Experimental and Numerical Evaluation of the Shear Behavior of Reinforced Concrete T-Beams with Hybrid Steel-FRP Stirrups

Mohamed F. M. Fahmy; Zainab E. Abd-ElShafy; and Zhishen Wu

Abstract:

This study presents the shear behavior of reinforced concrete (RC) T-beams with innovative steel stirrups hybridized in the longitudinal direction with a fiber-reinforced polymer (FRP) composite. Six beams were experimentally tested: three beams were reinforced with the hybrid steel-FRP stirrups, and the others served as control samples and were reinforced with conventional steel stirrups. Furthermore, a two-dimensional finite-element (FE) model was created and executed using FE analysis software to examine the effect of several influential parameters, including the type and amount of FRP used in producing the hybrid stirrups. Large-scale beams reinforced with carbon FRP (CFRP) stirrups were numerically simulated before and after replacing the transverse CFRP reinforcement with steel-FRP stirrups. Compared with conventional RC beams, concrete beams reinforced with steel-FRP stirrups successfully showed a considerable increase in the beam shear strength and deformability. Moreover, hybrid steel-FRP stirrups can provide design engineers with a new, flexible design to control both the structural response and the construction cost.

Keywords:

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Strength and Deformability of High Strength R.C Columns Subjected to Eccentric Loading

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Abstract:

The use of high-strength concrete (HSC) has been widely accepted by designers and contractors in reinforced concrete structures, especially heavily loaded column of high-rise building and bridges. To study the strength and deformability of HSC columns subjected to eccentric loading, nine columns were tested under eccentric loading and one column only was tested under axial loading. The investigated parameters were concrete compressive strength, slenderness and rectangularity ratios, and load eccentricity. The concrete compressive strength ranged from 36.0 to 75.0 MPa and the slenderness ratio was ranged from 6.67 to 10.0 while the considered eccentricities ratios ranged from 0.0 to 0.80. Also, comparison between experimental and analytical study was carried. The results indicated that increasing concrete compressive strength resulted in increasing the column strength capacity. While increasing the eccentricity are resulted in decreasing the column strength capacity. Also the comparison between experimental and analytical study indicated that both ACI 318R-14 and ECP 203-07 codes are acceptable and valid to determine both the load and the moment capacity of such columns subjected to eccentric loading if take into consideration the additional moment induced due to column deformations.

Keywords:

High Strength Concrete HSC; R.C Columns; Eccentric Loading; Strength; Deformability; Stress-Strain Curves

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Behavior of the Concrete Core at the Critical Zones of Concrete Filled Steel Tube Columns after Using CFRP Composites as Additional Reinforcement


Abstract:

This study proposed Carbon fiber reinforced polymers (CFRP) as additional transverse reinforcement at the critical zones of concrete filled steel tubular (CFST). An experimental study consisted of five main sets of specimens representing the ends of columns, such as those merging in through beam-column connections, was conducted. Each main set of specimens investigated the behavior of the concrete core for a specific case of CFST or CFRP wrapped CFST (CFCFST), and each main set comprised three similar specimens to get more accurate results. All specimens were 160 mm external diameter and 320 mm height and had the same concrete grade. The thicknesses of the steel tubes used were 2 and 3mm. The numbers of (CFRP) layers used were one and two layers. The results showed that one and two CFRP outer layers added to CFST greatly improved the concrete compression. Response showed 29% and 54% increase in the concrete core compressive strength, respectively. The increase in the steel tube thickness from 2mm to 3 mm caused 20% increase in the concrete core compressive strength. A new analytical model with a sufficient accuracy was driven to predict the concrete core strength for both CFST and CFCFST cases.

Keywords:

Concrete, Steel tube, Fiber reinforced polymer (FRP), Confinement, Buckling.

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