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The Structural Behavior of Fiber Reinforced Lightweight Concrete Beams: An Analytical Approach

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Abstract : Increased use of lightweight concrete in the construction industry is mainly due to its reduction in the weight of the structural elements, which in turn reduces the cost of production, transportation, and the overall project cost. However, the structural application of these lightweight concrete structures is limited due to its reduced density. Hence, further investigations are in progress to study the effect of fiber inclusion in improving the mechanical properties of lightweight concrete. Incorporating structural steel fibers, in general, enhances the performance of concrete and increases its durability by minimizing its potential to cracking and providing crack arresting mechanism. In this research, Geometric and Materially Non-linear Analysis (GMNA) was conducted for Finite Element Modelling using a software known as ABAQUS, to investigate the structural behavior of lightweight concrete with and without the addition of steel fibers and shear reinforcement. 21 finite element models of beams were created to study the effect of steel fibers based on three main parameters; fiber volume fraction (Vf = 0, 0.5 and 0.75%), shear span to depth ratio (a/d of 2, 3 and 4) and ratio of area of shear stirrups to spacing (As/s of 0.7, 1 and 1.6). The models created were validated with the previous experiment conducted by H.K. Kang et al. in 2011. It was seen that the lightweight fiber reinforcement can replace the use of fiber reinforced normal weight concrete as structural elements. The effect of an increase in steel fiber volume fraction is dominant for beams with higher shear span to depth ratio than for lower ratios. The effect of stirrups in the presence of fibers was very negligible; however; it provided extra confinement to the cracks by reducing the crack propagation and extra shear resistance than when compared to beams with no stirrups.

Keywords : ABAQUS, beams, fiber-reinforced concrete, finite element, light weight, shear span-depth ratio, steel fibers, steel-fiber volume fraction
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