The cohesive zone crack analogue for torsional fretting under mild wear conditions

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Abstract

Torsional fretting fatigue may appear in mechanical components that are in contact under vibrational twisting moments, inducing oscillatory frictional stresses. Fretting fatigue cracking is important, with its initiation being difficult to estimate. This work extends a well-known fretting fatigue model, the crack analogue model that examines fretting fatigue induced by circular contacts of metallic surfaces. This is done by inserting a mode III type cohesive zone at the contact edges. In our previous works on fretting fatigue of complete contacts, we proposed mixed mode I and II cohesive zones because of the nature of the stress fields around the contact edges. The proposed cohesive zones address several issues related to the mechanics of friction and wear, by combining them in the case of mild wear where asperity plastic shakedown is the dominant inelastic mechanism. Thus, the micromechanical behaviour of the surface topology and its evolution are naturally introduced into the analysis. The surface roughness becomes an internal variable that evolves with the cyclic loading, establishing a steady state friction coefficient. Alternatively, friction evolution can be established pointwise by monitoring the accumulated micro-slip. The work of friction dissipates the mechanical work and at the same time becomes the precursor of large scale wear. A predictive methodology for fretting crack nucleation is proposed through the fatigue threshold stress intensity factor used in ordinary fatigue.

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