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	Minoo Motedayen
Student number	6020631

Studio		
Name / Theme	Building Technology graduation studio	
Main mentor	James O'Callaghan	Group Structural Design & Mechanics
Second mentor	Marcel Bilow	Group Building Product Innovation
Argumentation of choice of the studio	As a student in the Building Technology track, my deep passion for the core concentrations of this track, particularly creativity and novelty in technical and architectural matters, strongly influenced my choice of project. This topic allows me to explore innovative solutions while maintaining a focus on sustainability, a critical issue of our era. I believe that this studio perfectly aligns with my interests and concerns, offering an ideal setting to advance my understanding and contribute to sustainable architectural practices.	

Graduation project	
Title of the graduation project	Modular Float Glass Systems - Designed for Reuse
Goal	
Location:	No specific Location (The Netherlands could be taken for default)
The posed problem,	Due to the challenges in recycling laminated float glass and the absence of modular and reusable systems in structural glass—key factors in reducing waste and enhancing sustainability in glass construction—**How might we achieve a modular glass structure that allows for easy disassembly and reuse of its components with minimal use of other materials?**
research questions and	Mentioned below
design assignment in which this result.	Mentioned below

Main Research Question:
" How can novel connection with minimal use of other materials, be designed to maximize adaptability and reusability of modular float glass systems? "

Sub-Questions:

- Design Feasibility:
  - What types of interlocking mechanisms or intermediate material (glass-to-glass connection) can securely and reusable connection between glass elements without permanent bonding?
  - Are the interlocking connections scalable or repeatable for different use-cases?

- Structural impact:
  - How do modular connections impact the structural integrity of float glass under different loads?
  - What testing methods are needed to validate performance under repeated assembly/disassembly cycles?

- Assembly Process:
  - How can glass panels be joined securely and efficiently to ensure a safe system that can be assembled by minimally trained personnel?

- Sustainability in Design:
  - How can the modules be disassembled from intermediate materials or joint components, and what are the potential reuse or recycling scenarios that can maximize the lifecycle of the components?
- Background Questions:
  - What are the existing examples of modular and demountable systems in other material systems, and how can these principles be adapted for glass?
  - What regulations and standards must be considered in the design and construction of modular glass structures, especially for public exhibitions?
  - What is the existing state of modular glass structures in architecture?
  - How in modular systems, size and form of a module is defined?

Design Assignment Overview:
Develop a modular, reusable float glass pavilion that promotes easy assembly and disassembly, adapting to various forms for enhanced sustainability and adaptability.

Sub-Objectives:

1. Innovative Connections: Design standardized, interlocking connections that remove the need for bonding, promoting modularity.
2. Validation: Test the pavilion to evaluate connection performance and system adaptability.
3. Simplified Assembly: Create an intuitive, IKEA-style assembly guide for non-specialists.
4. Lifecycle Integration: Implement strategies for the reuse, repair, or recycling of glass components.

Final Products:

1. Pavilion Prototype: A case study pavilion showcasing connection efficiency and modular adaptability.
2. Design Tools: Develop software in Rhino and Grasshopper, with ANSYS for structural validation.

Process

Method description

Methodology

This research adopts a cyclical approach that integrates conceptual development, design iterations, and experimental validation to develop a modular glass pavilion system. The methodology emphasizes adaptability, reusability, and sustainability, with each phase designed to inform and refine the subsequent one.

1. Literature Review and Theoretical Foundation

Literature Review is closely Correlated to Research Questions and Objectives. The initial phase involves a thematic review of existing research that directly correlates with the project's research questions, objectives, and boundaries. This ensures a fundamental understanding necessary to address the problem effectively.

2. Concept Development and Analytical Modelling

2.1 Connection Mechanism Design

- The system's modularity depends on innovative, non-invasive connections that are secure, reusable, and adaptable. Initial designs will draw on the insights from dry connections and reusable systems in other materials.

