

Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examenscommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Jet Wiersma
Student number	4663802

Studio		
Name / Theme	Building Technology Graduation Studio AR3B025 / Engineered circular bio-composites	
Main mentor	Olga Ioannou	Façade and Product Design
Second mentor	Mauro Overend	Structural Design
Argumentation of choice of the studio	<p>Building materials are all around us, they come in different shapes, sizes and materials. It defines the architectural visual of buildings and cities. Facades are the first anyone sees from a building, but often it does not reflect the sustainability we want and need to reach to climate goals and carbon reductions. What happens at the end of life of these façade panels. Mostly landfill of incineration to still get the embodied energy of the building product. That's why I want to research and test bio composite façade materials and how to recycle them into new products.</p> <p>Looking to recycle old and disregarded façade panels as a filler into new panels, helps reduce the need for virgin materials in the building product life cycle.</p>	

Graduation project	
Title of the graduation project	Recycling of bio composites materials into new Façade panels
Goal	
Location:	None
The posed problem,	<p>The use of bio composites materials has been on the rise in the last decade, more and more research is being done to ensure the quality and usability of these products compared to conventional building materials.</p> <p>Since this building material is quite new to the field, not a lot of research has been done on the end of life of these bio composite materials. Most of these (bio) composites materials end up in landfill and being incinerated (Bensadoun et al., 2016).</p>

	<p>It would be wasteful to have a sustainable building material that at its end of life ends up in landfill and being incinerated.</p> <p>The materials that are being recycled or reused are decreasing in mechanical properties (Bhattacharjee & Bajwa, 2018). This is another reason why the industry chooses for the cheapest and least circular option, landfill and incineration.</p> <p>How circular are building products if they ultimately become waste at the end of their lifecycle?</p> <p>This is everything but a circular solution, when incinerating embodied carbon is released into the atmosphere and polluting the environment. The building materials in the EU are making up around 20-30% of the life cycled emissions (Building Renovation: Where Circular Economy and Climate Meet, 2022). To reduce embodied carbon emissions the life cycle of building products need to be extended. Using bio based materials or materials from biologic origin is already better than using finite materials, since these materials can regrow.</p> <p>Circularity wise bio composite materials can be even more sustainable, extending the life cycle through reintegrating and recycling of these building materials after the first service life cycle. Reducing waste and enhancing its performance along the way.</p>
research questions and	<p>The main research question is:</p> <ul style="list-style-type: none"> - How can bio composite façade panels be recycled into new bio composite panels after its end of service life? <p>The sub questions are:</p> <ul style="list-style-type: none"> - What are the key properties of materials recovered from old bio composite facade panels, such as mechanical strength, thermal performance, and durability? - How do the recovered materials compare to virgin materials used in current bio composite panels? - What methods can be used to process and prepare materials from old facade panels for reuse as fillers? - How does the manufacturing process affect the quality and usability of the recovered materials? - How does recycling materials from old panels reduce the environmental footprint of new bio composite panels?

design assignment in which these result.	<p>This thesis focusses to explore the possibilities of recycling bio composite panels into fillers for new bio composite façade panels. Experimenting with different grain sizes and compositions of the recycled filler, will lead to a mixture for bio composite materials. After experimental testing of the properties of the façade panels, the aim is to find the limitations in the design possibilities.</p>
Process	
Method description	
Literature review	
<p>Before starting on testing and prototyping, literature research needs to be done to gain the right knowledge. This research will be focussed on all the different components used in bio composite material. These components are the filler, resin, fibre and additives. For the filler old façade panels will be used. The resin used in the testing will be furan and the fibre will be a natural fibre. Additives can be a lot of different materials or components.</p>	
<p>The literature research is divided in to different categories, circular building products, bio composites, materials (inside bio composites), manufacturing and requirements for the façade application.</p>	
<p>The first part concentrates on the circular building products and why they are relevant to today's building industry. While highlighting the R-strategies and which of the strategies will be relevant to this thesis.</p>	
<p>Secondly, focuses on bio-composites materials to understand how they are build and of which components they are build. Exploring the current studies on bio-composites and its end of life possibilities.</p>	
<p>In the third subparagraph the components materials within the bio-composites are investigated further to understand the different values and properties of these components.</p>	
<p>Next the manufacturing processes of bio-composites are highlighted and compared.</p>	
<p>Lastly, the requirements for the façade application are research and developed. Examining the standards and regulations for (fire) safety, durability and more.</p>	

The chapter will be concluded with a conclusion of the literature research to outline the most significant finds.

Experimental testing

In the testing phase 3 different test cycles will be performed, each test have their own objectives and outcome. Each test phase influences the next test phase on the testing materials and outline. The testing will deduct the different amount of parameters.

The assessment during the testing phase will done with a some specific criteria.

The first phase will mainly focus on the grain size of the recycled bio-composites. The different grain sizes of the filler material will be evaluate and compared to the virgin material properties. The properties tested will focus on mechanical, functional and the flow in the moulds. The best performing grain size will be used into the next phase of testing.

In the second phase the composition of the filler, fibre and resin is tested. The performance of the products will be compared and weighted against each other to select the best performing product.

The third and last phase of the testing will be focussing on the different mould designs, to determine the flow rate of the dough before the bio composite is fully cured. For optimal designing a good flow rate is necessary, to reach all kinds of 3D shapes. The product will be compared to already existing building products.

Design

Design of façade to show the possibilities with the freeform façade panels. While investigating and testing for the most optimal recipe for the bio composite panel, different design variations will be investigated. The ability of the dough to flow is defined by the viscosity, the lower the viscosity the more easily the dough can flow.

A goal of the design is that recycled bio composites can increase the design freedom of bio composite applications. By giving architects more design freedom, the product becomes more relevant for designers to use. While adding more circular products into the built environment.

Literature and general practical references

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Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

This graduation project focuses on circular product design and with a focus on recycling and reducing environmental impact. This fits inside the Building Technology masters scope of research and education. The architecture faculty also has a big focus on circularity and aims to have a circular building environment.

2. What is the relevance of your graduation work in the larger social, professional and scientific framework.

Bio composite material in building products is not widely used at the moment, for cladding with a lot of freeform design are often aluminium or other finite materials. Fossil resources are slowly depleting, so there is a need for renewable building materials. Looking at building products at a different way, to see the possibilities beyond the material properties. By researching bio composite recycling with the used of bio based materials, it can be an alternative for conventional finite materials. Finding solutions with the design, production, maintenance and end of life scenarios. This can define the research gap to find innovative ways to reuse, recycle building products into new circular products.

Recycling old bio composites materials can increase the life cycle of these products and reduce the overall environmental impact of the building product. This could help the further scientific research and innovations in the building industry.