Evolution equation based high-cycle fatigue model with stress history modelled as stochastic process

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September 11, 2018

Abstract

Mechanical fatigue phenomenon of materials has inherently stochastic features. For irregular loading histories, the classical method to predict a life time is the Rainflow method, which is based on a construction of an equivalent cycle. The method is essentially one dimensional, but can be extended to the multiaxial case considering an equivalent stress criteria. It could also be extended to a stochastic case. A common process is to estimate the autocorrelation function from measured stress data, then the spectral density function can be found by using the fast Fourier transform, and the life time can be approximated with a level crossing formula, usually the so called Rice's formula. In this paper a truly stochastic approach is described for an evolution equation based multiaxial high-cycle fatigue model applicable for arbitrary loading histories. The stochastic version of an evolution equation based continuum HCF-model is not only a particular method, but a broad concept to handle stochastic fatigue in a new way. The concept is essentially multiaxial and can be easily extended to take into account all the stochastic properties, of which are of interest. In this paper we describe the fundamental idea of the method, modelling our stress data using the Orstein-Uhlenbeck process. It is the classical basic process in stochastic and we consider it as an analogy to the classical sinusoidal load in non-stochastic case. Some examples to demonstrate the procedure are given.