DURABLE TEMPORALITY

- design and temporality in modular architecture.

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Examiner: Ola Nylander
Supervisor: Jan Larsson

Master Thesis, spring 2019
Chalmers School of Architecture
Architecture and Civil Engineering

CHALMERS
UNIVERSITY OF TECHNOLOGY

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STUDENT BACKGROUND

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BACHELOR STUDIES

Bachelor of Fine Arts in Architecture,
Umeå school of Architecture,
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MASTERS STUDIES

Architecture and Urban Design, Chalmers University of Technology:

- *Sustainable Development and the Design Professions*
- *Healthcare Architecture*
- *Architectural Competitions*
- *Color and Light*
- *Housing Inventions*
- *Residential Healthcare - Housing for seniors*

ABSTRACT

Housing shortage is a great issue in Sweden and 84% of the municipalities report that there is a lack of dwellings. The main reason for this lack is the low amount of construction in relation to the increase in population and to solve this problem Swedish government has implemented a new law that makes it possible to issue temporary building permits for housing. The intention with this change is to solve the housing shortage on a short-term basis while catching up and increasing permanent housing construction. Temporary building permits last for maximum 15 years before the site must be restored and the building must be torn down or moved.

Different types of prefabricated architecture have been around all over the world during the last century and the use is increasing over again. The current trend in Sweden is prefabricated timber modules and more recently there has been a development of constructing with CLT-modules. Modules are produced in a protected lane production inside a factory which makes it safe and efficient both when it comes to time and economics.

The CLT-modules that are produced today is used for permanent buildings, but this thesis proposes a temporary building constructed of CLT-modules. It investigates the relation between architecture, temporality and prefabricated CLT-modules to take advantage of the modularity in the design of a temporary multi-family building. Based on research, Swedish building regulations, the construction of CLT-modules and case studies of reference projects it proposes a building system that can be disassembled and moved. Joints are designed to allow for an easy dissemble while considering the expression of the building and modules are designed to be able to provide for a variety of apartments. This allows for a variety of scales and shapes of buildings which allows for a flexibility that suits different contexts.

CONTENT

INTRODUCTION

CURRENT SITUATION

In June 2016 Boverket appreciated that there is a need for 700 000 new housing units between 2015-2025, where 440 000 are required already before 2020 (Boverket,2016). The reason for this is both expected increase in population but also that the amount of development of residential during the previous years have been low in relation to the needs. In 2017 there was a proposition for a change in the regulations on building permits from the Swedish government.

Temporary housing as a solution to housing shortage has been present through history in the Swedish context. In the beginning of 1900, a big housing crisis affected the big cities of Sweden. Biggest was the lack of housing for workers and low-income families. To manage the crisis the politicians were forced to produce a lot of dwellings quickly and developed several temporary emergency housings. The big need of housing today makes the question of emergency housing relevant again. (Caldenby, 2016).

During the last years many housing factories has started up in Sweden. Sweden is said to be one of the pioneering countries in the world on prefab architecture (Architizer,2017). One of the newest companies for prefab architecture is Nock Massiva Trähus that I got in contact with during the fall of 2018. Their idea was to build timber modules for permanent housing by using CLT panels which they speak of as the timber industry's response to the prefabricated building element wall (Nock Massiva Trähus).

By combining the housing shortage, with the new building permit regulations and Nock's CLT modules I reached the following research question for this thesis:

RESEARCH QUESTION

How can one design a temporary building and take advantage of the modularity of CLT-modules to design a building that can be moved and adapt according to site context and scale?

PURPOSE/AIM

The purpose of this thesis is to prove how temporary buildings can be aesthetically attractive and work as a solution to the housing shortage in Sweden.

It intends to investigate the industrialized production of mass-timber modules in combination with construction and design and to use the findings to propose a temporary building constructed of CLT modules to show how temporality and design can work together.

READING INSTRUCTIONS

To properly understand the thesis, it is important to understand the definitions of the different terms used in relation to this topic of the investigation:

PREFAB CONSTRUCTION

Housing construction where elements are prefabricated within an enclosed factory space and later are assembled on site.

MODULAR CONSTRUCTION

Construction of housing using on three-dimensional volumetric modules.

COMPONENTS

Prefabricated elements used in production of the modules or the building.

METHOD

LITERATURE STUDIES

Literature studies are made to get an overview of the current development within the field. The studies aim to understand the use of timber in large scale buildings to get and overview of the limitations and possibilities when using timber in different parts of the construction.

Further analyses are made to understand the prefab construction process and the regulations concerning temporary building permits to be able to relate the design to reality.

CASE STUDIES

In order to understand where the development is today when it comes to temporary buildings and modular CLT construction, a selection of projects has been used for case studies.

The studies consists of 3 examples of temporary buildings and one example of a building constructed of CLT modules. The analyses of these building are used in the development of the design concept and structure of the proposal.

The projects are investigated in terms of mobility, adaptability, temporality and expression of the buildings.

STUDY VISIT

A study visit has been made to Nock Massiva Trähus factory in Älvängen outside Gothenburg to understand the process and possibilities of the production of CLT-modules. The whole production lane in the factory has been studied and the gained knowledge has later been adapted and used in the development of the design proposal.

THEORY

TODAY'S HOUSING MARKET

In the end of 2017 Sweden had 4'859'252 dwellings for 10'120'242 inhabitants (SCB, 2018a; SCB, 2018b). The ratio between inhabitants and dwellings shows that there is on dwelling per 2,1 inhabitants. Around 50 % of all dwellings are was apartments in multi-family housings and most of the apartments are 2 room apartments (SCB, 2018a).

According to Hyresgästföreningen, 84 % of the municipalities in Sweden reports to have a housing shortage (Hyresgästföreningen, 2018). The fact that there is a housing shortage although the housing stock shows a trend of one person households.
The state of the housing market affects the possibilities of getting a place to live. When the market isn't balanced it strikes hardest on the groups that have a weak position in the market, either they are new on the market, lacks income or references (Boverket, 2018a). These groups can be for example young people or newcomers.

The population will continue to increase, mostly in the regions of Stockholm, Gothenburg and Malmö. The great increase of population implies that Sweden needs to double the construction of housing compared to today (Boverket, 2012).

TEMPORARY BUILDING PERMITS

Previously regulations have allowed for temporary building permits when the need of the buildings can be proven to be temporary, which has been hard to prove and argue for when it comes to housing. The proposed change in regulation allows for temporarily building permits to be issued although the need of housing is not temporary. The government declares that the housing shortage in the long term shall be solved by permanent buildings but because of the great shortage there is also a need for other possibilities in the transition time when the housing shortage shall be solved (Prop. 2016/17:137).

For a temporary building a special building permit can be issued. This permit is given on a maximum period of 10 years with a possibility for extension to a maximum of 15 years in total. The building can on a temporary permit be constructed on any site. This includes sites which in the detail plan is dedicated to other purposes such as

parking places, green areas or other places where housing construction is currently not allowed. The requirements on getting a temporary building permit is that the construction doesn't disrupt the road safety or inconvenience for the surrounding. The buildings can't be placed or shaped in a way that it puts the residents in danger and the site must be able to be restored to original condition after the permit expires. Temporary building permits can only be issued on new constructions and doesn't include add-ons to current buildings (Boverket, 2018b).

PREFAB CONSTRUCTION

Prefab construction of building means that some or all elements in a building are constructed of site, often in a factory, before they are transported to the site where they are assembled. The constructions in these factories are similar to the ones taking place in factories for production of cars.

Construction in a factory environment is more efficient than traditional construction in and offers more control in each step of the process. Industrial production generally has lower waste in material which is not only cost efficient but good in environmental terms. The production time has proven to be shorter which is beneficial both in terms of economic and time efficiency but also in quality of the final product (Brege, S., Nord, T. & Stehn, L., 2017).
Lindbäck's factory in Luleå is one of Europe's most modern producer of modular multi-family housing and is generally seen to have come furthest when it comes to lean-thinking in the business. They produce volumetric timber frame modules which are completed with floor, walls, inner roof and fixed furniture in the delivery from the factory (Lindbäcks, 2019).

MODULAR CONSTRUCTION

The argument of building with prefabricated elements often circulate around the efficiency in the construction but the fact is that there is a lot of other benefits of industrializing the construction of buildings. Modular buildings are constructed of three-dimensional volumes that are produced inside a factory in a lane production. This can reduce the time of production to 30 % of the time it takes to construct a building on site. The modules are fully equipped in the production lane before they are transported to the site for assembly (Lawson, Ogden & Goodier).

The off-site construction makes it possible to prepare the site simultaneously as the buildings are produced and the organized lane production makes it possible for different kinds of work to be done to the modules at the same time, at different steps in the construction process. In ordinary construction, a lot of time is wasted because the workers must wait for each other to be finished before they can do their work (Lawson, Ogden & Goodier).

CLT MODULES

Timber is the only renewable material and our biggest resource of building material that we have in Sweden. These two factors make it hard to argue against using it in our constructions. The most common material used in the building construction today is concrete. Strategies are being made to reduce the CO2 emissions from concrete production and construction (Svensk Betong, 2017) but the fact remains that the material is not renewable to the extent as wood is.

One of the main argues to use concrete is its robustness and resistance (Svensk Betong, 2018) It makes it possible to build large and high buildings that we until recently haven't been able to build with timber. The development of CLT panels makes it possible to build with timber elements in a similar way as we build with concrete, but in a way friendlier towards our environment. Prefabricated CLT panels can be used to build developments of more than 10 storeys entirely out of timber, making it possible to create large developments with a lower CO2 impact (Lehmann, 2013).

CLT modules is relatively new on the market. Most common is to work with CLT as elements that are transported to the site. There are many benefits with the material regarding rigidity and environmental

aspects. Some argue that the negative aspect of this construction method is that fact that an unnecessary amount of material is being used when building with modules compared to traditional construction but one benefit of this is wood is a good storage for CO2 (Svenskt Trä, n.d.)

Factory lane at Nock Massiva Trähus, Author's own copyright.

NOCK MASSIVA TRÄHUS

Nock Massiva Trähus is a factory that produces volumetric elements for multi-family housing construction. Their production started in the beginning of March 2019 and they are in the production of their first project. Nock completes the buildings to up to 96% before the modules leave the factory. Unlike most other Swedish module companies, who build their modules with traditional timber frame construction, the modules produced in Nock's factory are made from CLT-panels.

The CLT-panels arrive pre-cut and pre-milled in flat packages to the factory and after only 4 hours these flat boards has become a volume. The process of the production differs from different project, but the capacity is the same. Every module moves through the production line every 4th hours which means that 2 modules can be produced each day.

After the flat packs has become volumetric modules, work can be done both on the interior and the exterior which makes the production very efficient. Since the production is inside the protected factory, the interior work can be made before the module is weatherproof. Meaning that interior and exterior work of the building can be made simultaneously as the site is being prepared for the building. The modules are assembled and anchored to each other with metal sheets on site. Installations are connected to each other and additional insulation are mounted together with the façade before the building is completed.

TIMBER FAÇADES

The main function of the façade is to protect the structure behind it from wind, water and other weather issues. To be able to do this the façade must be sealing to protect from moist and/or be able to transport the moist away dry-out. Another important function of the façade, more relevant to architecture is of course the aesthetic function. The choice of façade has a great impact on the expression of the building.

Wood has been widely used as a façade material through history in Sweden, but it isn't until the latest 10-15 years that it has been used in buildings higher than 1-2 stories. Wood is a renewable raw material and almost all the timber production we have in Sweden is certified by independent organs that aims for a sustainable production of wood. Wood is also a very light material that easily can be mounted to the module in factory before it is transported to the site (Sandberg, Pousette, Karlsson & Sundqvist, 2013).

Historically timber façades in Sweden has mainly been constructed of vertical or horizontal planks attached to wood laths. Recently several new timber façade products, such as shingles or façade boards, have entered the market. Common for all timber façades is that they must be mounted with an air pocket behind to ventilate moisture. The durability of a timber façade depends on a correct execution. If the montage maintenance and profiling of the facade is correct it can last up to 50 years or more (Sandberg et al., 2013).

