

9.5. Reflection

Graduation process

How is your graduation studio topic positioned in the studio?

This thesis with title “Bringing Glass Giants to life, Fabrication of mass-optimized glass components of complex form” introduces a novel all-glass structure design and involves two chairs within the Building Technology master track: the Structural Design & Mechanics chair and the Building Product Innovation chair. The former provides the necessary knowledge regarding glass as material and glass casting, topology optimization, structural verification and input related to lab experimentation. The building product innovation chair provides insight on the current means of production, assessment criteria for each fabrication method, detailing of connections and overall feasibility of the design. The combined knowledge of both chairs helps push the boundaries of glass design and fabrication towards the creation of a material efficient, safe to use, sustainable, and feasible glass structures of complex and custom shape, providing a unique aesthetic. The interdisciplinary approach of this work reflects the essence of the building technology track and compliments the holistic and diverse take that the MSc AUBS has towards architecture.

How did the research approach work out (and why or why not)? And did it lead to the results you aimed for? (SWOT of the method)

The complexity of the topic dictated an approach of the topic using several methodologies. The thesis consists of four parts: literature review, comparative study, lab experimentation and research by design. The primary focus is the lab experimentation with the aim to enable better surface quality and transparency of kiln cast glass on disposable moulds (3DPSM). The research is supported by a state-of-the-art literature review on glass, topology optimization and glass fabrication methods. Additionally, the development of a case study linking the work with a real-life scenario and setting context, requirements and functionality. The approach worked as expected with all parts came together in the end. Research yielded promising results, the optimization of the geometry was performed and verified structurally.

How does the research lead to the design?

Novel glass structural applications display a unique set of material and fabrication peculiarities.

A complex research and design process was needed to understand the topics involved and arrive at a sensible research and design output. The research part was crucial in understanding the design limitations of glass, its material properties, the reason why TO is necessary and to familiarize oneself with the most promising glass fabrication methods currently available.

The introduction of a case study helped establish a set of soft criteria leading to the selection of the most appropriate fabrication method for glass. Research and design from this point on were intertwined leading to the next steps. This is especially evident in the lab experiments that were conducted with the aim of improving one of the main disadvantages of kiln-cast glass on disposable moulds (surface quality and transparency). Hence, connecting research, design and fabrication of complex and customized structural glass components. The final design serves as the means for further experimentation by prototyping.

Societal impact

To what extent are the results applicable in practice?

The research work of (Bristogianni, 2022; Oikonomopoulou, 2019) and the plethora of master theses from (Bhatia, 2019; Damen, 2019; Konari, 2022; Koopman, 2021; Naous, 2020; Stefanaki, 2020) underlines the research potential on structural applications of cast glass within TU Delft. The importance of the research conducted in the glass lab is evident both in the academic and professional world with numerous publications and built examples (e.g., Crystal house, Qaammat Pavillion, Mirage). Apart from TU Delft other institutions (TU Darmstadt, MIT) display or have displayed in the past extensive research and interest towards the exploration of alternative fabrication methods of glass, highlighting the overall scientific relevance of the work. The experimental work as part of the thesis is going to be conducted in accordance with the ongoing research interest of the glass lab at TU Delft and involves companies (Ex One and HA) that sponsor materials for the research work, linking the topic of the thesis with the professional world.

While this thesis builds up and contributes to the above-mentioned knowledge, further investigation of the various factors that affect the surface quality and transparency of such components is needed. Further testing on larger scale and more complex geometry is needed.

Finally, this research is important for the work of artists and sculpturers were finishing quality and transparency on glass is important.

Does the project contribute to sustainable development? What is the impact of your project on sustainability (people, planet, profit/prosperity)?

Over the course of its history glass has transitioned from a fragile and opaque material to a durable, optically transparent, structural material that shows great potential in architectural and structural applications. Glass innovation is directly connected with advancements in many fields of science and society such as optical (lenses, mirrors and prisms), communications (glass fibers), automotive, renewable energy (solar panels), biology, medicine so on so forth. Glass is still relatively new in the structural world, compared to other materials, but displays great potential that can revolutionize the future application in the field of building industry, architectural engineering and structural engineering.

Having that said that this thesis dealt with the limitations of current means of fabrication and researched the possibilities towards the realization of transparent, structurally safe, sustainable and feasible cast glass structural applications contributing a small piece of knowledge.

Cast glass structures are more sustainable than laminated float glass structure. Recovered material that would have otherwise end up on the land field can be used reducing the raw material consumption and energy used. On top of that such structures are recyclable helping close the loop leading in a more circular built environment.

The use of recovered glass waste in casting leads in the creation of unique pieces with unique patterns and colour that have an almost artistic expression. The unique appearance apart from the fact that leads towards a more circular built environment, unlocks new ways of architectural expression with glass and helps redefine the beauty standards within the industry.

How does the project affect architecture / the built environment?

Cast glass structures is a niche research field, but the realised examples are indicative of a real-life demand. The output of the design part is a slightly utopic, size wise, but showcases a vision towards all glass structures. The outcome of the above-mentioned experiments will further verify the findings enabling applications of kiln cast glass on larger and more complex shapes and unique architectural and structural value. Thus, pushing the boundaries of what it is possible both design and manufacturing wise.