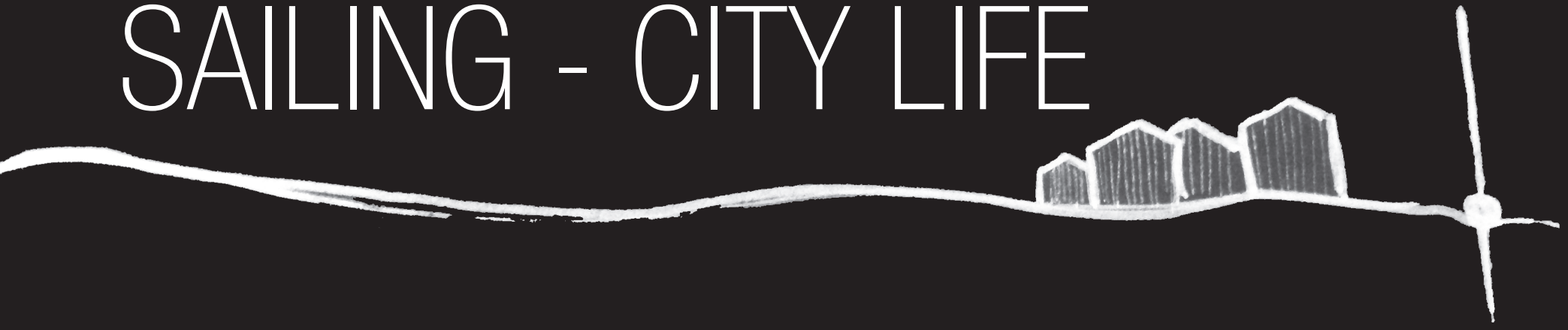
SAILING - CITY LIFE



Aalborg University - Architecture & Design, Msc04 - Architecture, June 2015, Group 04 - Line Ryltoft Zohnesen

SAILING

- City Life

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ABSTRACT

Connecting the marina life with the city. As sailors wants to be close to the city and the belonging facilities. Thisted Harbor has the potential of expansion, by converting the cargo pier into marina area. In this way the sailors come closer to the city and the city come closer to the water.

The new facility pier will be a gathering point, with cultural elements, and open environment where everyone are welcome.

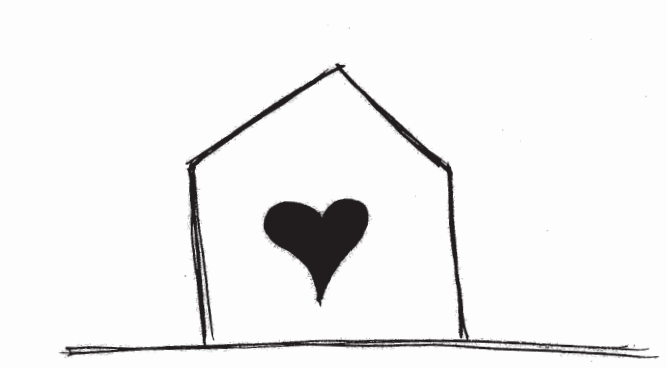
PREFACE

This project are made because of the personal interest I have in sailing, the inspiration came last summer (2014) when sailing for two weeks through Limfjorden and further out to Kattegat. This opened my eyes for the unexploited qualities there are at the harbour of Thisted.

Sailors are not private people, they what to get close the area they are entering, and lean about it. So often sailors are searching for boat spaces closest to the city centre, where there are life. The marina of Thisted are not in the centre of the city. However, the cargo pier are located in the between the marina and the city, unfortunately the pier are closed because of the cargo ships that occasionally enters the harbour. This area have all the location qualities that the sailors are searching. Further the citizens of Thisted have the wish of a closer connection to the waterfront, with useful areas where they can bring their children, feel the small society that the marina offers, and use the outdoor facilities as, hammocks, grill terraces and playful elements.

This report shows my interpretation of the solution; how to emphasize the qualities that the city and the site contains, but also which qualities that can be added in order to create a higher diversity on the waterfront.

The report are established in three main sections and one follow up section with the technical calculations. The three main sections are the program where I analysing the climate, the site and it surroundings and the user profile and ends with my suggestion to functions that must be implemented in the design.
The second section are the presentation where the final result are presented with a small text and a follow-up sketch. The last section are the detailing where I explain why I have done as I did, by explaining the thoughts behind.



CONTENT

INTRODUCTION

Thisted is a city with the potential to benefit from the qualities of Limfjorden. Many tourists' travels by water, which gives Thisted a great change of being a local centre for sailors in Limfjorden, this adds a certain value to the tourist attractions in the catchment areas.

There is a need for developing the marina and the harbour areas to strengthen the relation with the city and the cultural life that Thisted provides. Further, the marina are under dimensioned according to boat spaces in number, but also in size, as boats during time are getting larger.

The idea is that the city and the marina can benefit from each other, in such a way that the marina will gain a higher amount of memberships, and promote the society that sailor living contains. Further, the city and the cultural life will benefit from the guest sailors that are entering the harbour. This promotes the qualities of the surroundings, but also the shops and cafes will benefit from the money sailors a willing to use.

The aim of the project is to design new facilities and clubhouses for guests. The design will be centred and staged in the harbour, the cargo pier. The location can be considered as a key joint between the city and the water.

METHODOLOGY

Integrated design process (IDP)

IDP is a method divided into five phases: the problem, analyzing, sketching, synthesis and presentation. The process is based on interaction between the phases Instead of following the order of phases; IDP makes it possible to go back and forth in the project, so that the produced material always is verified in relation to previous phases. The improvement can be detailing, changing the problem or go in another direction in terms of design.

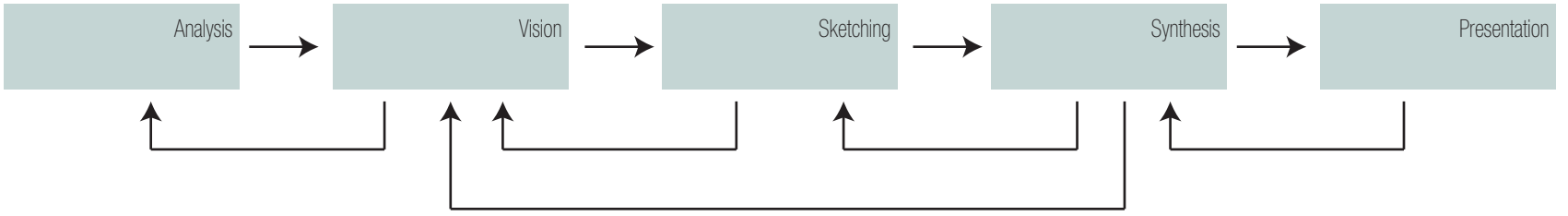
The first phase is problem; state the problem and an idea of how to solve the problem.

The analysis phase, collecting all data about the building site, environment, climate, local, user group and there wants and needs. Further, settlement of functionality, architectural inspiration and the principle of the technical demands are also determined in this phase. At the end of this phase, the design criteria's are listed.

The Sketching phase is where the knowledge from the studies and from experience of architecture and engineering combined. In producing ideas to the solution, with different focus areas and combining them to a more specific design.

The synthesis are the detailing, where the sketches becomes more hand able. All the design parameters are melting together in a detailed design with producing elevations, sections, plans etc. furthermore, this phase are also where the technical demands are optimized and documented. If some part of the design is not working, yet it is possible to go back to the sketching or analysis phases to redesign.

The presentation, where all the qualities are expressed clearly, and the detailing, design criteria and main principles are described and shown how they these are fulfilled. [Hansen & Knudstrup, 2005]



Ill. 01.1 Methodology , IDP

NORDIC ARCHITECTURE

Ill. 01.2 - 01.8 Nordic architecture inspiration

The Nordic countries that are defining the Nordic Architecture are Denmark, Finland, Iceland, Norway and Sweden. These countries are contributing to the contemporary architectural values in Scandinavia that are well known and respected in the rest of the world.

In the Nordic architecture there are a strong relation between the building and the surroundings, and this reflects on each design as there are a big different of landscape, each country have their unique climate and landscape, from mountain and fjords, to forest and lakes, to field and glaciers.

Tradition and history are also playing a huge role in the design, as the landscape and climate of each country have not changed during all of these years, and therefore architects can learn from the traditions. The relation to the context are a typical Nordic approach to find the spirit of the place and create new or improved places. Also the climate influence the design, and in Nordic architecture it is especially the low tech solutions that are incorporated in the design, this means the orientation of the building and the placement of openings according to the sun and ventilation, which again relates to the traditions that have been used for centuries.

Another approach to Nordic architecture are the Nordic model or Nordic way, which is the focus on welfare, it id world famous as it combines individually freedom with common and social trust. The governments are playing an important role in the welfare strategies, as they are the ones paying for the social buildings, and are setting the demands. In order to make these buildings cultural and social, the combination of functions are giving a wide spectrum of people to be a part of a community.

The Nordic Architectural approach will be show in this project, in the term of traditions of structure, materials, orientation and openings. Further, it will show in the design of respecting the context and climate.

Ill. 01.10 - 01.13 Tectonic Inspiration

TECTONIC

The question of what is Tectonic is something that many theorist have been discussing during time, they all have their own perspective, but they can all relate to the origin from carpentry. All theorists find the importance of honesty and clarity in the construction and materials. Some of the approaches are that tectonic is Architecture that unfold man space (Schmarsow), meaning that architecture origins from the needs of the human and that the use of the space are shaping it, here it is also important to consider the influence that the space are having on our psychology (Rasmussen).

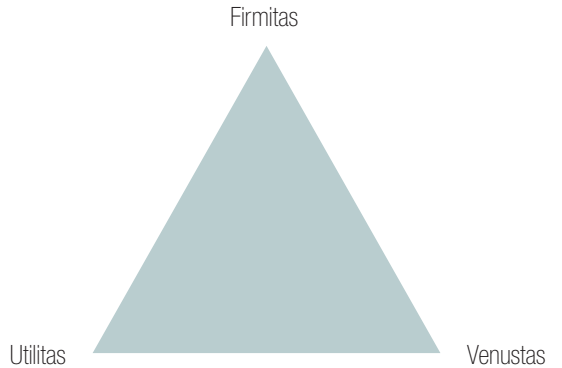
One of the most important and clear statement of tectonic is Sekler, that says that tectonic is the structure and construction, with the honesty of materials and each element should be used for the purpose of its exist. Further, on he defines the atectonic as the use of elements for only aesthetical purpose. Meaning that tectonic is when; structure, construction and materials are working together, creating the aesthetical qualities, it should not be necessary to add extra elements to fulfil the aesthetical.

Another important theoretic of tectonic is Semper with "Each technique has a certain material; style is the formal consequence of having adopted a certain material", he means that there are different solutions to each materials; concreate, steal and wood have each there purpose of use. Furthermore, Semper's evolution of architecture strictly relates to place, climate, culture, available materials and know technologies.

To the discussion of tectonic as a tool when designing, Vitruvius and his triangle of "utilitas, firmitas, venustas" is a significant parameter of designing. Utilitas, Firmitas, Venustas is the technical, functional and aesthetical parameters of a design, in order to create and design a beautiful and useful building all of these three has to work together. [Frampton, 1995]

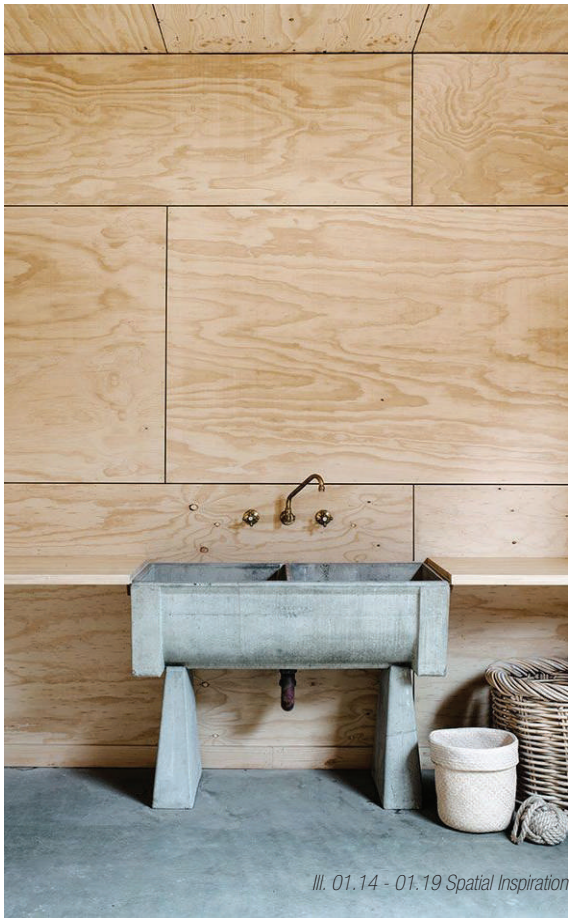
This theoretical approach used in the project are can be described with a few words: honesty, clarity and spatial sense. The structure, construction and materials should contribute to the spatial senses with the feeling of home and welcoming.

This approach are supported by the gesture and principle, meaning that the principle are supporting the gesture of the building design. The principle are the construction method and the technical aspect where the gesture are the spatial aspect with qualities, feelings and experience.



Ill. 01.9 Vitruvius triangle

THE SENSES



Ill. 01.14 - 01.19 Spatial Inspiration

The perception of architecture are by the eyes, but is this really the best and most efficient way of perceiving a building design. To see is only one of many senses that we are using, unfortunate the eyes have become the most dominate sense and the ears, mouth, nose and skin is now secondarily. The experience of architecture is not the same if one only sees it, or if one really experience it by feeling with hands, smell it, hear it or even taste it. All the sense have to work together to give the body an experience of feelings.

It is important that we as architects are trying to get the senses back; we need to make people feel the building instead of just seeing it. The feeling is also, what differs a house from a home; a house is the physical element of a design, where a home is the feeling inside the physical.

Our perception feeling of a building comes from memories. All have a perception of a certain material, example some associate wood with old summerhouses, others sheds. Some love the use of concrete cause it feels soft while others associate it with industrial halls that are cold and hard.

