Accepted Manuscript

Thermo-mechanically Coupled Cyclic Elasto-viscoplastic Constitutive Model of Metals: Theory and Application

Yilin Zhu, Guozheng Kang, Prof. Dr., Qianhua Kan, Otto T. Bruhns, Yujie Liu

PII: S0749-6419(15)00204-1

DOI: 10.1016/j.ijplas.2015.12.005

Reference: INTPLA 1995

To appear in: *International Journal of Plasticity*

Received Date: 25 July 2015

Revised Date: 6 December 2015

Accepted Date: 12 December 2015

Please cite this article as: Zhu, Y., Kang, G., Kan, Q., , Bruhns, O.T., Liu, Y., Thermo-mechanically Coupled Cyclic Elasto-viscoplastic Constitutive Model of Metals: Theory and Application, *International Journal of Plasticity* (2016), doi: 10.1016/j.ijplas.2015.12.005.

Thermo-mechanically Coupled Cyclic Elasto-viscoplastic Constitutive Model of Metals: Theory and Application

Yilin Zhu [1, 2], Guozheng Kang [1]*, Qianhua Kan [1, 2], Otto T. Bruhns [3], Yujie Liu [2]

[1] State Key Laboratory of Traction Power, Southwest Jiaotong University, Chengdu 610031, P.R. China

[2] Applied Mechanics and Structure Safety Key Laboratory of Sichuan Province, School of Mechanics and Engineering, Southwest Jiaotong University, Chengdu 610031, P.R. China

[3] Institute of Continuum Mechanics, Ruhr-University-Bochum, Bochum 44801, Germany

*Correspondent author: Prof. Dr. Kang GZ, E-mail address: guozhengkang@home.swjtu.edu.cn

Tel: 86-28-87603794; Fax: 86-28-87600797

Abstract

Thermo-mechanically coupled cyclic deformations often occur in metallic components subjected to cyclic loading. A framework of thermo-mechanically coupled elasto-plasticity (including rate-independent or rate-dependent plasticity) is first presented in this work based on the thermodynamic laws and logarithmic stress rate. Then, a specific thermo-mechanically coupled elasto-viscoplastic constitutive model is constructed from the framework to describe the thermo-mechanically coupled cyclic deformation of 316L stainless steel by using combined nonlinear isotropic and kinematic hardening rules and considering the internal thermal production. The nonlinear kinematic hardening rule is extended from that originally proposed by Abdel-Karim and Ohno (2000) and Ohno and Abdel-Karim (2000) for small deformation; and a cyclic hardening-softening-hardening feature observed in the cyclic test of the steel is reflected by using a nonlinear isotropic hardening rule consisting of several component equations. The strain amplitude dependence of cyclic hardening is considered by introducing a memory surface of plastic strain proposed by Chaboche et al. (1979), and the additional hardening effect caused by the non-proportional multiaxial cyclic loading path is involved by using the non-proportionality parameter defined by Tanaka (1994). Furthermore, the proposed constitutive model is implemented into a finite element code (e.g., ABAQUS) by combining the user subroutines UMAT and UMATHT. Finally, the proposed model is verified by comparing the predictions with the experimental results of 316L stainless steel. It