AR3AE100
Architectural Engineering Graduation Studio
Delft University of Technology

EXPLORING LIGHT EARTH AS MODERN BUILDING METHOD

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Choice of the studio

The name of this studio somewhat hints at it, the focus lies on the technical aspect within architecture. I think this is a nice correlation of the creative, non-tangible side of design and the concrete side with technical solutions. It is an overall approach that combines theory with a technical focus. This allows architectural and social solutions to be found, to which a deeper layer is added when a building also is being designed with a technical engineered approach. This provides the building not only to work well at building level, but also on surrounding- and regional level. In my opinion, this is the best combination that can be made in architecture, and I want to take on this challenge in my graduation project in this studio. My goal is therefore to design a building with architectural value based on technical principles that makes the building work as efficiently and optimally as possible without harming the environment.

Bio-based material
A bio-based material is a material intentionally made from substances derived from living (or once-living) organisms.

Landscape ecology
Landscape ecology can be described as the science of “landscape diversity” as the synergetic result of biodiversity and geodiversity.

Light earth building
In light earth building, loam is mixed with woodchips, pumice or other air pocket forming aggregates to create light, insulating walls, mostly within a structural wooden frame.

Hempitecture.com

Problem Statement

Housing dilemma in the Netherlands: the imbalance between affordability, sustainability, and shifting social dynamics

There is a need for a lot of new dwellings in the Netherlands: a total of 981.000 homes are expected to be needed through 2030 (figure 1). But the Dutch housing sector faces enormous challenges. Not only is the housing shortage enormous, but also the required reduction of CO2 and nitrogen emissions, combined with stricter laws and environmental regulations, creates unprecedented complexity in project development (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2023).

Other societal challenges include the energy and materials transition and the increasing exclusion of the middle class from the owner-occupied housing market. Combined with ambitions about affordability and sustainability, this often makes plans more expensive. According to alderman Reinier van Dantzig (Spatial Planning, Amsterdam), it is practically impossible to be both affordable and sustainable and then also build the very best architecturally. According to him, a choice will have to be made (Wagemakers, 2022). This could affect the percentage of social rent or the size of the dwellings, but also the sustainability requirements.

Furthermore, according to municipalities, a stagnation in the housing market is taking place because elderly people are not moving from their (too) large home to a smaller and more efficient elderly home (Van der Parre, 2021). Among (independently living) single or cohabiting 70-plussers, the largest living area is proportionally measured: 79 m2 on average per person (Centraal Bureau voor de Statistiek, 2022). In effect, a family in need of more space can't move into the larger home of the elderly. In this way, a starting family or first-time buyers cannot move into a 'starter' home in return.
Additionally, it does not do well that most residential buildings mainly are designed for a specific type of household in a specific time, further widening the gap between different segments of society. It is a way of thinking that lingers in our short-term economy (Till & Schneider, 2005, p. 157).

The outflow from the Randstad

In 2020, more people moved out of the Randstad than into it. The outflow from the Randstad to regions outside it has been increasing in recent years. In particular, couples and people older than 30 are leaving the Randstad more often than before. The strongest trend is seen among people in their fifties and sixties (Centraal Bureau voor de Statistiek, 2021), as seen in figure 3. Reason for this could be, for instance, gentrification - the phenomenon that cities are becoming crowded and unaffordable, pushing people out of the city. Also, it is generally assumed that corona measures, such as being more at home, could have an impact on people's moving behaviour. People would have become more in need of space in and around the home (Centraal Bureau voor de Statestiek, 2021). However, based on data on removals, it is impossible to say whether households' housing preferences have changed over time. This is because households' choice to move to a particular location partly depends on housing stock and regional price differences (Klopper & Kooiman, 2021).

This development is, among other places, also seen in het Gooi, an area on the border of the Randstad. For example, Hilversum is in demand and ranks third when it comes to places Amsterdammers move to (Visser & Bos, 2022).
The municipalities of Gooise Meren (Bussum, Naarden, Muiden), Laren and Hilversum are jointly developing a neighbourhood located in the middle of the Gooi. This area named Crailo, covers the last large area in the Gooi that can be laid out for housing as well as business activity (figure 2). Crailo is a very green context, it's part of the forest and heathland landscape. There are very high ambitions with regard to ecology and biodiversity. It is therefore chosen for this research.

