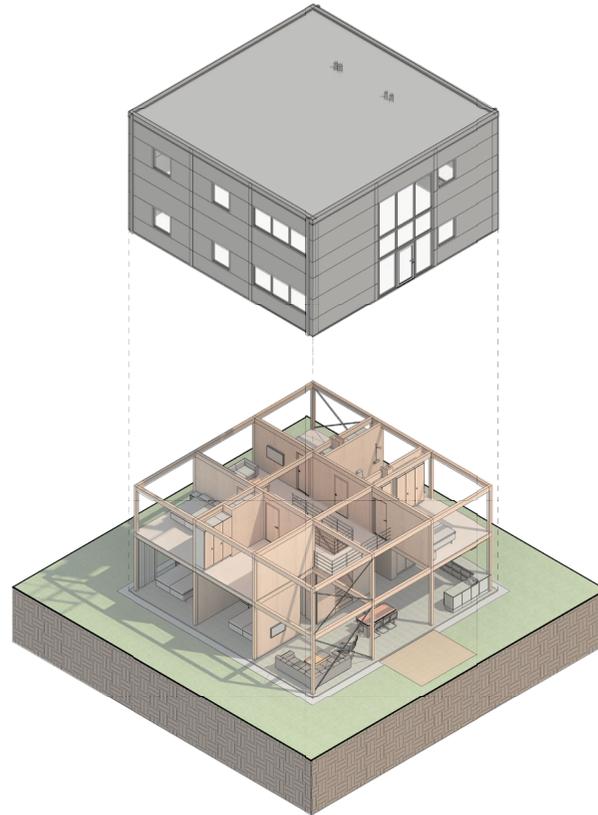


AFFORDABLE HOUSES

A NEW WAY TO GET MORE PEOPLE TO AFFORD A HOUSE



“A STRATEGY ON HOW TO USE FACADE MATERIALS COMMONLY USED FOR INDUSTRIAL BUILDINGS,
IN ORDER TO REDUCE THE STARTING COST OF A HOUSE”

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EXAMINER: MIKAEL EKEGREN
SUPERVISOR: BJÖRN GROSS

CHALMERS UNIVERSITY OF TECHNOLOGY
2018



CHALMERS

AFFORDABLE HOUSES

A NEW WAY TO GET MORE PEOPLE TO AFFORD A HOUSE

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2018
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PREFACE

I want to give a special thanks to:

PAROC
ALUMAN
BIDCON

Tutor: Björn Gross
Examiner: Mikael Ekegren

2018
Chalmers University of Technology
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ABOUT THE AUTHOR

During my the bachelor, I realized that the housing-building topic was something that interested me the most. I like the task of finding good floor plans, where the movement in the building, the experience of space and the light conditions place its part. Therefore, during the master period I choose to take the courses most related to housing,It has given me a wide variety of insights into housing building and design.

I wanted to find a topic that is close to me and the housing shortage is something I'm passionate about, because I'm looking for a house myself and I have seen how hard it is to get a good house that does not cost a fortune. And I know there are many other people who want to live in a single family house.



ABSTRACT

The aim of this master's thesis is to investigate the possibilities for a new way of building single-family houses.

Sweden is and has been in a housing shortage for a while now, the number of inhabitants increases both through immigration and the fact that people are getting older than before. There are many factors behind the housing shortages, but part of it is the construction industry. They focus on building multi-family buildings because it is the most profitable way to build now and many people think it's the solution to the problem.

But during investigations it has been found that approximately 7 out of 10 people want to live in a detached house. As fewer single-family houses are being built, housing prices increase and in order to afford to buy a house, people loan more money than they could afford if the interest rate would increase in the future.

As the market is now it can be cheaper to build a new house than to buy an old house and the easiest way is to buy it from one of the catalogue house suppliers. It is a fairly simple process to buy this kind of houses and you can get a fixed price that makes it easier to borrow money from the bank. There are a lot of companies that provide this type of houses and with a similar style, especially the ones that have a lower price. The question is then how you could build a house even more efficient and with a lower price, to make it possible for more people to afford to build a house.

Through research and investigations of building methods and the prices of materials a conclusion is made that the main building material for this thesis is steel sandwich elements. By using this material that is commonly used for industrial buildings you will get a lower price with a larger usable space than if you would build with the commonly used stud-walls that is about double the thickness.

A strategy is made to show how you could build these houses in stages which makes it less expensive in the beginning and makes it possible for more people to afford a new house.

The result of this master's thesis is showing how you could build with this material in a single-family house and it is shown through a catalogue of houses with different shapes and varieties of the floor plans.

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INTRUDUCTION

BACKGROUND

Today's high demand for housing has led to a lack of labor and skills in the construction industry. The quality of buildings is getting worse, major construction faults lead to increased building costs(Christer Harrysson, Glenn Welander, 2017).

About 80 percent of Sweden's population wants to live in single-family houses, but the most built housing is multi-family houses. But group-built houses are several ten percent cheaper to build than the multi-family houses cost per square meter of apartment space(Christer Harrysson, Glenn Welander, 2017).

According to the Boverket, 127,000 homes were built between 2012 and 2015 in Sweden, and now their estimates are that 440,000 new homes will be built from 2016 to 2020 (Boverket, 2017).

It is a huge difference, an average of 81,000 homes per year.

It is then important that not only will large-scale apartment complexes be invested, but housing that the majority of the population wants to live in will also be built.

CONTEXT

The context of this master's thesis is the housing shortage and how new ways of building houses could get more houses out to the market. The project is not specific for one site or area, it is a general strategy that can be adapted to the most places.

MAIN QUESTION

- How could you make more people afford to build thier own house?

SUB QUESTIONS/INVESTIGATION

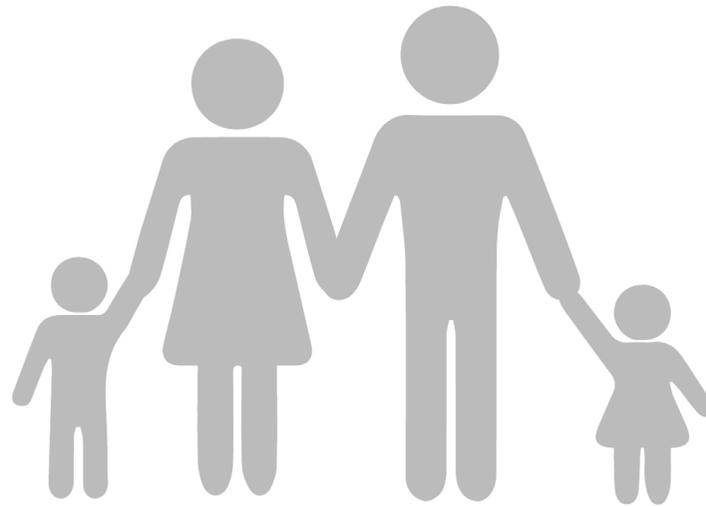
- What methods of building houses are most suitable?
- What kind of buildingmateriale are suitable?
- How could you expand the building?

METHOD

The method will be to research building methods and building material to find the most suitable way of building for the task. The design will be based on the materials qualites and constraints to make it efficient. And then through sketching by hand, building models and sketching on the computer design the houses.

FOR WHOM

The target audience for this master's thesis work is for those people who want to build their own villa or hire someone to build it for them. It is not intended for companies that mass-produce houses to get as much financial gain as possible.



INVESTIGATION

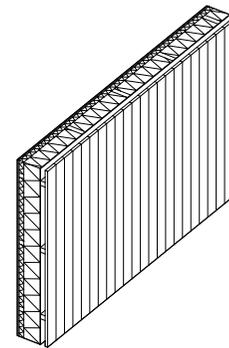
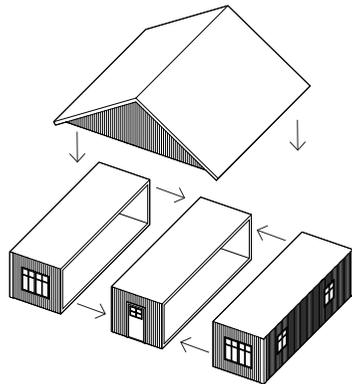
HOW DOES TODAY'S LESS EXPENSIVE BUILDINGS BEING BUILT?

The most common way of building houses nowadays is to use a lot of pre-made elements. Either it is pre-made modules or wall elements.

The way of building with modules is to build several modules at first in a factory before shipping them to the site where they are put together with more modules.

The way of building with wall elements is that you only building the wall in a factory, which are later on shipped and assembled at the building site.

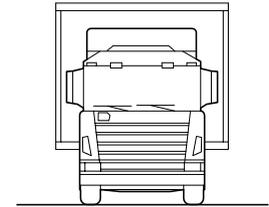
Which of the approaches you choose depends on how the house is designed, if it can be divided into module dimensions that make it possible to transport them in an easy way or if it needs to be built with wall elements.



TRANSPORTATION

TRANSPORTATION BY TRUCKS

One of the main advantages of modular buildings is that they can be built in a different location, they are usually built in an industrial building where there is weather-protected and streamlined process. After the various modules are ready they are usually transported with a truck to the site and assembled. When building with wall elements, the transport is also taken into account, getting space with all the construction parts in as few trucks as possible makes a big difference in transport costs.



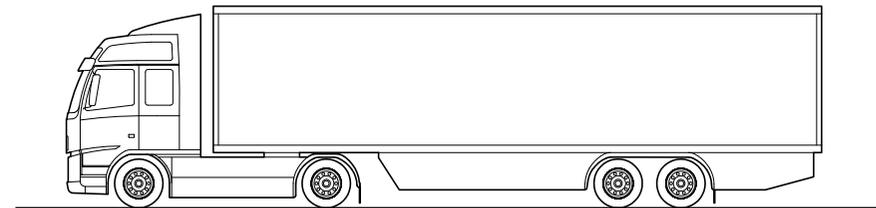
HOW MUCH CARGO CAN YOU HAVE IN A STANDARD TRAILER?

Dimensions / Load capacity - tilt trailer:

Length: 13.60m

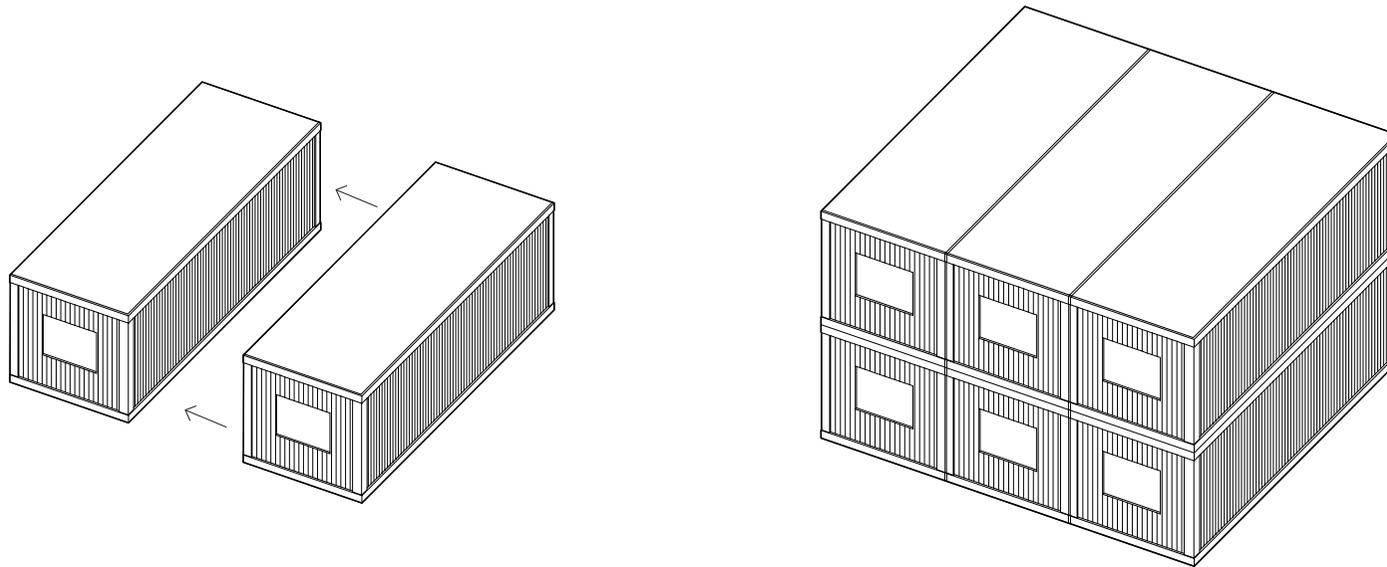
Width: 2.45m - 2.48m

Height: 2.50m - 2.70m



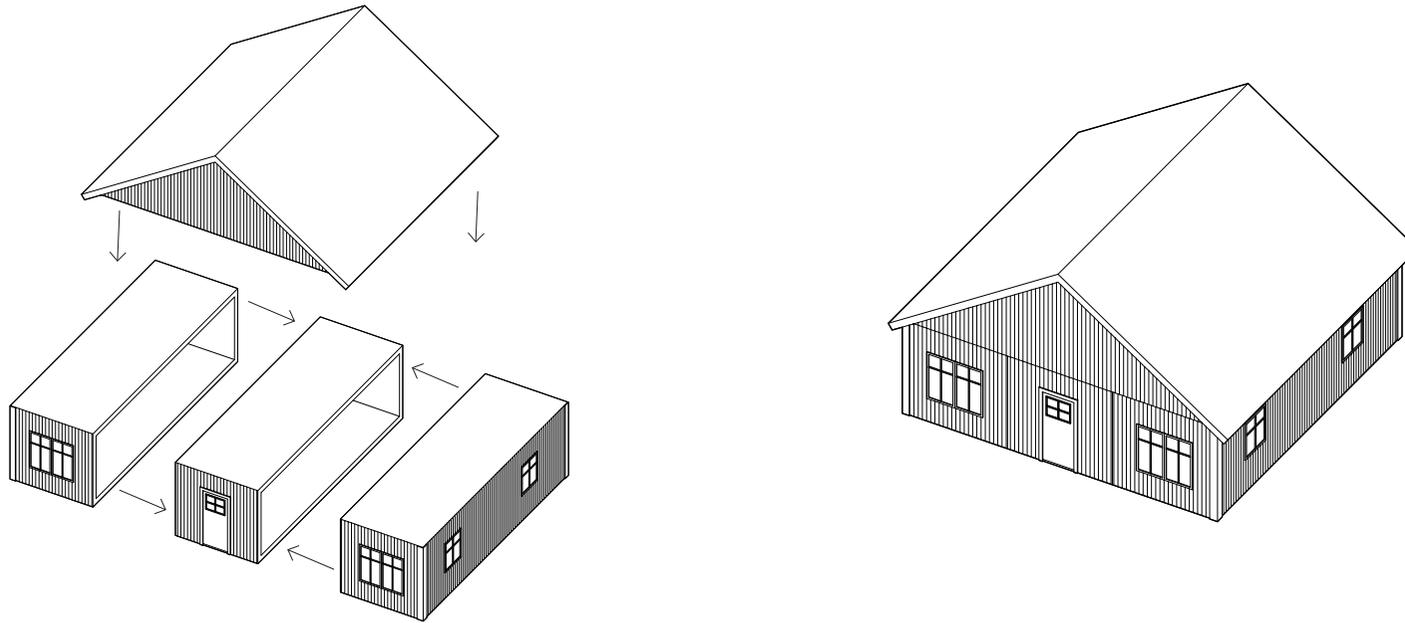
There are larger trailers as well, but if you want to minimise the costs, the standard transportation is often the best choice.

DIFFERENT MODULES - TEMPORARY BUNKHOUSE



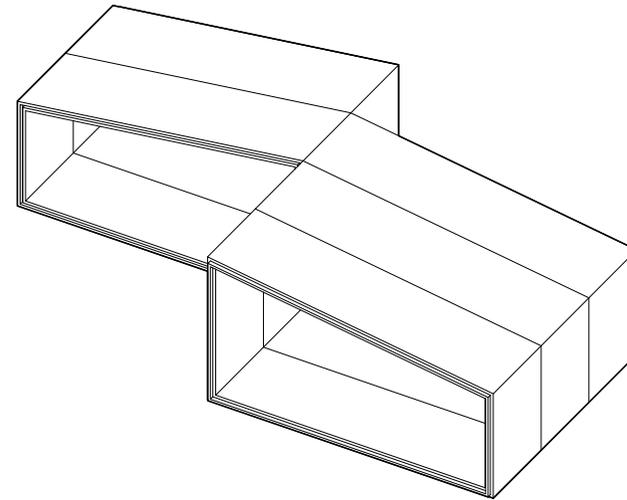
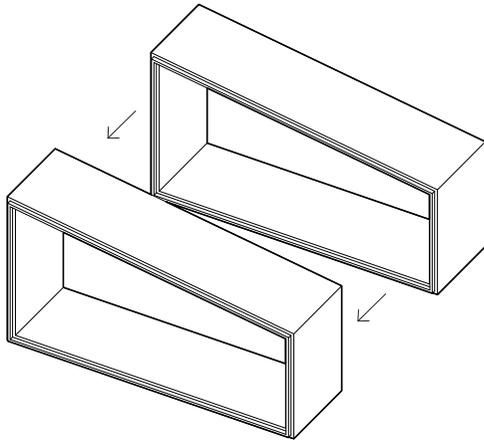
- This type of modular buildings are often being used for temporary buildings such as: schools, offices and housing for refugees.
- Often stacked on each other
- Often made with an wooden construction or with a steel frame.

DIFFERENT MODULES - MODULAR HOUSES



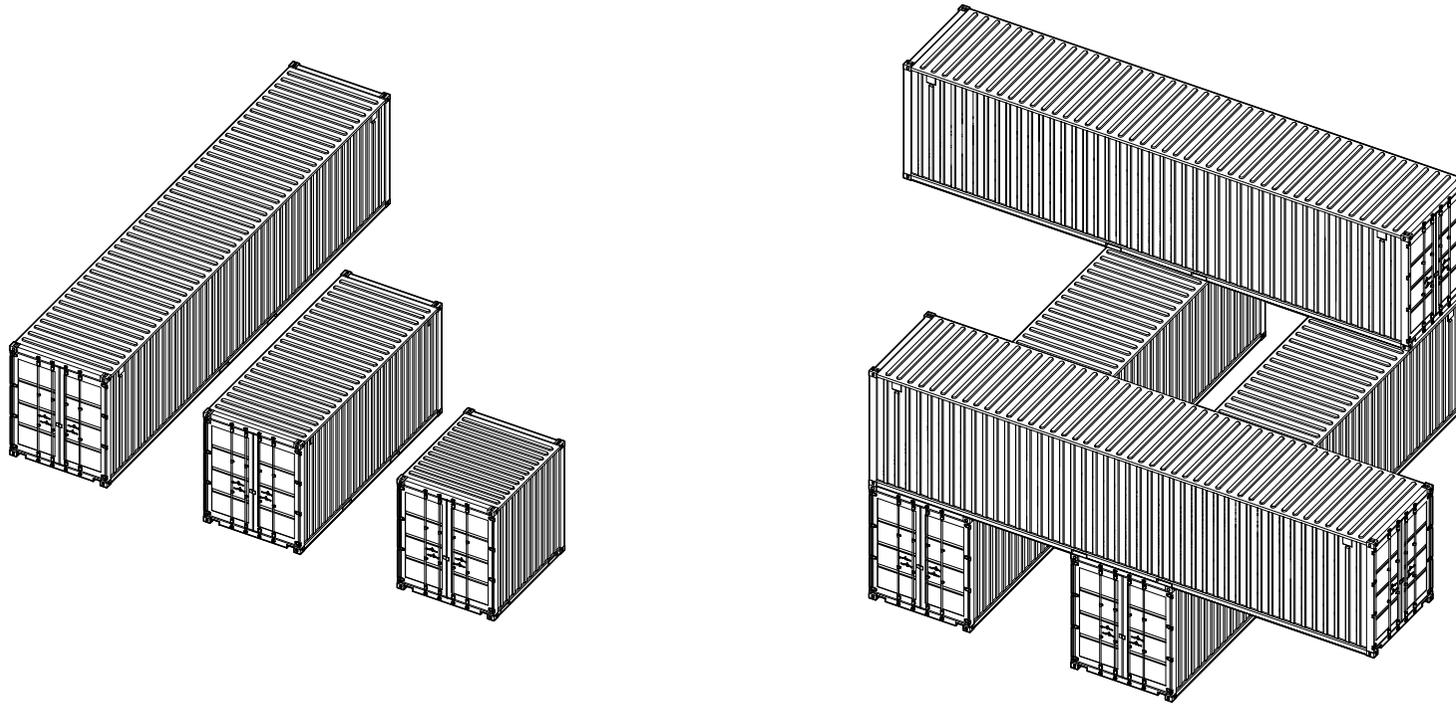
- Also called catalogue houses.
- Most common way of building private detached houses.
- Modules what puts together in to a detached house.
- Many companies makes this kind of houses in Sweden. The pricerange is huge and the lower prices is usually with lower standard but most popular.
- Often made with an wooden construction and wooden facade.
- Could also be made with pre-made wall elements and put together on the site.
- (Prices?)

DIFFERENT MODULES - CONCRETE MODULES



- A rather new concept of building modular houses.
- A concrete module designed by a portugese architect Samuel Goncalves.
- The design is influented by concrete drainage pipes.
- They are attaching to each other on the long side and could be combined with putting other units on the mirroed side.

DIFFERENT MODULES - SHIPPING CONTAINER

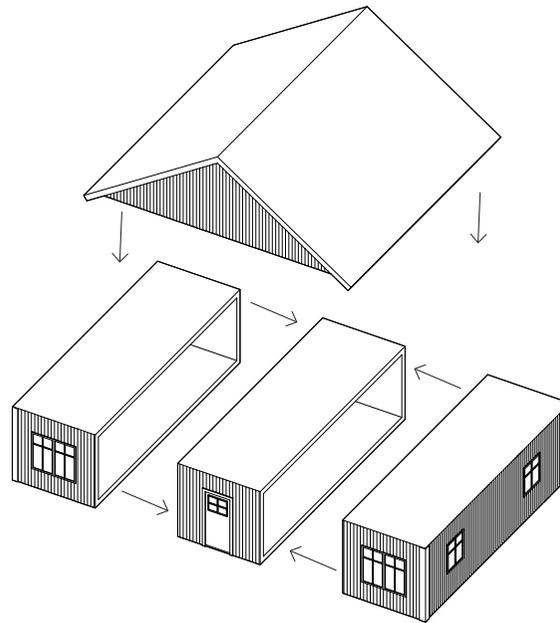


- Reuse old shipping containers, starting to get more common.
- Usually they are used for all types of shipping, but during some years it has been popular to turn them in to especially tiny-houses and apartments.
- They are constructed for being stacked on each other, so if they are put right they can be stacked very high.
- The construction are fully made of steel and if you are making a lot of openings you need to add more structural elements.
- The standard sizes are: 10 fot , 20 fot and 40 fot.

