Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Joris Jan Burger
Student number	4152921

Studio	
Name / Theme	Building Technology, Sustainable Design Graduation Studio
Teachers / tutors	Christian Louter, Serdar Asut
Argumentation of choice of the studio	Strong interest in novel materials, innovative ways of building and using technology to improve the built environment in a sustainable way.

Graduation project	
Title of the graduation project	Fabricating non-standard, structural concrete columns using 3D printed thin shell formwork
Goal	
Location:	Research: location independent Case study: Zurich, Switzerland
The posed problem,	Current techniques for producing concrete columns with a non-standard geometry are not effective in terms of process and material use.
research questions and	Can 3D printed, thin-shell formwork be used to construct full-scale, structural performing, concrete columns and serve as a more sustainable alternative to existing ways of fabricating formwork?
design assignment in which these result.	Design of an outside roof structure with a single structural concrete column with a non-standard geometry supporting a wooden roof.
The research subject is the exploration of a promising innovative technique of producing formwork for concrete construction. Some preliminary prototypes have been made but the challenge lies in scaling up the technique to be fit for use in construction. For this to happen several challenges need to be addressed such as	

reinforcement, scale and structural performance. After developing the technique it will be applied into a case study which is a pavilion in Zurich.

Process

Method description

Various types of methods and techniques of research will be utilized because a variety of subjects is studied. Quantitative research will be used for example, when studying concrete properties or 3D printing. When researching reinforcement a research by doing approach will be followed where different techniques are tested in a practical application.
For design an iterative process will be followed which is heavily informed by structural motivations.

Literature and general practical preference

The project builds upon earlier work done at the ETH Zurich for creating non-standard concrete columns using a slipforming process (Lloret et al., 2015). The project uses the same set-on-demand casting system of concrete to avoid high hydrostatic pressure. Furthermore many other projects that deal with "digital concrete" (Wangler et al., 2016) are taken as a reference. As for classical references the work of Pier Luigi Nervi is a practical reference, his innovative use of concrete to create optimized structure is inspiring.

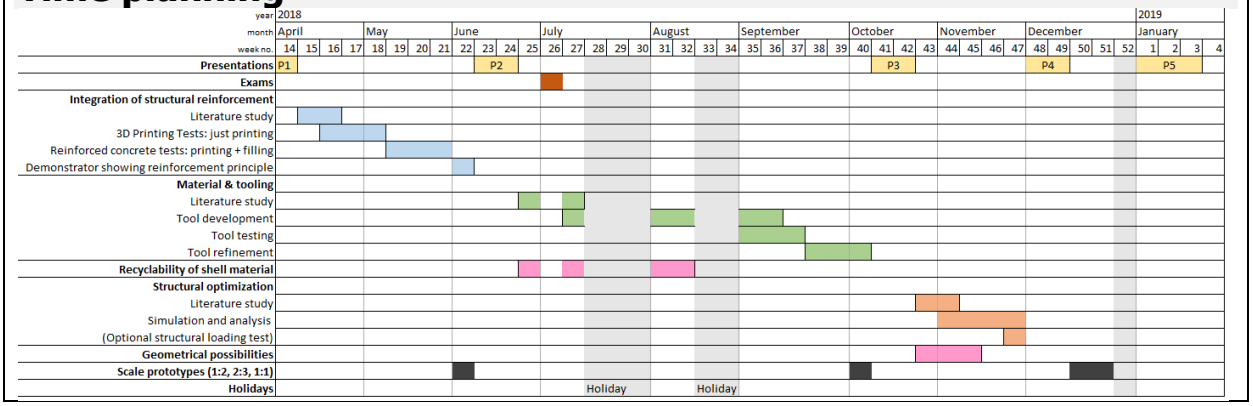
Reflection

Relevance

This research project addresses the strong societal demand of a more efficient use of building materials. Because concrete is such a heavily used construction material and all concrete needs formwork, this project has the potential to strongly reduce material use in concrete construction.

The projected innovation of the project lies in the fact that it will for the first time allow a thin, 3D printed shell to be used as a formwork for concrete construction. Although other 3D printed materials such as binder jetting have been successfully used as concrete formwork (Wangler et al. 2016; Aghaei Meibodi et al. 2017), a thin thermoplastic shell has been deemed impossible until now because of the strong hydrostatic pressure exerted by the concrete. In this project, this is overcome by using a set-on-demand concrete filling strategy. If other aspects such as reinforcement are addressed the technique could thus potentially revolutionize concrete construction.

Time planning



References:

Lloret, E., A. R. Shahab, M. Linus, R. J. Flatt, F. Gramazio, M. Kohler, and S. Langenberg. 2015. "Complex Concrete Structures: Merging Existing Techniques with Digital Fabrication." Computer-Aided Design. https://doi.org/10.1016/j.cad.2014.02.011.

Wangler, Timothy, Ena Lloret, Lex Reiter, Norman Hack, Fabio Gramazio, Matthias Kohler, Mathias Bernhard, et al. 2016. "Digital Concrete: Opportunities and Challenges." RILEM Technical Letters 1: 67. https://doi.org/10.21809/rilemtechlett.2016.16.

Aghaei Meibodi, Mania, Mathias Bernhard, Andrei Jipa, and Benjamin Dillenburger. 2017. "The Smart Takes from the Strong: 3D Printing Stay-in-Place Formwork for Concrete Slab Construction." Fabricate, no. May 2017: 210–15.