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	**Eda Akaltun**
Student number	5419123

Studio		
Name / Theme	Digital design tool for climate change resilient buildings	
Main mentor	Dr. S. Bianchi	[Academic field involved]
Second mentor	Dr. A. Rafiee	[Academic field involved]
Argumentation of choice of the studio	My main interest lies within climate change and the digitalization of the construction sector. The potentially harmful or even dangerous influences that climate change can have on a building on a structural level is of great importance to me personally, thus my interest in this topic.	

Graduation project	
Title of the graduation project	DIGITAL DESIGN TOOL FOR CLIMATE CHANGE RESILIENT BUILDINGS Subtitle: Designing an open-source tool to validate and conduct risk analysis on buildings in urban and building scale with respect to Climate Change.
Goal	
Location:	The Netherlands
The posed problem,	"The construction sector is in the early stages of adapting to the rapid climate change changes, including projects in the Netherlands."
research questions and	"How can we assess current Dutch IFC models regarding their climate resilience concerning climate change in an open-source manner?" The following sub-questions will have to be answered to be able to answer the main question:

	▪ What are the influences of climate change in the Netherlands? ▪ How do the changes in the Netherlands influence building materials? ▪ What are the new or increased risks because of climate change in the Netherlands? ▪ How can the resilience of buildings concerning climate change in the Netherlands be assessed? ▪ What are ways to assess IFC models in an open-source manner?
design assignment in which these result.	Developing and researching a method for a climate resilience tool

This research aims to answer what will happen regarding climate change in the Netherlands and which parts of a Building will be influenced by this structurally. After that, an assessment method and risk analysis for these changes will be researched. Lastly, a tool will be developed to assess the risks these buildings will be exposed to considering the changes. The same tool will serve to bring awareness to this topic.

The end product needs to correspond to the following points:
▪ An IFC should be loaded in, and a location should be obtained.
▪ For the given location, predicted climate data should be loaded.
▪ With the loaded IFC and predicted climate data, an assessment should occur based on the materials used in the IFC on a structural level.
▪ The depth and assessment method of the model is closely linked to the found quantification method as a result of the sub questions in this thesis. The assessment's quality is also tied to the given timeframe for this thesis.
▪ The given assessment should act as support during the design process or an existing building, making the end product a design tool for climate-resilient structures.

Process

Method description

The thesis will focus on the influence of climate change on the Netherlands, starting with a climate study to understand the changes occurring in the country. It will be followed by a theoretical study that limits the materials to common building materials found in the Netherlands, where the materials and their shortcomings in light of the changes will be researched. A risk analysis will be conducted on these materials, and the probability and severity of these risks will be investigated. A study of simulations will be conducted to quantify the changes, with the impact being made clear through either qualitative or quantitative means. The final step in the theoretical part of the

research will involve a study on how Dutch IFC models are built according to the Dutch IFC standard, with the help of an expert.

The practical part of the research will involve developing a tool using the information obtained in Python and making it open source through the open-source Mercury framework, resulting in an easy-to-use interface for engineers. The tool will allow the user to load in an IFC model and give a lo-cation to run a climate resilience assessment. The climate resilience assessment method details highly depend on the outcomes of the theoretical studies and simulations from the sub questions.

Aspect	Detail	Method
Climate Study (subquestion 1)	Climate Change in the Netherlands based on the evaluations and predictions of KNMI.	Theoretical study based on the Dutch government's publications & existing theories on how climate works.
Material study (subquestion 2)	Material study considering occurring changes in climate.	Theoretical study
Risk Analysis (subquestion 4)	Probability analysis on the determined risks based on the outcome of the material study.	Theoretical study & Simulations
Quantification study (subquestion 3)	Hand in hand with the Risk analysis, a method of evaluating the risk needs to be investigated. Which then needs to be translated in a form of indication for the climate resilience of a building.	Theoretical study & possible simulations
Dutch IFC study (subquestion 5)	Studying the structure of Dutch IFC models and their structure. This is according to the Dutch IFC standard.	Theoretical study and/or consulting experts.
Tool development (subquestion 5)	Developing a tool that is open-source with the obtained information that can load in IFC models and	Mercury GUI from a Jupyter Notebook.

Literature and general practical preference

KNMI
Intergovernmental Panel on Climate Change
Klimaateffectatlas
CBS

Already used sources examples:

Bert Metz, O. D. (2005). *IPCC Special Report on Carbon dioxide Capture and Storage.* Cambridge: Cambridge University Press.

CBS, PBL, RIVM, WUR. (2002, October 8). *CO2-concentratie (kooldioxide), 1980-2001*. Retrieved from clo.nl: https://www.clo.nl/indicatoren/nl021603-broeikasgasconcentraties-mondiaal

IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Working Group I Contribution to the IPCC Sixth Assessment Report.* United Kingdom and New York: Cambridge University Press.

KNMI. (2021). *KNMI Klimaatsignaal'21: hoe het klimaat in Nederland snel verandert.* De Bilt: KNMI.

United Nations Environment Programme. (2021). *A Practical Guide to Climate-resilient Buildings & Communities.* Nairobi: United Nations Environment Programme (UNEP). doi:ISBN: 978-92-807-3871-1

Scientific papers, books and experiments on materials
Material associations corresponding to the researched materials (example: For concrete, the Institute for civil engineers)

Mercury Python GUI
ifcOpenShell python

Reflection

1. This topic consists of different themes that are part of the Building Technology part. It starts off with a Structural Engineering and Material Science part where materials are assessed on their structural performance and weakening/degradation, furthermore it extends to computational for the development of the tool. Due to the topic being climate change, it also influences building physics to some extent.
2. **Climate change is a topic that affects everyone. Regardless of the opinion that one holds about it, it is already happening. It is a fact that the predicted changes will somehow influence future and existing buildings to different extents. Therefore, it is important to start putting these changes into the equation when designing new or maintaining existing structures.**