Flexural Behavior of Reinforced Lightweight Foamed Concrete Beams Using GFRP Bars

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ABSTRACT

The lightweight foamed concrete (LWFC) applications in the structural building are so restricted due to its low strength and brittleness. The experimental work of this study includes two parts: the first involves improving the mechanical properties for the LWFC using additives and fibers. Eleven mixes were cast and tested for compressive strength, splitting tensile strength, flexural strength, and modulus of elasticity with target density 1800 kg/m^3. Two types of fibers were added to LWFC mix, which were steel fiber, and polypropylene fiber, and hybrid fibers (steel+ polypropylene). The test results showed that the fibers addition into the LWFC mix decreases the flowability and enhance the mechanical properties. The hybrid fibers mixed with (0.4%+ 0.2%) of (steel+ polypropylene) fibers gave the best results and used in casting the reinforced concrete beams.

The second part of this work is the experimental study of the behavior of reinforced (Lightweight foamed, Normal) concrete beams using Glass Fiber Reinforced Polymer (GFRP) bars as the main reinforcement under two point flexural loads. This part includes twelve beams with dimensions (200mm x 250 mm x 1500 mm), divided into two groups: six of lightweight foamed concrete and six of normal concrete beams. For each group: three beams reinforced with GFRP bars in three different reinforcement ratios, two beams reinforced with hybrid

(GFRP+steel) reinforcements, and one beam reinforced with steel bars for comparison

The main variables considered are the concrete type (Lightweight foamed concrete, Normal concrete), reinforcement type (GFRP bars, Steel bars), and GFRP reinforcement ratio. The main parameters considered in this stage of experimental work are the ultimate load capacity, deflection, cracks width, concrete strain, and main reinforcement strain at mid-span length. Therefore, the experimental serviceability limitation, load-deflection curve, load-main reinforcement strain curve, load-concrete strain curve, load-neutral axis depth, ductility index and deformability factor are prepared for all tested beam.

The service load is 35% of the ultimate load for each tested beams. At the service load, the stiffness of GFRP reinforced lightweight foamed concrete beams was less than that of the normal concrete beams, thus the deflection of LWFC beams was higher than the deflection of normal concrete beams. According to the ductility index, the deformability factor of lightweight foamed concrete beams is more than that of normal concrete beams.

The experimental test results of ultimate load, deflection and crack width for all tested beams were compared with that estimated by ACI 440.1R-06 and ACI 318M-14 models. The comparison showed a good agreement between the experimental and predicted results such as increasing the reinforcement ratio and increasing the steel ratio in the hybrid reinforcing GFRP/steel. The ratio of predicted results to the experimental results was (1.1) at service load.