Focus:

Enable configurations that balance ease of assembly with structural performance, considering factors like edge treatment, stress distribution, and modular scalability.

2.2 Pavilion Design

- The pavilion serves as the testbed for the modular system, showcasing its versatility in form and adaptability for both indoor and outdoor use.

2.3 Digital Modelling and Simulation

- Use Rhino and Grasshopper to develop parametric models for the pavilion, enabling iterative exploration of module scalability and connection behaviour.
- Validate structural integrity through ANSYS simulations, focusing on load distribution, joint performance, and stress points.

3. Prototyping and Experimental Validation

3.1 Prototype Development

- Fabricate glass modules and connections, incorporating intermediate materials where applicable.

3.2 Structural Testing

- Conduct physical tests to validate the modular system's performance:
    - **Static Loads:** Evaluate the system's ability to support self-weight and light operational loads.
    - **Cyclic Loads:** considering a solution for repeated assembly/disassembly to assess durability and connection integrity.

4. Lifecycle and Sustainability Assessment

The lifecycle analysis evaluates the system's environmental performance:

- Reuse and Recycling: Explore end-of-life scenarios to maximize component reuse and material recovery.
- Durability Over Time: Assess long-term performance under repeated use and varying environmental conditions.

5. Iterative Refinement

This stage involves a cyclical process that begins with the literature review, progresses through design development, and continues through prototyping and testing. This iterative test and feedback loop ensures that if the design does not initially meet all the project requirements, aims, or boundaries, it is reprocessed and rethought until it satisfies all criteria. This method allows for continuous refinement and enhancement of the design, ensuring that each iteration brings the project closer to meeting its objectives comprehensively.

Literature and general practical references

To better structure the literature review for my proposed topic, I have prepared a categorized list as follows:

- **Glass prosperities & Current main connection types**
  - Fundamental knowledge of structural glass, including manufacturing, treatments, strength, lamination, and safety in design.
  - Overview of connection types (adhesives, embedded, bolted) to establish a foundation of existing methods, assess performance, identify limitations, and determine gaps. This analysis will help set boundary conditions and module sizes and explore the feasibility of glass-to-glass connections.
- **Modular systems with dry connections on other materials (wood, specially on brittle materials like, marble, stone, concrete)**
  - Examination of interlocking, dry, and demountable connection systems used in modular projects.
  - Identification of requirements and parameters for designing the size and shape of units/modules.
- **History of Modular glass systems**
  - Review of case studies and reference projects in the field of modular glass systems.
- **Review of intermediate materials for glass-to-glass contact**
  - Research on materials like silicones, gaskets, or hybrid elastomers for glass-to-glass contact may provide insights into reducing stress during assembly and disassembly. Considering exploring transparent materials for aesthetic harmony.
- **Testing methods for modular systems**:
  - Guidelines on setting up structural lab testing to evaluate the structural stability of modular float glass systems. This includes criteria for testing under cyclic loading in addition to static loading to account for stresses from repeated disassembly and reassembly.
  - Dynamic load testing, impact resistance tests, and edge strength tests specific to modular glass structures.

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 project is part of the Building Technology track at TU Delft, which integrates advanced construction technologies with sustainability in building design. Focusing on modular glass systems, the project aims to

reduce waste and enhance reusability through innovative, dry connection methods. This aligns with the track's goals of pushing structural possibilities and promoting sustainable construction practices.

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

    - Societal Impact: This research aims to revolutionize the glass industry by demonstrating how modular glass systems can drastically reduce waste and bypass the sustainability challenges traditionally associated with glass. The success of this project could inspire widespread adoption and transform building practices globally.

    - Scientific Breakthroughs: Positioned at the frontier of architectural and materials science research, this project has the potential to open a new chapter in the glass industry. By introducing modular and reusable designs, it paves the way for future innovations and creative solutions that could redefine the use of glass in construction.