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Housing development task up to 2030

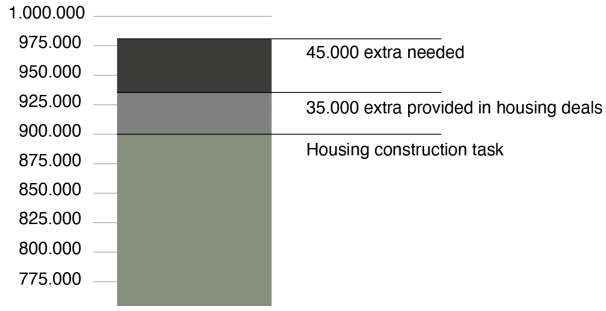

Figure 1
MBZ, 2023

Crailo

Figure 2
Apple Maps

Balance of people moved to and from the Randstad region

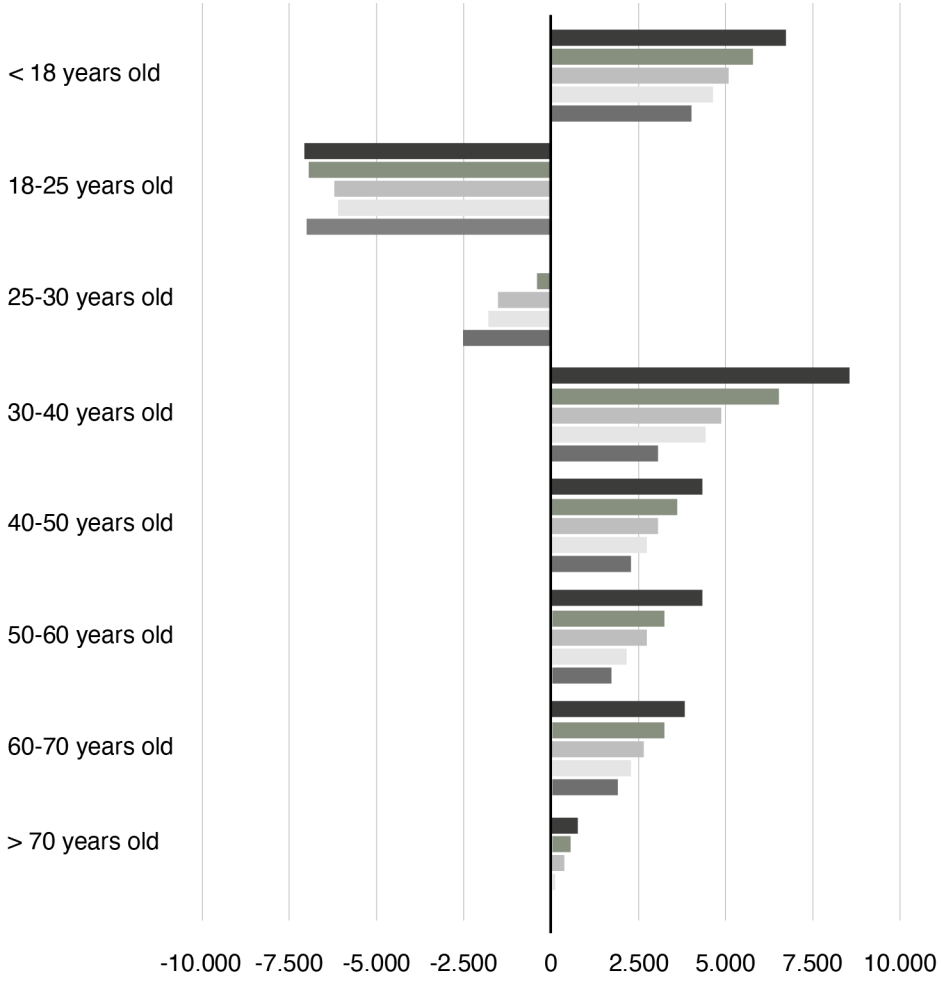

Figure 3
CBS, 2021

Over-exploitation of eco-landscapes

The building industry faces environmental challenges. Current ways of harvesting materials for our building industry often result in the over-exploitation of areas elsewhere. Solely focusing on the extraction of resources, other values of the exploited ecosystems are often being forgotten and undermined (Velu, 2022). It is therefore important to start using natural building methods. For the potential of harvesting resources for the built environment the provisional services are most suitable. Provisional services are the elements of an ecosystem that are not needed by the ecosystem to stay healthy. Wood and fibres are, in the case of the Netherlands, such provisional services. Earth is a supporting service, which means that the formation or conservation of soil in the ecosystem is needed to sustain the other services (Velu, 2022).

