Fretting Fatigue Analysis and Palliatives

by

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Abstract

The deleterious effects of fretting on the fatigue properties of a material have been known since the work of Warlow-Davies in 1941. However, a widely accepted fretting fatigue life prediction method still does not exist and debates persist as to what the critical parameter(s) for fretting fatigue are. This work demonstrates that the surface stresses due to contact can be used to characterize the damaging effects of fretting on the fatigue properties of a material.

The elastic stress analysis performed by Hamilton for a sphere on flat plane fretting geometry is used to determine the stresses due to contact for various experimental conditions provided in previous work. It is shown that the specimen fretting fatigue life is directly related to the surface stresses induced in the material by fretting.

Fretting fatigue life prediction methods are analyzed. The stress-life approach, which is widely used in industry, is examined for its applicability for fretting fatigue conditions. The damage tolerant approach is used to determine the relative magnitudes of the crack nucleation and long crack propagation stages of fretting fatigue life.

An analysis of fretting fatigue palliatives, focusing on shot peening and coatings, is presented. A systematic method to determine the optimum shot peening depth for fretted components is proposed. The method uses the elastic stress field expressions derived by Hamilton for a sphere on flat surface contact geometry and is demonstrated for Ti-6Al-4V. However, the method is general and can be applied for any material and any contact geometry which allows analytic evaluation of the stress fields.

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