

CHEESE BELL

The design of a full glass dome structure as a protective shelter for a small monument in Alkmaar.

Delft University of Technology
AR4B025 Sustainable Design Graduation Studio
MSc. Architecture, Urbanism and Building Sciences
Track Building Technology

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Reflection

Glass is a material that is used in many different ways and places, as well as an construction material. This can lead to beautiful projects, but glass as a building material can cause problems for the thermal comfort in the building. This graduation research focuses on the use of double curved glass panels for a dome over a small monument in Alkmaar, to give this monument a new function, within which this construction attempts to maintain the thermal comfort in the most passive way as possible.

Relationship between subject matter and graduation studio

The graduation studio focuses on innovative and sustainable design techniques in various fields. This graduation research covers the fields of structure (dome construction) with glass as construction material and climate design for thermal comfort in glass buildings. With this graduation research, the utmost of these two disciplines is being looked up.

The purpose of the glass construction is to perform it as easily as possible. This makes it harder to design the construction. Optimizing of the construction is an important subject to do this. Glass constructions can lead to beautiful results, but glass lacks a number of properties that other construction materials do have, which makes designing the construction with glass more difficult. The advantage of this is; if you can design with glass, you can design with any construction material.

Achieving thermal comfort can be difficult in some projects, especially if this has to be done passively. Achieving thermal comfort in a glass construction is therefore extra difficult. The goal is to do this as passively as possible. This does not preclude the fact that this graduation research does not require non-passive solutions to achieve thermal comfort, where passive solutions are not successful. (As bad as this is.)

Relationship between expectations and results

As always, things will turn out differently than expected. Glass is a beautiful material with which a lot is possible. Designing with glass as a construction material is challenging, but the result can be amazing. When designing with glass as a construction material, the goal is to achieve high transparency. It is the definition of transparency of the designer how this is translated in the design. The aim of this research is to make the design as transparent as possible by making the construction as simple and slender as possible. The simulations show that this is possible in theory. Practice comes into play here. Building a construction is always done by people and not in the most optimal conditions. Mistakes can be made. This can have fatal consequences for a glass construction. This can be prevented by taking this into account in the design. This does mean that there is a need to compromise on transparency.

Designing with glass creates problems, especially for thermal comfort problems. These problems can be easily solved by using a lot of energy, which is not a sustainable solution. With passive strategies, a large part of this requested energy can be removed. The hope was to take away as much of the required energy as possible with these strategies. As indicated, this will probably not take away all the required energy. This is also evident from the simulations, in which most extreme variants are viewed. However, in order to take away as much energy as possible in a passive manner, there must be compromised on transparency. By applying these measures only in most extreme situations, as much transparency as possible can be achieved at the other times.

An advantage of glass is that it is a transparent material. At the same time, this can also be a disadvantage, for example with many connections. This will all be visible through the glass. Every screw will be seen. To prevent this, it is wise to make some parts of the construction of a non-transparent material.

Relationship between chosen method and the methodical line of approach of the graduation studio

The methodology of the graduation studio has three steps: literature study, design through research and to build scale models to establish the relationship with the larger social and scientific framework.

This graduation research has broadly these three steps. Literature studies were used to determine design limits and thus draw up design criteria which will lead to a concept design of the glass dome. With in-depth research on these subjects, improved design limits and criteria can be drawn up, leading to design studies of different components in this design.

The final step differs from the methodical line of approach of the graduation studio. No scale models are being built. Digital models are created to analyze the structural behavior and the energy design, which ultimately influences the design. This is a repeating circle that will stop as the intended result achieved and what will lead to the final design. A caveat here is that the situation may arise where the intended results will not be achieved. In order to achieve a final design, the design criteria drawn up on the literature study need to be adjusted to less high criteria.

Relationship between research and design

The aim of this research is to design a completely glass structure in which the thermal comfort is maintained in the most passive way as possible without compromising the transparency of the construction. Transparency is an important subject in this research, otherwise it would not have been necessary to design with glass and no problems would have been created. The transparency is a starting point in the design of the construction and in the design of the thermal comfort.

For construction, this means minimalist solutions need to be devised in order to maintain as much transparency as possible. Reducing construction does not mean that the construction becomes easier to design. The construction as thin and simple as possible produces a nice transparent construction, but smart solutions have to be devised for this.

This design is made to give a small monument in Alkmaar a new function as a restaurant. At the same time, this special construction can give Alkmaar a new eye-catcher. In a restaurant, thermal comfort is an important point. This determines whether people come back or not. In a glass structure, thermal comfort complaints occur more easily, there are standard solutions for this, but these are not all passive solutions or it comes at the expense of transparency.

The literature study discusses the following important topics: glass as a structural material, dome structures, thermal performance, including passive possibilities. With this knowledge of the design boundaries, criteria can be drawn up which will lead to a concept design of the glass dome. With in-depth research on these subjects, improved design limits and criteria can be drawn up, leading to design studies of different components in this design.

Relationship between subject and societal impact

Glass is a theme that has long been involved in architecture. The best solution to avoid thermal comfort problems is by applying less glass, but many students and architects do not want that.

In this graduation research possible solutions will come forward for building physical comfort problems. Especially for buildings with a lot of glass, where thermal comfort complaints often arise. These solutions can hopefully also be used in other buildings with a lot of glass, so that it does not have to be a full glass structure.

With the transparency of glass structures, things can be shown that are not visible with other structures. Even wider, high transparency can be achieved with glass constructions. This graduation research can provide tools for projects where high transparency is required, while also taking physical problems into account.

With the design of dome over a small monument in Alkmaar, a function is added to this monument. At the moment the problem with this monument is that it has no real function. This is because it is a small monument and there are no sanitary facilities. Because it is a monument, it is not allowed to build anything against the building. That is why there has taken a more drastic measurement; placing a structure over the monument. This construction will be a new eyecatcher in Alkmaar. The monument is located in a recreation area. Nowhere in this area are facilities for these holidaymakers. Getting better facilities in this area is a must.

Personal reflection

For this research, I went to the utmost of different disciplines: the fields of structure (dome construction) with glass as construction material and climate design for thermal comfort in glass buildings. Structural Design and Architectural Glass were easy to combine in this study, since glass was the construction material. Climate design was separate from the structural research in this research. The two researches came together in the final design. So the road went separately. Researching in this way therefore took double effort for me, which ultimately resulted in the final design.

In my research, validation was an important tool to make certain design decisions. While this may not have taken up most of the research, it was the most important step. The final design was created with this medium. Most of the validation was done using different simulation software. I have come into contact with these software in recent years of study. The hardest part now was to use this software specifically for my design. This showed that the previous acquaintance with this software provided a basis for doing this, but this was not enough to start using it independently. In the period of this research, I had to teach myself how to deal with these.

Some of the results of the validations had consequences for the design. An outcome of one research had consequences for the other research, which will come together at the final design. This means some (design) steps had to be done several times. What has led to frustration and loss of time.

By looking at the utmost of the different disciplines, I challenged myself to get acquainted with both disciplines and created guidelines for myself, which I can use in the future. As thought it was a challenging project, where I encountered several obstacles and tried to solve them as best as possible.

“Designing with glass creates problems, but this does not mean that it should therefore be avoided.”
(Rijsterborgh, 2020)