COMBINED SURFACE CONTACT FATIGUE AND WEAR IN SPUR GEARS

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ABSTRACT

Recent results have shown that there is considerable interplay between fatigue and mild wear as modes of surface damage in spur gears. Because of this, any model that purports to describe the evolution of a gear’s tooth flank surface (roughness) must take both modes into account. The present work presents a model that integrates both surface contact fatigue and mild wear damage into a combined model of the surface evolution of spur gears during meshing.

Keywords: gear, fatigue, wear, roughness.

INTRODUCTION

Micropitting is a form of surface damage that consists in the apparition of a multitude of small pits, with depths of no more than a few tens of micrometres, on the damaged surface. It is generally classified as surface contact fatigue damage.

Mild wear is the natural rate of removal of material from rubbing surfaces that sets in when the contact is adequately lubricated. The tribology community regards this process as benign, which is a reason why little study has been devoted to it. However, Olver (Olver, 2005) pointed to a relationship between wear and micropitting when he observed that those forms of damage seem to act in competition, so that mild wear tends to suppress micropitting.

Brandão et al. (Brandão, 2012) performed a simulation of surface contact fatigue of spur gears during a micropitting test. They followed up on this with a simulation of mild wear for the same test (Brandão, 2014). Analysis of the result showed that each simulation taken by itself was unsatisfactory in its description of the evolution of roughness of the gear tooth flank surfaces. However, analysing both results side by side showed that the real surface evolution appeared to be a combination of the results of each simulation.

The present work presents a model that integrates both surface contact fatigue and mild wear damage into a combined model of the surface evolution of spur gears during meshing.

RESULTS AND CONCLUSIONS

Partial results from the application of the combined mild wear and surface contact fatigue simulation can be seen in Fig. 1, which shows the measured initial roughness profile of the flank of a pinion gear tooth in black, the measured final roughness profile in blue, the predicted roughness profile due solely to mild wear in green and the predicted final profile due to combined mild wear and surface fatigue in red.
There is a fairly good reproduction by the simulated roughness profile of the measured final roughness profile, both with regard to wear and to fatigue. The wear simulation gives the overall shape of the final profile and the fatigue simulation gives the location of micropits in correct number. Clearly, the good correspondence between simulation and measurement is merely qualitative but it is a good indication of the validity of the combined wear and fatigue damage model.

ACKNOWLEDGMENTS

The present work is funded by the European Regional Development Fund (ERDF) through the ‘COMPETE - Competitive Factors Operational Program’ and by Portuguese Government Funds through ‘FCT - Fundação para a Ciência e Tecnologia’ as part of project ‘Gear transmissions of high tribological efficiency and reliability’, reference number ‘EXCL/EMS-PRO/0103/2012’

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