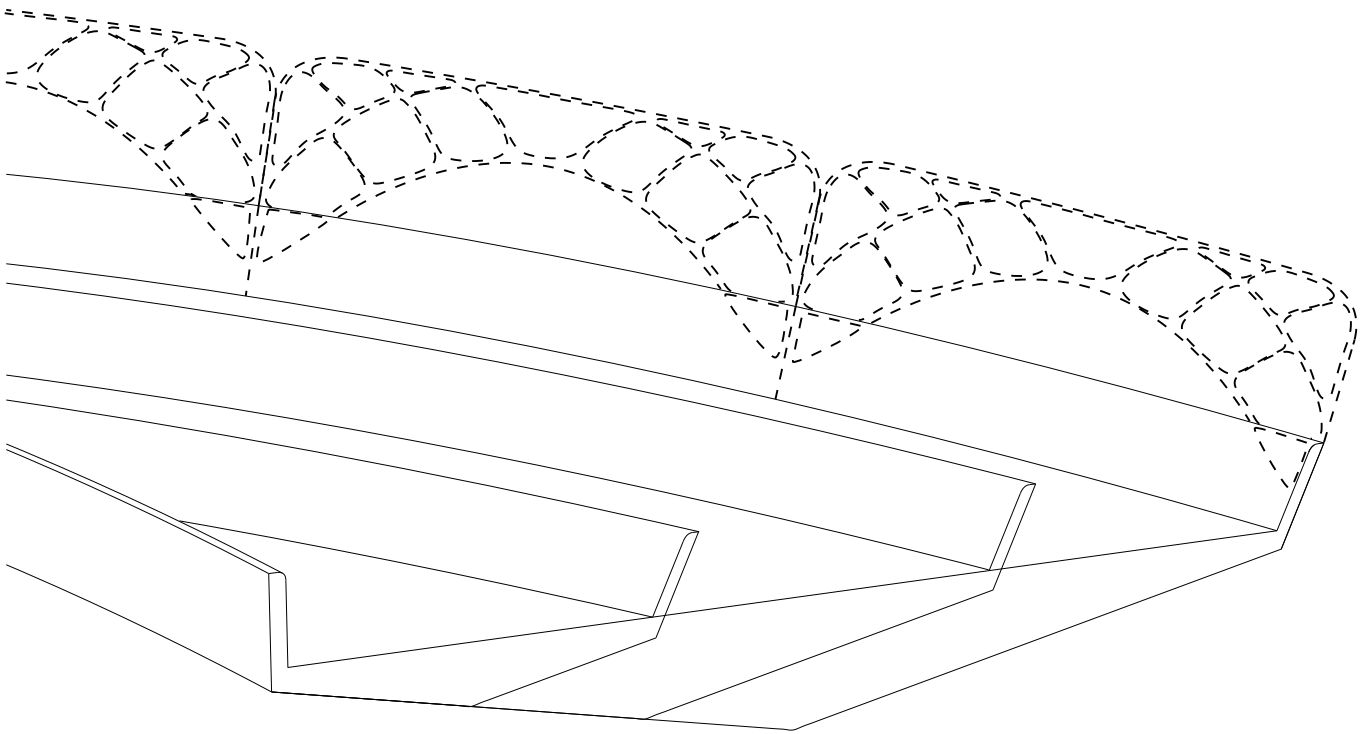


Reflection
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Modular series of FRP pedestrian bridges

The example of Tanthof Delft



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1.1 THE RELATIONSHIP BETWEEN THE THEME OF THE GRADUATION LAB AND THE SUBJECT/CASE STUDY CHOSEN BY THE STUDENT WITHIN THIS FRAMEWORK (LOCATION/OBJECT)

This graduation project is subjected on the Building Technology Master of the Architecture Faculty and thus aims to give an architectural and feasible solution for the building environment. The initial aim of the graduation was to produce a generic solution of series manufacturing pedestrian bridges. Of course, this aim of Architects craving to understand and design for massive production purposes is known since Modernism, but is still valid to a progressive industry. Thus, the innovation of the project would not be the product- principle of the footbridge-itself, but the material through which will be designed and would determine its materialization. More specifically, on this project the mechanical and aesthetic potentials of Fibre Reinforced Polymer (FRP) would be explored and would be used as principles for the design. FRP is not an entirely new material and is been used widely in the aerospace industry, but the architectural experimentation with this material is limited and interest arises again concerning its structural applications in civil applications.