FIRE IN TIMBER FAÇADES

One of the main issues with constructing wood façades on multi-storey buildings is the issue of fire protection. According to the regulations from Boverket, buildings higher than 2 stories are not allowed to have a façade made entirely out of wood if not certain fire protection actions are taken. The exterior wall of a building must be constructed so that it not contributes to spreading fire between different fire cells. This implies that fire spreading through a fire wall shall be limited but one must also take into consideration the great risk of fire spreading through and along the façade (Boverket, 2011). To avoid the spreading of fire in timber walls one must take different fire protection actions, examples of such actions are for example, self-closing doors or that the façade is not

executed continuously over fire cell borders (Sandberg et al., 2013). Using the actions described will not only solve the issue of the fire protection but also have an impact on the quality of the spaces in the building

Sandberg et al. discusses the possibility of using fire protecting treatments to the façade, this however is unsafe for use outside since the exposure to rain and moist can make the impregnated fire protection leak out. Fire protecting paint is also an option requires regularly expensive maintenance. The option to be able to use 100 % timber in the façade is by using accommodation sprinklers within the apartments. This prevent the apartments from a flashover and from spreading to other fire cells. Boverket allows this solution for fire protection in buildings with 100 % timber façades up to 8 stories (Boverket, 2011).

FOUNDATION

In 9 kap. 33 a § PBL it is stated that to receive a temporary building permit the site must be restored after the permit expires. It must be proven to be economically feasible to restore the site to its original state. To minimize the impact of the foundation work on site is advantageous when it comes to the restoring of the site, and gentle to the environment (Träguiden, 2003a).

The most common foundations for buildings are concrete slab, concrete plinths, basement foundation or suspended foundations of different kinds. The different foundations have different prerequisites and works for different contexts and terrains (Träguiden, 2003a). The plinth foundation has the benefits of being able to adapt to the context of the site and terrain and has minimal encroachment on nature especially in a hilly terrain since it doesn't require the flat surface like concrete slabs (Träguiden, 2003b).

PLINTH FOUNDATION

In Sweden, plinth foundations are mostly common in small buildings, but they also appear in construction of multifamily housing. The system consists of plinths combined with beams and systems of joists or binders. The plinths caries the loads pointwise to the ground and can mounted directly on mountain ground, foundation plates or poles. Beams or binders of concrete or glulam are placed on top of the plinths and on top of that the floor frame is placed. It is important to have enough air circulation to avoid mold and to drain the ground beneath to avoid assemblage of water (Bülow, n.d.).

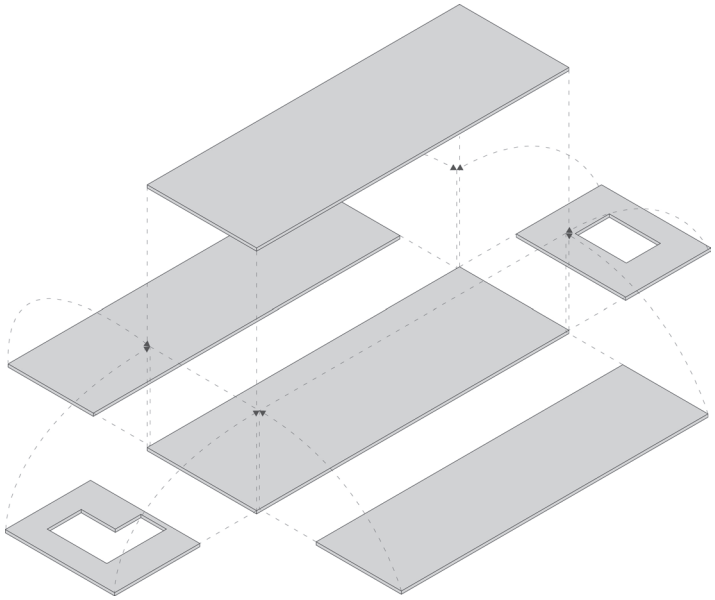
STUDY VISIT

The following images describes the process of the module production at Nock Massiva Trähus factory. The factory produces modules for permanent buildings.

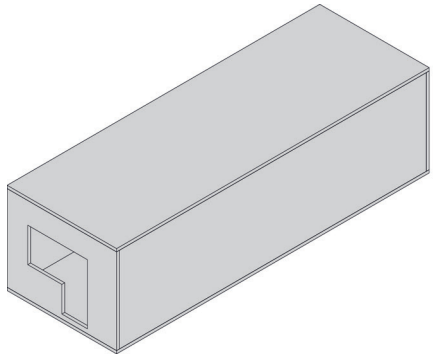
The study visit in the factory gave information about the order in the production lane which has been considered in the design proposal that has been constructed to fit the production lane.

Module assembly at Nock Massiva Trähus, Author's own copyright.

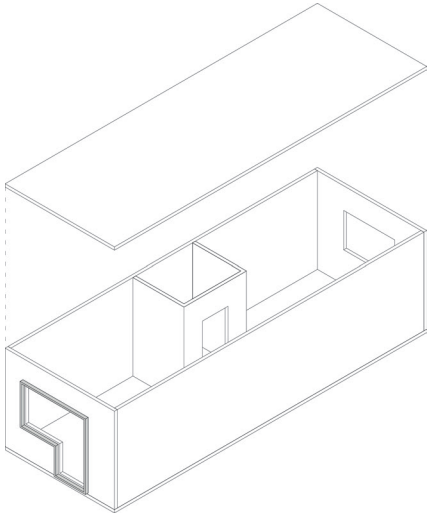
Window installation at Nock Massiva Trähus, Author's own copyright.



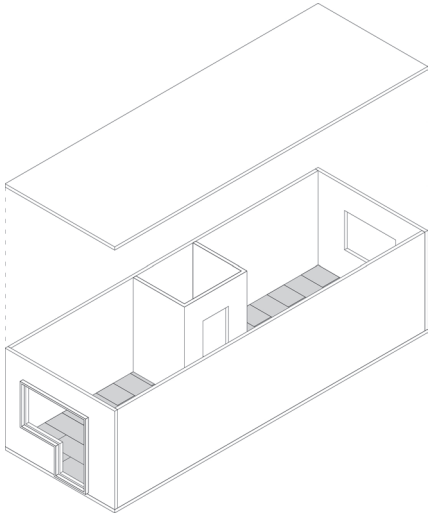
The CLT-boards arrives in flat-packs to the factory where they are assembled.



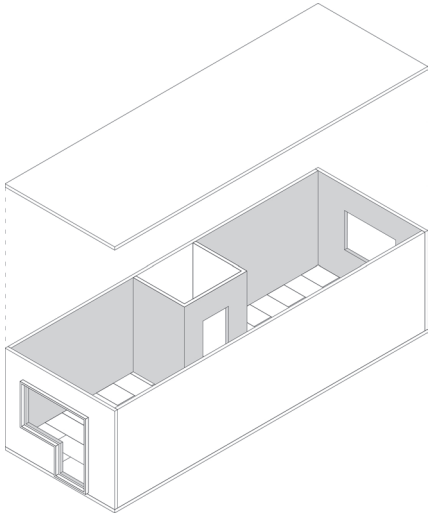
After 4 hours the module is assembled with all interior walls.



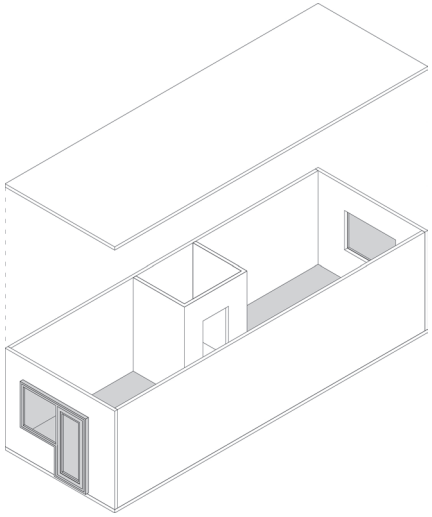
Frames for doors and windows are mounted.



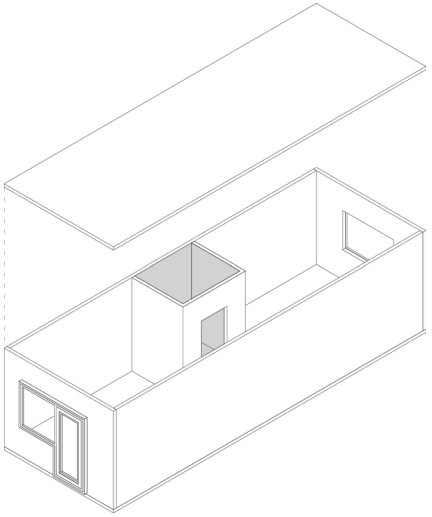
An internal floor is installed. Raised over installations in the floor.



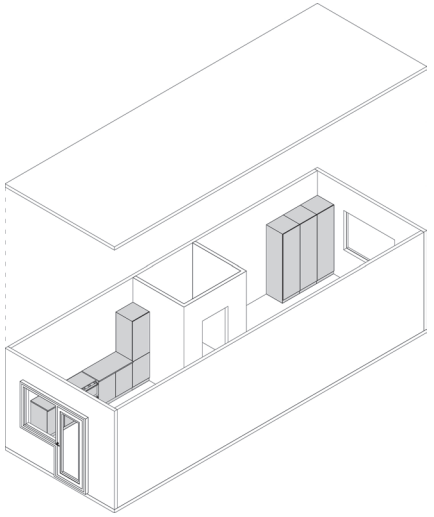
The module is treated with fire protection on the internal walls.



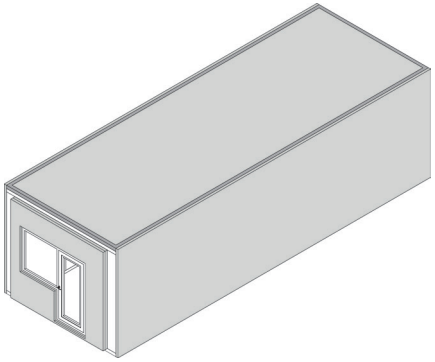
The finishing floor in the module is installed at the same time as the windows and doors.



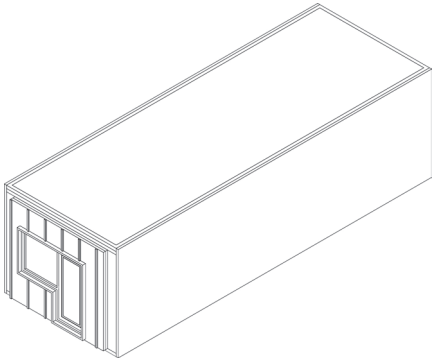
Moisture barriers and finishing is mounted in the bathroom.



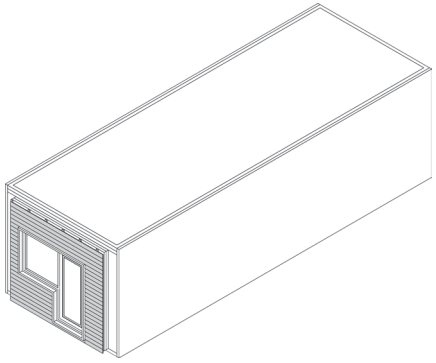
Kitchen and wardrobes are installed.



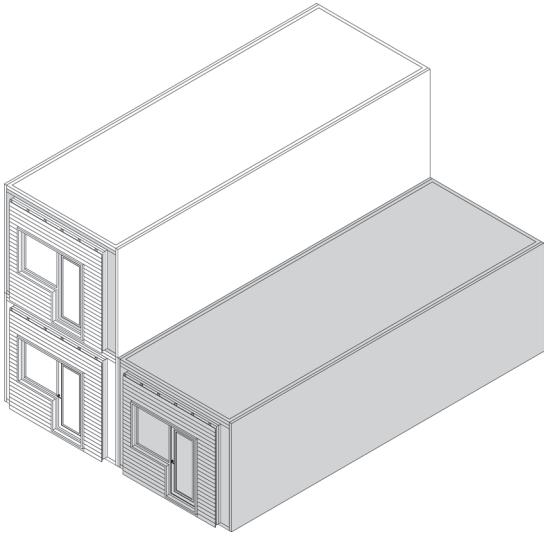
The module is covered in insulation and vibration protection is mounted on the roof.