All of these associations is a combination of all the senses, a certain smell, or sound will induce memories either good or bad, and these memories will shape the opinion and feeling of the building. [Pallasmaa, 2012]

In this project, it is a focal point to find and create this feeling of home even though the sailors are far from home. The sailors are having a peace of home with them in the small amount of space, the boat are there summerhouse. So therefore, it makes it more important that the facility and clubhouse give the same feeling, elsewise the sailors are not interested in use it. The aim is to work with the materials, size and height of rooms and the plans in order to give a flow that seems natural, but also integrate the facilities so that people interact with each other but also the building itself.

"The sense of touch is the sense that integrates our experience of the world with our experience of ourselves"

– Juhani Pallasmaa, 2012

SUSTAINABILITY

01_23 Sustainability inspiration

Social sustainability

Social sustainability is another way of approaching the theme sustainability; normally we talk about environmental, political or economic sustainability. In this Project, the focal point will be the social interfering between the types of people. [Dillard, J, Duion, V & King, M.C, 2008]

It is difficult to define Social sustainability, as many have tried but nobody can reach an agreement to the subject. An Australian non-profit organization called WACOSS has lined up goals of how to define social sustainability: Equity, Diversity, Interconnectedness, Quality of life and Democracy and governance.

Shortly told these points are about community and being social, all people benefits from being a part of a community with a diversity of people, we can all learn from each other. Further, we all have needs and often we are taking this for granted; water, electricity, food, etc. There are formal and informal means that are connecting people, and all can benefits from this as there is less change of ejecting groups of the society. All of this has to be supported by the government that are working close together with the citizens. [WACOSS, 2015]

Technical demands

The following demands are from the building regulation 10, with the focus on indoor climate.

Thermal indoor climate, are determined by the “percentage dissatisfactied” (PPD), which is how many people that feel either to cold or to warm indoor. Another thing that thermal indoor climate are determined by are the “Predicted Mean Vote” (PMV) which a measured by the activity level, clothe, air temperature, average radiant temperature, average air speed and air humidity. [Energi styrelsen - Termisk indeklima,2014]

Air quality have a demand of inlet and outlet air of at least 3 l/s per child and 5l/s per adult plus 0,35l7s per square meters floor area. The CO2 are not allowed to exceed 0,1procent of the indoor air. It is recommended to have hybrid or mechanic in common areas. [Energi styrelsen – Ventilation ,2014]

Daylight is an important factor for the indoor environment, and there is a demand of at least an average of 2 percent and 5 percent in living areas. This can be fulfilled be a small rule of glass area; if ordinary wall windows is at least 10 percent of the floor-area or roof windows have an area of at least 7 percent of the floor area. Last there is a demand of all occupants should be able to have a direct view to the outdoor, as these also will work as manholes in case of a fire. [Energi styrelsen - Dagslys,2014]

Further on there are some specific demands from the building class 2020 which will be the requirements to follow. The building class 2020 are focusing on sustainability, more precise the indoor climate and the solutions to this.

Transmission losses through the envelope cannot exceed 3.7 W per m2 envelope when the building are only one level. 4.7 with two levels and 5.7 with three levels and above. Transmission losses are calculated by the heat loss of the building.

The indoor climate is a focal point and therefore there are some requirements for the daylight and more specific the glass areas of windows. The glass area should be at least 15percent of floor area if the light transmittance is 0.75.

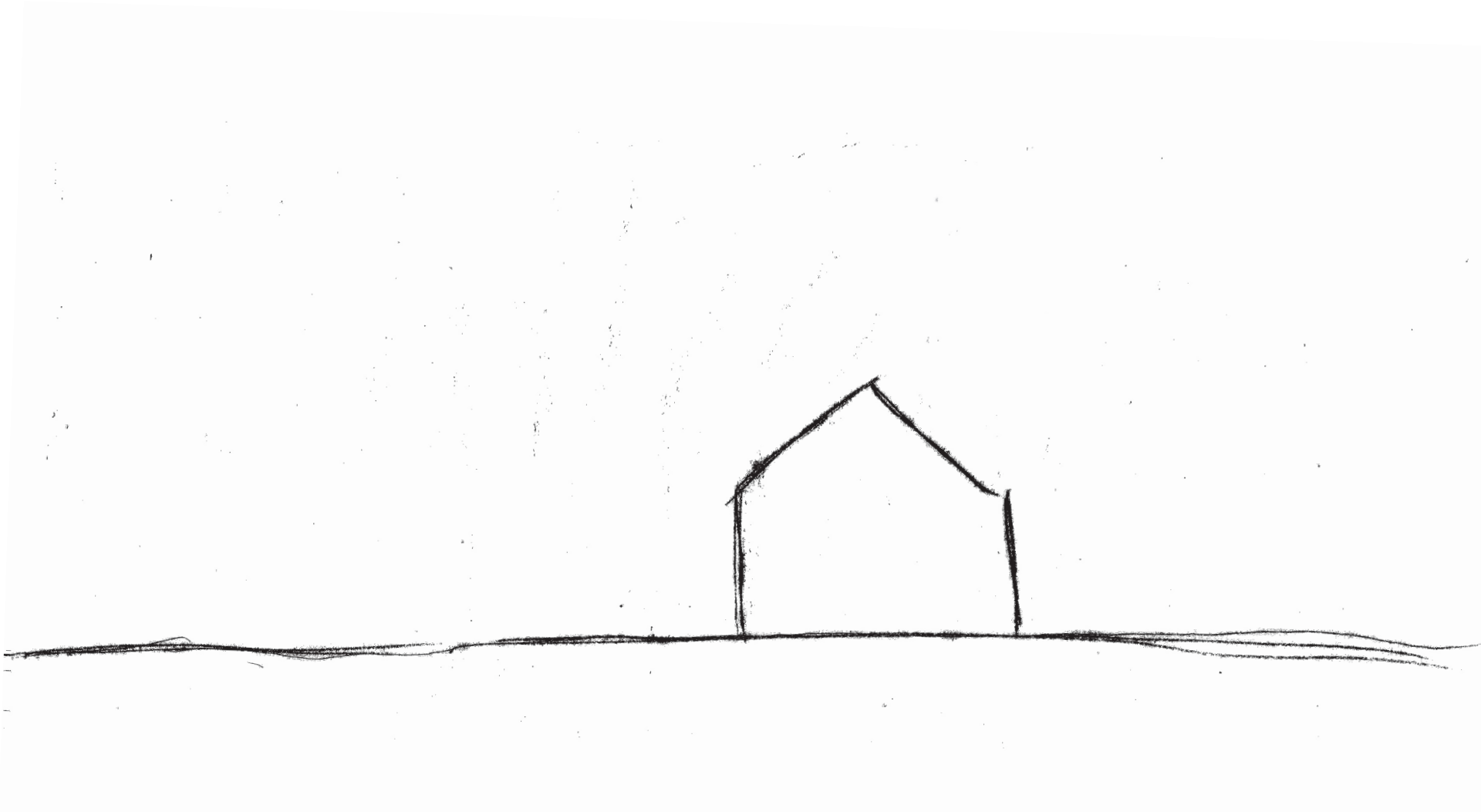
The ventilation have to be with heat recovering, with a dry temperature effect of 75 percent. The specific electrical use cannot exceed 1500J/m3.[Energi styrelsen,2014]

With the main focus of the social sustainability, there are some energy demands that needs to be fulfilled, to accomplish the Danish building regulation10 with the building class 2020 and the solution to this are passive strategies. The social sustainability is an important factor in the sailing life, and the sailors are already part of this specific community, where they are helping each other. Therefore, the citizens of the Thisted can benefit from this community and this is what the design of a new facility / clubhouse for sailor are emphasizing and invite to this interaction between several groups in the society.

VISION

The project aim to create an inviting environment and a “Facili-ty- and clubhouse” for Thisted marinas members and all guest sailors, which fulfil a tectonic value of aesthetic and construction qualities. The design should amplify the community that the sailor life is about, further the community and the clubhouse should invite the citizens of the city to be a part of the society that the marina have.

PROGRAM



"An older experienced couple that I meet last summer told me "When you leave you home harbor you do not know where you are going or which way to get there". This was something I really could understand after two weeks of vacation on the water, we never went where we planned but we ended up with having the best vacation"

– Rasmus Grønlund, Sailing for 2 year.

SAILOR LIFE

Ill. 01.23 - 01.28 Pictures from a sailors life

The life of a sailor is all about the peace that they find when sailing out of a harbor and into the open water, there are no need of planning where to go, just see where the wind is taking you. The life is about the community they are a part of no matter which harbor they are entering; everybody is helping each other, given advice and ideas of locations to visit.

When asking experienced sailors what it is about sailing that makes it a lifestyle and why it is fascinating, they all answered; the Freedom, the quiet and relaxing, when are on the water or just in your boat in the harbor, you forget all about time. It is the sound of sloshing water on the side of the boat, the nature itself; the landscape have a whole other appearance from the waterside. Another important parameter for sailors are the quality time they have with their family, it is their break from a hectic and stressful everyday life. An important lesson as a new sailor, that sailing is freedom and the boat takes you where the weather and heart feels like going, you cannot plan it.

"Sail with the wind" – Anja Mølgaard, sailing for 20 years.

When entering a new harbor each of the sailors had priorities of where they are searching for a space. Some hare searching for a quiet space with not too much noise around them, where others are searching close to the city where there are life and all the things are happing.

"… We usually search for small cozy harbors, that are connected with a city with dining options" – Kim Grout, sailing for 5 years.

No matter which harbor you are entering there is a special community. In some harbors members of the marina club are having their own "private" pier, with a social community, and the guest sailors are having theirs, and other harbors are mixed, but no matter how the harbor are decorated everybody are helping each other; if you have troubles finding a space or need help with mooring the boat, people are helpful.

In the evening when people are meeting on the terraces and grill area, they are exchanging stories, experiences and advices. Maybe they even find new companion to the next harbor. One thing that are worth noticing is that people are meeting regardless of age, everyone are equal they are all sailors and they are all searching for the same freedom, peace and relaxing environment. [Sailors, Thisted, 2015]


Thisted Marina

Ill. 01.29 Air foto of the harbor area

LOCATION DESCRIPTION

Place: Thisted
Population of the city: Approx. 13.000

Thisted is a medium size city, placed in the outskirts of Denmark more specific in the North West part of Jutland, with a population of 13.000 (Approx. 44.000 in the whole commune in 2014).

The city is located on a hill with a slope towards the waterfront. Close to the waterfront and marina, one can find the city center with shopping facilities and cultural functions, such as cinema, theater, outdoor theater, museum, cafés, restaurants, City Hall and hospital. The city, built from the old street grid, with one main road through the city and small and narrow streets with smaller open areas, where only a few are green areas.

Furthermore, Thisted have an industrial life with small and medium size firms and factories. Here among the slaughterhouse, Cimbria (making silos) and the malt factory.

The harbor were founded in 1840, as a meaningful industrial harbor, with a close collaboration with the previous mentioned factories. [Den store danske, 2014]

CONTEXT

Infrstruture

The infrastructure is after an old grid, with one main road going from southwest to northeast and runs past the harbor. The main road divides out to smaller and narrower streets. Furthermore the city contains a bus and train station that connects THY, with the rest of Jutland, these are not visible on the map, but located west from the harbor.

The harbor contains a small industrial harbor, with 10-50 ship calls per year, with export and import to several of the factories with connection to the harbor. [Skaarup, 2015]

Building density

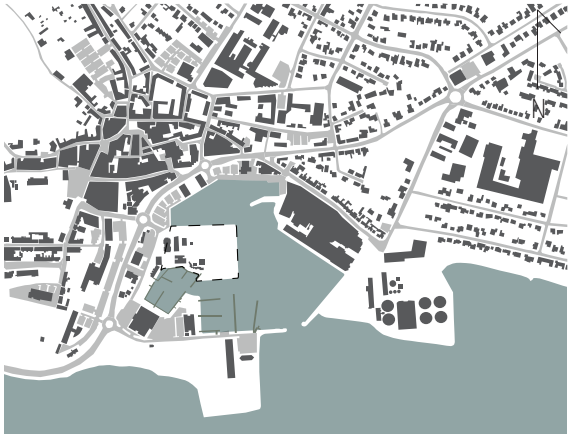
The building density around the harbor is high dens in the city center, with an average on 3-4 storage complexes and slowly dissolves into less dens areas of single-family houses towards the northeast.

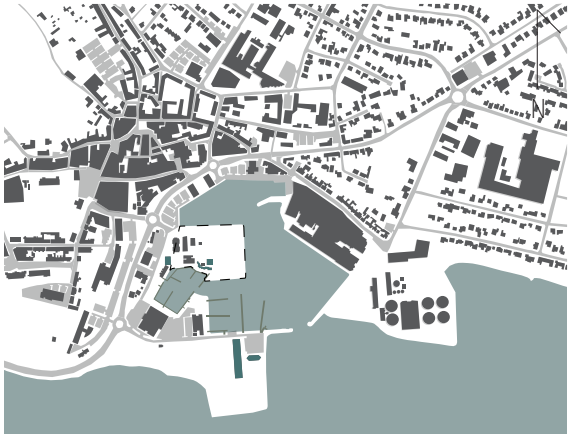
Further, on from single-family houses, towards the northeast and east, it turns in to industrial area and after that a newer residential area with a view over the fjord, these are not visible on the map.

Marina facilities

Today's marina facilities, is divided in two; towards the south is the marina club facilities with living room, kitchen, bath, toilets, laundry room and workshop. Towards the northwest is the municipality functions with toilets and bath and laundry room. The function on northeast is private shacks on ground rented by the municipality, these contains private workshops and living rooms.

The functions is clustered in each end of the marina, which gives that the members and guest sailors, that is placed in between are in some cases forced to walk a longer distance, which can be nuisance and create these less attractive places in the harbor.





Shopping and Supermarkets

The shopping facilities are gathered in a shopping street that starts from the waterfront and winds itself through the dense and narrow city center. There is also a shopping center in the middle of the street, with supermarket and small stores. Furthermore there are several supermarkets in the area.

All of these functions are in a walking distance from the harbor which is attractive and a big quality for guest sailor, as they what to have life and options around them. As a sailor one wants to have supplies close, as many do not have a big fridge on board.

