Tech Science Press

ICCES, 2024, vol.31, no.4
DOI: 10.32604/icces.2024.012282

PROCEEDINGS

Enhancing the Interlayer and Flexural Performance with SHCC as Bonding Agents in 3D Concrete Printing

Fei Teng[1] and Yiwei Weng[1,*]

[1]Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong, China
[*]Corresponding Author: Yiwei Weng. Email: yiwei.weng@polyu.edu.hk

ABSTRACT

3D concrete printing (3DCP) has challenges in weak interlayer bond strength and steel reinforcement integration. Existing methods to improve the interlayer bond strength and integrate steel reinforcement have limitations in automatic operation and limited mechanical performance improvement. Strain hardening cementitious composites (SHCC), with the high tensile strength and tensile strain capacity, have the potential to achieve self-reinforced structures in 3DCP. Nevertheless, the wider adoption of SHCC in 3DCP is limited by the high cost of fibers and fiber agglomeration during printing.

To fill the gap, this study investigates the use of SHCC as bonding agent of interface to simultaneously improve the interlayer bond strength and flexural performance of 3D printed structures. Two research questions were explored: (1) how the rheological properties of SHCC affect the interlayer performance, and (2) how the distribution of SHCC layers affects the flexural performance. Three SHCC mixtures with different rheological properties were designed by the adjustment of the dosage of viscosity modifying agent (VMA). A novel nozzle system was designed to synchronously print concrete and deposit SHCC. Splitting tensile test was adopted to evaluate the interlayer bond strength. Multi-layer SHCC-concrete beams with different configurations of SHCC distribution were printed, and four-point bending test was performed to evaluate the flexural performance.

The experimental results show that with the addition of SHCC bonding agent, the interlayer bond strength can be increased by 79.58%. In the SHCC-concrete beams, the specimen exhibits a ductile flexural hardening behavior with an appropriate SHCC distribution. The flexural strength, deflection, and energy absorption capacity increase by 25.53%, 182.35%, and 797.73%, respectively, compared to that of beams without SHCC bonding agent. The findings reveal that the newly developed printing scheme by using SHCC as bonding agent with optimal distribution has great potential to address the weak interlayer bond strength and reinforcement integration problems in 3DCP.

KEYWORDS

3D concrete printing; strain-hardening cementitious composites; interlayer performance; flexural performance

Funding Statement: The author would like to gratefully acknowledge the Project No.52308284 supported by National Natural Science Foundation of China and project supported by Guangdong Basic and Applied Basic Research Foundation (No. 2024A1515011870).

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.