MATTER TO MATTER

Forming architecture with reused materials

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department of Architecture and Civil Enineering

Examiner: Mikael Ekegren
Supervisor: Björn Gross

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Master's Thesis in Architecture within the masters programme Architecture and Urban Design at Chalmers School of Architecture and the department of Architecture and Civil Enineering

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CHALMERS
UNIVERSITY OF TECHNOLOGY

How can designing with reused building materials support the tectonics & materiality in architecture?

To what extent can reused materials be used in a new construction?

How can a construction be designed to enable disassembly and reuse of the materials?

ABSTRACT

The ongoing climate changes and unhealthy state of our planet is noticeably and world-wide arising, due to human actions. The reasons for climate change are many, however, the emissions of carbon dioxide from construction alone, stands for 21 % of Sweden's total impact (Boverket, 2019). The cause of these emissions can be generalized to two factors: increased development due to growing population and secondly, the untenable way resources are used. Further, the existing construction-norm is linear: we produce, we use and we dispose. Humanity's growth and changed habits drive the development and changes of our built environment which in turn drives the demolition of old buildings being replaced with new. Nevertheless, the situation has also actuated trends towards change. The necessary alterations towards a durable situation must come from both private persons, stakeholders and politicians. One answer to the issue is a circular system that repair, reuse and recycle buildings and building materials in a resource preserving way, which reduces waste and emissions and therefore also the construction-industry's impact on the environment.

This thesis focus on how to design resource preserving architecture by primarily building with reused materials from the local context and additionally, how to design to enable future reuse of materials and components. The result is a design proposal of a center for temporary accommodation for hikers and scouts, located on a site in nature outside of Stenungsund. The architecture aims to emphasize the quality, history, culture and identity of reused materials, which consistently are unique and calls for unique creations and construction, decreased material costs yet increased craftsmanship. The program and users in this situation go hand in hand with the time and collaborative-demanding design method. The base of the project is an analysis of the existing problem, followed by a material palette which maps the available materials of the local context, and material experiments on how to build, combine and design with secondhand materials to save them from being waste.

> *Imagine a building, a large building, which is entirely cladded in marble. With one single gesture, the architect does two things: builds a façade in marble, and provokes with a hole in the ground. One of these things is considered architecture the other is not.*
>
> (Gielen, 2019)

Acknowledgements

Thanks to

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Lennart, Scoutmuseet
Municipality of Stenungsund
Taleen & Sara for commencing the subject together with me
Friends & colleges for great advise, wide discussions and loving encouragements
Elias for the dearest support

Student background

Bachelor of Architecture and Engineering
Chalmers University of Technology
August 2014 - June 2017

Masters of Architecture
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August 2017 - June 2019

Internship
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February 2017 - January 2019

Personal reason of discourse

The debate about climate change have been present for as long as I can remember, and I'm thankful to have been raised to take somewhat durable choices growing up. However, the situation has turned urgent the past years and changed my thoughts upon the future considerably.

In the beginning of the process, I had lots of subjects and perspectives within this field that I wanted to explore, but due to the limited time, I had to choose one subject, and my architectural interest in details and materials made me decide on this thesis focus. I'm humble about whether my thesis could affect how we build in Gothenburg and Sweden, but I felt I had to try in my last project in school - is it possible to build resource preserving from reused materials?

During this six-month project, I've lived as my thesis suggests: to buy only secondhand products instead of new. This was another eye opener that gave me new perspectives and made me consider my purchases an extra time. Almost everything that I needed (rather wanted) to buy, was available to find secondhand. Nevertheless, some crucial (again, matter of definition) items, I had to buy new: toothbrush, bolts and socks, e.g. I challenge you to try it, I promise you'll save money and avoid hoarding stuff you never use.

I hope you as reader will be inspired by my thesis.
Allt gott, Sofia

TABLE OF CONTENTS

Reading instructions

The booklet was used as a tool during the thesis, and reflects the process of the project. It is catagorized and organized to chapters, though the process was not as linear. The booklet begins with an introduction and research with a global perspective of reuse. Secondly follows a zoomed in investigations with specific materials in the context of the project. Thenceforth, the site and situation analysis and lastly the design proposal as the result of previous research. The design proposal is presented from page 44.

THESIS FRAMEWORK

Premise

Today, international trade is rapidly increasing and it's possible to buy products from almost anywhere in the world. The assortment of materials and products is infinite. Less building materials are from local manufacturers, and even if a product is labeled as local, it can still mean that the material has been partly processed in another country. The environmental consequences of these habits are well known and there are numerous countertrends exploring the possibility to again use local resources. Simultaneously, our habits and needs for the built environment is changing and putting pressure on our societies and settlements to change as well. Furthermore, with resources easily available and cheap, we see a trend of redundant constructions being demolished without much concern. The waste is shipped away and put on piles, leaving plots as blank spaces, ready to be rebuilt. Thus, due to the unhealthy condition of our planet, owing to humans acting, it is crucial to have a holistic and sustainable point of view when designing future development.

A building does not only influence the site of where it stands, it changes the extracting-site of the used materials, possibly where they are produced, and further on, the site of where its relics are left.

This thesis has the existing consumption-norm as point of departure, with orientation to the building industry. Through mapping of available used materials and components to reuse, in an early stage and as interactive process, enables a circular design and resource preserving design method. The mapped materials provide for the opportunities and limitations of the building blocks in the project.

Aim & purpose

The aim with this thesis is to evaluate an alternative design method for new constructions: to investigate in available, local and reused materials and building components before deciding on the final design. The initial research and analysis has a global and national perspective, thereafter the thesis is zooming in to a site specific situation and context, as an example of how to apply this design method into a design proposal. The prospect is to assess the method and resulting building through an experimental process. Hopefully, it's possible to implement certain conclusions into future projects. However, considering that the method is site specific, a general conclusion is not strived for.

Guiding questions

How can designing with reused building materials support the tectonics & materiality in architecture?

How can reused materials and structures contribute to forming identity and connection to history and culture when designing?

To what extent can reused materials be used in a new construction?

Theoretical framework

The discourse of the thesis can be divided into three different factors, the *goal*, the *tool* and the *perspective*. The goal is a resource preserving development, awareness and culture, and the tool used in this thesis is the design of a case study. The base is of the thesis is the existing situation, described in the chapter "research", which is the predominant perspective and point of view henceforth.

Approach

Map the existing situation

Understanding and identify the existing situation, system, possibilities and problems.

↓

Site analysis ↔ Map availiable materials

Site analysis

Analysis of the site, people, community, program, nature and climate.

Map availiable materials

Mapping of the available materials in the local context of the project sets the opportunities and limitation of the project.

↓ ↓

Conceptual design ↔ Study the materials

Conceptual design

Development of program, spatial qualities, material qualities to set the base concept of the project.

Study the materials

Via experiments, research through design and research for design investigate in the properties of the available materials.

↓ ↓

Practice

Analysis of buildings that's reusing materials and research on details and building techniques.

↓

Design proposal

Delimitations

The existing situation is complex, and it's impossible to take all factors in consideration. The background research described in this thesis is simplified to allow for forthcoming thesis chapters. Further, a project in a realistic situation, built from reused materials, demand adaptation and awareness of multiple regulations in construction, fire safety, quality control and inspections from professionals within several expertise. This thesis is described from an architects perspective and emphasizes the architectural viewpoint.

Another aspect is whether reusing materials is 'sustainable' or not depending on the situation. No discussion of what's more durable, is needed if the comparison is to reuse a neighbors old roof tiles or to import tiles from across the world. However, there is a gray area when e.g. the transportation of reused materials increases, and production happen locally. Investigations of these situations and choises is beyond the framework of this thesis.

A large amount of the wasted materials, is of poor quality and cannot be reused, the thesis treats this issue by designing details, so minimal amount of building material is unusable after the buildings life length. However, a conclusion of what to rather do with the unusable materials is excluded from this thesis.

Finally, the possible ways to reuse and recycle materials is endless and is much researched on, to limit possible material experiments, focus lays to only use processes that can be executed by amateur private persons and what material was available during the process.

Architecture, tectonics & reusability

One important factor in this project, is to use and evaluate the possibilities to reuse building materials. Another, as important aspect, is the formation of architecture, quality of space and the tectonics of materials. Whether if it's possible to reuse building materials is granted, and has been done for as long as humans have existed. However, reused material have a less attractive and exclusive credit. Still, reused materials and components are consistently unique, unlike mass produced new materials. With this project, I wish to exhibit a project which highlights the history and traces of past and displays the exclusiveness of the specific materials selected for the project. The aim for the design is to mediate honesty, texture, solitary space, and tell a story about the past, present and future.

Research by design

A central part of the thesis includes both abstract and concrete experiments with reused materials, which is accordingly the root and research for the forthcoming design phase.

Design by reseach

While experimenting and designing, the issues are treated by researching materials properties and traditional techniques

Design for disassembly

The available reusable materials from demolished or renovated buildings are limited due to construction system and technique, sandwich-elements, material joints and demolition method. To consider the constructions mounting- and demounting-techniques from start enables a material preserving deconstruction at a buildings end of life.

Steward Brand introduces the method shearing layers in his book How buildings learn : what happens after they're built which includes the six S's: site, structure, skin, services, space plan, stuff. The Site is eternal and the geographical location and setting. The structure has a lifecycle of 30-300 years and includes the load bearing system and foundation. The skin is the exterior surfaces and is exchanged every 20 years or so. The Services are the utility / HVAC systems needs replacement or repair every 7-15 years and must be places so other elements aren't affected by repair. The space plan is the interior layout and walls that might need adaption every 3-30 years. The stuff is the furniture with the shortest life length. (Brand, 1997)

In the guide Design for Disassembly in the built environment by Guy and Ciarimboli, it appears that approximately 62 % of all material flows consists of construction material, and according to their estimations, 27 % of all existing buildings will be replaced within the coming ten years which will generate in massive amounts of waste materials. However, much of the built environment isn't designed for disassembly which aggravates the possibilities to reuse construction materials which feeds a further consumption and production of new construction material to meet future demands on the built environment. Thus, a changed method for design and construction of new buildings is vital for a durable development.

Why reuse?

Resource preserving advantages

By reusing materials and element the total impact on climate will be largely reduced due to shorter material transports, decreased processes in terms of material production, decreased CO_2 emissions as many reused materials are saved from incineration.

Reduced cost for materials

Reused materials are most often cheaper than new materials. However, this doesn't necessarily lead to reduced total building cost, but open up to the possibility if being self-constructed.

Minimizing pollution

By saving materials from incineration or landfill prevent discharge of contamination in nature.

To support the local labour market

As previously mentioned, the material costs will presumably be reduced, at the expense of increased demand for local craftsmanship.

Opportunities for social & economical inclusion

The shift of funds opens up to the possibility to self-construct to save money and/or set a personal mark on the building.

Historic and cultural attachment

Reusing materials and construction elements provides new buildings with details and traces from the past. Handicrafts and used components give buildings a time perspective and story.

Personalization of & respect for a building

Reusing materials and construction elements allows for individual solutions, entirely adapted to the specific context. Visualizing the value of materials when designing, contributes to the users respect and sympathy for the building, which may prolong the life length of a building.

How does the existing system work?

The existing system is linear: we produce, we use, and we dispose. Industrialization has led to mass production which has led to easy access and wide options of materials and construction techniques, but is consequently a contributing factor for the climate changes we see today. Now, organizations with focus on reuse and recycling in new constructions are developed to turn the existing building norms: to demolish buildings to become waste and replace it with a new construction.

The guide Design for disassembly in the built environment lists seven factors within todays building industry, that aggrevate the possiblities to disassemble building constructions for reuse. Below listed and summarized by the author:
- Use of unrenewable materials and increased use of composites
- Costs of labor to deconstruct are high
- The use of connection techniques are not demountable
- Loss of craft skills in the industry
- Coatings and cladding techniques are not demountable
- Short term ownership of buildings result in short term prospect
- False perception that buildings designed-to-disassembly have a shorter life length

The aim with the method design for disassembly, is to preserve resources and minimize the environmental impact (Guy & Ciarimboli, 2013). The guide Design for disassembly in the built environment includes construction system, component use, material choice, flexibility, convertibility, addition and subtraction of the building to the design method.

Towards a resource preserving design

The European Commission place waste managements in a hierarchy for most preferably to less preferably process (European Commission, 2010):
1. Prevention (change behavior)
2. Reuse (reuse & repair items)
3. Recycle (recycle materials & turn into new items)
4. Recovery (incineration with energy recovery)
5. Disposal (landfill & incineration without energy recovery)

However, buildings are constructed with multiple materials and in different functional layers, and to consider a more complex system, the Delft ladder was developed (Hendriks & Pietersen, 2000). The Delft ladder is based on the EC hierarchy, but being more flexible and adapted to construction. The list is published in the report Sustainable Raw Materials:
1. Prevention
2. Construction reuse
3. Product reuse
4. Material reuse
5. Useful application
6. Immobilization with usefull application
7. Immobilization without usefull application
8. Combusting with energy recovery
9. Combusting without energy recovery
10. Landfill

In Sweden, an approved application from authorities is required to demolish a building. There are regulations of how to handle the waste material. However, the primary responsibility lies with the owner and it's up to them to evaluate materials and elements placement in the European Commissions waste-management-hierarchy or the Delft ladder, which might carry economic interests rather than environmental.

Existing material flow

As mentioned in the EC hierarchy and the Delft ladder, materials can undergo several processes. Most materials end up at recycle centers at some point of their lifecycle. The process depends on material:

Linear flows:
Unsorted waste → *Incineration*
Wood → *Cutting* → Wooden Chips → *Incineration*
Plastic → *Sorting, shredding, washing, dissolve & sorting* → Lower quality plastic item → *Incineration or landfill* (Naturvårdsverket, 2019)
Cardboard → *Sorting, shredding, compaction* → Cardboard (can be reused ~ 6-7 times) → *Incineration* (Sveriges avfallsportal, 2016)
Electrical waste → *Sorting: plastic - plastic recycling, wires - metal recycling*
Appliances & devices → *disassembly, sorting to corresponding material*
Batteries → *Disassembly, sorting, recycling & longtime-conservation*
Textiles → *reuse* → Textiles → *fiber recycling* → Textiles → *Incineration*

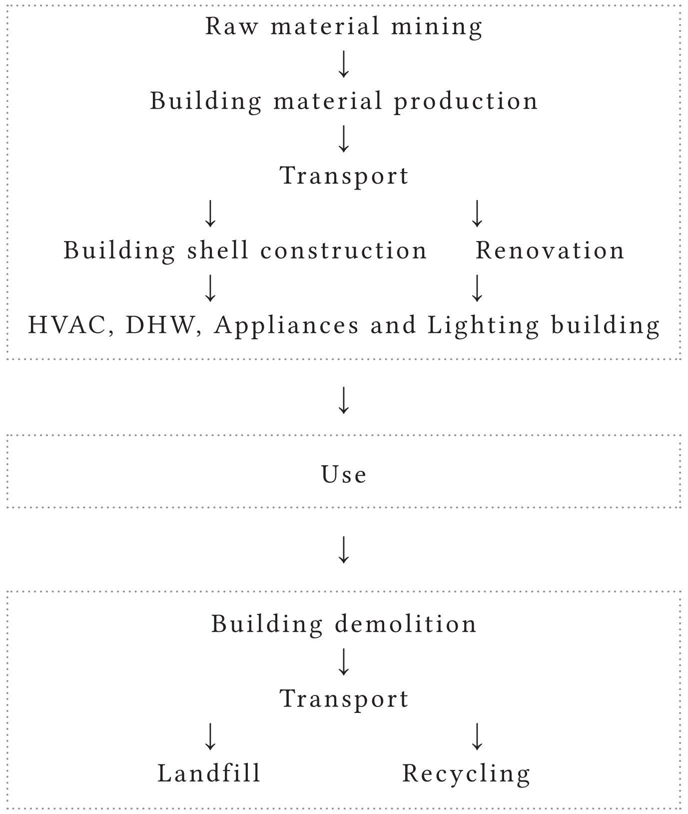
Circular flows:
Glass → *Sorting, melting* → Glass
Biological waste → Biogas or fertilizer
Corrugated cardboard → *Sorting, shredding, compaction* → Corrugated cardboard
Metal → *Sorting, shredding, smelter & steelwork* → Metal

Declaration:
Matter → *process*

The most resource preserving application is to use the material in its original stage and thereafter at the earlier stages in material flow. The worst-case scenario is as expected incineration without recovery or landfill. Nevertheless, this is the termination of most materials.

Lifecycle of conventional buildings

The lifecycle of conventional buildings is described in the article Life cycle assessment (LCA) and life cycle energy analysis (LCEA) of buildings and the building sector: A review in the journal Renewable & sustainable energy reviews.



Financial fluctuation

Designs from reused materials calls for individual solutions and craftsmanship in design projects. Furthermore, statistics show that material and labour costs constitute 40 % each of the total building cost (Sveriges byggindustrier, 2019), in a Swedish context. By using primarily waste- and reuse-materials, the proportions between material- and labour-costs will shift. This gives the opportunity for the proprietor to build some parts by themselves, to reduce the projects total building cost.

The construction industry and production in generall, is controlled by economical growth, where the norm is cost-efficiency and prefabrication in different scales. Reusing building materials break the linear system into a circular design system.
No reused materials are copies of each other and reusing construction elements depend on what's availiable right now, in the context of the project.

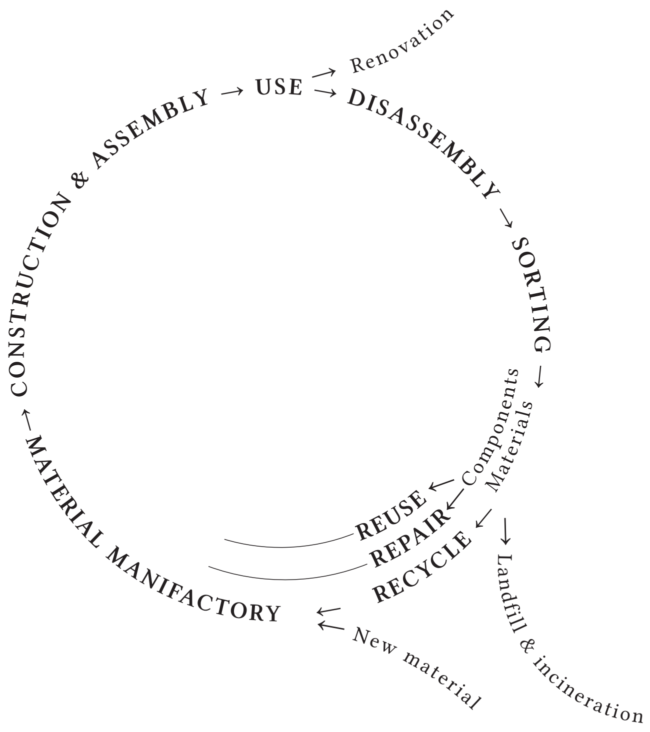
What is local?

What is then local and locally harvested materials? The word "local" can be used when talking about a neighbourhood, a city district or a national region and the term's definition is simply depending on the situation. However, LEED's definition of regional materials abides as:
"Building materials or products that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of the project site for a minimum of 10% or 20%, based on cost, of the total materials value." (Morton, 2013)

The radius of 800 kilometer based on the project's site, reaches to Umeå in the north and almost all the way to Prague in the south. The question of what's local leads to another question, "what is the sustainable way of using materials?", which this thesis digs no further in, and leaves open. However, all reused materials in the design project is harvested from the southern half of Sweden.

Circular design

A circular design system repair, reuse and recycle buildings and building materials which is research preserving, reduces waste and emissions and increase local employment, that contributes to the reduced climate effects from the project and strengthened local economy. (Gorgolewski, 2018)



What is waste?

The Swedish national encyclopedia defines waste as "*Quantities of useless or used objects*" (translated by author) which lays the value of objects in the eye of the beholder.

Reuse & recycling

The terms reuse and recycle are differentiated and the first-named is defined as "*Use again or more than once.*" and recycle as "*Convert (waste) into reusable material.*" both defined by Oxford Dictionaries.

Practice - examples

Traditional & local reuse in Zheiiang

The building technique wapan was developed in the rural areas in the province of Zheiiang, China as a response to frequent occasions of typhoons. The construction technique allows the citizens to quickly rebuild their homes from the ruins after the storms, by placing random, reused tiles and bricks on top of each other, without any masonry. The method creates strong walls, which are rather resilient to distresses. The excluding of masonry brings great benefits when rebuilding and reusing the blocks. (Golden, 2012)

Earthbag construction

Filling bags with sand, earth or whatever material is available on site is a technique which traditionally have been used to build military bunkers and as protection of flooding. The production and construction emit minimum amount of CO2 and can be disassembled and reused or return to sand or earth.