Green areas

There are not many green areas close to the harbor. On the map that there are only three, where the one towards the south is an old graveyard, the middle one is also an old graveyard but is later transformed into a park, and the one towards the north are a forest and park area with the outdoor theater and a playground. This one is placed far from the harbor and therefore not attractive to the member or the guest sailors to use. The city center have small lawns of grass but nothing with useful functions.

Factories

The harbor is also a center for some of the factories in the city, as they are exporting and importing products that are easier and cheaper to transport by ship.

The factories are that are visible on the map is the slaughterhouse, treatment plant and Cimbria. The last mentioned is one of the three to four factories that are shipping from the harbor. Further, there are luxol and DLG, which are not visible on the map but are located approx. 15km towards the northeast. Last the largest shipping (import and export) are to the Malt factory which is located 2km towards the west.[Skaarup, 2015]

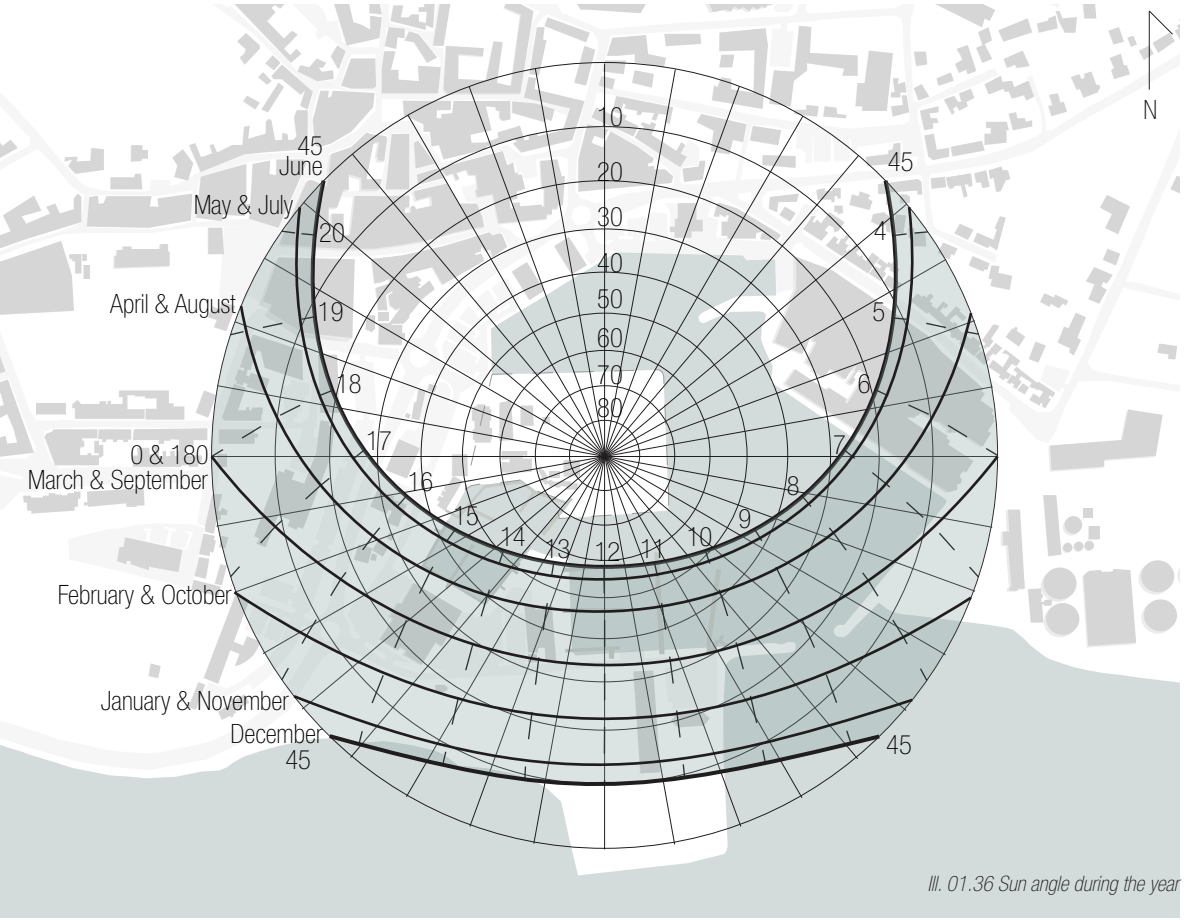
Ill. 01.30 - 01.35 Context diagrams

CLIMATE CONDITIONS

Sun angle

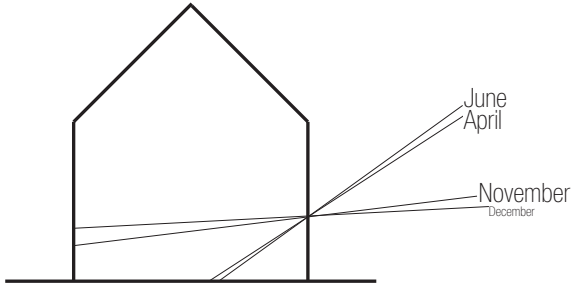
The rises in different angels according to the location and time of year. In June the sun rises in northeast around 3am and sets in northwest around 9pm. This means that in this month we have the longest days. Compared to December with the shortest days, the sun rises at 8-9am in a southeast direction and sunset at 3-4pm in the southwest direction.

Furthermore are the angle of the sun during the day also different, in June at 12am the angle to the earth is around 60 degrees, and in December the angle at the same time of day is around 10 degrees.

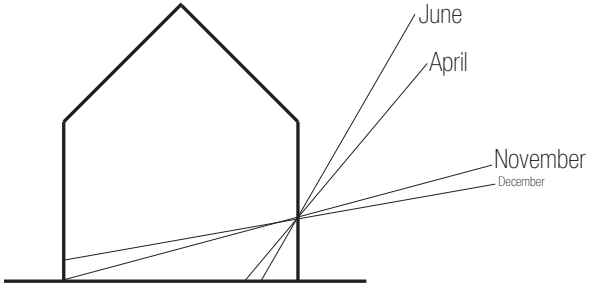


Ill. 01.36 Sun angle during the year

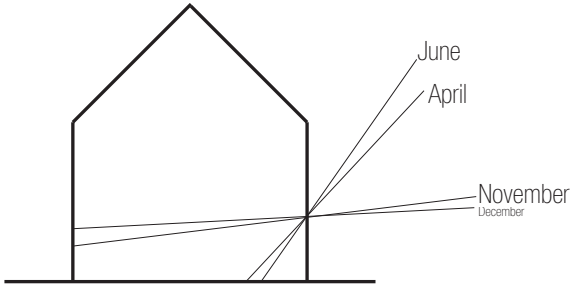
The sun angle is important to have data of when designing according to orientation, placement of function, building height, window size, overhang and more. As the sailing season are from first of April to first of November, the minimum conditions will be at these two months. In April, the sunrise will happen in the East-northeast direction and a sun angle of 50 degrees to November with an East-southeast direction and an angle of 15degress. The maximum conditions will be in June.



Ill. 01.37 Sun angle at 9 am



Ill. 01.38 Sun angle at 12am



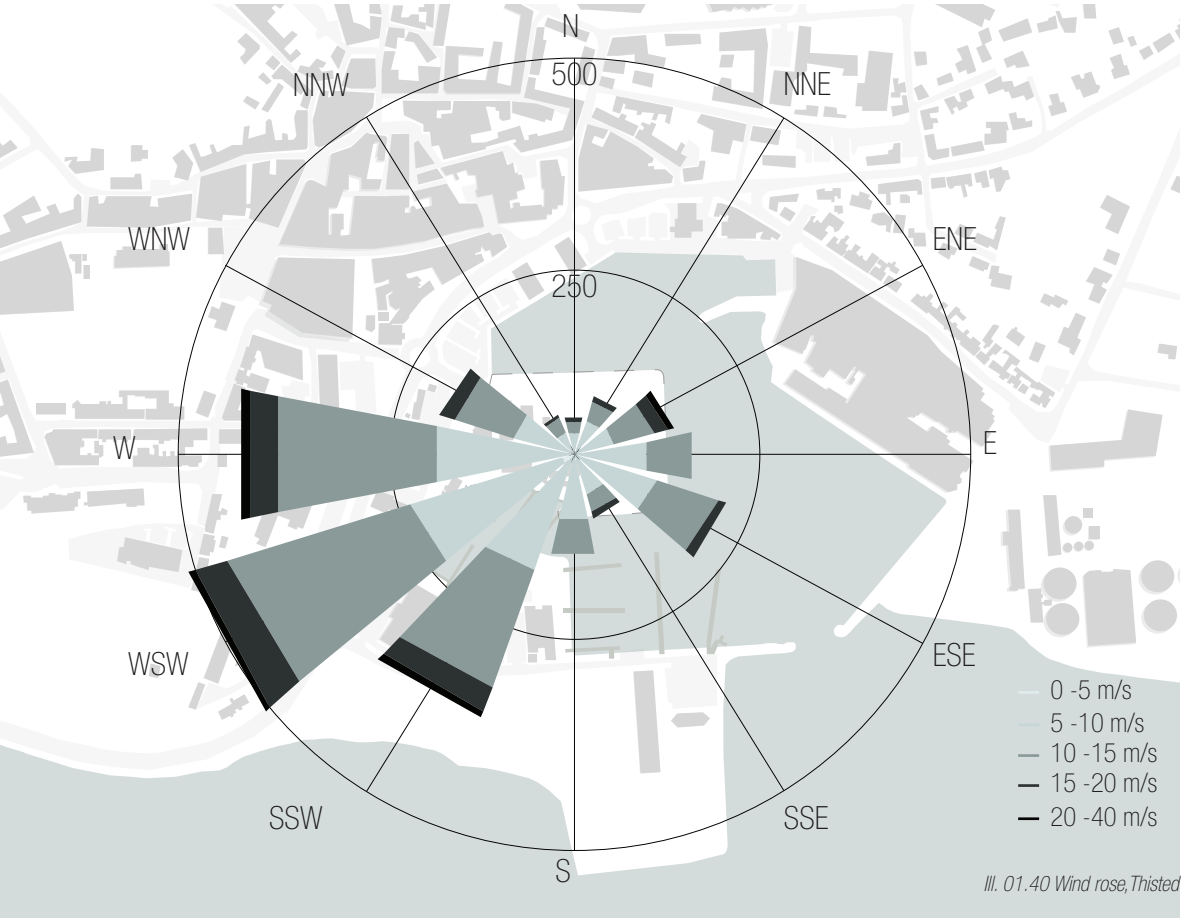
Ill. 01.39 Sun angle at 3pm

Wind

This diagram shows the average wind direction and wind speed during the year- from this one can see that the primary wind direction is the West-southwest direction and it is from this direction Thisted will experience the strongest wind. As a secondary wind direction, there is South-southwest and West.

The most common wind speed during the year are 5-15 m/s, which also matches the ideal sail weather for a sailboat which is around 8-10m/s, and the less wind the better it is for motor sailors.

The wind speed is important along with the direction, according to orientatio of function and ventilation strategies.



Ill. 01.40 Wind rose, Thisted

Wind direction and wind speed

The wind direction and average speed per month are important, as the functions in the building are not used equally during the year as the sailor season are from 1th of April to 1th of November.

The average wind per month are from 5m/s to 7m/s, which is relatively low. [Weatherspeak, 2015]

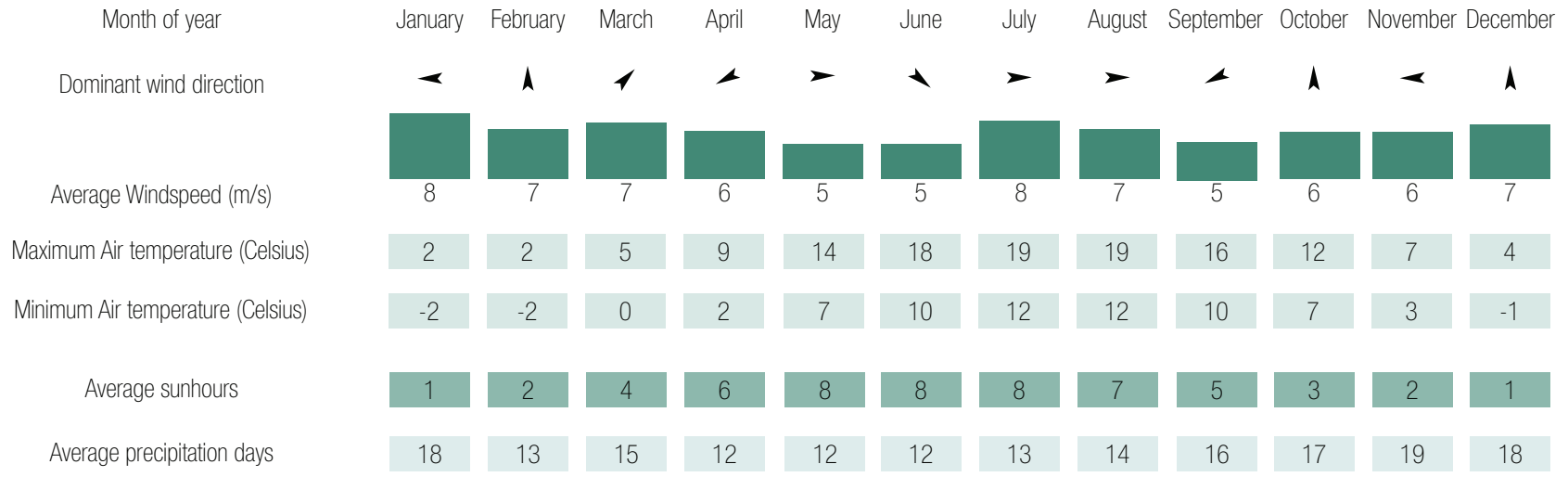
Temperature

The diagram shows Maximum and Minimum temperature per month.

