

Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences



Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-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	Rianne Reijnders
Student number	4550846

Studio	
Name / Theme	Architectural Engineering, Harvest
Main mentor	Roel van der Pas Architecture
Second mentor	Jos de Krieger Research
Argumentation of choice of the studio	My interests lay in the coming together of architecture and other disciplines, especially landscape architecture and building engineering. I firmly believe that an architect should be able to technically support and defend their design and concept. A good design should integrate its clever construction and technical elements with the concept, instead of engineering elements being something that should mold to the concept after it has been created. This motivated me to choose the architectural engineering studio to develop my own skills accordingly. Furthermore, I always had a fascination for Landscape architecture, which really is apparent in my study. For example, organizing landscape design Honours classes in the bachelor and writing two papers about the formal and English landscape garden in my first year of the master. In the end the architecture master suited me more, but I still try to include as many landscape elements and designs in my projects as possible. This is also why the track Harvest within Architectural Engineering was my preference for a graduation studio.

Graduation project	
Title of the graduation project	Seaweed: The Sea's Solution for Sustainability or Sourcing Seaweed Sustainable Building Materials
Goal	
Location:	Westpoort, Amsterdam
The posed problem,	Sustainability is one of the biggest buzzwords surrounding the future of the building industry. This is not surprising as since the end of the last century the negative effect of the building industry on the environment was already well known. Direct effects of the building industries on the

environment are the depleting of non-renewable resources, high quantities of certain emissions like CO₂, NO₂ and similar and the production of air, water and solid waste. Besides the obvious damages, indirectly the buildings industry contributes to hazardous influence on existing habitats because of highly toxic waste and spreading industrial development (Cole & Rousseau, 1992). Although worldwide organizations, for example European Environmental Bureau, U.S. Sustainability Alliance, have been striving for many years to direct all industries in the right direction of bettering their impact on Mother Earth. The latest report of the Global Alliance for Buildings and Construction: 2020 global status report for buildings and construction, shows that we still have a long way to go before we achieve the UN Sustainability Development Goals (Hamilton et al., 2020, p 6-11).

According to the report of the UN two pressing factors are CO₂ emissions and electricity use. The building industry uses 55% percent of global energy consumption, making an impact on this front would have a high impact. On the other hand, CO₂ emissions have risen compared to 2019 instead of decreased (Hamilton et al., 2020, p 4). The building industry is moving very slowly in implementing measurements that moves the industry to be more sustainable. One of the main causes of this is the lack of sustainable building materials. To put it lightly: standard materials like concrete, brick and steel do not have the most environmentally friendly production process. The research of sustainable alternative building materials is definitely an active field (Delgado, 2020; Yhaya et al., 2018), but so far not many products have made it to the shelves.

The Netherlands, and many other countries, also feel this worldwide concern about the building industry, that the reports of the UN and the Global Alliance for Buildings and Construction bring to the foreground. So in 2016, the Netherlands created the Nationwide program Circular Economy. In which they describe the goal to get the Netherlands circular before 2050, see image next page (Het ministerie van Infrastructuur en Milieu al., 2016, p 60-65). To reach these goals before 2050, we need accelerate and activate the creation and use of more sustainable and circular building materials.

One of these promising building materials is seaweed (in this case the term seaweed also includes seagrass), see image below, research into seaweed has been thriving since 2012. So far, many promising materials have been presented (Baloo et al., 2021; Berglund et al. 2021; Dove et al., 2016; Widera, 2014; Yang, 2012), but there is still a lack of evidence of integrated use. The only avenue that has been properly explored and documented are traditional building methods with seaweed in Denmark and Coastal Asia (Wang & Tong, 2013; Widera, 2014). The next step in this progress would be to see how a seaweed-based building material

