# 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 | Larissa Götze |
| Student number | 5845548 |

| **Studio** | | |
|---|---|---|
| Name / Theme | Architectural Engineering | |
| Main mentor | Stephan Verkuijlen | Architectural Engineering + Technology |
| Second mentor | Mo Smit | Architectural Engineering + Technology |
| Argumentation of choice of the studio | My choice for the aE Graduation Studio originated from my interest in the very practical matters of today's building industry. Not only am I excited about the pool of technical knowledge provided by the tutors but also about having the company of like-minded students during the graduation year. Particularly aspects of sustainability and material exploration, and approaches of hands-on research and design enthuse me. | |

| **Graduation project** | |
|---|---|
| Title of the graduation project | Rammed Earth: Exploring the material's potential to address residential challenges within Central European suburbs. |
| **Goal** | |
| Location: | Alexisquartier Munich, Germany |
| The posed problem, | The currently mostly inefficient resource management and linear application of materials neglect valuable existing stocks, and grey energy and emissions, as well as energy and emissions related to active climate control strategies, contribute to a building sector misaligned with sustainability objectives. Simultaneously, the housing sector constantly sees new buildings being erected, especially in sub-urban areas, due to population increase but also wrong occupancy of existing dwellings. |

| | |
|---|---|
| | Amidst these challenges, rammed earth, an ancient material, is experiencing a sustainable construction resurgence by transforming mostly waste-denoted non-hazardous soil excavations into a building material which offers intrinsic qualities of circular use and enhanced climate control, whilst inheriting the load-bearing capacities of average sub-urban building heights of three to four stories. However, traditional on-site fabrication is expensive and labor-intensive. While recent attention has sparked progress in prefabrication, the rammed earth field remains a niche, thus lacking concrete strategies for large-scale use.<br>On a societal level, many suburbs are challenged by segregation, which is often expressed in the spatial distinction of areas with predominantly single-family houses, and such with high-rises, mostly accompanied by disparities of the residents in income and social background. |
| research questions and | How can advancements in rammed earth prefabrication allow for broader use of the material in multi-family residential buildings in the sub-urban Central European context?<br><br>Q1: What are the current values and bottlenecks in the prefabrication of rammed earth elements that influence their efficiency, circularity, and aesthetics?<br><br>Q2: How can prefabricated rammed earth elements be used in a modular way that responds to requirements for housing purposes? |
| design assignment in which these result. | How can a housing system out of rammed earth present an aesthetic solution to the current challenges of multi-storey residential buildings within the sub-urban environments of Central Europe, whilst allowing for optimum occupancy to lower the future need for new buildings? |

## Process

### Method description

Workshops are used to generate basic knowledge of the material rammed earth to help determine the scope of the graduation project:

- Hands-on workshop on rammed earth at the AHK Amsterdam
- 6-week online learning course "Introduction to Rammed Earth"

Site visits to production facilities are essential to understand the status quo and to get insights into the professional handling of the material:

- Lehm Ton Erde
- August Lücking
- BC Materials

Value Chain Mapping and the creation of a Pugh Matrix of selected case studies are used to evaluate, compare, and elaborate on the status quo:

- Lehm Ton Erde
- August Lücking
- Erne AG Holzbau
- Le Pisé

Literature study serves as the backbone of both the research and the design. Prototyping helps to determine design-related objectives.

### Literature and general practical preference


1. Boltshauser, Roger. 2019. *Pisé - Rammed Earth : Tradition and Potential*. Zürich: Triest Verlag für Architektur, Design und Typografie.
2. Boltshauser, Roger, and Martin Rauch. 2011. *Haus Rauch: Ein Modell Moderner Lehmarchitektur.* Basel: Birkhäuser.
3. Erden. 2023. Design Guide for Rammed Earth: Building with 100 % Earth. https://www.erden.at/Design-Guide.
4. Gomaa, Mohamed, Sascha Schade, Ding Wen Bao, and Yi Min Xie. 2023. "Automation in rammed earth construction for industry 4.0: Precedent work, current progress and future prospect." *Journal of Cleaner Production* 398 (April): 136569. https://doi.org/10.1016/j.jclepro.2023.136569.
5. Minke, Gernot. 2013. *Building with Earth : Design and Technology of a Sustainable Architecture.* Basel: Birkhäuser. https://doi.org/10.1515/9783034608725.
6. Meuser, Philipp. 2022. *Vom Seriellen Plattenbau Zur Komplexen Großsiedlung: Industrieller Wohnungsbau in der DDR 1953- 990*. Vol. Teil 1. Berlin: DOM.
7. Röhlen, Ulrich, and Christof Ziegert. 2020. *Lehmbau-Praxis: Planung Und Ausführung.* Berlin: Beuth Verlag GmbH.
8. Sauer, Marko, and Otto Kapfinger, eds. 2015. *Refined Earth: Construction and Design with Rammed Earth.* München: Detail. http://ebookcentral.proquest.com/lib/delft/detail.action?docID=4332914.

9. Schroeder, Horst. 2019. *Lehmbau : Mit Lehm ökologisch planen und bauen*. Wiesbaden: Springer Vieweg. https://doi.org/10.1007/978-3-658-23121-7.

## 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 graduation project focuses in research and design on the creation of new buildings, which falls into the "make" domain of the Architectural Engineering Graduation Studio. This domain includes aspects such as "product development, structures, façade, craftsmanship", which are all part of the planned graduation project.
2. What is the relevance of your graduation work in the larger social, professional and scientific framework.
   A significant amount of new low-rise buildings, typically constructed with non-sustainable materials, could potentially be substituted with rammed earth. The numerous advantages of the material are recognized, primarily although only within the communities that already engage a lot with topics of sustainability or earthen materials. Due to the lack of familiarity and the material's niche presence in the built environment, misconceptions and concerns often persist. The design of a versatile housing system aspires to explore and to raise awareness of the material's possibilities. Simultaneously, it seeks to address the existing social challenges that areas with possible application of rammed earth, more specifically sub-urban areas, often have to deal with.