The numbers of temperature can be used for ventilation strategies and design parameters both indoor and outdoor [Weatherspeak, 2015]

Precipitation and Sunhours

The sun hours shows the number of sun hours per month and the precipitation shows and average number of days with rain or snow per month. These two conditions can be held up against each other, as a high number of sun hours gives a low number of days with rain or snow. This parameter is to estimate the quality of a potential outdoor area. [Weatherspeak, 2015]



Ill. 01.41 Climate scheme per month. Thisted

Ill. 01.42 View over Limfjorden. Thisted

THISTED

A part of the life along the Limfjord

Thisted harbour are one of many harbours along Limfjorden that are suffering from the international down going economy, the cargo ships are in quest of larger harbours along the coast of Denmark. This have an downgoing effect on the harbours in fjorden, alone in Thisted the has been a decreasing development from 90.000 tons of cargo in 2007 to 30.000tons in 2013. With this decreasing progress, the industrial harbours are in danger of closing in the next ten years. [Mikkelsen, 2015, page 8]

After discussing, with a PhD student at Aalborg University that are researching in the field of coast development along limfjorden, what the solution to this down going spiral could be. The discussion came up with two scenarios; one is to adjust the water level by digging 1 meter deeper, and use the necessary money to improve and upgrade the harbours to obtain the larger cargo ships. Another solution would be to change the use of the industrial areas, and let the city benefit from the qualities that these can provide to the marina and city life. [Mikkelsen, 2015, page 9]

The PhD student hosted a workshop for members of cities along fjorden, to attend in a brainstorm and the result of those was a vision for each of the harbours, with identifying the problem and idea solving. Specific to Thisted harbour, the vision supports the idea of using the harbour area for cultural purpose, where the city and the water work together. The wish is a live harbour front where also the city is represented, so that people are interacting with each other. [Mikkelsen, 2015, page 22]

THISTED MARINA

Active members of the sailing club: Approx. 300 people
Average guest sailors in Thisted marina: 1000 per/year
Average age of marina club members: over 60 years.

Thisted Marina have work together with the municipality of Thisted during the last couple of years; in develop a new local plan for Thisted Harbor front. In this local plan, the marina have the wish of expanding the facilities and create a larger connection with the city center. Further, the Marina and harbor are trying to work together in a cultural aspect and trying to invite people to the waterfront, as they sees it as one of Thisted's biggest qualities that they wants to share with the rest of the city. [Thisted Marina,2015]

Current condition

The marina are at the moment, having a total amount of boat spaces of 175, with 160 boats of the club members, which do not give a large amount of guest spaces. Today, the marina have up to date facilities, renovated in 2012-2013 and they are now running a contemporary marina, that are recognized between sailors in the Limfjord. [Thisted Marina, 2015]

All boat spaces are divided from pontoon piers, which is the most efficient when the water rises in the harbor. The marina are having trouble finding spaces for boats over 40-45 foot, and therefore the larger guest boats finds it more attractive to lay in the industrial harbor next to the city center. [Thisted Marina,2015]

User profile

Primary users are the guest sailors, in all ages. The family types are scattered in singles, couples or families, with children and grandchildren in all ages. Which means that the size and types of boats differs, there are the primitive sailors that are depending on all the facilities in the marina, then there are the sailors that have just what they need and still benefits from the facilities in the harbors and then there are the modern sailors that have everything in equipment.

There are several factors to think of when designing as each of them have different need. The challenge in the design will be to make the functions a flexible as possible so that everyone benefits from it. [Thisted Marina,2015]

Needs and Wants

In the hopefully new local plan the marina wishes to exploit the unused area and make it more tourist friendly, also because the marina are having an increasing number of members and boats, which are giving them difficulties with finding place for them all.

The marina aiming for improvements that can give younger people an interest in the culture that the sailor life have. Further, they wish to build a playground in connection with the water, so children can play safely with the water. All of these actions are all to increase the interest of the sailor life and invite all ages. [Thisted Marina,2015]

Potential

The harbor has the potential to expand the marina, but this will affect the industrial harbor, that has to decrease or move to another location. As mentioned the harbor have unexploited area, with qualities, of a social gathering point in the future. The location of the harbor are as well a quality in the middle of the city and the nature.

Vision

As mentioned the Marina are working on expanding the marina, and improve qualities, in order to attract potential guest sailors in Limfjorden, to sail via Thisted on their journey.

The chairman of the marina mentions that the average age of the members are rather high, over 50 which the marina think is unfortunately, as they are afraid of the consequences that this can have on the involvement of the society. The marina wants the development of the harbor can invite and give an interest to young people that can benefit with ideas and new energy to the club. [Thisted Marina,2015]

Ill. 01.49 Air foto of the cargo pier as it is today

N

PROJECT SITE

Current condition / Industrial harbor

Site location: The industrial harbor/pier.
Size: 17982.2 m2

The industrial harbor are located in connection to the city center and provides several firms and factories with exporting and importing. During 2014, there were 20 ships with an amount of cargo of 24000 ton. In 2015, they are expecting an increasing to 35000 ton. One factory are the primary user of the harbor with 65% of the export and a lot of the import.

The industrial pier are used for cultural purposes as well, every year there are 3-5 events where both the harbor and the pier are used. These in an area called ISPS, but by EU, law there cannot be any activity on the pier when there is a cargo ship in the harbor. This law sets some limitations when design on the pier, a result of this could be either that; the site has to be divided in two or the cargo pier can be moved to another part of the harbor.

The municipality are the owner of the industrial harbor, and they have a wish for excavate the harbor so that they can have cargo ships with depth of 5 meters, instead of 4 meters as it is today. This excavation will mean that the cargo can increase from 2500 to 4500ton and will be and improvement in the economical spectra to travel the cargo by water instead of driving by trucks. [Skaarup, 2015]

Further the cargo pier are attractive to guest sailor during the summer season, especially for the bigger boats that can have some difficulties with the dimensions in the boat spaces, but also because of the location in the middle of the city. The only disadvantage is that there are only four electrical plugs, and pure opportunity for water. Furthermore, the toilet and baht facilities are placed in a distance from the pier; this also means that there are no guarantee for the Wi-Fi to work in such a long distance. [Dansk Sejlunion, 2015]

The reason for choosing this project site is supported by the analysis of the marina, what they wishes and need but also the analysis of the placement of the existing marina and the city center. After trying to find a better location for the extension of the marina the analysis where made on the cargo pier, which were founded most attractive as a sailor and an architect.

1

2

3

4

THE PLACE


2


5&6

Ill. 01.50 -01.56 Pictures from the cargo pier, the place

Today the site and place are all about the functional aspects with industrial purposes containing; Parking lots, ISPS area (only work related access), Storage area, a small shopping complex, a fish shop with restaurant and last small sheds for sailors. The cargo pier are having the qualities of being the link between the water and city, but at the moment there are no coherence to the location and exploiting of the qualities, in the place and its surrounding. There are a lack of joined personal character and soul, this are only to be found in old measure house because of the history. Further, the small sheds are have personality of a small relaxing and calm community.

Qualities of the site

The site have a central location in the city, and the pier are staged in the harbor meaning that no matter where one are on the harbor, one always have a view to the pier. Further, the pier have a visual connection to where the shopping street starts and a direct connection to the square that are in the middle of the shopping street. This will give a natural connection as a tourist to enter the city, and use the facilities that it offers, further it will create a link for the citizens of Thisted to the environment that the sailors and the harbor have. The site are also able to have qualities in the winter season, with the connection to the shopping street and the existing storages on the harbor.

Key point Analysis of the site with boundaries, traffic, topography and typology, to get an idea of what qualities and challenges there site contains.

1) Boundary
Transverse road along the waterfront.
Boundery between the city and water

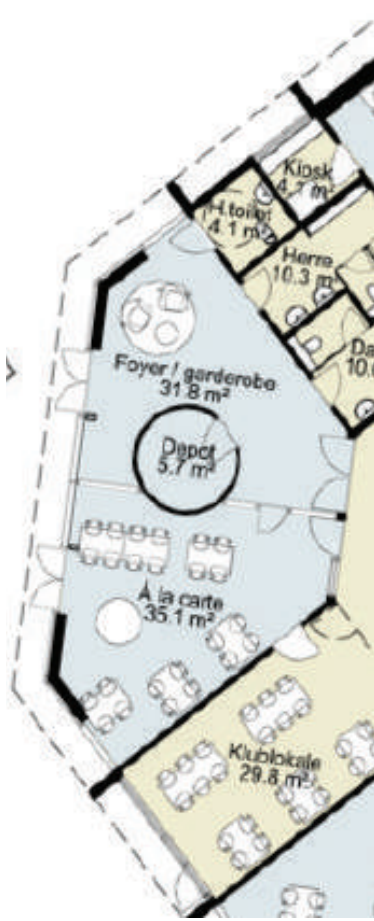
2) Typologies
Pitched roof 1-2 storage retail purpose.

3) Edges
The water itself.

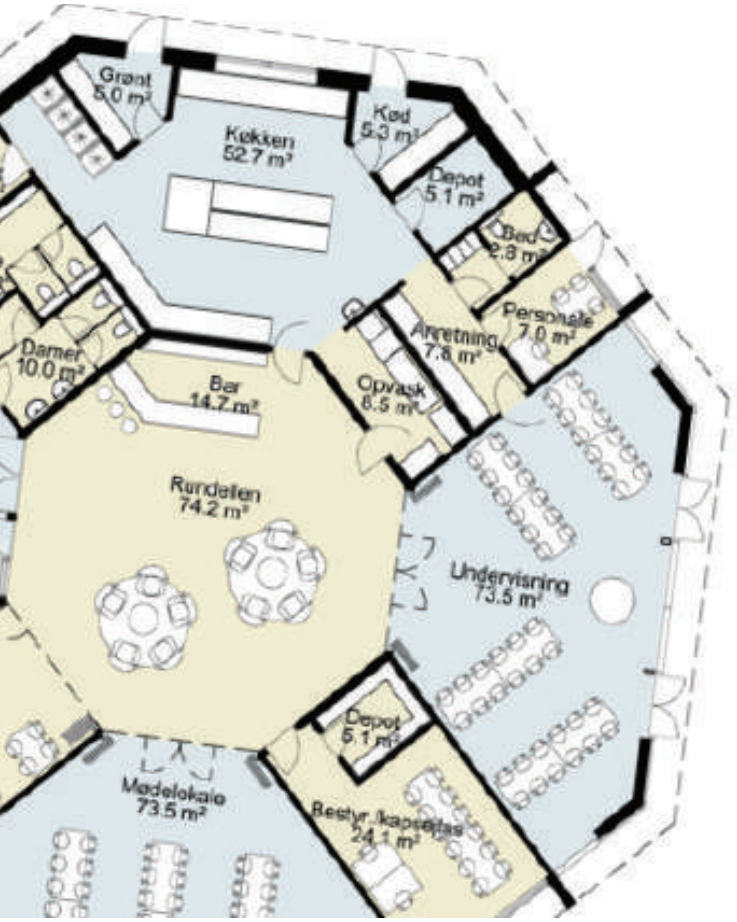
4) Landscape unused space
Storage and parking

5) Landscape (section)
Flat with a small slope towards the city

6) Movement (traffic and pedestrian)
Heavy traffic towards the west, medium traffic (low speed) towards the northwest and on the south part of the site.



Ill. 01.57 - 01.60Horsens marina clubhouse



CASE STUDIES

Horsens Marina Club

Architect: Ginnerups tegnestue
Year: 2014
Location: Horses, Denmark
Type: Clubhouse

Horsens marina clubhouse are a focal point on the marina. The design is octagonal core containing a public restaurant, bar, club facilities for guests and are the distribution room to the four wings. The wings contains the marina clubroom, toilets, kitchen, the private facilities for the staff, and last a small ice crème stand.

The tectonic qualities and principle in the design are solved in a delight manner with the pillars in each of the eight corners, carrying the exposed roof construction, with simple and hidden metal joints so the plywood float over the common area as a chandelier.

There are a visual view through the building, as between the four wings there are glass area, which makes the orientation of the functions easy to read.

The building are raised 2.5 meters, due to the problem of flooding. This rise creates a natural terrace for public use and a view platform over the marina. Further, the platform are dividing the high-speed activity and the low-speed activity, a having a natural and invisible boundary. There are two kind of stairs: one to walk and the other is for sitting, relaxing and observing the surroundings.[Horsens marina, 2015]

What to extract from this project:
Integrating the private and the public functions, gather so they benefits and supports each other's qualities.
The dividing of high-speed and low-speed activity
Staging the view over the water.
Create a visual connection through the building in order to follow the life; from inside out and outside in.
Designing a usable outdoor space, despite any weather conditions.

FUNCTIONS

From previous analysis of Thisted Marina with their wants and needs, the user profile, Thisted industrial harbor and case studies, and last the questions asked directly to the sailors a room program have been put together, in the aim of fulfilling the needs of all implemented. The room program is for the new facility- and clubhouse on the cargo pier.

The room program are divided are different building complexes after functions, this does not necessary means that the functions are locked for designing, it is more are guide for what the main facilities in the complex needs to be related to. The complexes are Public spaces, Cafe and shop, Guest facilities and Workshops: multifunctional workshop and Junior dinghy workshop.