In order to investigate to what extend such project could be materialized an area-case study should be found. The selected neighbourhood was Tanthof Delft, where most of the pedestrian bridges are made out of wood and due to aging or unsuitable design they have to be replaced. Due to the real problem that this area is facing and the interest for replacement of the bridges of the municipality its-self the case study enriched the project it-itself and placed it on the sphere of a real project.

For example, in the beginning a dimensional pattern was researched that would facilitate the module dimensions,. Since, the bridge network was not relevant to the building network, such patter did not exist and the modules should be based on common sense and the designers criteria. Such decisions seemed at the moment to make the project more complex and difficult to design, but in fact shown me how is to solve complex problems in reality and how the engineer need to create its own pattern in order to solve a problem.

Also, since Tanthof is a typical Dutch neighbourhood the solution for that area could be applicable for similar neighbourhoods, so from that point of view the solution should be based on the problems and data from Tanthof but should also give a more generic solution. As example



Fig1: Typical sides from the Tanthof Delft

to that is the railing of the design, which subject to one principle, but the final result can change according the different site.

1.2 RELATIONSHIP BETWEEN THE PROJECT AND THE WIDER SOCIAL CONTEXT

Due to the Dutch landscape the pedestrian bridges is a repetitive and necessary element in order to cross over the land. Especially for the Netherlands bridges are some times the only way to cross over the water and thus a very important infrastructure. The responsibility of placement such infrastructures is governmental or municipal. The preliminary purpose of the project was to extend the manufacturing of pedestrian bridges from one stand piece to a repetitive product. In order to do so the project is focused on an area that could be used as a model for similar problematic areas, where a big number of bridges need to be designed and installed in short time. Apart from the element of necessity though this project also takes into account the aesthetic integration of such infrastructure in the build environment, providing with a holistic solution. Furthermore, the project wishes to offer a time and cost efficient solution for municipalities in replacing or adding pedestrian bridges in the rural and urban landscape.



Fig2: Typical sides from Dutch landscape

1.3 THE RELATIONSHIP BETWEEN RESEARCH AND DESIGN

The series of modular pedestrian bridges for Tanthof Delft explore the aesthetic and structural properties of FRP and thus a primary research on the material itself and its manufacturing processes need to be done in the beginning. Though this research a better understanding of the material behaviour, design demands and potentials was achieved. Parallel to that literature research also visits to manufacturers of FRP pedestrian bridges helped set the design principle of the design and grasp the challenges of such design.

More specifically through the research on the material it was more clear to my the weaknesses and the strong points of the material, as well as the limitations and the design consideration of the moulding manufacturing technique.

Moreover, during the visits I had the chance to discuss with FRP specialists and verify the literature results I already had. Also, since the manufactures also

constructed footbridges they helped me grasp the design principles of a pedestrian bridge, not only as a structural or architectural project, but also as public infrastructure. For example, the replaceable railing seems to be an element that could persuade a client to invest money on the project or not.

On the other hand, since this project consists of different aspects, as the FRP material, the modularity, the mouldability, the pedestrian type of bridge, it was really easy when researching only for one of these aspects to extend to unnecessary research. Also, since FRP is a material mostly used for aerospace applications the literature was short when come to architectural applications as structural material and these added some more difficulty and time delay. Finally, it was a challenge for me to design a product that could be applicable to many occasions and thus I decided to experiment with design aspects (modularity, moulding manufacturing technique, FRP material, infrastructure design). It took time to grasp the different aspects of the design and researched into every of these aspects even if at the end sometimes the literature was not useful. Non the less, it gave me a more spherical knowledge that expend the topic of the graduation project.

Concluding, the general methodology approach of the project is research by design, because the final product(pedestrian bridge design) was equally important as the aforementioned aspects of the research and so it had to be secured from the beginning of the research that a aesthetic result (according to my criteria) would be produced.

