

STATIC AND FATIGUE BEHAVIOR OF REINFORCED CONCRETE BEAMS STRENGTHENED WITH DIFFERENT FRP STRENGTHENING TECHNIQUES

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Abstract

Fibre-Reinforced-Polymer (FRP) reinforcements have been recently used extensively as an alternative reinforcement material to steel for new construction as well as for strengthening and repair of existing concrete structures. Externally bonded FRP sheets and strips are currently the most commonly used techniques for flexural and shear strengthening of concrete beams and slabs. Near-surface mounted (NSM) FRP reinforcements is currently emerging as a promising strengthening technique and a valid alternative to externally bonded FRP reinforcements.

This paper presents test results of the static and fatigue behavior of fourteen reinforced concrete T-beams strengthened in flexure with different strengthening systems using FRP rebars and strips as NSM reinforcement in addition to FRP strips and sheets as externally bonded reinforcement. Seven beams were tested under a monotonic three points static concentrated load using displacement-control mode at a loading rate of 1.0 mm/min. The other seven beams were loaded by applying a sinusoidal loading pattern at a rate of 3Hz. Upper and lower load limits were chosen equal to 90% and 20% of the yield load of comparable beams loaded statically up to failure. Two beams were unstrengthened and used as control specimens one tested under static loading and the other one tested under cyclic fatigue loading. The FRP reinforcements used in this investigation included carbon-fiber-reinforced-polymer (CFRP) rebars and strips, and glass fiber-reinforced-polymer (GFRP) rebars. The static and fatigue behavior as well the effectiveness of the materials used for the various NSM strengthening systems using the same axial stiffness are compared. The structural performance, strength and stiffness degradation of the beams subjected to cyclic loading were examined and compared with similar beams tested under static loading. The behavior prior to and after cracking, ultimate carrying capacity, modes of failure, and fatigue life of all tested beams are presented and discussed in this paper.

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