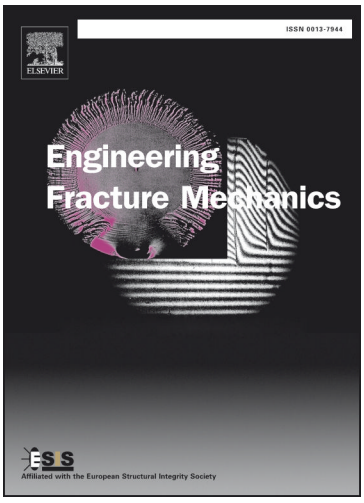

A theoretical method to determine the tortuous crack length and the mechanical parameters of concrete in direct tension—a particle size effect analysis

Dong Li, Liu Jin, Xiuli Du, Jingbo Liu

PII: S0013-7944(17)31315-2
DOI: https://doi.org/10.1016/j.engfracmech.2018.04.039
Reference: EFM 5965

To appear in: *Engineering Fracture Mechanics*

Received Date: 14 December 2017
Revised Date: 12 April 2018
Accepted Date: 25 April 2018

Please cite this article as: Li, D., Jin, L., Du, X., Liu, J., A theoretical method to determine the tortuous crack length and the mechanical parameters of concrete in direct tension—a particle size effect analysis, *Engineering Fracture Mechanics* (2018), doi: https://doi.org/10.1016/j.engfracmech.2018.04.039

A theoretical method to determine the tortuous crack length and the mechanical parameters of concrete in direct tension—a particle size effect analysis

Dong LI[a, b], Liu JIN[a, *], Xiuli DU[a], Jingbo LIU[b]

[a]Key Laboratory of Urban Security and Disaster Engineering of Ministry of Education, Beijing University of Technology, Beijing 100124, China

[b]Department of Civil Engineering, Tsinghua University, Beijing 100084, China

*Corresponding author, Email: kinglew2007@163.com, Tel: +86 15811171018

Abstract: Cementitious materials, mainly in the form of concrete, belong to a class of macroscopically heterogeneous materials. The building technology of mass concrete structures enables large-sized coarse aggregate to be used. The maximum coarse aggregate size, in conjunction with the mechanical properties of the interfacial transition zone (ITZ), have great influences on the mesoscopic crack path and the macroscopic mechanical behavior of concrete. Herein this study, based on some pioneering work [15-17, 35], the effects of varying the maximum coarse aggregate size and the ITZ strength on the global mechanical properties of concrete in direct tension are theoretically modelled from a mesoscopic point of view. The particle size effect behavior of concrete is analyzed based on the proposed theoretical method, and some general conclusions can be drawn as: 1) The degree of tortuosity of the mesoscopic crack path in direct tension increases with increasing maximum coarse aggregate size and with decreasing ITZ strength; 2) The fracture energy and the tensile strength of concrete increase dramatically with increasing ITZ strength; 3) For normal strength concrete, the fracture energy and the tensile strength decrease with increasing maximum coarse aggregate size, while for relatively high strength concrete, the trends are the opposite; 4) The properties of ITZ could significantly affect the homogeneity of concrete. High quality ITZ could make the mechanical properties of concrete more homogeneous and get a relatively high strength concrete, consequently a short characteristic length and a high brittleness number are resulted; 5) For normal strength concrete, the characteristic length increases with increasing maximum coarse aggregate size, while for relatively high strength concrete, it is fairly insensitive to the maximum coarse aggregate size. It is hoped that this theoretical method may be helpful in the study of size effect and in the design of concrete and future cementitious materials.

Keywords: Size effect; Maximum coarse aggregate size; Interfacial transition zone (ITZ); Fracture energy; Tensile strength; Characteristic length; Brittleness; Meso-mechanical analysis