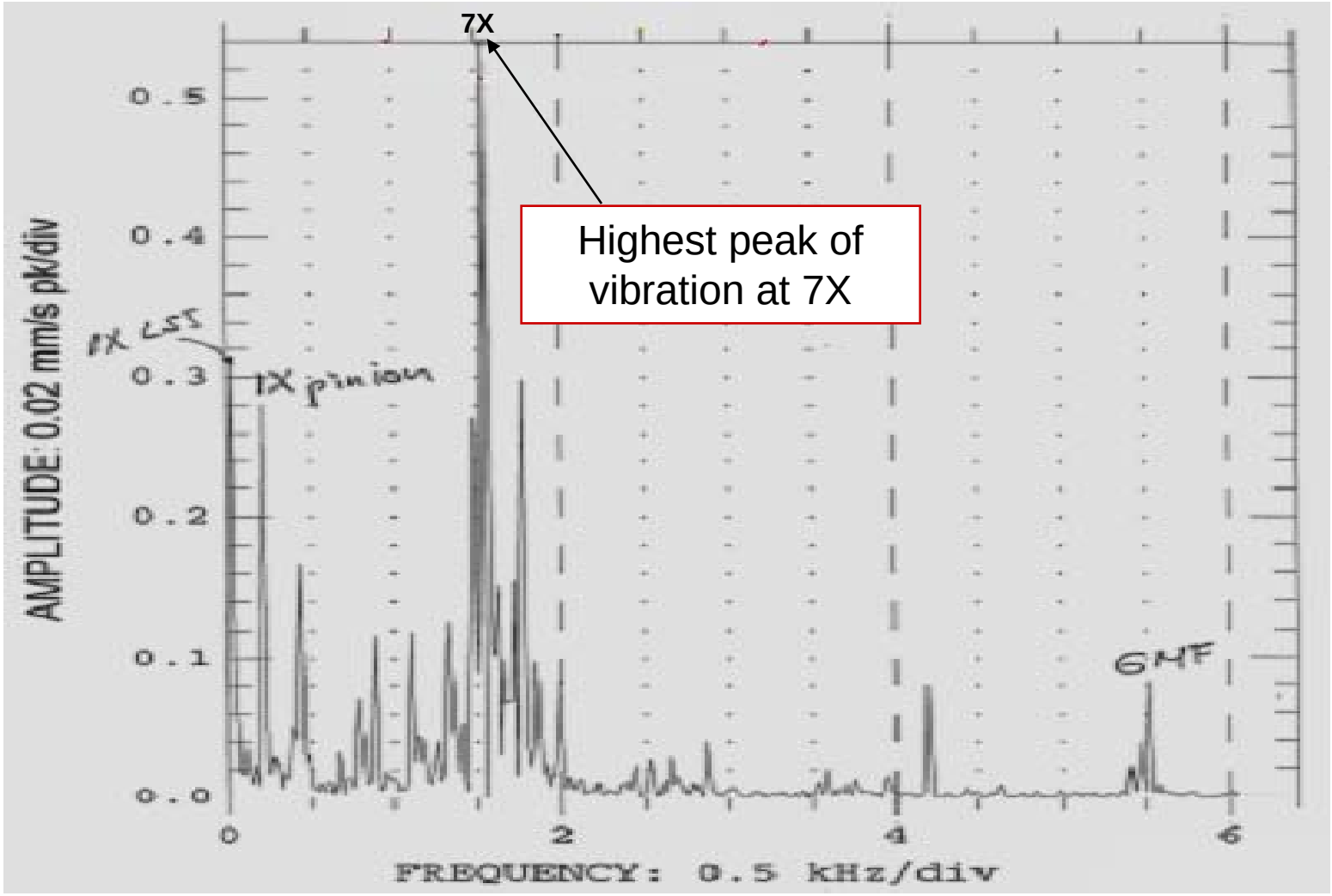
Train Sketch



Gearbox Cross-section