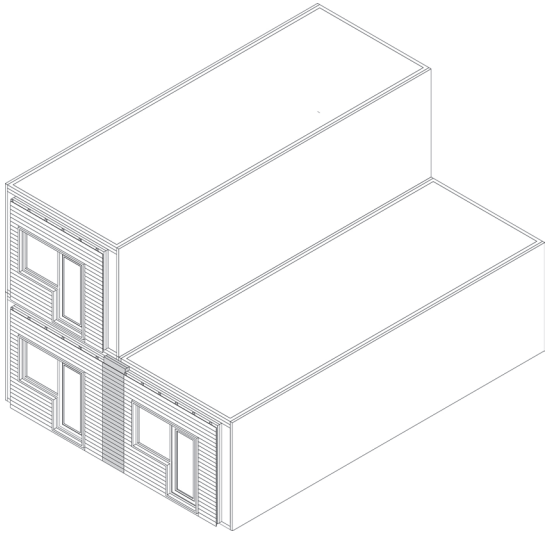
The structure for the facade is mounted.



The facade is mounted leaving some areas free to be able to join the modules on site.



On site, the modules are assembled in a steps formation for stability reasons. The modules are attached with metal sheets.



The joints are covered with moist protecting material before insulation and facade is attached on top.

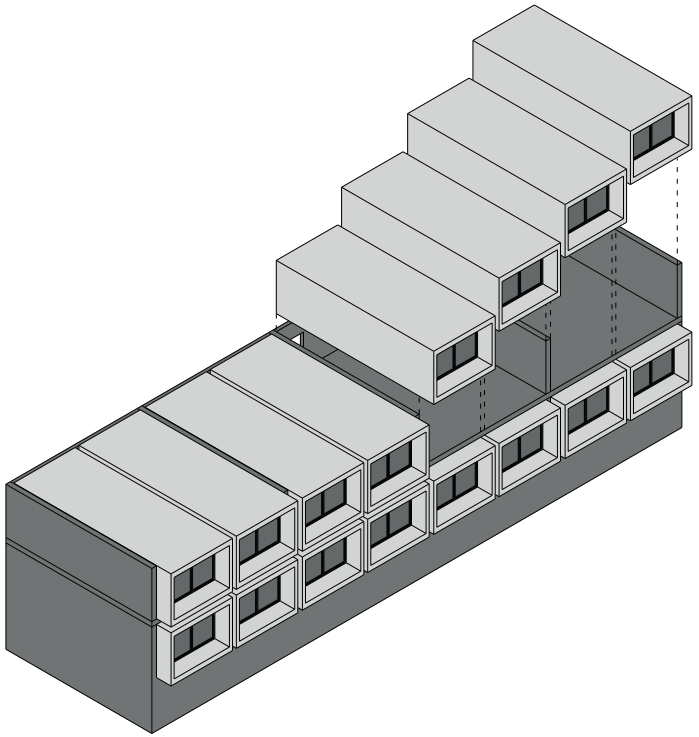
CASE STUDIES

SNABBA HUS VÄSTBERGA

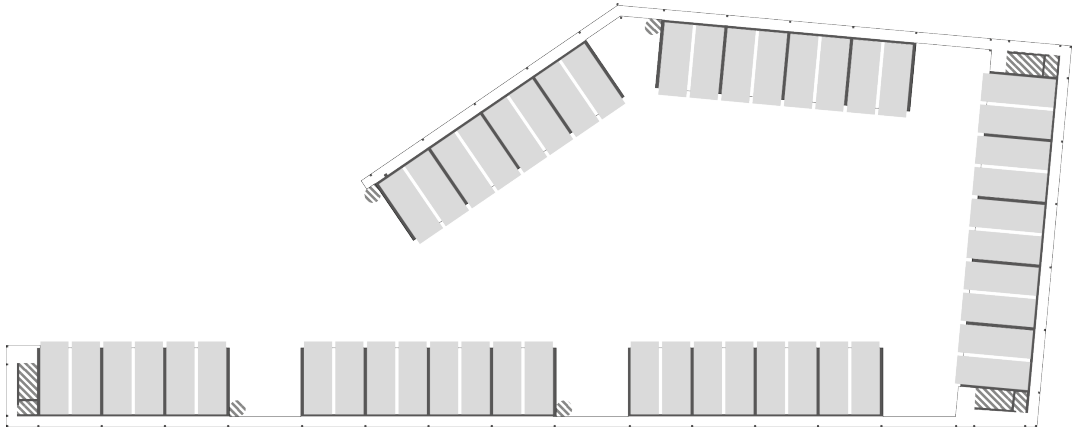
Stockholm, Sweden.

architect: Andreas Martin-Löf
size: 15'000 m², 280 apartments.
typology: temporary youth housing
material: concrete, timber, polycarbonate
apt. size: 31-33 m²

The projectis constructed of prefabricated apartment modules that are placed in a concrete structure shaped according to the specific site conditions (Snabba Hus, 2019). The building complex consists of 6 buildings that are connected by semi-external circulation balconies surrounding a common courtyard. The balconies are covered in prefabricated polycarbonate and aluminium slatted panels. (Andreas Martin-Löf Arkitekter, 2019)



building composition



floorplan diagram

ANALYSIS

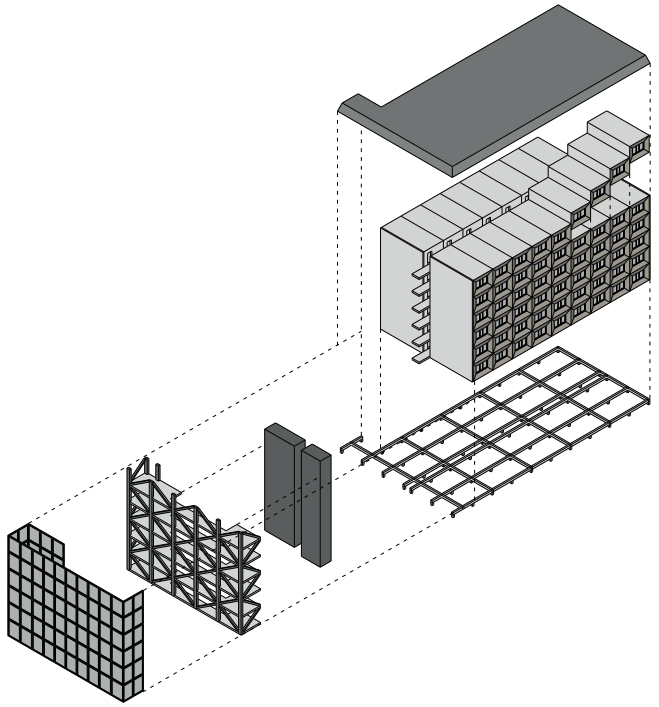
The system allows for flexibility when it comes to shape of the finish building since it has a separate circulation construction that can bind together different blocks of buildings. The architect takes great use of the modularity in the expression of the building, but one can question if the great amount of concrete is necessary and if it in fact is very mobile.

GIBRALTAR GUESTHOUSE

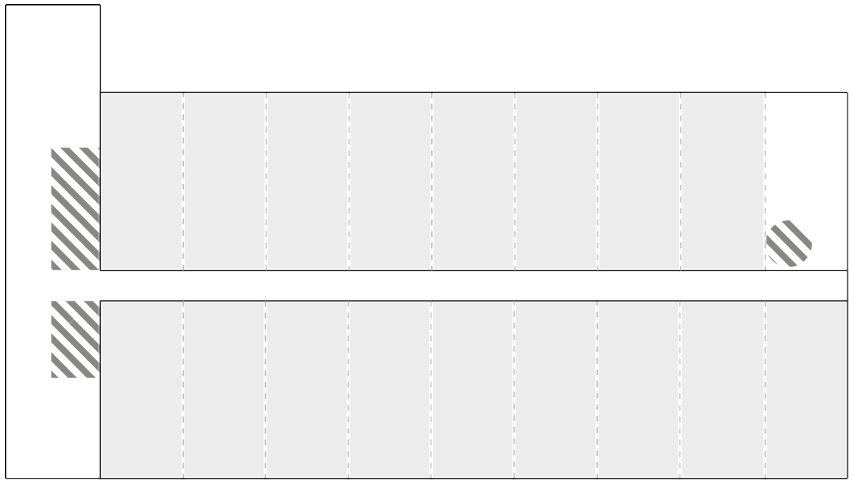
Gothenburg, Sweden.

architect: Bornstein Lyckefors
size: 4600 m² , 100 apartments
typology: temporary student housing
material: timber modules, gulam, glass
apt. size: 28 m²

The building is a hybrid building where different types of timber construction are combined. It consists of prefabricated timber modules that are combined with a glulam structure (Bornstein Lyckefors, 2019). The modules are arranged along an internal corridor that ends in a six-storey glazed common area. It stands on a temporary building and is intended for students and guest researchers on Chalmers University. (Chalmers Studentbostäder, 2019).



building composition



floorplan diagram

ANALYSIS

The enclosed and compact system makes the shape of the building fixed which can make it hard to adapt to other types of sites.

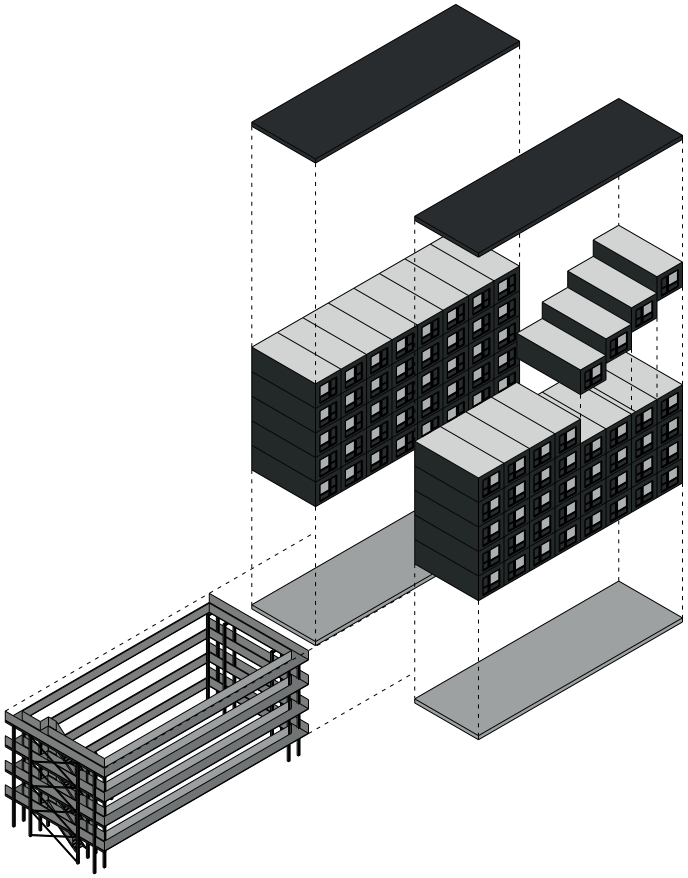
The pier foundation makes minimal impact to the site which makes it beneficial to a temporary building permit where the site must be restored after the expiration of the permit.

