

Master's Thesis Project Proposal

Evaluation of the bond behaviour of the interface between 3D-printed and cast concrete

Supervisor

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Start: Immediately / by arrangement

Background & Objective

Three-dimensional concrete printing (3DCP) is an emerging technology offering advantages in material efficiency, design flexibility, and automation. It has been successfully applied in housing, infrastructure, and bespoke structural components.

One promising application is the use of 3D-printed elements as formwork for cast-in-place reinforced concrete (RC). This hybrid approach combines the geometric freedom of 3DCP with the structural integrity of RC, enabling load-bearing applications such as walls, beams, and columns. However, current design practices often ignore the structural contribution of the printed formwork, leading to material overuse and misrepresented stiffness. Additionally, the mechanical interaction between the printed formwork and the cast concrete is poorly understood, raising concerns about debonding, differential shrinkage, and interfacial failure mechanisms. While cast-to-cast concrete interfaces have been widely studied, research on printed-to-cast interfaces remains scarce.

This thesis aims to investigate the bond properties of the printed–cast interface. Based on a literature review, a suitable tensile and shear test method is to be selected/developed. Furthermore, the influence of different key variables (such as casting time or concrete type) on the interface bond are to be evaluated.

Main Tasks

1. Literature review on bonding between printed and cast concrete
2. Literature review on new-to-old concrete bonding
3. Define and justify a suitable test method to assess tensile and shear behaviour
4. Participate in specimen production: printing, casting, and preparation
5. Execute tests and evaluate fracture surfaces
6. Analyze bonding performance under varying conditions
7. Summarize findings and implications for practical applications

Requirements

- Interest in concrete technology and additive manufacturing
- Motivation for practical lab work and independent problem-solving
- Familiarity with mechanical testing (preferred)

- Ability to work independently and in coordination with a team

Language for the written version:

English / Deutsch

Literatur

- [1] Bos et al., "Additive manufacturing of concrete in construction: potentials and challenges of 3D concrete printing," *Virtual and Physical Prototyping*, vol. 11, no. 3, pp. 209–225, 2016, doi: 10.1080/17452759.2016.1209867.
- [2] V. Mechtcherine et al., "Extrusion-Based Additive Manufacturing with Cement-Based Materials – Production Steps, Processes, and Their Underlying Physics: A Review," *Cement and Concrete Research*, vol. 132, 2020, doi: 10.1016/j.cemconres.2020.106037.
- [3] Atkinson and Aslani, "Performance of 3D printed columns using self-sensing cementitious composites," *Construction and Building Materials*, vol. 375, 2023, doi: 10.1016/j.conbuildmat.2023.130961.
- [4] Wang et al., "Interfacial bonding properties of 3D printed permanent formwork with the post-casted concrete," *Cement and Concrete Composites*, vol. 128, 2022, doi: 10.1016/j.cemconcomp.2022.104457.
- [5] Wang et al., "Interfacial Properties of Three-Dimensional-Printed Permanent Formwork with Cast-in-Place Concrete", doi: 10.1089/3dp.2021.0213.
- [6] Bekaert et al., "Evaluation of the Bond Strength Between 3D Printed and Self-compacting Concrete," in *2nd RILEM International Conference on Concrete and Digital Fabrication: Digital Concrete 2020*, 2020, pp. 228–234, doi: 10.1007/978-3-031-06116-5_34.
- [7] Bai et al., "Interfacial bond properties between 3D printed engineered cementitious composite (ECC) and post-cast concrete," *Cement and Concrete Composites*, vol. 157, p. 105897, 2025, doi: 10.1016/j.cemconcomp.2024.105897.
- [8] Guan et al., "Evaluation of the Performance of Reinforced Concrete Beams with 3D-Printed Permanent Formwork," *J. Intelligent. Con.*, vol. 2, no. 4, pp. 1–17, 2024, doi: 10.26599/JIC.2024.9180030.
- [9] F. Bos et al., "RILEM TC 304-ADC ILS-mech Study Plan," 2023, doi: 10.14459/2023mp1705940. 2023.