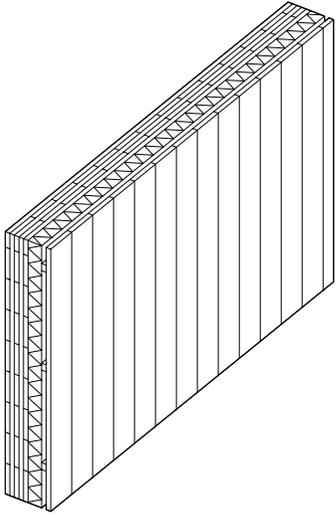
CONCLUSION OF MODULAR HOUSES

The way of building with premade modules is proven to be efficient and good method to build houses fast. The most common method is to build the so called catalogue houses which can be built with premade wall elements or modules. It is this building method that this thesis will investigate further with a aim of finding a new way of looking at it.

The next step is to look into different walls to find something interesting to rethink.



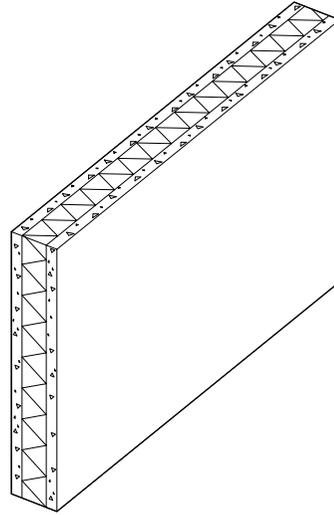
DIFFERENT FACADEELEMENTS - 4 TYPES



CLT WOOD
(367 mm)

- 22 + 22 mm Cover boarding
- 28 mm Nailing batten
- 9 mm Gypsum
- 200 mm Studs + Insulation
- 95 mm CLT

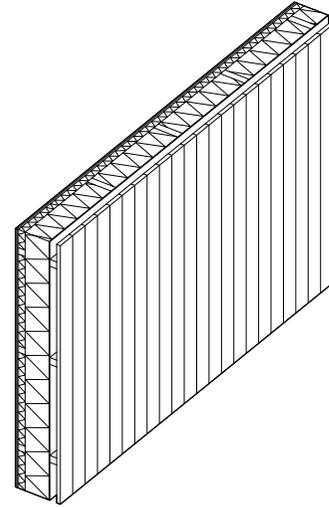
U-value:
0,1598 W/m² K
Price/m²:
1357,30 sek excl. tax
(+ price for painting inside and outside)



CONCRETE
- sandwichelement
(370 mm)

- 70 mm Concrete
- 200 mm Insulation
- 100 mm Concrete

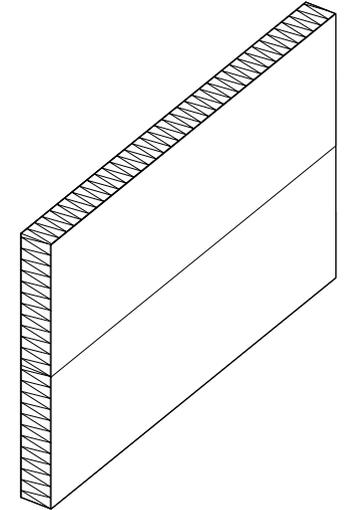
U-value:
0,1625 W/m² K
Price/m²:
1878 sek excl. tax
(+ price for painting inside and outside, if you want it)



STUDD WALL
(384 mm)

- 22 + 22 mm Cover boarding
- 28 mm Nailing batten
- 9 mm Gypsum
- 220 mm Studs + Insulation
- 70 mm Nailing batten
- 13 mm Gypsum

U-value:
0,147 W/m² K
Price/m²:
1217,74 sek excl. tax
(+ price for painting inside and outside)



STEEL
- sandwichelement
(200 mm)

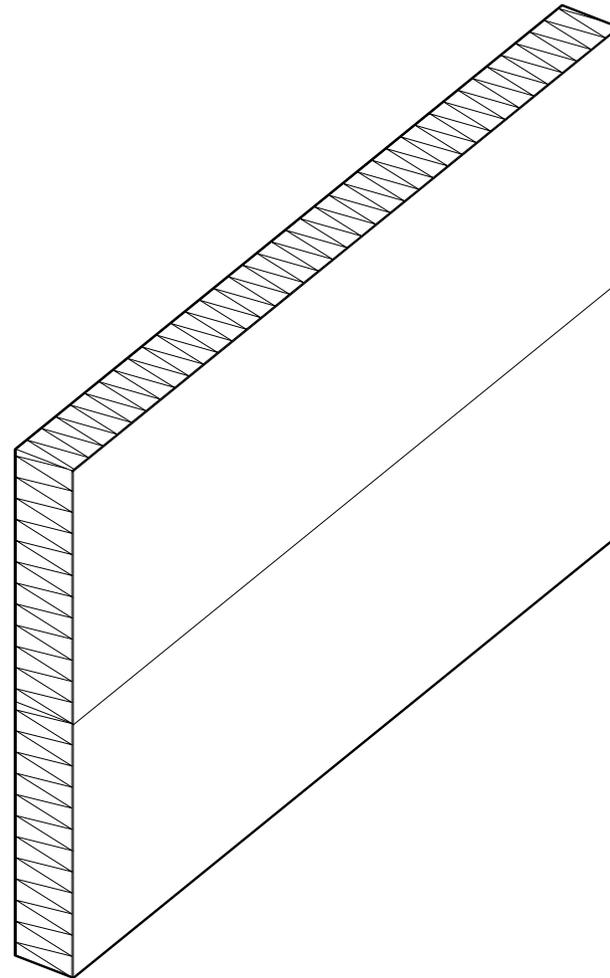
- 0,5 mm Steel
- 194 mm Insulation
- 0,6 mm Steel

U-value:
0,18 W/m² K
Price/m²:
800 sek excl. tax
(Paroc Delign)
not included the structure

The prices and the u-value of the clt wood, concrete and stud wall is taken from a thesis work in 2012 made by Martin Sundberg and David Åsberg, Building technology at Jönköping School of Engineering. The price is not concluding finnish surfaces, paint and wallpaper is extra. The price of the steel sandwichelement is from the company Paroc, that is one of the manufacturer of this type of material and it comes as a finnish product.

CONCLUSION OF FACADEELEMENTS

The wall element that has the lowest price are steel sandwich element. They are also almost half the thickness as the other ones in the investigation, wich leads to more usable space inside the building. The steel sandwichelement will allow new ways of thinking when building houses and it is this material that sets the parameters for the strategy and the design of the houses for this work.



PAROC SANDWICHELEMENT

Paroc is one of several companies that supplies sandwich elements and they are based on the same concept, I have chosen to use their elements as an example.

Paroc sandwich element is a high-grade building element with a core of stone wool and a surface made of steel sheet. The combination of materials leads to its strength and can be used as outer walls, inner walls and ceilings.

Paroc sandwich elements are non-combustible and are classified in Euroclass A2-s1, d0. (Paroc, 2018)

The company Paroc has thought about how they can be environmental friendly and are now able to recycle the excess material. (Paroc, 2018)

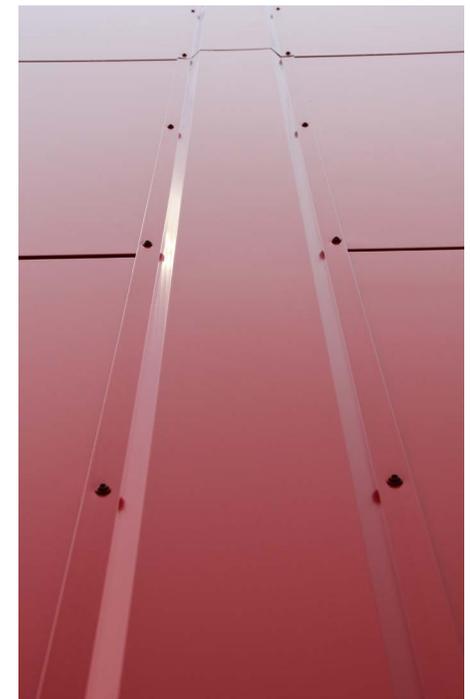
These elements are mostly used for large industrial buildings, warehouses, offices, factories and shops. (Paroc, 2018)

There are several ways to give these buildings different expressions, it is possible to get them in all different types of colors, different types of cover plates at the joints and various punches in the plate. You can also install other facade cladding, such as wood paneling, various steel profiles, bricks and plaster. (Paroc, 2018)

They have panels for exterior walls, interior walls and ceilings, all of them with different qualities. (Paroc, 2018)

The elements come in many thicknesses, and they are: - 50, 80, 100, 120, 150, 175, 200, 240 and 300 mm (Paroc, 2018)

The standard height of the elements are 1200 mm and the maximal length is 12 meter, but they also have a model called "Paroc flex" that has a height of 300-1100 mm and thicknesses 80-240 mm. (Paroc, 2018)



REFERENCE - ÄLGÖ KONSTHALL

FACTS:

Year built: 2007-2011

Gross area: 260 sqm

Architects: Spridd and Encore

Builder: Mikael Richter

Construction cost: 3,000,000 SEK

The cost of doing it cost less than 10,000 SEK/square meters.

Älgö Konsthall is located on Älgön outside Stockholm. It is a single-family house, a statue rental, and an additional residence combined into a house. It is the artist Mikael Richter with a family who has been building the house, they needed an open cost-effective house that would accommodate flexible work space, accommodation and place to hang out. They found the solution using Paroc sandwich elements with a steel structure and a hole concrete beam for transparency and lower cost.

The house is on two levels with a roof terrace on top. On the first floor, Michael's art studio and a guest house / home they rent. On the other planet, the family's residence is linked to the art of the theater.



STEEL SANDWICHELEMENT - PROS & CONS

PROS

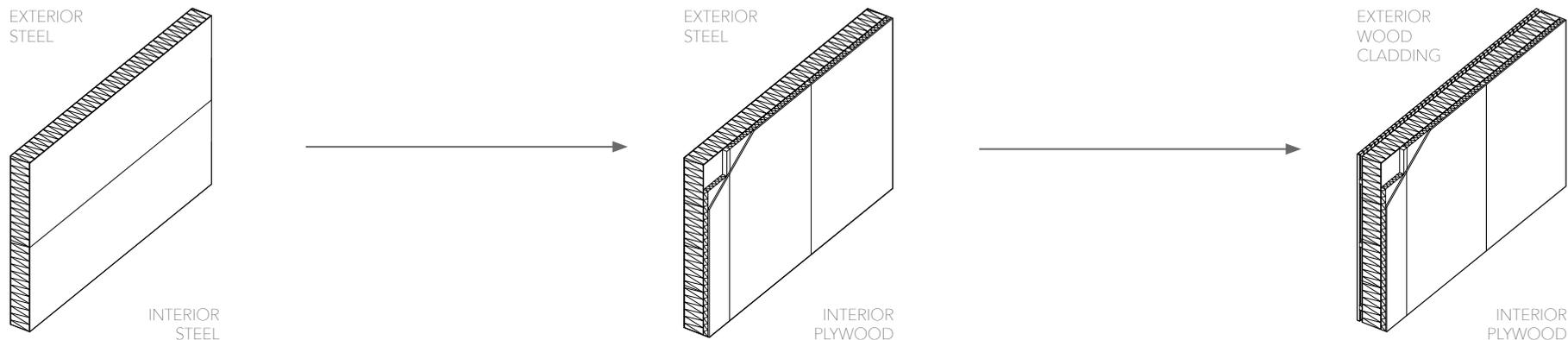
- It is a quick building method which leads to lower labour costs and less chances for construction errors.
- It is a very thin wall and has a great U-value.
- Because of its thin walls it makes the interior floor area bigger than regular walls that is usually about twice the thickness, that gives you more floor area for the money.
- The wall is finished as it is and you don't need to add extra materials on the exterior or interior if you don't want.
- They are easy to take down and they are reuseable and you could easily expand the building by take down some sections and add more.

CONS

- It is not common to have steel facade interior and exterior, so some people might not like it.
- If you only have the steel sandwichelement the facade is not very strong against impacts. Therefore, you might need some form of protection at the bottom
- Metal isn't very enviromental friendly, but Paroc is recycling the excess material.

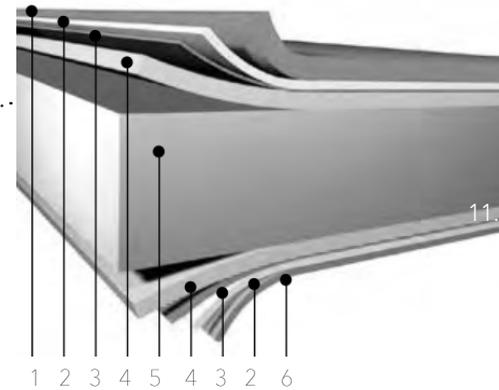
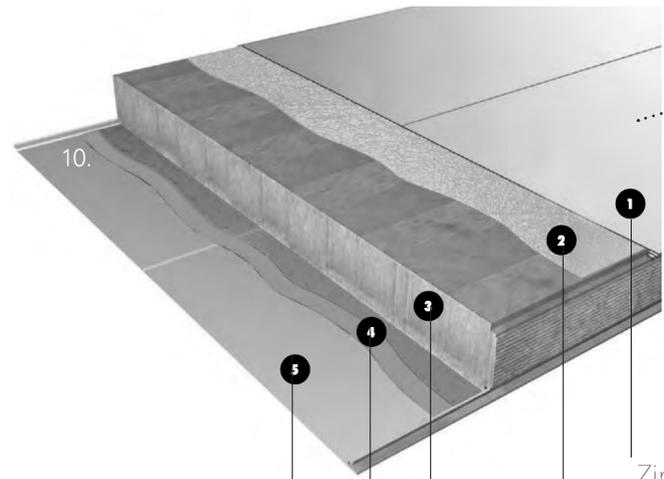
DEVIDE THE BUILDING COSTS

An important advantage of building with these elements is the time aspect versus the money. Due to the qualities of the material you can start by building the house without any other material on the inside and the outside, you get a complete shell for the house immediately. You can later on, if you want to, if you can afford it, build an installation inside, as well as a new facade material on the outside. This makes a low building cost at the beginning and you could get the house finished quickly.



PAROC SANDWICHELEMENT - LAYERS DETAIL

Parocs sandwichelement is mainly seen as a steel-stone wool-steel structure and that's true, but they are also made with other thin layers. On this two illustrations you can see all the layers.



- 1 Coil coating
- 2 Primer
- 3 Primer
- 4 Zinc
- 5 Steel
- 6 Epoxy coating

10. Zinc-coated steel sheets with top coating according to environmental demands

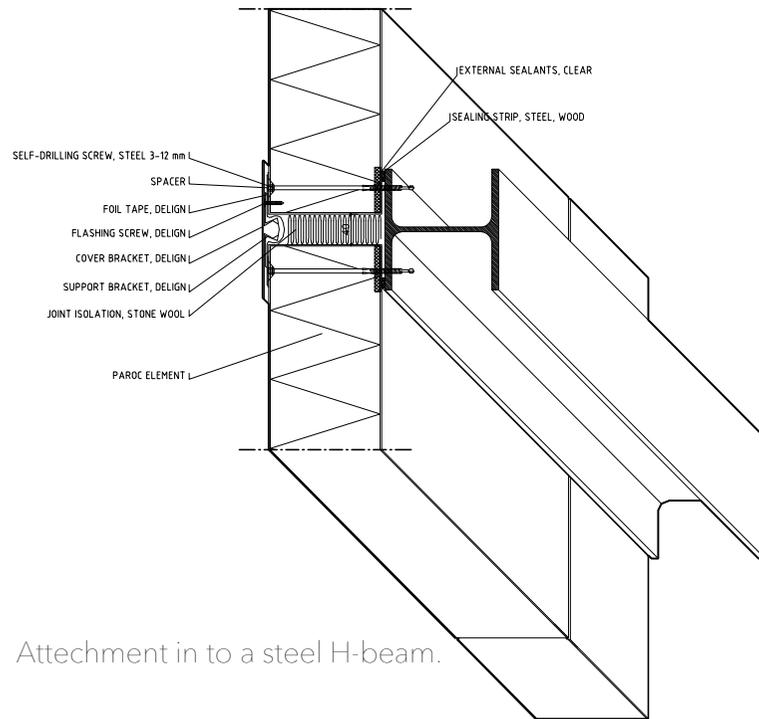
11. Specially developed adhesive, that covers the whole surface area.

Non-combustible core of structural stone wool lamellas give equal strength properties in each cross section of the panel.

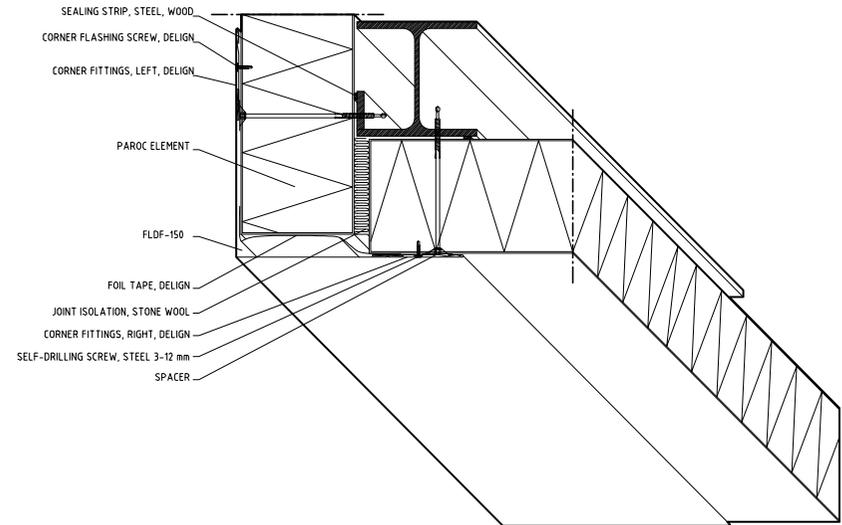
Multi-layer primer to ensure the bonding between the adhesive and the zinc layered steel sheet.

Fire safe joint design that makes the panel tight for hot gases and flames and gives up to 4 hours fire resistance properties.

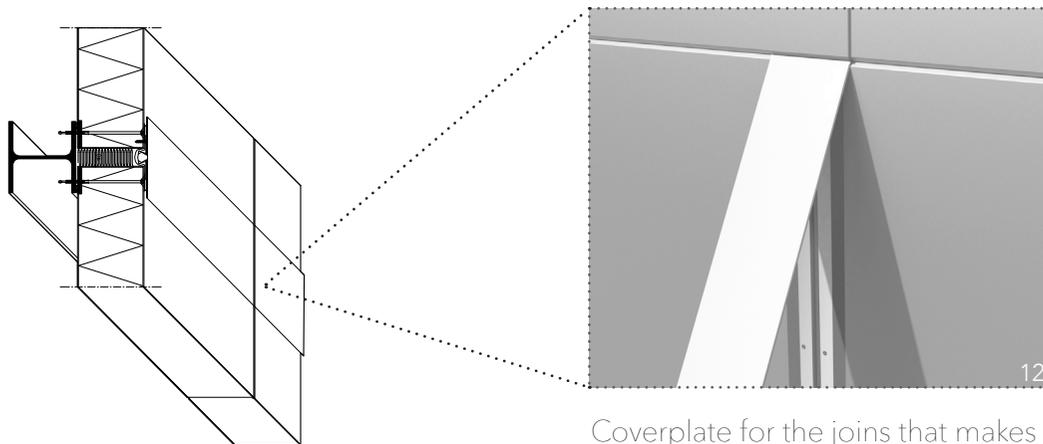
PAROC SANDWICHELEMENT "DELIGN SERIES" - DETAIL



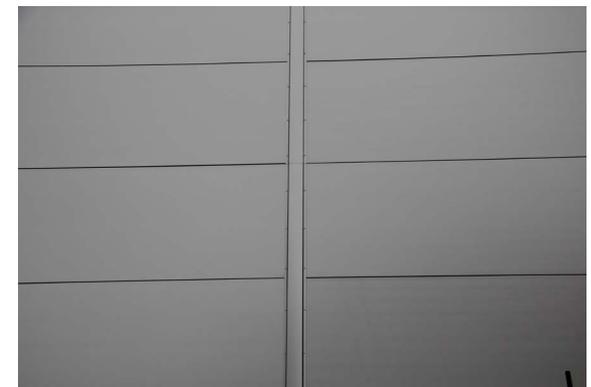
Attachment in to a steel H-beam.



Coverplate for the corners.



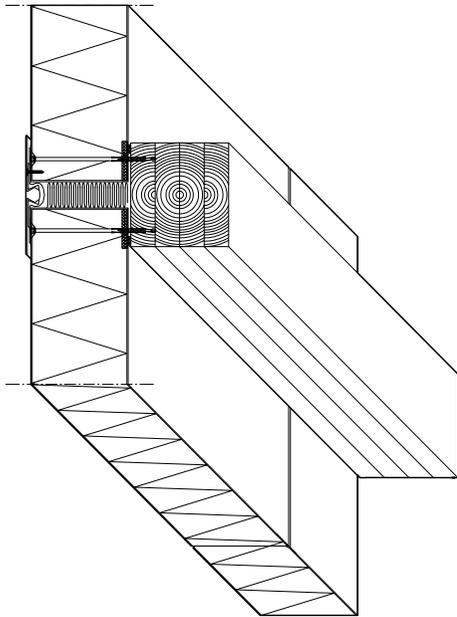
Coverplate for the joints that makes the horizontal lines continuous.