ZUIDERZEEWEG

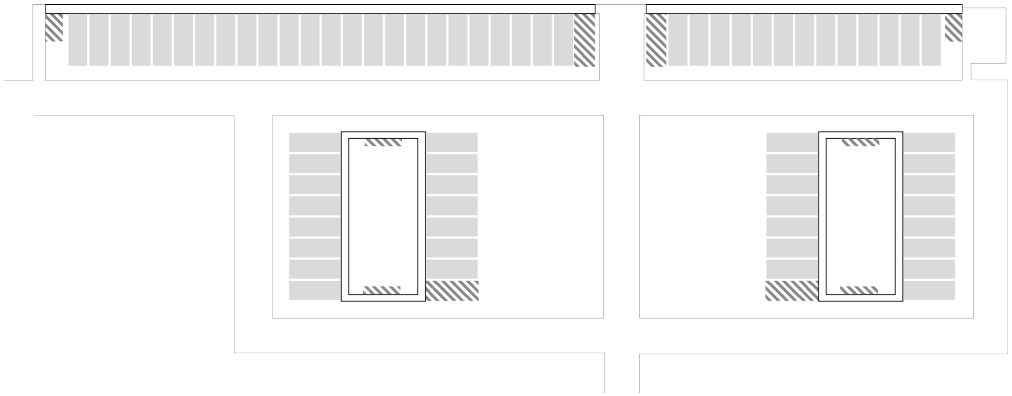
Amsterdam, The Netherlands.

architect: Fact Architects
size: 12395 m², 335 apartments
typology: temporary student housing
material: steel with timber facade
apt. size: 30m²

The project is a temporary project containing student apartments. The modules are constructed of an insulated steel skeleton that are covered in a black timber facade after assembly. Circulation takes place on exterior circulation balconies. Two of the buildings are connected to circulation structure that creates blocks surrounding a cortyard while the other two are linear volumes with circulation stretching along the sides (Fact Architects, 2019).



building composition



floorplan diagram

ANALYSIS

The project shows two different building shapes of module combinations using steel circulation which shows capacity of adaptability and flexibility of the system.

The united timber facade gives a sense of robustness that makes the building feel less temporary.

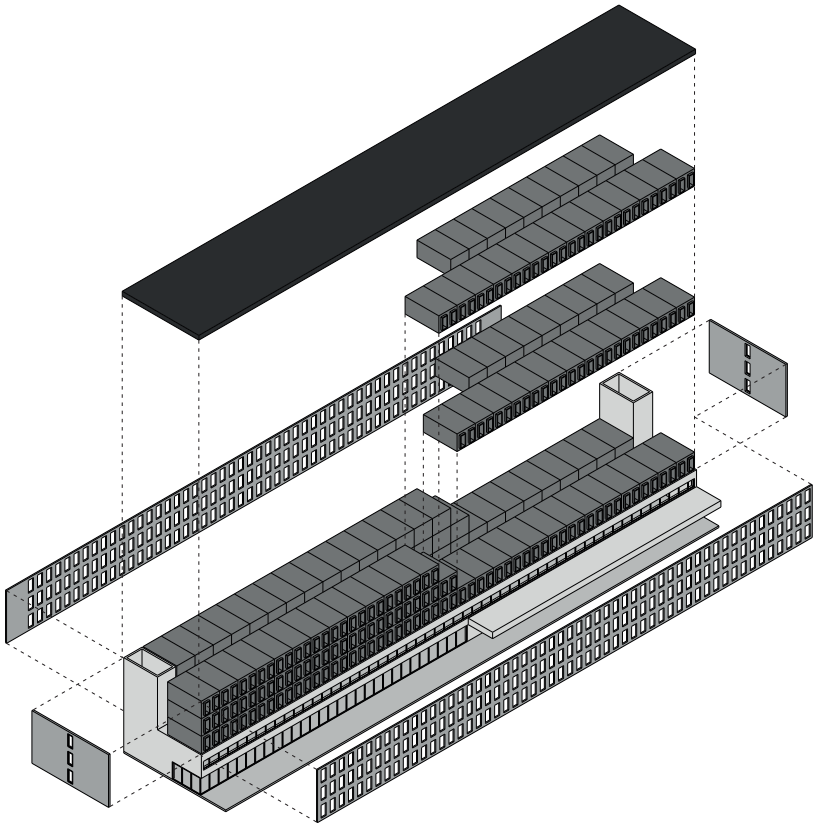
BMW AMMERVALD

Reutte, Austria.

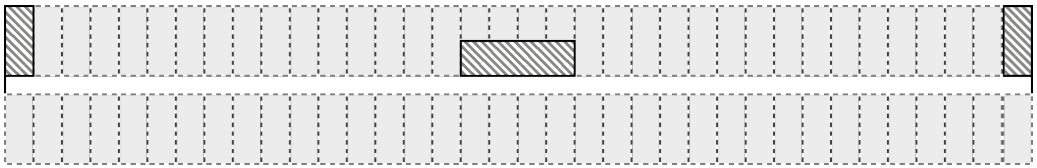
architect: Oskar Leo Kauffmann & Albert Rüf
size: 12395 m², 335 apartments
typology: permanent, hotel building
material: concrete, clt modules

The project is not a temporary one but uses prefabricated CLT modules in the construction. The modules are placed on top of a concrete foundation and faces an internal corridor.

The modules are attached to each other before the facade is mounted which makes it less temporary and flexible but gives a less temporary expression from the outside (Mörz, 2009).



building composition



floorplan diagram

ANALYSIS

The project shows how CLT modules can be used in permanent construction. The base of concrete adds to the permanency of the modules. The facade is mounted after the assembly which makes unites the building. The internal corridor and the facade makes the shape of the building very fixed and decreases the flexibility of the building.

DESIGN PROPOSAL

STAKE HOLDERS

Trends shows an increase in one person households. This however doesn't mean that there is no need for larger apartments. The stakeholders of this building will be people that is not yet a part of the housing market, and who are waiting for permanent dwellings. These people will probably be young people that are moving in to their first own apartment r newly arrivals in Sweden. The system will therefore consist of both apartments that are suited for single households but also apartments with additional bedrooms for larger households.

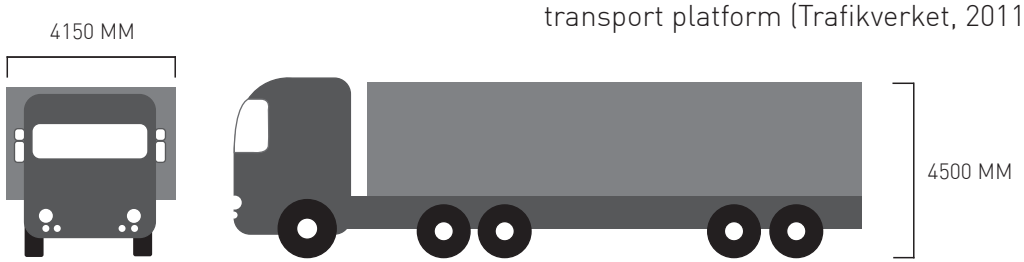
CONTEXT

This project is a modular system for buildings and is therefore not site-specific. The project contexts will instead be based on made-up scenarios of building placed on different sites in different contexts.

The different contexts are made up to require different typologies of buildings to show the possibilities of the system.

LIMITATIONS

The limitations in the design of the system is based mainly upon the maximum transportation width on Swedish roads which is maximum 4,15 meters. The length is more flexible and has been decided of the space all the functions requires. The height of the module is limited from the free height on Swedish roads. This height is 4,5 meters. The height of the module is therefore decided from the height of the transport platform (Trafikverket, 2011).



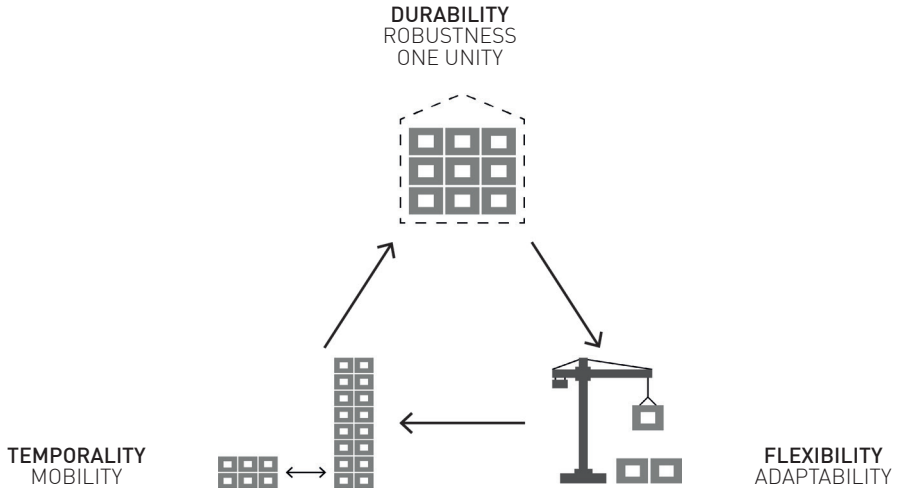
DESIGN CONCEPT

The research and the analysis of these projects resulted in 3 key concepts for how to solve the task of the thesis question:

Durability - when it comes to expression, to create a building that has the robustness feeling of one unity.

Temporality - to maintain the mobility of the robust and united building and make it easy to disassemble.

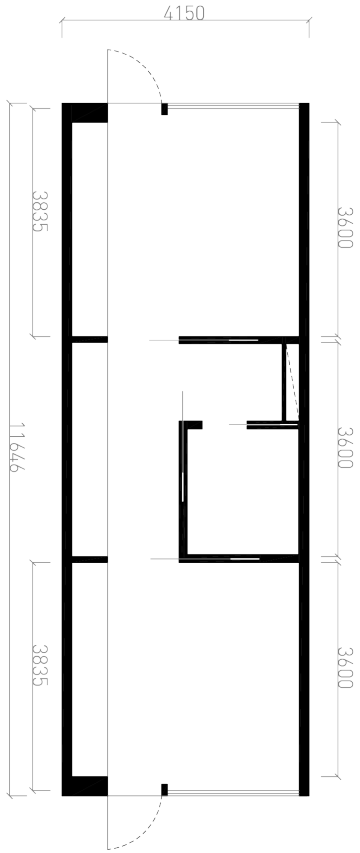
Flexibility to create a building that can adapt to different situations and context to make is durable through time.



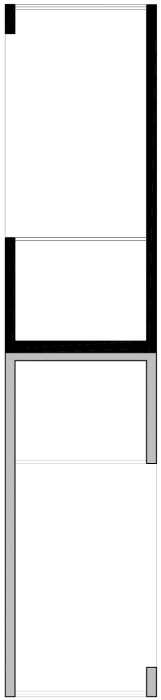
THE MODULAR SYSTEM

The modular system is based on two different sizes of modules. One that includes all the basic functions of a home and one that is added on to provide larger extra space.

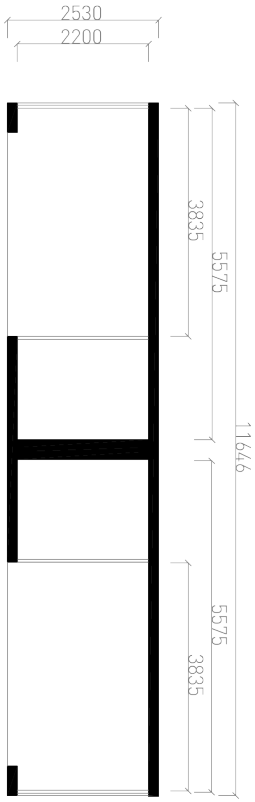
The module is symmetrical with two identical rooms on each façade of the module which both has an entrance door included in the window component towards the façade. The symmetry allows the module to be used in both directions and the door that isn't used as an entrance can be used for ventilation or as a balcony door.



modul 1.