Couze et St Front

The small town Couze et st front is located 100 km east of Bordeaux and was originally the settlement around a papermill. The original small cottages were shared by two to three mill-working families with separate entrances. As the population's conditions improved, the houses were refurbished, but with minimum encroachment of the original esthetics. Old openings, beams and mixed materials are still visible as a trace of times past, on the facades and wall around the small town. The pictures above present facades from the village.

Villa Maria

A private residence designed by Mats Fahlander located in the wild nature outside of Stockholm. The building is placed to make minimum damage on the site. Due to the narrow budget, simple materials and tow tech solutions are used with great detail to highlight the materiality.

CONTEXT

The region

The region of Bohuslän is in south-west Sweden, along Skagerrak sea. The area is primary known for activities along the cost, such as fishing and cold baths. The region's largest cities are likewise situated along the cost: Kungälv, Lysekil, Marstrand, Strömstad, Uddevalla, Stenungsund amongst other. The areas to the east and inland are less known and with fewer tourists. The green areas consists of agriculture and generous forests with crossing tracking trails, such as Bohusleden who extends across the whole region.

The proposal in this project is situated on a site referred to as "Hålan", beside the lake Hällungen, 14 km east of Stenungsund.

History & tradition

The municipality of Stenungsund's comprehensive plan for 2019 describes the history and tradition of the municipality of Stenungsund as a recent development. Historically, the region was sparsely settled with agriculture and forestry. The early settlement Stenunge by (that later developed to Stenungsund) was first mentioned in 1388. The region slowly grew to a trade-node, but it was not until the middle of the 1900s that the region expanded to a level close to the development of today. The development during the mid-1900s included industrial buildings and housing which led to a massive settlement and an unusually young population. Agriculture was still a common occupation as well as the newly developed industry such as herring conservation, the chemical center and the power station.

Traces from the past are still present in the countryside, where settlements and barns from early agriculture are used as housing.

Site of the project

Both the material mapping and design project are based on a site located outside of Stenungsund, next to the lake Hällungen, where a scout-organisation owns a property, "Hålan", of 7 hectares of land and a small cottage. The site is today primarily used for hiking-camps and is often left empty. However, the site has many passers-by, due to crossing walking trails and its vicinity to the hiking trails Bohusleden and Kuststigen. Development of the plot is valuable for the organisation who requires more space and extended functions, but also for the public, who could use shelter and outdoor spaces, collect fresh water and rent the space when its unoccupied.

Scale 1:200 000

Fig. 1 ©Lantmäteriet I2018/00069

A. The path leading to the site during winter.
B. When entering the site, the path disintegrates to a meadow. The existing cottage is located to the right.
C. The existing cottage by fall.
D. View looking at the placement of the project.

Entering the site

The site is situated isolated from large-scale infrastructure, and is easiest reached by car via narrow graveled roads, and the last part slowly by car or by foot. The last part of the road is owned by the organization and has no other maintenance. Due to the narrow road and the sloped topography, no large transportation vehicles can deliver construction material to the address.

The last two km are usually reached by foot, with nature closely present, by sight, smell and sound. Due to the narrow path, the trees overhang the path, and filtering the sunlight through the branches. When reaching the site, the path disintegrates to a large meadow. which is divided to two by some threes and a brook.

Nature

The nature around “Hålan” has a generous biodiversity with different ground types, vegetation species and wild animals. The topography is rugged and often sloped due to the rocks of gneiss and granite. Pockets in the rock is replete with soil, which nourish the diverse vegetation. Most of the forest consist of pine trees, except along the lake, where the majority of the trees are young and have leaves. Along the shoreline wild reed occur. The meadow is the remain of previous agriculture and animal keeping, and is covered with high grass. The field has contracted over the years and is nowadays divided by two, separated by sparse birches. The nature reserve by the mesa “Börs flåg” is the view across the lake.

Comprehensive plan & regulations

The site is not included in the Comprehensive plan for development, and is claimed as water protection area. A shoreline protection is stated 100 m from shore, and an it’s an ongoing investigation towards an enlargement to 300 m border. The existing house is located 100 m from the shoreline.

Scale 1:50 000

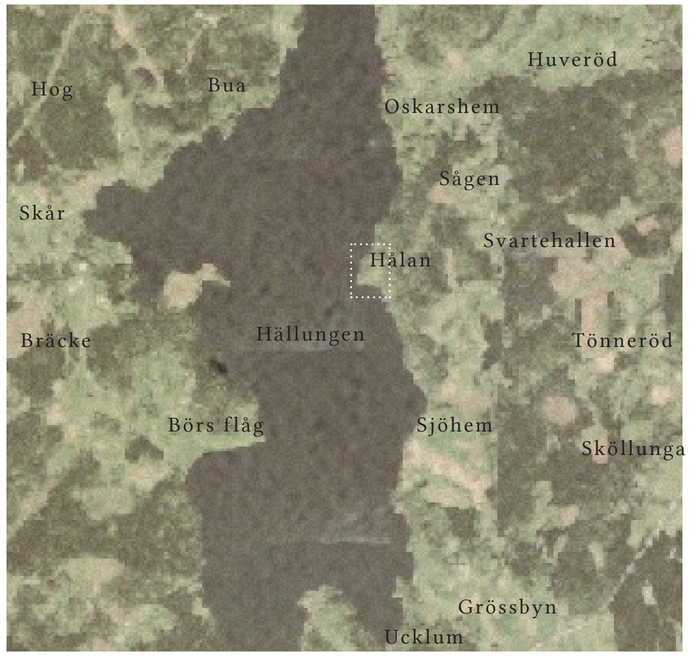


Fig. 2 © Lantmäteriet I2018/00069

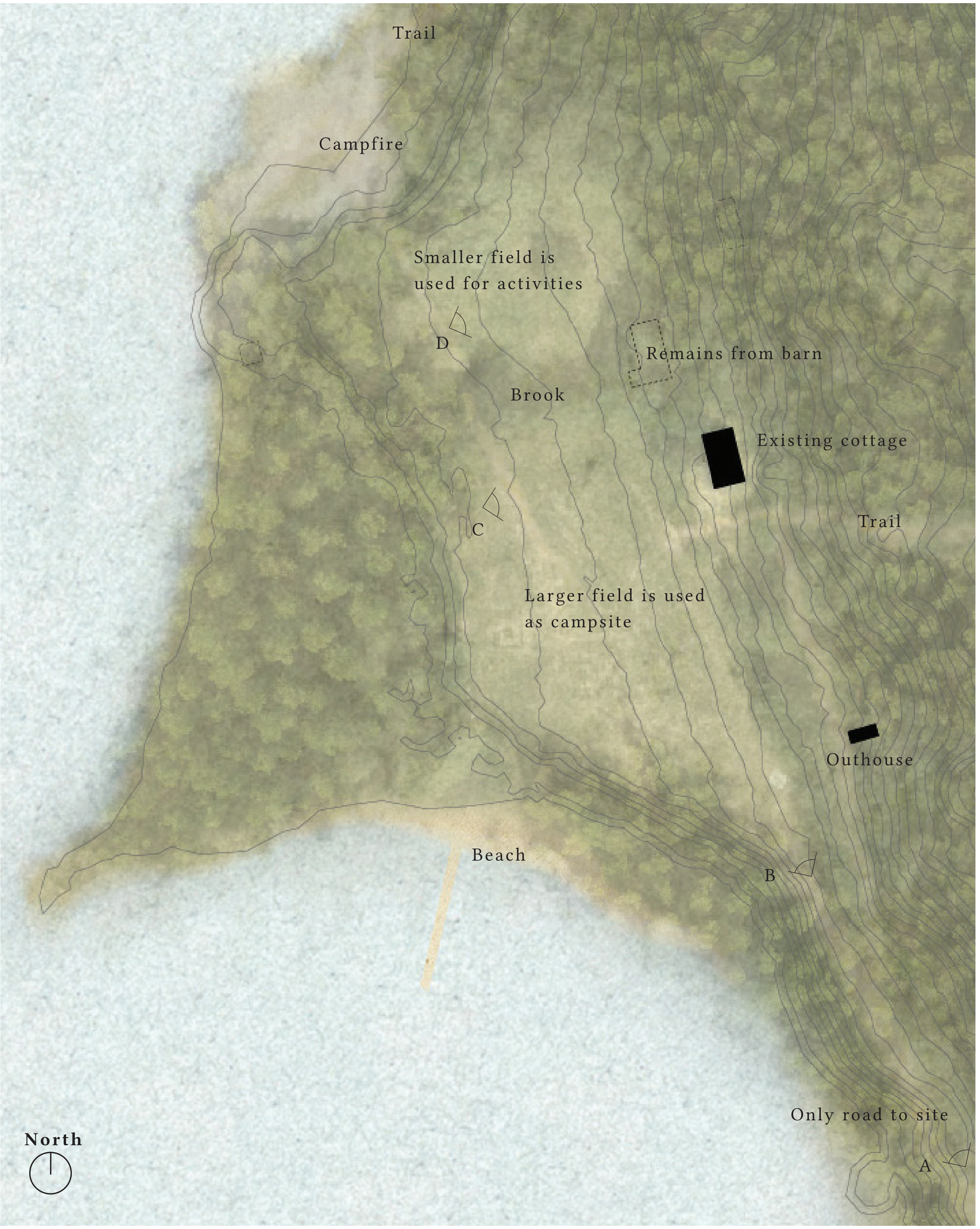
Trekking trails

The famous trekking trail Bohusleden is parallel to the lake, but lays 5 km east of the site, and Kuststigen lies about the same distance north of the site. Neither of the trails pass the site, but the surroundings are known for the wild nature and rich paths. The site is tied by three paths leading to Sjöhem, Sågen and Oskarshem, which in turn are connected to a wide network of local trails across Västra Götaland. Even though the paths crossing the site aren’t named, they’re visited daily by trekkers and passersby. The largest path cross both of the fields, from north along the lake, to the road in south. Another trail leads east and starts just behind the cottage and is further up the hill split in two, both leading around the top of the hill.

Personal connection

I was aware of the site and its users, since I was active in the scout organisation during my childhood. I’ve attended a handful of hiking camps and planned and lead two of them as well as I’ve inhabited the cottage during many weekends growing up. The development of the site and the preservation of the collaborative and communion culture lies dear to me.

Scale 1:1500



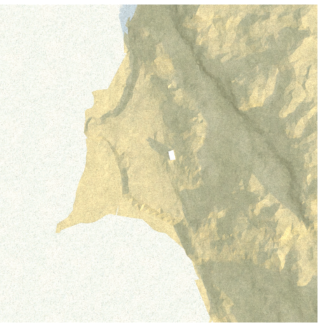
Seasons

The program for the site is focusing on outdoor activities, around the year. For that reason, the weather is an important factor to consider the development of the site and its buildings. Site visits was carried out in November, January, April and June. Implementations from the varying experiences during the site visits formed the program and placement of buildings.

Average temperatures

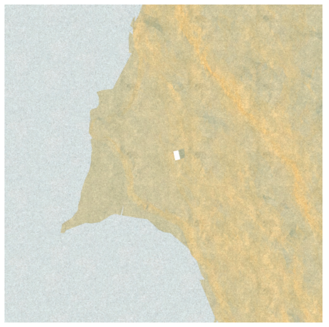
Jan	0 - 2	Jul	18 - 20
Feb	-2 - -4	Aug	16 - 18
Mar	-2 - 0	Sep	12 - 14
Apr	6 - 8	Okt	8 - 10
Maj	14 - 16	Nov	4 - 6
Jun	16 - 18	Dec	2 - 4

The pictures are taken from the path to the site, towards the mesa Börs flåg.



March - 08:00

March - 12:00



March - 17:00

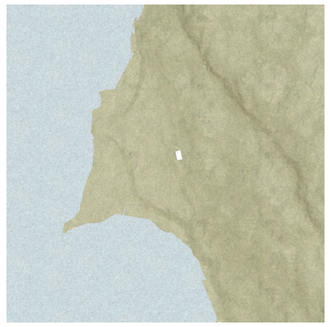
July - 06:00

July - 11:00

July - 17:00

December - 09:00

December - 12:00



December - 14:00

Sun study

Sun rise & set

Jan 1st	08:58	15:32	July 1st	04:15	22:17
Feb 1 st	08:17	16:34	Aug 1st	05:06	21:30
Mar 1 st	07:06	17:42	Sept 1st	06:12	20:12
Apr 1st	06:40	19:51	Oct 1st	07:18	18:45
May 1st	05:18	20:59	Nov 1st	07:27	16:24
June 1st	04:19	22:01	dec 1st	08:34	15:28

The scout-union of Långedrag

The site is owned by the scout-organisation *Långedrags sjöscoutkår*, whom use the site for camps for scout patrols, all over the year. The largest camps are arranged for about 100 children and 20 adults in the late spring. The existing cottage can room about 20 people, and during larger camps the participators are staying in tents and windshields. During the larger camps, the scouts build up temporary settlements with dining areas, outdoor kitchen, portals and other structures that are disassembled at the end of the camps. The material used is most often reused multiple times and the scout-community is skilled at collaborative activities.

The organisation wish to improve the estate on site to upgrade the temporary residency. There are some problems with the existing infrastructure on site: the cottage is out-of-date and needs refurbishment, installation of water closets and drainage and accessibility adaptation. Even with a refurbishment there is a need for a larger building that can house more people.

Requirements specified by the administration of L-sjö:

40 non-prearranged sleeping places (floor space)
10-20 beds
Dining area for 60 persons
Kitchen to provide for the same amount of people

Self construction

Due to the fellowship of the primary users of the site, it is possible to assume that the building on this site can be partly built by volunteers. The maintenance of existing buildings and boats within the organisation is managed entirely by volunteers. The weekly activity-based building, located in Gothenburg was built by volunteers and students from a construction high school. The weekly activities are run by volunteers, and the economic situation is tight, and therefore, the situation is ideal for construction with reused material: it's cheap but requires more craftsmanship and engagement for both the preparatory work with collecting materials, and during the construction.

Temporary design

Examples of temporary construction built on the site are tables, windshields, chairs, portals, kitchen, place for dishes, to mention a few.

Hikers and other visitors

The site is not only used by the organisation, but also by passers by and hikers due to trails crossing the site. Therefore, the site is not private the way a home is, the new design propose to welcome passers by to use some functions and spaces, such as lookout, shelter and water supply to utilize the attractive nature on and around the site. The program of the new building additionally provide possibilities to rent out the full building or parts of it then the organisation isn't attendant.

Theoretical timeline

Gather interested parties & actors

Collect materials
    Develop system to gather materials
    Storage for harvested materials - use the existing building on site
    Harvest materials
    Quality control
        Process & repair
    Experiments & investigations - characteristics & properties
Thesis includes

Hire professionals
    Establish roles & responsibilities

Site
    Establish program
    Analysis of the local and broader context as well as culture and history
Thesis includes

Finance - secure funds

Design proposal
    Form follow material
    Design for disassembly
Thesis includes

Project planning

Establish construction schedule

Groundwork

Construction
    Temporary constructions
    Sleeping cabins
    Main buildings
    Observation tower
    Sauna

Disassembly

Move / sort reusable materials

Construction

Disassembly

Sort reusable materials

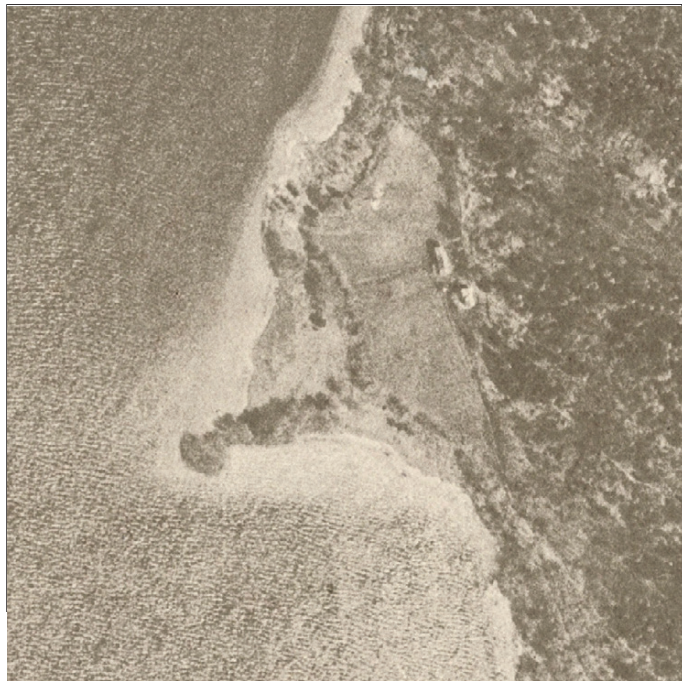


Fig. 3 Satelite photo from 1960. © Lantmäteriet I2018/00069

Fig. 4 Satelite photo from 2018. © Lantmäteriet I2018/00069

Traces from the past

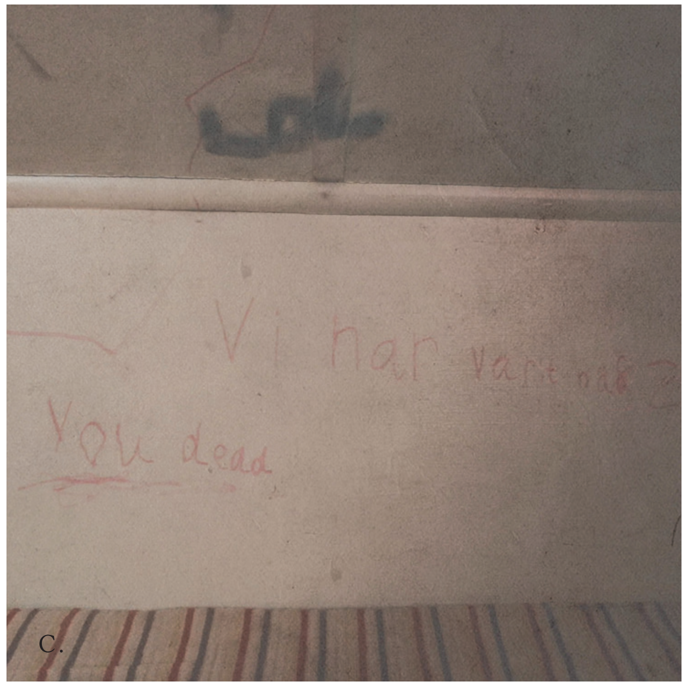
According to documentation preserved by Scoutmuseet Göteborg, the site has been settled since 1787 as a solider cottage. Solider cottages were usually 7x4 meters large and founded by the local army unit and habited by lower-class farmer families in exchange for the husbands voluntary service in the military unit (I. Karlsson, 2004). According to documentation by Scoutmuseet Göteborg (2018-02-04), least three solider families cultivated the site between 1787 and 1830, admitted in Fräkne Kompani, within the regiment of Bohuslän. Thereafter, according to L. Johansson (personal communication 2018-02-04) was the property presumably privately owned until it was bought by the parental-cooperative within the scout organization of Röda Sten in the 1950s. Orthophotos from Lantmäteriet show a barn, also documented on photos in Scoutmuseet, used for cows according to L. Johansson (personal communication 2018-02-04) but was demolished between 1960-1975. Traces from the foundation are still visible on the site.

Culture

The site has been used by scouts for the last 50-70 years, and it has been owned by different scout-organizations. Maintenance is carried out by cooperated volunteers. The scout-culture is built on teamwork within care, creation, knowledge about the nature - cross generational.

The fields beside the lake are used to establish a temporary settlement during camps for approximately 120 people, were the group together build accomodations, outdoor kitchen, dining area and so on. The camps are for a few days, and when the scouts leave the site, all structures are disassembled and gathered, so the construction material can be used again for next camp. This goes in circulation.

The social culture ought to be considered, in the program development, large scale planning and in the detail designs. The will to create, preserve and develop can be used as a valuable tool for participatory design and self-construction.



A. Remains from the old barn: foundation and a pile of old roof tiles.
B. Stuff around the site.
C. Writing on walls in the existing cottage. The loft is filled with names and years: a logbook-wallpaper.
D. The site is full of inventive low-tech temporary structures to ease the outdoor life.

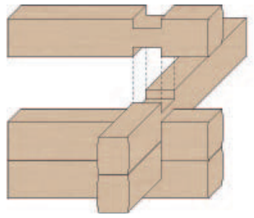
MATERIAL PALETTE

The material mapping for this project focus on materials usable (defined by the author's perspective), within building constructions. The mapping focus both on materials that could be used in its existing shape or that through a light process can transduce to usable a material.

The search for available materials were via mediums accessible for private persons, during a 10 month period. Mediums used were online advertisements from business and private persons, second hand stores, mapping of buildings to be demolished, waste materials collected on recycle centers and biproducts from industries.

The material palette presented below, includes only a few of the materials and components that's available in a Swedish context. However, these materials were the conditions and framework used for the specific design proposal of the thesis.

