

Title:  
3D printed concrete bridges

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### Summary

The purpose of the master's thesis is to identify the challenges associated with 3D concrete printed bridges, opportunities and important conditions for the concrete and the equipment. Through the work on the thesis, it is endeavoured to review the 3D printing market with current practices for 3D concrete printing.

The research question and the operational questions are:

*How do we see the future with 3D printed concrete bridges?*

- How is the market for 3D printing?
- Which conditions must be met to 3D print concrete bridges?
- What challenges do we see with 3D printing of concrete bridges and how can they be handled?
- What opportunities does 3D printing of concrete bridges give?

### Method

Literature review and semi-structured interviews were selected as primary methods for conducting information. The literature study was used to find knowledge and to obtain a theoretical basis. The reason for choosing a semi-structured interview is to allow interviewees to respond openly and have a dialog and allow new ideas. This was selected as an empowerment tool to highlight tacit and latent practices towards technology. The goal was for the correspondent's responses to represent the construction

industry. Therefore, a total of 25 interviews was carried out with representatives from the entire value chain, universities and research organisations.

### Results

The most important requirements for concrete properties are mentioned in Figure 1.

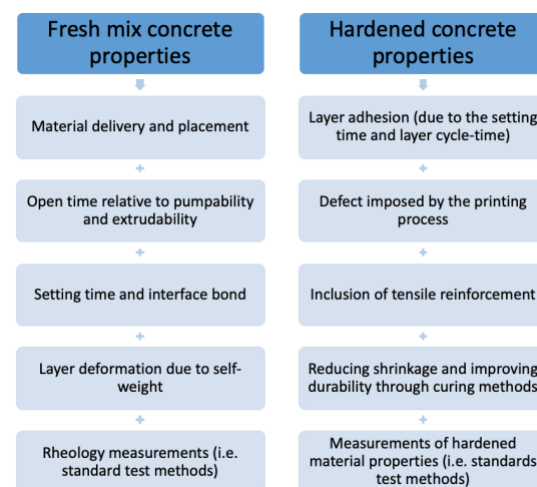


Figure 1 Requirements Concrete Properties

Several challenges are connected to 3D printing.



Figure 2 Challenges

The most significant challenges are size, for both the equipment and the structure being printed, reinforcement handling, to fulfil the

requirements for the concrete property, sustainability, regulation, knowledge and training. But all these challenges have opportunities to be handled and can lead to a great impact.

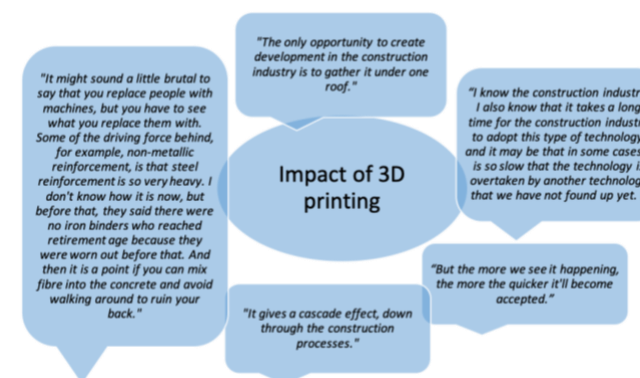


Figure 3 Impact of 3D Printing

### Conclusion

The 3D printing market is moving very fast, and the study indicates that there will be a market. Many leaders are eager to adopt new technology, but not all are capable of doing so. Risk is a significant factor in how willing the companies will be to invest and how capable they are. Also, a claim must come from the clients for the technology to be implemented. In Addition, for 3D printing to be adopted by the construction industry, there has to be a cultural change. The construction industry has been known to be conservative, which is an obstacle for new technologies such as 3D printing. Therefore, collaboration is highly needed.

There are several approaches for 3D printing and the equipment, robots, being used. Contour crafting, concrete printing, and D-shape are the

most prominent processes targeted for construction. The type of printer depends on the size of the structure, and whether the bridge should be printed on-site, at a factory, or as components at a factory. The equipment is also affected by weather, climate, printing speed, pressure, maintenance and cleaning.

The main requirements for concrete properties are printability, pumpability, and buildability, within an open time window.

There are many challenges that 3D printing has to deal with, and several requirements are given for 3D printing to succeed. A complicating factor for the application of 3D printing in the construction area is that the requirements in this sector are tough with respect to durability, safety, and strength.

The study results show that there are several advantages with 3D printing in the construction industry that can lead to great opportunities. 3D printing can most definitely be used for elements, in particular where there is flexibility with design. 3D printing gives opportunities with design, material efficiency and increased security. 3D printing opens up for how we look at tools, equipment, materials, and design.

*"3D Printing has an incredible potential to revolutionize the whole way we build because it not only means we get higher productivity, but it also has a huge impact on how things are going to be."*