modul 2.1



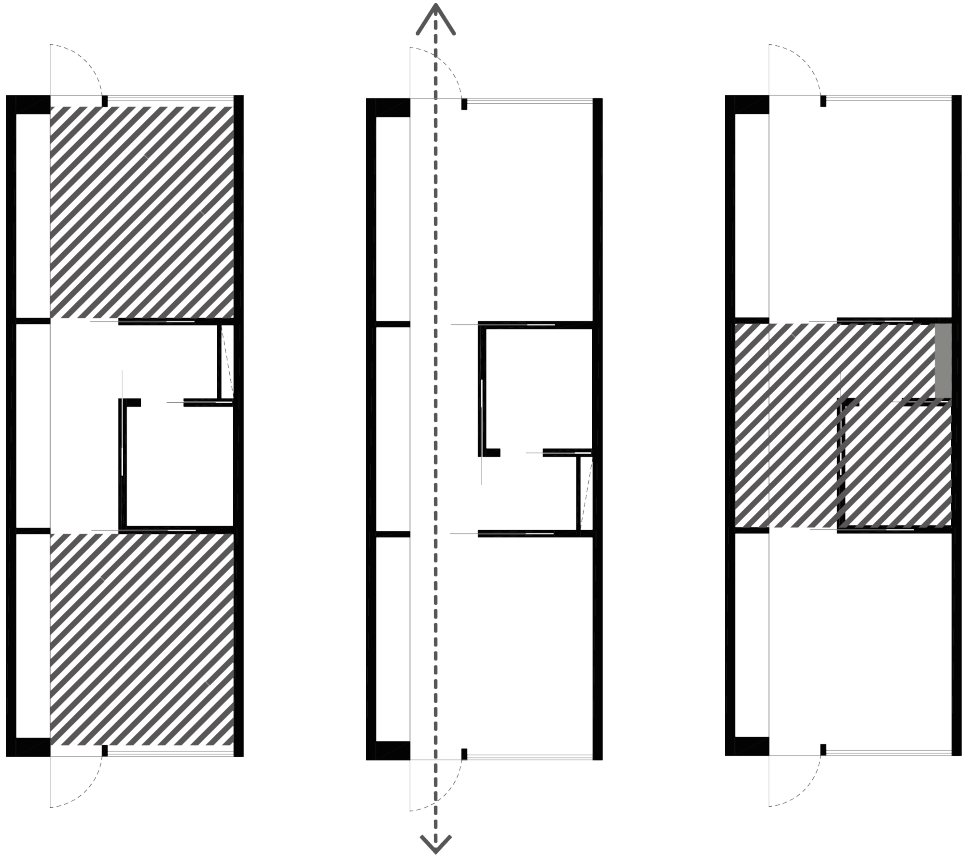
modul 2.2

THE BASE MODULE

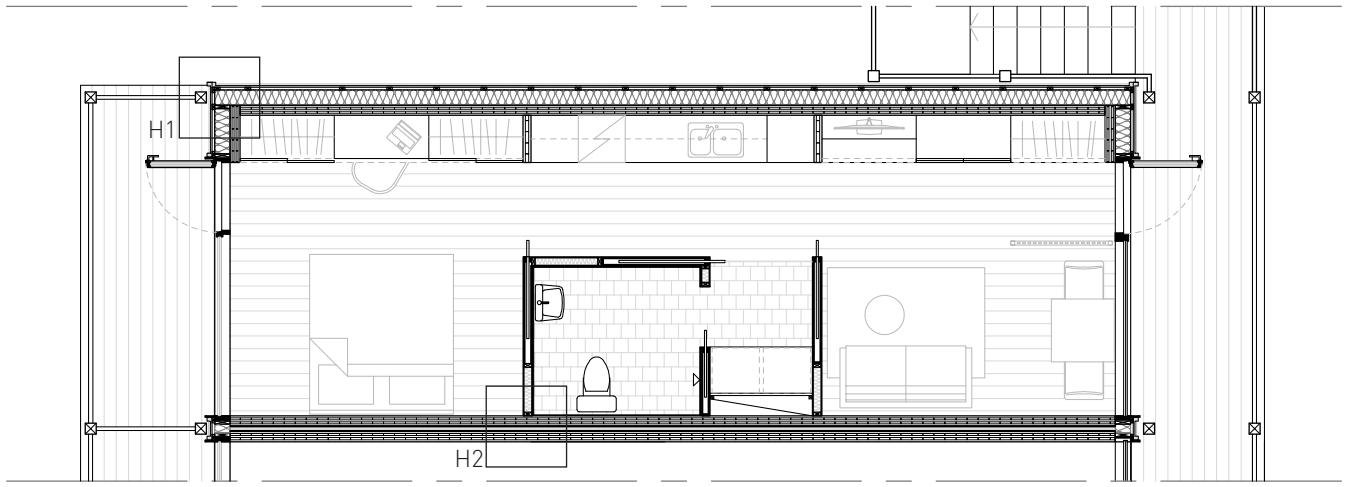
The base module contains two equal rooms located towards each facade with connection between them providing a clear sightline through the apartment.

The centre of the module contains all the wet areas and the installation shaft. Installations are placed in a lowered roof and in a vertical shaft.

The symmetry makes it possible to use the same module in two directions which creates a flexibility in the system and makes the production of the building more efficient since only one type of module needs to be constructed.

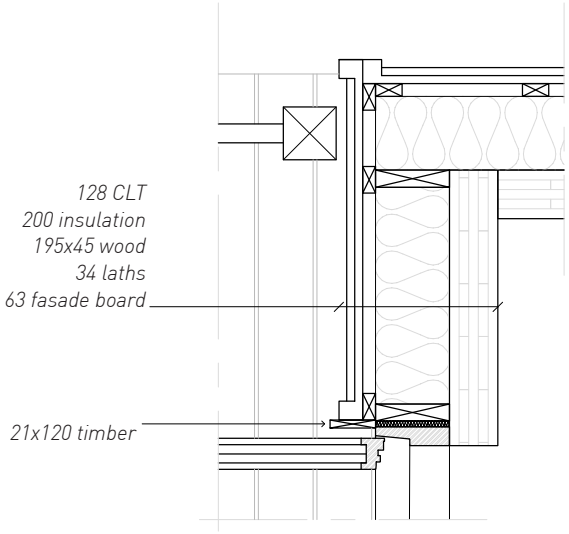


symetry *sightline* *wet area*

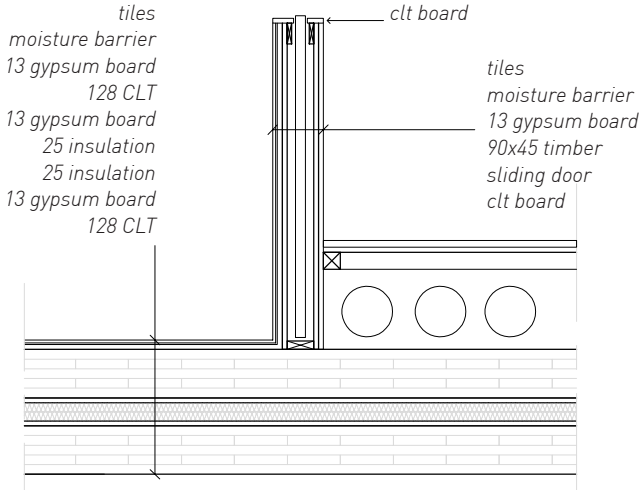


plan module 1.

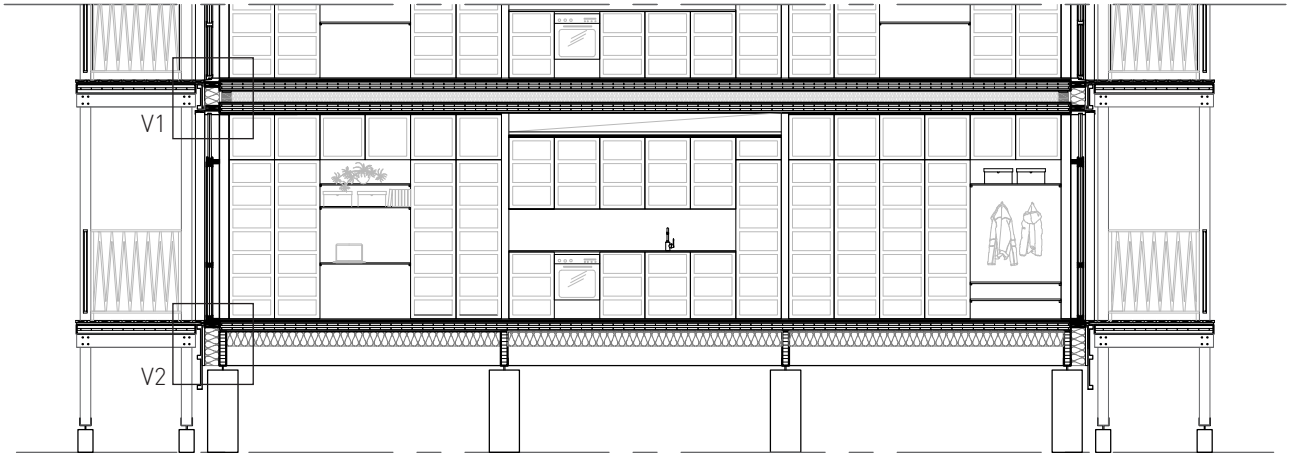
1:100


128 CLT
200 insulation
195x45 wood
34 laths
63 fasade board
21x120 timber

H1 1:20

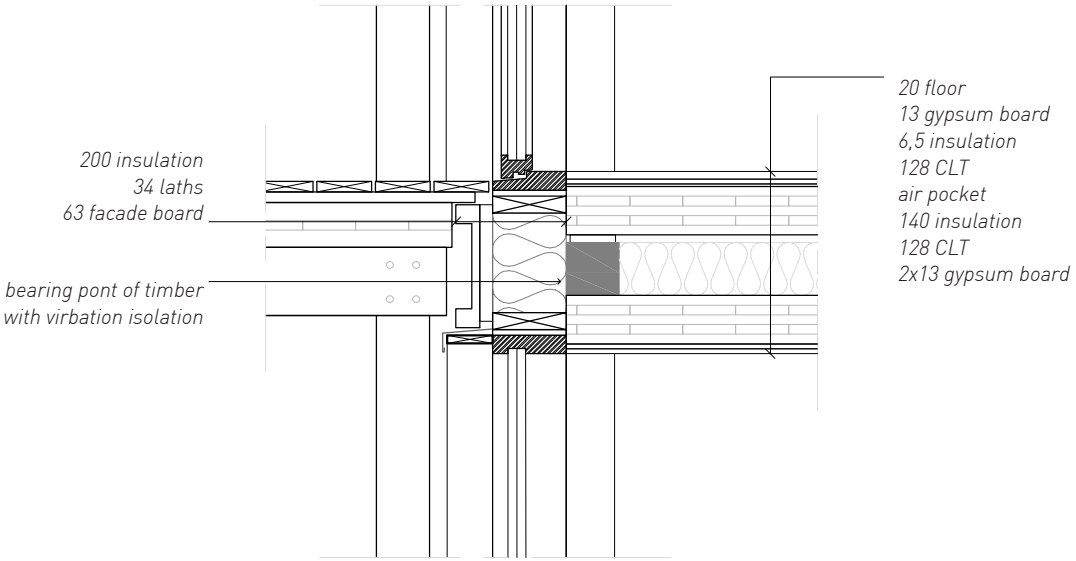

tiles
moisture barrier
13 gypsum board
128 CLT
13 gypsum board
25 insulation
25 insulation
13 gypsum board
128 CLT
clt board
tiles
moisture barrier
13 gypsum board
90x45 timber
sliding door
clt board

H2 1:20

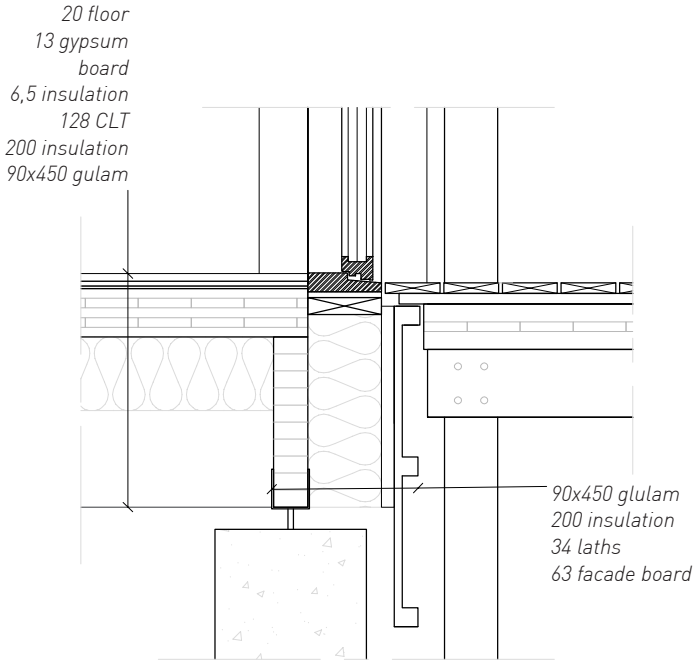


section module 1

1:100


200 insulation
34 laths
63 facade board
bearing pont of timber
with virbation isolation
20 floor
13 gypsum board
6,5 insulation
128 CLT
air pocket
140 insulation
128 CLT
2x13 gypsum board