1.4 THE RELATIONSHIP BETWEEN THE METHODOICAL LINE OF APPROACH OF THE GRADUATION LAB AND THE METHOD CHOSEN BY THE STUDENT IN THIS FRAMEWORK

As already mentioned, the project is an example of complex design that sets different principles in order to give an holistic and feasible solution as final product. From the beginning of the research the material that would be used and the production method through which the bridge would be manufactured was set. This facilitated the research to focused on the material and the manufacturing technique, but the module unit was still vague, thing that created confusion during the design process. As a result, there was more research to be done in order to outline a concrete modular design and solid research question and its corresponding methodology.

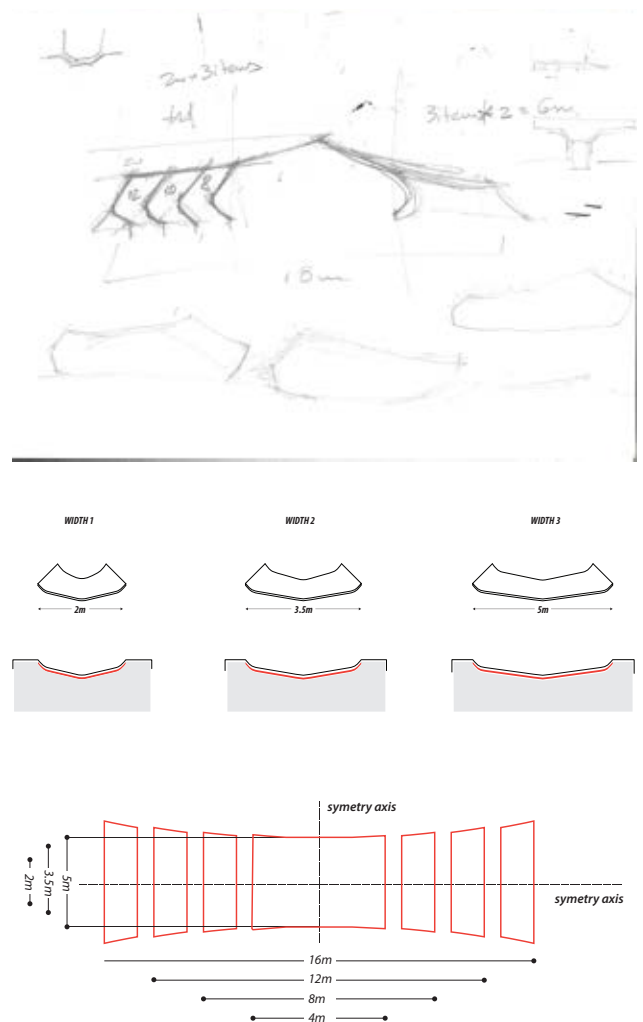


Fig3: Researching on modular design and manufacturing technique

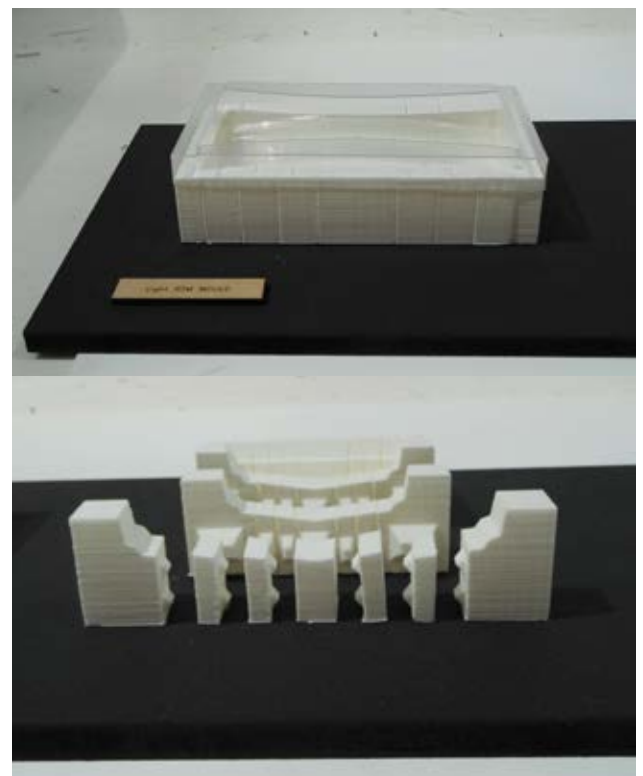


Fig4: Proposed mould

Since the design principles and the appearance of the bridge would be decided during the graduation process (research through design) the research direction would alter during the designing process and this would disorient the process. In order to overcome this problem a constant zoom in/zoom out between research and application of the research outcome on the design would redetermine and restrict the research field. The mid-deadlines of the graduation process (P1/P2/P3/P4/P5) also structured the time management of every sub-research to design implementation.