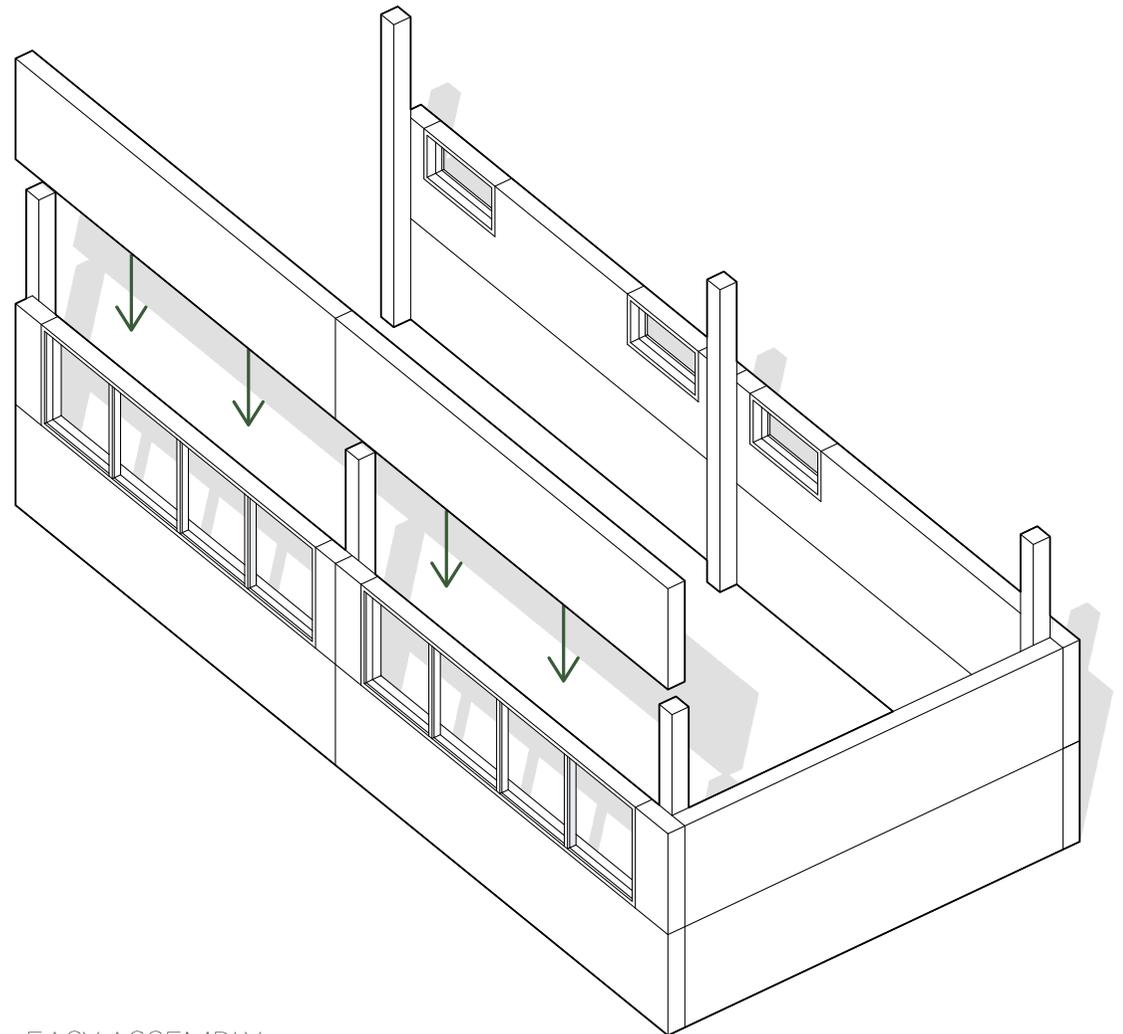
This is NOT delign series and it makes the joints more obvious.

ASSEMBLY

The wall elements are stacked on top of each other and then being screwed in to a pillar. After that you need to attach a coverplate in the seam where the two elements meet.

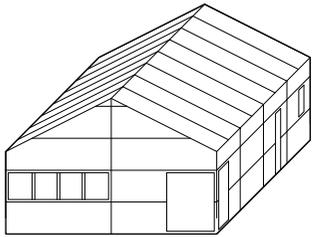


STEEL SANDWICHELEMENT AND
WOOD BEAM PILLAR

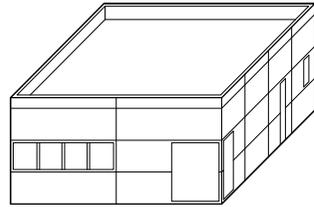


EASY ASSEMBLY

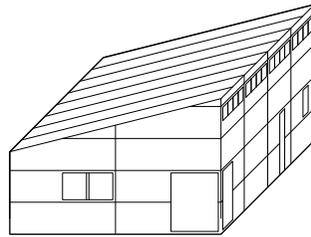
DIFFERENT TYPES OF HOUSES AND TWO EXPANSION METHODS



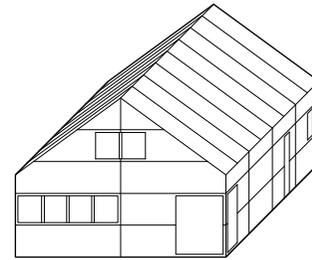
One Floor



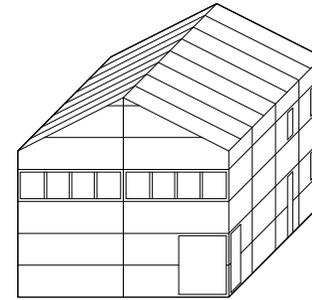
One Floor



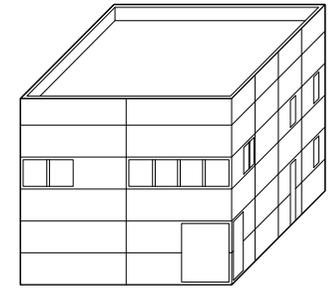
One Floor



One And A Half Floors



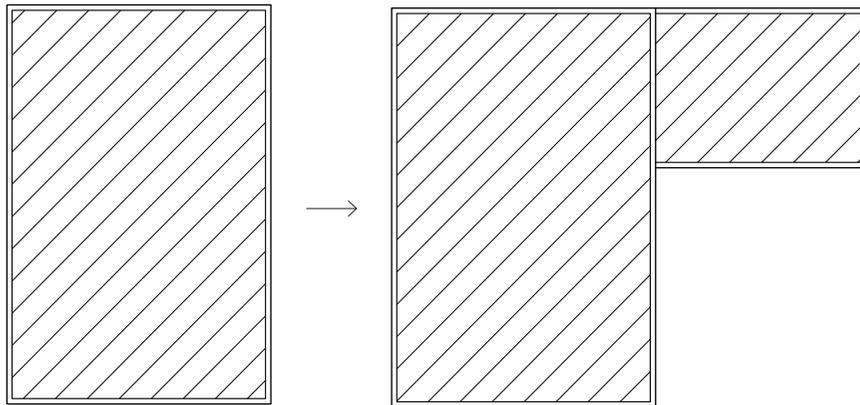
Two Floors



Two Floors

VERIETY OF HOUSE TYPES

There is a lot of different types of houses you could build with the material, as long as it is straight facades.

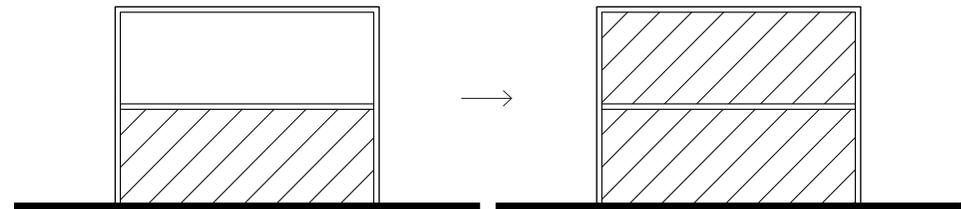


EXPANSION IN PLAN

By building what you need in the beginning and later on add new elements.

EXPANSIONS

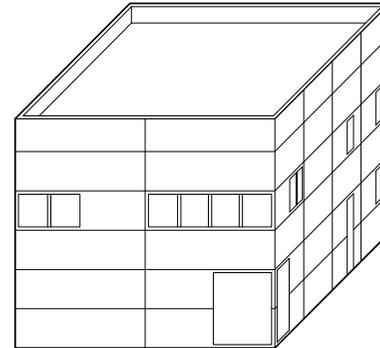
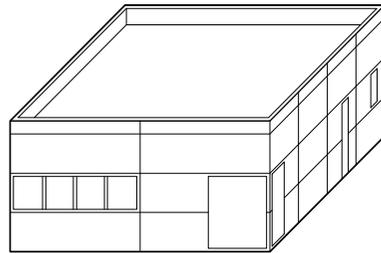
When drawing a house, it is important to try to look into the future and see how the building could be changed as needed. This will make it a more sustainable building. Expansions could be



EXPANSION IN SECTION

By building two floor high at the beginning but starting by finishing the ground-floor. When the time is right you could build on the second level too.

CONCLUSION OF HOUSE TYPES



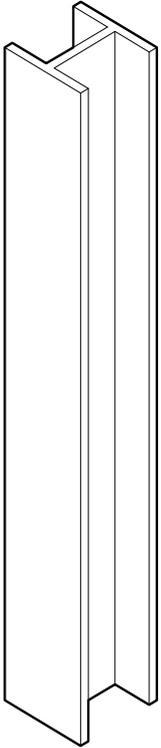
CUBIC HOUSES

To get the most out of the material's properties, get as little losses of material as possible and the shortest construction time, the cubic volume were chosen.

It uses the straightness of the elements and does not need to adapt to other directions than straight cuts.

BUILDINGMATERIALS

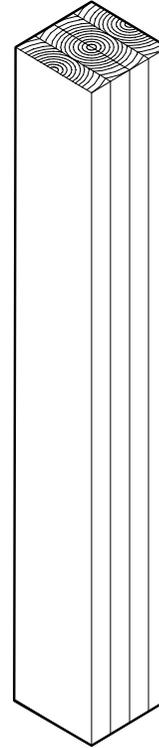
PILLAR- AND BEAM STRUCTURE- 2 TYPES



HEA STEEL BEAM

- Most commonly used when building industrial buildings.
- Easy to install and has great load bearing capacity in large ranges.

Price example, 140 x140 mm:
About 548.50 SEK/m excl. tax

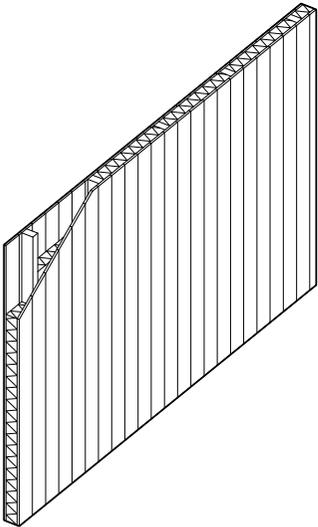


GLUELAMB BEAMS

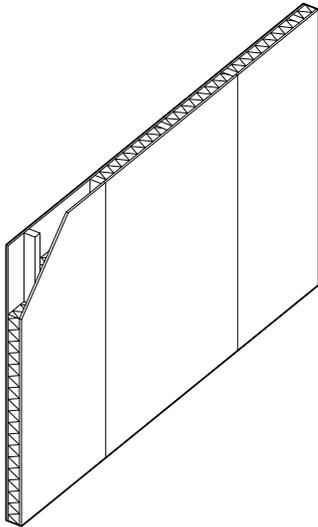
- Great material for the environment
- You get a warmer feeling inside the building with wood than steel.
- Has great load bearing capacity.

Price example, 140 x140 mm:
About 252 SEK/m inkl. tax

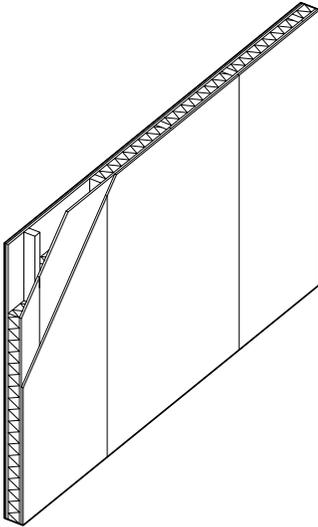
INNERWALLS - 5 TYPES



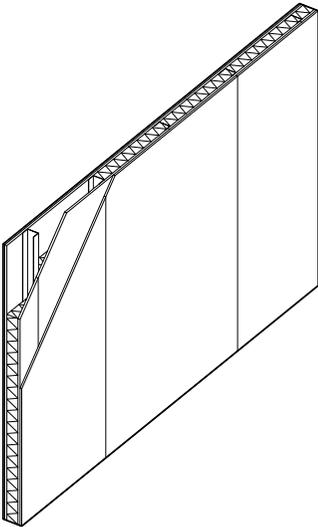
WOOD CLADDING
(100 mm)



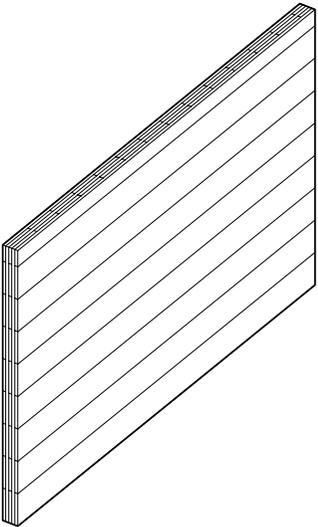
PLYWOOD
(100 mm)



OSB & GYPSUM
120 mm

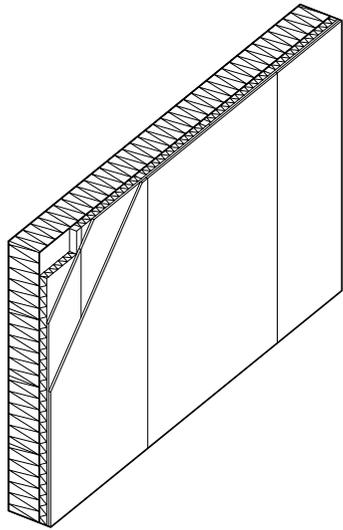


OSB & GYPSUM
(120 mm)



CLT WOOD
(95 mm)

INTERIOR MATERIAL - 4 TYPES



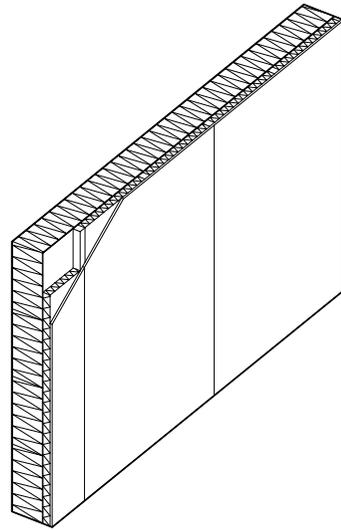
OSB AND GYPSUM

(99 mm)

- 75 mm wood studs and insulation
- 11 mm OSB board
- 13 mm Gypsum board

Price/m²:

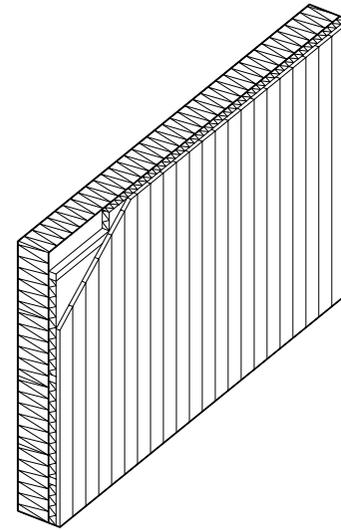
About 200 sek incl. tax
(Only the material)



PLYWOOD

(86 mm)

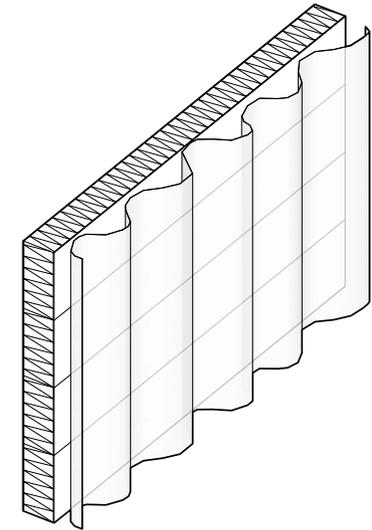
- 75 mm wood studs and insulation
- 11 mm Plywood board



WOOD CLADDING

(108 mm)

- 75 mm wood studs and insulation
- 11 mm OSB board
- 22 mm Cover boarding



TEXTILE

(1 mm)

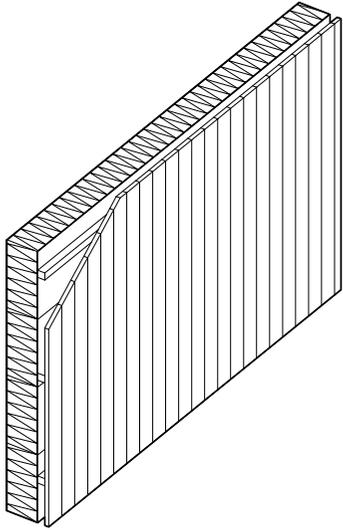
- 1 mm Textile

Price/m²:

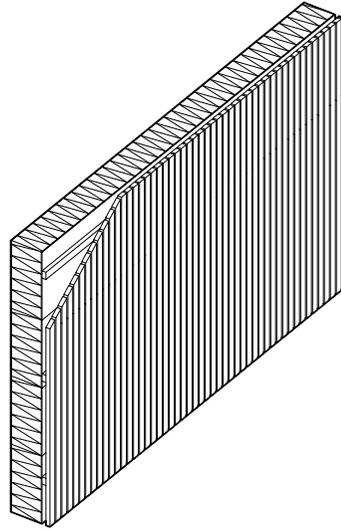
26.10 sek excl. tax
(without fixtures)

The price for the osb and gypsum wall is from beijerbygg.se(2018), and the price for the textile is from ikea.se(2018).

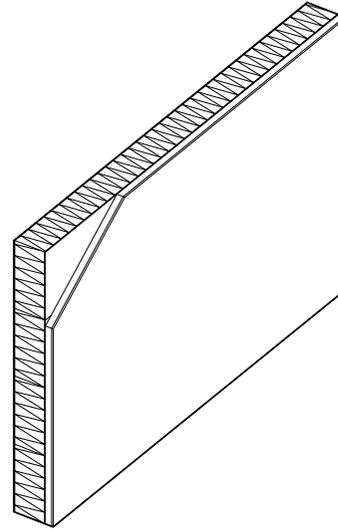
EXTERIOR MATERIAL - 4 TYPES



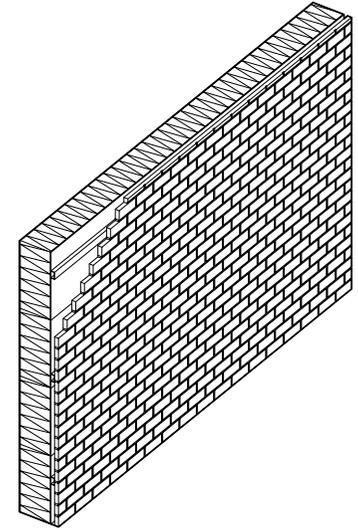
WOOD CLADDING



WOOD CLADDING 2



PLASTER



BRICK BOARD

MAIN MATERIALS

To keep the cost down from the beginning, the main materials that are being used for the example houses are the ones that have the lowest price in their category and are efficient to build with.

Some of the materials are:

- Steel sandwich elements
- Gluelamb pillars and beams
- Fabrics to hang on the interior facade faces of the steel elements
- Plywood interior walls.
- Ground concrete floor with floor heating on the entrance level
- Wooden intermediate floor
- Wood fiber acoustic ceiling
- Corrugated metal roof with insulation
- Metal windows



PRICE EXAMPLES

STUD WALL: **1217,74 SEK** / m² - without finished faces

HEA STEEL BEAM: **548.50 SEK** / m

OSB AND GYPSUM: **200 SEK** / m²

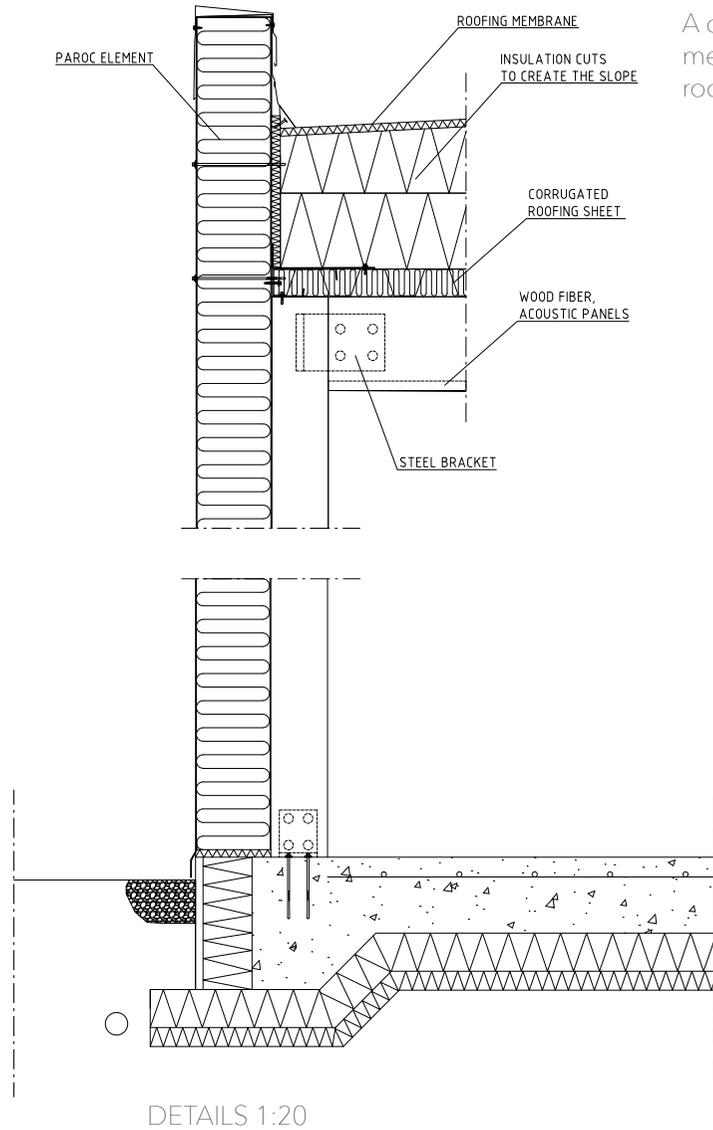
PAROC SANDWICH ELEMENT: **800 SEK** / m²

GLUELAMB BEAM: **252 SEK** / m

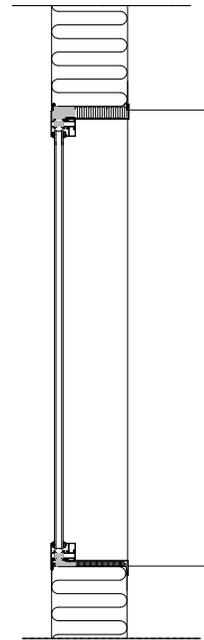
FABRIC: **26 SEK** / m²

DESIGN PROPOSAL - Part 1
DETAILS

COMMON DETAILS

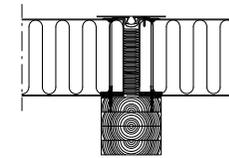


A detail section through the meeting of the wall and the roof.