A natural building method that uses wood, fibres and earth, is the light earth building technique. It has a lot of potential due to its variety in compositions of materials and infills of wooden structures. This allows it to be made in multiple contexts and used on a regional scale. However, light earth construction as used today was recognised as a discrete technique in the mid-20th century and first documented in Germany in the 1930s, after which it has not been developed very much. It is therefore an outdated method of construction, which no longer meets today's high building and living requirements (Morgan & Scott, 2003).

Research focus

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Design Objective

Addressing the issues described in the problem statement, a more holistic approach to building and architectural design is required. A desired situation is that when people move to the outside borders of the Randstad, an affordable alternative residential building with accompanying fine living environment is created outside the city. Also, it can be concluded that more elderly homes should be built, which have enough to offer that it is worth the 'effort' to move out of the former house into a more efficient home.

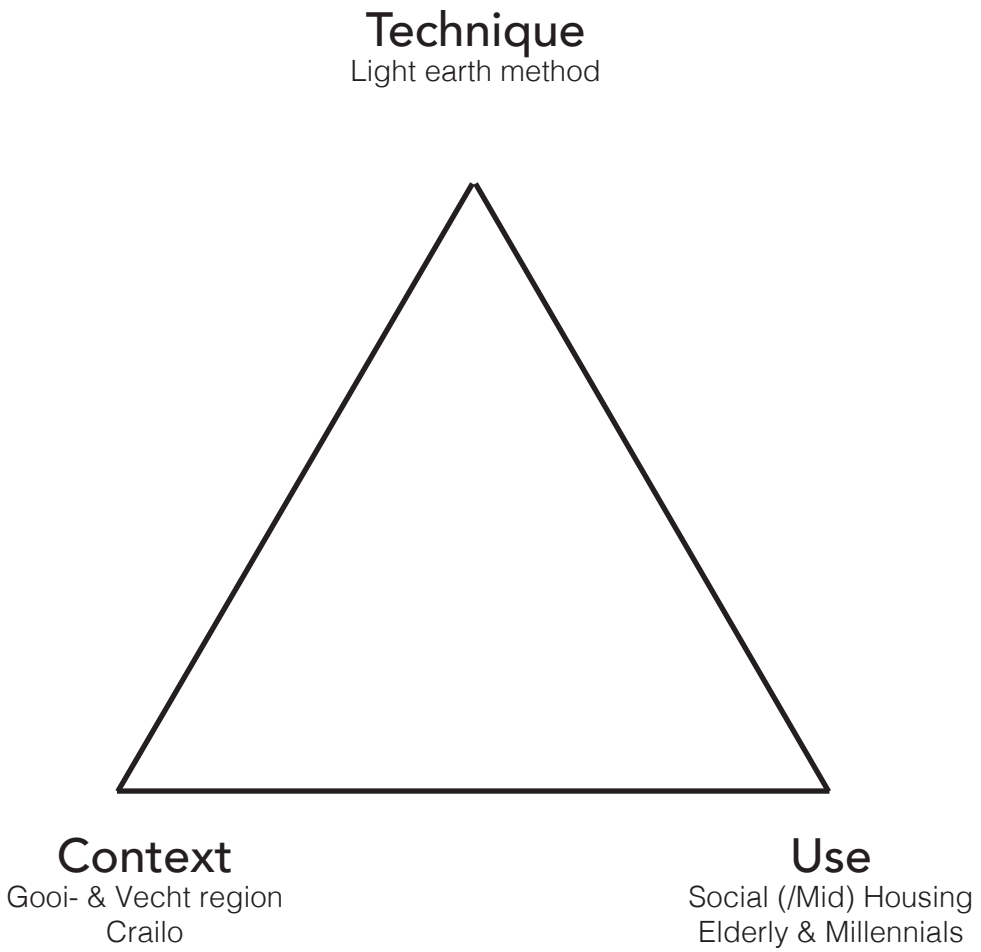
These matters highlight the need for architecture to respond to the dynamic landscape around it, mainly the pressing challenges of climate change and sustainability. It takes into account the needs of diverse populations and the ever-changing landscape. This should be connected to the way of building, using a building method with resources from the region while being careful not to over-exploit it. This could make sure the harvested resource is regenerative and stays so in the future. Furthermore, the building must align with the landscape, rather than the other way around.

