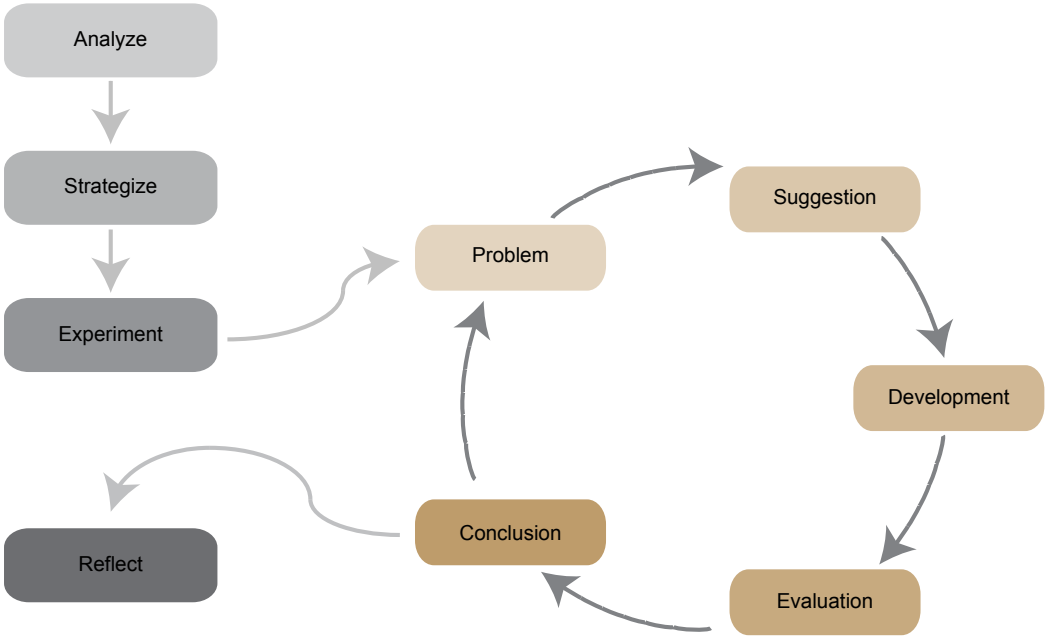

3. Pre design

Pre-design:
How can the façade be adapted to meet the facade quality demands while keeping the circular aspects and material properties into account?

What are the effects of these adjustment for the design?

4. Design

What is the best biobased circular modular façade design regarding the quality demands?

How can de facade be produced and installed?

How does the façade relate to other facades in terms of lifetime, costs, production time, waste, CO2 emission and energy.?

9.10 | Abstract view of the proposed research method

9.2.1 | Research outline

From the beginning the aim of the research was to gather information to support a final design. Biobased composite is a developing material which hasn`t been tested or used much yet, therefore information on the subject was very limited. This made de research as much difficult as challenging.

The other part of the research question, to design a circular facade, made the research and especially the design part far more complicated. The few example projects that have been designed with biobased composite are not circular because this was not a requirement.

The method showed above was proposed during the P2 evaluation. The idea behind it was that in the experiment phase, the part were the design should take place, a continuous cycle of problem solving and development took place which should result in the “best” design option for both biobased composite as circularity, combined in a facade design.

Why was this approach applied? Information was gathered from various directions and the results would be used as a foundation for a final design. These two steps would form the analyse and strategize after which the experiment should start. This experiment consists out of a series of developing, evaluation and adapting the design until the “best” design was found.

9.2.1.1 | Problem

During the research it turned out that is was very difficult to draw conclusions which would lead into one direction and which could be used as design guidelines. All information was, until then, gathered with the idea that one final design would respond to all this information.

When starting the design, due to a lack of restrictions it was very difficult to define any design guidelines.
For this reason a more technical approach was chosen which first looked into the optimal application of biobased composite in consultation with circularity and then to which options fitted four relevant case studies best.

9.2.1.2 | Research questions

This change in approach directly changed the second part of the research questions. The research questions regarding the design could no longer be answered. These questions were therefore changed in chapter 6, which introduction substantiates this shift.

3. Product concepts

What are common used facade elements?

