

Viscoplasticity with Damage Evolution for Reliability Engineering

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Abstract

We have developed a unified constitutive model for viscoplasticity with damage evolution. This model has been established since author's Ph D dissertation accomplished in China. We have followed the internal variable theory established by Jim Rice. We have specified the back stress as key internal variable for plasticity defined by dislocation dynamics and also by crystal slip theory. Second internal variable called drag stress is adopted for viscoplastic effects. Third internal variable for damage evolution is introduced by Gurson model based on voiding mechanism. The evolution equations of three internal variables are well established. Moreover, the return-mapping algorithm for the unified viscoplastic constitutive model is well developed and implemented in ABAQUS as user subroutine in the United States. The viscoplastic model is first verified by the creep and plastic behaviors of stainless steels at high temperatures. Its powerful capability is furthermore demonstrated by the failure mechanism and failure modes of solder alloys used in mobile devices. The last case study is to utilize the model to bolted flange connections for addressing their reliability issues.