V1 1:20

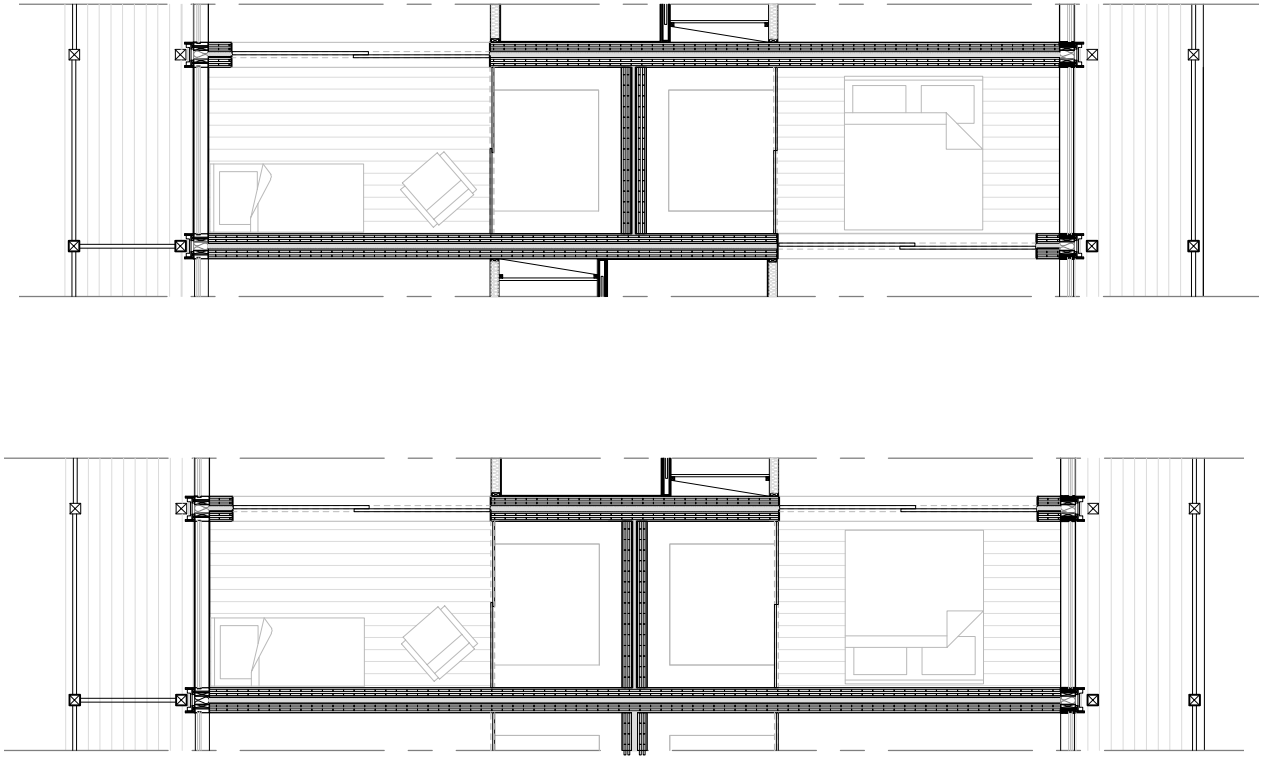

20 floor
13 gypsum
board
6,5 insulation
128 CLT
200 insulation
90x450 gulam
90x450 glulam
200 insulation
34 laths
63 facade board

V2 1:20

THE SECOND MODULE

To be able to provide for apartments larger than the base module, a second module has been designed. This module comes in two variations and is symmetrical. It has been created from the measurements of a double bed which creates a narrow module that is efficient in space and, together with the base module, creates a variation in the facade.

The first variation of this module has one room facing each direction while the other has two that faces the same direction. The middle of the module contains a storage space in the inner core where a lowered roof contains installation. Sliding walls separates the module from the base modules and bedroom from the storage space.



dry modules

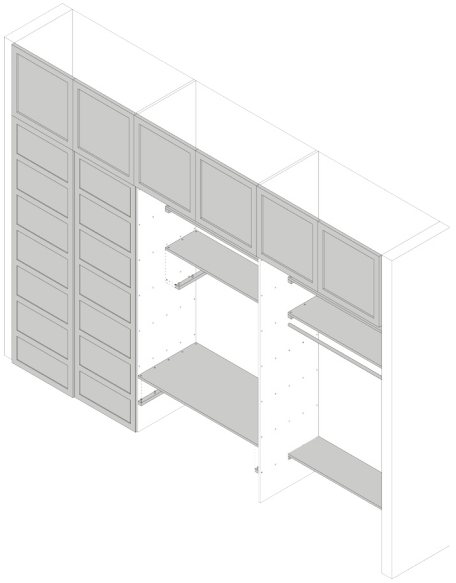
1:100

FUNCTION WALL

The dry module is equipped with a storage stretching through the whole apartment. The middle part contains the kitchen which is excessively large for an apartment of this size but makes it possible to use the same base module when creating larger apartments.

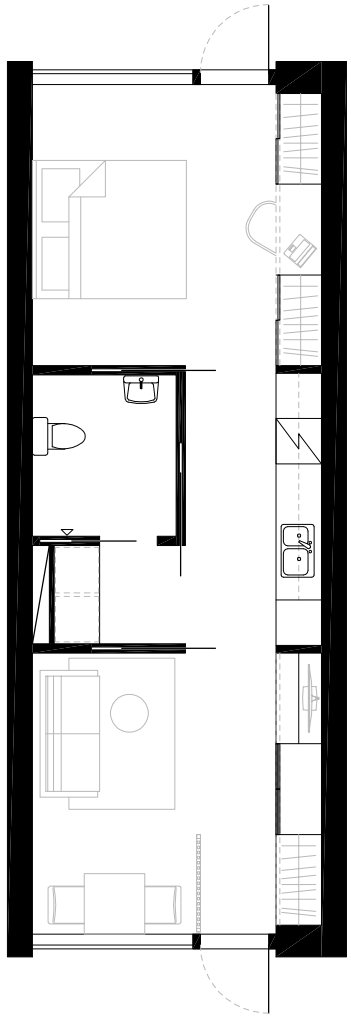
In the two rooms the storage is divided into three sections of 1.2 meters and has 4 sliding doors that makes it possible for the resident to open or close two of the sections.

The interior of these sections has a flexible shelving system that can be adjusted according to use. They can for example contain study space with a desk, a foldable bed, be an open shelf or be used as a tv-furniture. Above the flexible shelving system six fixed lockers are placed to take advantage of the full ceiling height.



part of function wall

function wall variations



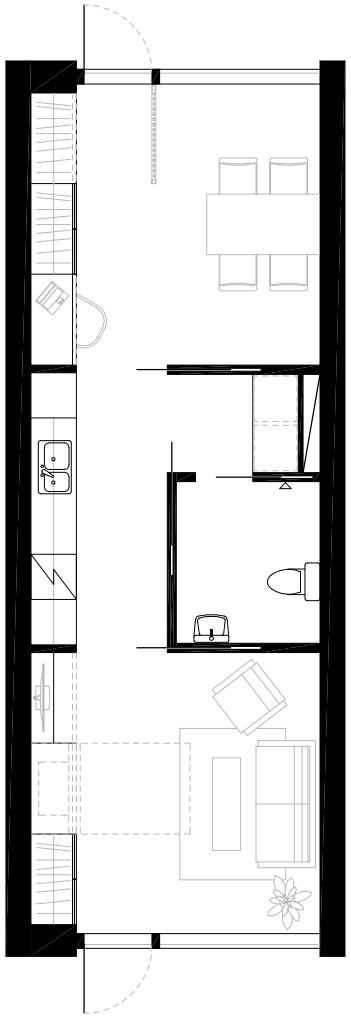
isometric drawing of the base module

the function wall stretches through the apartment

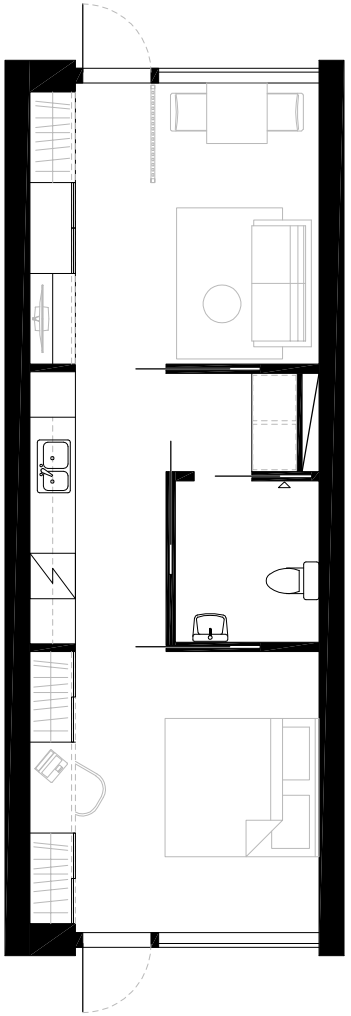
THE APARTMENTS

The different apartment provides the system with four different apartments. The first apartment consists of only the base module and is 42m². The second and third apartment type is based on one and a half module and is 52,3m² and the largest apartment based on both modules is 62,6m².

The modules can be stacked together in different combinations which makes it possible to decide what types of apartments each building should contain.



