The Use of Ultrasonic Rayleigh Waves in Probing Tribological Contacts

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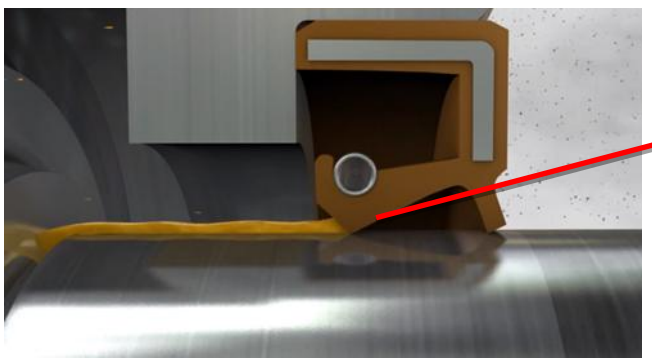
Ultrasound has been proven to be a viable method to non-invasively monitor the contact interfaces formed in various engineering components. Primarily, only ultrasonic bulk waves have been used. Due to the inherent nature of Rayleigh Waves, it is envisioned that its use will extend the capabilities of the ultrasonic method to probe interfaces which have been proven difficult to analyse with conventional bulk waves.

Introduction

One of the problems faced in using conventional ultrasound techniques is when the material is either highly attenuative or the ultrasonic pulse has to pass through discontinuities arising from the design of the component. All of these problems can be avoided by the use of Rayleigh Waves. The defining characteristic of a Rayleigh wave is that it travels along the surface of a solid. In that manner, with a proper configuration; the Rayleigh Wave would have an uninterrupted path to and back from a contact of interest. This is especially true for an interface formed between a seal and a shaft (pic below).



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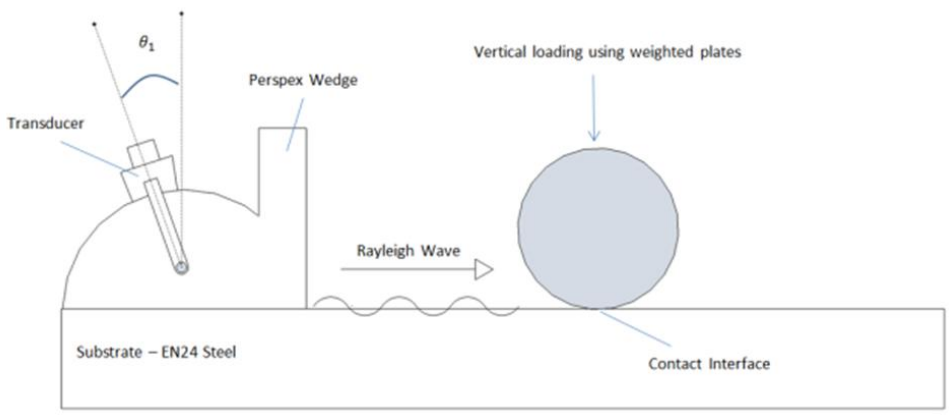
The goal of the current research is to first establish a working relationship between reflected Rayleigh waves and properties that can be derived from the interface.

Experiments

- Rayleigh waves are generated by the wedge method where regular bulk wave are converted to Rayleigh waves when they are incident on the surface at the Rayleigh angle.
- The waves are sent and reflected off a contact interface with varying degrees of loading.
- Reflected pulse are then analysed to observe for changes when the loading is changed



Application to the Industry

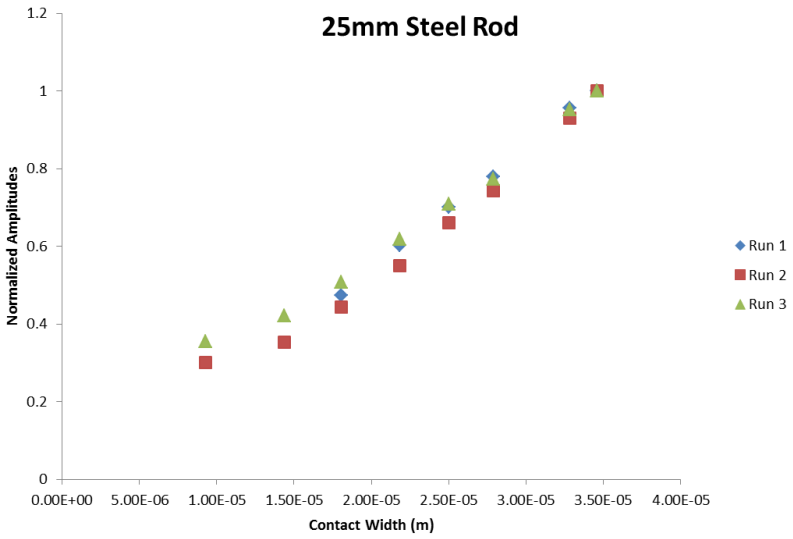
Wind Turbine – Renewable Energy

Quite a number of wind farms are located offshore where strong winds offer optimal power output for the wind turbines. Preventing unexpected breakdowns due to failure of the components are crucial to prevent unnecessarily long down times. One of the ways in which wind turbines fail is through the breakdown of the rotary seals due to inefficient lubrication between the lip of the seal and the rotating shaft. It is hoped that by incorporating the Rayleigh Wave into an online condition monitoring system, the imminent failure of the rotary seals can be predicted before actual failure happens. This allows for a planned maintenance to be scheduled, minimizing downtime and repair costs.

Seals Manufacturing – R&D

Since the use of Rayleigh Wave would theoretically provide a way to obtain critical information from a seal-shaft interface, this would greatly aid in optimising the design of rotary seals. Lubricant film thickness formed between the lip and the shaft can be obtained for each prototype seal at different rotational speeds. This allows a simple way to check if the seals are working as intended and a suitable design choice can be made.

Results



Early results are promising, showing a distinct relationship between reflected amplitudes to contact width. The next step is to theoretically model the physical system to produce a predictive model that would agree with the experimental data.

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