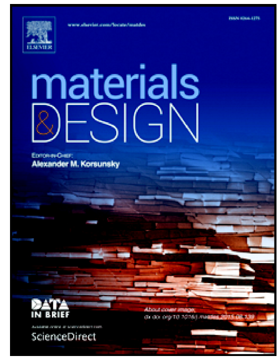
Accepted Manuscript



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PII: S0264-1275(17)30751-7
DOI: doi: 10.1016/j.matdes.2017.08.005
Reference: JMADE 3264

To appear in: *Materials & Design*

Received date: 21 May 2017
Revised date: 19 July 2017
Accepted date: 3 August 2017

Please cite this article as: Junfeng Guan, Xiaozhi Hu, Xiaohua Yao, Qiang Wang, Qingbin Li, Zhimin Wu , Fracture of 0.1 and 2m long mortar beams under three-point-bending, *Materials & Design* (2017), doi: 10.1016/j.matdes.2017.08.005

Fracture of 0.1 and 2 m long mortar beams under three-point-bending

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Abstract: Two hugely different mortar beams with the volume ratio close to 1:1000 were tested under three-point-bending (3-p-b) to verify fracture predictions for the large and long (LL) structures from results of the small and short (SS) specimens. They differed by both size and geometry: SS specimens with span length S = 0.1m, width W = 40 mm and S/W = 2.5, and LL beams with S = 2m, W = 500 mm and S/W = 4. This study performed and analysed quasi-brittle fracture of 0.1m SS specimens with initial notch a_0 from 1 to 25 mm for determination of tensile strength f_t and fracture toughness K_{IC}, from which fracture of 2m LL beams with a_0 of 250 mm was accurately predicted. Experiment results from the two vastly different 3-p-b beams, highly heterogeneous SS and nearly homogeneous LL in comparison to aggregates, were analysed by the boundary effect model (BEM).
Keywords: size effect; boundary effect model (BEM); aggregate size; tensile strength; fracture toughness

1. Introduction

Real mortar and concrete structures and notched samples tested in laboratories are rarely geometrically similar besides their obvious difference in size. Fracture predictions for large engineering structures based on experiments from small laboratory samples are possible only after a number of differences between the two are carefully considered and properly modelled. These include size, geometry, thickness, loading condition, size ratio by comparing structure and aggregates, and crack length and structure/specimen boundary conditions, as emphasized separately in a number of publications [e.g. 1–20]. The significance of those variables is already evident even we consider small and large three-point-bending (3-p-b) concrete specimens. If the small and large 3-p-b specimens have different span and width (S/W) ratios, or short and long beams, they are not geometrically similar. Two notches/cracks (a_0) of a given length in the small and large specimens have different effects on fracture because the un-notched ligaments (W-a_0) are different, which has been elucidated by the boundary effect model (BEM) [12, 13]. Similarly, if concrete has a maximum aggregate d_{max}, the small and large 3-p-b specimens are different by at least one size ratio, either in terms of a_0/d_{max} or $(W-a_0)/d_{max}$. It is possible that in some cases real mortar or concrete structures under safety consideration may contain short cracks comparable to the notches in small test samples, but in other cases they may even contain well-developed cracks much larger than the size of common laboratory specimens.

To address the above issues, in this study, 3-p-b tests of very large and very small mortar

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