Investigating the Behavior of Lightweight Foamed Concrete T-Beams under Torsion, shear, and Flexure

Ahmed Farouk Mohamed Hassan Deifalla ,Awad A, Elrahman AA, Seleem H

Abstract

Compared to conventional normal weight concrete, Lightweight Concrete (LWC) has significantly lower own-weight-to-strength ratio and good thermal insulation. Previous studies showed that the design codes underestimate the strength of LWC beams under pure shear force or pure torsion moment. In addition, the behavior and design of LWC T-beams under combined bending, shear and torsion was never investigated. Thus, this current study explores the effect of various parameters on the behavior of lightweight foamed concrete (LWFC) T-beams under combined shear, torsion and moment. Investigated parameters included the following: shear-span-to-depth ratio, torsion-to-shear-depth ratio, flange-to-web-width ratio, and transversal reinforcement ratio. An experimental program was conducted which included testing five T-beams under various ratios of combined loading. In addition, a numerical model was developed for LWFC T-beams under combined loading and verified using available experimental results. Moreover, a parametric study was performed to further investigate the effect of the selected parameters on the behavior of LWFC T-beams. Last but not least, the most recent internationally recognized design code is selected and used to calculate the T-beams strength, which was compared with the ones from the experimental and numerical investigations. For small values of the shear-span-to-depth ratio, the LWFC T-beams strength increased with the decrease of the torsion-to-shear-depth ratio compared to those with large values of the shear-span-to-depth ratio. In addition, the effect of the flange width was found to be insignificant. Moreover, the failure mode for beams with transversal reinforcement ratio above 1.2%, changed from under-reinforced mode to an over-reinforced one. Last but not least, the strength predicted using selected design code was found to be overly conservative compared to that experimentally measured and that numerically predicted for LWFC T-beams under combined loading.

Engineering Structures 2020, September