apartment 1. 42 m²



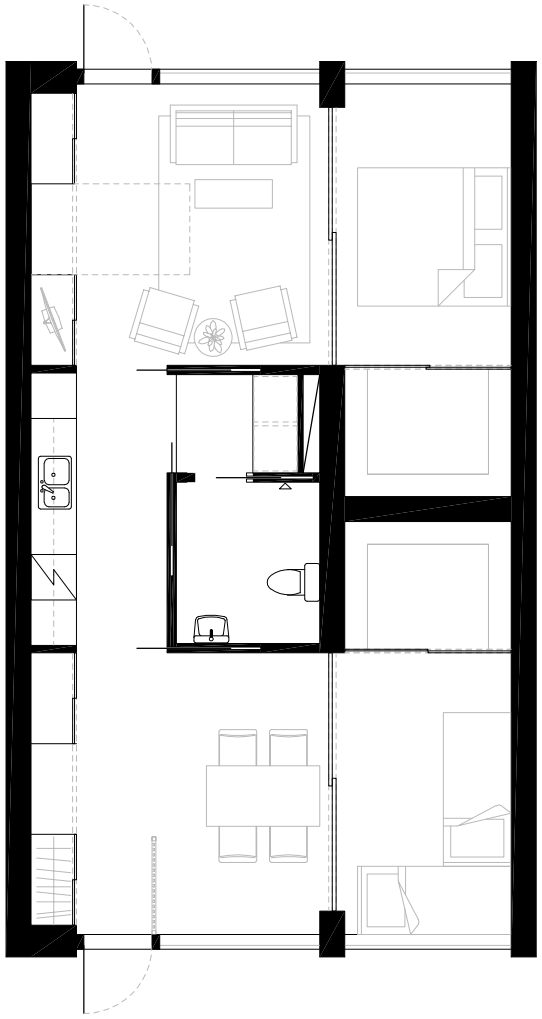
1:100

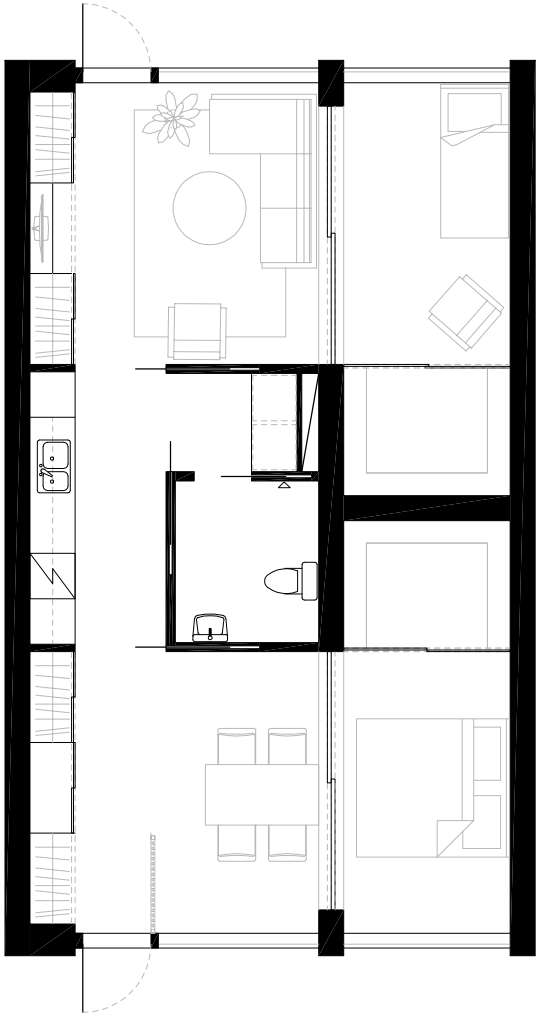
apartment 2. 52,3m²

1:100

apartment 3. 52,3m²

1:100





apartment 4. 62,6m²

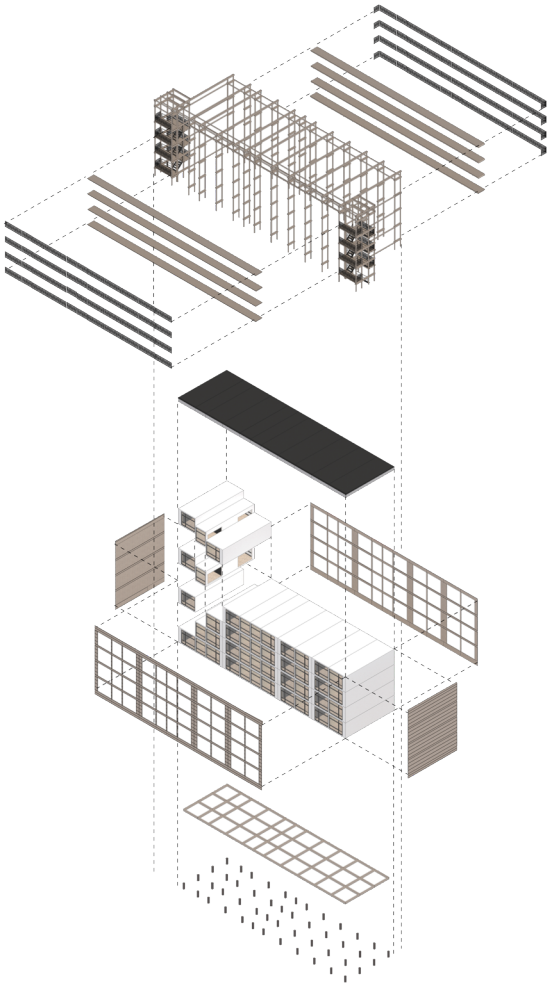
1:100

view through module joint

BUILDING COMPOSITION

The composition of the building must be strict but flexible. The modules are general to be able to use in different compositions but still must make it possible to shape different interior atmospheres.

In the following pages, three examples on buildings constructed by using the same modules are designed to show the flexibility of shape and scale. The buildings can be designed to fit different sizes and different context by adapting the free glulam structure that is used for vertical circulation and entrance balconies.



FOUNDATION

This building system is constructed with a foundation consisting of a glulam grid that is placed on top of pillars. This makes it possible to place the building on any site without the need to flatten out the site.

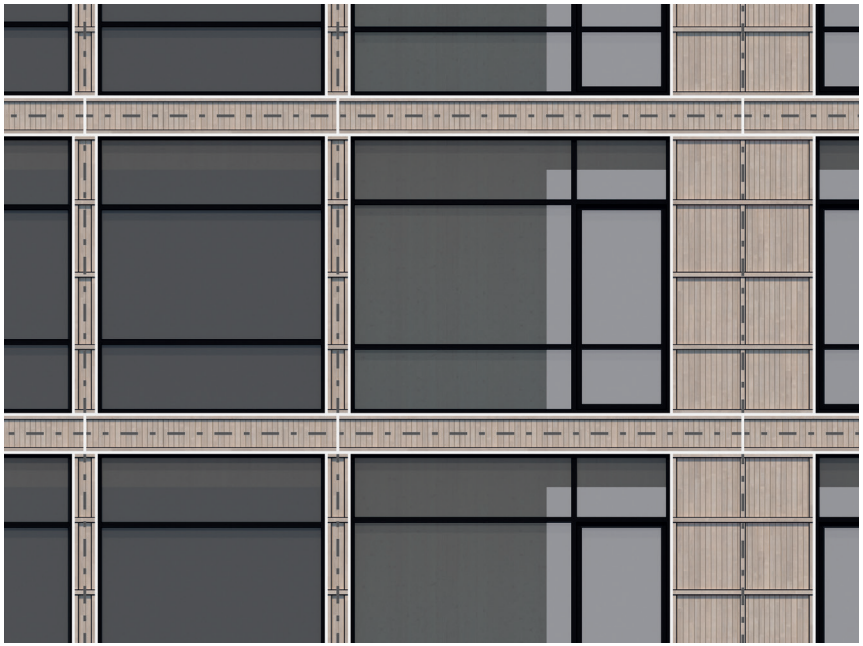
The pier foundation is flexible but is of course not optimal on all sites. Depending on the site condition another solution might be more beneficial. The system can be placed on any type of system and it is important to understand that the foundation typology can't be solved in advance since all since all sites has different conditions. This is a non-site-specific project and it must therefore be evaluated when the building has a site.

THE FACADE

The main part of the long façades of the building is glased by the large windows in in the module. The windows are divided in horizontal sections where the lowest and the highest sections consists of fire protected glass to prevent fire from spreading between the modules.

The rest of the facade is constructed of prefabricated façade components. These are designed with wooden battens in several layers to create a depth in the facade and covers the joists between the modules.

The components are mounted after the assembly of the modules and can be disassembled when the building is going to be moved.

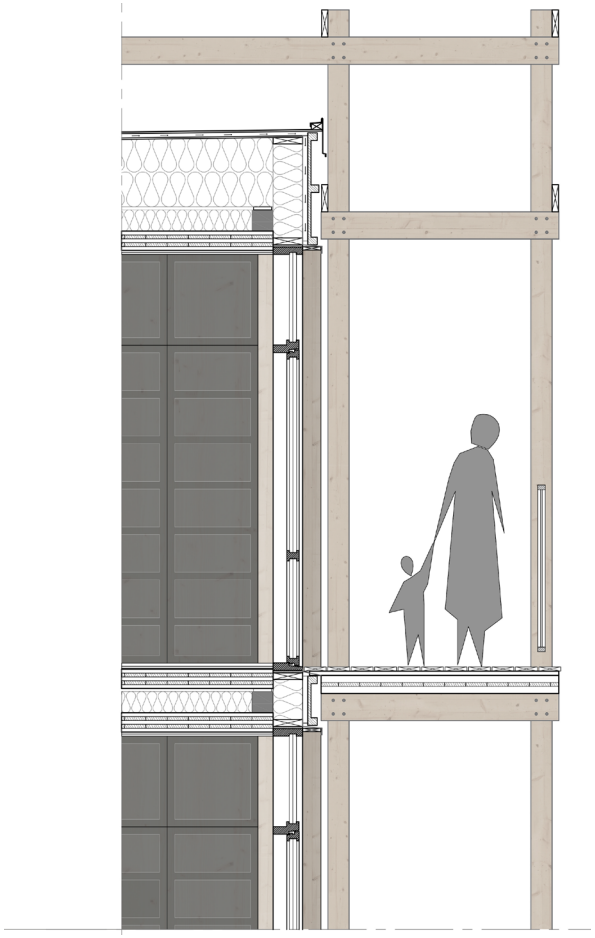


facade components in relation to module joists

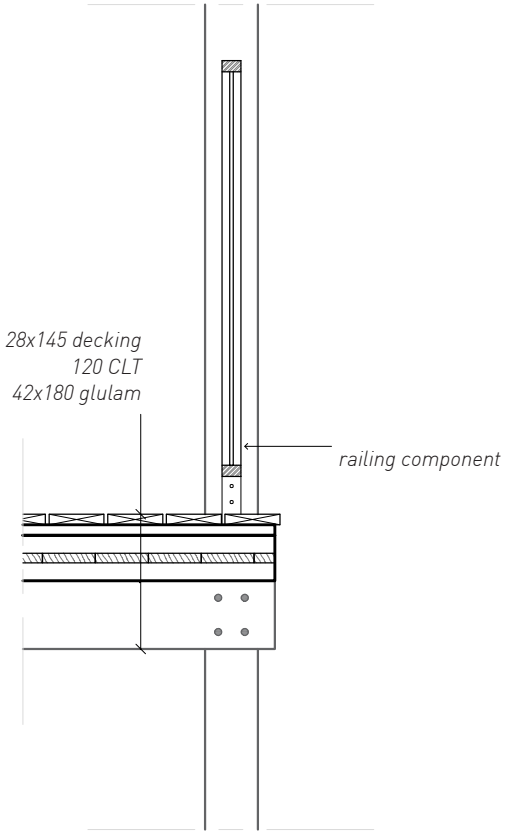
ENTRANCE BALCONY

The vertical and horizontal circulation is placed on a separate structure surrounding the building. This structure consists of a glulam grid that caries the load of horizontal entrance balconies, stairs and private balconies on each side of the façade of the building. The beams and pillars of this structure is joined by large bolts so that the structure can be dismantled into components and be reused.

After the assembly on site a metal sheet is mounted between the façade of the building and the CLT slabs to create a fire screen that protects flames from spreading through the facade of the building in case of fire.



