PITTING IN LUBRICATED ROLLING AND SLIDING CONTACT

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In modern industry, the designer is commonly restricted by the requirement that mechanical elements, like wheels, gears, bearings, cams, etc., should carry high loads at high speed with both size and weight kept to a minimum. For such applications, predicting component operational failure becomes crucial for ensuring an adequate design. Mechanical elements subjected to rolling and sliding contact conditions fail by several mechanisms, and the most prominent among these is surface pitting.

The new computational model for simulation of the surface initiated crack propagation in the lubricated contact area that leads to surface pitting of mechanical components is presented in this paper. The discretised equivalent contact model, with the assumed size and orientation of the initial crack, is subjected to contact loading conditions, accounting for the elasto-hydro-dynamic lubrication effects and tangential loading due to sliding. The influence of a lubricating fluid, driven into the crack by hydraulic mechanism, is also considered. The virtual crack extension method is used for simulation of the crack propagation in the framework of the finite element analysis.

The model is applied to a real pitting problem of a gear and corresponding computational results in terms of pit sizes correlate well to the development of micro pits observed in experimental testing.

Key words : *contact parameters, surface crack, crack propagation, surface pitting simulations*

1. Introduction

The modern mechanical components, subjected to significant cyclic contact loading usually fail due to material fatigue, which is manifested in the surface pitting [9, 10]. The pitting originates from small, surface-breaking or subsurface initial cracks, which grow under repeated contact loading. At some point, the cracks curve back towards the surface, which eventually causes the material surface layer to break away and a void occurs on the surface [9]. This void is called a pit. Initial pitting, commonly termed micro-pitting, is usually the first indication of inevitable progressive macro-pitting. The latter can seriously hamper the operating conditions of the component, as it induces additional vibrations into the system and can even lead to complete component failure. Micro-pitting is characterised by pits, whose depth usually does not exceed 20 μm. Typical micro/macro-pits observed on gear tooth flanks are shown in Figure 1.

The initiation of fatigue cracks represents one of the most important stages of the pitting process. Position and mode of fatigue crack initiation depends on the microstructure of a material, the type of applied stress and micro- and macro-geometry of the specimen [9].

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