How can biobased composite be used in these elements?

What is the effect of the change in material use to the weight, schadowcosts and circularity of the element?

4. Final concept design/Case study.

Which variant does suit each ot the case study facades best?

How can this variant be applied on the facade?

What does this mean in terms of weight, insulation value, schadowcosts and circularity compared to the original facade?

9.2.2 | Adapted method

As shown above in the text, the new method focused first on common applied products to establish the possibilities of biobased composite and their effect on the products properties.
These results were used to establish which concept designs could be defined for four case studies. These facade typologies were defined to represent common office buildings in the Netherlands.

The research results shifted thereby from being the foundation for one final design to input for several facade concepts.

9.2.3 | The process

While starting up the process, there were several parts of the research which needed direct action to be able to gather the information in time. Two main parts were collecting (scientific) information and preparing material tests.

9.2.3.1 | Gathering information

To gather information on specific material properties from the few companies who had carried out tests, many institutions have been contacted. However, by emailing or calling authorities with a question concerning a graduation research the main answer is “the information is confidential”, or no answer at all appears.

An approach that worked far better is approach people in person at a fair or conference.
Much information was later on handed by employees of DGMR who had visited conferences providing very useful information.

Although a strict planning was set up at the start of the graduation, unforeseen aspects such as new useful information turned up at later stages.

9.2.3.2 | Material tests

This part was divided into recycling tests and ageing tests. The material tests took rather longer than expected.
At first a research plan for recycling test was set up, but unfortunately the authority who would help suddenly backed out. After discussing the plan with another scientist, it turned out to be too complicated to generate any useful results. The recycling tests were neglected.

The planned accelerated ageing tests were also delayed since no institution in the Netherlands had the required QUV machine available. Eventually another test machine was found, which would provide different but useful results. The material tests were performed at the last possible moment since the duration of one of the tests was a full month. Even though, it is very nice to finally have the chance to perform the tests and add a part to the overall knowledge of biobased composite.

9.2.3.3 | Planning

At the start of the graduation an overall planning was made including week tasks and week goals. This planning would make it easy to keep eye on the progress but also to grant all action with an appropriate amount of time.

This planning was off course several times changed. It was also affected by the change in final product, for which the actions changed.
The problems finding information and finding the facilities to perform material tests also influenced the planning.

Overall, the planning was very useful and helped the project both by starting up quickly as by structuring it. It has changed several times during the process due to different factors but the broad lines remained the same.

The original research focused on one final design. During the research it turned out that the results could be better translated into different concepts than into one design. The design approach was changed and a more technical and conceptual approach was used. This did influence the research questions.
The overall planning as set up at the beginning of the project has changed several times due to different influences, however the broad lines could be maintained.

9.2.4 | Theme of the graduation studio

The theme of the graduation lab “Sustainable design graduation studio” implies that the research should add something to the knowledge about sustainability in any form.

Since the increasing landfill and pollution are actually a real concern of mine, also outside the graduation studio, a possible (sub)solution to this problem interests me. After researching a former composite facade project of DGMR during my internship there, the possibilities of composite arose my interest. The complex production process and the fact that the possibilities can still be further explored make room for technical innovation.
Combining these aspects has placed me on the path of biobased composite, a composite which is reinforced with natural, growing fibres. Combined with circularity, which regards the whole life cycle of an element, most aspects of a facade that can be connected to sustainability are covered.

9.2.5 | Wider social context

One quote forms the basis of the problem definition. “The Dutch building industry produces annually twice as much waste as all Dutch households together, which increases the burst of landfill loading” (SUEZ, 2016).

Waste and landfill loading are problems that eventually will concern everyone. When the building industry is able to improve its material-management and decrease the amount of waste, this will decrease the problem significantly.
Large steps are necessary to improve the end-of-life scenarios significantly, and waste separation is also not commonly applied. When products are at least designed to be reusable, demountable or otherwise recycleable or compostable, it makes it far more easy to actually do so, which is a good first step.
Therefore I wanted to make a first step designing the facade in the most circular way possible.

