Numerical Implementation of Bounding-Surface Model for Simulating Cyclic Inelastic Response of Metal Components

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ABSTRACT

This study presents an efficient numerical implementation of the bounding-surface cyclic-plasticity model in a finite element environment, suitable for simulating the structural behavior of metal components subjected to strong cyclic loading. The model is based on the Dafalias-Popov "bounding surface" concept [1], equipped with appropriate enhancements that allow for efficient simulation of repeated, alternate inelastic deformation in metal components. The implementation is performed using an efficient elastic-predictor/plastic-corrector method.

The two surface follow Von Mises (J_2) plasticity. The flow rule is initially controlled by the yield surface. Upon reaching the bounding surface, the two surfaces stay together and the flow rule is controlled by the bounding surface. The two surfaces lose contact when reverse plastic loading occurs. The hardening modulus H is defined directly through an appropriate function of the "distance" δ in the stress space between the current stress point on the yield surface, and the "congruent point" on the bounding surface, which has the same outward normal vector

The model is employed for simulating laboratory physical experiments on steel pipe bends [2]. First, stress-controlled and strain-controlled experiments are simulated, in strip specimens extracted from the bends. Upon appropriate calibration from these small-scale tests, the model is employed for predicting the mechanical response of a large-scale physical experiment. The good comparison between the experimental and the numerical results demonstrates the suitability of the model for large-scale computations and its efficiency in predicting the mechanical response of structural metal components under severe repeated loading.

REFERENCES

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