Experimental and analytical study on eccentrically loaded Fiber concrete columns reinforced longitudinally with GFRP bars

ABSTRACT

In this paper, experiments were carried out to analyze the behavior of the square columns reinforced longitudinally by GFRP bars along with different ratios of hooked end fibers under eccentric compressive loading. Eight short square columns with a cross-section dimension of 150x150mm and a height of 1200mm, were fabricated to conduct the experimental program. A 150mm enlargement in column-cross at both ends was considered to develop an eccentric axial load. The columns were tested under different load eccentricity ratios (0.26, 0.5, 1). Different tie spacings (50, 100, 120) mm. Different ratios of steel fibers 0%, 0.5%, and 1% were incorporated into the concrete mix. It was observed that columns with steel fibers demonstrated good characteristics, including higher ultimate load, increased ultimate deflection, and enhanced ductility and toughness compared to the columns without steel fibers due to multiple cracking behaviors. The ductility of the columns reinforced with GFRP bars was enhanced by 46.8%, and 68% for steel fiber volume ratios of 0.5% and 1%, respectively. The energy absorption was increased by 42% and 77% for steel fibers ratios of 0.5% and 1%, respectively. When GFRP bars were used as longitudinal reinforcement, there was an improvement in the bond behavior between the concrete and the GFRP bars. All concrete columns reinforced by GFRP bars failed due to flexure-compression failure. There was no observed rupture of GFRP bars during the experimental test and the maximum strain did not reach 40% of their ultimate strain capacity. Nonlinear Finite Element analysis was conducted to simulate the behavior of tested columns. The equations from previous studies and the codes were established to predict the nominal peak capacity of columns considering all parameters. In general, there was a reasonable level of agreement observed between the experimental data and the theoretical results determined for seventy-column specimens in the current study and from previous studies in the literature.