A Multiaxial Fatigue Damage Model for Isotropic Materials

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Abstract: This paper presents a novel failure model for the prediction of low cycle fatigue life and residual strength of isotropic structures under multiaxial loading~~.~~. The approach herein proposed does not discretize every load cycle, using instead a loading envelope whereby the load value remains constant at a maximum level while the number of cycles is obtained from a given elapsed time defined within a pseudo-time framework. The proposed formulation is based on the smeared cracking approach accounting for damage propagation due to static and fatigue loadings, where the static component is based on the Von-Mises yield criterion and Prandtl-Reuss stress flow rule; whereas the crack propagation in cyclic loading component is based on the Paris-law. Furthermore, the formulation combines damage mechanics and fracture mechanics within a unified approach enabling to control the energy dissipated in each loading cycle. The proposed constitutive model accounts for the static damage followed by fatigue induced damage accumulation, depicted in Figure 1. The model has been implemented as a user defined material model within S4R shell elements available in ABAQUS/Explicit finite element code. An accurate prediction between numerical model and experimental results is observed in Figure 2, considering in terms of Paris plots for the single element simulation and real structures.

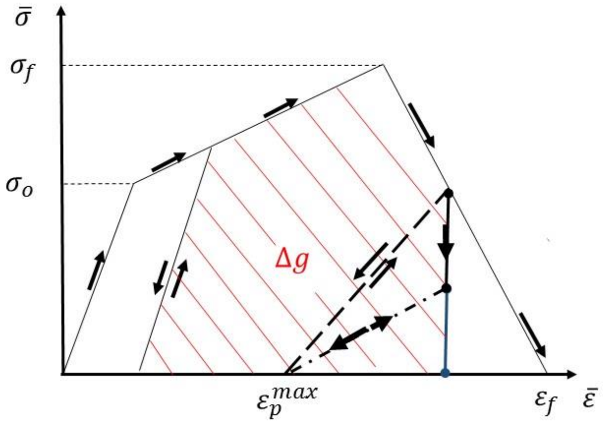

Figure 1. Constitutive model behavior for isotropic material under static followed by damage induced by cyclic loading.

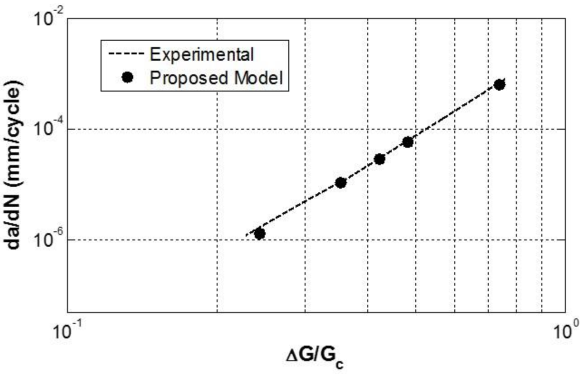

Figure 2. Single element validation.

Keywords: Multiaxial loading, Fatigue Damage Model, Isotropic Material, Constitutive Model, Finite Elements