DETAIL 1:20

A cut through one of the fixed windows. The window is from Aluman and is special designed for Paroc sandwichelements. That is why it can be flushed with the facade.

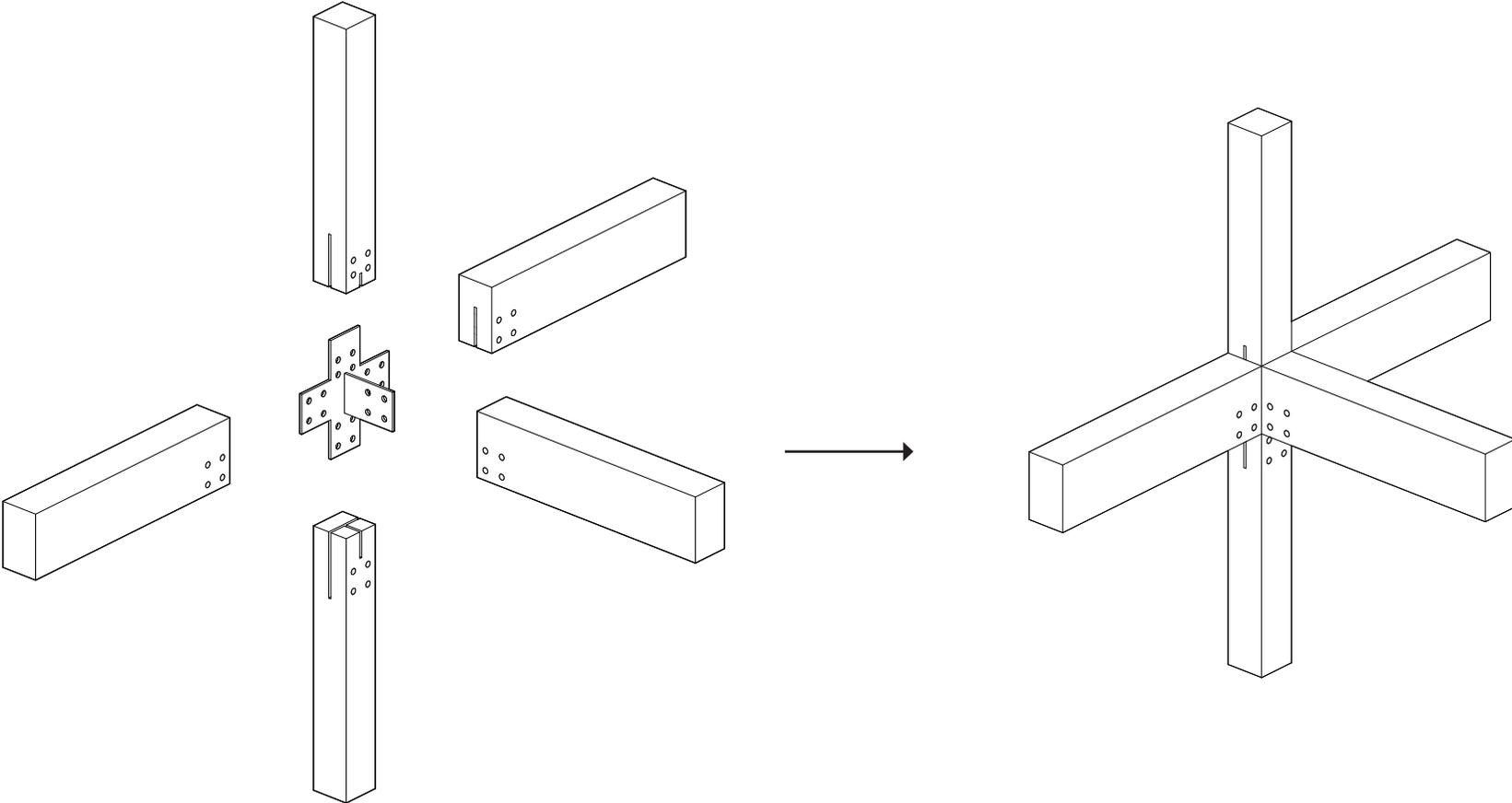


DETAIL 1:20

A cut through the seam between two elements and how they attach to a wooden pillars.

PILLAR AND BEAM ASSEMBLY

The pillar and beams are put together by making slits in the wood and connecting the structure with a bracket and then secure them with bolts.



DESIGN PROPOSAL - Part 2
THE HOUSES

REFERENCES - RIBBON WINDOWS & SIMPLICITY IN FACADES

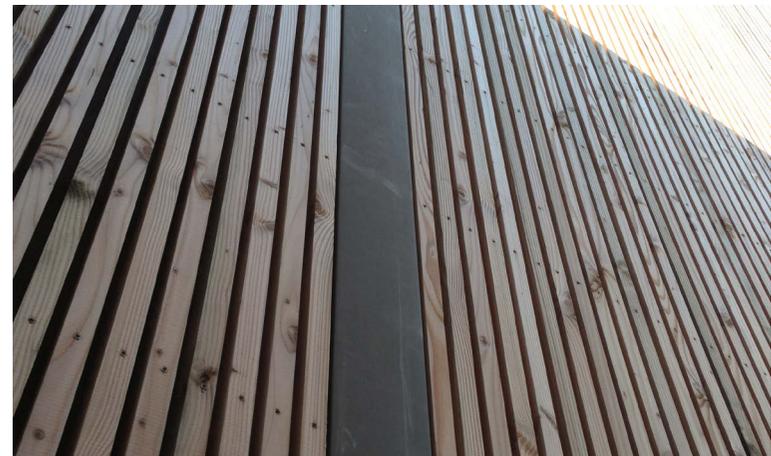
MASION LA ROCHE

Le Corbusier - Paris - France - 1923-1925



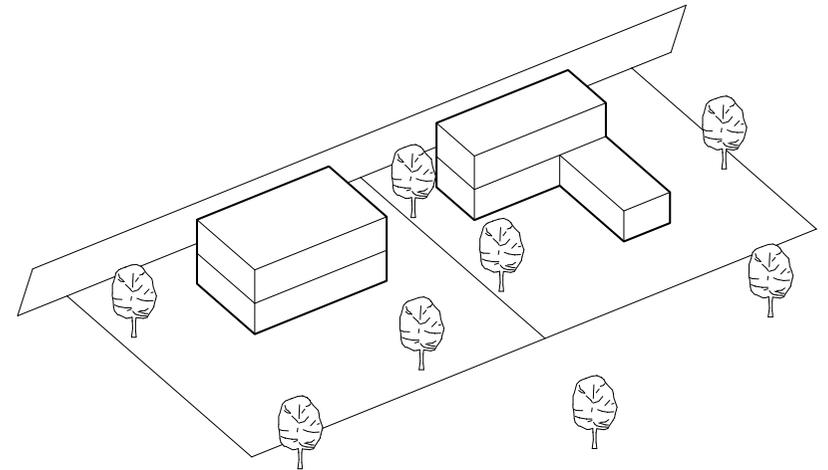
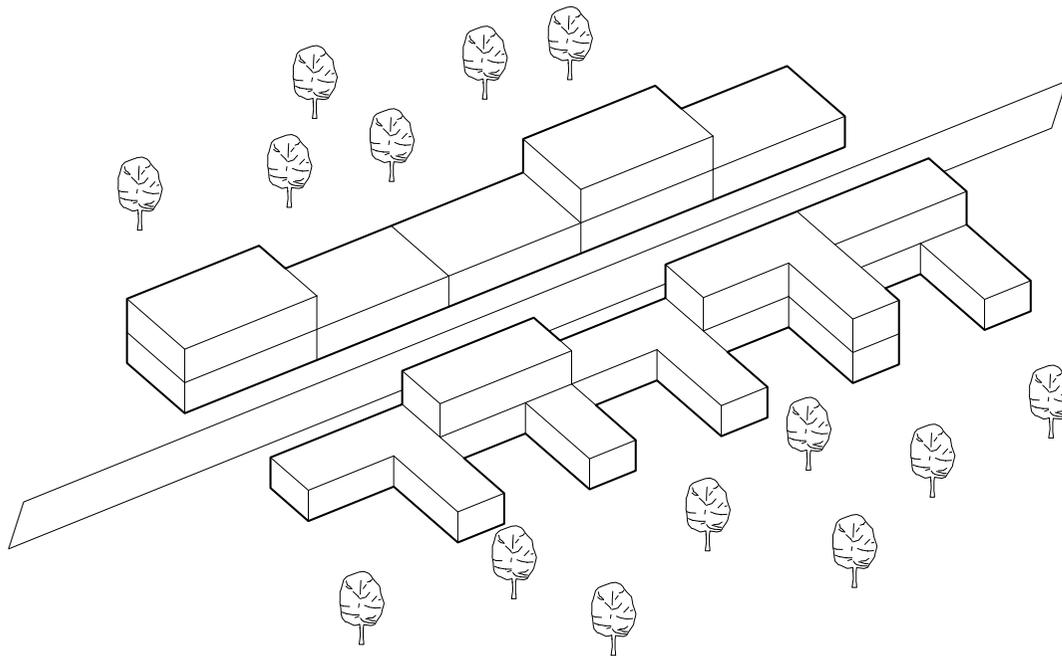
WOOD BOX

Björn Gross & Anna Einarson - Gothenburg - Sweden - 2017



VOLUMES - ROWHOUSE AND AS INDEPENDENT

The houses are designed so that they can both be put together in a townhouse and they can also stand for themselves.

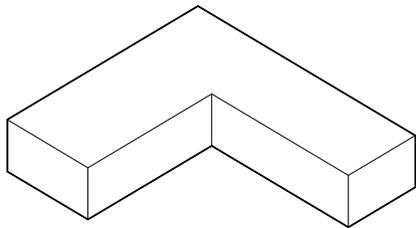


THREE MODEL TYPES - VOLUMES

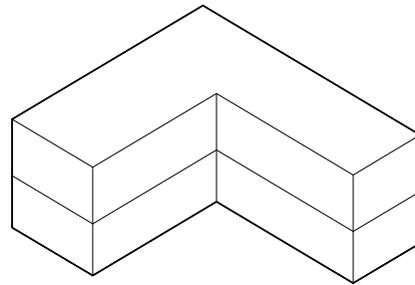
Three types of models has been investigated, an L-shaped, a rectangular and square shape. All of them can can be made in to a single floor house or a double floor.

THE L-SHAPE

The L-shape gets a natural private area inside the L. This makes a great house in a area with many other houses and still have privacy.



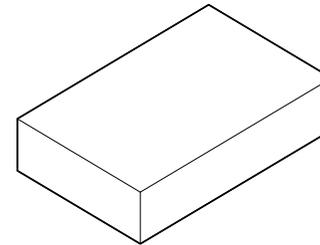
1 FLOOR



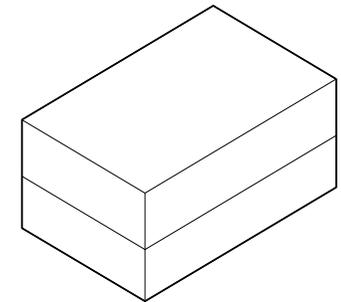
2 FLOORS

THE RECTANGLE

The rectangle shape will take the least amount of groundspace witch can be more suitable for small plots.



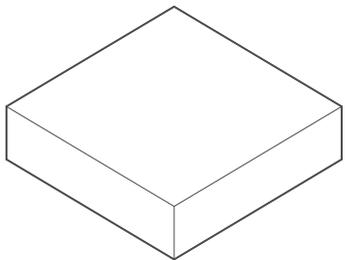
1 FLOOR



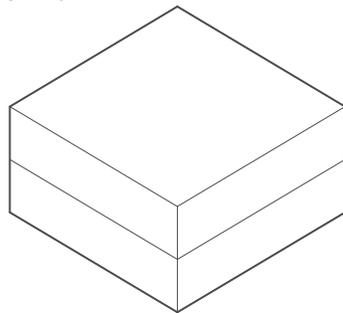
2 FLOORS

THE SQUARE

The square shape could get a dark core but if you design in carefully you could get great qualities from it.



1 FLOOR



2 FLOORS

MODEL PHOTOS

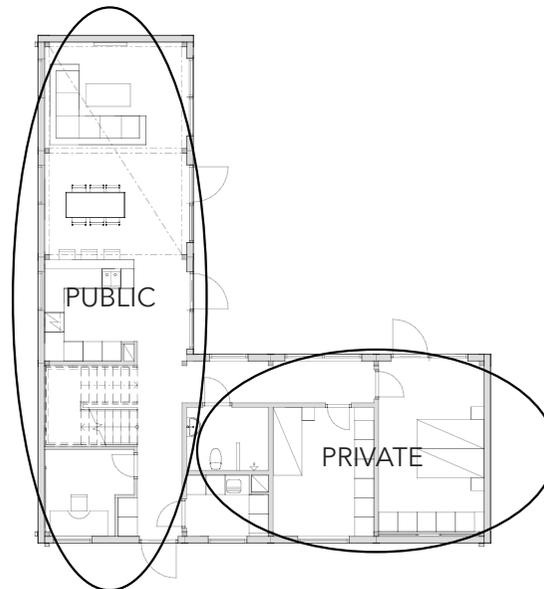


A 3D-printed facade in dark grey plastic is made to mimic the true way of building with the facade-elements, stacking them on top of each other with the joins in the center on the pillars.
The model is also showing how the coverplates works and how they make the horizontal lines continues.
The interior shows the warm feeling you get from the wood in the constuction and interior walls.
Grey cardboard is showing both the concrete floor and also the acoustic ceiling.

GENERAL DESIGN IDEAS

With the facade materials qualities you are able to build the whole shell of the house at first and then you could build what ever you like to build on the inside. This is a very intriguing idea for some people, but the minority people wants to have the idea of a finished plan. For that reason this thesis will show examples of floorplans in the different house models.

The starting-point of all of the single-family houses is to have a large open space with the kitchen, dining area and living-room area. This creates a large area where the whole family could be together and not feel cramped. This area should be bright with lot of windows for external light and a welcoming feeling. The second idea is to have a more private part of the house for the bedrooms, with smaller rooms and less windows to create a safe and relaxing feeling.



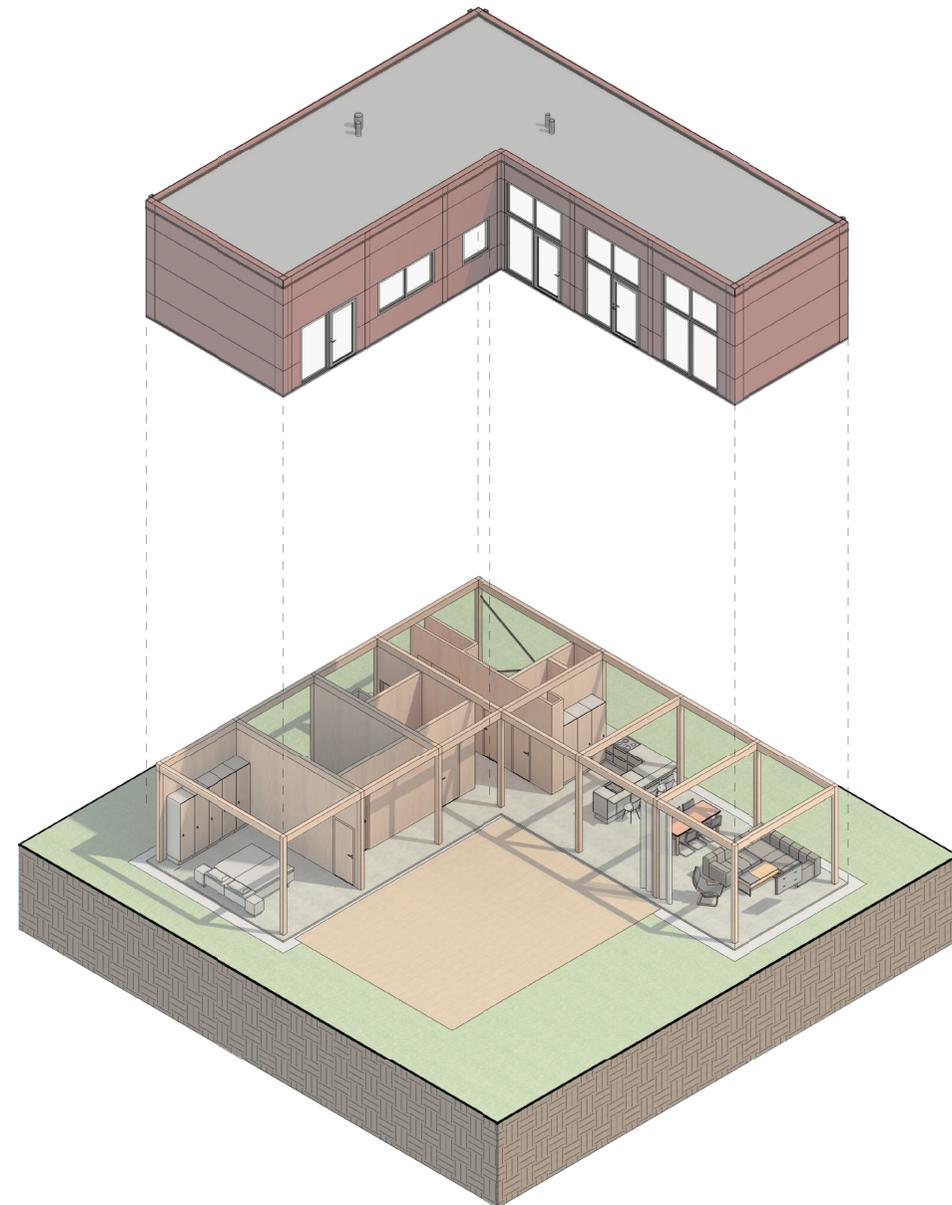
THE L-SHAPE 1 FLOOR

Building area:
- One floor: 131 sqm

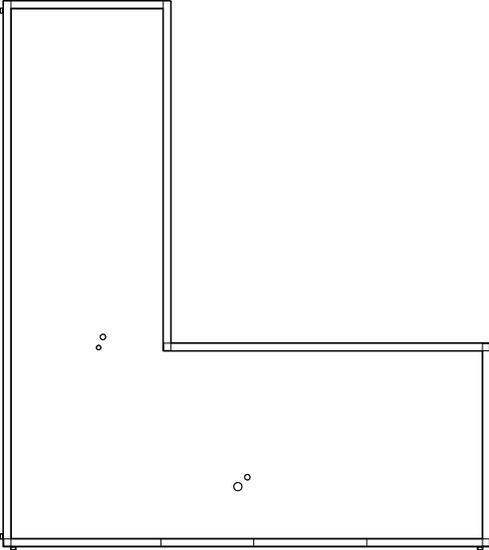
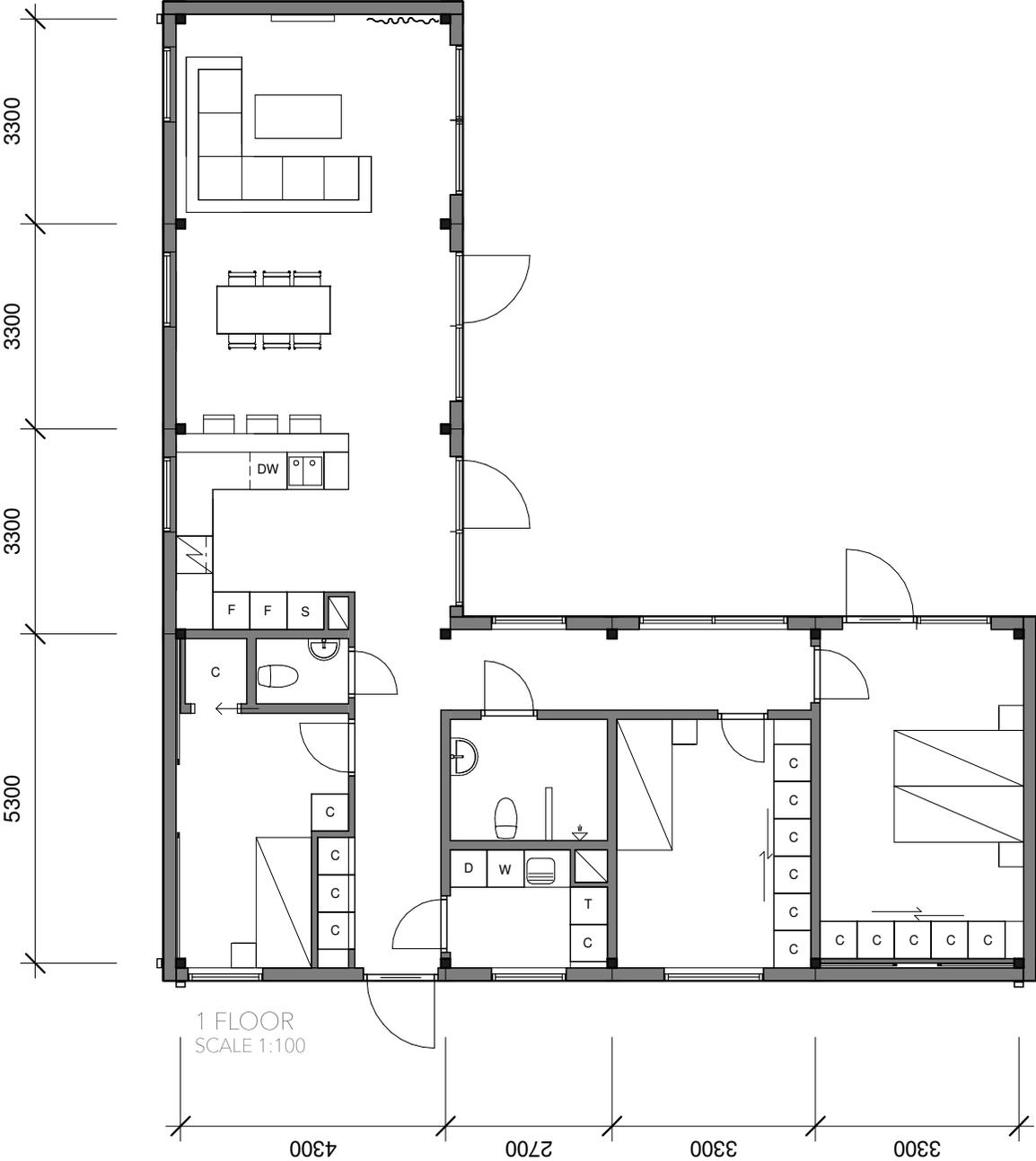
Usable area:
- One floor: 119 sqm

Colour choices and extra:
- Red facade
- Dark grey windows and drain-pipes for a contrast.

