Implications of Mode of Control and Loading Rate on the Determination of Concrete Fracture Properties

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ABSTRACT

Keywords: fracture energy, strain rate, concrete properties

Among all the parameters that characterize the concrete behavior, the fracture energy is one of the most crucial for the (numerical) investigation of damage propagation and failure in reinforced concrete members. Currently no standards exist that provide guidance to the characterization of concrete fracture properties. The experimental evaluation of fracture energy is influenced by different laboratory limitations, such as specimens' size [1] and mode of control during the fracture test. In order to investigate the differences between specimen geometries and evaluate the effect of mode of control on the fracture test, a numerical analysis supported by an experimental campaign and digital image correlation (DIC) is presented. The Lattice Discrete Particle Model (LDPM) [2] has been used to simulate concrete and to provide realistic crack patterns and crack widths. In the first part of the study the relationship between load point displacement rate, opening rate at the position of a surface-mounted extensometer, and actual strain rate at the crack tip are established for a number of specimen geometries and sizes by means of calibrated numerical simulations. For this purpose, the position of the crack tip is identified through an energetic approach. It is well-known that concrete is a visco-elastic material with strain-rate dependent fracture properties [3]. The potential influence of differences in loading rate on the determined fracture energy owing to these two phenomena is investigated in the second part, based on simulated three-point bending tests of differently sized specimens with two notch depths, loaded at different rates. The simulations are supported by an experimental campaign including Digital Image Correlation (DIC) data of the ligament area of beams loaded at different rates. The latter study has relevance both for the determination of a recommended loading rate and for permitting an acceleration range in the post-peak to shorten the test duration.

References:

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