The evaluation is set from my own perspective, and doesn't apply to a scale. For example the price designation "low" means that it is remarkably lower than the price for the new product. The estimation regarding amount is subjectly rated based on the frequency of advertises and availability on second hand stores.



Timber constructions

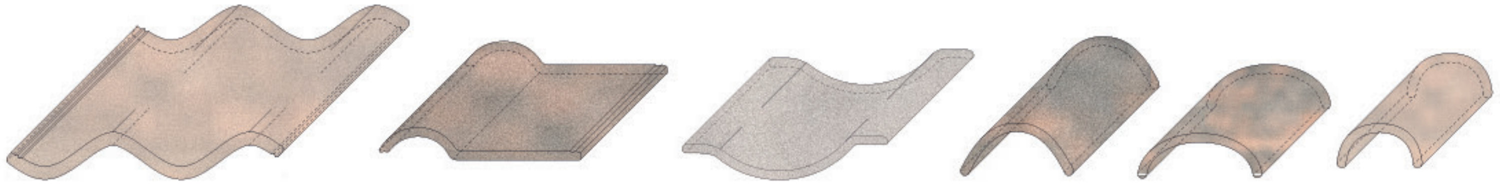
Plan: rectangular
Matter: timber
Colour: light wood
Dimensions: varying: length=4200-6000 mm, width=5400-7500 mm
Harvested: private persons
Price: demounting & shipping costs
Amount: common in ads online
Lifelength: > 100 yrs

Wooden planks

Cross-section: varying standard sizes
Matter: pine wood
Dimensions: length < 3 m
Harvested: private persons & recycle centers
Price: free
Amount: very large volumes
Lifelength: > 100 yrs

Wooden chippings

Cross-section: varying
Matter: wood
Colour: mixed
Dimensions: ~ 30x30 mm
Harvested: recycle centers
Price: free
Amount: very large volumes
Lifelength: > 100 yrs
Comment: difficult to obtain due to regulations



Tiles #1

Cross-section: sinus curved & S-shaped
Matter: scorched clay
Colour: terracotta
Dimensions: varying (~420x340)
Harvested: private persons
Price: free or very low
Amount: large volumes
Lifelength: > 100 yrs
Comment: tiles produced during WW2 lack quality (Byggnadsvårdsföreningen, 2018).

Tiles #2

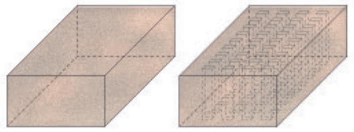
Cross-section: sinus curved & S-shaped
Matter: concrete
Colour: gray
Dimensions: varying (~400x300)
Harvested: private persons
Price: free or very low
Amount: large volumes
Lifelength: < 100 yrs

Ridge tiles

Cross-section: U-shaped
Matter: scorced clay
Colour: terracotta
Dimensions: varying (~420x250)
Harvested: private persons
Price: free or very low
Amount: meduim volumes
Lifelength: > 100 yrs
Comment: limited amounts of identical dimensions

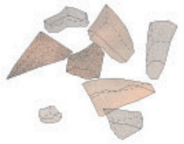
Floor tiles

Cross-section: rectangular
Matter: concrete
Colour: gray
Dimensions: varying (~400x400)
Harvested: private persons
Price: free
Amount: large volumes
Lifelength: < 100 yrs



Bricks

Cross-section: rectangular
Matter: scorced clay
Colour: terracotta
Dimensions: varying (~250x120x60)
Harvested: private persons
Price: low
Amount: large volumes
Lifelength: > 100 yrs



Crushed masses

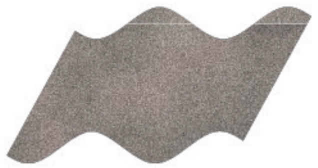
Cross-section: irregular
Matter: ceramics, porselain, rock, bricks, concrete
Colour: varying
Dimensions: varying
Harvested: private persons, demolished buildings & recycle centers
Price: free
Amount: large volumes
Lifelength: eternal / varying
Comment: often unsorted and mixed materials and sizes

Fire wood

Cross-section: varying
Matter: timber
Colour: mixed
Dimensions: ~ 300x10x10 mm
Harvested: private persons
Price: low
Amount: very large volumes
Lifelength: > 100 yrs

Bark

Cross-section: irregular
Matter: timber
Colour: dark brown
Dimensions: 10 mm^2
Harvested: private persons & recycle centers
Price: free
Amount: very large volumes
Lifelength: > 100 yrs



Corrugated sheets

Cross-section: sinus curved
Matter: steal, aluminium & ployester
Dimensions: varying
Harvested: private persons & recycle centers
Price: low
Lifelength: > 50 yrs

Crushed glass

Cross-section: varying
Matter: glass
Colour: brown, green, transparent & blue
Harvested: from recycle centers
Price: free
Amount: very large volumes
Lifelength: < 100 yrs
Comment: difficult to obtain due to regulations

Textiles

Matter: textile fibers
Colour: all
Harvested: secondhand stores, recycle centers
Price: low
Amount: large volumes
Lifelength: > 50 yrs

Furnishings, doors & windows

Harvested: from private persons, second hand stores & demolished buildings
Price: free - exclusive
Amount: very large amounts
Lifelength: > 100 yrs

EXPERIMENTS

Experiments were made with materials from the material palette with the purpose to construction alternatives, test quality, aesthetics, functions, compositions, form finding and spatial relations. I limited the project to only use processes that an “amateaur” could accomplish, partly for being able to do all experiments by myself, but also so that the result could be at least partly self constructed, since that is one of arguments for the thesis statement. The experiments were the second step of the development of the palette and framework for the design proposal. Not all of the experiments or materials are used in the design.

#1 Terrazzo boards

The terrazzo boards are made from cement and ballast, and can be produced without industrial tools or knowledge. The terrazzo boards in this experiment used reused crushed materials as ballast. After the board are dried, they must be polished to achieve a flat surface. To get a smooth surface different fineness of sanding is used, however, in this example only the roughest sanding tool was used. The tiles are 30 x 30 cm each. The original state of the material is crushed materials, which usually is used as landfill, and when the terrazzo boards are too worn to be reused, the material state will return to being crushed masses. So, the materials cycle is not broken by this use but the cycle has lengthen.

Terrazzo 1:
Cement
Carbon black pigment
Rusty used bolts
Crushed terracotta tiles

Terrazzo 2:
Cement
Oxide yellow pigment
Crushed tiles in terracotta & white clinker
Used staplers

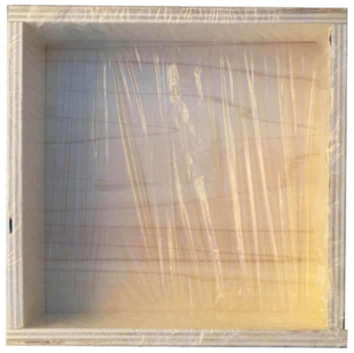
Terrazzo 3:
Cement
Brown & green crushed glass

Terrazzo 4:
Cement
Red pigment
Carbon coal
Crushed porcelain

Bearing capacity:	yes
Water repellent:	if treated
Knowledge requirements:	none
Handwork (time):	relatively extensive
Material cost:	< 5 kr / plate
Costs for tools:	approximately 10 000 kr total
Material accessibility:	accessible
Maintanance:	none
Demountable & reusable:	reverts to crush masses

Process

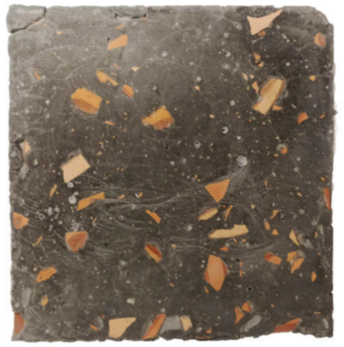

Mixture: cement, pigment & ballast


Mold form, wrapped in plastic


Poured in mold


Battered to loose bubbles


Dried plate


Roughly sanded with concrete sanding mashine

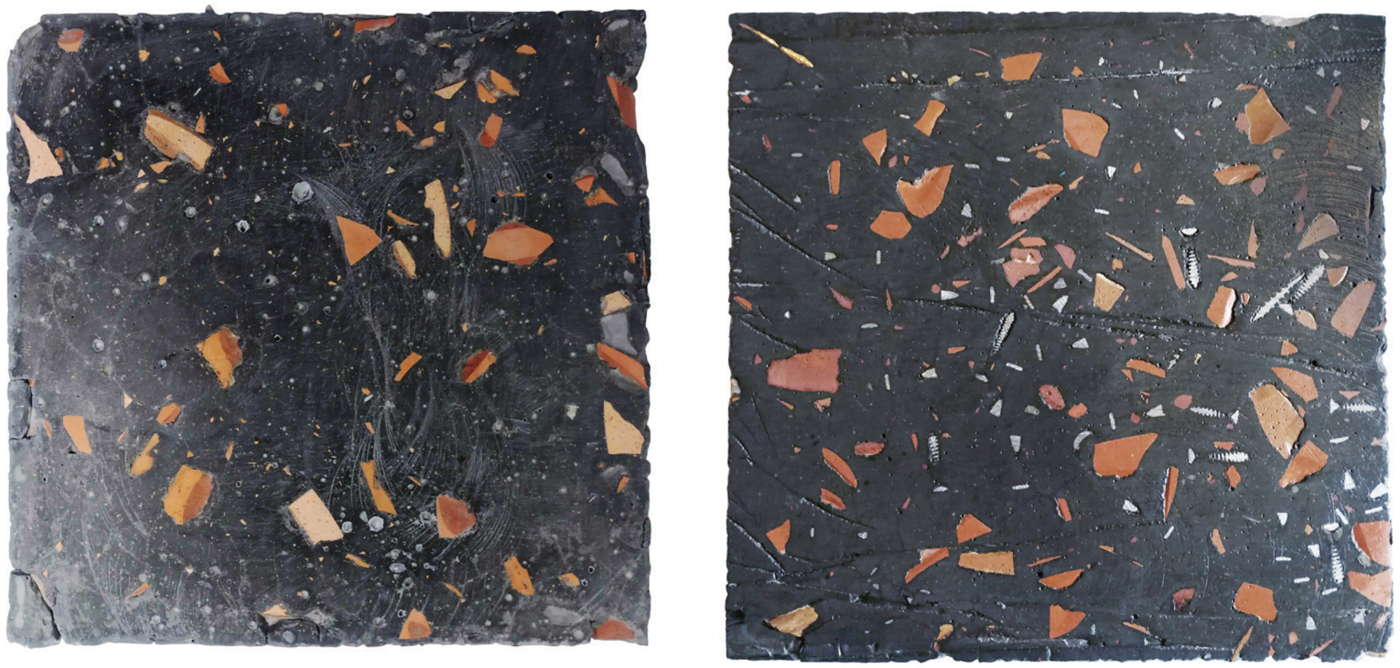

Fine sanded with sanded paper by hand


Treated with paraffin oil to avoid dust emissions

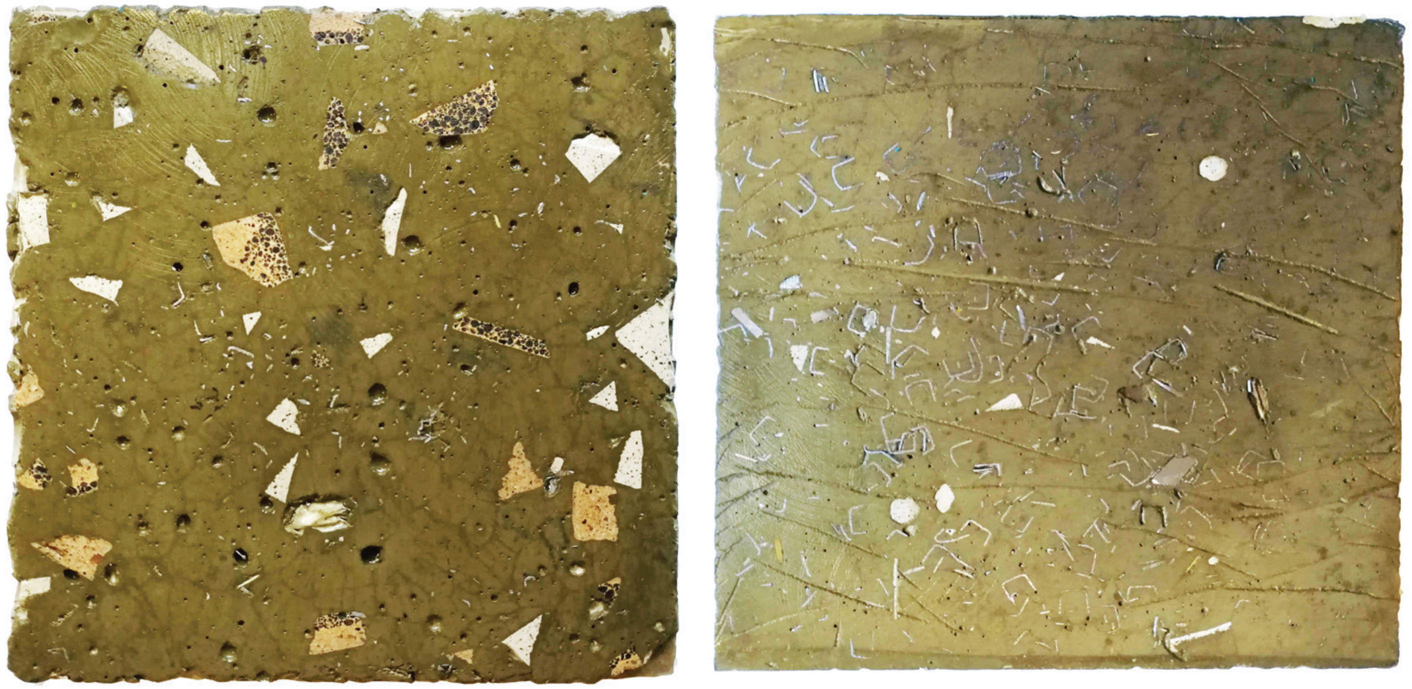

Finished plate

Top

Bottom



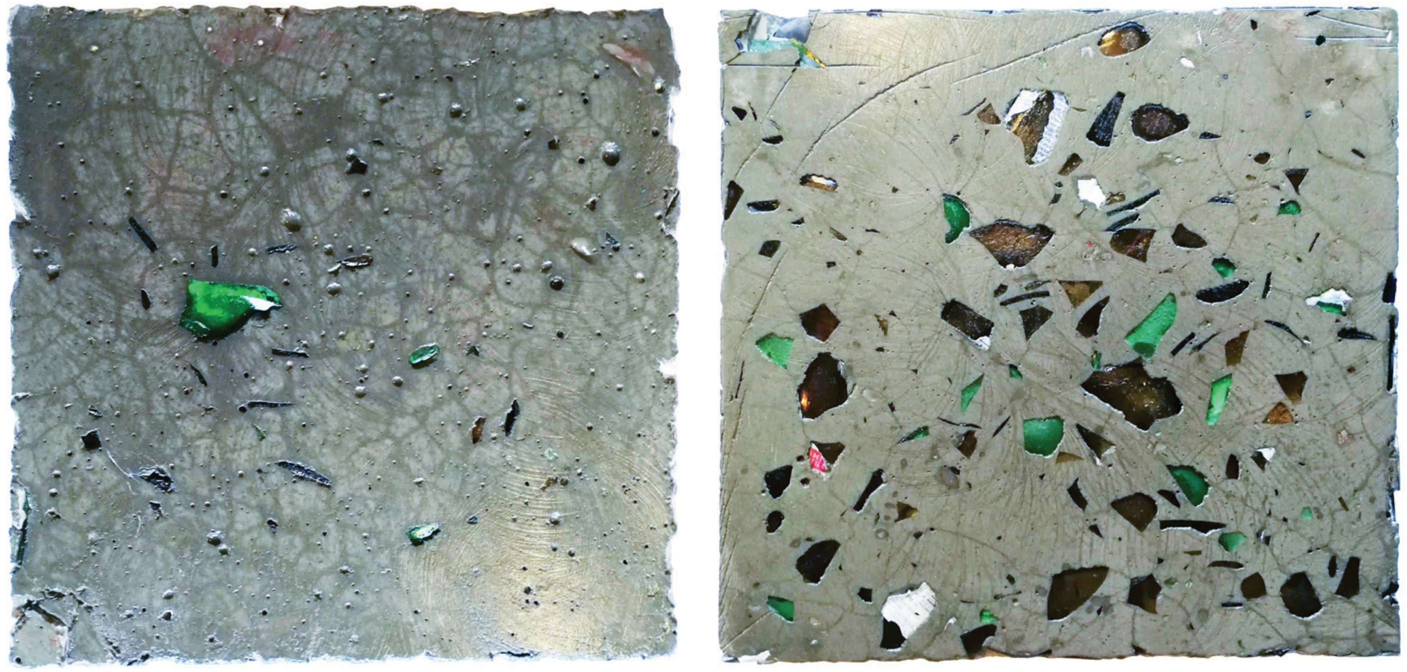
Terrazzo 1



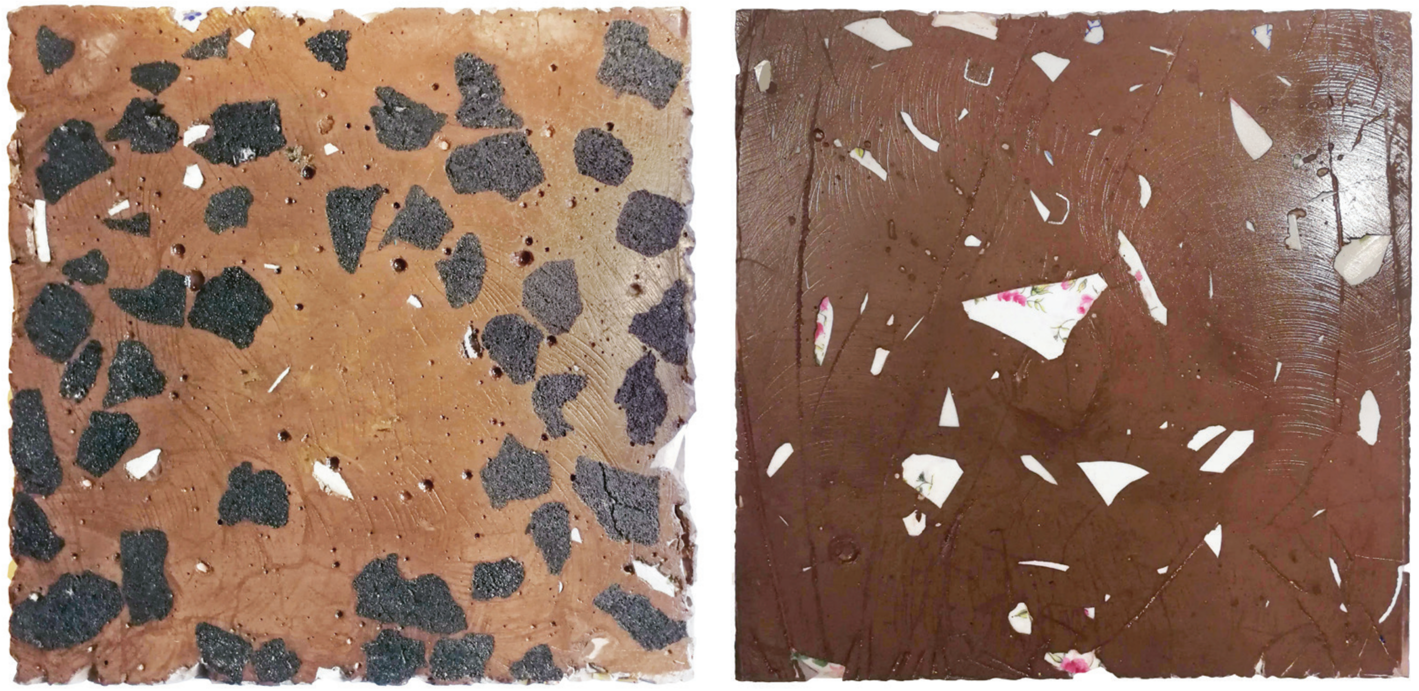
Terrazzo 2

Top

Bottom



Terrazzo 3



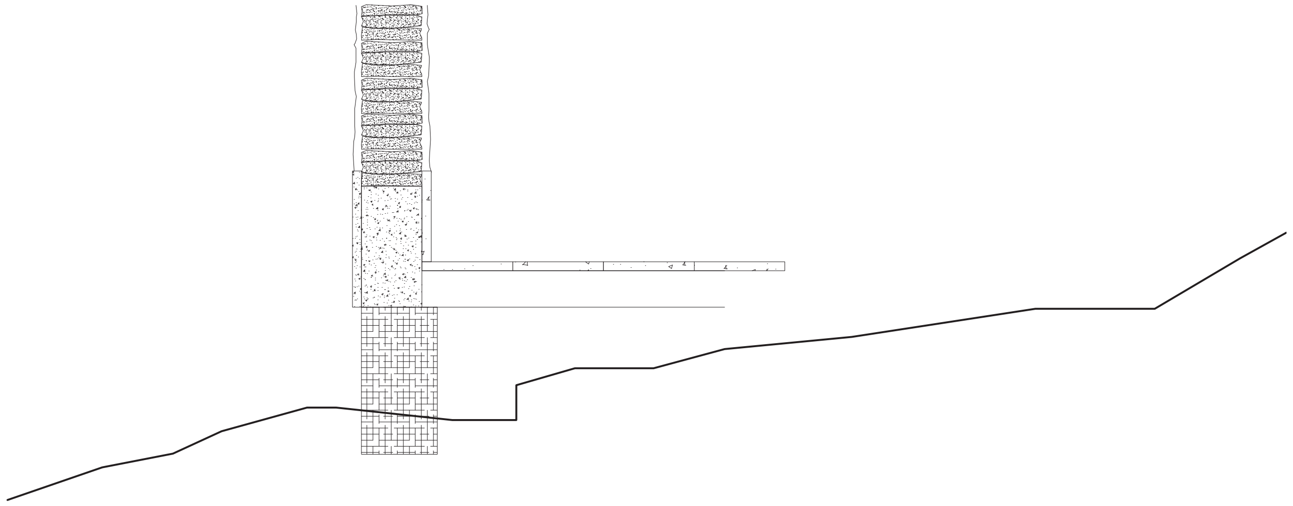
Terrazzo 4

#2 Bags of crushed masses as bearing construction

The first try with earth bags were made with two equal pieces of fabric. The result was rather unstable for construction, as the higher the wall grew, the structure became unstable. Another test were thereafter made.