Along with the material aspect also the modularity and the structural aspect has a leading role on the project. One of the benefits of FRP is that has no strict geometrical limitations and can be formed in almost any way the designer wishes, allowing for a wide range of structures to be designed. That was one of the challenges that had to overcome, since there was no initial structure limitation from cross-sectional structure to shell structure or 2-D element structure(profiles) were feasible. From the primary free-form design limitation the 2-D element was eliminated but still no sufficient criteria between sectional of shell structure could be determined according to material or manufacturing technique.

Moreover, the bridge design would be modular but the right size of the module needed to be determined. The range of the module could expand from brick size that was the common bridge building material of the typical Delft bridge of the old town to bigger modules as facade-deck-railing that simulates more the modern division idea for pedestrian bridges. At the same time the module would influence the appearance of the final product.

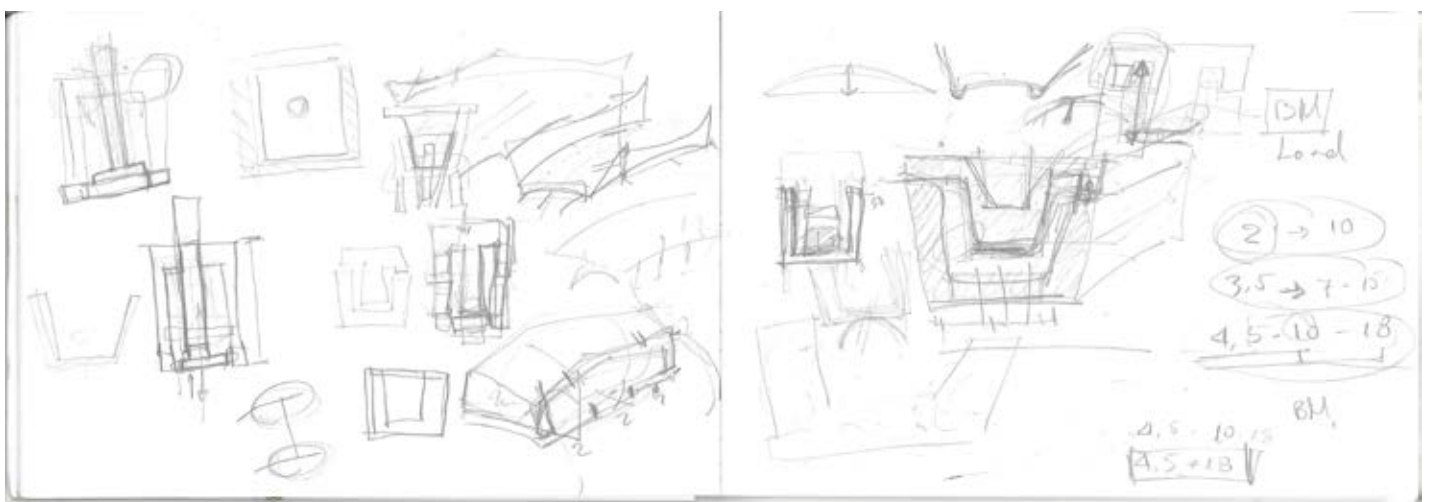
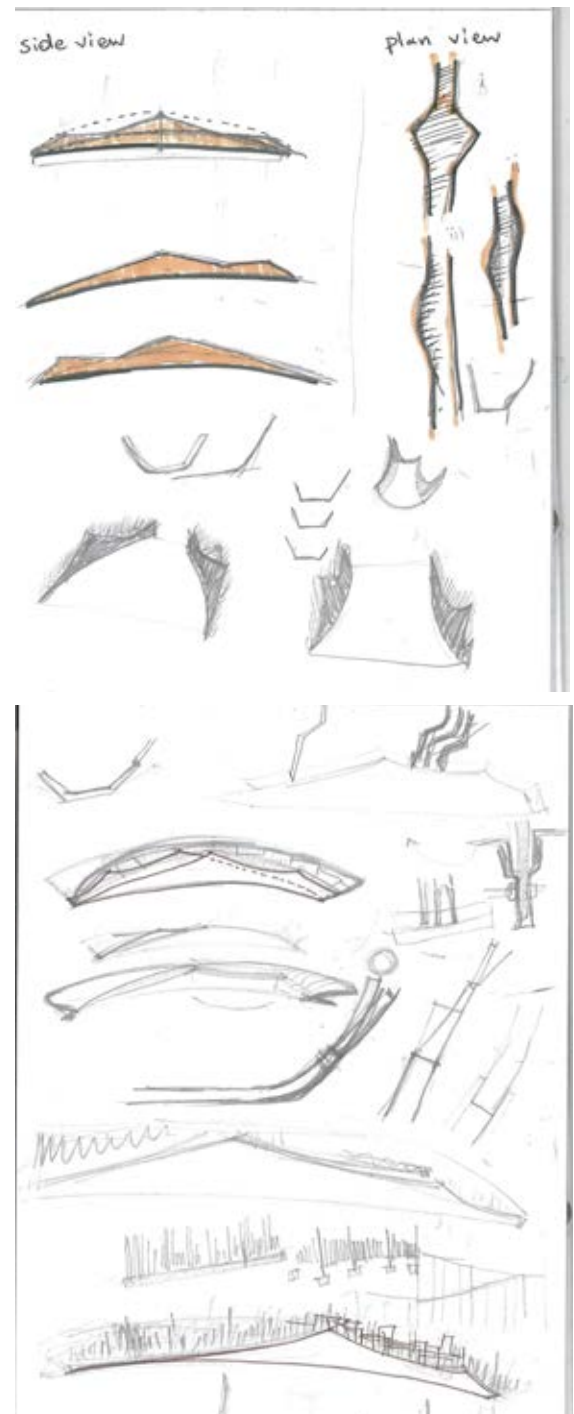