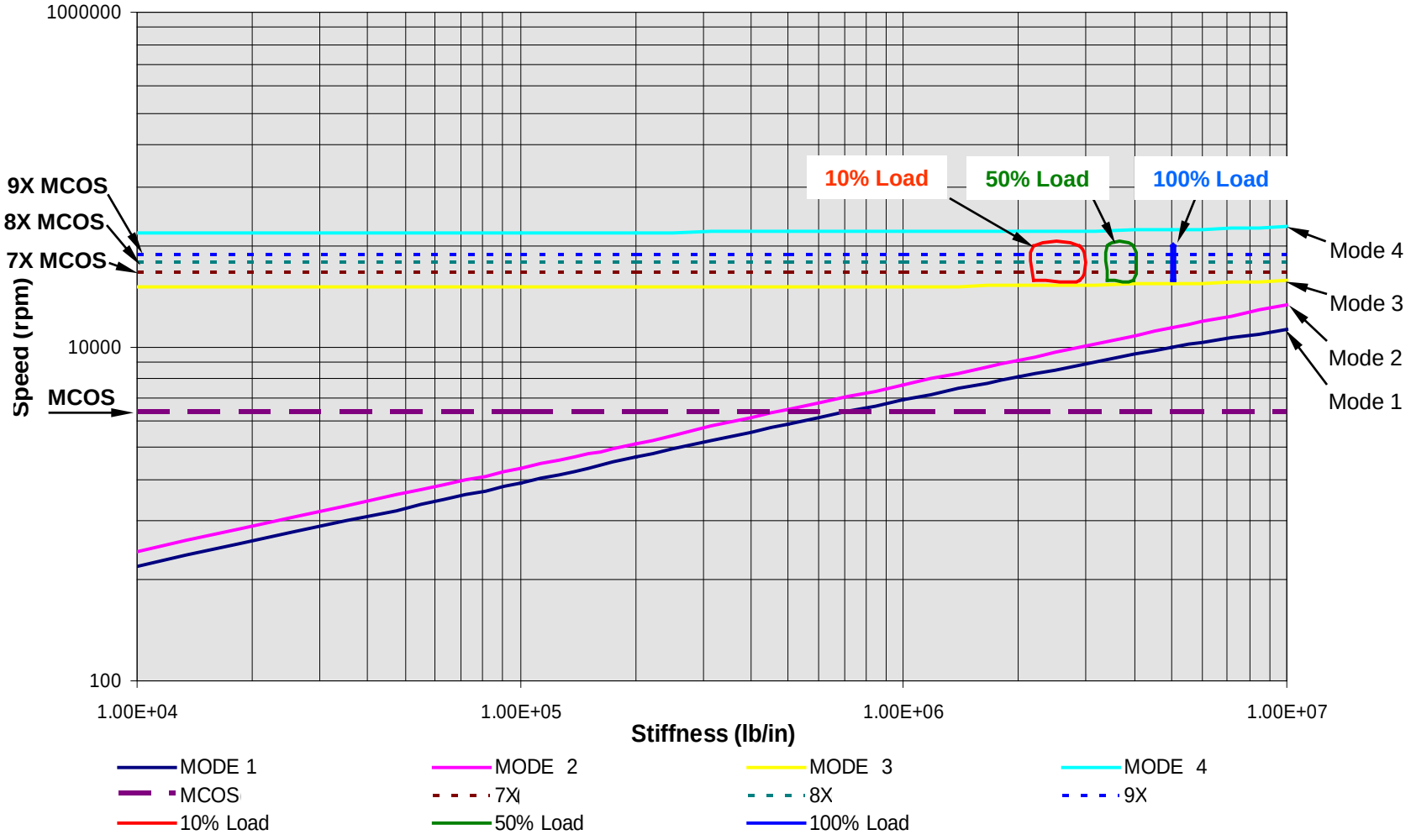


Original Pinion Vibration Spectrum