Public spaces

	Climate		Key parameters			Quality and Potential		Light	
	All year / Only season	Orientation	People capacity	Size (m^2)	Number of functions	Spatial qualities and potential	Functional demands	Daylight	Artificial light (lux)
Toilets	All year	-	2	2 - 4	2	-	Gender specific, accessible for disabled	■ □ □	180
Grill terraces	Only season	S-W	8 - 10	15	4	-	Benches and grill area, for visitors. maybe sheltered and fenched	■ ■ ■	150 - 180
Picninc benche area	Only season	S-W	4	6	4	-		■ ■ ■	150 - 180
Green area	All year	W-S-E	-	20 - 30	1	-	For children and dogs.	■ ■ ■	150 - 180
Playground	All year	W-S-E	8 - 10	-	1	Open, light, calm, easy to clean - Close connected - outdoor access	Play area close to the water, " play safely with water"	■ ■ ■	150 - 180
Parking area	All year	N	-	20 - 30	1			■ ■ □	150 - 200
Rental station	Only season	N	-	-	1		Self rental of bicycles and handcarts	■ ■ □	150 - 200
Waste area	Only season	-	-	5	1		Disposal of waste - conatainers	■ ■ □	200
Autocamper area	Only season	S-W	-	30 - 40	1	-	Area with veiw and facilities as when camping	■ ■ ■	150 - 180

Cafe and shop

	Climate		Key parameters			Quality and Potential		Light	
	All year / Only season	Orientation	People capacity	Size (m^2)	Number of functions	Spatial qualities and potential	Functional demands	Daylight	Artificial light (lux)
Toilets	All year	-	2	2 - 4	2	-	Gender specific, accessible for disabled	■ □ □	180
Kitchen	All year	S-W	4	30 - 40	1	-	Cafe kitchen for preparing of food - indcluding diswasher and washer.	■ ■ □	150 - 180
Storage	All year	S-W	-	20	1	-		■ □ □	150 - 180
Cafe area	All year	W-S-E	-	50 - 100	1	Open, light, calm, visible construction, honest materials	Lunch and icecreme cafe	■ ■ ■	150 - 180
Shop area	All year	W-S-E	8 - 10	30 - 50	1		Boat equipment, news, bakery - a kiosk	■ ■ ■	150 - 180
Parking spots	All year	N	-	-	4	-	Customer parking	■ ■ □	150 - 200
Office	All year	N	4	15 - 20	1	-	For employees	■ ■ □	150 - 200
Waste area	All year	-	-	10	1	-	Disposal of waste - conatainers	■ □ □	200
Tecnical room	All year	S-W	-	2 - 5	1	-	Ventilation	■ □ □	150 - 180

Ill. 01.61 - 01.62 Functions program

Guest sailor facilities

	Climate		Key parameters			Quality and Potential		Light	
	All year / Only season	Orientation	People capacity	Size (m^2)	Number of functions	Spatial qualities and potential	Functional demands	Daylight	Artificial light (lux)
Toilets	Only season	-	1	2 - 4	3 - 6	-	Gender specific, accessible for disabled - connected to each other.	■ □ □	180
Showers	Only season	-	2	2 - 4	5 - 8	-		■ □ □	180
Chaning room	Only season	-	2	5	2	-		■ □ □	200
Laundry room	Only season	-	-	10	1	-	2 Wash. - 2. dry. - Tables and hangers.	■ ■ ■	200 - 250
Kitchen	Only season	N-E	8 - 10	15 - 20	1	Open, light, calm, easy to clean - Close connected - outdoor access	An area with calm and welcoming expression. Gather point for sailors.	■ ■ ■	200
Dining area	Only season	S	15 - 20	30	1			■ ■ ■	150 - 200
Sailor living room	Only season	S-W	15 - 20	20 - 40	1	Honest material use - views. Peaceful and quiet envirnment		■ ■ ■	150 - 200
Emptying of Chemical toilets	Only season	-	-	5	1	-	Small room with the equipment to disposal and cleaning of chemical toilets	■ □ □	200
Harbor office / payment stand	Only season	-	2	5	1	-	Area to get information and pay for the night	■ ■ □	200
Storage	Only season	-	-	20	1	-	An area for the cleaning/ tecnical equipment	■ □ □	200
Fuel Station	Only season	-	-	10 - 20	1	-	Container at the waterfront with fuel	■ □ □	200
Waste area	Only season	-	-	5 - 10	1 - 2	-	Disposial area for cans, glass other waste	■ □ □	200
Hostel room	Only season	E-S-W	2-4	12	2 - 3	Peaceful, quiet, calm - view	For sleepovers, with to small a boat or guest but no bedspace	■ ■ ■	150 - 200

Workshops

	Climate		Key parameters			Quality and Potential		Light	
	All year / Only season	Orientation	People capacity	Size (m^2)	Number of functions	Spatial qualities and potential	Functional demands	Daylight	Artificial light (lux)
Multi functional Workshop							Gender specific, accessible for disabled - connected to each other.		
Toilets	All year	-	2	2 - 4	1 - 2	-		■ □ □	180
Chaning room	All year	-	2	5	1 - 2	-		■ □ □	200
Kitchen	All year	N-E	4 - 6	8 - 15	1	Open, light, calm, easy to clean -	A small tea kitchen.	■ ■ ■	200
Workshop hall	All year	-	-	150 - 250	1	Multi functional, due to the season	Honesty of use, tools and materials are a natural element	■ ■ ■	200 - 250
Crane	Only season	-	-	-	1	-	Connected with the workshop hall area		200
Storage	Only season	-	-	20	1	-	An area for the cleaning/ tecnical equipment	■ □ □	200
Junior Dinghy workshop									
Workshop hall	Only season	-	-	80 - 120	1	-	Hall for the memebers of cinghy club, for equipment	■ ■ ■	200
Storage	Only season	-	-	20	1	-	An area for the cleaning/ tecnical equipment	■ □ □	200
Kitchen	Only season	-	-	10 - 20	1	-	A small tea kitchen.	■ ■ ■	200
Waste area	Only season	-	-	5 - 10	1 - 2	-	Disposial area for cans, glass other waste	■ □ □	200
Toilets	Only season	-	2	2 - 4	2 - 4	-	Gender specific, accessible for disabled - connected to each other.	■ □ □	180
Showers	Only season	-	2	2 - 4	2 - 4	-		■ □ □	180
Changing room	Only season	-	2	2 - 4	2 - 4	-		■ □ □	200

Ill. 01.63 - 01.64 Functions program

"… Actually does almost all harbors/marinas in the Limfjord works really good. Each harbor/marina has its own individually and unique charm and I do think that this is what all harbors should aim for…"

– Anja Mølgaard, sailing for 20 years.

CONCLUSION

The analysis have given a knowledge and understanding of the area, existing functions and the surroundings. Further, the user profile, the marina and the unity that this community have, has given a clear idea of what these people and community are searching for.

The municipality, marina and harbour are wishing for an agreement for the use of the waterfront. There are a common whish for empathizing the society and community qualities by a cultural area, on the harbour.

During analysis of the area, existing functions and the surroundings there are found the qualities and the lack of it. The water that surrounds the project site, are not a seen as a boundary. Instead, it is seen as a quality to the project site, as it gives the sailor the opportunity to come close to the city, and the city the close connection to the waterfront.

The intension is to respect the existing functions as they can benefit from the project of connecting the city with the water. The only function that are changed are the cargo pier, which either will be relocated closer to industrial functions or closed down.

A sailor life is about the connection with the nature and feel the power of the nature, this is given on the water, where the sailors can feel free and find the peace and relaxing elements that they often are searching for. When the sailors returns to the harbours, they are searching for that special community that there are between sail-ors; the helpfulness, the close society, the connection across generations and age.

This strong community that the sailors have is to be implemented in the design, in a way where the citizens of the city can feel that they are a part of it.

Shortly summarize of the program is to design by the use of the Nordic architecture, with the principles of tec-tonic with focus on the honesty of materials and construction. The design should emphasize the feeling of home and welcoming to all guests sailors, auto campers and citizens of the city. A way of achieving a “feeling” the structural elements will be used. The design should be a gathering point for all guests that wants to be a part of the community that the marina have. The design will be multifunctional in relation to the season and will have both marina functions but also cultural functions.

DESIGN PARAMETERS

The essential of the design is that it should be inviting, give a feeling of home in the more private, and stress less environments. Further, in the more public areas as the workshops are, it should be possible to follow the life from inside to out but also from outside to in. No matter if, one are a sailor or a guest from the city side or waterside, there will be life and this should create a curiosity for the community and the sailing life style.

The structure should associate to the old boathouses, with the framework stabilized by cross's. This principle will support the gesture. The gesture should not be with a to clean and pure expression, meaning that it is a work area and it is okay to have tools and equipment lying around or to have paint residues or sawdust on the floor. These will give a more raw and rough expression. This is just another reason for the overall expression du be clear and simple, elsewise to much will happen and the expression can get messy.

For the design, it is important that it will multifunctional according to the two seasons. Further, a wish for the design is that it will be a landmark and direction point, for the harbor. Multifunctional will support the idea of a gathering point, as it is not only for the close community that the sailor have, but also for the citizens of the city. This will reinforce the social aspect of bring people together no matter their social status or age.

TECHNICAL PARAMETERS

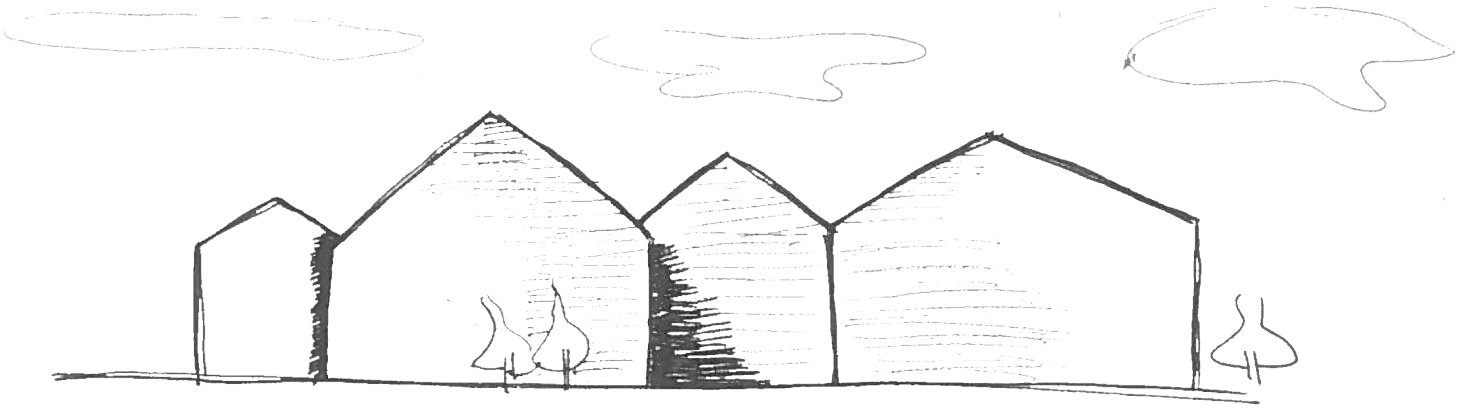
- Optimal light conditions – daylight
- Tectonically approach – Gesture / principle
- Use of honest and Nordic materials

FUNCTIONAL PARAMETERS

- Open spaces / Multifunctional spaces
- Integrated functions
- Connection the city and the waterfront – Marina
- Cultural gathering point
- The feeling of home

AESTHETICAL PARAMETERS

- Stress less environment
- Unique in the sense of feeling and experience.
- Follow life inside and outside.
- Integration with the water



CONCEPT

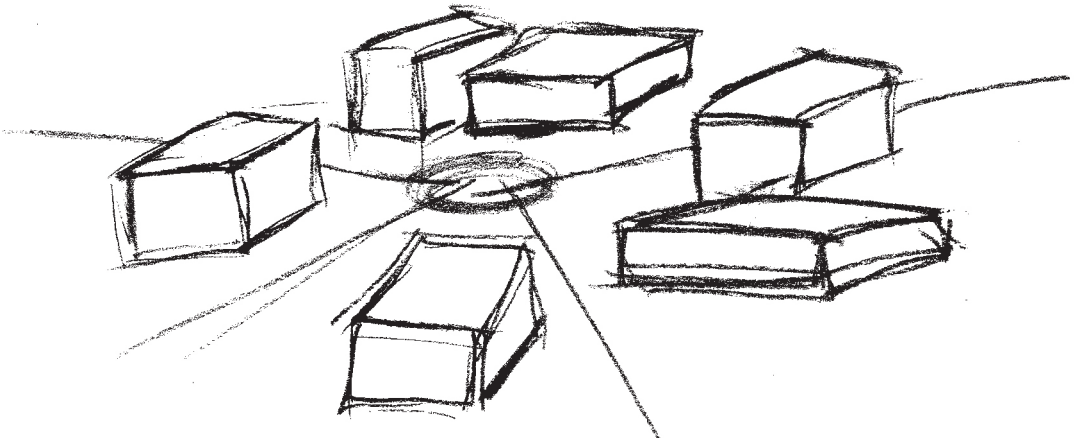
The form concept of the project arising from the traditional boathouse. Functions are divided from each other to create an outdoor space, where people can interact, find inspiration and achieve new relations, to other people but the city.

Each of the function have their own identity, similar function also have similar identities. The identity are defined by private and semi-private status in functions, and can be reflected in the form both interior and exterior.

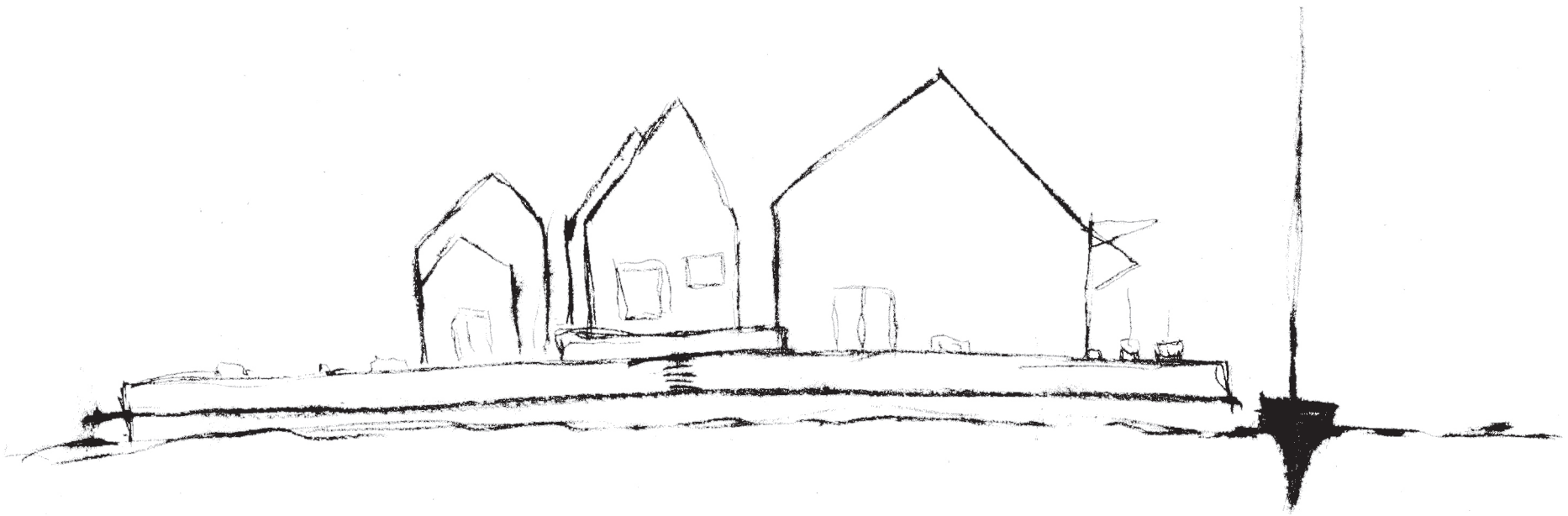
Multi-functional building or building with multiple functions. Several of the buildings works multifunctional or have multiple functions, some depends on season others are function combined and used simultaneously.

