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Fretting Fatigue Life Prediction of Ti-6Al-4V Alloy

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Abstract—*Fretting occurs when assemblies of components are subjected to an oscillating tangential force leading to the degradation of contacting surfaces due to minute relative slip, typically 5-50 µm in amplitude. In fretting fatigue, the frictional shear stress acting on the fretted surface causes stress concentration leading to a decrease in fatigue life. In this paper, fretting fatigue life of specimens made from Ti-6Al-4V was predicted and compared with the experimentally measured lives for two different contact pressures (150 MPa, 300 MPa) and load ratios (R= 0.1, 0.7). Using contact loads (normal and frictional) and bulk stresses on the specimen, contact tractions were evaluated from a numerical solution to the singular integral equations governing two-dimensional contacts. Subsurface stresses were then calculated and used to find the initiation life using the three multi-axial fatigue parameters proposed by Findley, Socie and Chu-Conle-Bonnen. Since the stresses are non-uniform with a steep gradient, small area near the contact interface is subjected to high stresses whereas the bulk is subjected to lower stresses. Consequently, a stressed area approach was adopted to account for size effect.*

During plain fatigue, crack nucleation dominates and accounts for most of the life of the specimen and initiation life can be taken as nearly the same as the total life, since initiation as well as propagation occurs at the same uniform stress level. In fretting, initiation occurs at very high stresses due to stress concentration at the interface, while propagation occurs at lower bulk stresses. Consequently, propagation forms a significant fraction of overall life and has to be accounted for. Propagation life was calculated using standard fracture mechanics based approach. Fractographic observations indicate an initiated crack length of ~200 µm, which was taken as the initial length for all propagation life calculations. The sum of initiation and propagation lives, thus predicted, was taken as the total fretting fatigue life and compared with the experimental values. The results show that all the parameters under-predict and hence are conservative in their life estimates. Findley parameter gives the best prediction, within a band of 40% to 92% of experimentally observed fretting fatigue lives.

Keywords*: Fretting fatigue, multi-axial fatigue, life estimation, Initiation life, propagation life.*

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