Effect of *T*-stress on the initial fracture toughness of concrete under I/II mixed-mode loading

Yanhua Zhao, Wei Dong, Bohan Xu, Jin Liu

PII: S0167-8442(17)30415-9
DOI: https://doi.org/10.1016/j.tafmec.2017.10.009
Reference: TAFMEC 1964

To appear in: *Theoretical and Applied Fracture Mechanics*

Received Date: 7 September 2017
Revised Date: 24 October 2017
Accepted Date: 24 October 2017

Please cite this article as: Y. Zhao, W. Dong, B. Xu, J. Liu, Effect of *T*-stress on the initial fracture toughness of concrete under I/II mixed-mode loading, *Theoretical and Applied Fracture Mechanics* (2017), doi: https://doi.org/10.1016/j.tafmec.2017.10.009

Effect of *T*-stress on the initial fracture toughness of concrete under I/II mixed-mode loading

Yanhua Zhao[1], Wei Dong, Bohan Xu, Jin Liu

State Key Laboratory of Coastal and Offshore Engineering, Dalian University of Technology, Dalian 116024, P.R.China

Abstract: The mixed-mode stress intensity factors (SIFs) and *T*-stress for different geometries of four-point bending specimens were calculated by means of finite element analysis through a software suite Abaqus, where the influence of the crack length, loading point and crack location were considered. Thereafter, a series of four-point bending tests were re-interpreted to account for the consequences of the *T*-stress on the initial fracture of concrete, where a generalized maximum tangential stress (MTS) criterion was employed. The results indicate that the inclusion of *T*-stress is essential to predict a more realistic initial fracture toughness of concrete subjected to mixed-mode I/II loading.

Keywords: fracture mechanics; concrete; fracture toughness; crack initiation; *T*-stress

1. Introduction

As the constant term of the infinite Williams's series expansion for stress component parallel to the crack flank [1], the *T*-stress is believed to significantly influence the stress and strain fields around the crack tip, and thus the failure of fracture. Accordingly, conventional criteria for predicting the mix-mode fracture should include the term of *T*-stress. For example, when the MTS criterion [2] is used to describe fracture of brittle materials, K_{Ic} denoting fracture toughness for mode I decreases along with the bigger value of *T*-stress when the *T*-stress is greater than a certain value. For mode II fracture, the consequences of the *T*-stress are more significant: where K_{IIc} (representing mode II fracture toughness) increases for negative *T*-stress and decreases for positive *T*-stress [3]. The mixed-mode fracture experiments on glass proved the inclusion of *T*-stress could provide a more reasonable explanation for test results [3-5]. The test on high strength cement mortar showed that taking into account the non-singular term for strain field near the crack tip could provide highly accurate predictions for the crack propagation conditions [6]. Over the recent years, the study on the *T*-stress has extended to other engineering materials, such as rock [7,8], wood material [9] or metal-like materials with elastic-plastic crack-tip fields [10], or materials attributed to compressive loading [11], or cracks reinforced by composite patching [12]. All these studies confirm that the fracture behavior at the crack tip is dominated by the singular and non-singular term as well.

Initiated in 1961 by Kanplan [13], concrete fracture has made remarkable progress.

[1] Corresponding author, Associate Professor, E-mail: yanhuazh@dlut.edu.cn