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ABSTRACT

Optimization of Damage-Based Fretting Contact for Life Prediction of Drawn Wires

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This paper presents the refinement/optimization of the developed damage mechanics-based fretting wear model for Hertzian line contact condition. A calibration is done to the fretting wear damage model by comparing the wear coefficient between simulation and experimentally measured data. The effect of the different loading condition with the amplitude and mean stress on the measured fatigue life of a single wire is presented using the life parameter, χ. The residual Young's modulus data are presented in terms of normalized quantities. The fitting constants are obtained and the fitted equation is used to describe the degradation of Young's modulus at N number of cycles. The data is applied to the fretting wear damage model and integrated into the user material subroutine (UMAT) of the Abaqus FEA software to predict the fretting wear and fatigue life of the steel wire. The load cycle block method with each block representing 2000 cycles is employed for computational efficiency. The fretting wear quantified using the proposed model is verified by comparing the wear scar size at 50,000 cycles with published experimental results for two wires in contact at the lay angle of 15º, 30º and 45º. The extracted wear coefficients are employed for the fatigue wear model of the steel wire ropes. A scaling factor of 0.0062 is obtained, which accounts for the effect of the wear debris and treated as the coefficient of wear damage. The calibrated fretting wear damage model is then utilized to predict the fretting wear failure between two wires at different contact angles. The damage evolution found to be nonlinear with faster wear rates with increasing number of cycles. Once the element reaches D_c ,the stresses carried by that element are redistributed to the neighbouring elements, thus causing faster wear rates. Different shear stress causes fatigue crack to occur faster for bigger contact angle and slower for smaller contact angle. The corresponding contact pressure is also higher for big lay angles as compared to small lay angle. The fatigue life of the two wires in contact is found to be shorter with the increasing lay angles.

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