World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:13, No:09, 2019

First Cracking Moments of Hybrid Fiber Reinforced Polymer-Steel Reinforced Concrete Beams

Authors : Saruhan Kartal, Ilker Kalkan

Abstract : The present paper reports the cracking moment estimates of a set of steel-reinforced, Fiber Reinforced Polymer (FRP)-reinforced and hybrid steel-FRP reinforced concrete beams, calculated from different analytical formulations in the codes, together with the experimental cracking load values. A total of three steel-reinforced, four FRP-reinforced, 12 hybrid FRP-steel over-reinforced and five hybrid FRP-steel under-reinforced concrete beam tests were analyzed within the scope of the study. Glass FRP (GFRP) and Basalt FRP (BFRP) bars were used in the beams as FRP bars. In under-reinforced hybrid beams, rupture of the FRP bars preceded crushing of concrete, while concrete crushing preceded FRP rupture in over-reinforced beams. In both types, steel yielding took place long before the FRP rupture and concrete crushing. The cracking moment mainly depends on two quantities, namely the moment of inertia of the section at the initiation of cracking and the flexural tensile strength of concrete, i.e. the modulus of rupture. In the present study, two different definitions of uncracked moment of inertia, i.e. the gross and the uncracked transformed moments of inertia, were adopted. Two analytical equations for the modulus of rupture (ACI 318M and Eurocode 2) were utilized in the calculations as well as the experimental tensile strength of concrete from prismatic specimen tests. The ACI 318M modulus of rupture expression produced cracking moment estimates closer to the experimental cracking moments of FRP-reinforced and hybrid FRP-steel reinforced concrete beams when used in combination with the uncracked transformed moment of inertia, yet the Eurocode 2 modulus of rupture expression gave more accurate cracking moment estimates in steel-reinforced concrete beams. All of the analytical definitions produced analytical values considerably different from the experimental cracking load values of the solely FRP-reinforced concrete beam specimens.

Keywords : polymer reinforcement, four-point bending, hybrid use of reinforcement, cracking moment
Conference Title : ICCET 2019 : International Conference on Concrete Engineering and Technology
Conference Location : Paris, France
Conference Dates : September 19-20, 2019