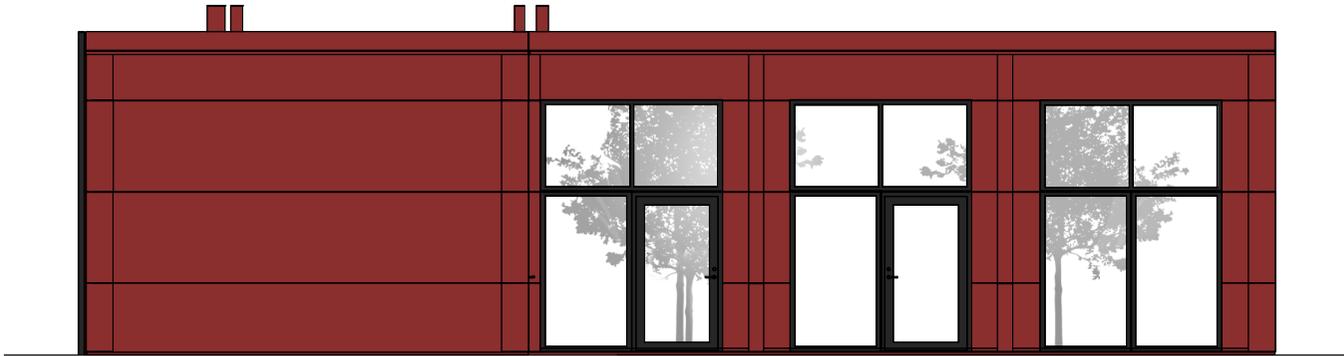
The L-shape was the first plan to be finished. It is putting the focus in to the private yard with a lot of windows and less windows to the other facades. The house is very suitable for a dense single-family area where you still get a private yard and don't have a lot of windows where people can look in to the house.



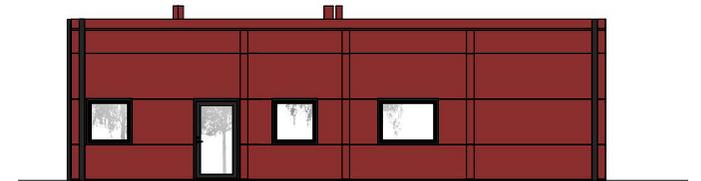
THE L-SHAPE 1 FLOOR - PLANS



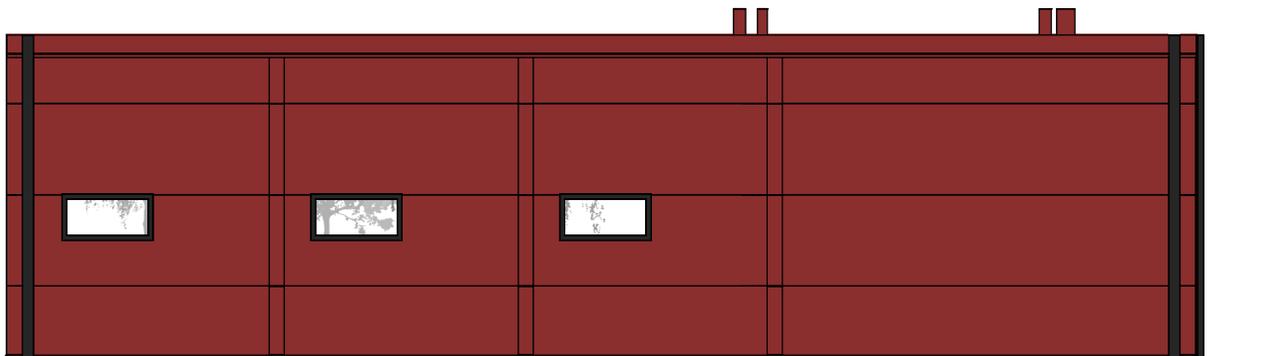
THE L-SHAPE 1 FLOOR - FACADES



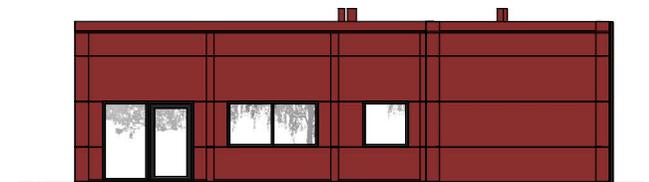
WEST FACADE
SCALE 1:100



NORTH FACADE
SCALE 1:200

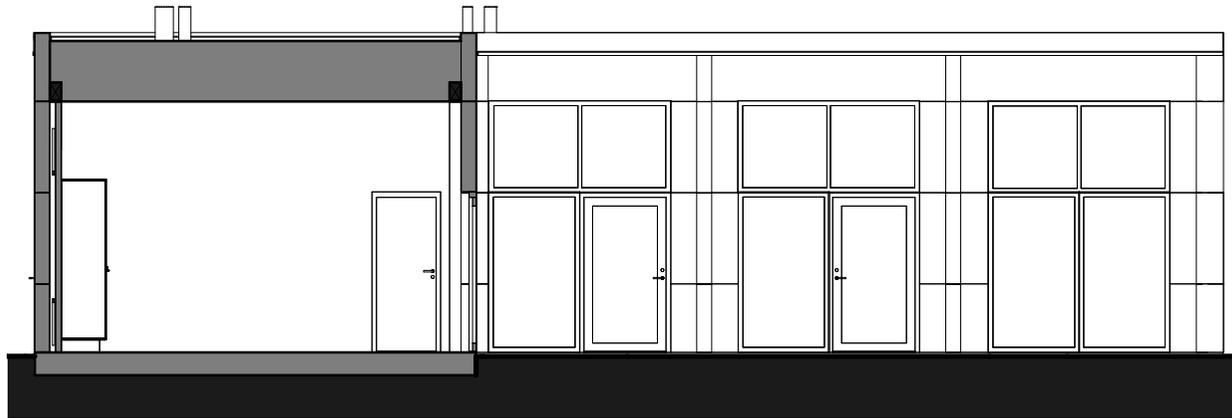


EAST FACADE
SCALE 1:100

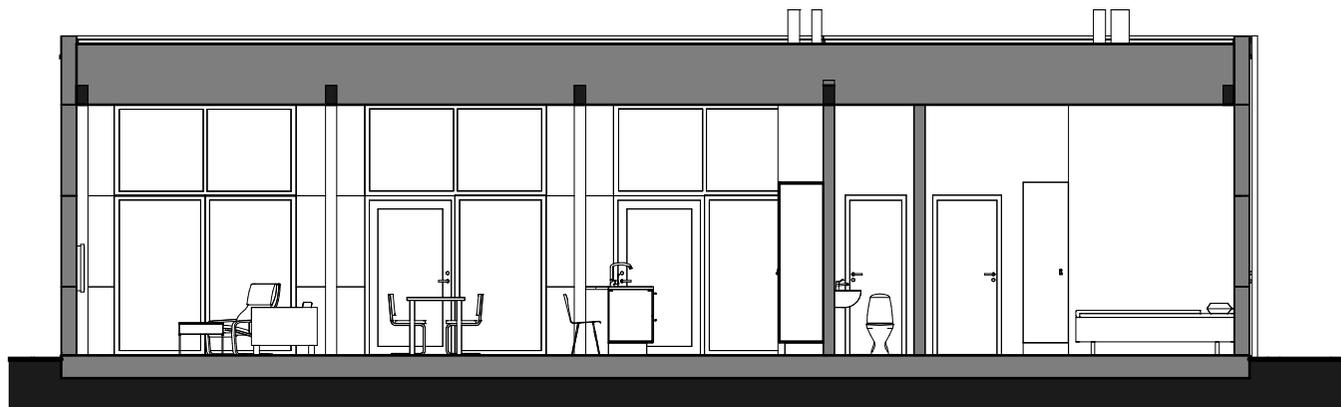


SOUTH FACADE
SCALE 1:200

THE L-SHAPE 1 FLOOR - SECTIONS



A-A SECTION



B-B SECTION

SCALE 1:100

THE L-SHAPE 1 FLOOR - EXTERIOR PERSPECTIVE



EXTERIOR PERSPEVTIVE



PERSPEVTIVE SECTION

THE L-SHAPE 1 FLOOR - INTERIOR PERSPECTIVE



INTERIOR PERSPECTIVE, LIVINGROOM



INTERIOR PERSPECTIVE, VISUAL CONNECTION

THE L-SHAPE 2 FLOORS

Building area:

- One floor: 131 sqm

Usable area:

- First floor: 119 sqm

- Second floor: 88 sqm

Colour choices and extra:

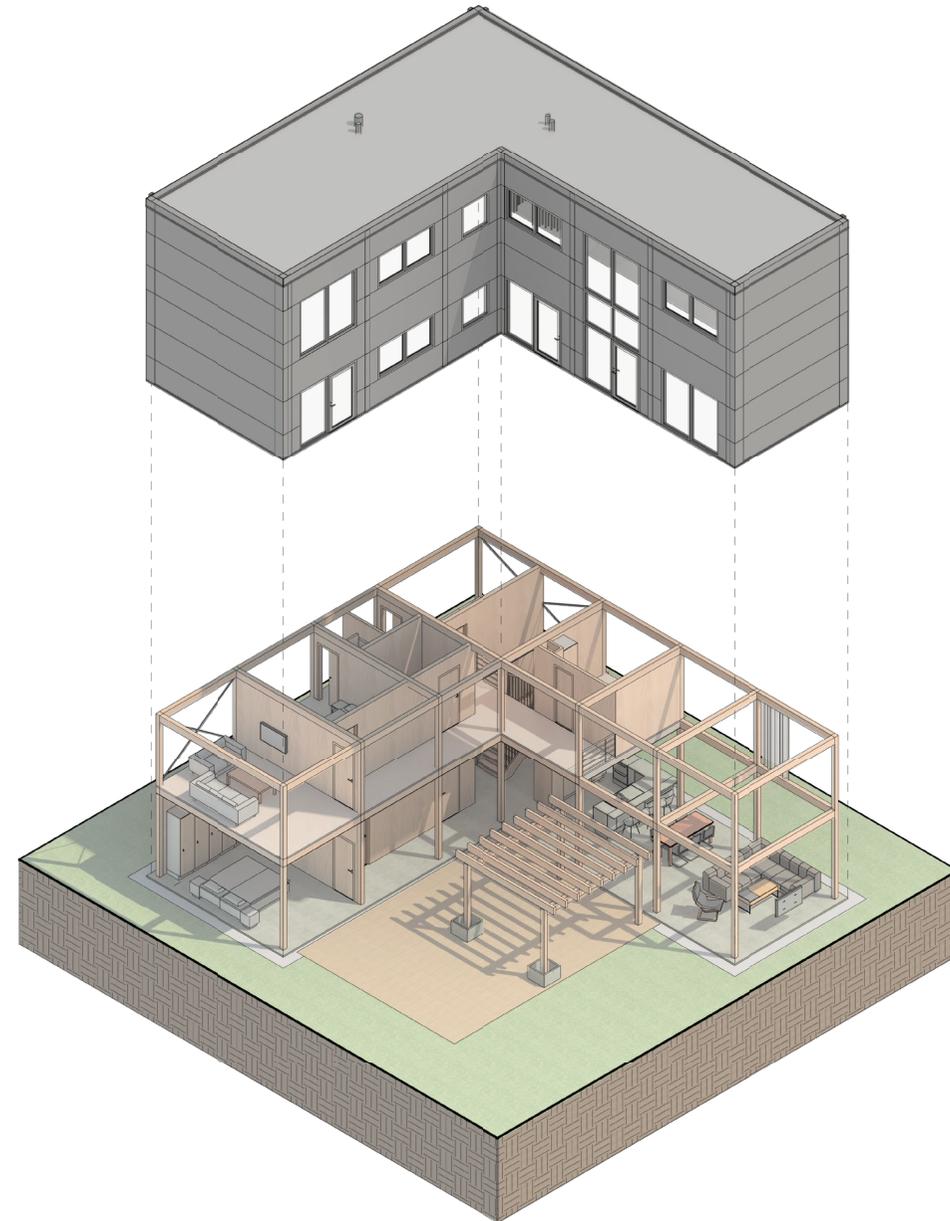
- Dark grey facade

- Grey windows and drain-pipes for making them less visible.

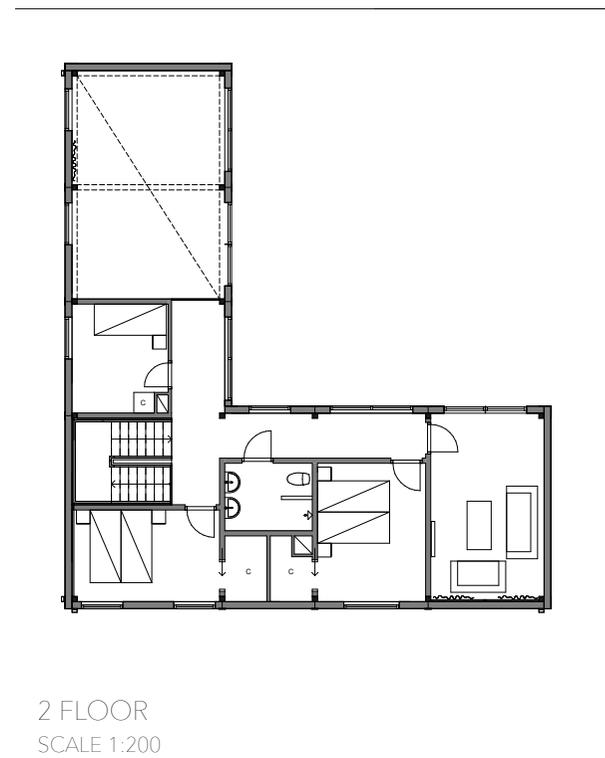
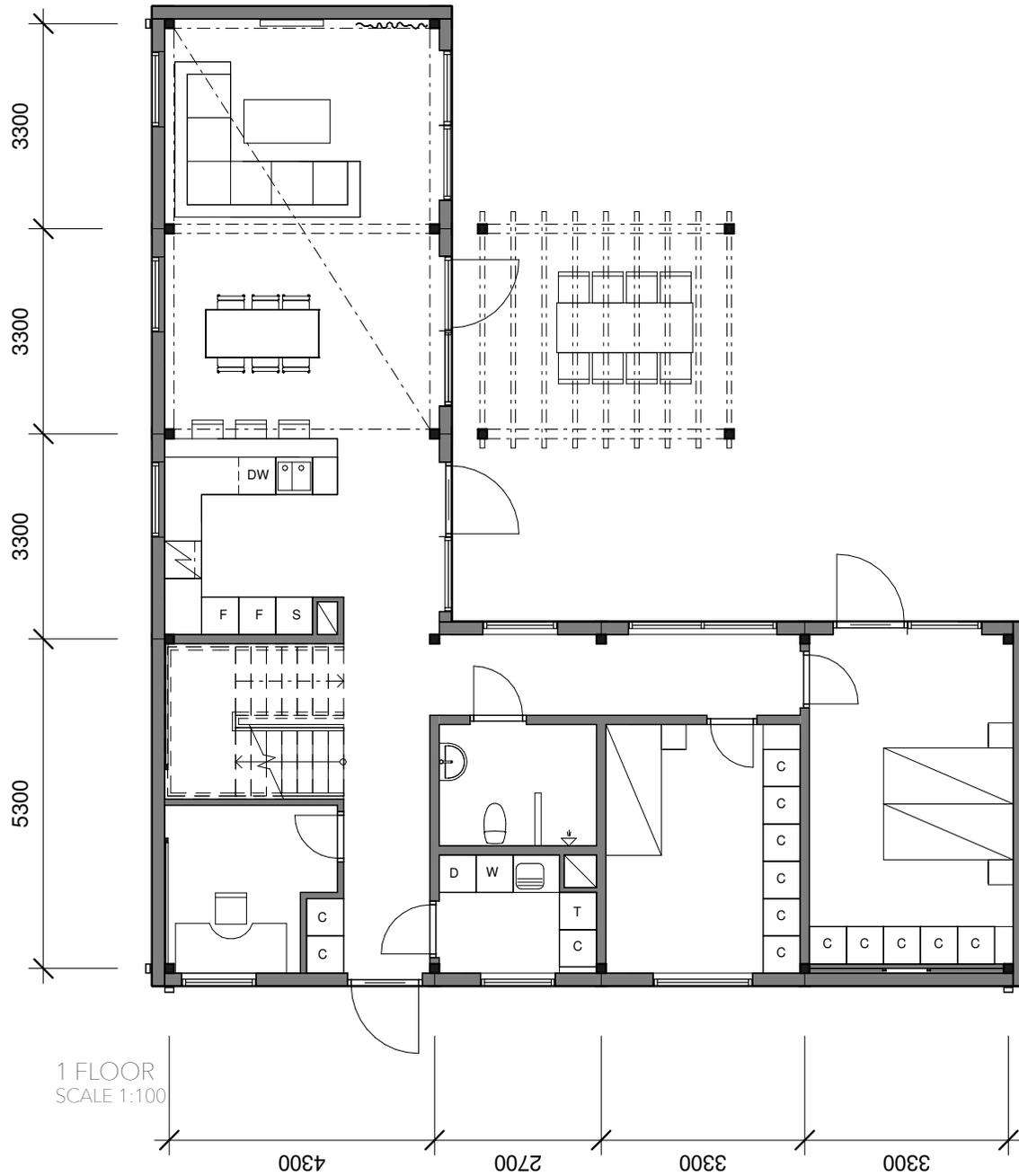
- Wooden pergola

The living and dining area gets a lot of volume because of the double high ceiling. The pergola that is outside on the yard is making some sun-protection to the inside but also creates a lovely place to relax outside.

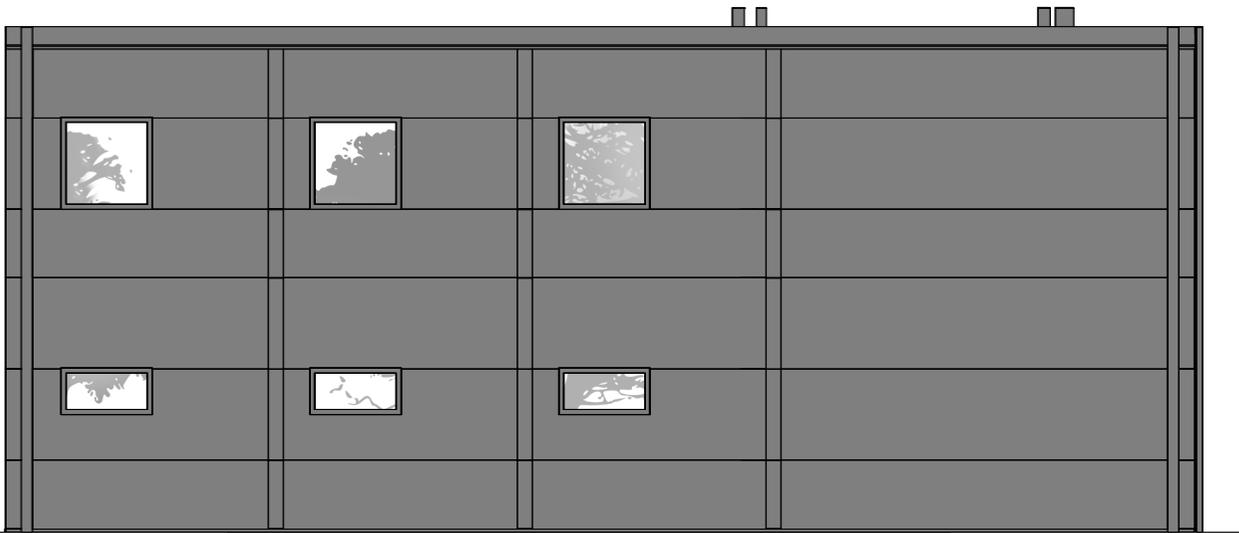
The extra living-room in the second floor is placed on the other side of the house from the first floor living area to make it possible for privacy, for example if there is a big family party and the children wants to play loudly they could be in the second living-room without disturbing the parents or the opposite.



