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Master's Thesis Project Proposal

Finite Element Modelling of 3D Printed Concrete

Supervisor

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Introduction

3D concrete printing has developed rapidly in recent years, enabling automated construction and complex geometries[1]. The presence of interlayer interfaces is a characteristic feature of layer-wise printed structures, and their properties influence crack initiation, load-bearing capacity, and failure mechanisms. Accurate representation of interlayer behavior is therefore required for realistic structural assessment and reliable prediction of mechanical performance[2]. Moreover, the characteristics of interlayer bonding influence the overall structural performance of 3D printed concrete, altering its durability during long-term service and its seismic response under cyclic loading[3].
Finite Element modeling provides an effective approach to investigate these aspects and to link experimental observations with predictive analysis. This thesis develops numerical models that incorporate interlayer behavior, material characteristics, and reinforcement strategies, with the aim of improving simulation reliability and supporting the application of 3DCP in large scale construction.

Objective

This project aims to develop numerical simulation approaches for 3D printed concrete that incorporate multimaterial printing and reinforcement.

Principal procedure

- Literature research on interlayer behavior, multimaterial systems, and reinforcement strategies of 3D printed concrete
- Evaluate different finite element platforms such as ABAQUS, ANSYS, COMSOL, or comparable software to identify the most suitable tools
- Build numerical models that incorporate anisotropy, weak interlayer bonding, multimaterial printing, and reinforcement

- Identify key materials and interface parameters from literature and experimental data
- Perform simulations under various loading and boundary conditions to assess structural behavior
- Compare simulation results with experimental results to evaluate predictive accuracy
- Analyze results, discuss limitations and propose improvements for future modeling methods

Requirements

- Interest in concrete structures and additive manufacturing technologies
- Basic knowledge of finite element analysis
- Familiar with ABAQUS, ANSYS or comparable platforms
- Programming skills are beneficial but not mandatory
- Good command of English for thesis and presentation

References

[1] R. J. M. Wolfs, F. P. Bos, and T. A. M. Salet, “Hardened properties of 3D printed concrete: The influence of process parameters on interlayer adhesion,” Cem. Concr. Res., vol. 119, pp. 132–140, May 2019, doi: 10.1016/j.cemconres.2019.02.017.
[2] T. Ding, Z. Wang, H. Liu, and J. Xiao, “Simulation on pull-out performance of steel bar from 3D-printed concrete,” Eng. Struct., vol. 283, no. March, 2023, doi: 10.1016/j.engstruct.2023.115910.
[3] C. Liu, Z. Liang, H. Liu, Y. Wu, Y. Zhang, and G. Bai, “Seismic performance of 3D printed reinforced concrete walls: Experimental study and numerical simulation,” Eng. Struct., vol. 333, no. January, 2025, doi: 10.1016/j.engstruct.2025.120176.