The Gooi- and Vecht region is a combination of typical Dutch landscapes and soil types, such as forest and heathland on sand, peat meadow & lake area on peat and agricultural area on clay. This great diversity of landscapes within a relatively small area makes the region an ideal environment for developing bio-based building materials on a regional scale. A large part of the Gooi- and Vecht region is part of the Utrechtse Heuvelrug. Here, a raised sand layer lies as a deposit over other soil layers, this is where we find a lot of forest and heathland (Smit, Groenendijk, Köbben & Vélu, 2022). So, this area makes it possible to work with regional harvested materials, such as wood, earth and fibres. Furthermore, Crailo is not part of the 'Goois Natuurreservaat' and therefore this area has great potential for residential development within this forest and heathland area.

Besides the great opportunities to harvest the resources from the near area, research has shown that living in a natural environment stimulates cohesion between people. Greater social cohesion may be associated with several physical and psychological health benefits. Green spaces can encourage positive social interactions that promote social cohesion in ways that improve health and well-being (Jennings & Bamkole, 2019).

Design Question

*What are the ingredients for a design of an **eco-positive residential building**, which allows for **co-habitation** of diverse population groups and can be constructed with **affordable biobased materials** from the region, following a landscape-based approach?*



Thematic Research Objective

The construction industry has the ambition to be fully circular by 2050. It is therefore essential for the future of this industry to choose biomaterials, which are locally sourced, non-toxic and have minimal ecological impact.

The materials come from the specific region where the building is being built. In this case, the region will be Gooi & Vechtstreek, which is, as mentioned, located in the middle of the Netherlands. There is a continuous residual flow of wood in the south of the area, between Hilversum and Hollandsche Rading. Also, the soil in the region has the potential to use earth as a building material. Local arable farming of, for instance, flax and hemp also has potential. This combined with loam and clay, can form the building method light earth.

Light earth building uses a mixture of earth and fibers to fill walls, floors and roofs. Here, the fibers have the potential of storing carbon when applicated in the built environment. Light earth building has a long history because of its local and natural character, but is not a part of todays industrialized building culture. However, the technique is sometimes finding its way in more contemporary buildings, for it can achieve satisfactory technical properties (Volhard, 2016). Light earth building is often employed in conjunction with timber frame construction. There are several approaches to this, the question being which approach is the most suitable for nowadays building demands, and if it can be applied in an innovative manner in the construction of a residential building.

Furthermore, the building, due to the choice of materials and methods, will possess certain characteristic traits, thereby giving a specific architectural identity upon it. This architecture should be contemporary and demonstrate that building with bio-based materials, in this case by using the light earth technique, can also be modern and innovative. By harnessing the benefits of light earth building, the architecture industry can pave the way for a green future where the built environment coexists with the natural world.

Archdaily.com

Thematic Research Question(s)

The question that this paper is aiming to answer is:

*In what ways can the **light earth method**, using **locally sourced materials** from the Gooi & Vecht region in the Netherlands, address **contemporary** residential **requirements**?*

Therefore, the following sub-questions are asked:

Properties of the light earth method in timber frame structures

- *What is light earth and what technical properties can it achieve?*
- *How do conventional prefabricated timber frame structures work, and what specifications are essential regarding relevant building factors?*

Locally sourced materials from the Gooi and Vecht region

- *What types of fibres and earth do we find in the Gooi and Vecht region and how can they provide for light earth building without over-exploitation of the area?*

Contemporary requirements

- *What are the contemporary residential requirements in terms of sustainability, energy efficiency, comfort, and aesthetics?*

