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	Georgia Giassia
Student number	5382777

Studio		
Name / Theme	Building Technology Sustainable Design Graduation Studio	
Main mentor	Telesilla Bristogianni	Researcher, Structural Design and Mechanics
Second mentor	Marcel Bilow	Associate Professor, Product Development
Argumentation of choice of the studio	[Argumentation of choice of the studio]	

Graduation project	
Title of the graduation project	Bio-host glass: A recycled porous glass, optimized for bioreceptive applications in the urban environment.
Goal	
Location:	Delft, The Netherlands
The posed problem,	The general problem of climate change and accumulative material waste, form the starting point of this study. On the one hand, engineering bioreceptivity in favor of the urban environment and the building envelope consists a major solution with minimum costs and maintenance, for the development and expansion of the green & blue network as a way of mitigating climate crisis. On the other, the existing open-loop recycling in the glass industry, leaving many waste sources of glass to be landfilled, calls for initiatives towards a more sustainable waste management. The building sector has proven to be a field that apart from producing annually large amounts of waste, can also absorb in facade materials with a bulkier section, a higher percentage of imperfections. Since bioreceptivity was approached as a phenomenon to be prevented until now, a gap in the literature is observed regarding products made from recycling glass. This, forms a promising opportunity for experimental research to provide innovative applications for closed-loop recycling, based on the bioreceptive criteria for a material that include porosity, surface roughness and water

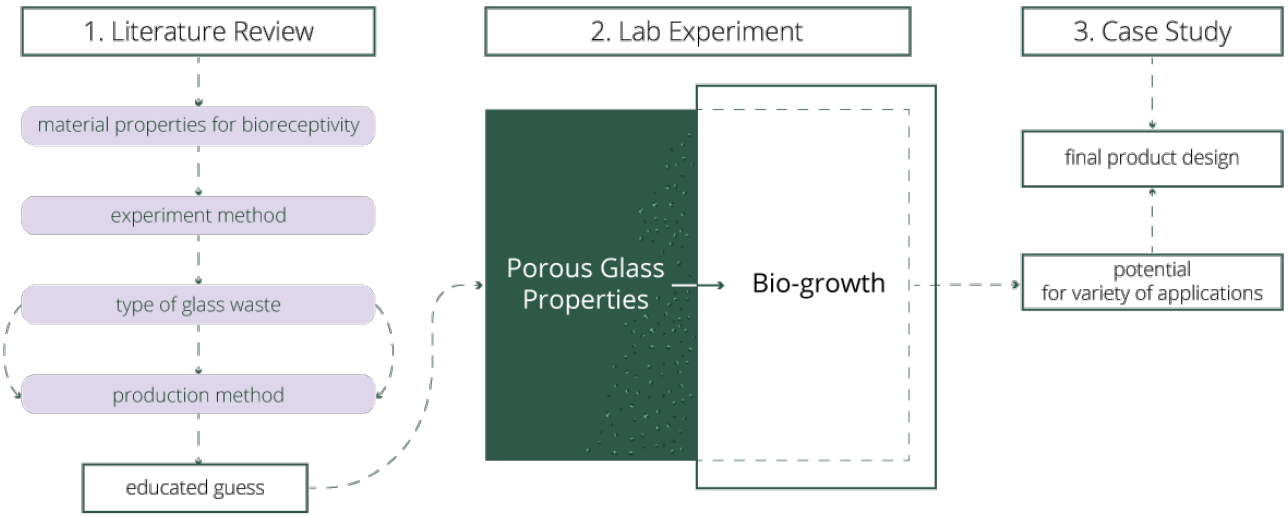
	retention that in any other material would constitute a major flaw.
research questions and	The main research question is formulated as follows: 'How can porous glass be manufactured out of glass waste to obtain optimum bioreceptivity and which are the possible applications for this new product?" This, can be further analyzed: (1) What is bioreceptivity / what are the benefits and the general conditions for a material? (2) What type of plants or microorganisms are involved in this? (3) How can we assess this phenomenon? (4) How can we increase the bioreceptivity potential? (5) What sources of glass waste are unutilized and have potential to satisfy the bioreceptive criteria? (6) What evidence exists in literature and the already conducted experimental work regarding porosity in recycled glass? (7) How do we manufacture glass foam and does the type of porosity of glass foam favours bio-growth? (8) What type of products and applications can be designed based on the new material properties and the limitations of the production method?
design assignment in which these result.	The research will exploit recycling glass waste, currently unutilized through experimental analysis on the material microstructure and different porosity ratios of recycled foam and/or fused glass, to reveal the best hydraulic properties that present maximum bioreceptivity. The final design for application will be dependent on the material properties.