The second test of bags were made of two equal pieces of fabric, and with a thin ribbon on the sides to distribute the content more evenly. The adjustment stabilized the construction considerably, but simultaneously aggravated the production.

1:25



Wall construction

50 clay plaster	[RC]
200 bags of crushed materials	[RC]
50 clay plaster	[RC]
30 terrazzo boards	[RC]

#3 Wood experimets

Reused dovetailed timber construction

Uncladded exterior

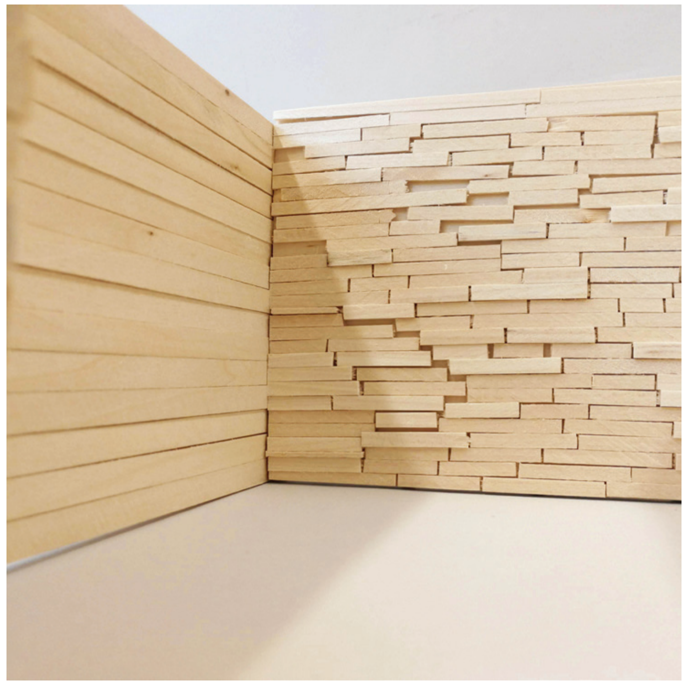
Uncladded interior

Secondhand shelf

Secondhand shelf

Photoshoped with firewood and loft bed

Reused short wooden planks



Cladded with short pieces of wood, randomely

Cladded with short pieces of wood, organized

Timber constructions usually has subsidence after a time, nevertheless, it's rather common to move timber constructions from one site to another. With today's requirements on heat resistance the timber it self is not enough as insulation. Therefore additional wall-layers is must for new constructions and the timber can only be visible either exterior or interior.

The tests the impression with either solid timber or with different types of cladding. The experiments were made physical and digital.

One issue with reusing short pieces of wood and placing the randomly, is the high of nails or bolts necessary. However, if the pieces are sorted it's possible to construct with fewer nails. In these model only glue was used. The following experiments had therefore focus on how to reuse pieces of wood with different lengths without over-consuming nails, bolts or glue.

#4 Bearing construction from reused wood planks

The reusable pieces of wood are of different lengths and cross-sections, therefore it's beneficial to find ways to use different sizes for different purposes. In the experiment above, large and long latches were mounted together three by three with a rail to fit on top of each other. The structure takes pressure well, but is as one component unstable. However, the properties for this construction is very similar to traditional timber constructions, so a similar building structure and joints would presumably stabilize the construction. No nails or bolts are used in this constructions, which enable reuse and recycling.

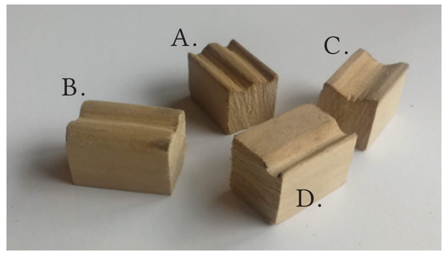
#5 Facade from reused wood without bolts

The next issue to consider, was the very large amounts of short pieces of wood. In the wall detail above, latches > 500 mm were sawed to preceding measurement and placed on top of each other without any nails or bolts in a rail made from longer latches. The wooden pieces are perced by gravity and stabilized by the rail-latches. These latches are bolted into the construction, which enable the facade layer to be changed, which is beneficial partly due to the exposed position, but also since reused materials may have lower quality.

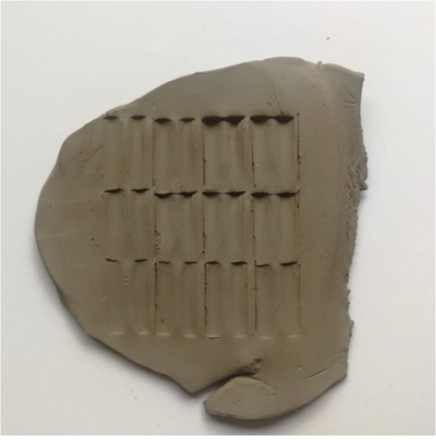
#6 Tile pattern: elevation

Tests of possible tile patterns made from the tiles found during the material mapping.

A. Sinus curved tiles, front
B. Sinus curved tiles, back
C. U-shaped tiles
D. ʔ-shaped tiles




C & D


B.


B.


A.


C.


C.


A.

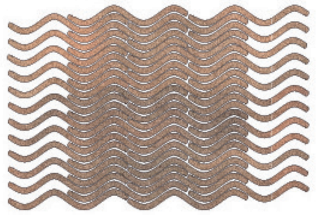

D.


D.

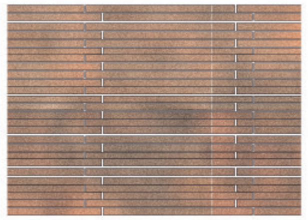
#7 Tile patterns: cross-section

Stacked tiles without mortar

Sinus curved tiles

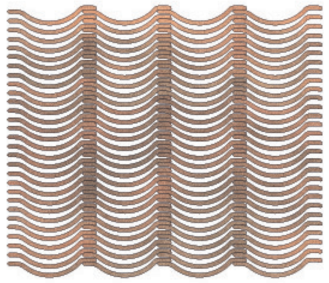


Sinus curved tiles form a closed, wave-shaped pattern. The structure is rater rigid with widespread loads.

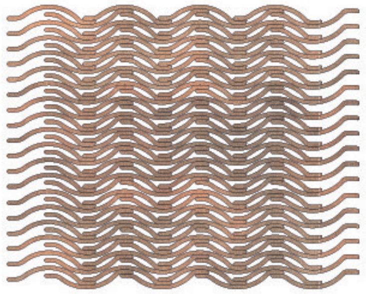


The stack seen from the side. Depending on how the tiles are stacked the horisontal pattern can get verticality.

Wave shaped tiles

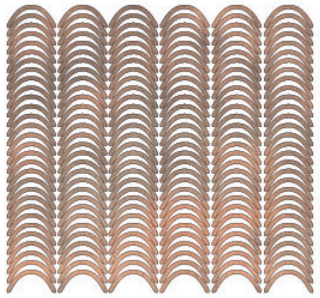


Wave shaped tiles stacked on top of each other, sorted vertically. The joint form a verticality and the tile and space in between form soft horisontal lines.

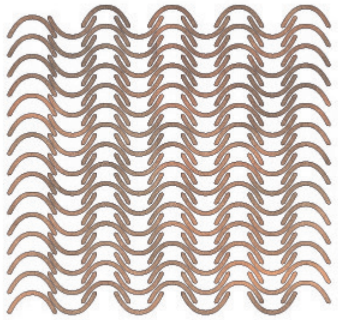


If placed altering on top of each other the pattern act balanced. Both structures are weak due to vertcal point loads, if one tile breaks the loads are unpredictible.

U-shaped tiles

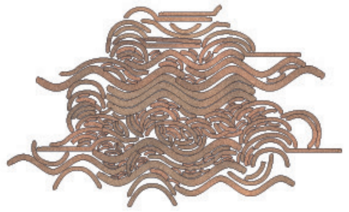


Ridge tiles stacked on piles. The structure unstable to loads from the side.



The stability improves when the tiles are weaved together. However, this structure is weak, and depend on all elements not breaking.

Mixed types of tiles



Mixed types of tiles placed on top of each other according to the traditional wapan technique. The structure is not depending on all elements properties, if one element breaks, the structure would recomposite and slightly shrink.

Reflection

Tiles can create infinite amounts of different patterns to express the tectonics, shapes, direction, colours etcetera. Here I've chosen to display a few of the patterns made by tiles from the material palette. The composition which is most suitable for loadbearing is, as expected, the traditional wapan technique. However, stacked tiles without mortar can be used to create temporary or semi-temporary spaces and landscape architecture. The tile-patterns could also be placed on the ground, with gravel in between to create pattern on a path. The tectonics as well as the construction ought to both be simultaneously considered when composing a structure.

DESIGN PROPOSAL

SITE PLAN

Scale 1:1000

Current use

Today the site is primary used during camps for the scout organisation. The larger, south field, house the tents and temporary constructions such as outdoor kitchen and dining. Activities occur on the smaller, north field, in the forest, by the beach and on the lake. The existing cottage provide the camps with a few indoor sleeping places and complementary kitchen and water.

Site plan, declaration

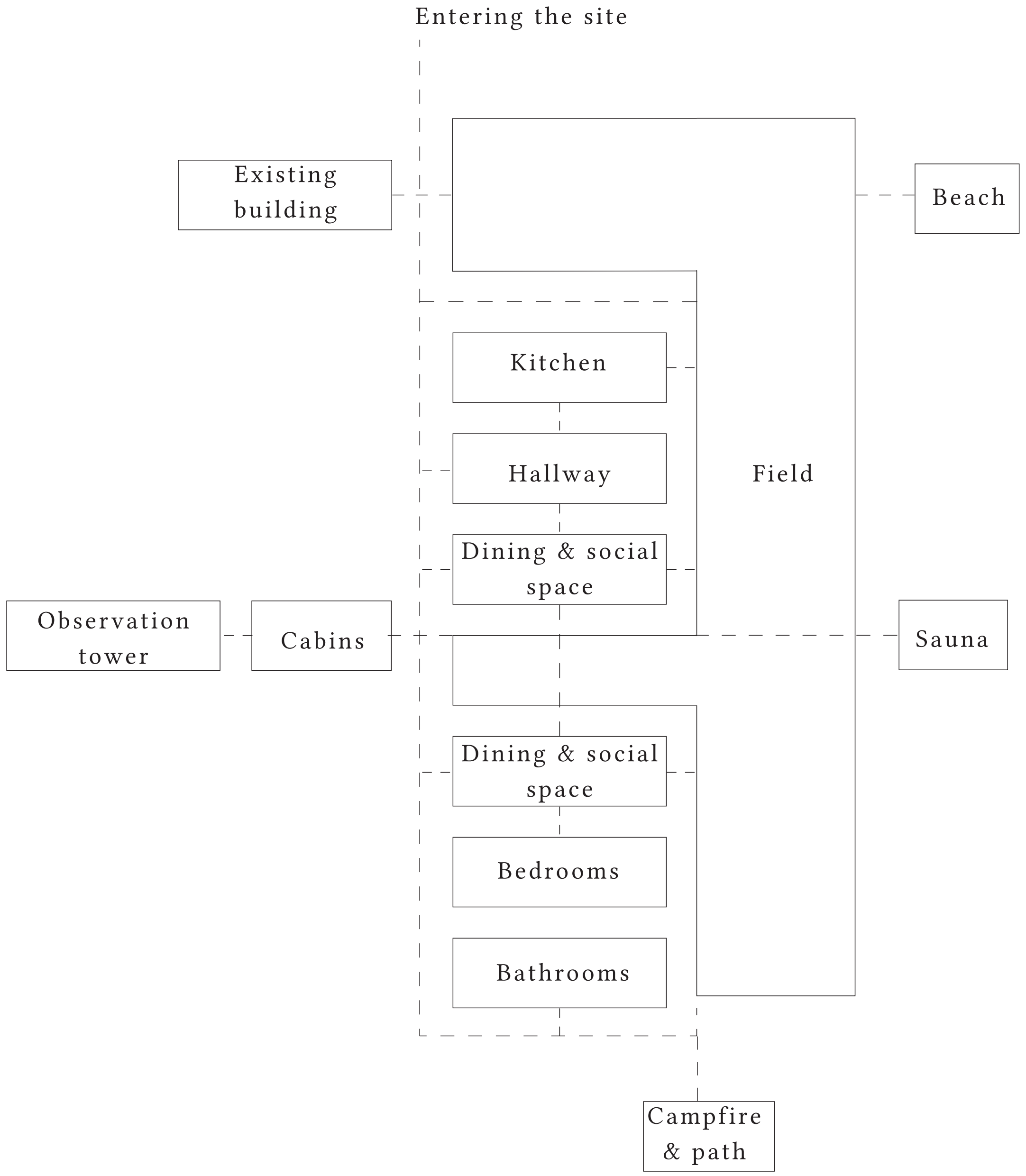
A. Main buildings (230 m^2)
South building
Kitchen, 45 m^2
Social space, 82 m^2
Sleeping loft, 110 m^2
North building
2 Bedrooms, 24 beds, 26 m^2
Social space, 38 m^2
Sleeping loft, 160 m^2
Bathrooms, 16 m^2
B. Cabins (38 m^2)
Sleeping cabins divided into three units
D. Sauna (15 m^2)
Sauna & antechamber
D. Observation tower
E. Existing cottage (160 m^2)
Material storage during the construction, 200 m^2

Additions

The addition includes five buildings with social space, sleeping places, kitchen, sauna and an observation tower. The relation between the buildings is formed by the current flows and use of the site. Hence, the paths connecting the buildings consist of a perpendicular gesture between the functions, who meet by the main buildings. These are placed along the east side of the north field, with view towards the active field, and to the lake. A bit up in the forest, the sleeping cabins are situated, somewhat private from the other buildings and activities. Walking the stairs even further up east, the visitor reaches the observation tower with view over the fields, the forest and the lake. Straight across the stairs and the fields lays the sauna, down by the lake. Many of the functions are separeated since the program is very outdoor and nature focused and benefit from being very close to nature, both physical and visual. Most rooms have more than one entry and exit to provide for both active and more private communications.

This kind of project demands that material is harvested for quite some time to gather enough amounts. Since the existing cottage is of rather poor condition, it could be used as storage until the other buildings are finished, it can thereafter be renovated. Complementary storage could be tents on the field or in the organizations facilities in Gothenburg.

