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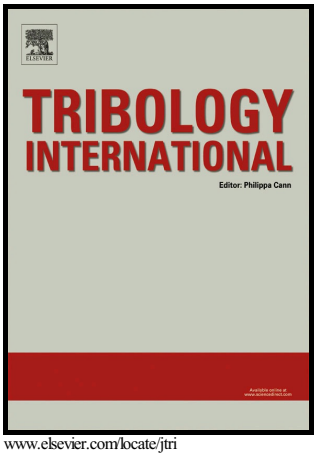

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Multiscale analysis of the effect of roughness on fretting wear

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Abstract: Fretting occurs when two loaded contacting surfaces are exposed to oscillatory relative movement of small amplitude. Depending on conditions such as surface finishing, coefficient of friction, normal load and slip amplitude, fretting may reduce the service life of a component by fretting wear. The effect of surface roughness on the fretting wear profile is still uncertain and may be significant. However, most of the finite element (FE) models that are used to predict fretting wear do not take it into consideration. In this paper, we propose a multiscale procedure to study roughness effect on fretting wear using FE models. In order to do that, we treat the problem in two scales: a) micro scale to analyse the effect of roughness on the contact pressure for frictionless conditions, and b) macro scale to estimate the wear profile evolution for a cylinder on plane contact configuration.

Keywords: Multiscale analysis, Finite element analysis, Fretting wear, Roughness

1 Introduction

Fretting happens when two contacting surfaces, normally loaded, are submitted to small oscillatory relative movement. It may lead to catastrophic failure of many mechanical components due to fatigue (known as fretting fatigue), or it may produce loss of fitting due to wear (fretting wear) or even a combination of both.

Among these failure mechanisms, wear is a complex material damage process involved in many research areas such as contact mechanics, friction and material science. Understanding the engineered contact surface, where asperities are statistically distributed, is very important for studying these research topics [1], in particular fretting wear [2, 3].

However, the effect of roughness on wear and frictional response is still uncertain and a brief literature review shows that there are even conflicted conclusions to the problem. On one hand, some studies [4] showed that roughness has a considerable impact on friction characteristics and should, therefore, be taken into consideration. On the other hand, some defend that its effect is negligible [5]. For fretting conditions, experimental results presented by Kubiak and Mathia [6] and Kubiak et al. [7, 8] showed that roughness has a strong influence on the fretting regime and also on the amount of wear for both lubricated boundary and dry metallic (steel/steel) fretted bodies. Although their findings indicated that surface