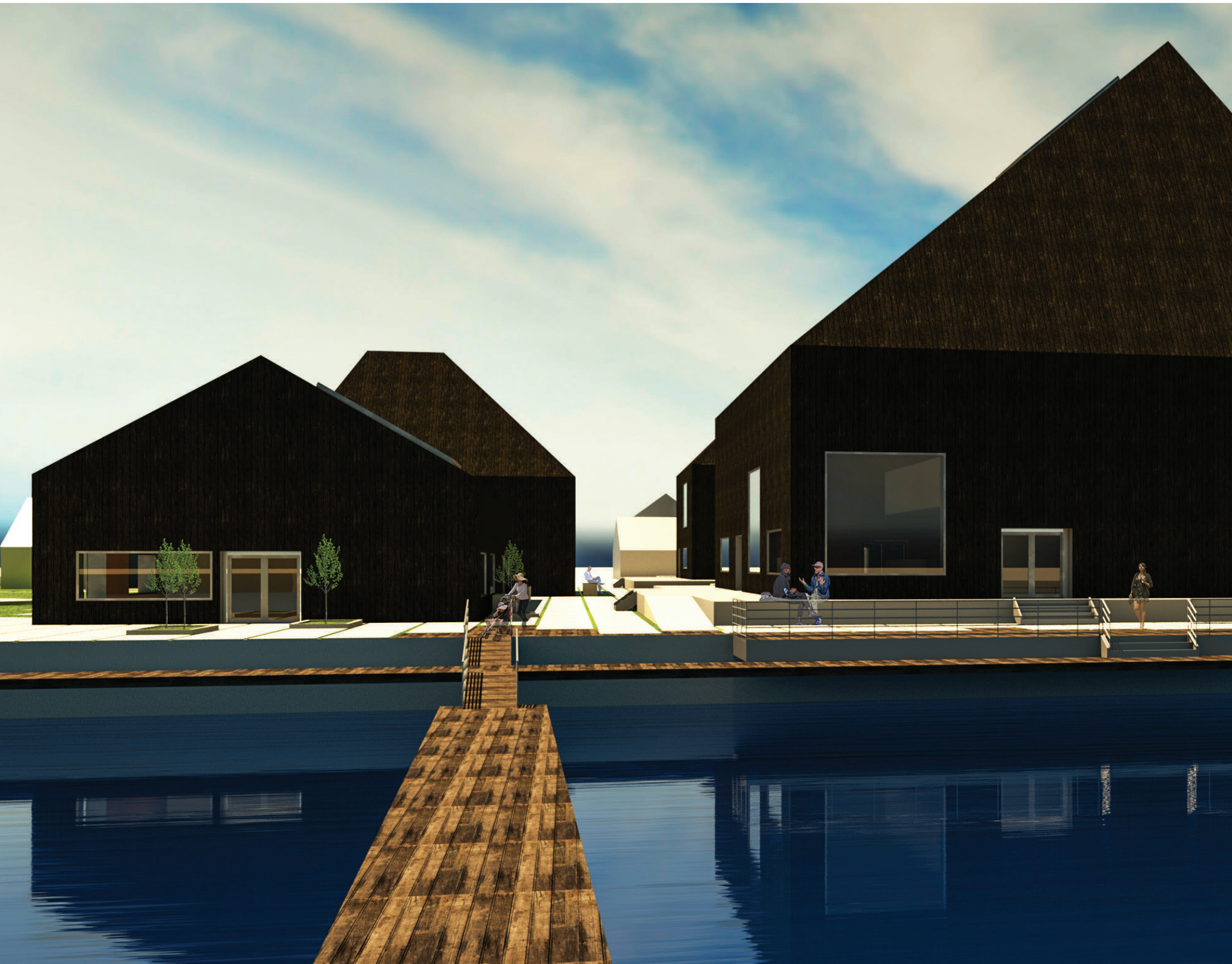
Construction concept are the frame structure, that associate to history and tradition, along with the building core continues throughout the design.

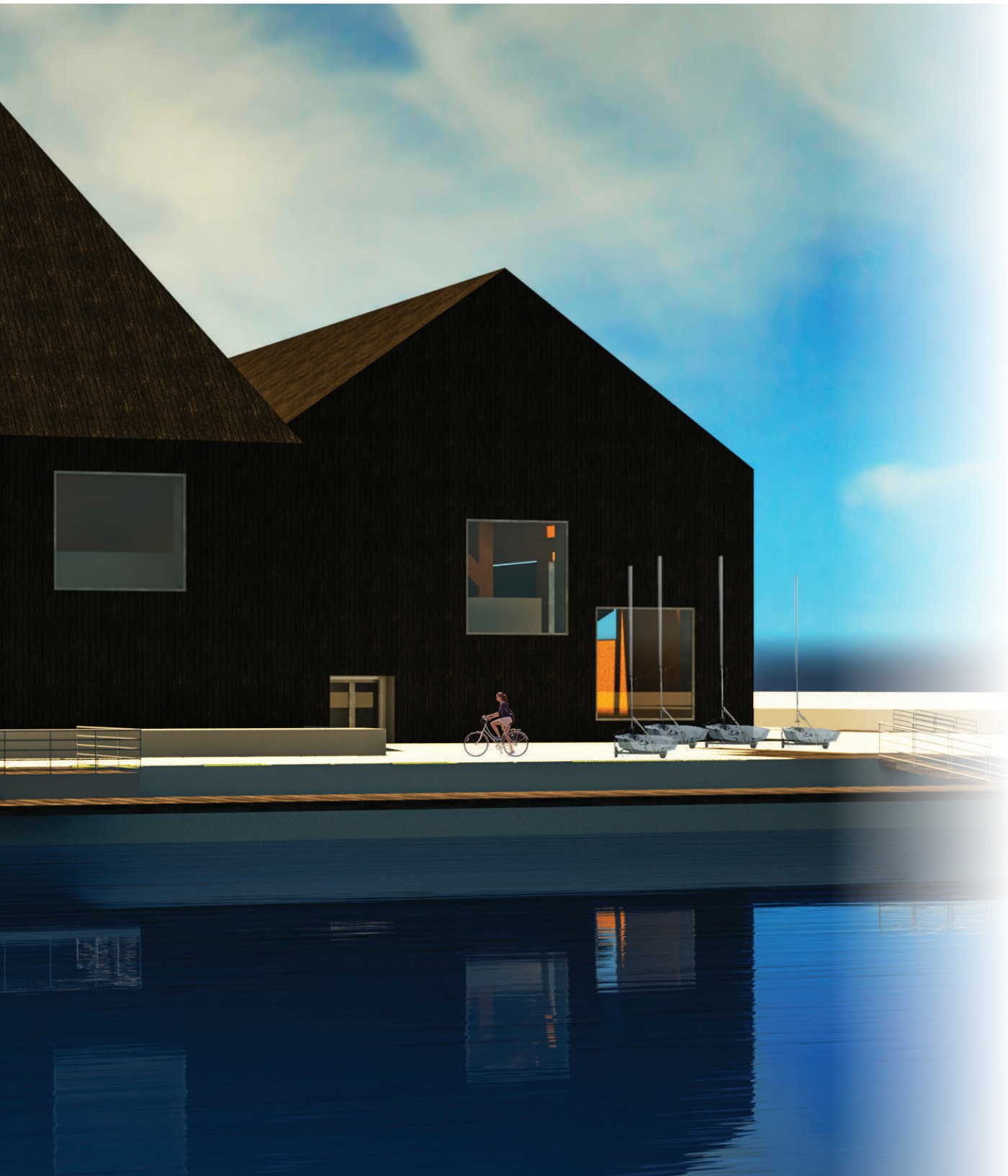
The Core is a self-standing element, that contains smaller functions as kitchen, toilet etc. this gives a visual clear and unbroken frame structure, which will give the experience of a continuously structure.



PRESENTATION





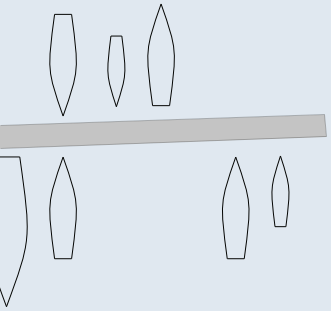


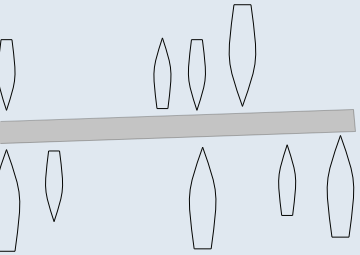
PRESENTATION

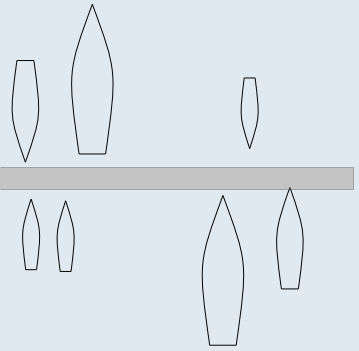
The Design are having focus on the feeling and sense and letting the function define the outer shape. It is the experience of walking between the buildings or entering each building, which creates associations to a welcoming, calm and relaxing environment. Another aspect are the social interaction between citizen and sailors, in order to create a closer association from the city to the waterfront.


Boat and work area
Dinghy area
Parking
Common area
water mirror /
benches
Parking
Terraces / recreational area
Autocamper parking / boat storage

