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Continuum mechanics fatigue modeling: state-of-the-art

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Abstract

The continuum mechanics fatigue model (CMFM) proposed by Ottosen et al. (2008) is gaining increasing interest in the research community as a practical approach for macroscopic stress-based high-cycle fatigue analysis. Using an endurance surface that can move in the stress space, the model maps triaxial stress tensor histories to a fatigue damage scalar in a time-continuous manner, providing a highly robust analysis framework that is well suited for integration in the finite element method. Since its publication, the method has seen a variety of applications, including complete machinery simulations and topology optimization. The framework comprises four main features: the endurance function, the back-stress evolution, the damage evolution, and the loading-unloading criteria. In the recent years, several generalizations and modifications of these model features have been proposed to account for various of effects, including stress-gradients, variations in the ratio of shear and normal stress fatigue strengths, anisotropy, large mean stresses, non-linear damage accumulation, and more. This work provides a brief review of the state-of-the-art of continuum mechanics fatigue modeling, and the various formats that are available in the research literature. We address the capabilities and limitations of the approach and its various formulations, with the aim of educating engineers who may benefit from adopting the methodology for practical applications, and to enlighten fellow researchers about research gaps and outlooks for further investigation.

Keywords:

Continuum mechanics Fatigue model High-cycle fatigue Multiaxial stress