A General Model of Fuzzy Plasticity

ZHANG Chunliang[1,*], ZHANG Liangchi[2]

1 School of Mechanical and Electrical Engineering, Guangzhou University, Guangzhou 510006, China

2 School of Mechanical and Manufacturing Engineering, The University of New South Wales, Sydney NSW 2052, Australia

Received May 26, 2009; revised June 4, 2010; accepted June 20, 2010; published electronically June 26, 2010

Abstract: The transition between the elastic and plastic states is sharp in the classical plasticity theory. To overcome this problem, many constitutive models, such as multi-yield-surface model and two-surface model, have been developed. However, these models can not represent the true deformation process in a material. In order to capture nonlinear hardening behavior and smooth transition from elastic to plastic state, a general model of fuzzy plasticity is developed. On the basis of the theory of fuzzy sets and TAKAGI-SUGENO fuzzy model, a fuzzy plastic model for monotonic and cyclic loadings in one dimension is established and it is generalized to six dimensions and unsymmetric cycles. The proposed model uses a set of surfaces to partition the stress space with individual plastic modulus. The plastic modulus between two adjacent surfaces is determined by a membership function. By means of a finite number of partitioning surfaces, the fuzzy plastic model can provide with a more realistic and practical description of the materials behavior than the classical plasticity model. The validity of the fuzzy plastic model is investigated by comparing the predicted and experimental stress-strain responses of steels. It was found that the fuzzy plasticity has the ability to handle many practical problems that cannot be adequately analyzed by the conventional theory of plasticity.

Key words: plasticity theory, fuzzy model, membership function, plastic modulus, stress-strain curve

---

*Corresponding author. E-mail: nhzcl@163.com
This project is supported by National Hi-tech Research and Development Program of China (863 Program, Grant No. 2008AA04Z407)