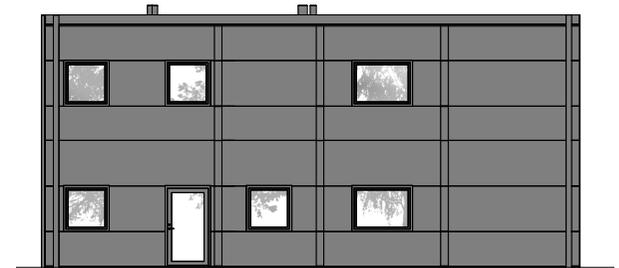
THE L-SHAPE 2 FLOORS - PLANS



THE L-SHAPE 2 FLOORS - FACADES



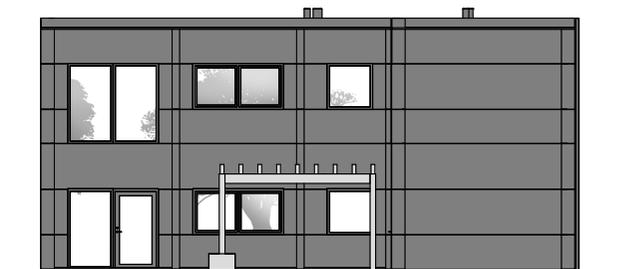
EAST FACADE
SCALE 1:100



NORTH FACADE
SCALE 1:200

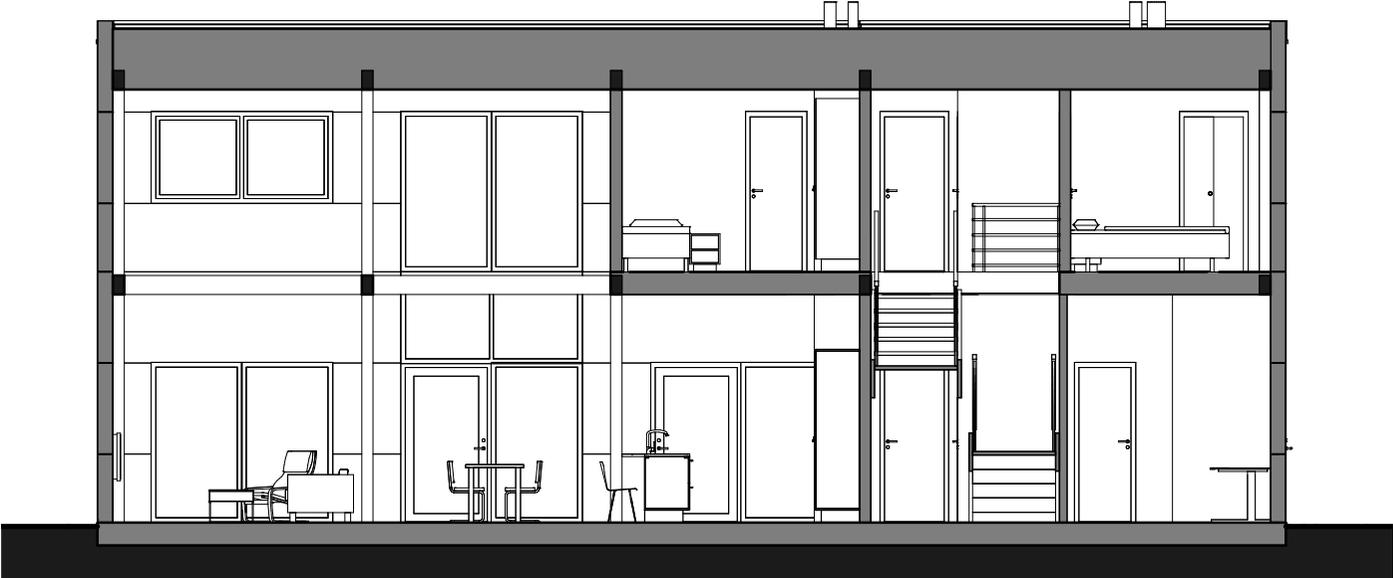


WEST FACADE
SCALE 1:100



SOUTH FACADE
SCALE 1:200

THE L-SHAPE 2 FLOORS- SECTIONS



A-A SECTION



B-B SECTION

THE L-SHAPE 2 FLOORS - EXTERIOR PERSPECTIVE



EXTERIOR PERSPEVTIVE



PERSPEVTIVE SECTION

THE L-SHAPE 2 FLOORS - INTERIOR PERSPECTIVE



INTERIOR PERSPEVTIVE, BALCONY



INTERIOR PERSPEVTIVE, KITCHEN AND LIVINGROOM

THE SQUARE 1 FLOOR

Building area:

- One floor: 149 sqm

Usable area:

- One floor: 139 sqm

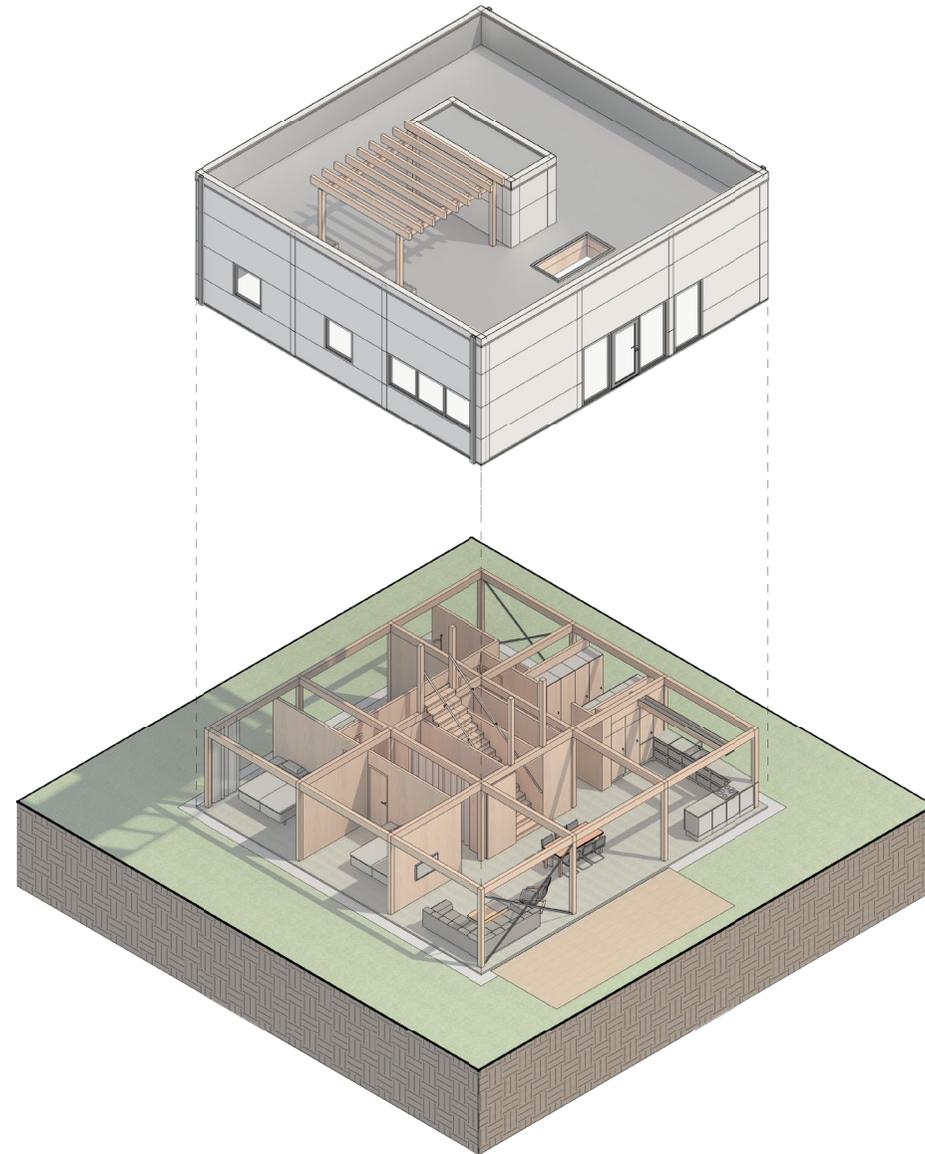
- Roof terrace 130 sqm

Colour choices and extra:

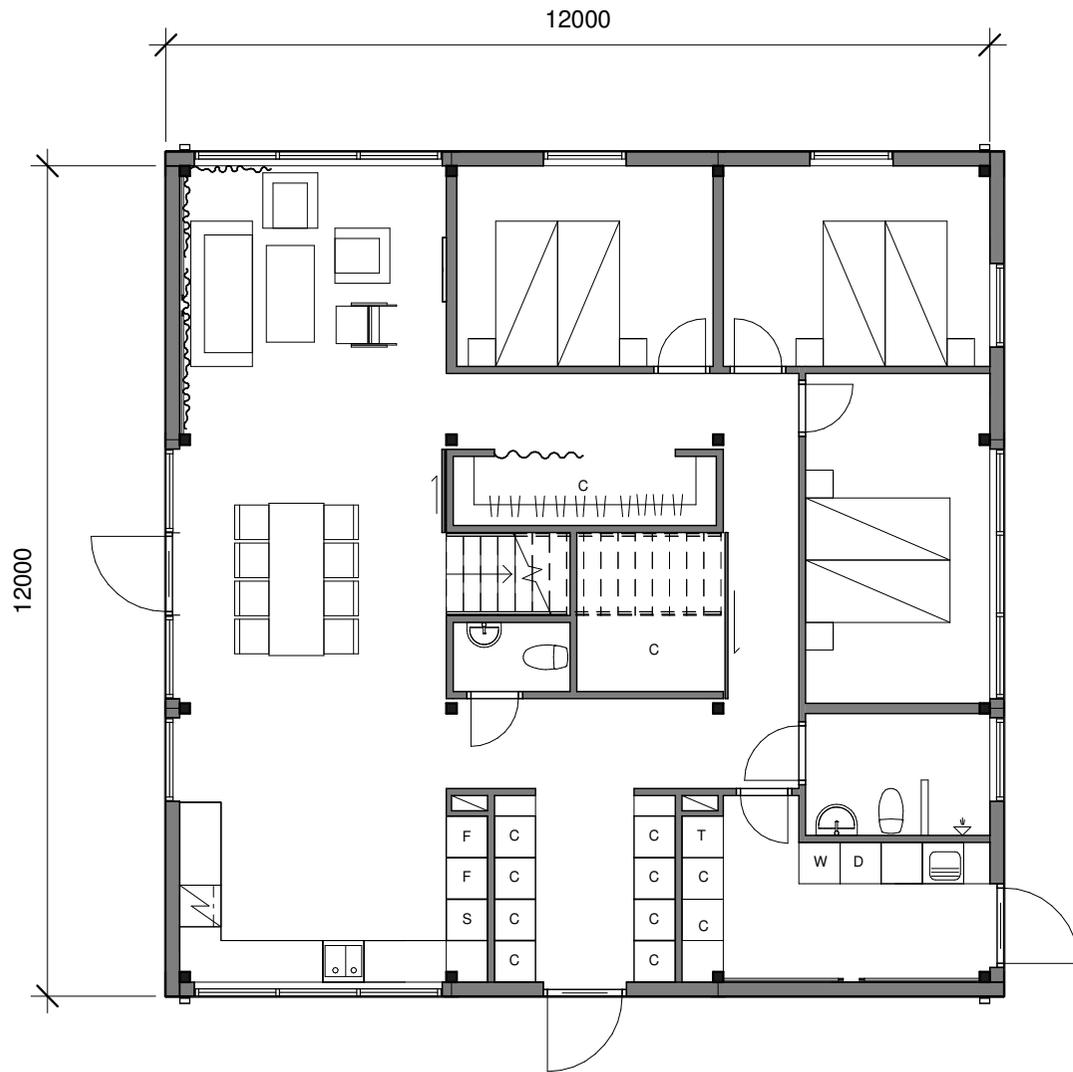
- White facade
- Grey windows and drain-pipes for contrast.
- Wooden pergola on the roof terrace
- Roof skylight

The measurements of the house is based on how large the facade elements could be shipped in a trailer. The 12 meter is divided in to three parts to make the elements thinner and making it possible to expand the building in different sections and different directions.

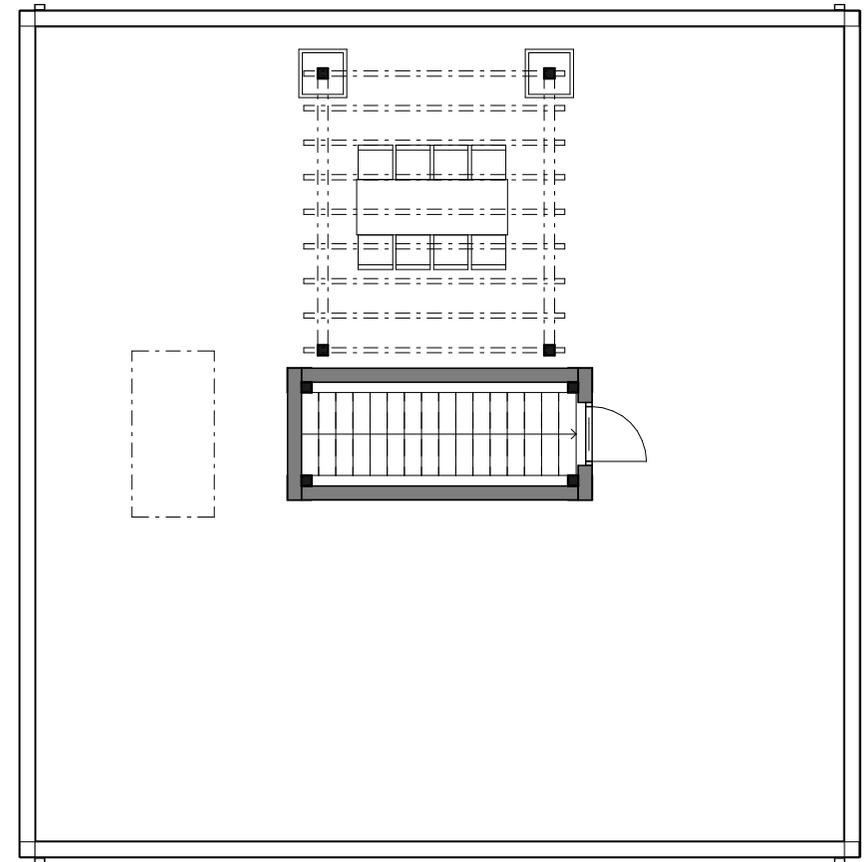
The house has a roof terrace witch is accessible from a internal stair. On the terrace their is a pergola that creates a pleasant space.



THE SQUARE 1 FLOOR - PLANS



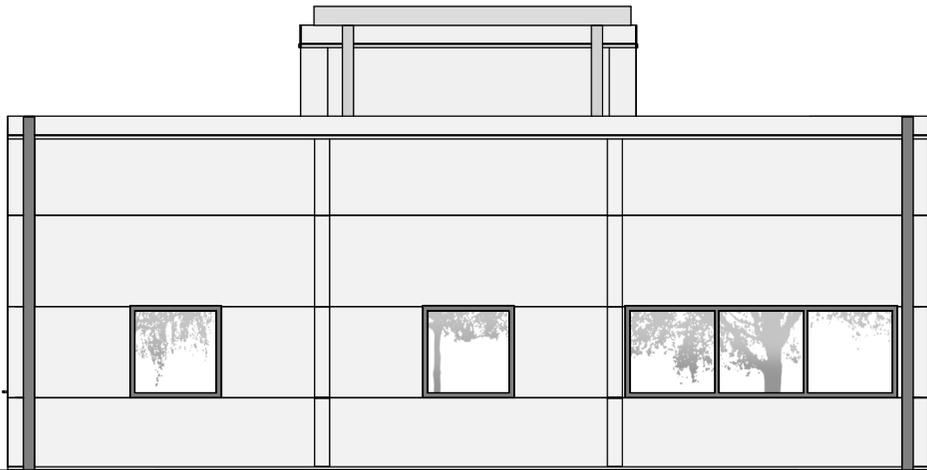
1 FLOOR



ROOF TERRACE

SCALE 1:100

THE SQUARE 1 FLOOR - FACADES



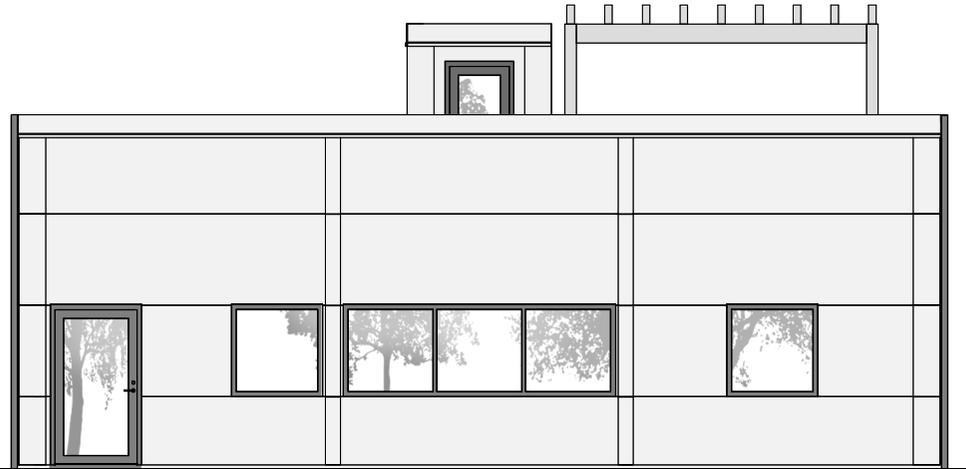
WEST FACADE



SOUTH FACADE



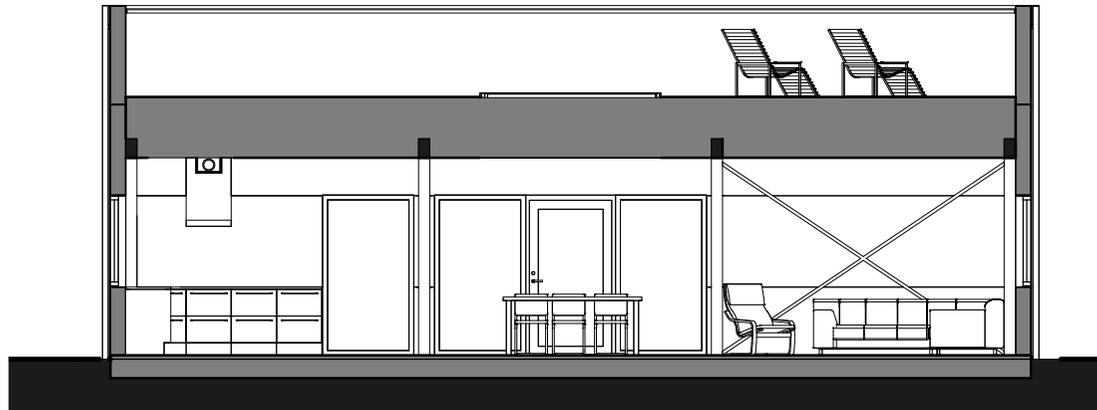
EAST FACADE



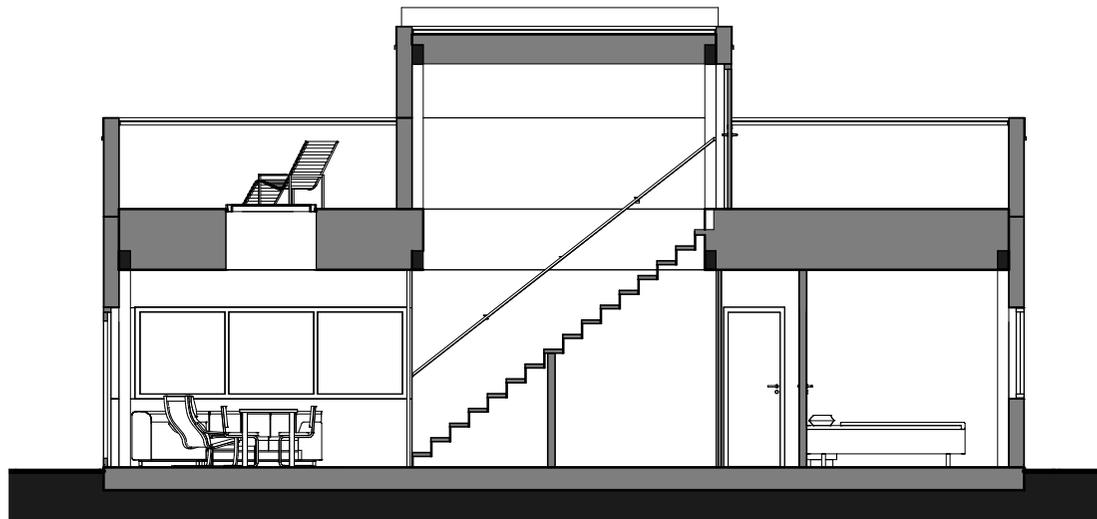
NORTH FACADE

SCALE 1:100

THE SQUARE 1 FLOOR1 - SECTIONS



A-A SECTION



B-B SECTION

SCALE 1:100

THE SQUARE 1 FLOOR - EXTERIOR PERSPECTIVE



EXTERIOR PERSPEVTIVE



PERSPEVTIVE SECTION

THE SQUARE 2 FLOORS - INTERIOR PERSPECTIVE



INTERIOR PERSPEVTIVE, LIVINGROOM



EXTERIOR PERSPEVTIVE, ROOF TERRACE

THE SQUARE 2 FLOORS

Building area:

- One floor: 149 sqm

Usable area:

- First floor: 139 sqm

- Second floor: 104 sqm

Colour choices and extra:

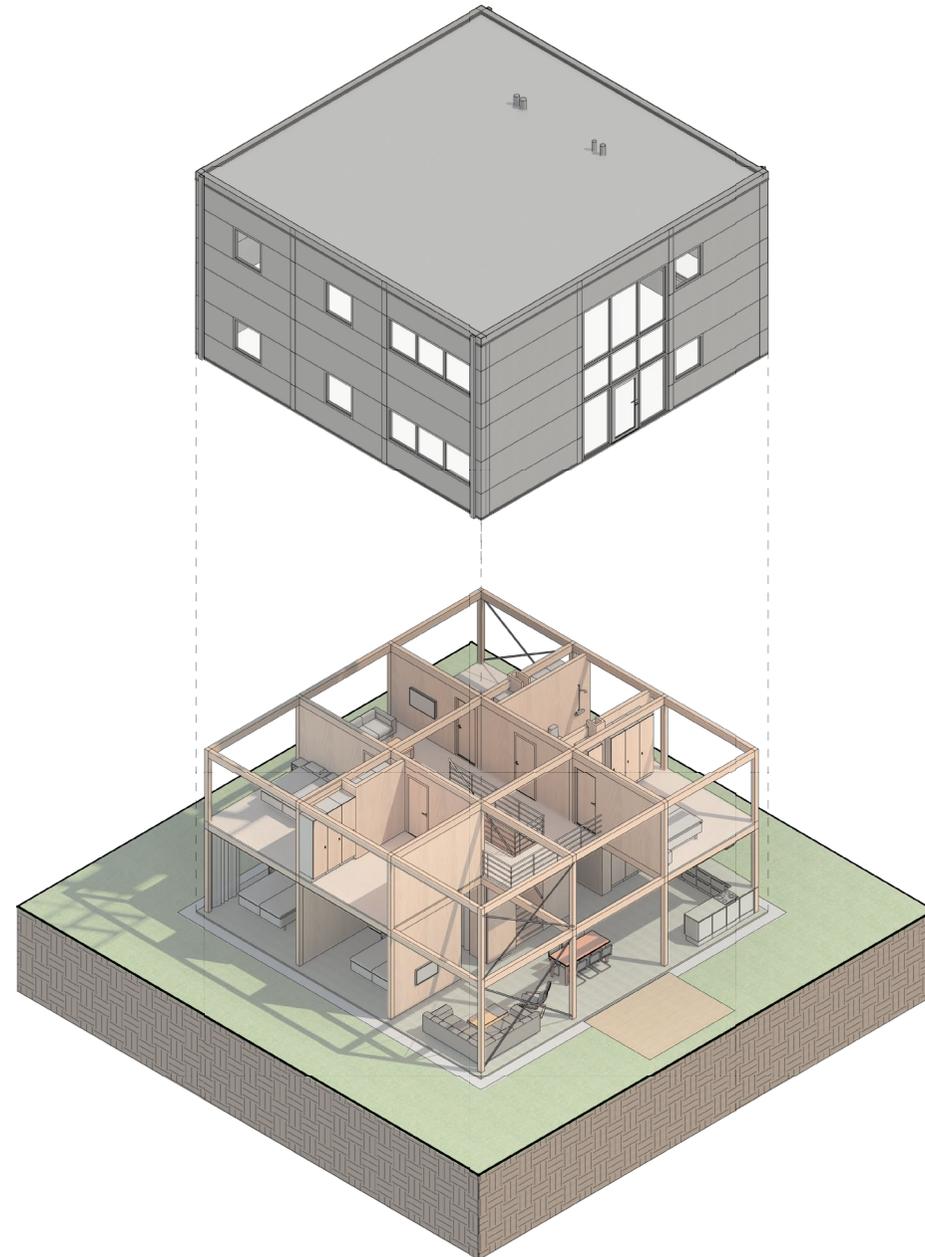
- Dark grey facade

- Grey windows and drain-pipes for making them less visible.