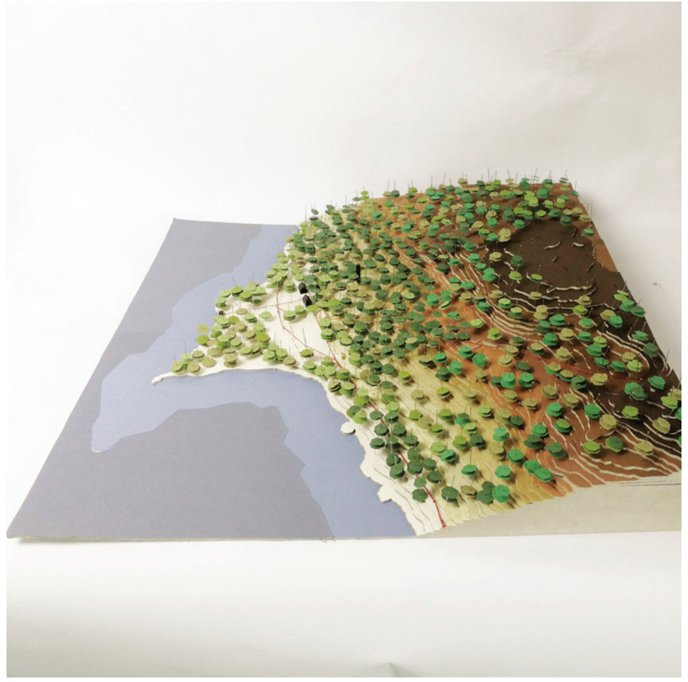
SPACE PROGRAM



☐ Function

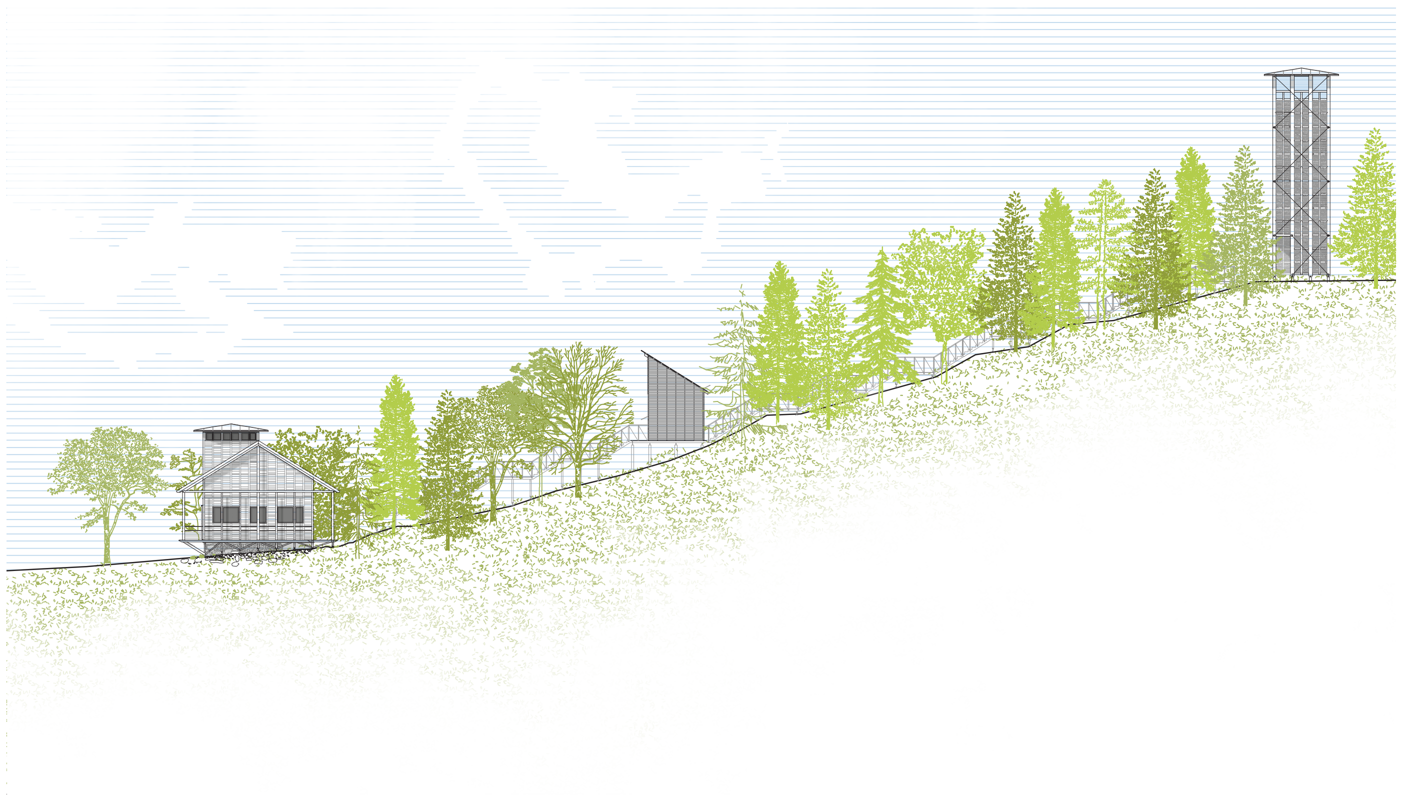
- - - - - - - Communication

Physical model



Physical model

Section S1

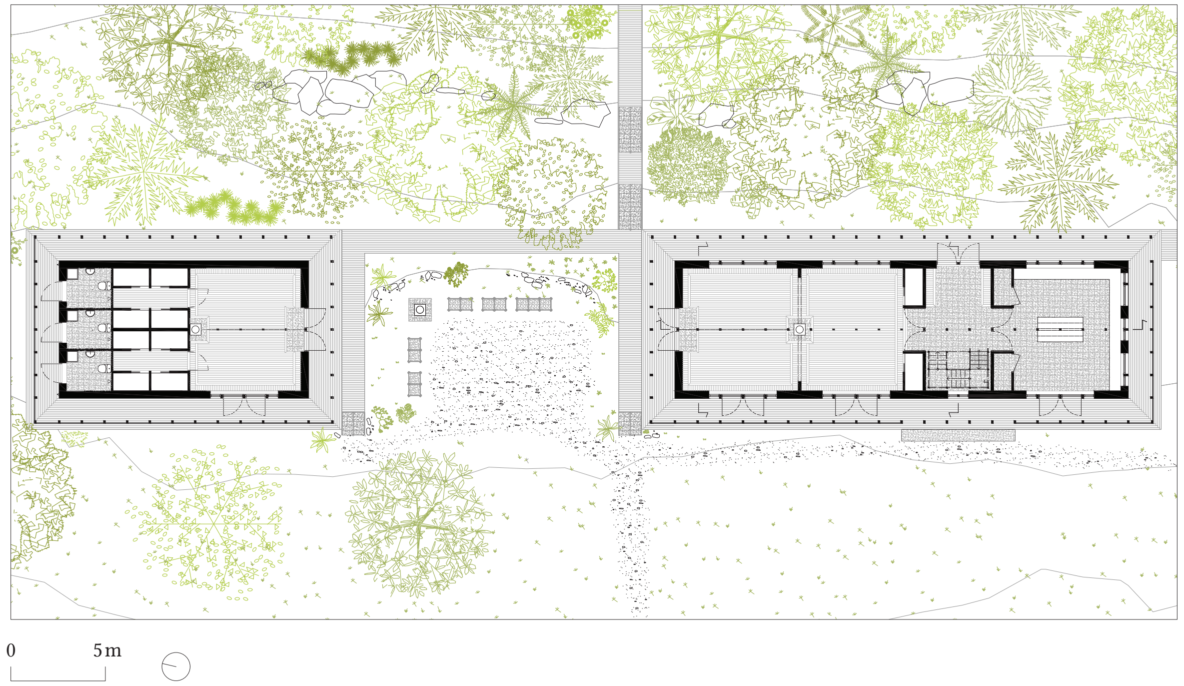


Scale 1:500

MAIN BUILDINGS

Scale 1:400

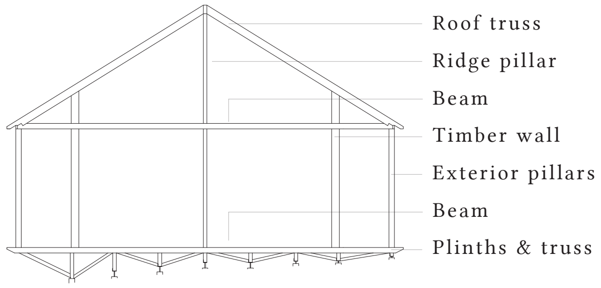
General plan



The two buildings lay along a line in the landscape that extends the walk approaching the site, passing room after room when following the path. The walk alter views to quiet nature, loud plays, cooking, card games and secluded chitchats. The main functions are distributed into two buildings, situated in the center of the scene, where the rooms are placed on a line after one another along the topography, separating private and social spaces, where the social spaces are situated in the center and face each other with an outdoor social area in between. The two volumes mirror each other both by the expression of the opposing facades and by the construction of the units.

The complex is reached either via the planar path who connects the buildings to the existing building and the road, or by stairs to the field in front. The activities on the site are strongly connected to nature and outdoor life, and the relation between indoor and outside is gradually gestured by the arcade around both buildings and large windows and doors.

Both structures are constructed by reused wood, and the rooms are dimensioned based on common sizes of timber constructions. The bearing system is a collaboration between timber walls and a pillarsystem. The roof trusses rely both the timber walls and exterior pillars at the edge of the trusses and pillars which support the 26 meters long ridge. An alternative construction is to remove most of the ridge pillars by placing a glulam beam along the ridge. That alternative is dismissed as the glulam pillar would definately be newly produced and contravenes the concept of the project.



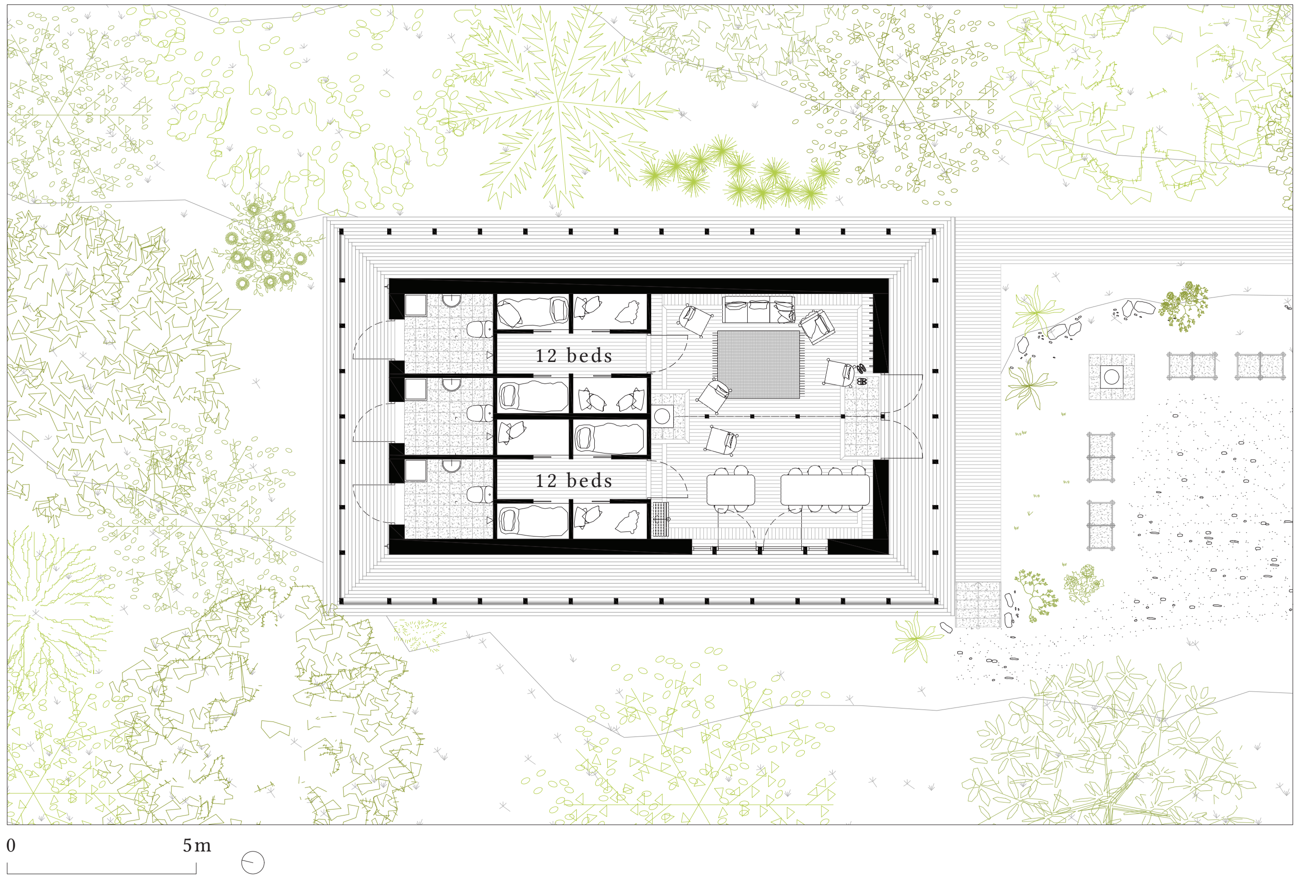
Principle solution *Scale 1:200*

Arcade

Social indoor area

Plan, first floor

North building



The north building house social space, two bedrooms and bathrooms reached from outside to be further accessible. During camps, at least a patrol of 25 scouts can sleep on the loft and four beds for leaders or scouts. During larger events the north building room 24 people in beds and at least 12 more on the loft. All of the rooms on the first floor have large openings to the active field to west and the pine forest to east. An arcade enclose both buildings to extend the rooms during warm weather, and can be used as shelter, didactic-area or for sitting down on chatting or carving wood.

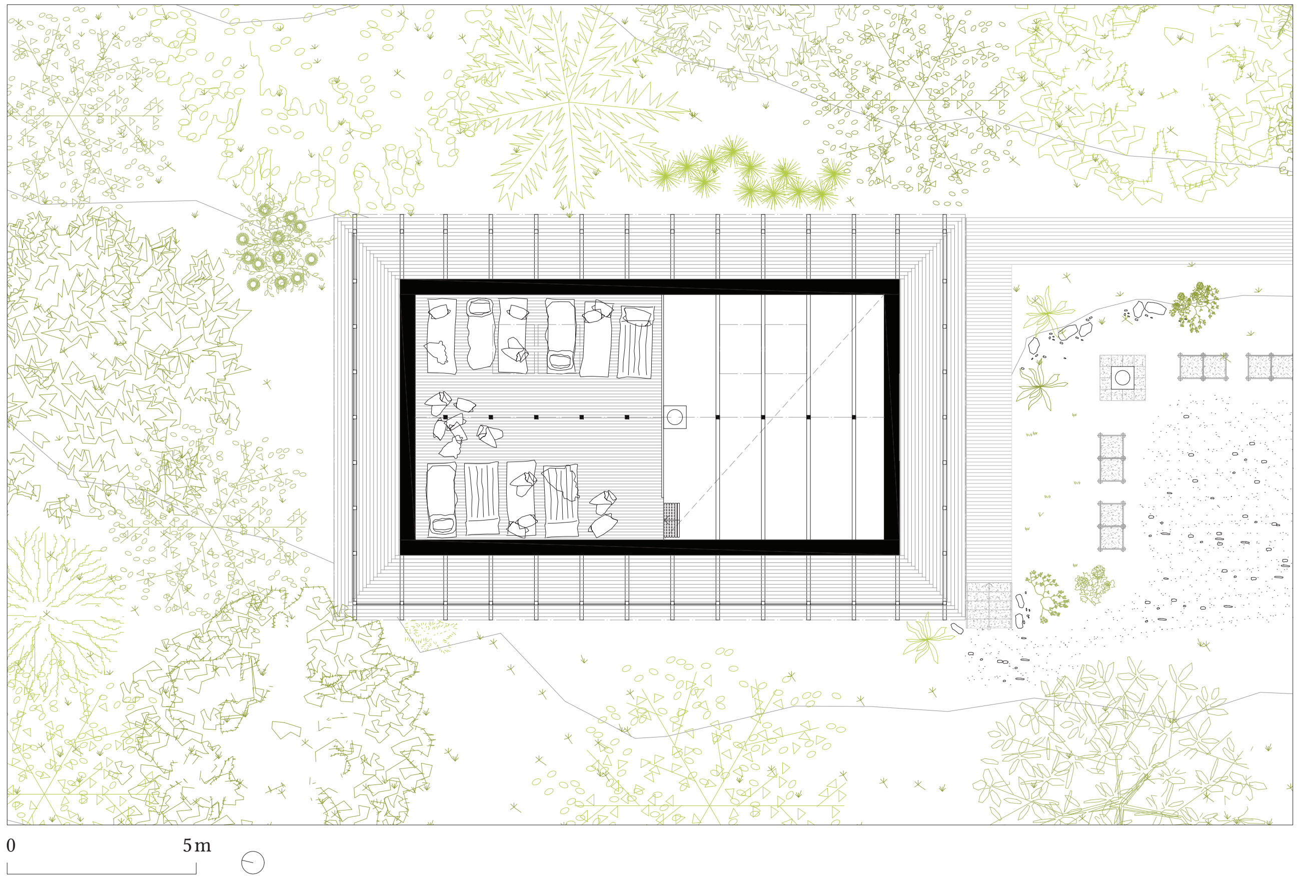
Plan, first floor

South building

The site was originally settled with a solider cottage in timber and a barn. Neither of them are still standing, but the foundation of the barn remains along with a pile of tiles from the old roof. The south building is placed on the old foundation of the barn, but stands on plinths to make minimal impact on the setting. The ruins are visible to accentuate the past use of the site, the same way the reused materials do. The south building house kitchen, social space, some beds and the sleeping loft.

Plan, loft

North building



The loft act as sleeping area during camps were the visitors bring their mattresses and sleeping bags. The north building houses approximately 12 people on the loft.

Plan, loft

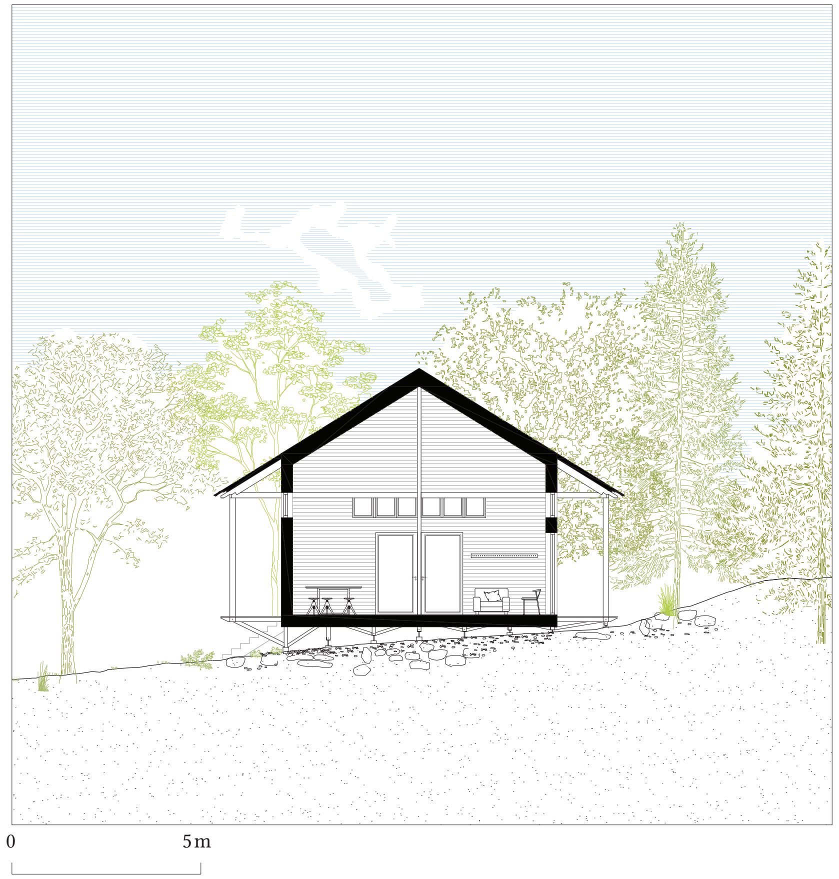
South building

The loft in the south building is divided into two rooms, where one of them have a hatch down to the social area. The lofts have skylights to east.

Section S2

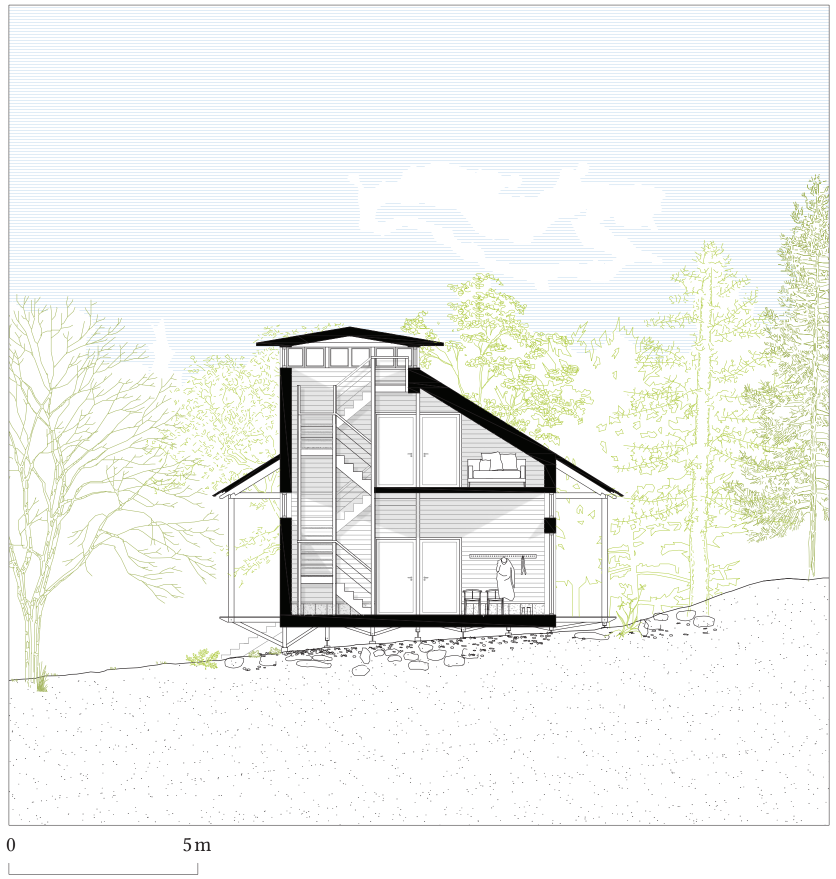
The loft and the social room are connected by a hatch, for occational communication between them. The rooms are connected by double door so two persons can meet without having to stop for one another. Half of the social space in the south building has ceiling height to the ridge, and is open to the loft to connect the two rooms. The loft is open with no fixed furniture or walls, and is used as extra space for sleeping on brought sleeping pads.

Section S3



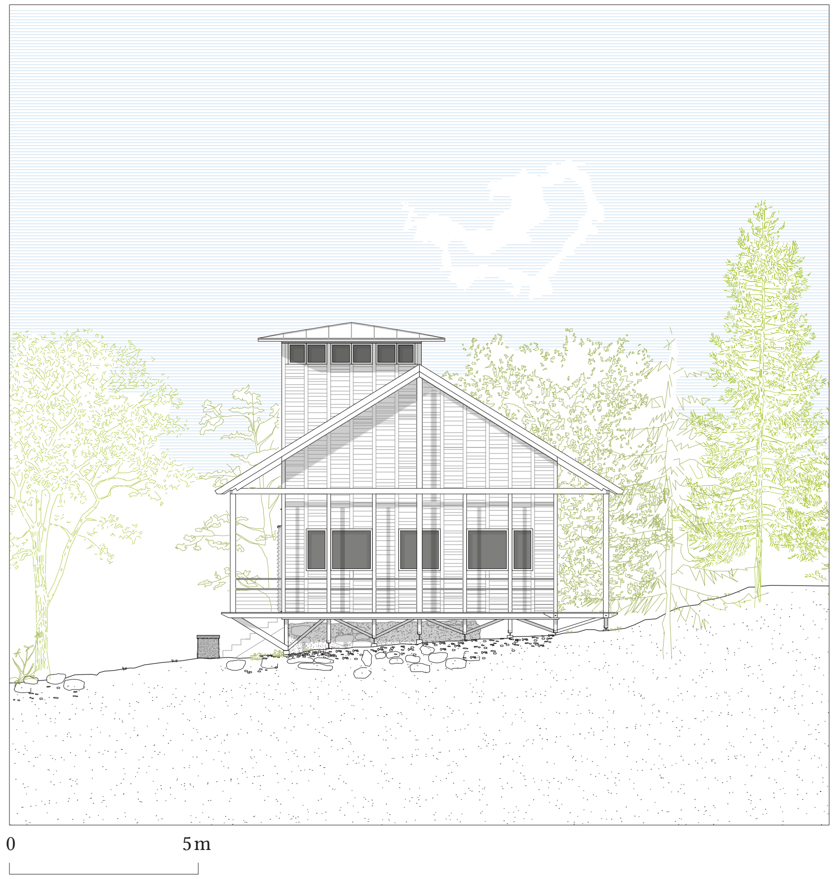
The bearing wall layer of timber and wood is visible from the interior, and the social room is separated into two zones by half of it having double ceiling height and by the patterns on the floor.