Thematic Research Methodology

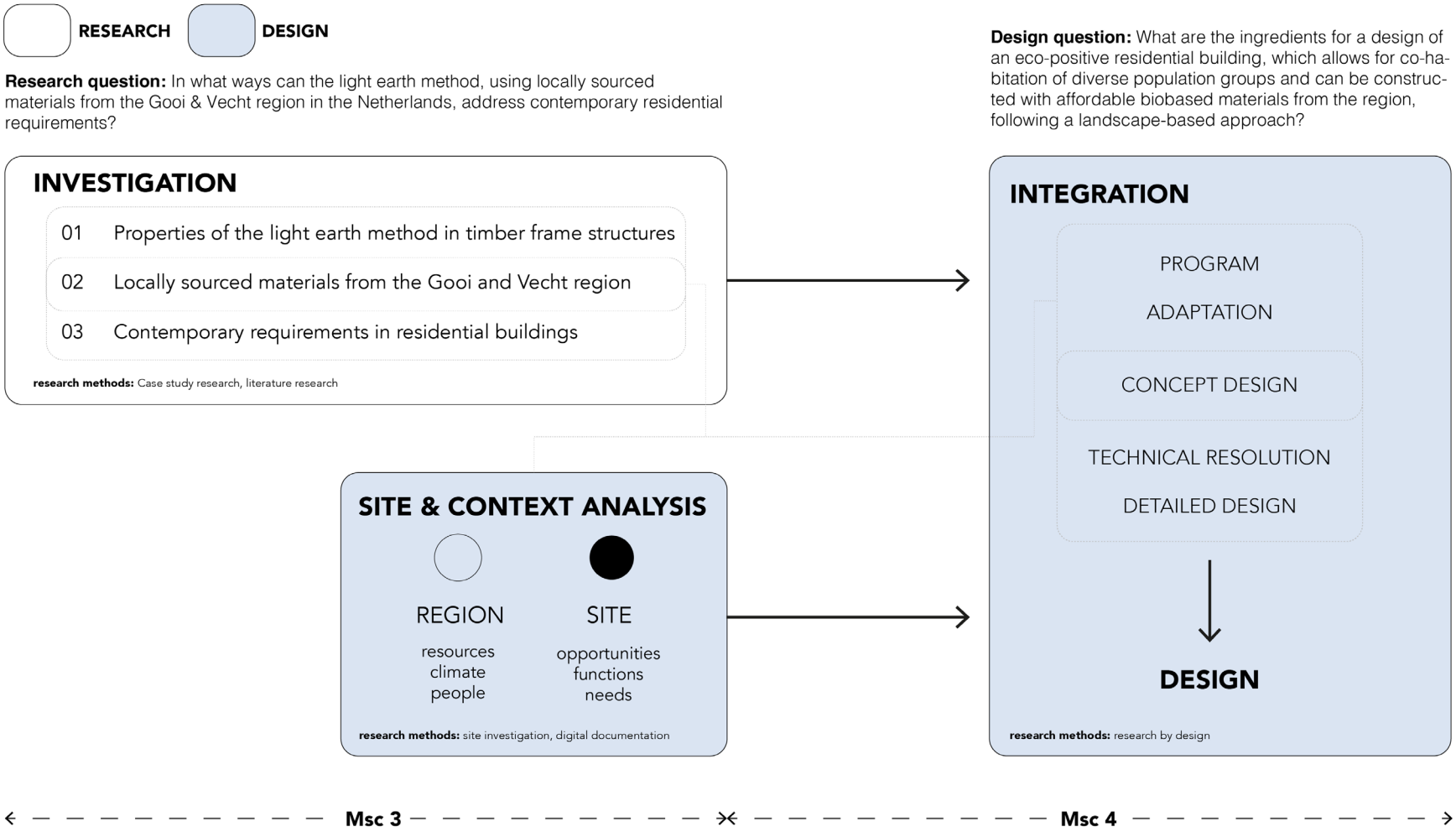
The first part of the research, focusing on the properties of the light earth method in timber frame structures, will be done by literature study. Franz Volhard's book Light Earth Building gives the technical properties that can be achieved with light earth building. Different types of mixtures of light earth are compared on their technical properties. It also discusses the different known ways of building with light earth. The construction methods found with light earth will then be assessed for their potential to be appleid in a (residential) building.

In addition to investigating the light earth method, literature research is also being conducted on conventional prefabricated timber frame elements. This provides an insight of how these structures are used today, and what the requirements are in terms of key performance indicators, which is important to understand for further development.

