New Ductile Fracture Criterion for Prediction of Internal Fracture in Skew Rolling

Koji Yamane*, Kazuhiro Shimoda† and Koichi Kuroda‡

* Research and Development, Process Research Laboratories
Nippon Steel Corporation
1-8 Fuso-Cho, Amagasaki, Hyogo, 660-0891, Japan
E-mail: yamane.6nq.kohji@jp.nipponsteel.com, Web page: https://www.nipponsteel.com

† Same as the above
E-mail: shimoda.he3.kazuhiro@jp.nipponsteel.com

‡ Same as the above
E-mail: kuroda.d88.kohichi@jp.nipponsteel.com

ABSTRACT

Skew rolling is the process of reducing the diameter of a round billet. In this process, a heated round billet is rotated and advanced by rolls as the roll axes are skewed counterclockwise to the pass line. Depending on the rolling conditions, internal fracture may occur in the rolled material. This phenomenon also occurs in cross rolling to form axially symmetric parts. The mechanism of internal fracture has been researched since the 20th century. On the basis of such studies, various theories on its mechanism have been proposed. However, since the theories are based on qualitative experimental results that have not been quantitatively evaluated, the mechanism of internal fracture has not been fully clarified. To investigate the internal fracture initiation and propagation, we conducted hot rolling experiments and quantitatively evaluated the stress and strain history of the rolled material by elasto-plastic finite element analysis. The results show that the internal fracture arises on the internal surface in which shear stress acts owing to the combined effect of tensile and shear stress. In this paper, a new ductile fracture criterion is discussed to quantitatively predict the occurrence of internal fracture in skew rolling.

REFERENCES