[This should be formulated in such a way that the graduation project can answer these questions.
The definition of the problem has to be significant to a clearly defined area of research and design.]

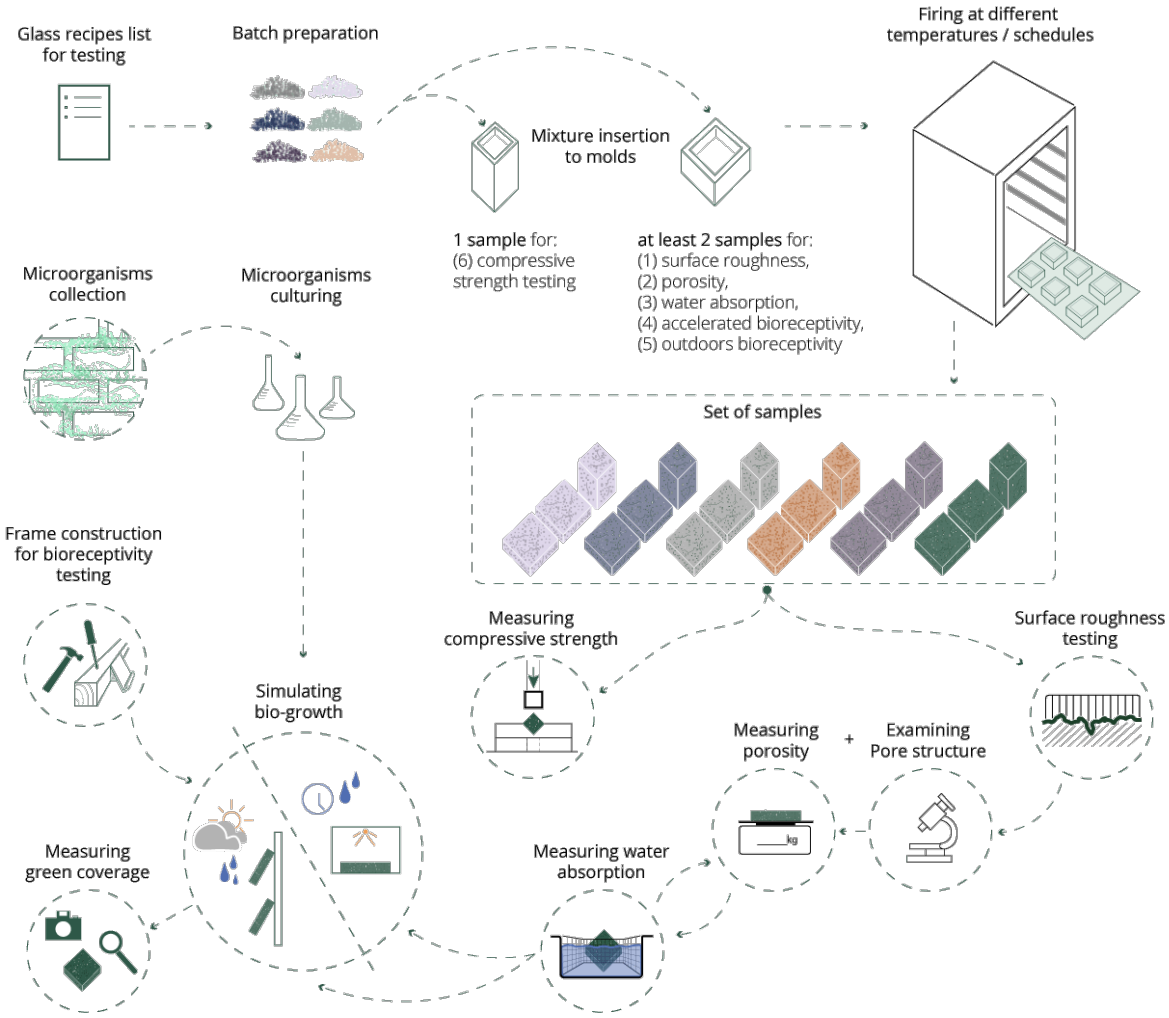
Process

Method description

The methodology that is aimed to be followed for this research is a combination of three research methods. In the first part, during the literature review, knowledge through the gathered information is going to be obtained by answering the sub-questions to best way possible. In the second part, from the knowledge gained certain assumptions are formulated, but also specific sub-questions due to lacking of literature sources are going to be investigated through experimental research. While, in the third and final method, the most promising results of the previous will be illustrated in a case-study showing the design and construction implementation of the developed material.



In this flowchart the aforementioned process of the three different methodology stages is illustrated.



Infographic with the distinctive steps of the experiments

Inside the lab, first and foremost the production method for porous glass will be studied, in regards of three main parameters: (1) the glass recipe (type of waste and additives), (2) the powder/particle size and (3) the temperature for foaming/heating based on the findings from kiln-casting and foaming methods. As the next step, the created samples, will be measured for their material properties: (1) density, (2) surface roughness, (3) porosity, (4) water absorption and (5) compressive strength. Then, the most promising set of the samples will be tested for bioreceptivity either with accelerating the microorganisms' growth in a controlled environment, or outdoors by constructing a set that ensures identical conditions for all the tested samples with adequate water content. Depending on the ease of feasibility and access to relative equipment, the method to simulate the microorganisms' colonization is going to be chosen.

By comparing these results, conclusions can be drawn for the potential of the material application, mapping its advantages and limitations. Hence, choosing a case-study to illustrate the effect of a bioreceptive porous glass is mandatory, in order to address all the possible points of attention or for future research for this new product.

Literature and general practical preference

The following documents, journals, papers and websites will be referred:

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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)?

