

A new insight on size effect of concrete notched beams

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Abstract:

Size effect of notched beams made of a quasibrittle material deviates from what predicted by linear elastic fracture mechanics because of the presence of a large fracture process zone that is associated with the softening behavior of the material after the tensile strength is reached.

Size effect of concrete and other quasibrittle materials has been extensively studied. The size effect formula proposed by Z. Bažant, which has been recently implemented in the ACI 318 code for the shear strength contribution of concrete to the shear strength of reinforced concrete beams, is certainly one of the most renowned formulas and is also based on solid engineering mechanics principles.

Size effect of notched beams has been observed experimentally in many studies. However, the range of sizes investigated has been often limited by some difficulties related to the test setup. This paper presents the largest ever-attempted size effect study of plain concrete notched beams. Five depths (D) are considered, i.e. 75 mm, 150 mm, 250 mm, 500 mm, and 1000 mm. The notch length a_0 is equal to $0.25D$. The net span (S) is equal to $3D$. To overcome some issues that arise when deep beams are tested vertically, the 1000 mm- and 500 mm-deep notched beams have been tested horizontally using an innovative test setup that makes the beam float on top of Plexiglas balls. Some additional 500 mm-deep notched beams are tested vertically, in order to compare the results with those of the 500 mm-deep notched beams tested horizontally and verify that the horizontal setup does not introduce unexpected phenomena.

Digital image correlation analysis is used for all 5 sizes to measure the size of the fracture process zone, in order to discuss the size effect phenomenon, and propose a new method to determine the critical value w_c of the crack opening that is a fundamental parameter of the softening curve used in the cohesive crack model.