Site area: 10518.11m^2
Built area: 2615.7m^2
Built ratio: 49.74%





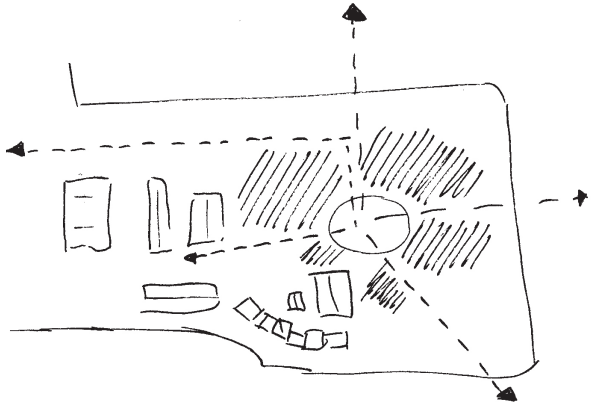


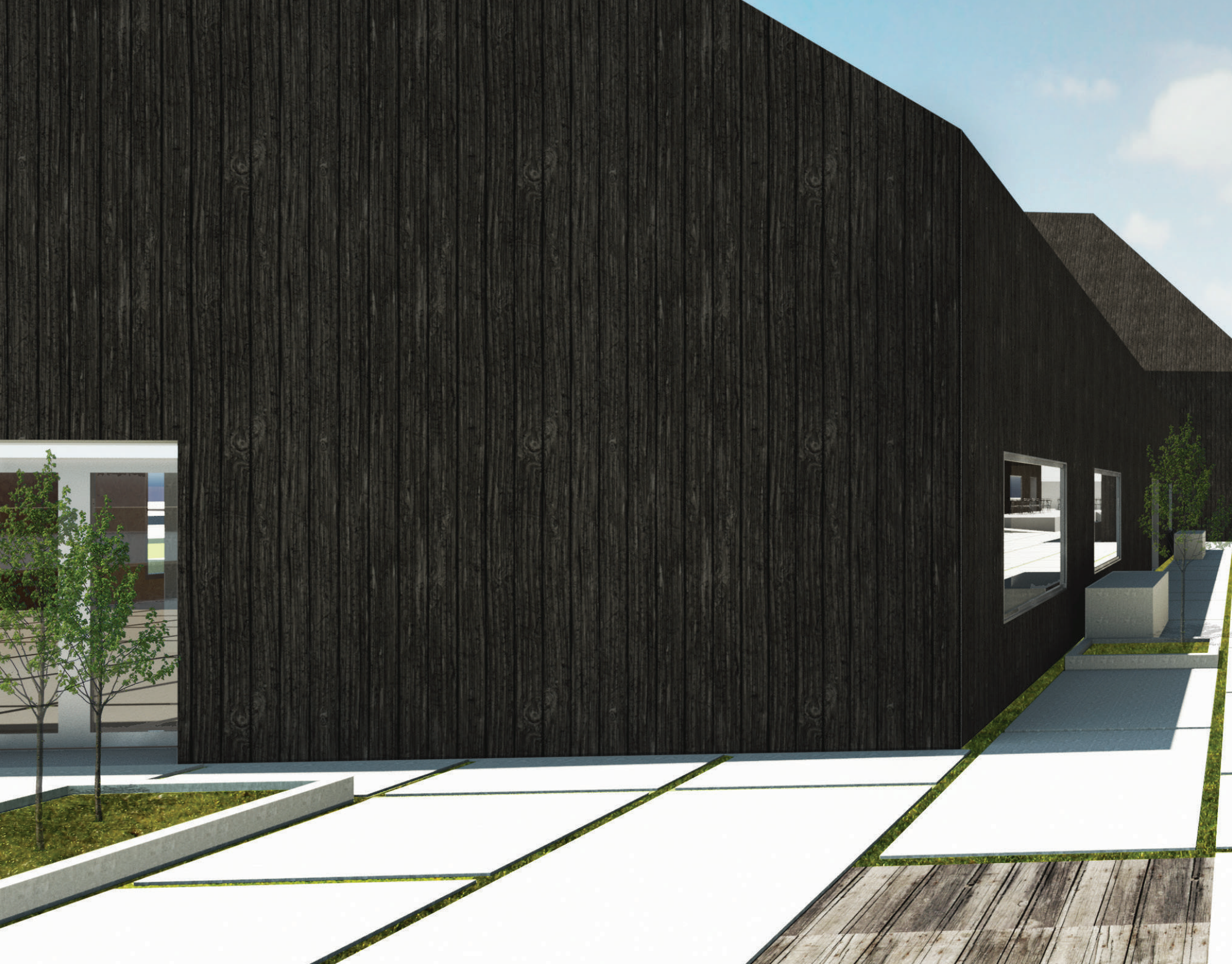
MASTER PLAN

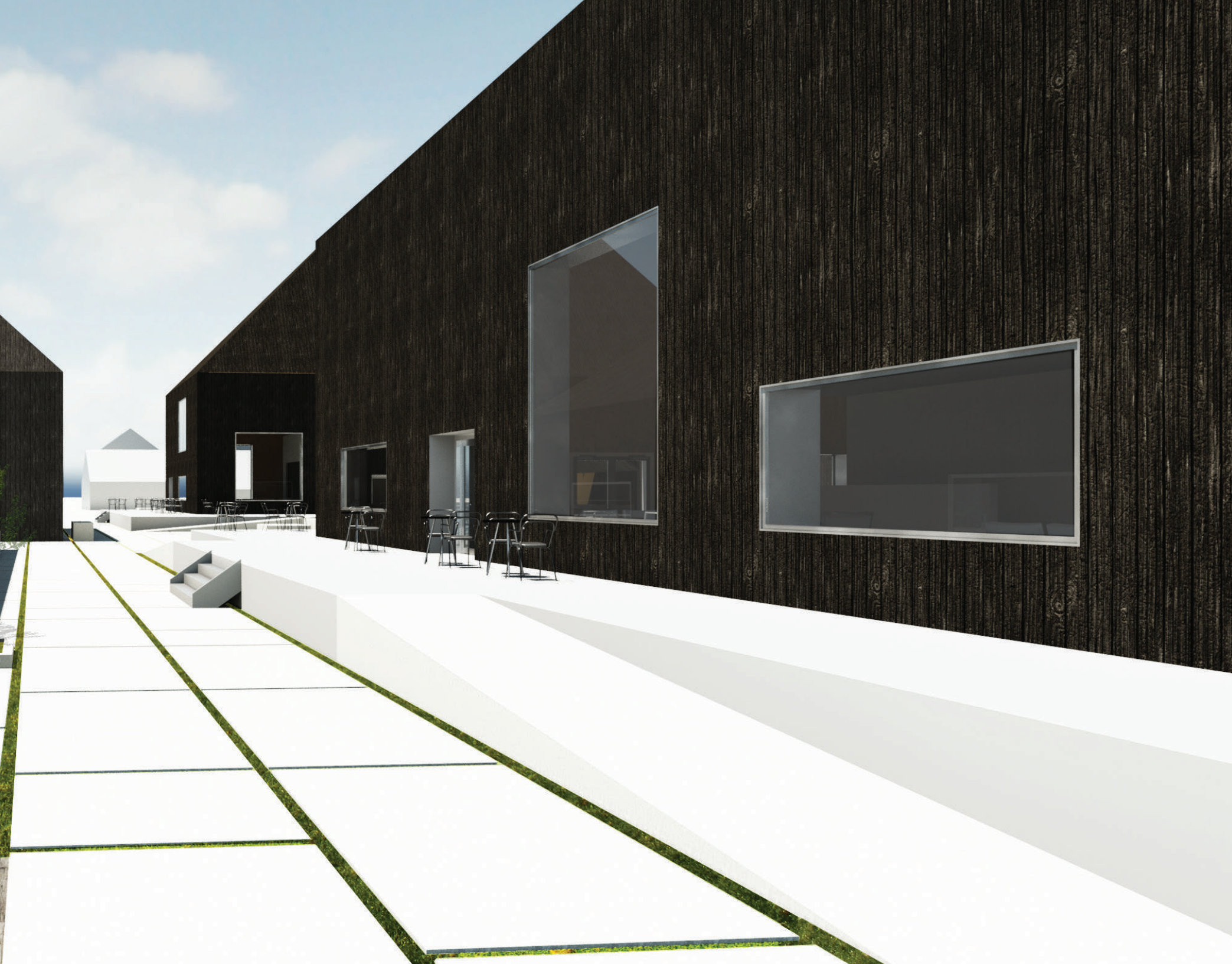
The site area are surround by water from three sides, each of the sides have their own purpose; Towards the north are the working area, with space for mast storage and preparation of boats and dinghy boats, with entrance to the workshops. Towards east are the main piers for sailors, which also are the main access to the site from the waterside. The south are the recreational green area, with a view over the marina and out towards the fjord. The last entrance to the site are from the west where it is possible to enter by two roads, one for boat transport and purpose. The other are for visitors to the area, by either foot, bicycle or car. This road ends out in a gravel road leading to the auto camper parking. These entrances are leading to the heart of the site, which are surrounded by the buildings and creates an outdoor space. From the common area, there are a visual connection between indoor and outdoor. Visitors can follow the life inside/out and outside /in, this creates curiosity and an interest in the area and sailing society, or for sailors an interest in the qualities of the city.

The site becomes a link between water and land. The design of dividing the buildings are creating an outdoor space where people from the city and guest can interact and share experience and information with each other.

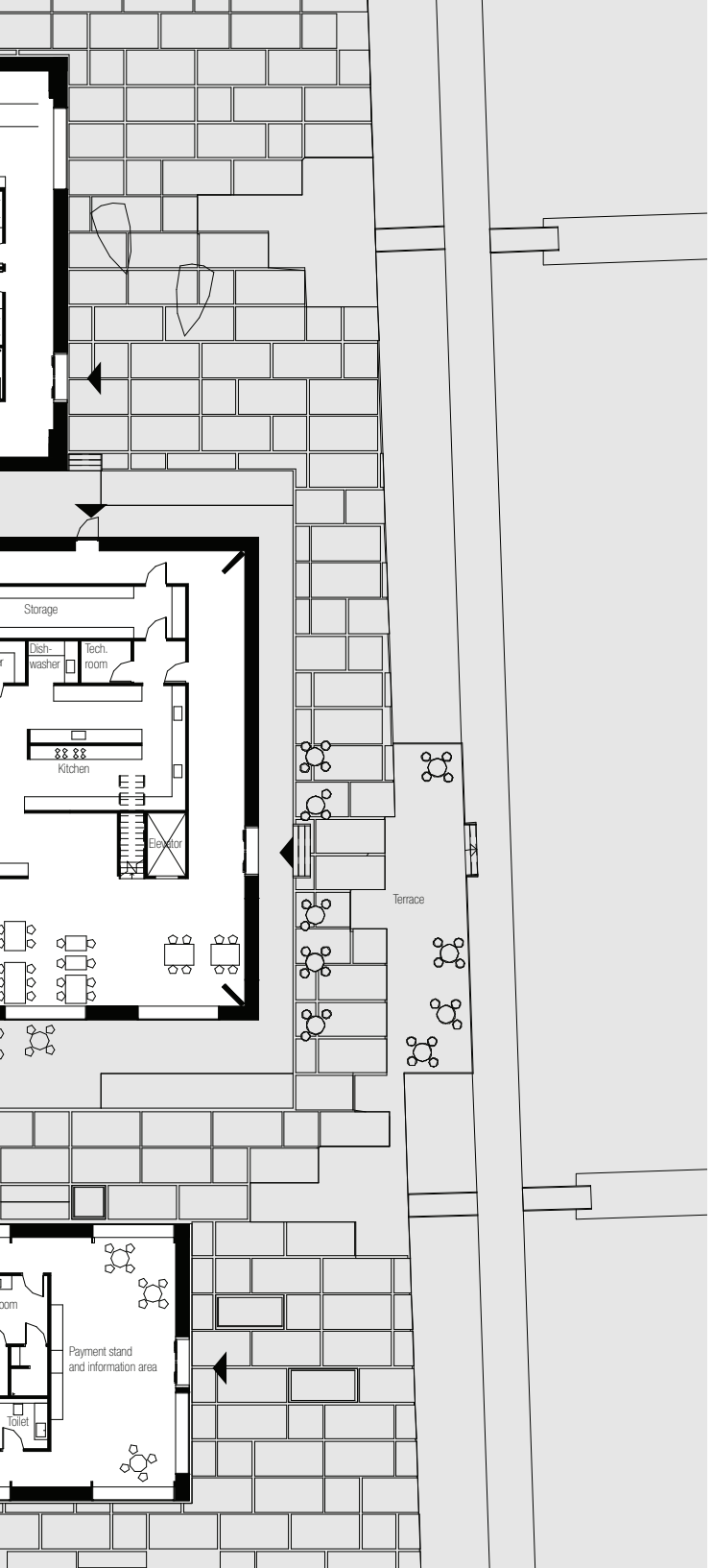
The pavement are concrete elements with Lyme grass growing in-between, to give a visual division of space that the human can relate to. In order to break down the boundary between the city and the water the pavement are illustrating this public welcoming, by melting from asphalt, to concreate elements with Lyme grass and further into wood piers and grass. The concrete pavement also rises and become benches and small tables, or it falls and becomes water mirror, for children to play in.








Boat storage
Technical room
Toilet
Workshop
Storage
Elevator
Dinghy storage
Workshop
Shower
Shower
Elevator
Tech. room
Toilet
Toilet
Tech. room
Toilet
Toilet
Elevator
Kitchen
Dining area
Terrace
Terrace
Office
Cooler
Toilet
Toilet
Bar area
Cafe area
Kiosk area
"Bar" area
Shop area
Storage
Tech. room
Shower and changing room
Toilet
Toilet
Toilet
Washing machines and dryers
Family Toilet/ shower
Tech. room
Family Toilet/ shower
Shower and changing room
Toilet
Toilet
Toilet



PLANS

Workshop: 396.7 + 846.3 = 1243m^2
Restaurant: 508.5m^2
Toilet: 364.2 m^2
Kitchen: 226.5 m^2
Shop: 273.5 m^2

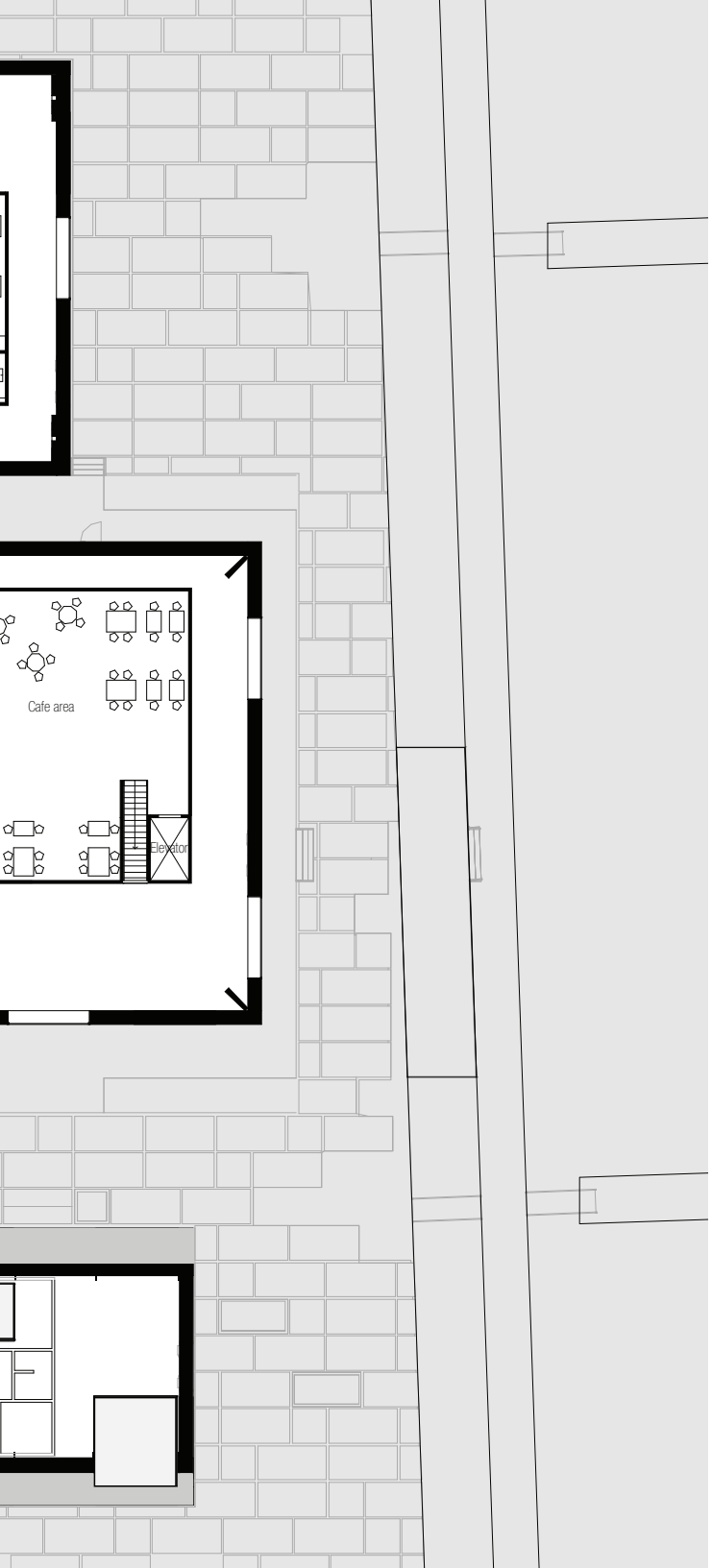
The buildings are, divided according to functions, orientated by use and placed in relation to each other, in order to become multifunctional.

The workshop are the main building in this design, with the other buildings are following the same principle but with the function to give them an individual identity, by the use of functions meaning; public, semi-private or private. Each of the buildings have two orientations; the primary are towards the common area, and the secondary are towards the water or the city.