The sustainable design graduation studio aims for innovative design technologies in the built environment. Glass is one of the prevailing materials widely used for its unique optical properties offering transparency, not only by the building industry, but also the automotive and industrial/laboratory equipment to name just a few. In terms of circularity, all these products that currently compile waste ending up in the landfill, are a source of raw material for products that just have not been tested and therefore invented. Thus, the topic is related to the ongoing research at TU Delft on glass structures out of recycling unutilized waste and it is using evidence from their work, aiming to provide new findings.

Building Technology is focused on creating solutions simply by analyzing the output's needs, whether this is related to energy and reduction of material usage or adaptability for future uses, together with all the possible inputs, and finding a match based on breaking down the problem into quantifying tangible parameters that can

be met. This approach is also followed in this project, by gathering information from literature, experts and validating through experimental analysis, aiming to reach the final goal of developing a new alternative and outlining its advantages and limitations.

What's more, under the scope of sustainability by creating solutions for adjusting or mitigating strategies for climate change, that benefit the urban environment, the objective of the master program is achieved. Since the proposal of a new product is being investigated, even without its successful complete determination in the next few months during this thesis, the novelty of the current work will stir new concepts across different disciplines for further investigation and design. These ideas might foster either the same goal of pursuing the development of a bioreceptive porous glass as an alternative of concrete, or for totally new products by delving into the potential of their porosity.

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

In combination with the aforementioned which also apply to this question, only by providing evidence if this solution is more sustainable and efficient from the current materials with bioreceptive potential, this project contributes in the general social, scientific and professional framework. Due to the lack of experimental work combining bioreceptive applications and glass recycling, the methodology as a general strategy that this is achieved, also provides useful insights and can be used as an example for future investigations. Not to mention, that in the case that the research leads to providing proof for a successful new application being more sustainable than the existing ones, since it is mainly composed out of landfilled waste, the societal relevance will be immense.