The two floors makes it possible to have areas with double high ceiling to create a more open volume and bright area.

Slidingdoors makes it possible to seperate the living- and diningroom with the more private bedroom area.

It is a 7 bedroom house with two living-rooms but you could also extend the second floor in to the double high space to create two more rooms if needed.



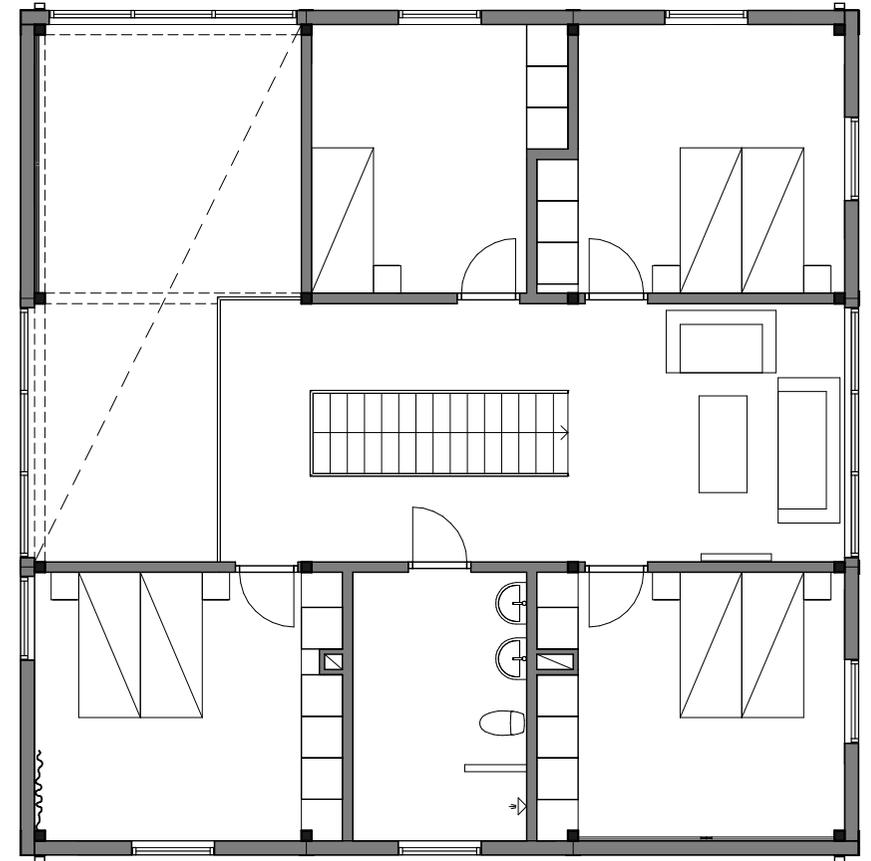
THE SQUARE 2 FLOORS - PLANS



NORTH



1 FLOOR



2 FLOOR

SCALE 1:100

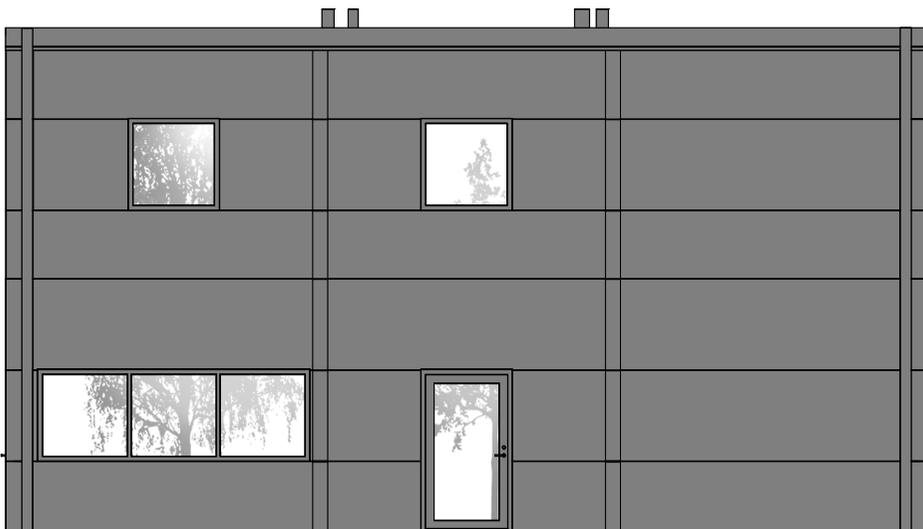
THE SQUARE 2 FLOORS - FACADES



WEST FACADE

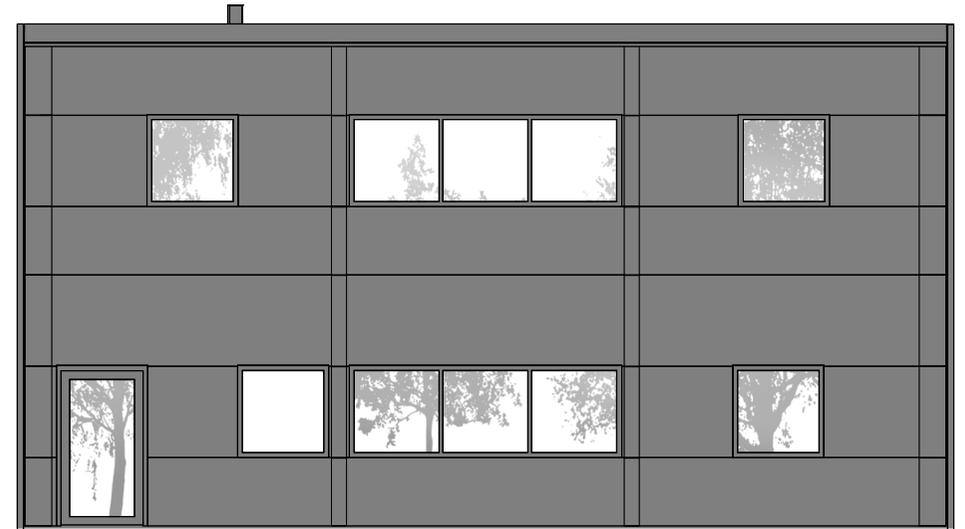


SOUTH FACADE



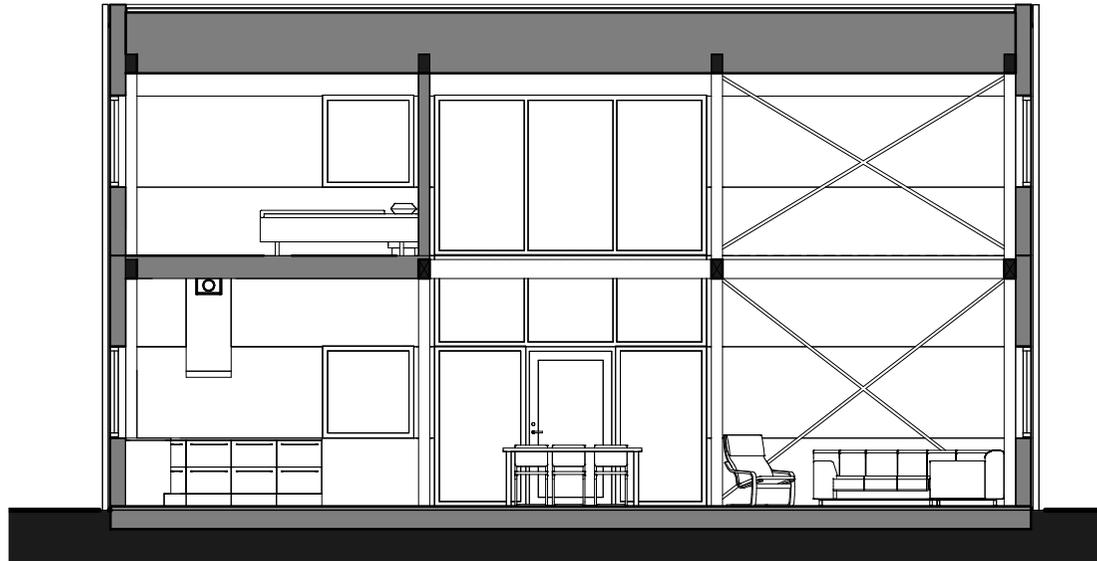
EAST FACADE

SCALE 1:100

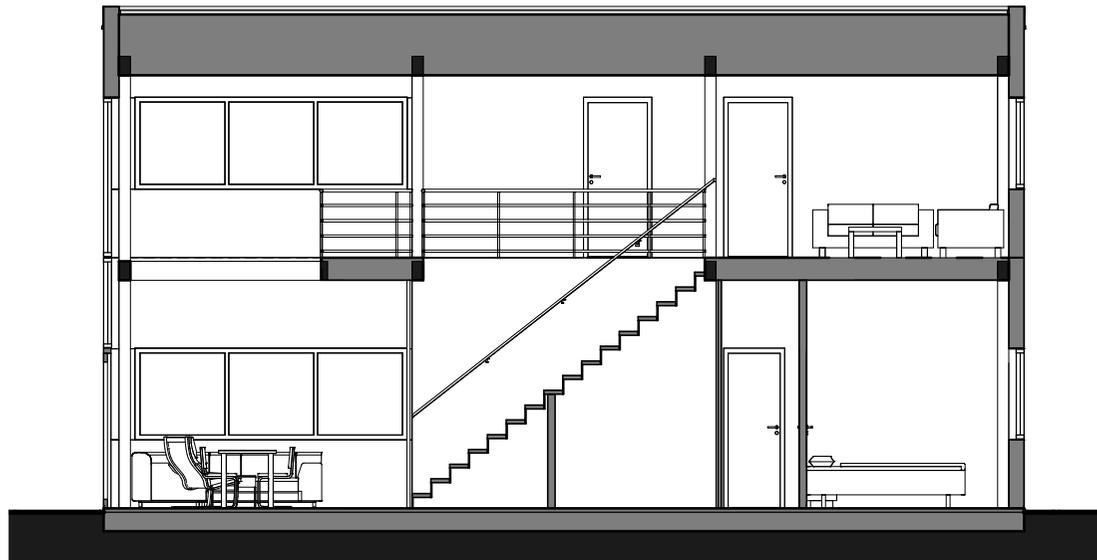


NORTH FACADE

THE SQUARE 2 FLOORS - SECTIONS



A-A SECTION



B-B SECTION

SCALE 1:100

THE SQUARE 2 FLOORS - EXTERIOR PERSPECTIVE



EXTERIOR PERSPEVTIVE

PERSPEVTIVE SECTION

THE SQUARE 2 FLOORS - INTERIOR PERSPECTIVE



INTERIOR PERSPEVTIVE, LIVINGROOM



INTERIOR PERSPEVTIVE, BALCONY

THE RECTANGLE 1 FLOOR

Building area:

- One floor: 100 sqm

Usable area:

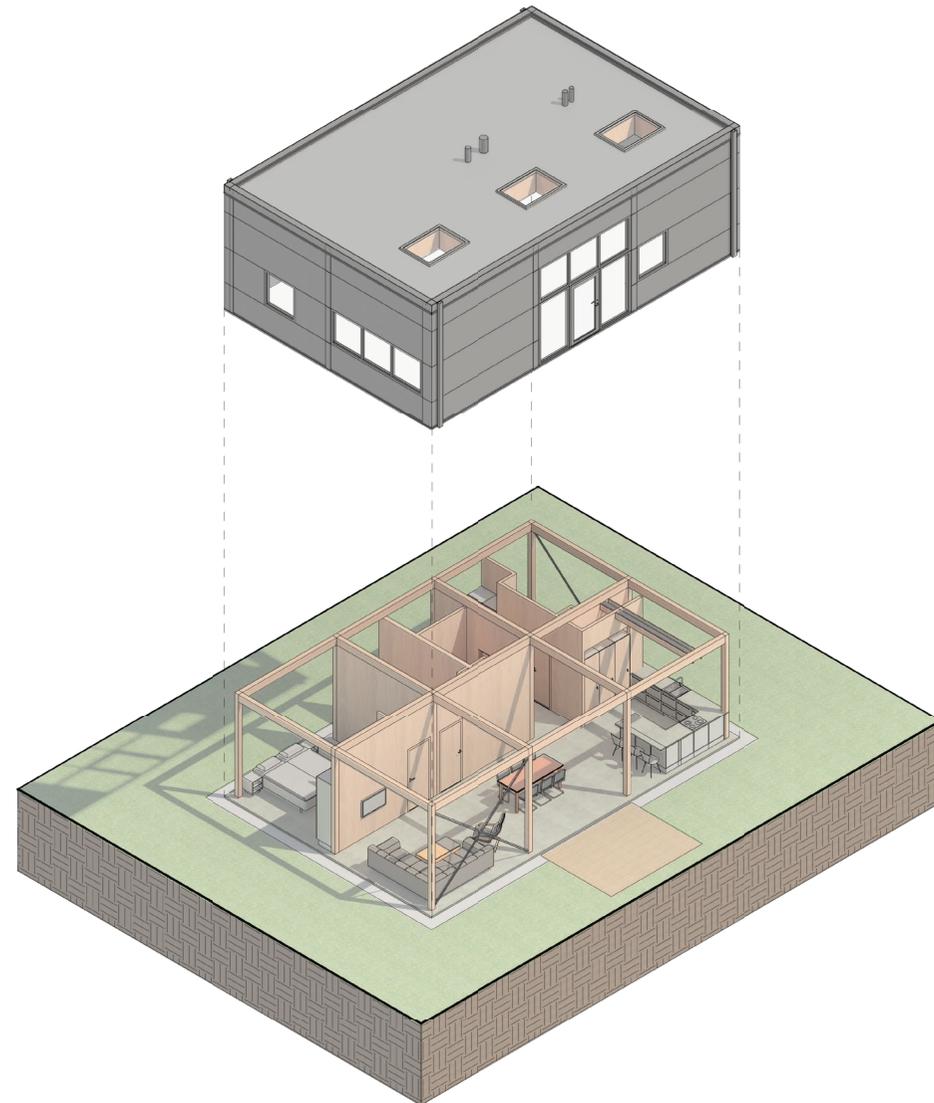
- One floor: 92 sqm

Colour choices and extra:

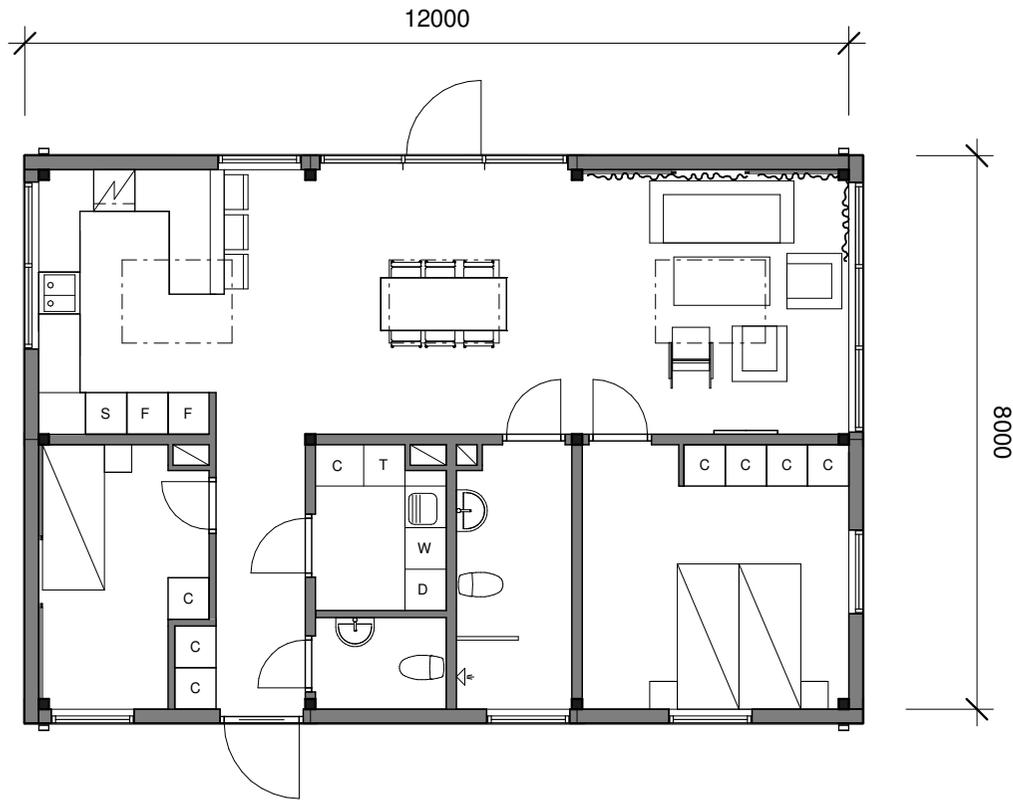
- Dark grey facade
- Grey windows and drain-pipes for making them less visible.
- Roof skylight

The measurements of the house is based on the square house but one section-row is removed to create a compact version.

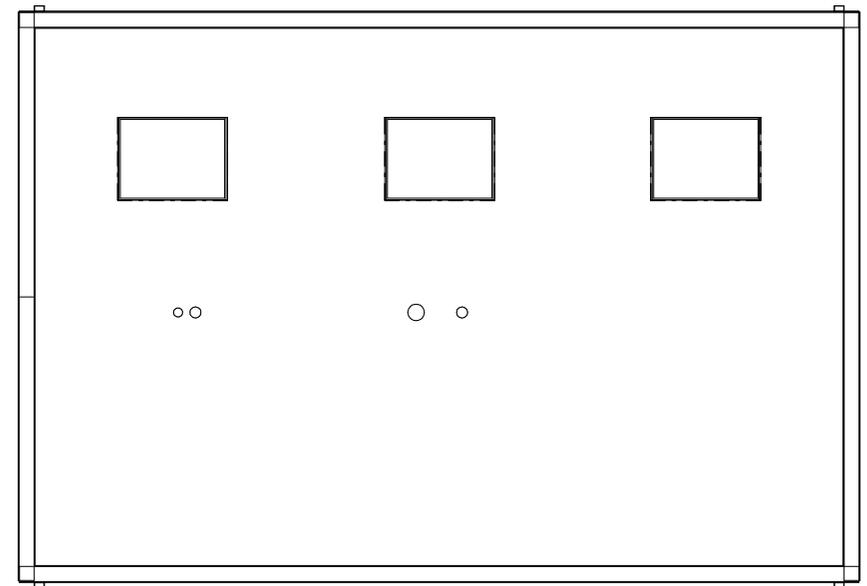
The skylights opens up the rooms both with external light and the space underneath.