Fig5: Sketches during the research process

From the beginning of the graduation though the high aesthetic result of the bridge series had to be succeeded. Hence it was decided that first the design would be determined and would have modular principles, aka repetitive elements that could produce bridges of different dimensions. This decision created a parallel design of final bridge appearance and simultaneously module unit design. The aim of that process would be an aesthetic bridge design that could be repeated in different length and widths according to Tanthof's need. At the same time the design should have principles that would allow for manufacturing and material optimisation, aka use of less material and less moulds.

The decision of working on the final product and the module at the same time might have created some time delay and confusion, as long as many unused designs and sketches, but resulted in a holistic-linear solution. To overcome this delay and confusion that is created when researching through design, I had to set some strict criteria that would help me evaluate my results and design directions.

This brings me to the next challenge I had to overcome during the design process. Due to the wide range of options it was easy for me to lose focus of the assignment. Since the project tries to design the series of pedestrian bridges from the manufacturing to the installation phase a wide range of engineering expertise

could influence the project. It could be viewed from a material scientist point of view that would focus on how the material would fail or from a mould expert that would try to optimise the mould layout and the resin pressure during the light RTM process. Finding the focus point of an architect was a challenge to me initially but finally decided to have an opinion on all the aforementioned matters, but target on the materialisation and realisation of the project itself and leave the details to the other experts, or to further research. Thus, as already having the design principles, the manufacturing process, the structure and the modules matrix, the last thing to be designed was the logistics (cost, transportation, installation).

To conclude, the appropriate methodology for the project was research through design due to the set goals of the project. This decision though triggered a series of difficulties and non-linear research and problem analysis that could have been avoided if the module was set from the beginning of the project. Then, the project would revolve around the realisation of such generic module and the appearance of the final design would have set as secondary aim. In order to set the final design as primary aim along with the feasibility of the project a series of strict limitations were established to filter the design options.



Fig6: Proposed design