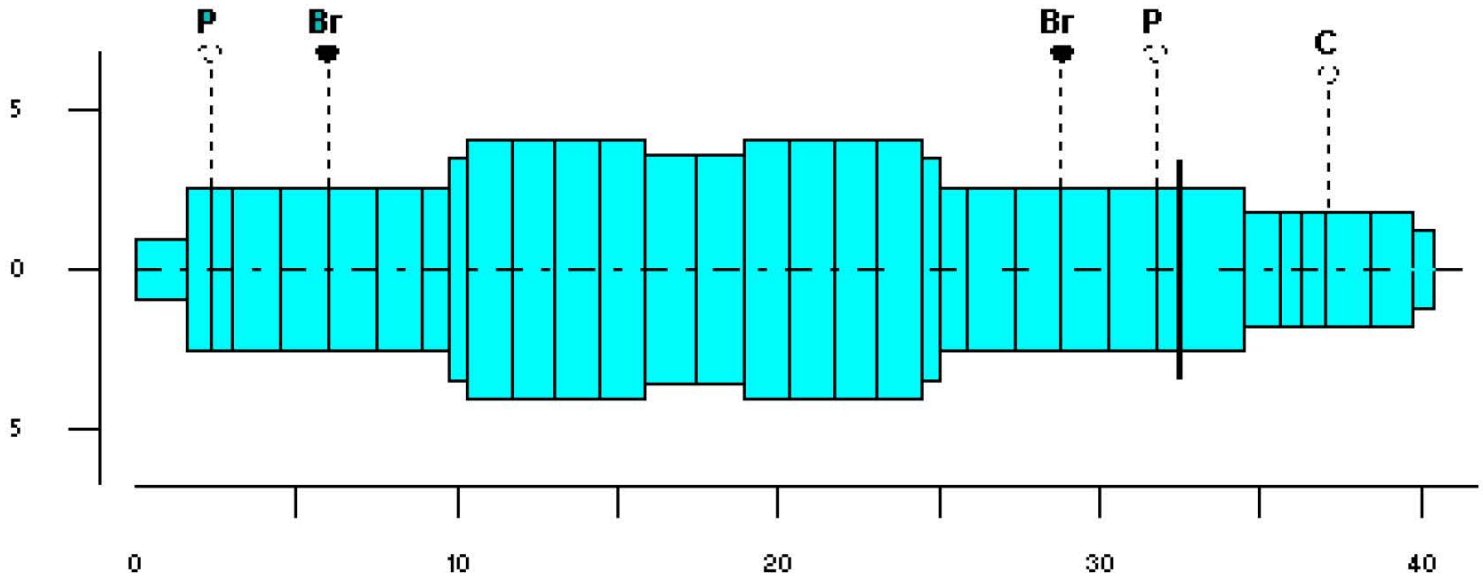


Analysis Method

