Behaviour of Ultra-High Performance Reinforced Concrete Beams and Fracture Mechanics Based Design

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Abstract
Ultra-High Performance Concretes (UHPC) until now have only been used for recent structural applications. Extraordinary properties of UHPC have not yet been exploited for design and application yet. UHPC that distinguish it from conventional concrete; their higher compressive strength, higher tensile strength with ductility, increased durability. It also has a great potential to use improving and rehabilitating of existing concrete structures. Shortage on the codes of structural design and construction guidelines for UHPC is the biggest challenging issue at the moment. A general overview on the properties of UHPC, some studies carried on Gazi University will be summarized. A new method has been proposed for the load bearing capacity of reinforced concrete (RC) beams under bending load. Unlike the widely used existing models, the proposed method was developed using fracture mechanics principles. First, shape functions frequently used in linear elastic fracture mechanics were simplified numerically. Second, design coefficients (β1, β 2, β 3) were formulated depending on the normalized crack length (ξ). Then, depending on the dimensionless parameters (λ p and M) managing flexural response, an empirical equation giving normalized crack length was experimentally obtained. In relation to this, 27 RC beams were tested by using 2D digital image correlation method to investigate the effect of concrete strength, tensile reinforcement ratio and steel fiber content on the flexural response. It has been observed that those parameters greatly influenced the load bearing capacity of the RC beam by manipulating the normalized crack length. Finally, proposed method was verified with the test results of 68 RC beams collected from various studies in the literature. Besides, a comparison was made between the proposed method and the frequently used ACI models with respect to load bearing capacity. In relation to this, mean absolute percentage errors in the proposed method and the ACI model were found to be 8.6% and 9.5%, respectively.