World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:13, No:09, 2019

Multiaxial Fatigue in Thermal Elastohydrodynamic Lubricated Contacts with Asperities and Slip

Authors : Carl-Magnus Everitt, Bo Alfredsson

Abstract : Contact mechanics and tribology have been combined with fundamental fatigue and fracture mechanics to form the asperity mechanism which supplies an explanation for the surface-initiated rolling contact fatigue damage, called pitting or spalling. The cracks causing the pits initiates at one surface point and thereafter they slowly grow into the material before chipping of a material piece to form the pit. In the current study, the lubrication aspects on fatigue initiation are simulated by passing a single asperity through a thermal elastohydrodynamic lubricated, TEHL, contact. The physics of the lubricant was described with Reynolds equation and the lubricants pressure-viscosity relation was modeled by Roelands equation, formulated to include temperature dependence. A pressure dependent shear limit was incorporated. To capture the full phenomena of the sliding contact the temperature field was resolved through the incorporation of the energy flow. The heat was mainly generated due to shearing of the lubricant and from dry friction where metal contact occurred. The heat was then transported, and conducted, away by the solids and the lubricant. The fatigue damage caused by the asperities was evaluated through Findley's fatigue criterion. The results show that asperities, in the size of surface roughness found in applications, may cause surface initiated fatigue damage and crack initiation. The simulations also show that the asperities broke through the lubricant in the inlet, causing metal to metal contact with high friction. When the asperities thereafter moved through the contact, the sliding provided the asperities with lubricant releasing the metal contact. The release of metal contact was possible due to the high viscosity the lubricant obtained from the high pressure. The metal contact in the inlet caused higher friction which increased the risk of fatigue damage. Since the metal contact occurred in the inlet it increased the fatigue risk more for asperities subjected to negative slip than positive slip. Therefore the fatigue evaluations showed that the asperities subjected to negative slip yielded higher fatigue stresses than the asperities subjected to positive slip of equal magnitude. This is one explanation for why pitting is more common in the dedendum than the addendum on pinion gear teeth. The simulations produced further validation for the asperity mechanism by showing that asperities cause surface initiated fatigue and crack initiation.

Keywords : fatigue, rolling, sliding, thermal elastohydrodynamic
Conference Title : ICATES 2019 : International Conference on Advances in Tribology and Engineering Systems
Conference Location : London, United Kingdom
Conference Dates : September 25-26, 2019