Another problem concerning everyone, is the end of finite resources. Some resources are already scarce and some commonly used materials will run out. When this happens it is very comforting if replacing possibilities have been researched already. Therefore biobased composite would serve a good example of an “infinite” material, because it simply grows.

To continue the above mentioned statement, another problem was found during the research. A personal difficulty when defining the test environment turned out to be a worldwide problem: The certification of new materials.

Long-term applied materials such as concrete and brickwork all have certain quality certificates, and their laboratory test methods have been developed linked to the results of long-term degradation in real life situations.
Contractors or investors have, very understandable, a great preference for these materials which have proved themselves over the past hundreds of years. The problem is, how can new, possibly very sustainable materials, acquire their position on the market when no one is interested in taking the first step and test their qualities?

The laboratory tests for accelerated weathering are not defined for other materials than the widely accepted ones. Since the test results are linked to practical results it is very important to take a first step and apply these new materials, but also to share the results of these first practices. Only when information is shared and extensive practical and laboratory tests are carried out these materials will stand a change on the building market. Regarding the depletion of resources of a great deal of common building materials and the immense amount of waste produced by the building scene, innovation seems just the necessary thing.

9.2.6 | Research and Design

From the beginning of the graduation, and even before that, I had the idea that the final result of my graduation should be one final design, elaborated into details.
One reason for this was that detailing facades is the part that I like most during my Masters. Besides this, the graduation has taken place in cooperation with DGMR, who are specialized in facade technology and have a lot of experience supervising building detailing.

To be able to design a facade using a new material I knew little about, I started with an extensive research. Since few information is publicly available, this included calling and emailing institutions up until Italy. Quite some information is researched concerning bridges, however the safety requirements of a facade focus on very different aspects. For example fire-safety and thermal and acoustical insulation are main elements for a facade. Information about these aspects was very limited, and in many cases not publicly available. Some information I have only found through asking the entire office of DGMR, after which employees provided me with very useful databases and conference papers.

Some information however does not exist yet. The fire-safety of an facade element can only be tested when the whole element in its actual size is built and tested using a huge oven. This was not possible during this research because I firstly lack the resources to build such an element and besides that the time and resources are far too limited. On aspects like this nothing else than substantiated guesses can be made.

My plan was to gather all the information, and weigh all possibilities of the aspects such as production methods and connection methods, to find a set of optimized design parameters which would lead into a facade design. However, there were still many different options after doing this.

The approach of building-up knowledge to form a basis for the design decisions worked to a certain level, but then a lack of knowledge on the specific possibilities of biobased composite application appeared.

A different approach was defined using examples of building products to get a grip on the possibilities of biobased composite. For this, more research was done in order to make a design. Also for the final design the case studies were defined and analyzed to serve a concept.

The main method for this graduation research was research through design. The information found was all collected to serve as background information on material properties or possible concepts, and to explore the possibilities of the material. Off course while designing, minor problems occurred which needed to be answered, and therefore research through design has also taken place.

9.2.7 | Expectations

When starting a scientific research, an objective attitude must be adopted. However, when starting to research a subject you are enthusiastic about, it is almost insurmountable not to wish the research results are positive.

9.2.7.1 | Result

The result I had in mind was a final design which responded to the shortcomings of the material and therefore made it possible to be used for a high performance facade design.
However the result itself had changed. The new concepts could still show that biobased composite was a very good option, but because the approach was different and one to one compared to existing designs, the shortcomings of the material became very clear as well.

9.2.7.2 | Reflection on result

These results were the objective results from the research, however they showed that biobased composite is not by far in all applications desirable.

These findings are off course very valuable, however they were not as positive as hoped for when starting the research.

My personal impression is that the material can still be very valuable, but need extensive research to be optimized and generally accepted in the building environment. The last aspects probably needs time too.
It is important to use biobased composite for the right purposes, but when the shadowcosts can be reduced I believe it will offer new possibilities.

9.11 | Cotton
9.12 | Dried flax

The research connects to the theme of the graduation studio by adding knowledge on renewable materials which can lead to sustainable solutions. The wider social context is mainly addressed by the fact that a solution to the increasing pile of landfill was approached.

The research method was mainly research through design.
The research results were not as positive as hoped for when starting the research.