The research will have its focus on the Gooi and Vecht region, Crailo in particular. This means that the provision of the resources for the light earth method will be sought in that surrounding. However, case studies from other regions or projects to which the Crailo area and its landscape could be similar will also be analysed. Although this research focuses on the Crailo area, the building method with light earth could also be incorporated in other contexts.

After delineating the light earth method in timber frame structures, this study explores its applicability within the context of contemporary residential buildings, addressing various required characteristics. This last part initiates an exploration of design question by including the aspect of various target groups.

Research Stucture



Relevance

The research, primarily conducted in the Netherlands, holds broader applicability to regions sharing contextual similarities. While the technical research primarily centres on Dutch methods and materials, its insights extend to areas featuring similar materials and facilities with the requisite technical infrastructure.

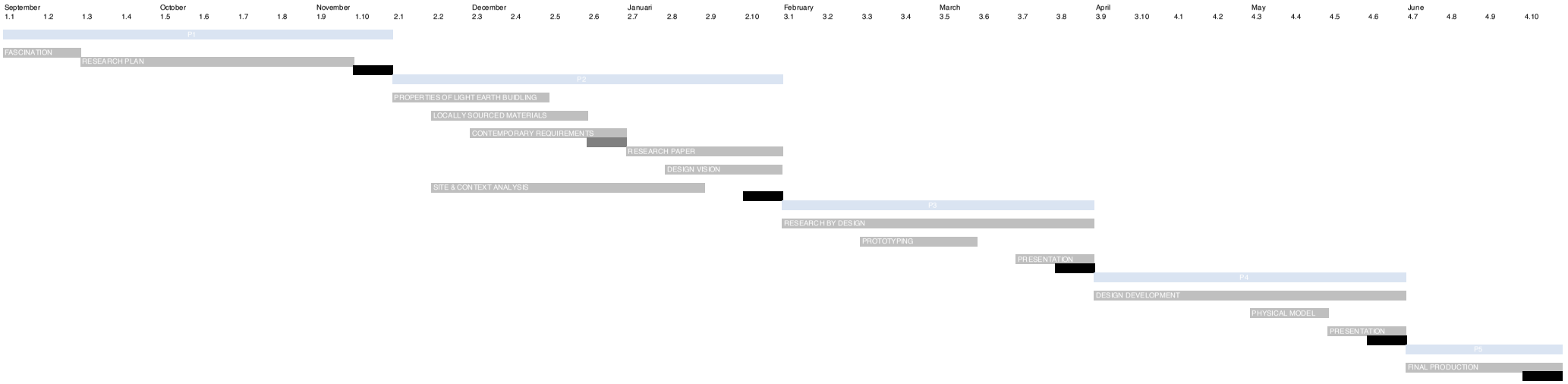
Regarding the overall design research, the architectural design is finely tailored to its specific location in the Gooi and Vecht region, yet it possesses the potential for wider influence. The need to create buildings that take into account the emissions and footprint of their components is highly relevant for the Netherlands, in line with the goal of having a circular building sector by 2050. This approach can also be embraced by the global construction sector as it seeks to reduce material consumption and enhance overall quality and efficiency.

Expected results

The aim of this article is to provide insights and guidelines for the development of a bio-based method with light earth construction. It will focus on how bio-based materials can be incorporated more into new buildings.
It is expected that the construction method can be improved by understanding the specific properties of the light earth method, where the materials are sourced locally. Different regions have unique soil compositions and using the right mix can improve the performance and durability of the material.
Building with the light earth technique is actually an age-old method of construction, yet it has not been incorporated into our building industry because the old way does not meet today's living requirements. The way to improve this method is to make it innovative with modern techniques in prefabricated timber frame structures.

The reputation of building with biobased materials is not very modern or contemporary. But this upgraded method can prove that it is possible to design an affordable, sustainable and architecturally very valuable residential building from biobased materials.

Planning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FASCINATION
RESEARCH PLAN
P2
PROPERTIES OF LIGHT EARTH BUIDLING
LOCALLY SOURCED MATERIALS
CONTEMPORARY REQUIREMENTS
RESEARCH PAPER
DESIGN VISION
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P3
RESEARCH BY DESIGN
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P4
DESIGN DEVELOPMENT
PHYSICAL MODEL
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P5
FINAL PRODUCTION

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