	<p>can be produced and used on a scale bigger than the individual house, such as a neighborhood.</p>
<p>research questions and</p>	<p>The product that is going to be produced will shape the design of the facility and it's flows immensely. The thematic research question will determine which product seems feasible for the location. To limit the research, only building skin products will be considered, because of the easy recognition of the use of seaweed when used on the façade. After all the goal is to introduce seaweed as a new building material and a visual use on the outside of the building will be more impactful. Most important that the building product can compete with standard building materials in terms of sustainability. Therefore the thematic research question is:</p> <p>Is a seaweed-based building-skin more sustainable (CO₂, water use, energy use) in the end than sourcing standard nonlocal building products?</p> <p>The sub questions are as follows:</p> <ul style="list-style-type: none"> ● What seaweed-based building skins are currently developed and is there potential for local production of this cladding? (max 5) ● What base materials are needed for the production and how can these be locally sourced? ● What are the waste material flows from this production and how can these be locally processed? ● Is the seaweed-based building-skin more sustainable (CO₂, water use, energy use) than a facade made from reed, bricks or Trespla plate?
<p>design assignment in which these result.</p>	<p>How could the production of seaweed-based building materials be integrated in a transforming industrial and residential neighborhood in Westpoort Amsterdam?</p> <p>The overall design question will lead to a final design project that consist of the design of a production facility that makes seaweed-based building materials in one of the old factories or warehouses in Westpoort. It will also house public functions like a restaurant, hotel and/or shop to introduce the community to seaweed as a new material. Beside the design of a place, the flows and interactions of the production and other activities of the facility will be considered and connected to the surrounding companies, landscape and communities. The sub questions are as follows:</p> <ul style="list-style-type: none"> ● How would the flows of the building materials interact with the neighborhood and surrounding areas? ● How would the production facility of seaweed-based building material need to be designed? ● How would buildings that are made with seaweed-based materials look like technically and architecturally? ● How can the local community be able to be part of the process?

Process

Method description

For the method I made use of some questions from the lecture about the research methods given by Tanja Tsui. The questions were quite essential in creating an overview of the research methods which is why the methodologies are presented with the table below.

Sub research question	What data do you need?	How can this data be collected?	How will this data be analyzed?	What will be the expected result?
1.What seaweed-based cladding are available/possible?	Quantitative data about different types of seaweed cladding. Qualitative data about the pros and cons of these types of cladding.	Literature study	Comparative overview	List of currently available and sustainable products
2.What base materials are needed and can be locally sourced?	Product recipes and where and how these ingredients can be produced/harvested.	Literature study, location analysis, hopefully some recipe testing	Location analysis and flow charts	Insight about the input of the production process
3.What are the waste materials and how can these be locally processed?	Product recipes and output/byproducts of the production process. Ways to process/ re-use these waste- and byproducts.	Literature study and looking at the potential waste streams from question 2	Extending/ Closing the flowcharts from question 2	Insight about the output of the production process and how we can deal with the waste- and byproducts.
4.Is the chosen cladding more sustainable (CO2, water use, energy use) in the end than sourcing standard nonlocal building products?	Quantitative data about CO2 emissions, water use, energy use and other relevant waste streams from the production of the new cladding and	Literature study, national statistics	Comparative spreadsheet	To see if the seaweed alternative is more sustainable and if not, where it

	from a standard cladding (ex. Bricks, tiles, concrete etc.)			could be improved.
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Literature and general practical preference

The literature consulted are mainly research papers and reports about seaweedfarms and seaweed products. Also organization like the Dutch Design week make it easier to discover new approaches on seaweed in the build environment. Of course company webpages will also help to see what seaweed based building materials are market ready. A location visit helped understand the landscape and setting. A visit to a seaweedfarm and a loam brick producer was planned to get first hand information on these production facilities. Finally there was testing done by myself to see what "recipes" worked for seaweed loam bricks, which produced a lot of data. Lastly for the sustainability comparison, environmental product declaration reports and similar, own calculation based on the testing, next to some individual papers were used to collected numbers on CO²-emission, water-use and electricity-use.

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)?

My research looks into seaweed based building products and how these can be locally sources and how we can build with these materials. The material study into seaweed as a building product fits within the architectural engineering scope. Because of the focus on local resources and production, the studio Harvest lends itself greatly to create flowdiagrams and discover how to locally resource this. Lastly this research into seaweed is done to discover it usefulness as building material and how we can use and design with it. It's essential as an architect to know the materials you are designing with and let them inspire you. Although material knowledge is not only interesting for Architecture but the whole build environment.

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

The final design project will be a exemplary project of the local production and use of more sustainable building material on the scale of a neighborhood. Although we are doing good work in researching, we need to make the next step to setting up bigger scale projects to start living more sustainable and responsible. Although in this case, seaweed is quite specific for the Westpoort and location or areas with similar climates and resources. It still promotes new ways of living that would influence the environment less negatively and focuses on circular economies, local materials and communal commitment. The research into new building materials widens the scope of options for designers and builders. It also gives new insights in old and new materials as building material and their impact on the world.

Literature

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