Tribodynamic Analysis of a Ball Type Constant Velocity Joint – WTC 2021, Lyon

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Constant velocity joints are used to transmit power between two shafts at an opposed angle. In order to understand the tribology of these joints a tribodynamic model has been developed, which incorporates an integrated tribological model of the constant velocity joint contact, taking into account lubrication and surface topography. The findings from the tribodynamic model have been used to inform the experimental investigation of the contact conditions using tribometry. Initial findings from the tribodynamic model correlate well with provided data in the literature and can help to provide explanation of the potential wear occurrences.

Keywords : tribology, constant velocity joint, CVJ, grease, tribometry

1. Introduction

Constant velocity joints are mechanical systems designed to transmit rotational motion between two shafts which meet at an angle. Ball type constant velocity joints use a set of balls constrained by raceways to transfer the motion between the two shafts. The balls follow a reciprocating motion within their respective raceways (see Figure 1), with variable rolling and sliding motions throughout the rotational cycle [1]. Such ball-race contacts, by nature, are prone to some wear particularly at the ball reversal points along the track. The aim of this work is to understand and characterise the causes of this wear.

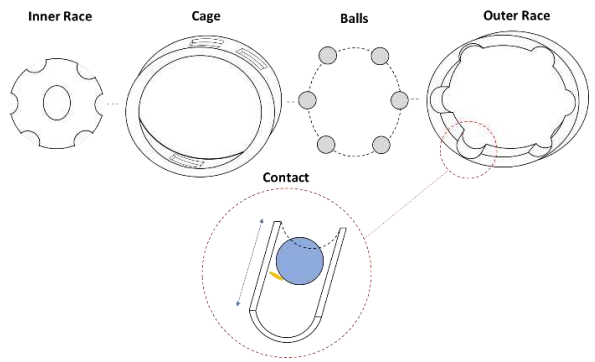

Figure 1: Ball type constant velocity joint schematic, with example investigated contact

2. Methods

Contact conditions of the ball-race contact have been investigated for the range of operating conditions of the joint. The ball-race contact that is of interest is a sphere – cylinder contact, conformal in a single axis. Loading of the contact primarily occurs on the edges of the raceway.

A tribodynamic model has been developed, which can provide transient contact forces in addition to the relative motions occurring in the contacts. The model includes an integrated tribological contact model considering lubrication and surface topography effects. Lubrication parameters have been determined through rheometry techniques of the grease lubricant, and subsequently the grease is characterised using an appropriate model. Surface topography and geometry have been characterised experimentally, for both new and worn samples.

The findings of the model have been utilised to conduct representative experimental investigation of interfacial wear behaviour. An equivalent contact has been constructed between a ball and flat using classical Hertzian contact mechanics theory. This contact has then been experimentally tested using a tribometer, with representative loading, lubrication, contact temperature and kinematics.

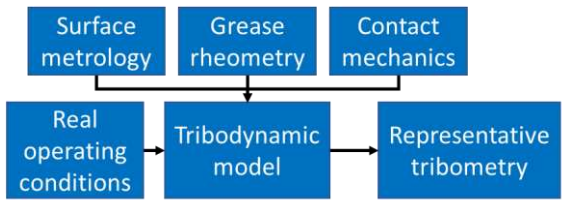

Figure 2: Methodology flowchart

2.1. Results

The results from the model have been validated with the available data in the literature. This results from the model allow for prediction of the contact loading conditions during operation of the constant velocity joint. The combined results from the model and the experiments allow for assessment of the surface topography changes at various load and speed operating conditions. The impact of design parameters upon the predicted contact stresses has also been identified through a parametric study.

3. Discussion

Through the development of a tribodynamic model for the ball type constant velocity joint it is possible to assess the impact of design parameters upon the tribological performance of the joint. This allows for earlier consideration of these factors in the design life of the joint facilitating improved design life.

4. References

[1] Fish, G., Cole, J. "Tribology and Lubrication Requirements of Constant Velocity Joints," SAE Technical Paper Series, 980835, 1998.