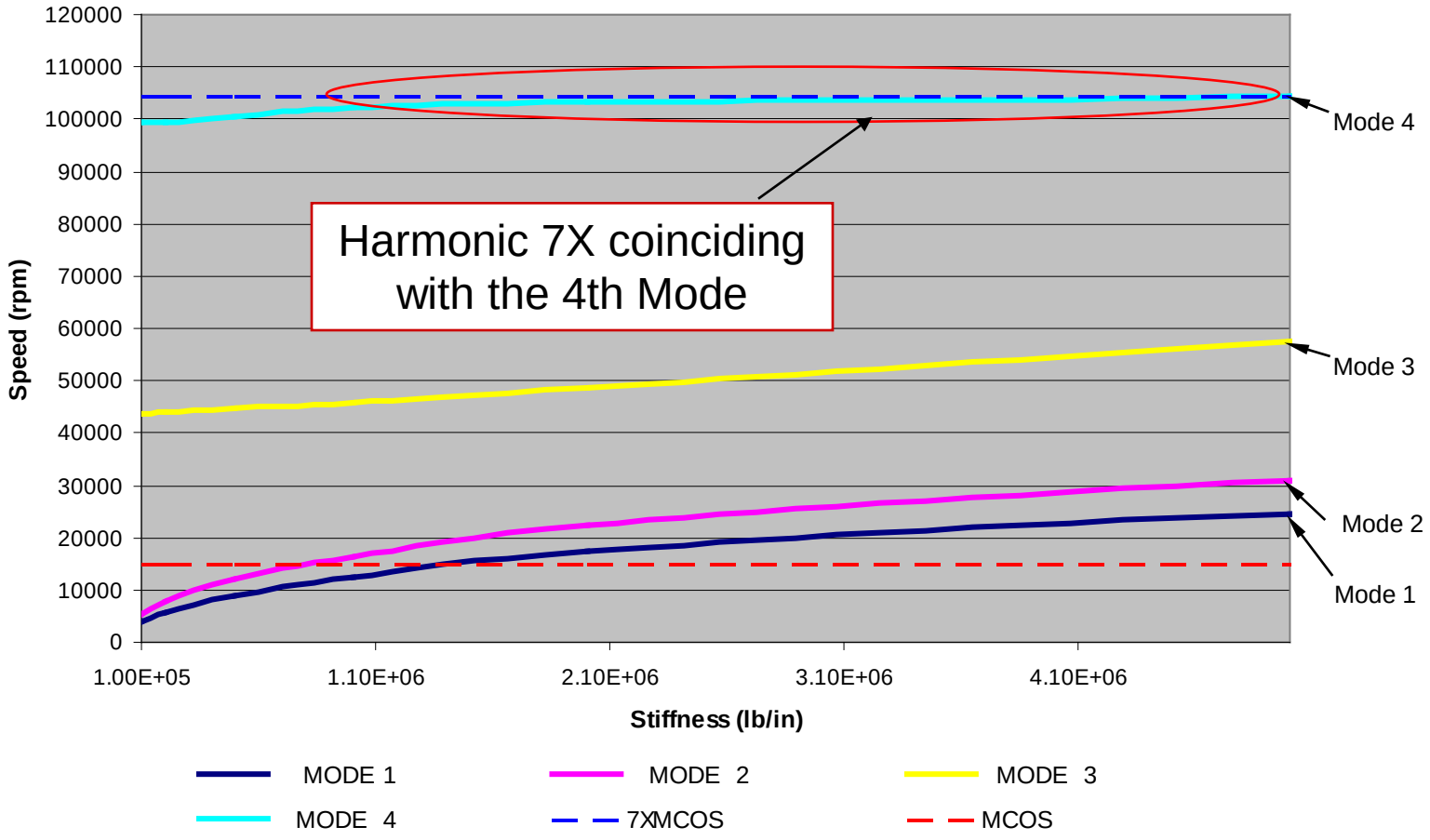
- Typical Undamped Planar Critical Speed Map Analysis