facade detail 1:50



1:20

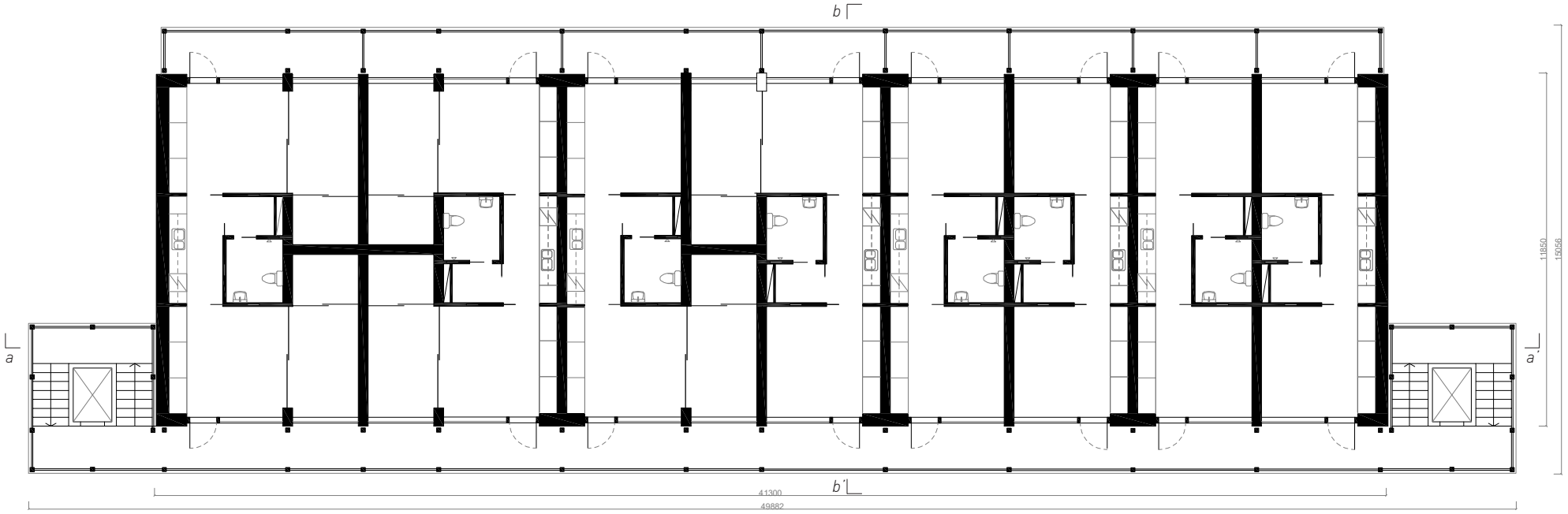
facade zoom-in 1:50

facade rendering

A BUILDING

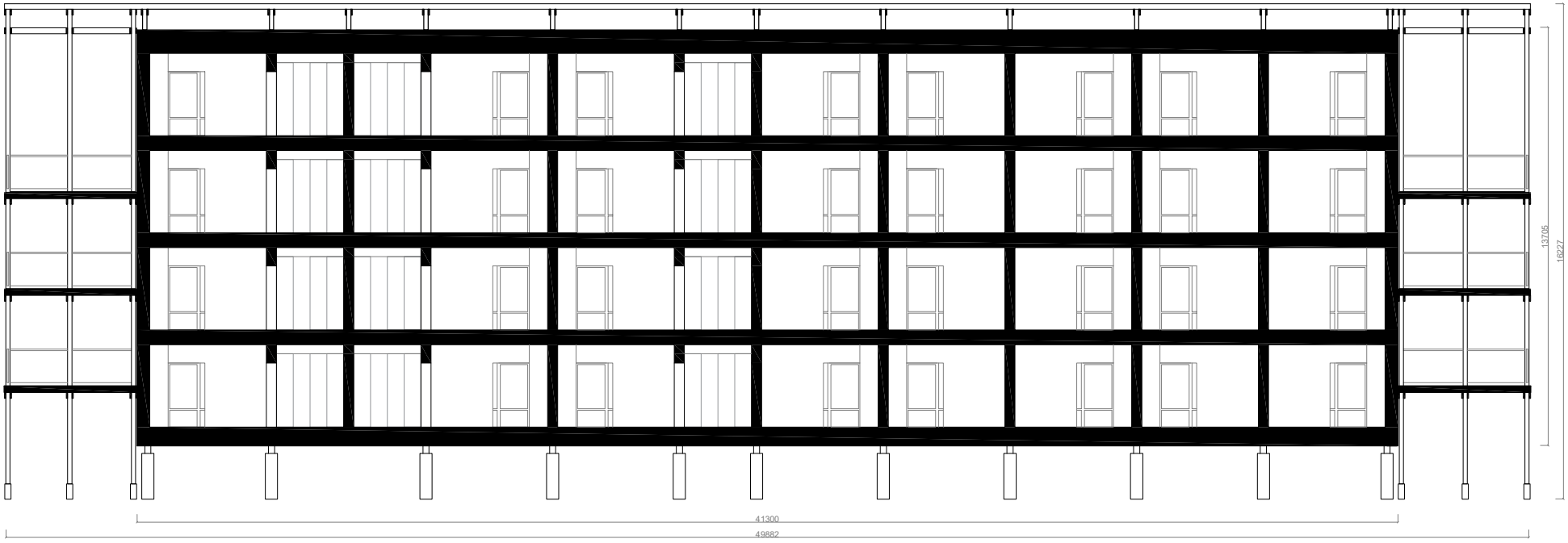
The following pages shows the construction of a building in the shape of a lamella. The building is a 4-storey building with a variety of apartments on each storey.

Private balconies and public entrance balconies are placed on each side of the building and vertical circulation on each end of the building.



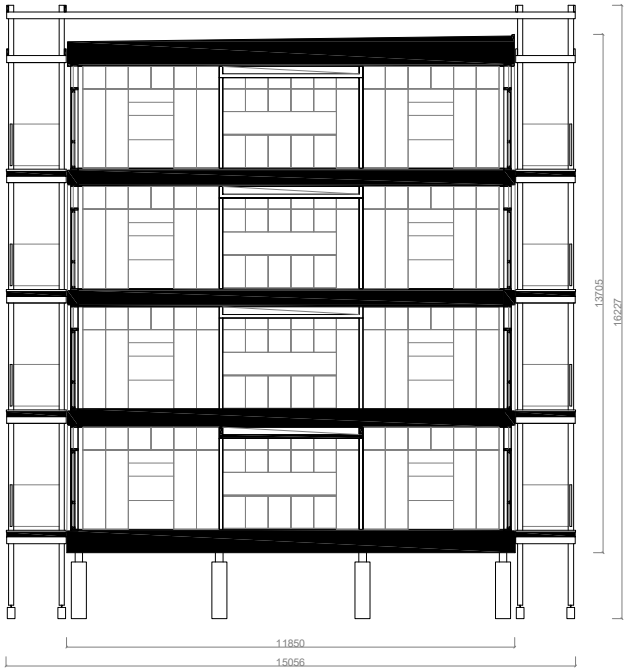
lamella structure plan

1:200



section a-a'

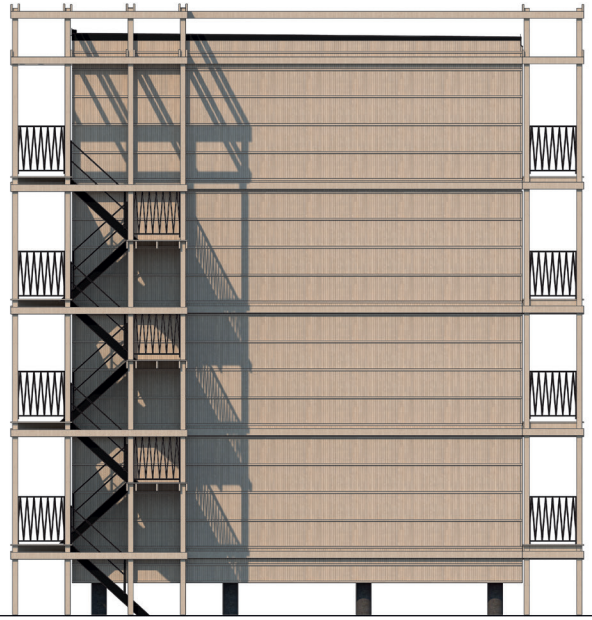
1:200



section b-b' 1:200

long facade

1:200



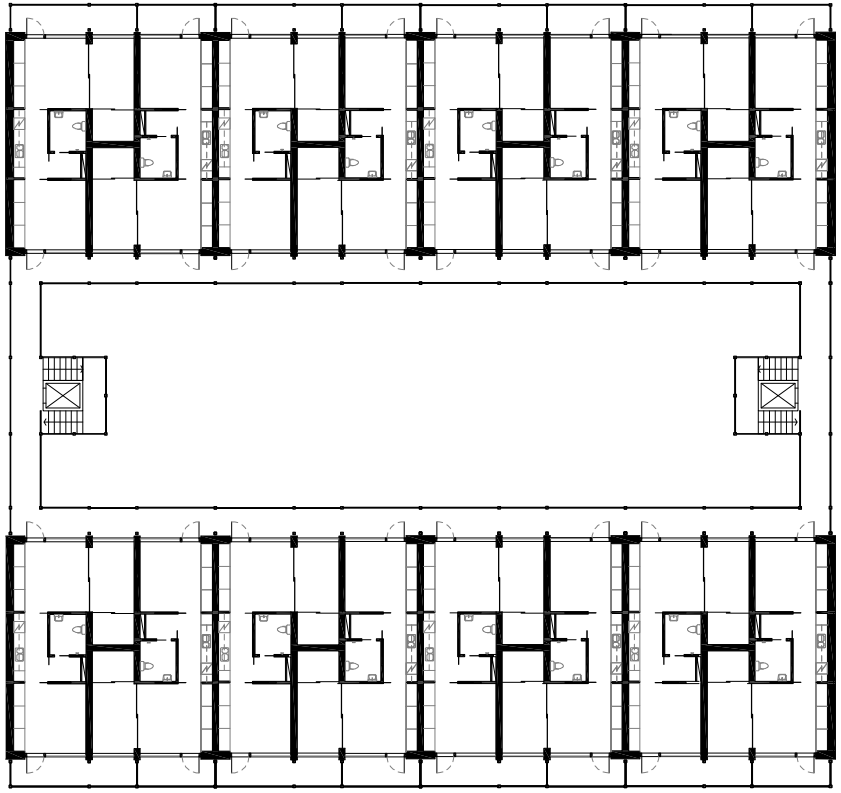
short side elevation 1:200

BLOCK STRUCTURE

By placing two lamella structures together one can create a building that suits a block structure.

The two structures of entrance balconies and private balconies are connected between the building surrounding a courtyard.

Som adjustment to the glulam structure is necessary for this structure the system is otherwise the same. This floorplan contains only two types of apartment, the ones consisting of one and a half module.



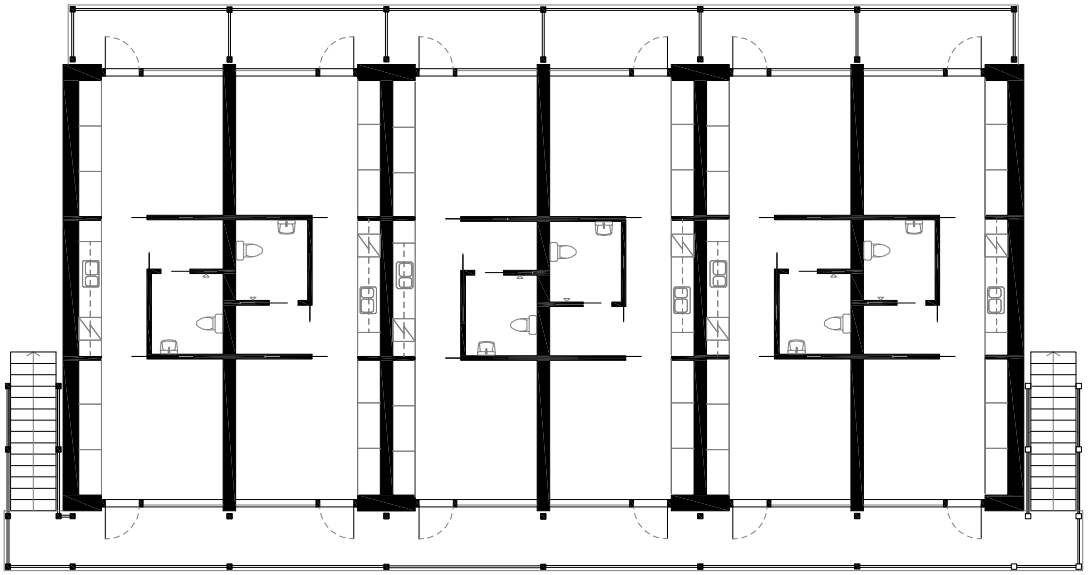
block structure plan 1:400

courtyard view

SMALL SCALE BUILDING

This drawing shows an example of how a building for a rural could look like. The building consists of 10 small apartment consisting of the base module.

These apartment can be suited for young people or as student apartments. It has linear stairs on two sides of the building entrance balconies on the front facade.



small scale apartment plan 1:200

small scale building in a hill.

FINAL THOUGHTS

With this thesis work I have managed to propose a solution on how to use mass timber modules in temporary buildings. The building and its components create a system that is flexible, durable and temporary, but what happens when the need is no longer temporary and the temporary change of regulation changes back. The building is design under the circumstances of being a temporary building but there is nothing that limits it from being permanent and with a regular building permit this building can be assembled as quickly on any site for permanent use.

The system can be adjusted to different sites and heights but requires adjustments since all situations are not the same. Some adjustments need to be done to the circulation structure depending on the building shape and scale. The same foundation cannot no fit all sites and context. This must all be considered, but the system takes advantage of the CLT modules and can be moved and adapt to different contexts.

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IMAGES AND DOCUMENTS

All photographs and images are taken or made by the author.