Influence of Externally Bonded FRP Orientation on Shear Capacity of Reinforced Concrete Deep Beams

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Many research studies have shown that the internal reinforcement has a significant influence on increasing the shear capacity of reinforced concrete deep beams. This study investigates the potential of using externally bonded FRP reinforcement for shear strength enhancement of RC deep beams. Experiments include serval RC deep beams with a rectangular cross section and a shear span to depth ratio (a/h) equals to 1.5. The deep beams were tested under symmetric three-point bending monotonically until failure. One beam specimen was a control test with no strengthening. The remaining beams were strengthened with three composite systems, namely 0° unidirectional CFRP, 0/90° bidirectional CFRP and ±45° bidirectional GFRP. The three composite systems were applied with different orientations and locations of the beam using epoxy adhesives for shear strength enhancement evaluation. Behavior of the tested deep beams is indicated by their levels of ultimate shear strength, mid-span deflection, FRP reinforcement strain, crack propagation, strut angle, and by their type of failure. The behavior of the tested deep beam specimens is compared to each other experimentally. Test results show different modes of failure and gain in the ultimate shear strength over the control beam depending on the orientation of the fibers in the sheets.

Keywords: Reinforced concrete, deep beams, externally bonded systems, bi-directional GFRP sheets