

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 | Nadine Nossbaum |
| Student number | 4659716 |

| Studio | | |
|---------------------------------------|--|---------------------------|
| Name / Theme | | Architectural Engineering |
| Main mentor | Dafne Swank | Design |
| Second mentor | Stephan Verkuijlen | Building Technology |
| Argumentation of choice of the studio | This studio is chosen to explore my fascination with sustainable innovation and reusing and recycling materials, focusing on addressing environmental issues through innovative architectural approaches and promoting circular economy practices. | |

| Graduation project | |
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| Title of the graduation project | Building with Recycled Plastic Materials: Designing Modular Student Housing and Exploring Circular Solutions |

| Goal | |
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| Location: | TU Delft Campus, The Netherlands |
| The posed problem, | Plastic is a material that has become deeply embedded in everyday life due to its versatility and widespread use in both short- and long-term products. However, our current use of plastics is not sustainable. The still increasing production of plastic has led and will lead, if not handled responsibly, to a huge increase in plastic waste. Since most plastics are not biodegradable, they remain in the environment for hundreds of years, leading to serious pollution problems, harming ecosystems. Moreover, plastic production and disposal are energy-intensive and dependent in most cases on fossil fuels, contributing significantly to greenhouse gas emissions leading to further climate change. Since most |

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| | <p>plastic waste is not recycled, it often ends up in landfills, is incinerated or leaks in the environment, exacerbating degradation. Plastics are difficult to reuse because they are often designed for single-use applications and frequently consist of complex compositions. This underscores the importance of further research into recycling to harness their potential as a valuable resource.</p> <p>Packaging is the largest contributor to plastic waste, yet many people remain unaware that the items they discard daily hold the potential to become valuable raw materials. Recognizing this potential requires a fundamental shift in perception, encouraging a view of waste as a resource that can replace traditional (building) materials.</p> |
| research questions and | <p><i>What recycled plastic materials and related production techniques are available to be used in housing design and construction?</i></p> <p>Sub questions:</p> <ol style="list-style-type: none"> 1) What recycled plastic materials and related production techniques are currently available? (The focus materials are PolyAl and Mixed Plastics) 2) What parameters can be used to evaluate the technical and design performance, and environmental potential of the materials in housing design and construction? 3) How do the materials perform based on key technical, design and environmental parameters? 4) How can the materials based on key parameters be applied in housing design and construction? |
| design assignment in which these result. | The aim of this project is to design a modular housing system using recycled plastic materials, with a circular approach utilizing the (existing) plastic |

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| | <p>recycling infrastructure. The system will create housing units on the TU Delft campus, addressing the urgent need for student housing while exploring scalable and sustainable solutions.</p> <p>The modular housing strategy will be built around a catalogue of recycled plastic building components, offering design flexibility while ensuring that the structures can be easily disassembled, reconfigured and recycled at the end of their use.</p> <p>In addition to its sustainability focus, the project will prioritize the creation of functional, adaptable living spaces that meet aesthetic and building design standards.</p> |
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Architectural Engineering Triangle-Approach:

Technology The project explores the use of recycled plastics in modular housing, focusing on related production techniques such as compression, extrusion and injection molding. It investigates how the allocated materials can be used to create modular units that are reconfigurable, reusable and recyclable. Key to this is an understanding of recycling technologies and how recycled plastics can be processed into structural and non-structural building components and how these could be (dis-)assembled.

Context Delft is selected as location for this initiative due to TU Delft's need for student housing on its South campus. This small-scale student program provides an ideal opportunity to test the application of the recycled plastic materials in modular housing strategies. Additionally, with this part of the campus being referred to as an 'experimental living lab,' it serves as an ideal location for such initiatives. Having TU Delft as a nearby research institute allows for ongoing exploration and development of using recycled plastic materials in building construction.

Use This modular housing system, designed for students, offers sustainable living spaces. The concept is to create a catalogue of modular components that form a basic structure, while also allowing flexibility to adapt certain elements according to personal needs within specific limitations. Intended for temporary use, the system is designed so that, once no longer needed, its components can be reconfigured, reused or (partially) recycled.

Process

Method description

Case study analysis Analyzing and identifying case studies of buildings and projects that incorporate recycled plastic waste streams and their production techniques, examining their impact on housing design.

Literature review Investigating the various plastic waste streams in combination with the available production techniques and understanding their specific possibilities for application in the built environment.

Field research Exploring the researched plastic waste streams and production techniques in real-world settings to assess their feasibility and potential for housing design and construction.

Material analysis Examining the composition and properties of recycled plastic materials, considering parameters such as strength, stiffness, durability, fire resistance, UV stability, etc.

Comparative analysis Comparing the characteristics of recycled plastic materials with traditional building materials (wood, steel, concrete) to identify similarities, differences and the potential of recycled plastics in building design.

Research by design Investigating the practical application of the recycled plastic materials and production techniques in housing design, using a modular student housing unit as a prototype to test integration possibilities.

Literature and general practical preference

The appendix attached to my research provides an overview of production technique representations, parameter explanations, material parameter dat, and analyses of case studies and field research.

The case studies focus on the following companies: Recoma, Ecopeal, Save Plastics, Lankhorst, Aectual, Newpal, Block Solutions and ByFusion (ByBlock).

Field research visits were conducted at Better Future Factory, plastichuisje.nl and ReconPolymers.

Further Research 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)?

My graduation project focuses on designing a modular housing system using recycled plastic material, applying circular design principles to address plastic waste problems. In line with the studio's emphasis on innovation, the project uses underutilised waste streams to create environmentally responsible housing solutions. It integrates materials science, design and environmental impact and combines architectural theory with technical expertise to address housing challenges. This research explores new material applications in construction, focusing on sustainability and adaptability. Rooted in the MSc Architecture, Urbanism and Building Sciences programme, the project addresses the urgent demand for student housing in Delft while promoting a circular economy. It serves as a practical application of my studies and makes a meaningful contribution to sustainable architecture and resource-efficient building practices.

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

This project lays the foundation for understanding how the researched recycled plastic materials can be applied in simple modular housing construction. By exploring these materials, it highlights their potential for broader applications, showcasing how minimally used raw materials can contribute to sustainable (and circular) building design solutions. As these materials have the potential to lower CO₂ emissions and significantly reduce waste production.

Additionally, the project aims to inspire a shift in perception, encouraging people to see what they discard in daily life not as waste, but as valuable raw materials. This perspective not only promotes sustainable practices but also supports the transition toward a circular future.

Ultimately, this objective is not just about building homes; it is about promoting sustainability and resourcefulness that can inspire future building projects.