Section S4



The stair to the sleeping loft is lit up by elevated windows and goes all the way up to the roof. Since the stair has three landings between the loft and the tower all lengths of visitors can enjoy the view. The top landing exclusively welcomes the littelest guests.

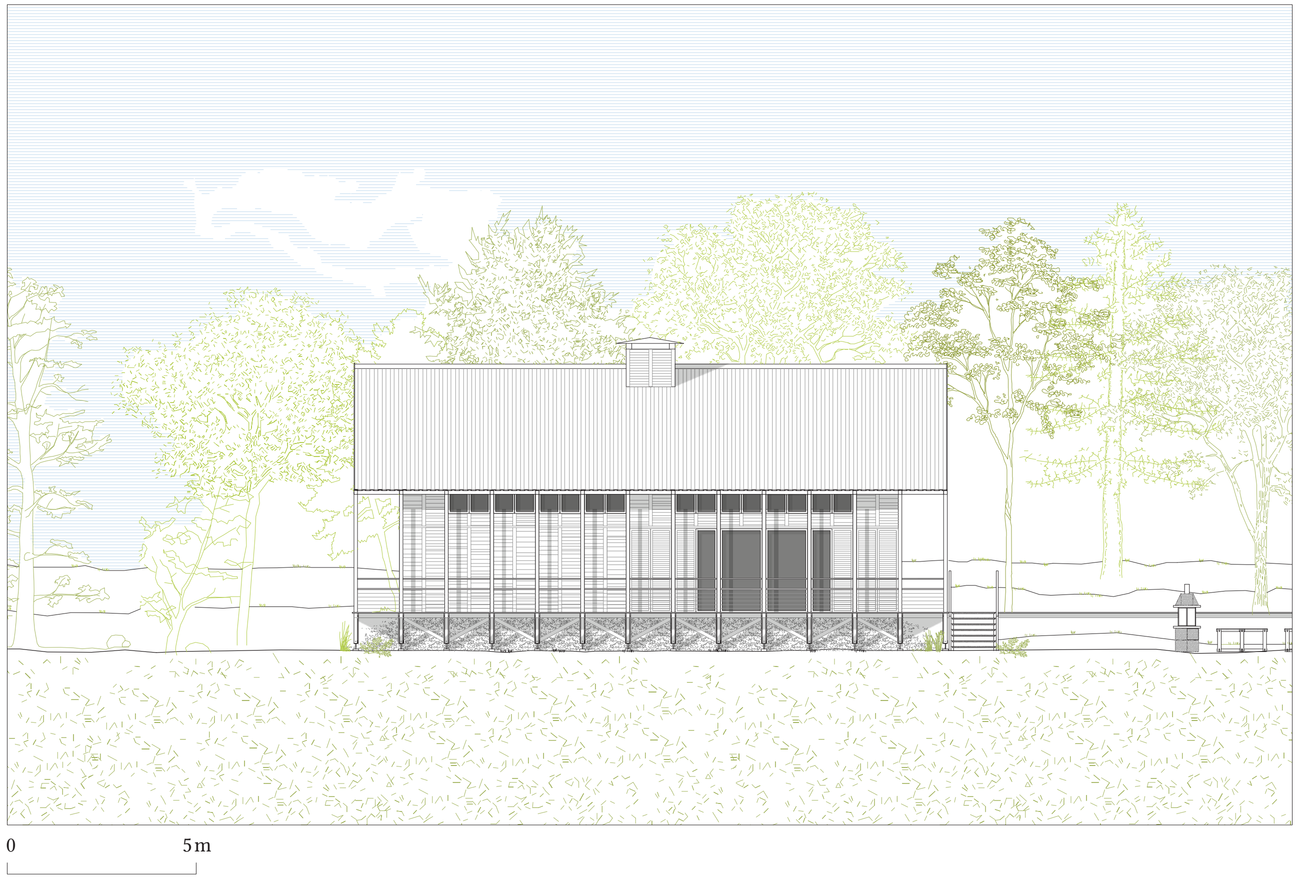
Facade to south



The arcade surround the buildings under the same roof with visable beams enclosing the space. The beams and pillars are the bearing construction in interplay with the massive wooden walls.

Facade to west

North building



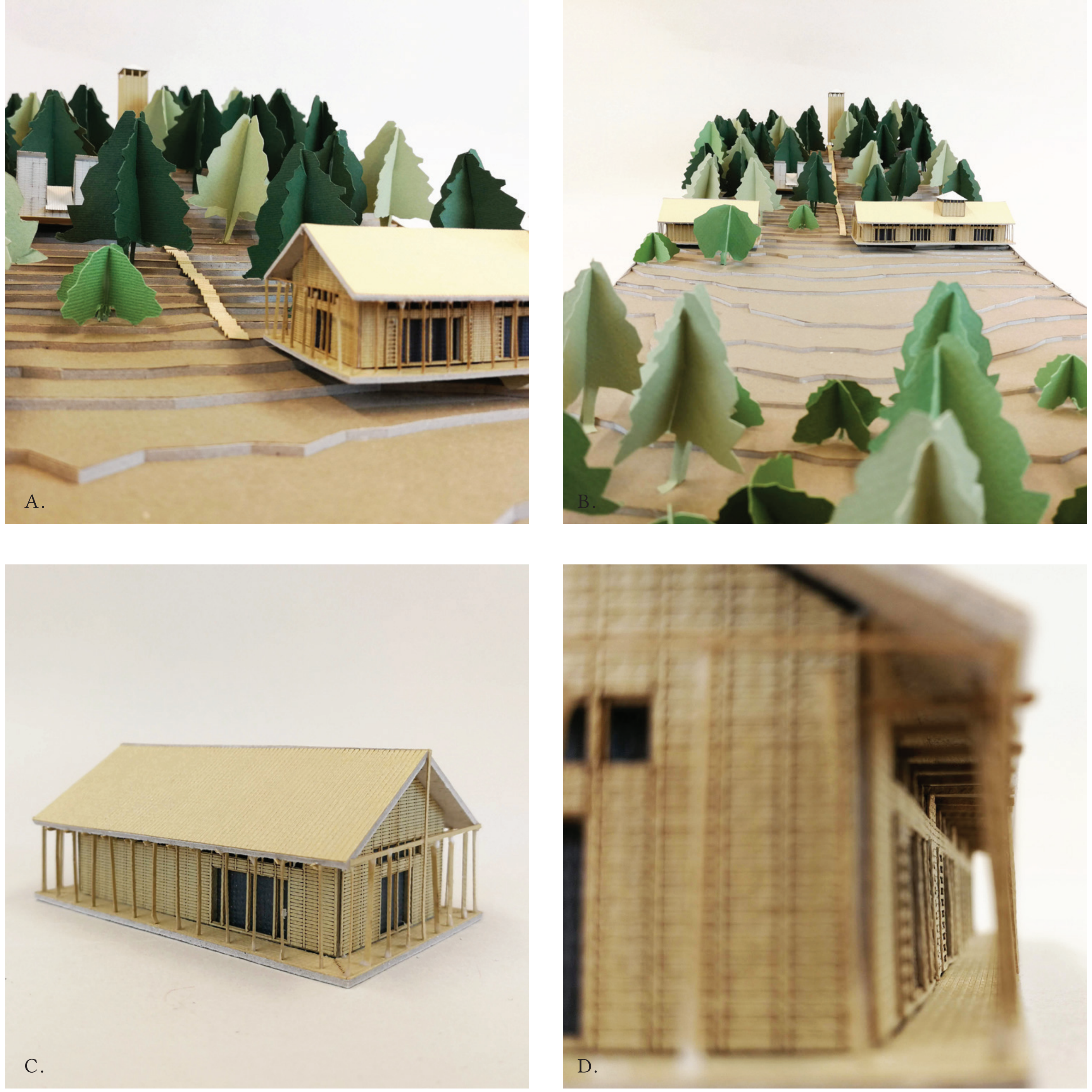
The facade to the field is half closed to keep the bedrooms private to the active field right outside. Elevated windows let the sun into the bedrooms. The bathrooms are reached from outside to enable use for when being outside and are distanced from the social spaces for privacy.

Facade to west

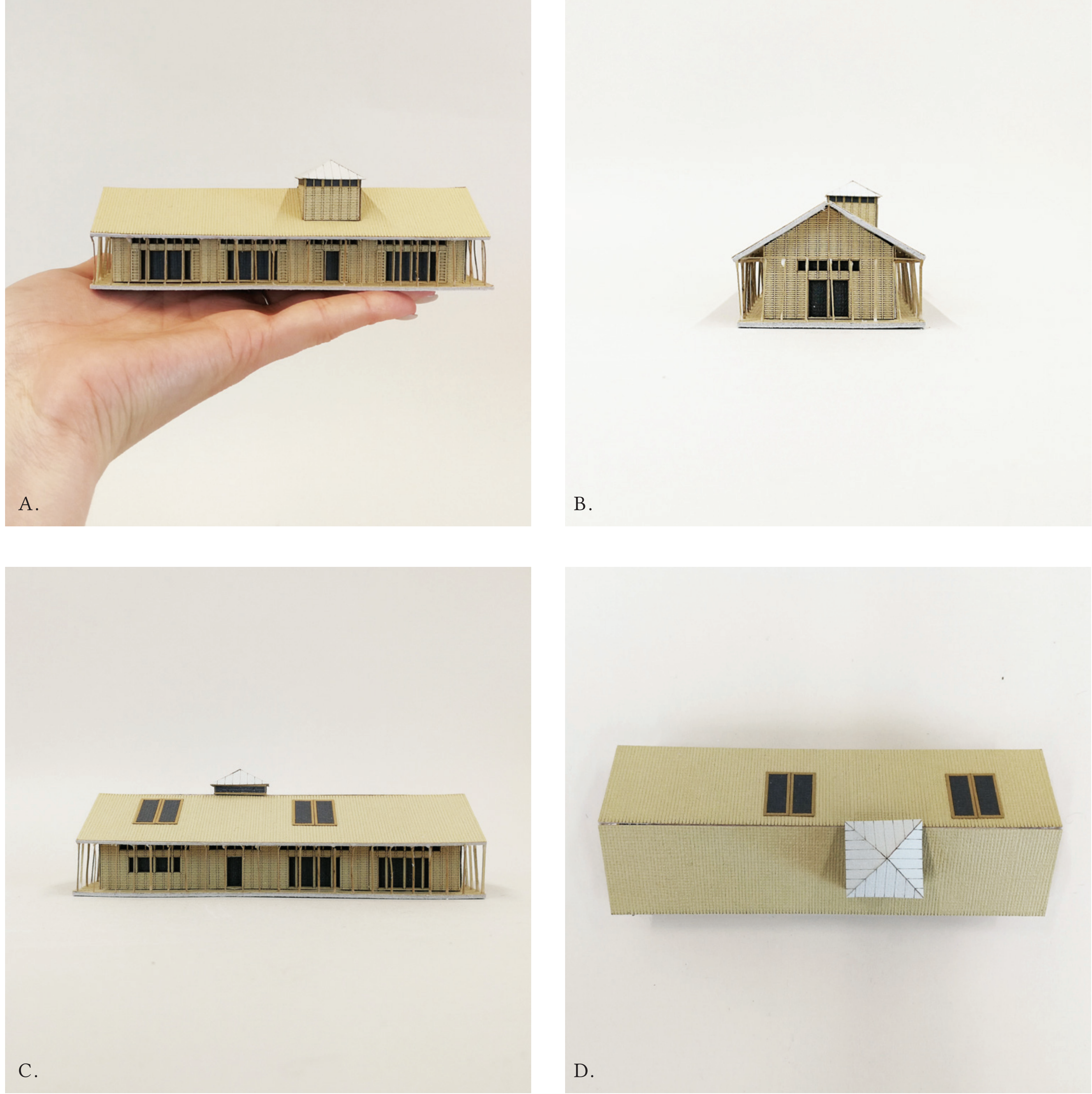
South building

Behind the facade lays social spaces, therefore the larger, centered windows are openable. To protect from the low evening sun, there are camouflaged sun shades which can cover all bottom windows. The rooms have windows to two sides: the active field on one side and the calm pine forest on the other.

Physical model



A. View from the field
B. Front view
C. North building, perspective
D. South building, arcade



A. South building, west facade
B. North facade
C. East facade
D. Roof plan

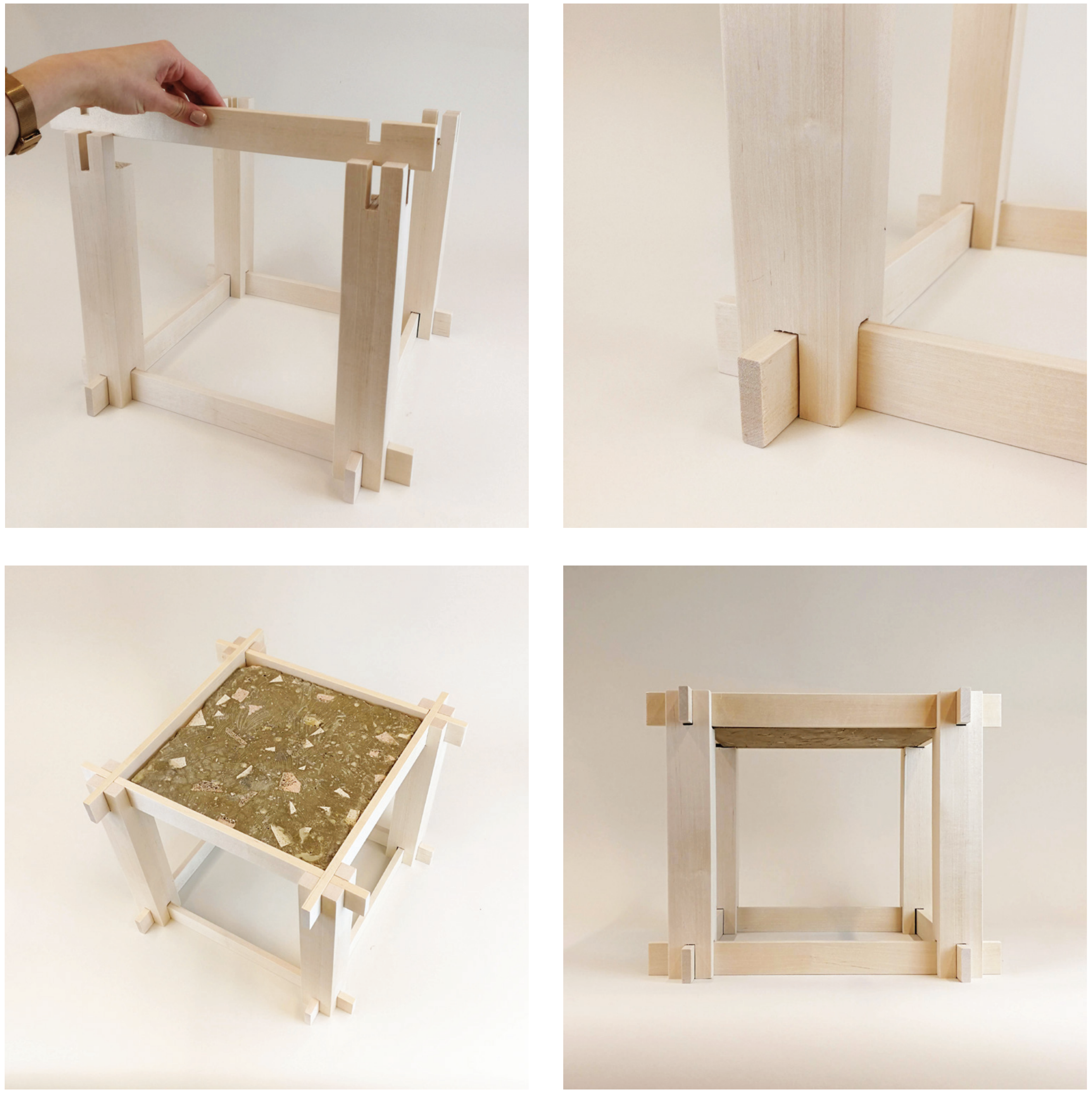
Social indoor area

Floor detail

Detail model

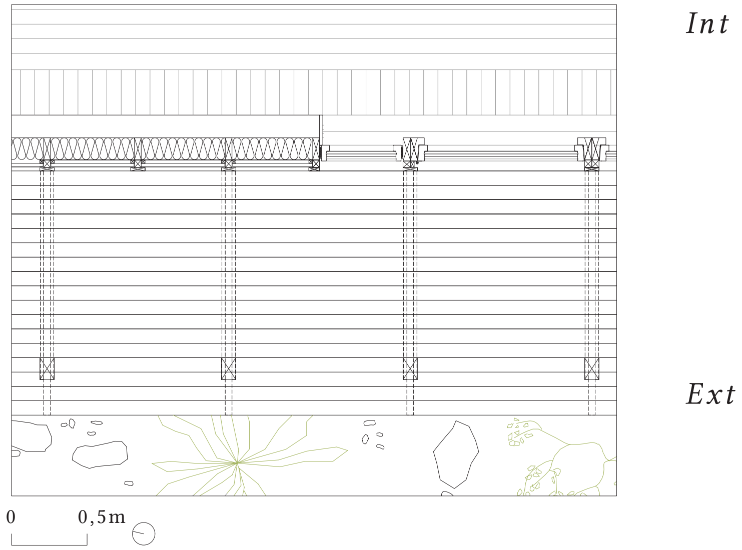
The detail model was made in scale 1:25 and cover a section of the bearing construction. The distance between the trusses and pillars is 1200 mm.

Demountable bench



The terrazzo boards are used as steps in stairs, floor tiles and as the bench above. The structure doesn’t use any bolts and are demountable without any tools. The bench can therefore easily be moved around or be mounted together to a longer furniture.

