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Application of nodal natural element method to kinematic shakedown analysis of strainhardening structures

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This paper develops a computational solution method for the kinematic shakedown analysis of strainhardening structures under the variable-repeated load. The mathematical programming formulation for estimating the upper bound shakedown load is established based on the Koiter's theorem. In this nonlinear formulation, the Konig's technique is used to deal with the difficulty caused by time integration, and the two-surface yield criterion is adopted for considering the limited kinematic hardening. The problem field is discretized by utilizing a stabilized conforming nodal integration scheme, and the kinematically admissible cumulative displacement field is approximated by adopting the Laplace interpolation in Galerkin framwork. A direct iterative algorithm is used to linearize the objective function subjected to several equality constraints, and the proposed iterative process can guarantee the obtained shakedown load to monotonically converge to the upper bound of true solution. The provided numerical examples verify the precision and the efficiency of present iterative solution method.

Keywords: Kinematic shakedown analysis, Direct iterative algorithm, Stabilized conforming nodal integration, Laplace interpolation, Natural element method