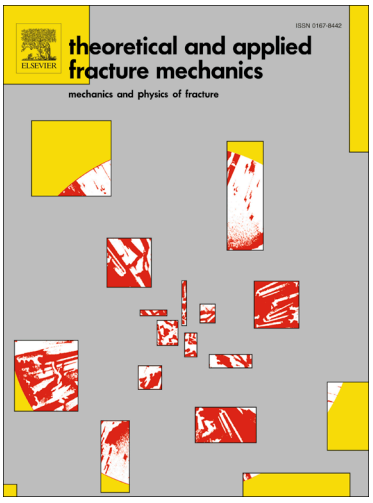

Simulation of ductile fracture of structural steels with void growth model and a continuum damage criterion based on it

Yue Yin, Xiaofan Liu, Qinghua Han, Zhuo Liu

PII: S0167-8442(18)30249-0
DOI: https://doi.org/10.1016/j.tafmec.2018.09.018
Reference: TAFMEC 2112

To appear in: *Theoretical and Applied Fracture Mechanics*

Received Date: 24 May 2018
Revised Date: 15 September 2018
Accepted Date: 24 September 2018

Please cite this article as: Y. Yin, X. Liu, Q. Han, Z. Liu, Simulation of ductile fracture of structural steels with void growth model and a continuum damage criterion based on it, *Theoretical and Applied Fracture Mechanics* (2018), doi: https://doi.org/10.1016/j.tafmec.2018.09.018

Simulation of ductile fracture of structural steels with void growth model and a continuum damage criterion based on it

Yue Yin[a,b], *Xiaofan Liu*[a], *Qinghua Han*[a,b,*], qhhan@tju.edu.cn, *Zhuo Liu*[a]

[a]Department of Civil Engineering, Tianjin University, Tianjin 300072, China

[b]Key Laboratory of Coast Civil Structure Safety of the Education Ministry, Tianjin University, Tianjin 300072

[*]Corresponding author.

Highlights:

1. Ductile fracture of structural steels was investigated by tension tests on single-edge notched specimens.
2. Ductile fracture of the single-edge notched specimens was simulated with VGM and a continuum damage criterion based on VGM.
3. The accuracy of VGM and the continuum damage criterion based on VGM was verified by comparison with test results.
4. The efficiency of VGM and the continuum damage criterion based on VGM was compared.

Abstract

Ductile fracture of single-edge U-notched and V-notched specimens under monotonic tension was investigated. Both experimental and numerical studies were conducted. In the tests on eight specimens, all ductile fracture initiated at mid-thickness of the notch tips and propagated all the way across the width of the specimens. Obvious plastic deformation was observed during both the fracture initiation and propagation procedures. Ductile fracture of these specimens was then simulated with void growth model (VGM) and a continuum damage criterion based on VGM. Extremely fine mesh and relatively coarse mesh were adopted in finite element analysis for the simulation. Load-displacement curves and the entire ductile fracture procedures obtained with the two fracture criteria for all the eight specimens agreed well with corresponding test results or with each other, by which the accuracy of both fracture criteria was verified. The efficiency of the two fracture criteria was also discussed. It was found that the computational cost of VGM is unacceptably high due to the request of extremely fine mesh along the fracture surface. With the continuum damage criterion, the ductile fracture of structural steels can be simulated accurately enough at acceptable computational cost even for steel components or connections with complicated configurations.

Keywords: Ductile fracture; Continuum damage criterion; Void growth model; Single-edge notched specimens; Monotonic tension

1. Introduction

Ductile fracture constitutes a significant failure mode of structural steels, which often causes cracking of components or connections and may result in the collapse of the whole building structures. It is thus necessary to figure out the mechanism of ductile fracture and setup doable numerical approaches for the simulation of the ductile fracture of structural steels [1-8].

Recently, micromechanical models, which are based on plastic damage mechanism of materials, received extensive attention. As one of these micromechanical models, void growth model (VGM) [9, 10]