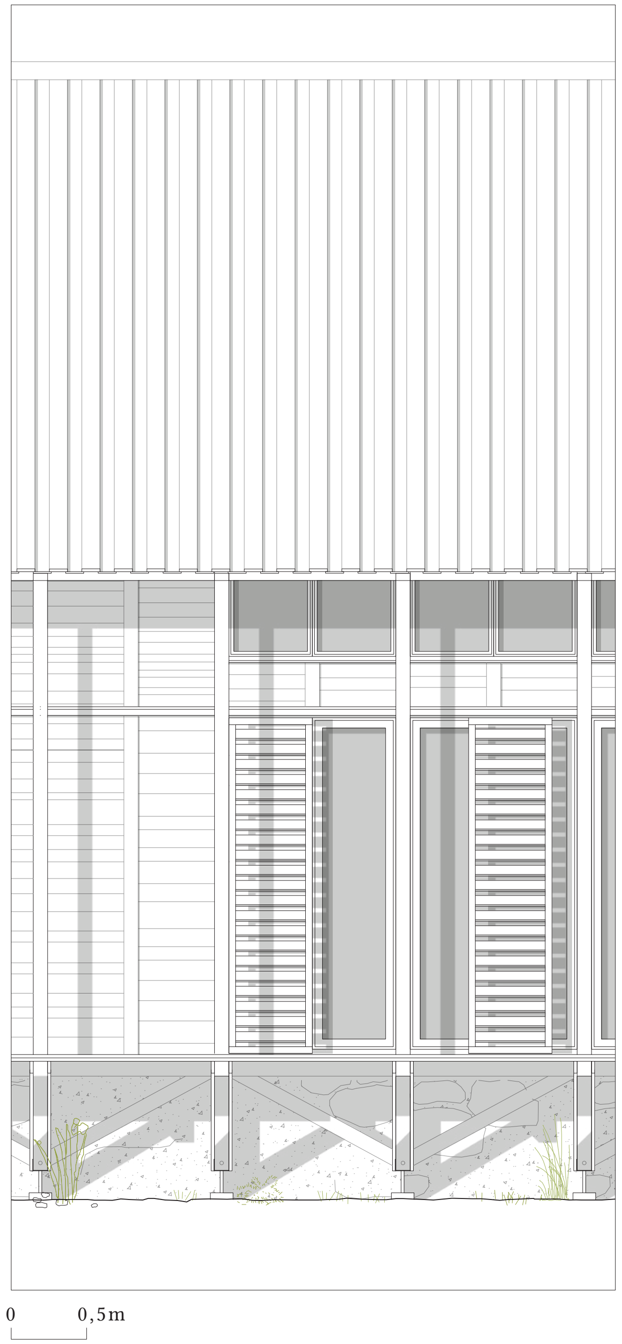
Detail H1



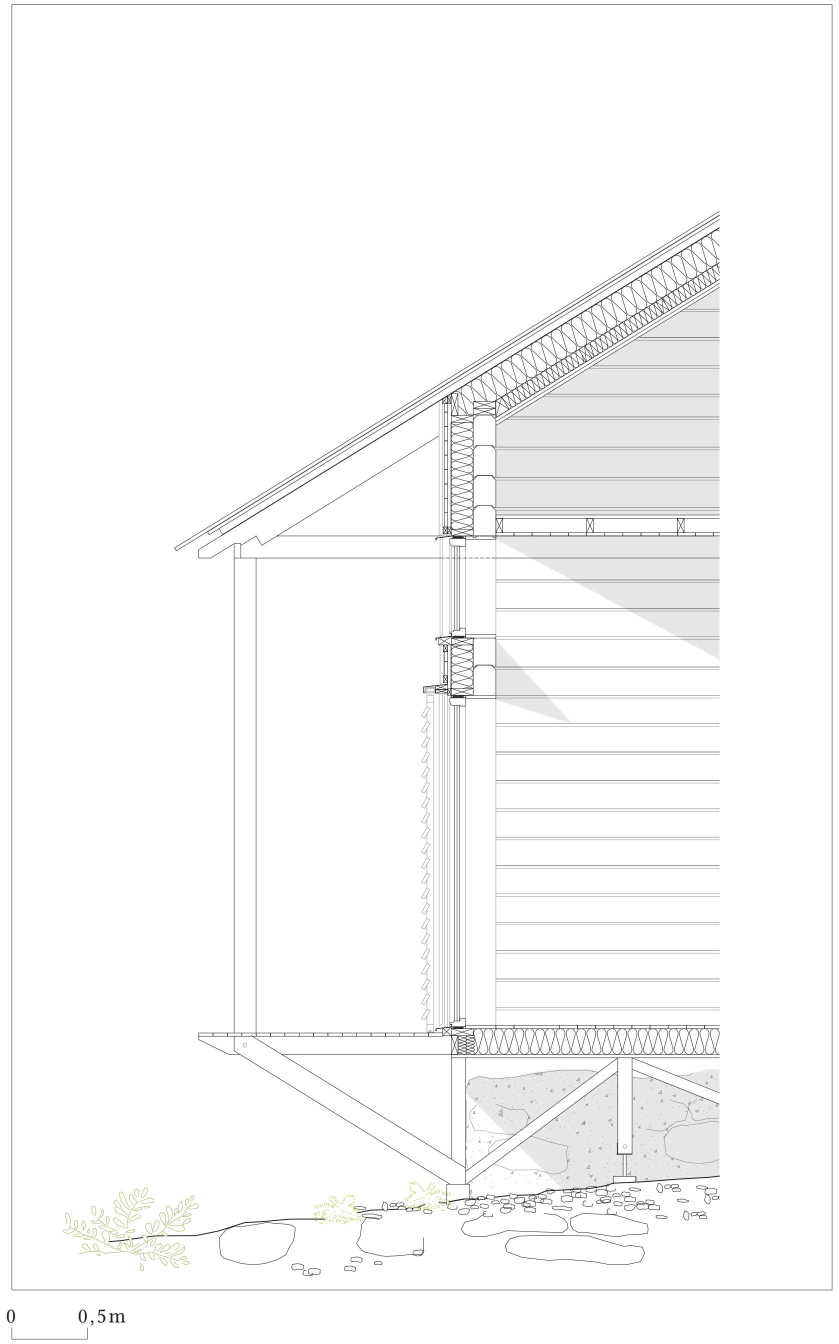
The facade is constructed with short pieces of reused wooden planks placed on top of each other without nails or screws. The planks are mounted by laths, bolted to the construction. The planks can therefore be replaced, with minimal screws used. Layer specification is found on the next spread.

All windows to west have a sun shades, consisting of tilted latches in frames. The shades are mounted on rails and controlled manually. The south building partly stands on top of ruins of the previous barn. The building lean on pillars, to minimize the impact on the ground, and the remnants are accented to be honest about the previous service of the site, in line with the reused materials.

Detail E1



Detail V1



Wall construction

22 x 95 lath [RU]

22-28 x 95 facade planks [RU]

The facade consists of reused wooden planks placed on top of each other mounted in rails [see plan view on previous page] with no nails or screws due to three reasons. Firstly to save material, secondly to ease replace pieces, which might turn bad faster than new material, and lastly not to mix joined materials to ease the demounting, reuse and recycling of the building.

22 x 45 aircap [RU]

2 layers of board [NEW]

Wind-board is not reused of recycled to insure the quality of wind-proofness.

145 x 45 cellulosa fiber insulation [RC]

Cellulose fiber insulation consists of recycled newspapers. The production emit about 0,23 kg CO / kg material (cf. 1,7 kg CO / kg mineral wool, the heat resistence is equal). The wooden latches can be reused since it's not the bearing construction.

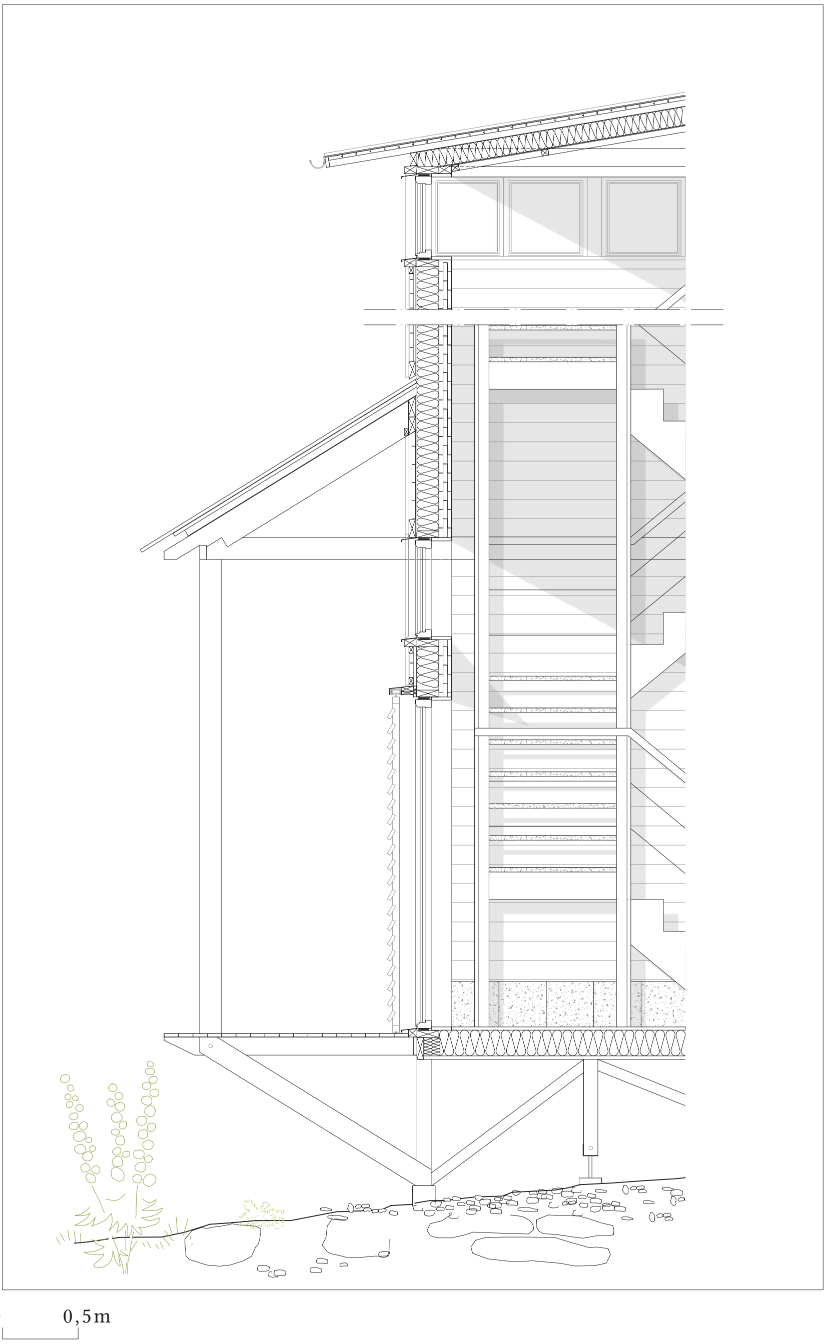
150 x 200 dovetailed timber [RU]

Traditional timber constructions have a very long life length and can be disassembled and moved. Where the space plan fits with the dimensions of a reused timber construction, it is used as the bearing layer of the construction.

The two main buildings are designed with new doors and windows to insure a good indoor climate and high heat resistance. Buildings with lower comfort requirements use reused windows.

[RU]	**Reused**
[RC]	**Recycled**
[NEW]	**New material**

Detail V2



Wall construction

22 x 95 lath	[RU]
22-28 x 95 facade planks	[RU]
22 aircap	[RU]
2 layers of board	[NEW]
145 cellulosa fiber insulation	[RC/RU]
84 wood construction	[RU]

To complement the timber construction, a wood construction is made from reused wood planks, joined three by three, placed on top of each other. The construction can be disassembled similar to a traditional timber construction. (See material experiments for model photo)

Roof construction

22 x 95 wooden roof planks, two layers	[RU]

The roof planks are reused, as the facade planks, however, they are mounted with screws not to risk falling due to greater stress and loads. Screws are used prior to nails to ease disassembly.

22 x 45 laths & airgap	[RU]
2 layers of board	[NEW]
195 x 45 truss & cell. fiber insulation	[NEW/RC]
45 x 45 stud & cell. fiber insulation	[RU/RC]
22 x 95 wooden planks	[RU]

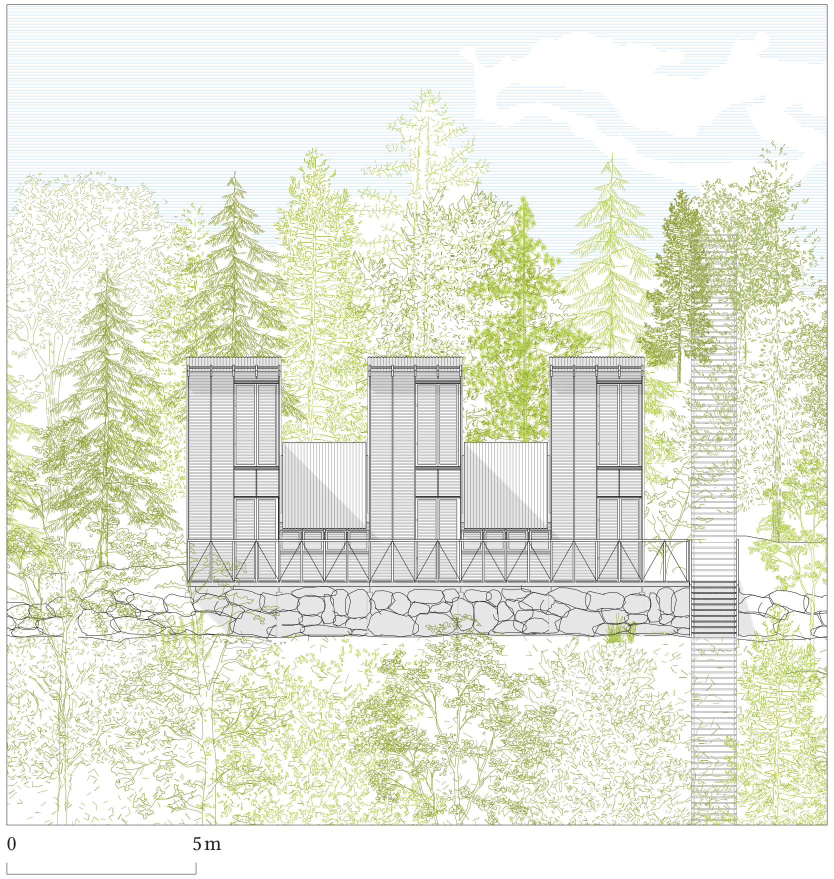
[RU]	Reused
[RC]	Recycled
[NEW]	New material

View from the stairs

Detail of wall and roof

The sleeping cabins are adding sleeping possibilities, and are distanced from the main buildings and the activities there. The construction is simple and function as an upgraded wind shield, with no water or electricity. The cabins have hatches instead of windows, and the lower roofs can be opened to match the taller roofs, to feel the nearness of the forest yet sleeping comfortable. The cabins can house up to 20 persons.

West facade

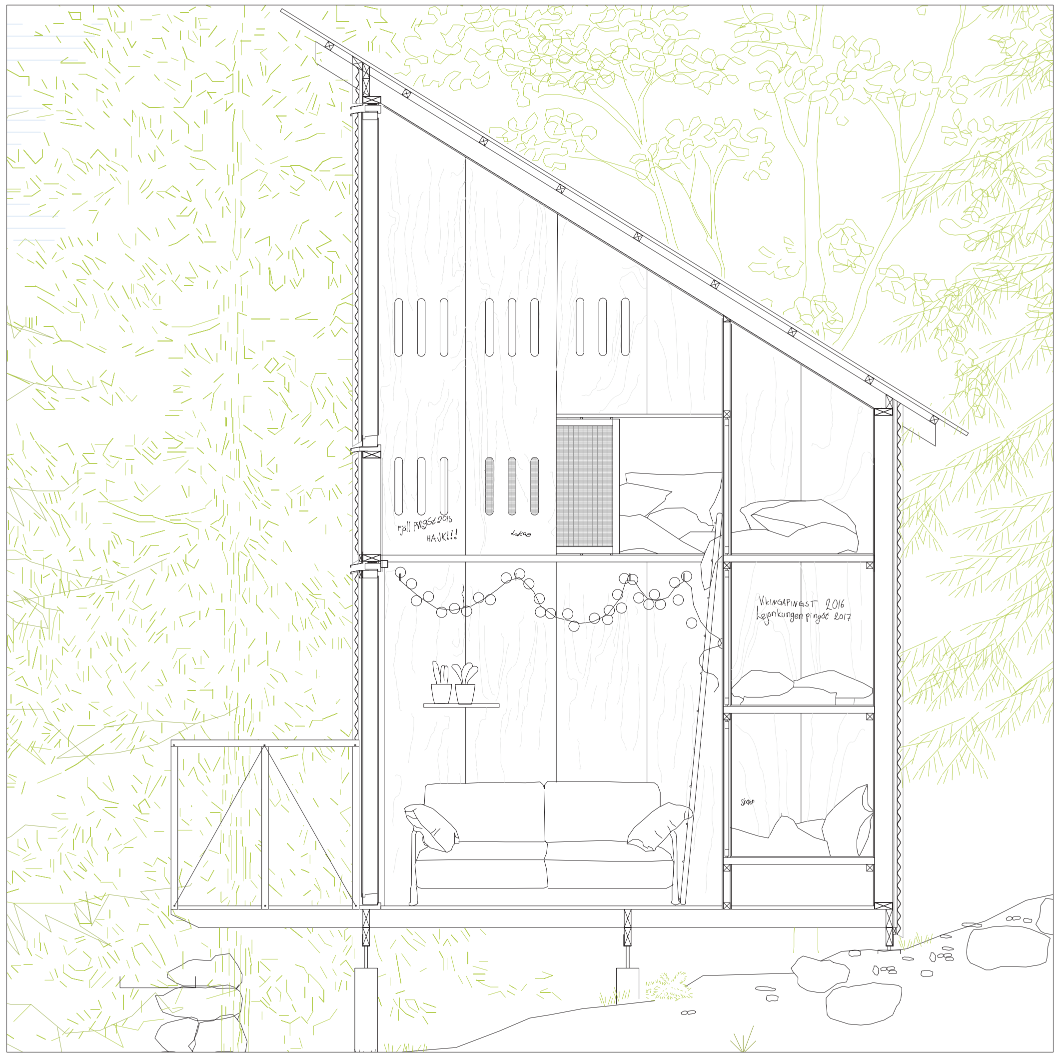


The volume consists of five units, two smaller than the others, which are reached from the middle one. The construction is simple and the facade consists of reused corrugated sheets, divided into sections of 600 mm. All units have hatches instead of windows for natural ventilation, view and light.

Plan

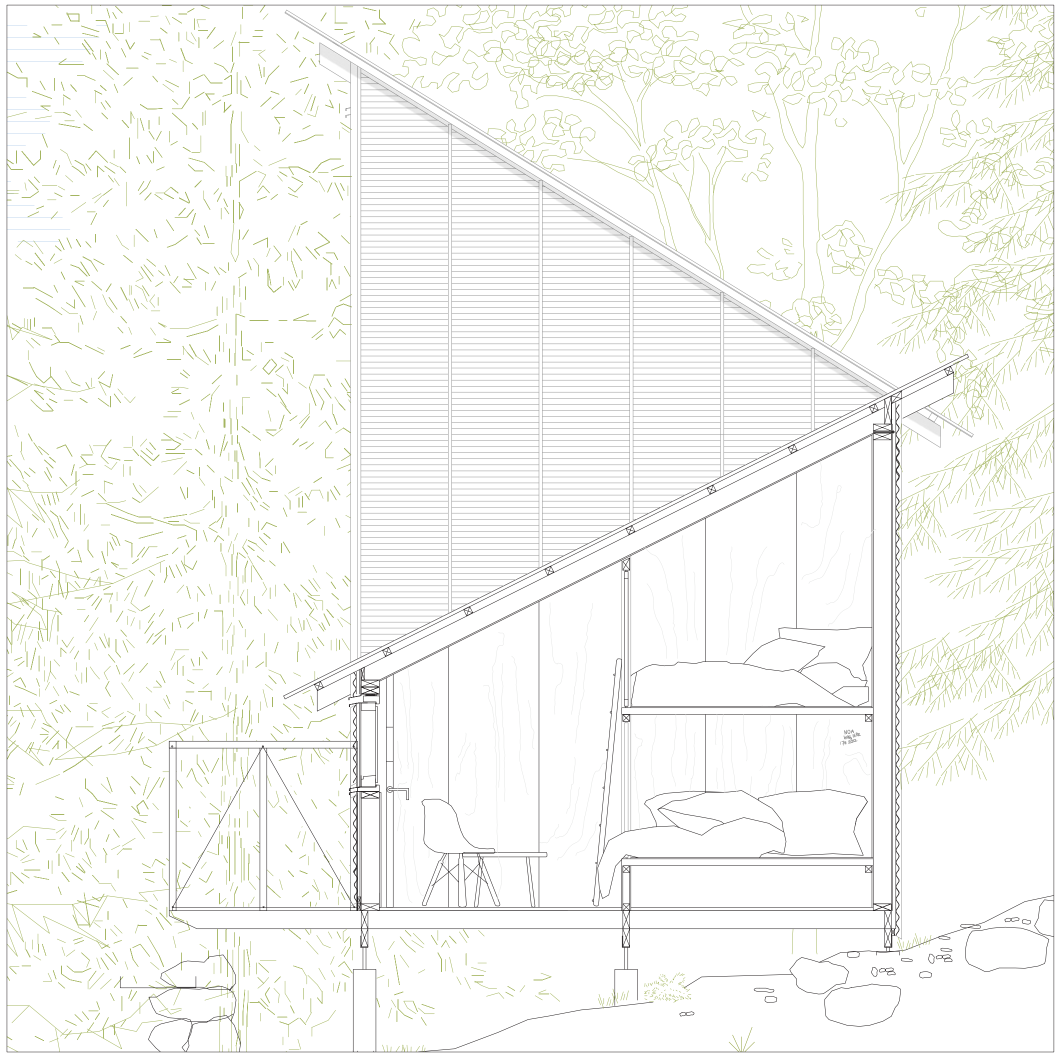
The volume is maximized with beds: the taller units contain four beds, whilst the smaller accommodate two double beds each. The cabins are situated a bit away from the field and the main buildings to heighten the presence of nature.

Section S5



The cabins have four beds in each unit, that all have hatches to provide some privacy. The hatches are made from rough woven linnen and the walls have openings to ventilate the bunk beds. To achieve a good indoor air climate in the units and to experience the nature, all rooms have large hatches to ventilate and open up to nature. The roofs on the two lower rooms can open parallel to the other roofs during warm summer nights.

