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Topology Optimisation for Reduction in Material Use for Precast Concrete Elements: A Case Study of a 3D-Printed Staircase

Authors : Dengyu You, Alireza Kashani

Abstract : This study explores the potential of 3D concrete printing in manufacturing prefabricated staircases. The applications of 3D concrete printing in large-scale construction could enhance the industry's implementation of the Industry 4.0 concept. In addition, the current global challenge is to achieve Net Zero Emissions by 2050. Innovation in the construction industry could potentially speed up achieving this target. The 3D printing technology offers a possible solution that reduces cement usage, minimises framework wastes, and is capable of manufacturing complex structures. The performance of the 3D concrete printed lightweight staircase needs to be evaluated. In this study, the staircase is designed using computer-aided technologies, fabricated by 3D concrete printing technologies, and tested with Australian Standard (AS 1657-2018 Fixed platforms, walkways, stairways, and ladders – design, construction, and installation) under a laboratory environment. The experiment results will be further compared with the FEM analysis. The results indicate that 3D concrete printing is capable of fast production, reducing material usage, and is highly automotive, which meets the industry's future development goal.

Keywords : concrete 3D printing, staircase, sustainability, automation
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