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	Milan Bezem
Student number	5331749

Studio		
Name / Theme	1. Adaptive Reuse	
Main mentor	Vincent Gruis	
Second mentor	Hans Wamelink	
Argumentation of choice of the studio	General interest in the circular economy	

Graduation project	
Title of the graduation project	Enabling the reuse of structural building component
Goal	
Location:	Netherlands
The posed problem,	The construction sector has a substantial impact on climate change, accounting for nearly 35% of the Netherlands' CO_2 emissions and half of its resource use (Circle Economy, 2024). As the Dutch government aims for a fully circular economy by 2050, the built environment offers a critical opportunity to advance this goal (Ministerie van Infrastructuur en Waterstaat, 2024). The construction industry, especially through its use of emissions-intensive materials such as concrete and steel, contributes significantly to the Netherlands' environmental footprint. Although the Netherlands seems to be progressive in the field of recycling, with 88% of all construction and demolition (C&D) waste being recycled, less than 8% of the materials used in new construction actually come from secondary sources (Circle Economy, 2022). This indicates a wide gap between recycling rates and actual material reuse. Reuse is defined as 'reusing objects in the same function'(CB23,2024). Looking at a building, this can happen at six different layers according to Brand (1997). Stewart Brand shows many layers of a building that have different timeframes for renovations and can each be considered for deconstruction and reuse. The six layers are: stuff, space plan, services skin, structure and site (Brand, 1997). Of these six layers, reusing structural components offer the most environmental benefits, as structural building components account for the biggest portion of a building's embodied carbon and are designed to last the lifespan of a building, often exceeding 100 years (Piccardo et al., 2024). Ideally, structural components would be repurposed directly from one building

	to another, thus maintaining the material's embodied energy and extending its useful life. However, actual reuse of structural components remains limited, with the majority being downcycled for lower-grade applications such as backfilling, which reduce their value and embodied carbon (Küpfer et al., 2023). Despite its environmental benefits, the reuse of structural building components is hindered by different barriers. Rakhshan et al. (2020) identified different barriers and classified them into six major categories: economic, environmental, organizational, regulatory, social and technical. He indicated that addressing the economic, social and regulatory barriers should be prioritized. Gorgolewski (2008) argues that the barriers to the reuse of construction components are rarely technical or economic, but are mostly based on organizational, contractual and social structures. The stakeholders' behaviours, attitudes and social structures are crucial aspects in making the shift to a circular construction sector. As most companies are reluctant to change their business model, close cooperation between key actors in the construction value chain, like construction and demolition companies, can address this barrier (Rakhshan et al, 2020). For example, cooperation between key stakeholders of a demolition project and key stakeholders of a new building can facilitate the knowledge of a known list of structural components to reuse early in the design phase of the new building. However, this cooperation often never happens (Nußholz, 2019). These issues represent a gap in understanding how collaboration between key actors within the value construction chain can address the key barriers of reusing structural building components and improve the reuse of structural building components.
research questions and	*'How can collaboration between key actors in the construction value chain enable the reuse of structural building components from existing buildings reaching their end of their lifecycle?'*
design assignment in which these result.	The graduation project focuses on the reuse of structural building components from existing buildings reaching their end-of-life phase to newly constructed projects. The aim is to develop a prescriptive framework or strategy guide that enhances collaboration between key actors in the construction value chain. By addressing critical barriers and drivers, the framework will guide stakeholders in systematically reusing structural components like concrete or steel, emphasizing sustainability and efficiency. This framework will incorporate insights from a literature review, document analysis, case-analysis and a workshop, to improve decision-making, workflows, and inter-organizational collaboration. The design assignment seeks to provide a practical, prescriptive process-orientated framework that stakeholders can implement to advance circular construction practices, aligning with the Dutch government's ambition for a fully circular economy by 2050.

Process

Method description

This research adopts a qualitative, exploratory approach to provide valuable insights into improving collaboration between key actors in the value construction chain for the reuse of structural building components. Qualitative research methods are used, which is optimal for understanding processes, the roles and relationships between stakeholders, and complex, context-specific phenomena

common in construction. A qualitative approach allows to explore naturally occurring behaviours and decisions within their real-world settings, reducing bias from interference. The research methodology used in this study are a literature review and a case study, providing a detailed understanding of industry practices, barriers, and areas for potential improvement in structural components reuse processes. The literature review provides a comprehensive overview of existing knowledge related to reuse practices, while a case study provides useful new insights and lesson learned from current real-world experiences (Creswell, 2013). The case study methodology is used to answer the main research question, by investigating collaboration processes and barriers and drivers in circular construction projects involving reuse of structural components, such as structural steel or concrete.

The qualitative research methods used in this research are a semi-systematic literature review, semi-structed exploratory interviews, semi-structured explanatory interviews, document analysis, cross-case analysis and a workshop. Findings from these qualitative research methods will be interpreted by following a theory-driven (deductive) approach, aiming to identify generalizable principles for enabling effective collaboration and improving reuse practices (Creswell, 2013).

Literature and general practical references

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Reflection

1. The track Management in the Built Environment (MBE) emphasizes the integration of management, design, and construction processes within the built environment. This aligns with my graduation project, which focuses on improving collaboration between key actors in the construction value chain to enhance the reuse of structural components in circular construction projects.
The MSc Architecture, Urbanism, and Building Sciences (AUBS) program provides a broad framework for addressing complex challenges in the built environment, and my research contributes to advancing sustainable practices within this context.

2. This study contributes to filling gaps in the academic literature about how effective collaboration between key actors in circular construction projects can improve the reuse of structural building components. It will address the lack of a comprehensive understanding of how actor dynamics can impact circular construction projects. Furthermore, the study aims to contribute to the development of prescriptive frameworks that integrate theoretical insights with empirical findings, enabling a structured approach to improving circular construction practices.
Improving the reuse of structural building components aligns with national and global sustainability targets, such as the Dutch government's ambition to achieve a fully circular economy by 2050 (Ministerie van Infrastructuur en Waterstaat, 2024). This study has a societal impact by addressing the environmental and economic benefits of reuse, as it reduces carbon emissions and construction waste, and promotes resource efficiency. Next to that, this study encourages sustainable business practices and fosters collaboration across the construction sector.