THE RECTANGLE 1 FLOOR - PLANS

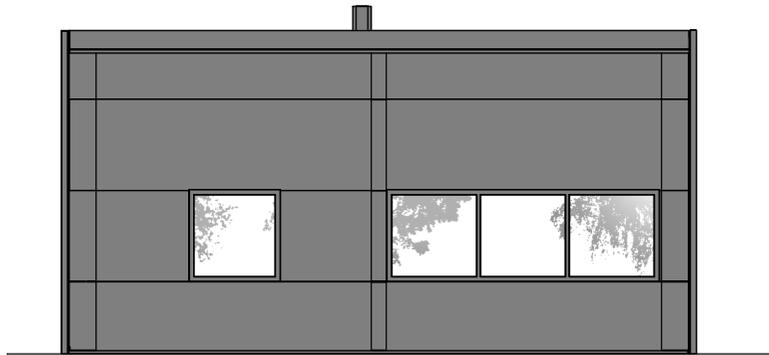


1 FLOOR



ROOF PLAN

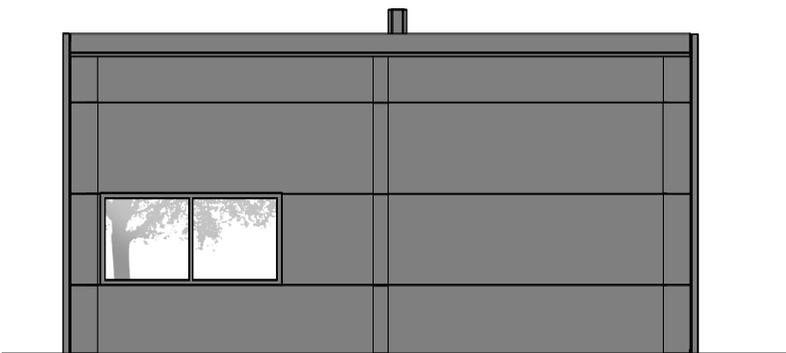
THE RECTANGLE 1 FLOOR - FACADES



NORTH FACADE

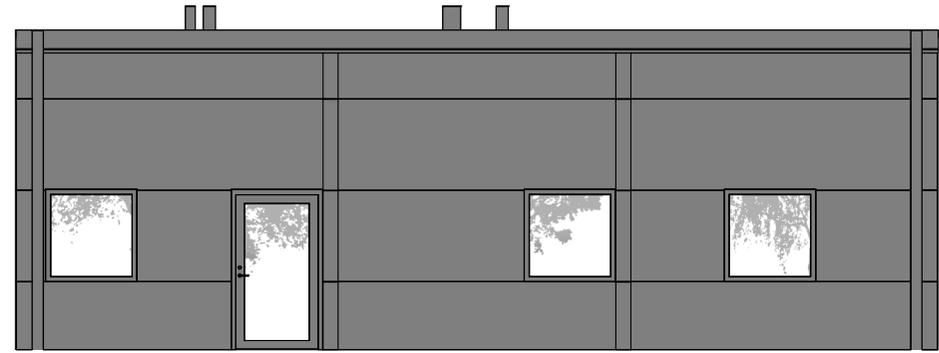


EAST FACADE



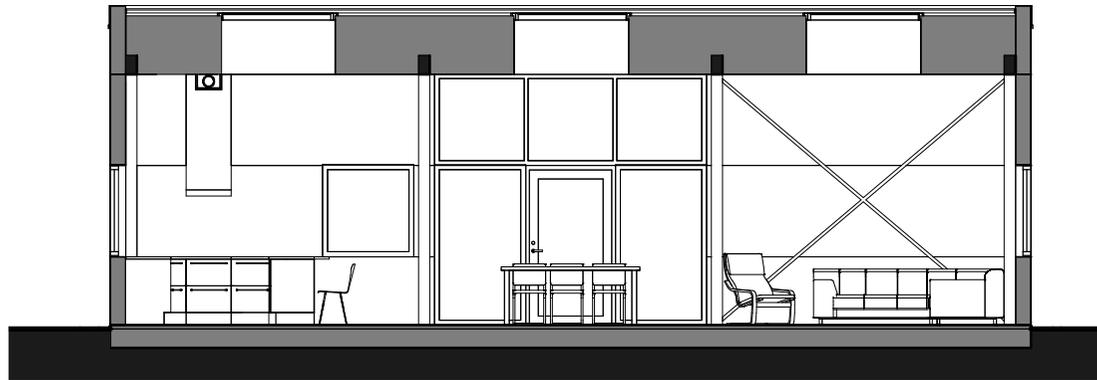
SOUTH FACADE

SCALE 1:100

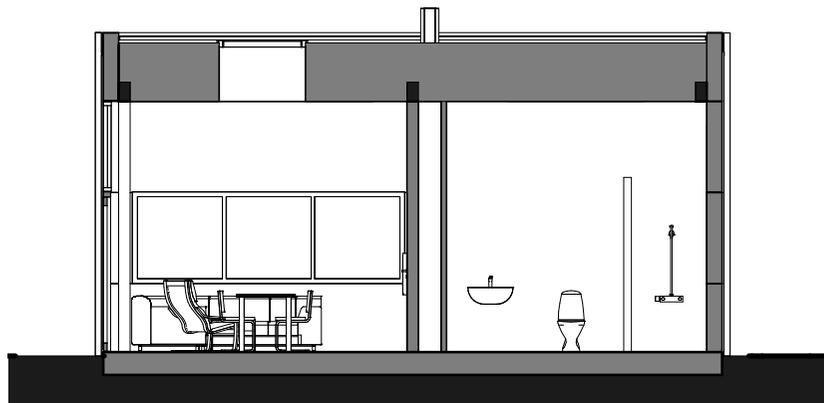


WEST FACADE

THE RECTANGLE 1 FLOOR - SECTIONS



A-A SECTION



B-B SECTION

SCALE 1:100

THE RECTANGLE 1 FLOOR - EXTERIOR PERSPECTIVE



EXTERIOR PERSPEVTIVE



PERSPEVTIVE SECTION

THE RECTANGLE 1 FLOOR - INTERIOR PERSPECTIVE



INTERIOR PERSPEVTIVE, DININGROOM



INTERIOR PERSPEVTIVE, LIVINGROOM

THE RECTANGLE 2 FLOORS

Building area:

- One floor: 100 sqm

Usable area:

- First floor: 92 sqm

- Second floor: 78 sqm

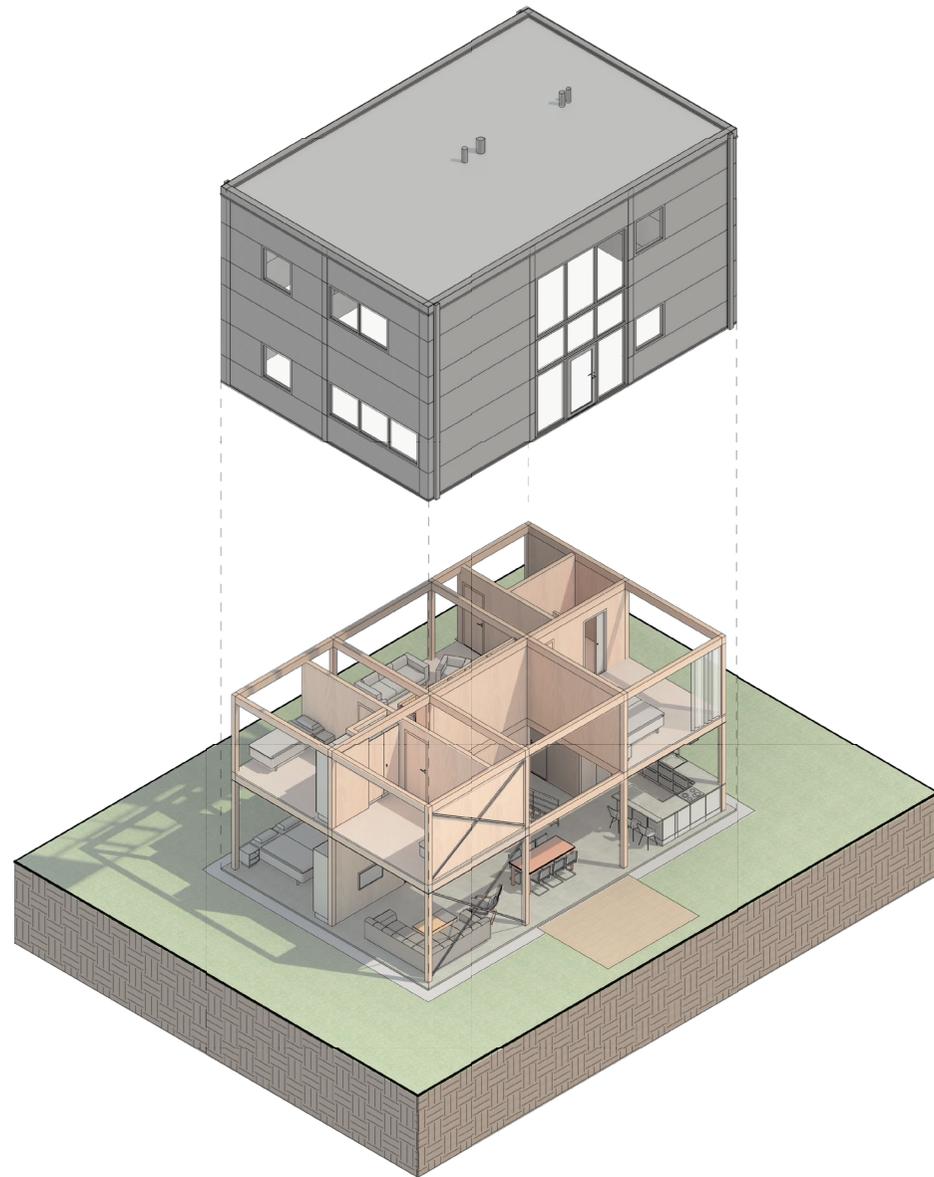
Colour choices and extra:

- Dark grey facade

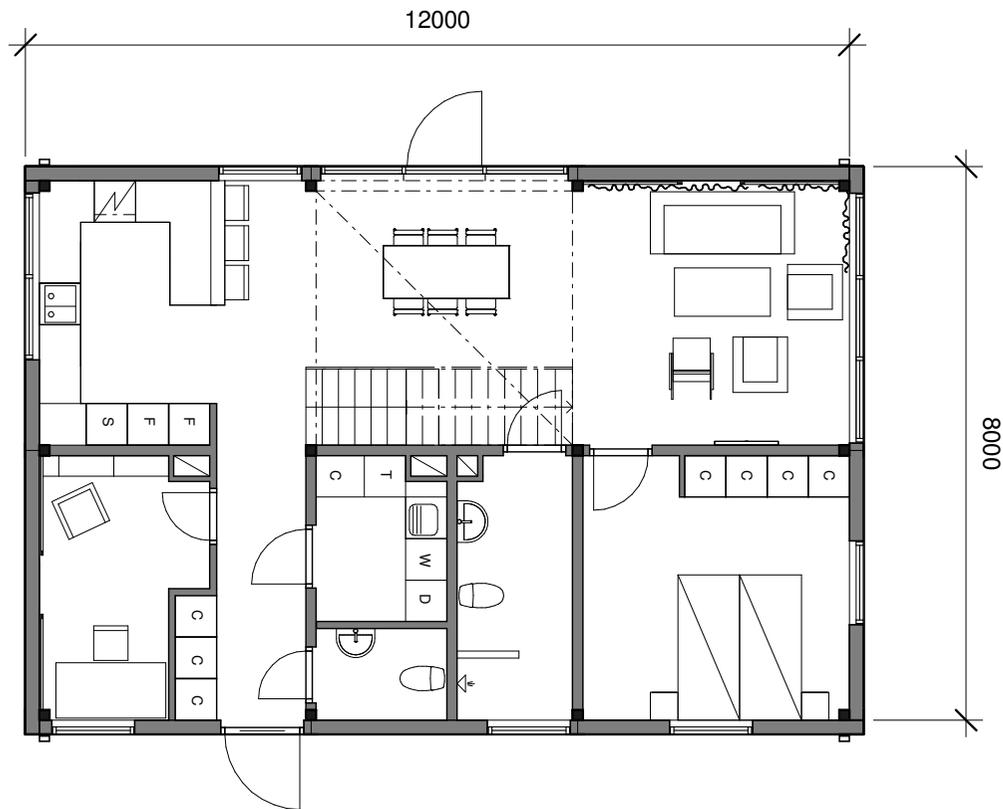
- Grey windows and drain-pipes for making them less visible.

The stairs are located in the open floorplan dining area with a double high ceiling and a lot of windows to create a bright interior.

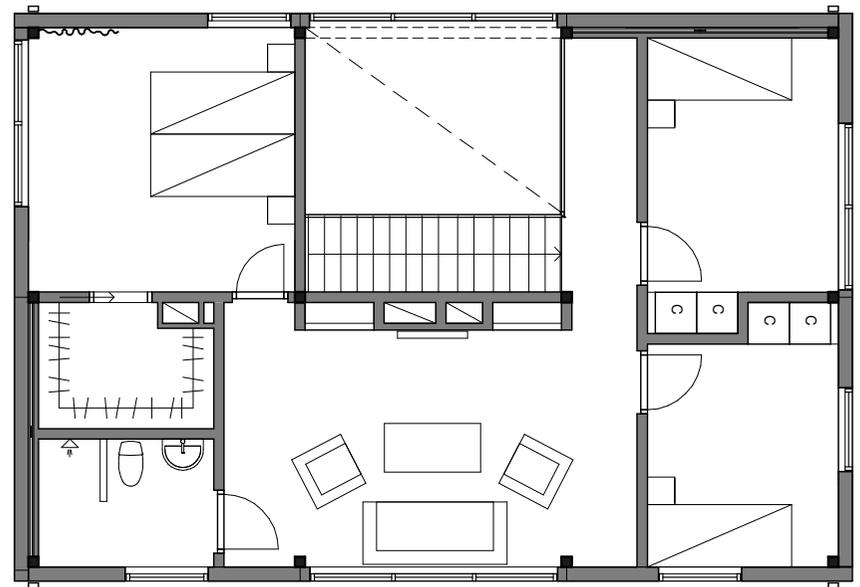
If needed more bedrooms, the double high space could easily be made in to a room.



THE RECTANGLE 2 FLOORS - PLANS



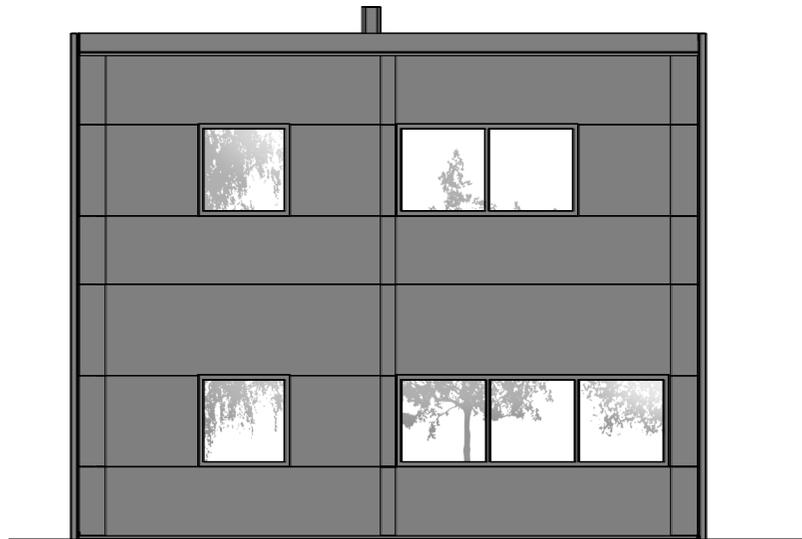
1 FLOOR



2 FLOOR

SCALE 1:100

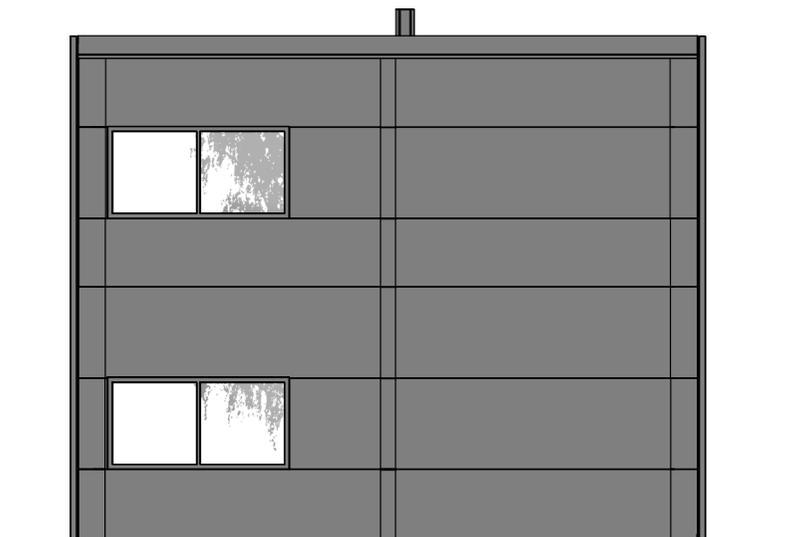
THE RECTANGLE 2 FLOORS - FACADES



NORTH FACADE

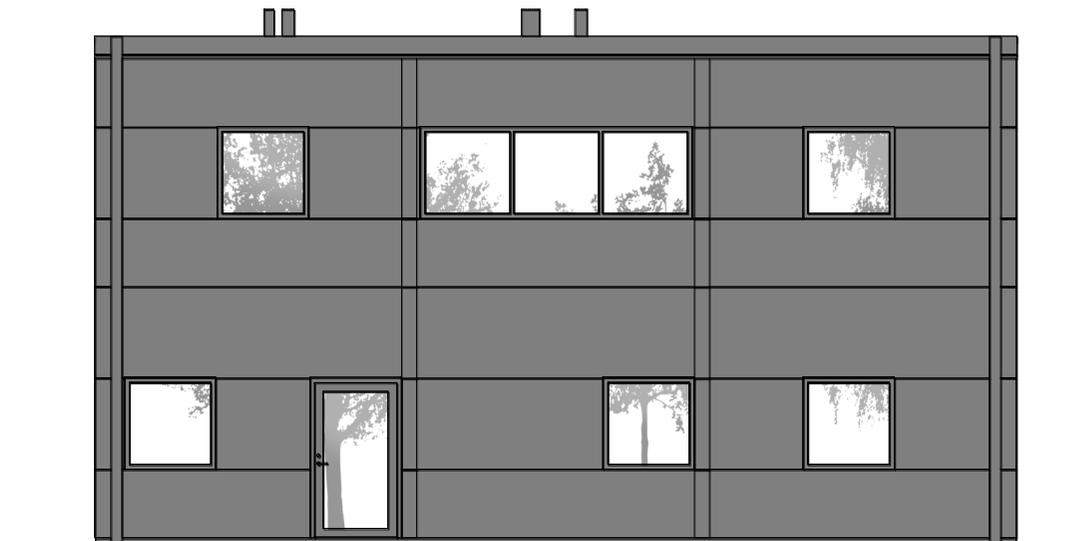


EAST FACADE



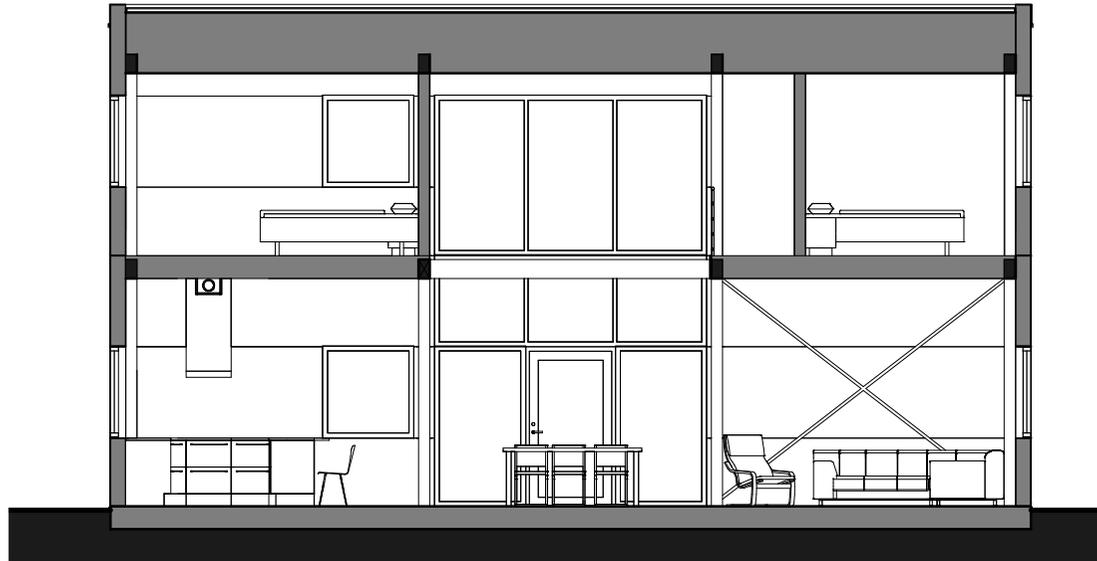
SOUTH FACADE

SCALE 1:100

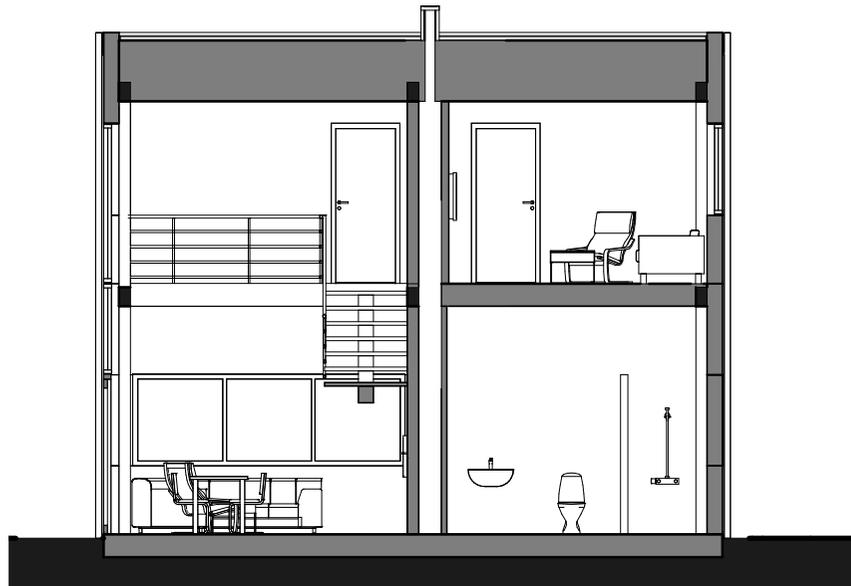


WEST FACADE

THE RECTANGLE 2 FLOORS - SECTIONS



A-A SECTION



B-B SECTION

SCALE 1:100

THE RECTANGLE 2 FLOORS - EXTERIOR PERSPECTIVE



EXTERIOR PERSPEVTIVE



PERSPEVTIVE SECTION

THE RECTANGLE 2 FLOORS - INTERIOR PERSPECTIVE



INTERIOR PERSPEVTIVE, LIVINGROOM



INTERIOR PERSPEVTIVE, SECOND FLOOR LIVINGROOM

CONCLUSION

This thesis has brought up an interesting way of looking at single-family houses.

The steel sandwich material makes it possible to create a lot of different houses in many varieties of expressions. It is very customizable, even after it has been built you could change the look of the house by adding other facade materials or another material in the inside.

The fact that you get more liveable space for less money than a regular stud wall is something that many people would find interesting.

Something that has been hard is to find the prices for the materials, which led to fewer prices than wanted. But the most important prices were presented.

If the thesis would have been continued, the result would have shown a more variety of houses. It would also have shown the houses in different stages, different facade expressions and how they could expand from a small house to a bigger one. An example of how the buildings could fit in different sites would also be relevant to show.

As the master's thesis turned out it is showing the potential of building single-family houses with steel sandwich elements in a convincing way.

REFERENCES

INFORMATION

- Paroc, folders and information on their website. Retrieved 2018-01-20, from <https://www.paroc.se>

ARTICLES

- Boverket. (2016). Reviderad prognos över behovet av nya bostäder till 2025. Karlskrona: Boverket. Retrieved 2018-03-16, from <https://www.boverket.se/globalassets/publikationer/dokument/2016/reviderad-prognos-over-behovet-av-nya-bostader-till-2025.pdf>
- Harrysson, C., Welander, G. (2017, 19 Jun). Bygg fler småhus - bra, billiga och energieffektiva. Göteborgs Posten. Retrieved 2017-11-10, from <http://www.gp.se/debatt/bygg-fler-smahus-bra-billiga-och-energieffektiva-1.4375596>
- Johnsson, D., Edgren, G., Lind, H. (2017, 18 May). Ge fler chansen att bosätta sig i småhus. Svenska Dagbladet. Retrieved 2017-12-07, from <https://www.svd.se/ge-fler-chansen-att-bosatta-sig-i-smahus>
- Hallemar, D. (2017, May) Villamattan. Arkitektur, 4. 24-27.

Photos

- Photo: 1, 2, 3, 10, 11, 12
www.paroc.se (2018)
- Photo: 4, 8, 9
<http://www.konst.org/swe/> (2018)
- Photo: 5, 6, 7
<http://www.spridd.se/algokulturhus> (2018)
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- The rest of the illustrations and photos are taken or made by the author.



CHALMERS

AFFORDABLE HOUSES

A NEW WAY TO GET MORE PEOPLE TO AFFORD A HOUSE

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