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Experimental and Numerical Investigation of Fracture Behavior of Foamed Concrete Based on Three-Point Bending Test of Beams with Initial Notch

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Abstract : Foamed concrete is known for its low self-weight and excellent thermal and acoustic properties. For many years, it has been used worldwide for insulation to foundations and roof tiles, as backfill to retaining walls, sound insulation, etc. However, in the last years it has become a promising material also for structural purposes e.g. for stabilization of weak soils. Due to favorable properties of foamed concrete, many interests and studies were involved to analyze its strength, mechanical, thermal and acoustic properties. However, these studies do not cover the investigation of fracture energy which is the core factor governing the damage and fracture mechanisms. Only limited number of publications can be found in literature. The paper presents the results of experimental investigation and numerical campaign of foamed concrete based on three-point bending test of beams with initial notch. First part of the paper presents the results of a series of static loading tests performed to investigate the fracture properties of foamed concrete of varying density. Beam specimens with dimensions of 100×100×840 mm with a central notch were tested in three-point bending. Subsequently, remaining halves of the specimens with dimensions of 100×100×420 mm were tested again as un-notched beams in the same set-up with reduced distance between supports. The tests were performed in a hydraulic displacement controlled testing machine with a load capacity of 5 kN. Apart from measuring the loading and mid-span displacement, a crack mouth opening displacement (CMOD) was monitored. Based on the load – displacement curves of notched beams the values of fracture energy and tensile stress at failure were calculated. The flexural tensile strength was obtained on un-notched beams with dimensions of 100×100×420 mm. Moreover, cube specimens 150×150×150 mm were tested in compression to determine the compressive strength. Second part of the paper deals with numerical investigation of the fracture behavior of beams with initial notch presented in the first part of the paper. Extended Finite Element Method (XFEM) was used to simulate and analyze the damage and fracture process. The influence of meshing and variation of mechanical properties on results was investigated. Numerical models simulate correctly the behavior of beams observed during three-point bending. The numerical results show that XFEM can be used to simulate different fracture toughness of foamed concrete and fracture types. Using the XFEM and computer simulation technology allow for reliable approximation of load–bearing capacity and damage mechanisms of beams made of foamed concrete, which provides some foundations for realistic structural applications.

Keywords : foamed concrete, fracture energy, three-point bending, XFEM
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