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EFFECT OF ROUGHNESS ON MICROPITTING: A NEW GEOMETRIC ANALYSIS

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KEYWORDS

- Rolling contact fatigue
- Modelling in tribology
- Surface topography
- Micropitting

ABSTRACT

Micropitting, a form of contact fatigue observed on gear teeth due to repetitive rolling and sliding during frictional interactions, is subject to the influence of various factors. This numerical investigation focuses specifically on geometric variables, particularly surface roughness. The proposed work aims at, firstly, understanding which features of the roughness asperities influence micropitting and, secondly, connecting this fatigue study conducted at the local level of a single asperity, to a complex case of a real roughness profile, involving multiple asperities.

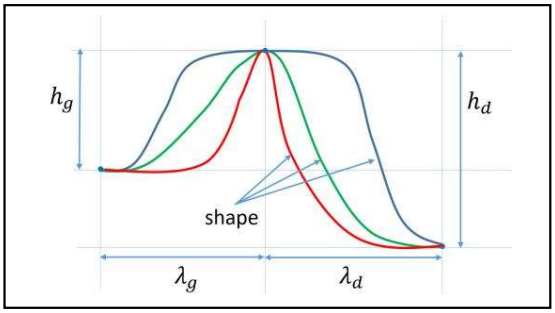

Fig.1 Asperity parametric model

The analysis assumes elastic bodies and 2D roughness profiles, a reasonable assumption for ground surfaces. Each roughness asperity is characterized by a set of geometric parameters $(h_g, h_d, \lambda_g, \lambda_d)$ aimed at encompassing all conceivable dimensions of an asperity (refer to Fig. 1). Additionally, an extra parameter n is introduced to quantitatively describe the shape of the asperity—whether it is sharp or blunt—through a parametrized function, f_n. The rolling contact behavior of such asperities is simulated using ISAAC [1], a semi-analytical solver.

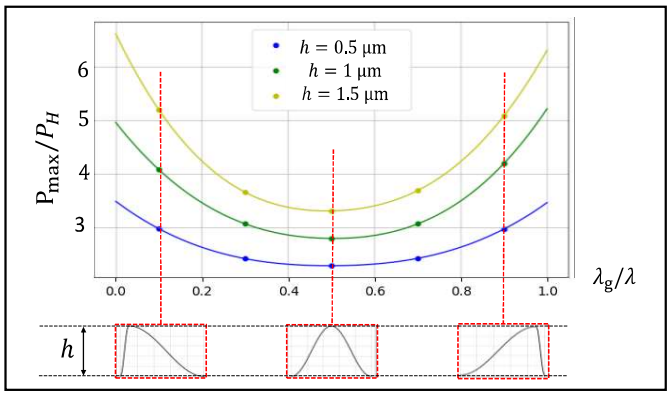

Fig.2 Effect of λ_g and h on pressure concentration

The defined geometric parameters have a considerable effect on mechanical quantities. For example, in Fig.2, the maximum pressure P_{max} reached during the rolling for different geometries, normalized by Hertz pressure P_H, is shown for three values of height in a particular case $h_g = h_d = h$, plotted against λ_g / λ, λ being the total wave-length $\lambda = \lambda_g + \lambda_d$. The pressure increases as the slope gets steeper (see illustrations at the bottom of the figure Fig.2).

The objective of the study is to investigate in detail each geometric parameter and its impact on fatigue through various criteria, such as Dang-Van, Crossland. A repository containing a fatigue indicator based on geometry is established, the next step involves applying this analysis to a real profile, as the superposition of several asperities, and correlating the fatigue results with the statistical roughness parameters commonly used by engineers, such as R_a, R_q, R_{dq} etc.

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