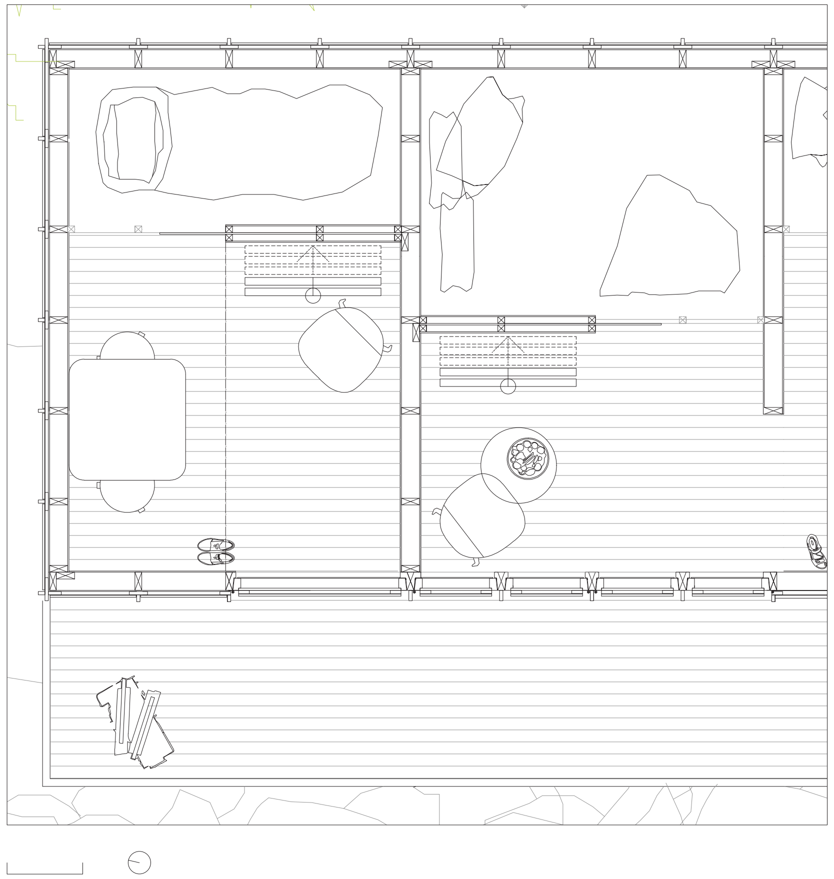
Section S6



Roof construction

22 corrugated sheets	[RU]
22 x 95 laths	[RU]
12 plywood	[RU]
45 x 120 studs	[RU]
12 plywood	[RU]

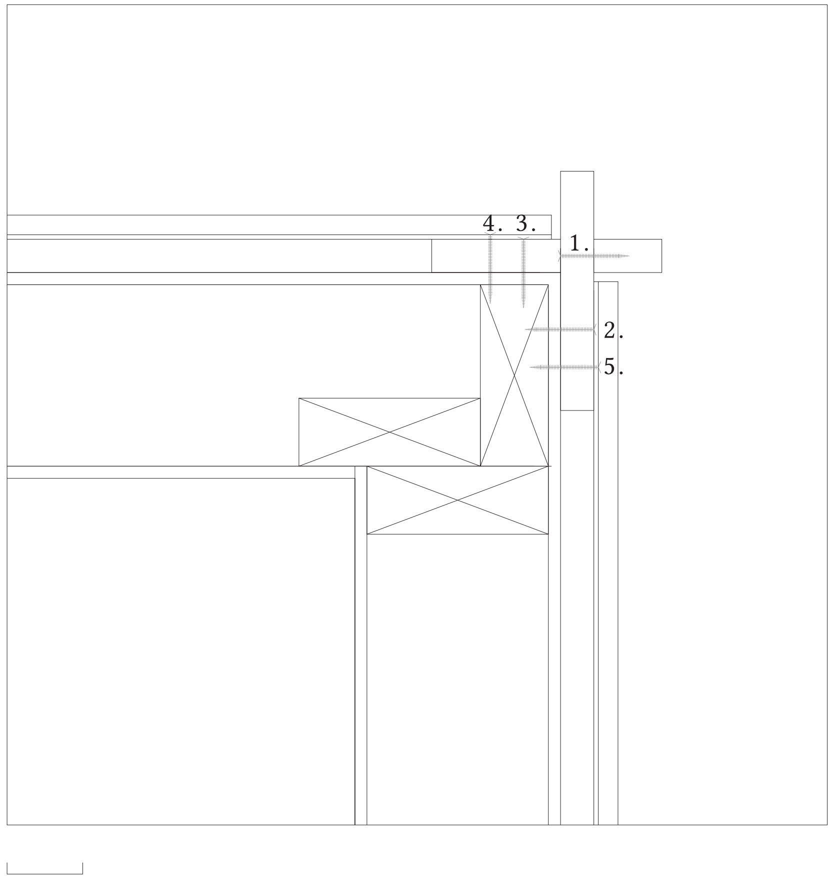
Detail H2



Wall construction

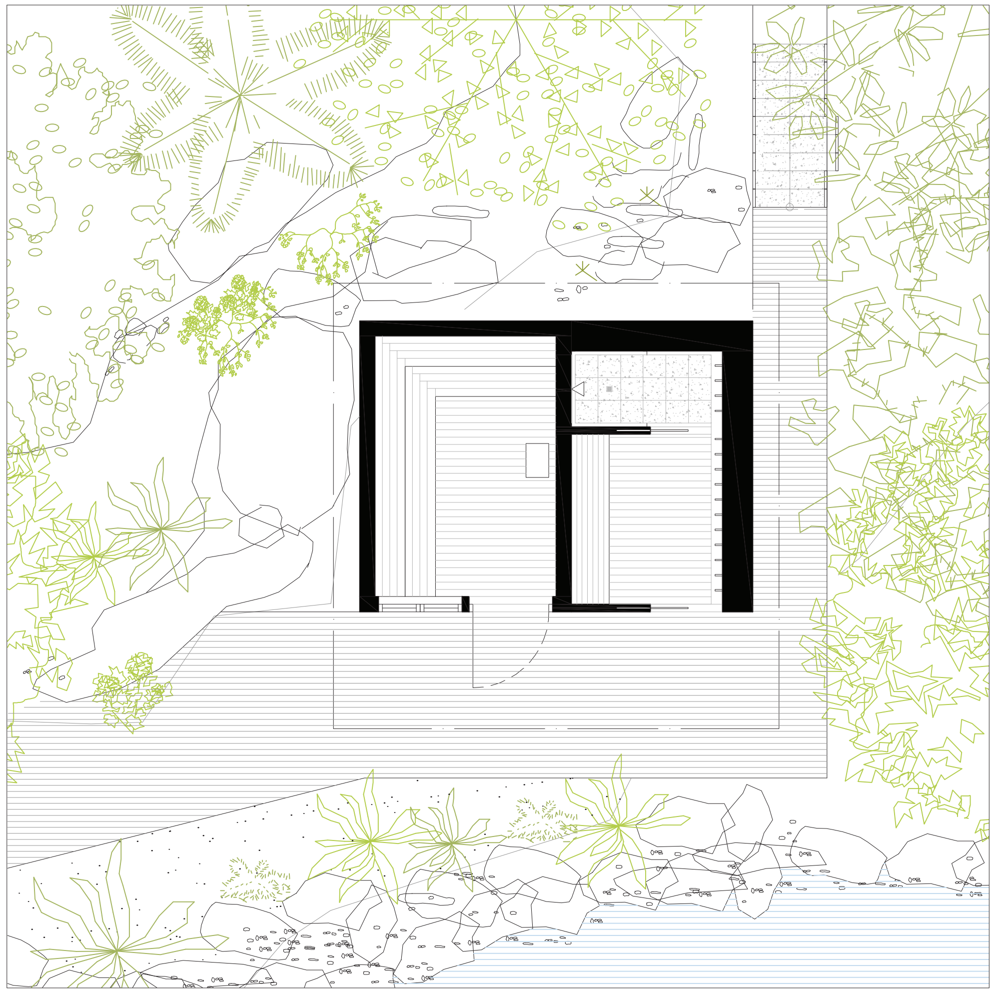
22 corrugated sheets	**[RU]**
22 x 45 latches	**[RU]**
12 plywood boards	**[RU]**
45 x 120 studs	**[RU]**
12 plywood boards	**[RU]**

Detail H3



Detail of how to attach the corner latches. The bolts are mounted in the order above. Nr 1 is mounted before it's attached to the wall. Nr 4 & 5 fasten the metal sheets.

Plan



The sauna is situated right by the water, straight down from the other buildings. The thicker wall to the antechamber and shower simply consists of old roof tiles stacked on top of each other.

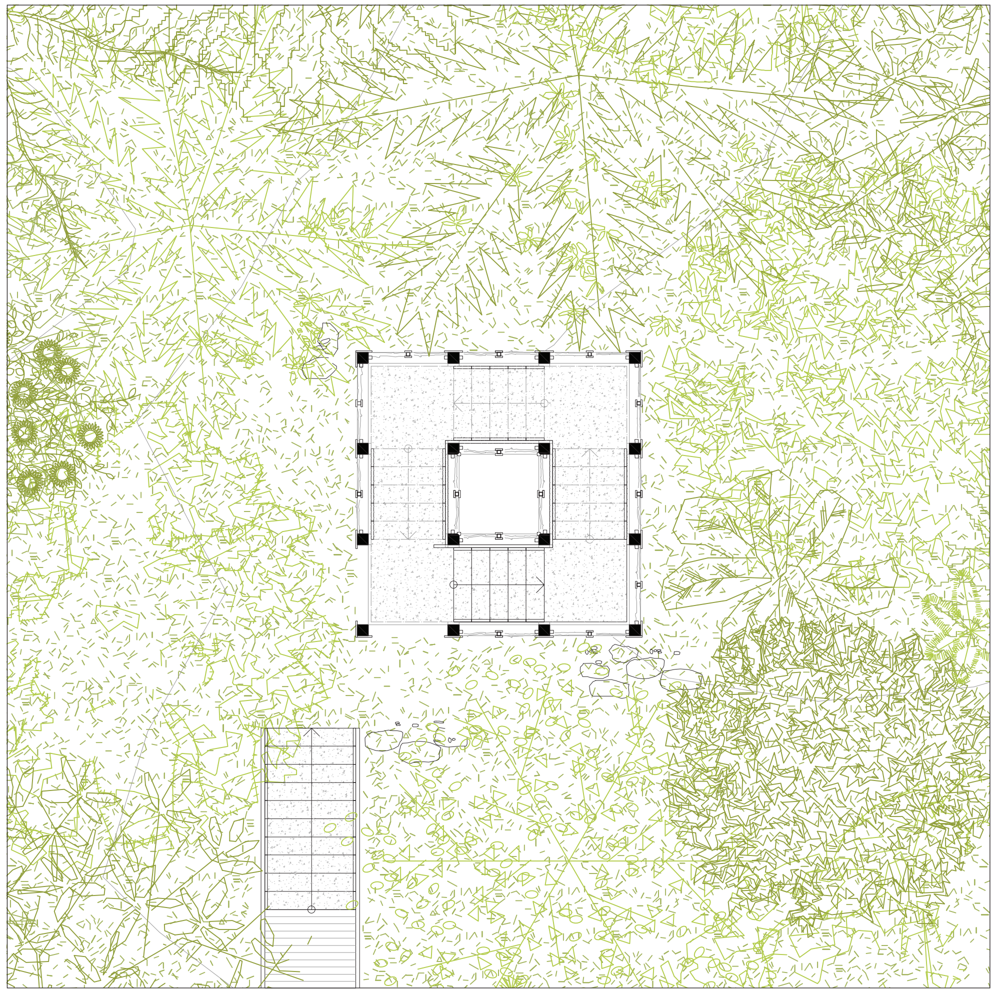
West facade

The sauna look out across the lake to west. The situation is secluded through rough terrain and vegetation and is reached either via stairs from the field or by a path from the fire camp.

View from the lake

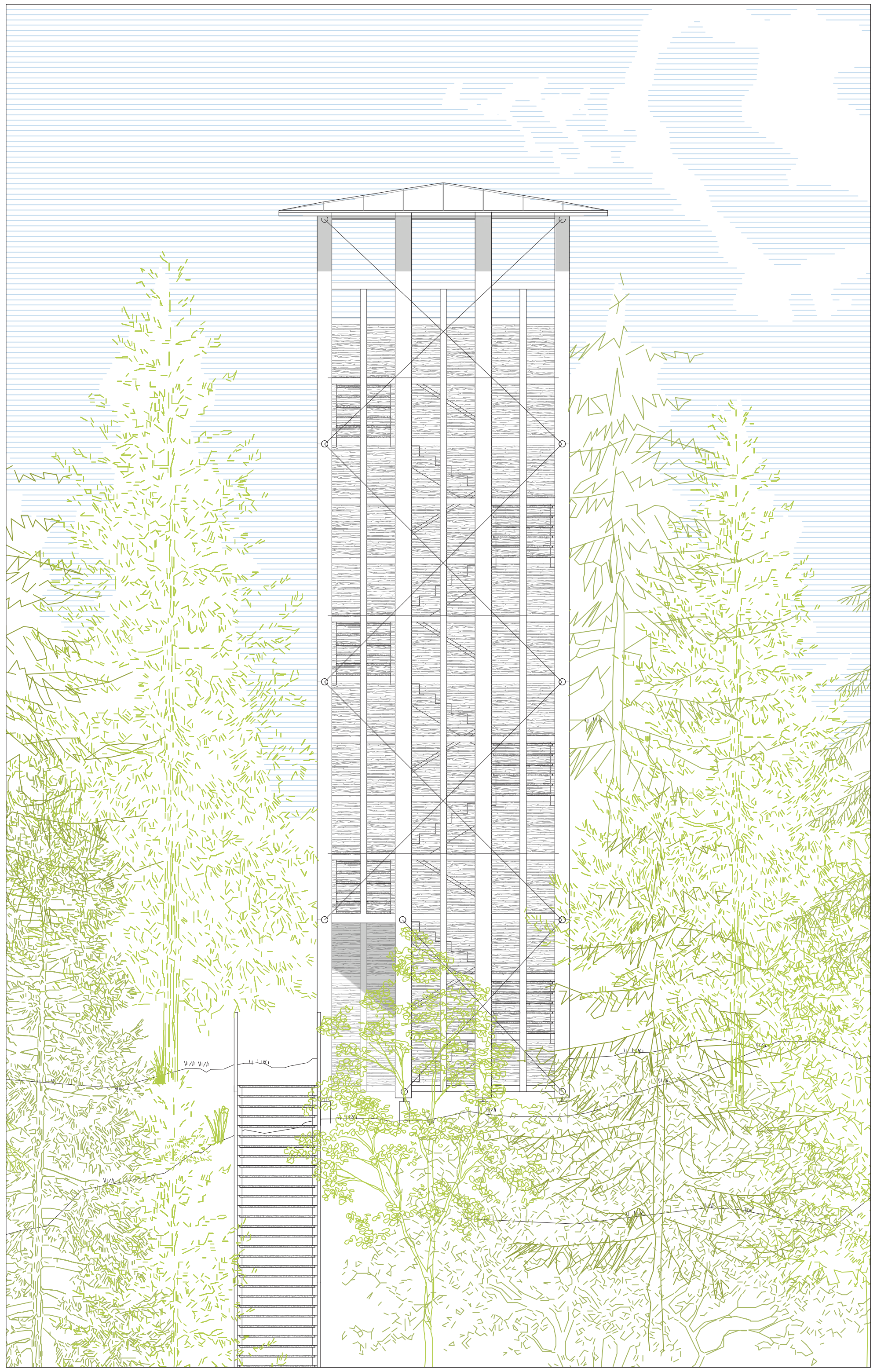
Stair detail

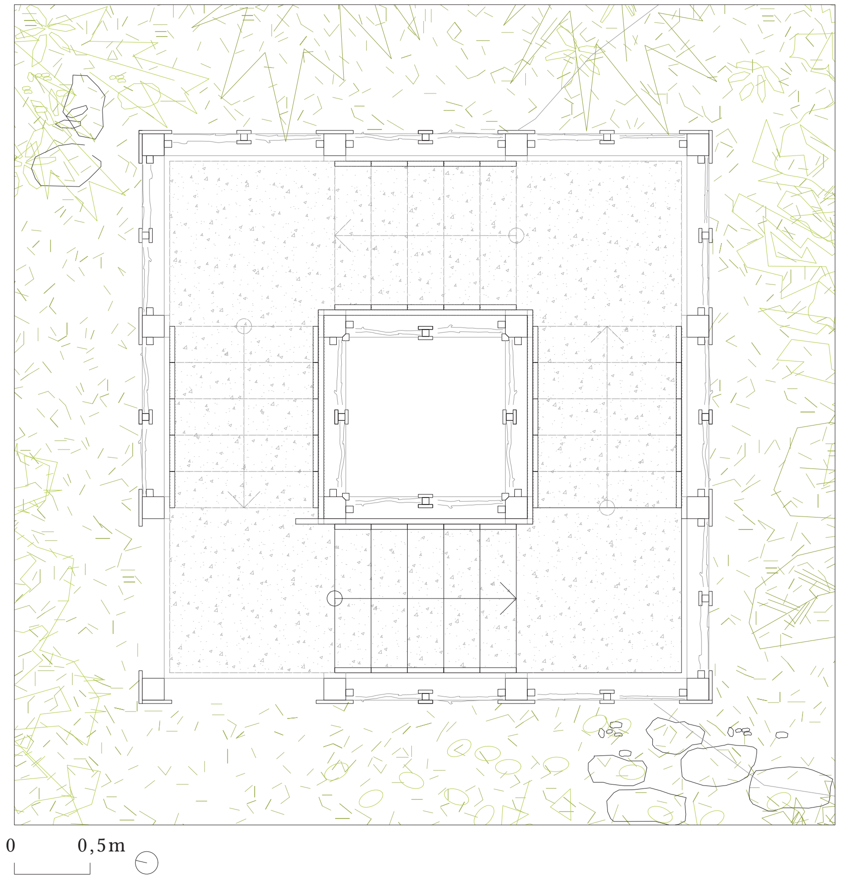
Plan



The observation tower is inspired by the stories which the reused materials carry. Most materials origin similar paths, but has during their life length been exposed to different uses and purposes. The way up to the top of the tower is rather long and arduous, and the visitor walks 18 meters up on stairs. The stairs are made from wooden frames and terrazzo boards as steps, where each board consists of different types of reused crushed materials as ballast. When gasping for air and looking down at your feet, you might glimpse an old bolt, a piece of painted porcelain or a chunk of roof tiles.

West facade





The tower is built by new pillars in wood from local manufacturing, and are constructed with minimal amounts of nails and bolts to be relatively easily demountable and could be moved to another site. During the construction of the main buildings large amount of young trees and bush wood are cut down. These branches are salvaged and becomes the railing and front of the tower. The branches are uneven and natural, which form an irregular pattern where the passer-by glimpses the up-rising view when walking up the spiral movement.

View from observation tower

CONCLUSIONS & REFLECTIONS

In this thesis, I've only scratched on the surface of the very complex system of the construction industry, our economical systems and politics which all regulate the non-resource preserving way be build today. The overall conclusion to that situation is that something must change. My investigation concerning the "how", has involved a small scale and local situation and didn't aim to apply anything other than that situation.

My thesis begun with a hypothetical answer to the issue: to reuse materials and to design for disassembly, where the questions was how to do this, not if it was the correct answer. One question was "To what extent can reused materials be used in a new construction?", which has a very simple answer: that it depends on what qualities are aimed for and what means are accessible. I chose to design the buildings with highest requirements for quality, energy efficiency and durability with a mix of reused, recycled and new materials. To legitimate the new materials I aimed to design the details so the structure could be reused in the future. However, I acknowledge that doesn't apply for 100 % of the materials. For example I used new wind-board without a proposition of how to reuse it. Still, that situation could have been solved if the owners and contractors of the situation were different. I had to draw the line of what I thought the owners of the site actually could construct. Other buildings, for example the cabins have lower standard requirements, and was therefore designed with only reused materials.

Another guiding question was "How can the construction be designed to enable disassembly and reuse of the materials?", which I found many examples of, both in literature (Guy & Ciarimboli, 2013) and by experiments. The argues can be summarized to the following strategies:

- Design details which can be demounted with common tools
- Avoid glued materials, composites and sandwich elements
- Separate bearing construction and design the constructions in layers where the layers with shorter lifelength or which need maintanance accessible

- Prioritize materials with high quality to enable long lifelength and reuse
- Plan the construction and deconstruction simultaniously and from start
- Use standard sizes to enable reuse and replacement
- Storage spare parts so pieces can be exchanged without changing the whole system
- Design foundation and volume so the construction can be expanded
- Design flexible rooms that can be used for multiple purposes

These strategies was in the back of my mind throughout the design process, and even though all strategies are not always fulfilled, it has been a useful tool to argument my decisions on.

Throughout the process, I've set out to find what it is with certain reused materials or components which makes them interesting, and how to capture that sense when reusing or recycling it. The theory was entirely based upon my own perspective and perception. I've found tiles with paw prints, walls and plywood boards with name tags and texts which led my thoughts to the past. Traces from people makes me think about who and what has happened, and I can't state what it is specifically that make me think about the history, but only conclude that these details do.

My last and hardest question was "How can designing with reused building materials support the tectonics & materiality in architecture?" and as architecture is perceived individually, it's problematic to argue other than subjectively. For me personally, traces from previous use, handcrafted items or deviations in otherwise perfect patterns makes me take a second look. I seeked to design to let the history and curiosity of the design grow, as the beholder observe and experience. Simply because that's engaging from my point of view.

That was my aim, and I believe we have lots to gain from further valuing our resources.

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Figures

	Figure number	
18	Fig. 1	© Lantmäteriet I2018/00069 Kartsök och ortnamn. (2019-02-06). Lantmäteriet. Retrieved from https://kso.etjanster.lantmateriet.se/ (2019-02-06)
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