Cyclic plasticity simulations with yield surface distortion by ABAQUS

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Abstract

To improve the ratcheting predictions, the need to consider yield surface distortion has been recognized. Rokhgireh and Nayebi (2012) combined the nonlinear kinematic hardening model of Chaboche with the yield surface distortion model of Baltov and Sawczuk (1964) for the simulations of uniaxial and multi-axial ratcheting. The simulated results of uniaxial ratcheting of CS1026 and SS 304 were compared to the experimental results of Hassan and Kyriakides (1992), Kang and Kan (2007), respectively. On the other hand, the simulations of multi-axial ratcheting involving CS1026 and SS 304 were compared to the experimental results of Bari and Hassan (2002), Corona et al. (1996), Hassan et al. (2008), Kang et al. (2004). It was illustrated that the modified model (Rokhgireh and Nayebi, 2012) gives good predictions of the ratcheting strain increment in various uniaxial and multi-axial tests.

Since ratcheting predictions is of great importance to safety assessment and structural design, it is imperative to develop a robust numerical framework for ratcheting simulations. Due to the complex task of numerical implementation, the general-purpose finite-element commercial codes, e.g. ABAQUS and ANSYS, are comparable tools for accurate simulations of ratcheting responses. However, the existing plasticity models in ABAQUS or ANSYS cannot describe yield surface distortion.

The paper is to present simulations of cyclic plasticity phenomena by ABAQUS. The advanced constitutive model by Rokhgireh and Nayebi (2012) is to be formulated and implemented into ABAQUS via the user subroutine UMAT. Formulation and implementation are to be validated with comparisons between simulations and experiments of CS1026 and SS 304 (Hassan and Kyriakides, 1992; Kang and Kan, 2007), respectively. Finally, a numerical framework based on ABAQUS will be provided with advanced constitutive models general enough for simulations of cyclic plasticity phenomena to aid safety assessment and structural design.

Keywords: Cyclic plasticity, Distortional hardening, Elastic shakedown, Plastic shakedown, Ratcheting, ABAQUS.

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