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Experimental and Numerical Study of Ultra-High-Performance Fiber-Reinforced Concrete Column Subjected to Axial and Eccentric Loads

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Abstract : Ultra-high-performance fiber reinforced concrete (UHPFRC) is a specially formulated cement-based composite characterized with an ultra-high compressive strength (f_c[’] = 240 MPa) and a low water-cement ratio (W/B= 0.2). With such material characteristics, UHPFRC is favored for the design and constructions of structures required high structural performance and slender geometries. Unlike conventional concrete, the structural performance of members manufactured with UHPFRC has not yet been fully studied, particularly, for UHPFRC columns with high slenderness. In this study, the behaviors of slender UHPFRC columns under concentric or eccentric load will be investigated both experimentally and numerically. Four slender UHPFRC columns were tested under eccentric loads with eccentricities, of 0 mm, 35 mm, 50 mm, and 85 mm, respectively, and one UHPFRC beam was tested under four-point bending. Finite element (FE) analysis was conducted with concrete damage plasticity (CDP) modulus to simulating the load-middle height or middle span deflection relationships and damage patterns of all UHPFRC members. Simulated results were compared against the experimental results and observation to gain the confidence of FE model, and this model was further extended to conduct parametric studies, which aim to investigate the effects of slenderness regarding failure modes and load-moment interaction relationships. Experimental results showed that the load bearing capacities of the slender columns reduced with an increase in eccentricity. Comparisons between load-middle height and middle span deflection relationships as well as damage patterns of all UHPFRC members obtained both experimentally and numerically demonstrated high accuracy of the FE simulations. Based on the available FE model, the following parametric study indicated that a further increase in the slenderness of column resulted in significant decreases in the load-bearing capacities, ductility index, and flexural bending capacities.

Keywords : eccentric loads, ductility index, RC column, slenderness, UHPFRC
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