Original Pinion Geometric Model

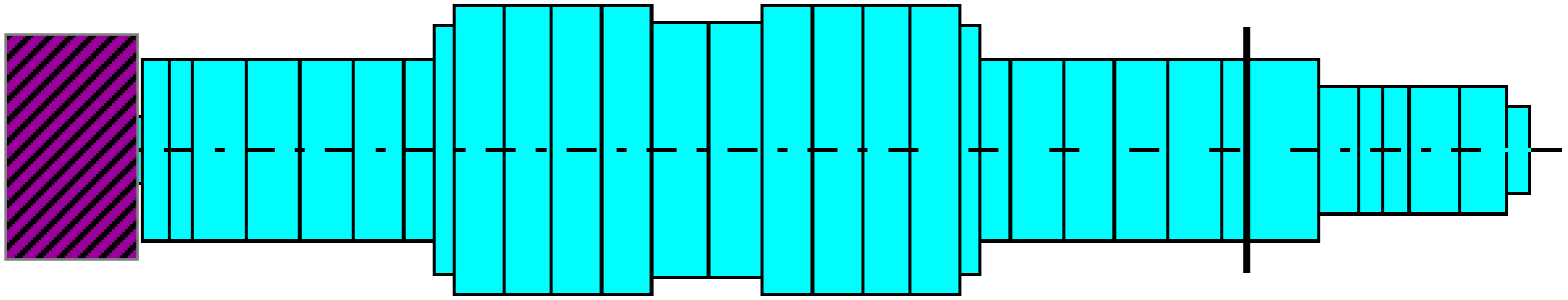


Original Undamped Planar Critical Speed Map



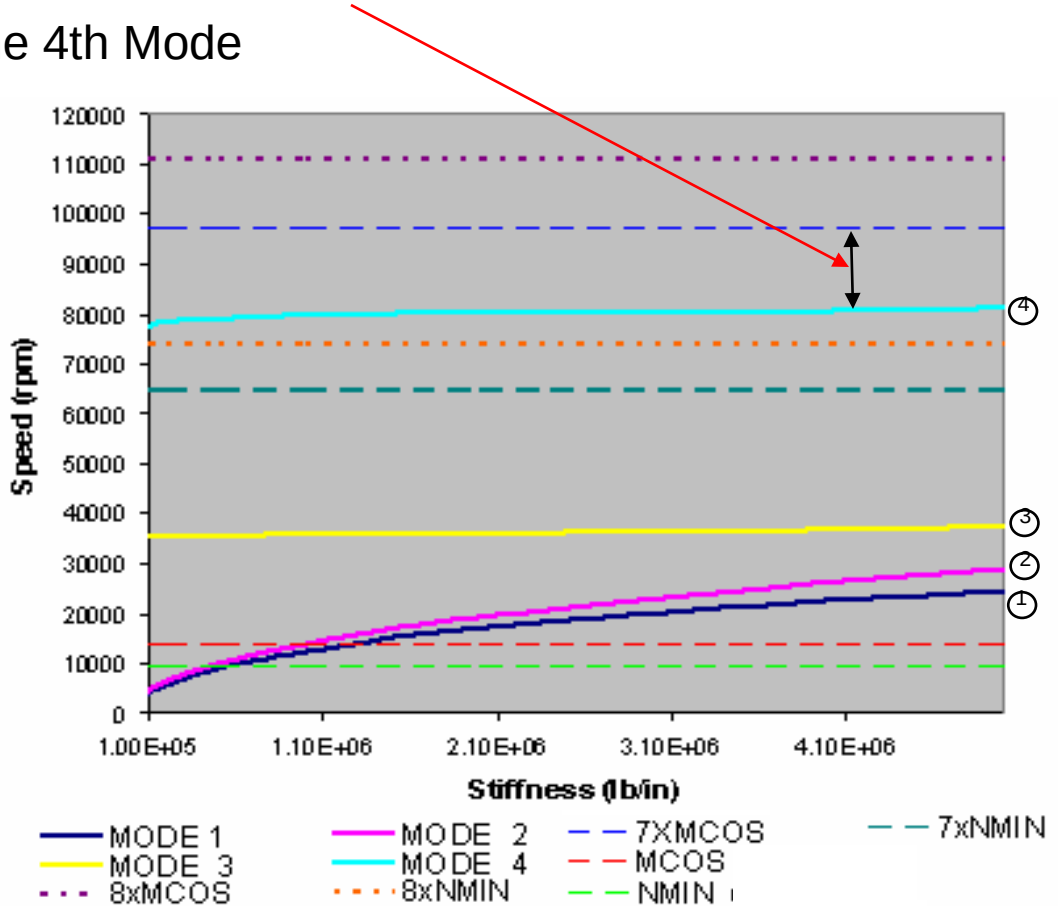
Modified Pinion Outputs

- Design Revision
  - Added 10 % of pinion's weight at the non-drive end



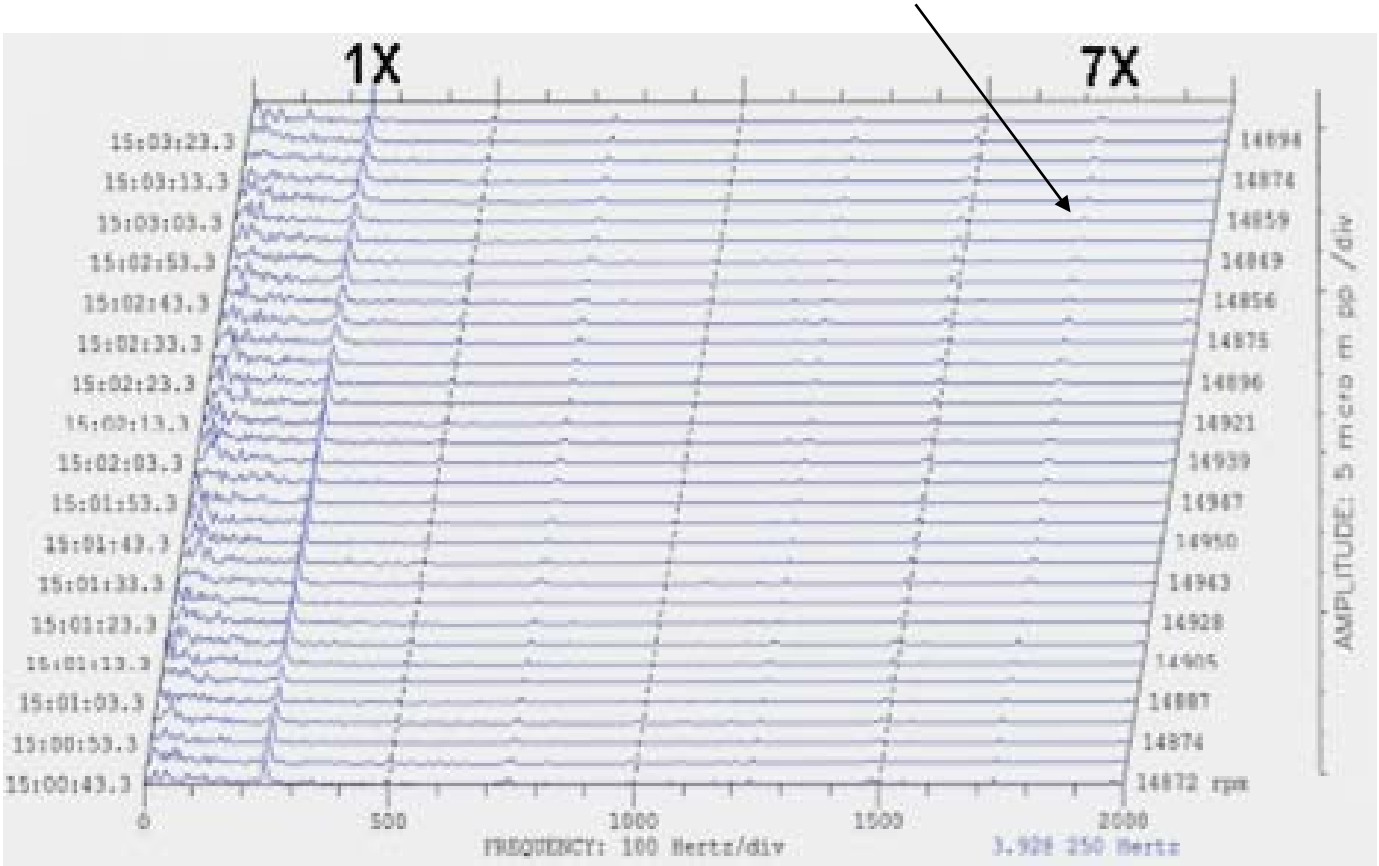
Modified Pinion Outputs

- Undamped Planar Critical Speed Map
  - Acceptable separation margin between operating speed's harmonics and the 4th Mode



Modified Pinion Outputs

- Modified Pinion Spectrum Plot
  - Non-vibration (peak at 7X diminished)



Conclusions

- Has been demonstrated that through rotor dynamics analysis, resonance can be predicted and eliminated, ensuring a high degree of reliability on machines operated in critical services, avoiding expensive down time to the users.
- Minor changes on design allowed smooth operation with acceptable lateral vibration characteristics.
- The methodology used can be applied to any gearbox.

Lesson Learned

- This case should serve to enlighten designers and users to better understand the rotor dynamic analysis value, and endorse its indispensable application on critical rotating machines.

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