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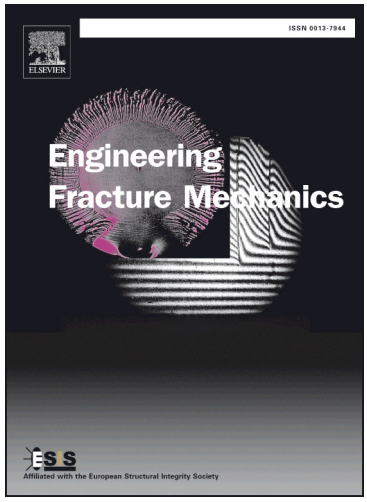

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Chun-Qing Li, Guoyang Fu, Wei Yang, Shangtong Yang

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DERIVATION OF ELASTIC FRACTURE TOUGHNESS FOR DUCTILE METAL PIPES WITH CIRCUMFERENTIAL EXTERNAL CRACKS UNDER COMBINED TENSION AND BENDING

Chun-Qing Li[1,*], Guoyang Fu[1], Wei Yang[2] and Shangtong Yang[3]
[1]School of Engineering, RMIT University, Melbourne, Australia
[2]College of Engineering and Science, Victoria University, Melbourne, 8001, Australia
[3]Department of Civil & Environmental Engineering, University of Strathclyde, Glasgow, UK

ABSTRACT

Linear elastic fracture mechanics has been widely employed for fracture analysis of cracked pipes. For ductile metal pipes, the existence of plasticity eases the stress concentration at the crack front, which increases the fracture toughness of the pipe. Therefore, when using linear elastic fracture mechanics to predict the fracture failure of ductile pipes, the plastic portion of the fracture toughness should be excluded. This paper intends to derive an analytical model of elastic fracture toughness for ductile metal pipes with circumferential external surface cracks under combined axial tension and bending. The derived elastic fracture toughness is a function of crack geometry, material properties and loading conditions of the cracked pipe. The significance of the derived model is that the well established linear elastic fracture mechanics can be used for ductile materials in predicting the fracture failure. It is found in the paper that, the elastic fracture toughness increases with the increase of the internal pressure of the pipe and that an increase in fracture toughness and yield strength of the pipe materials will result in a more ductile and brittle pipe failure respectively. The derived analytical model enables more accurate prediction of fracture failure of ductile metal pipes with circumferential external cracks.

KEYWORDS

Fracture Toughness; Ductile material; Circumferential Crack; Plasticity; Stress Intensity Factor.

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*Corresponding author: Professor Chun-Qing Li, Email: chunqing.li@rmit.edu.au

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