Technische Universität München

TUM School of Engineering and Design

Univ.-Prof. Dr.-Ing.
Dipl.-Wirt. Ing.
Oliver Fischer

Theresienstraße 90
Gebäude N6
80333 München
Germany

Tel +49.89.289.23039
Fax +49.89.289.23030

massivbau@tum.de
www.cee.ed.tum.de/mb

Bachelor's Thesis Project Proposal

Durability of the Interface Between 3D-Printed and Cast Concrete – A Literature-Based Investigation

Supervisor

Mohammad Olabi, M. Sc.
Room: N1603
Tel.: 089/289-23025
E-Mail: mohammad.olabi@tum.de

Start: Immediately / by arrangement

Background

Three-dimensional concrete printing (3DCP) is rapidly emerging as a promising technology in construction, offering benefits such as automation, material efficiency, and architectural freedom. A growing application is the use of 3D-printed concrete elements as permanent formwork for cast-in-place reinforced concrete (RC). These hybrid systems enable efficient construction while maintaining structural performance.

Although mechanical behaviour at the printed–cast interface has received initial research attention, very little is known about its durability, particularly regarding how long-term environmental exposure may affect the bond, transport properties, or failure mechanisms at this interface.

At the same time, a substantial body of research exists on the durability of 3D-printed concrete by itself, and an even larger body on durability of cast concrete and new-to-old interfaces. By combining and comparing these two knowledge domains, this thesis aims to build the first systematic overview of what is known—and unknown—about the durability of the printed–cast interface.

Objective:

To conduct a structured literature study on the durability-related behaviour of 3D-printed concrete, cast concrete, and conventional concrete interfaces, and to identify the most relevant durability mechanisms and test methods for future experimental research on printed–cast interfaces.

Main Tasks

1. Literature Review – Durability of 3D-Printed Concrete
    - Identify durability studies focusing on carbonation, chloride ingress, moisture transport, freeze–thaw resistance, and microstructure of 3D-printed concrete.
    - Summarize key findings, process parameters, and durability limitations related to layer interfaces and printing-induced anisotropy.
2. Literature Review – Durability of Conventional Cast Concrete
    - Review how cast concrete responds to major degradation mechanisms (carbonation, chlorides, freeze–thaw, sulphates, fire, etc.).

- Summarize standard test methods and typical results.

3. Literature Review – New-to-Old Concrete Interfaces
    - Examine existing knowledge on cold joints, bonding mechanisms, interfacial transition zones (ITZ), and long-term durability of such interfaces.
    - Highlight similarities and differences compared to printed interfaces.
4. Comparative Analysis & Identification of Knowledge Gaps
    - Compare 3D-printed material durability with cast concrete and with new-to-old concrete bonds.
    - Identify which durability mechanisms are most likely to be critical at a printed–cast interface.
    - Summarize open research questions and unresolved challenges in current literature.
5. Definition of Relevant Durability Tests for Future Research
    - Based on literature, propose which tests (e.g., carbonation depth, chloride migration, freeze–thaw, moisture transport, fire exposure) are most suitable for evaluating printed–cast interfaces.
    - Provide recommendations for specimen types and possible interface configurations.
6. Final Report & Presentation
    - Compile the findings into a structured thesis document.
    - Present key insights, research needs, and suggested next steps for experimental studies.

Requirements

- Interest in concrete technology, durability, and material science
- Good analytical skills and motivation for scientific reading
- Ability to summarize and synthesize technical literature
- No laboratory work required

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.

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[3] Zhang, Y., Lima, L.N. de, Böhler, D., Arunothayan, A., Babafemi, A.J., Baz, B., Caneda-Martinez, L., Schutter, G. de, Du, H., Freund, N., et al.: Durability assessment of 3D printed cement-based materials: a RILEM TC 304-ADC interlaboratory study. Materials and structures, vol. 58 (2025). doi: 10.1617/s11527-025-02797-5

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[6] van der Putten, J., Volder, M. de, van den Heede, P., Deprez, M., Cnudde, V., Schutter, G. de, van Tittelboom, K.: Transport properties of 3D printed cementitious materials with prolonged time gap between successive layers. Cement and Concrete Research, vol. 155, 106777 (2022). doi: 10.1016/j.cemconres.2022.106777

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