The principle of the indoors in the buildings are the concrete core embraced by the wooden outer wall. The core are containing the hard and private functions, those that cannot be changed in use. Further, the surrounded by the softer functions, that has the opportunity to become multifunctional or changeable according to season.

All buildings have a core containing functions such as kitchen, toilets, storage and technical room. The core are self-standing and have no connection to the outer walls, which creates a free, simple and light expression of the inner environment. The placement of the core creates different spaces, small and intimate or larger and spatial. The idea is to give a simple but interesting


Toilet
Kitchen / dining / living area
Elevator
Kitchen / dining / living area
Elevator
Toilet
Toilet
Elevator
Living area
Toilet
Toilet
Staff kitchen / office
Toilet



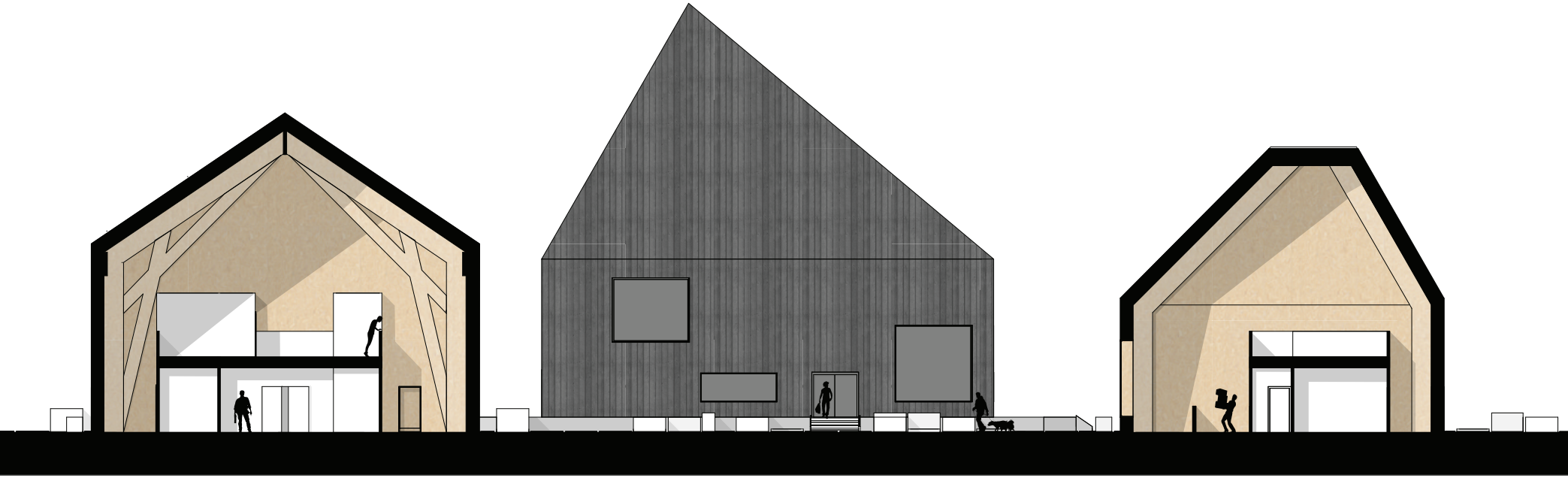
feeling of the space. The core design gives the structure of each building a complete expression, in the outer walls.

The boat hall are used for boat storage and preparation of boats during the winter season and as a cultural hall during the summer season, when the boats are in the water and the hall will be empty. The core in the boat hall contains a workshop, toilet and a technical room for ventilation. On the first floor, the core becomes a plateau with kitchen and living room for the ones that have their boats for storages, or as a backroom at cultural events. The large gates are making it possible to transform the indoor and outdoor areas, as they can become one, where the gates become an overhang, and defines and sheared indoor and outdoor space. The dinghy workshop have the same identity, as the function a similar. Therefore the design are alike the boat hall, with added changing rooms. On the first floor the dinghy workshop, have a kitchen and relaxing area, that works as a teaching area for students.

The restaurant and guest kitchen are raised on a plateau as a physical way of indicating the low activity and relaxing environment. Where guest can feel like home and use it on their own terms. The buildings have large windows, orientated to the common area and towards the water, in order to give an overview of the possibilities that the area have. From the open and light ground floor, to the first floor that are more intimate and private, without losing the quality of the view.

The shop or kiosk, have window orientation towards the city and the common area, this will be a shop for different items, and therefore it is important to create a space that can contain this diversity. The first floor are the private area for the staff, which are designed in such way that they still have an overview of the shop.

Last, there are the toilet building that also works as an information and payment area. Here the core are a little bit different from the others, as there are no functions on the first floor. The cores are instead closed by glass that goes from top wall to roof and enclose the functions underneath. The toilet facilities are divided into men and women departments, and family facilities in the middle.



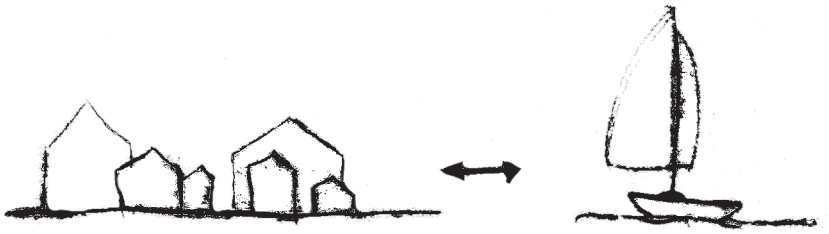
MULITFUNCTIONAL

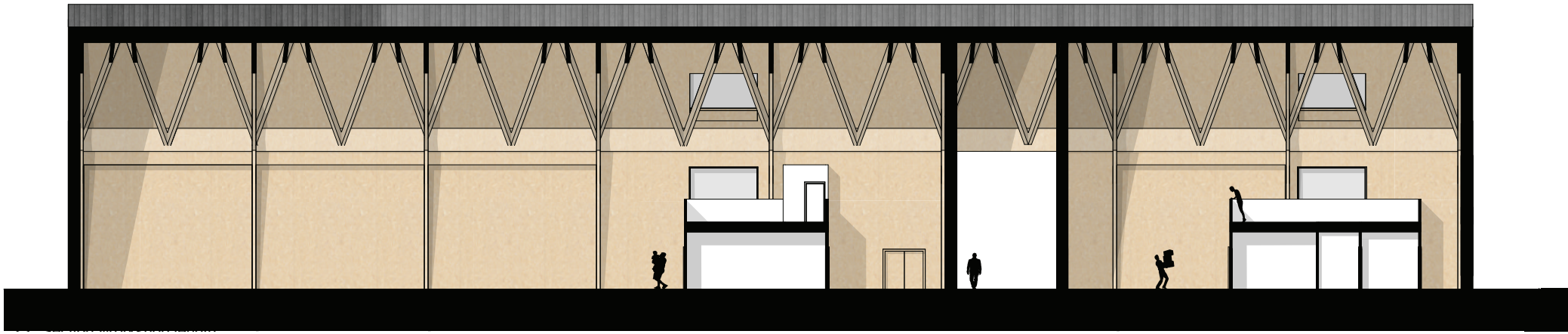
The multi functionality are depending on season. Auto campers are having same season as sailors, which means that the auto camper parking are only used in summer season. Therefore, it is ideal to use the area as boat storage area during winter season.

The boat hall will be used during winter season for preparation and storage of boats, but during the summer season the hall will be empty. A cultural house are mostly empty during the year, except when hosting big events. That is why the two functions are working well together, as the cultural house can be used during the summer season. The combination of functions are also supported by the interaction between harbour and city.

Auto campers are having same season as sailors, which means that the auto camper parking are only used in summer season. Therefore, it is ideal to use the area as boat storage area during winter season.

By combining the functions and usage, empty areas and buildings are prevented, which is a quality as the impression of unused space can influence the whole area in a negative way. The social aspect will also be enforced as the barriers, between city and marina life will be degraded. As a cultural house could host different events that both the marina and the city will benefit from.





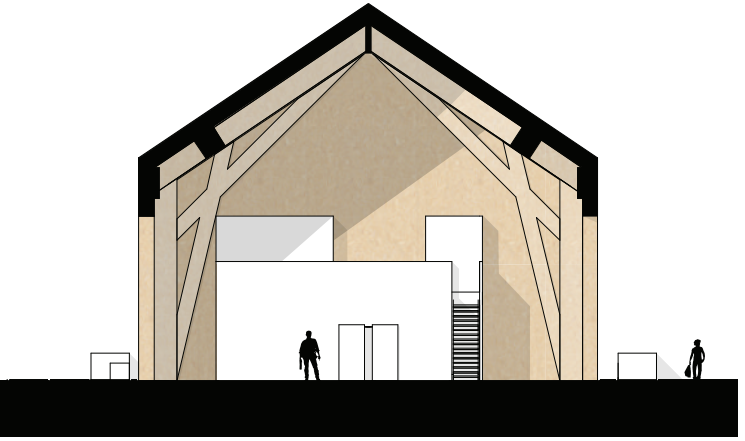
STRUCTURE AND MATERIAL

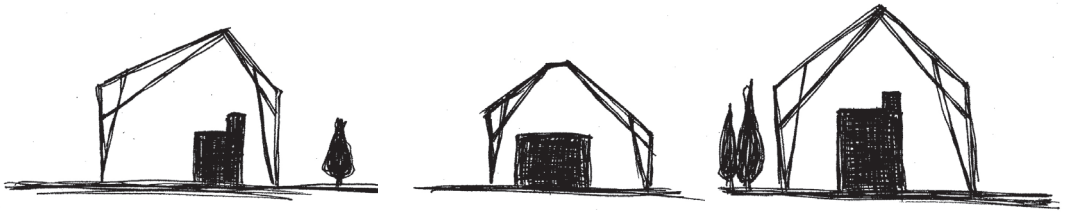
Defined by functions and use

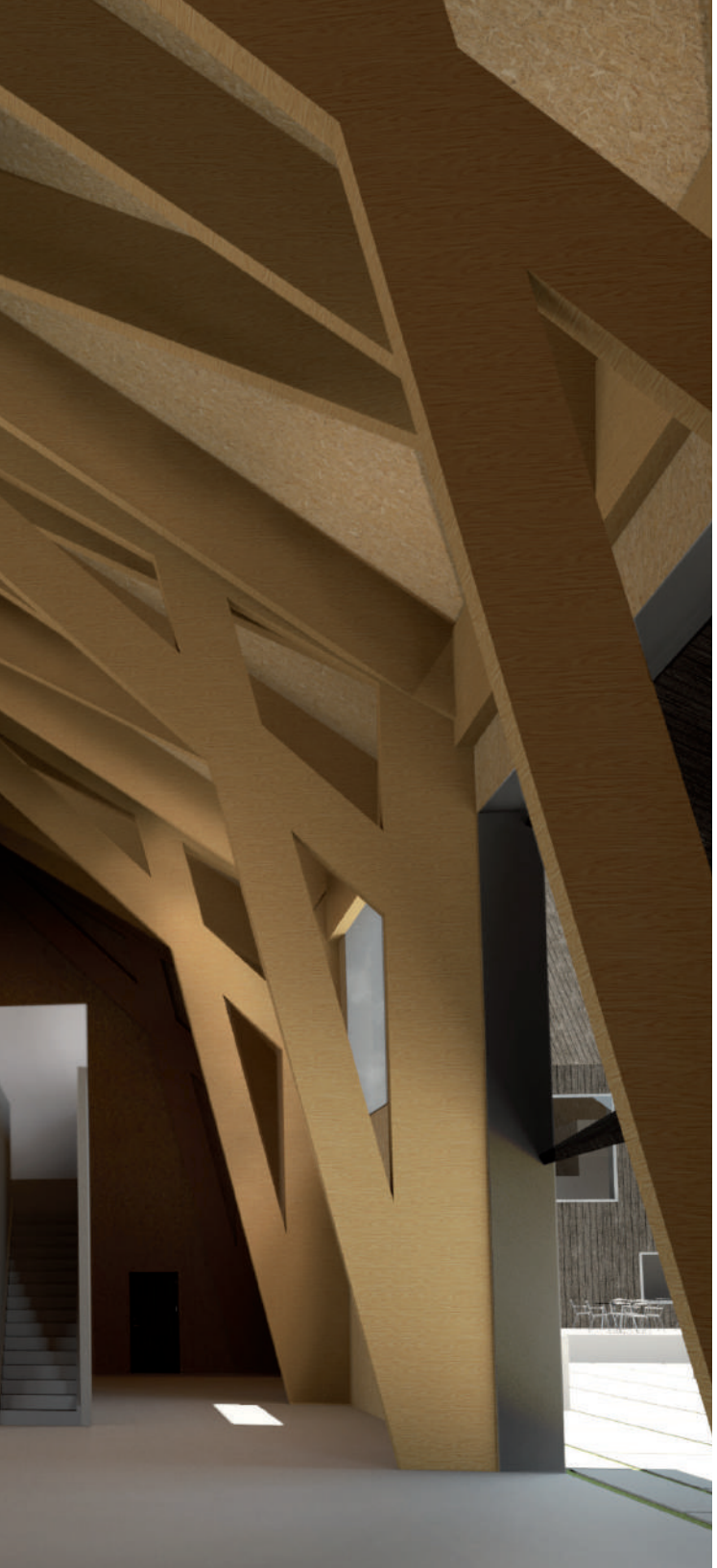
The expression of the structure have a historical background, as it is inspired by the old wooden boat houses, with the exposed structure, in a rough but still clear expression. The roughness are also to be seen in the choice of material, with glue laminated bearing structure and OBS boards that helps staging the structure and its expression.

There are two kinds of structures in the project, where the workshop structure are the main and are scaled for the toilet building. The rest of the buildings have a structure that are similar to the workshop structure, but fitted to the functions that it embraces. The focus have been on the workshop.

The structure itself are a combination of frame structure, transversal beams and trusses, which gives it a complex expression and have a high level of details, that risk drowning in other material. It is therefore important the materials are simple but still functional, in the meaning that it is okay to work on the boat with paint and dust; all will create a history of its own. The functional aspect is important as well. The overall experience of the structure should include tools and equipment as a natural element.





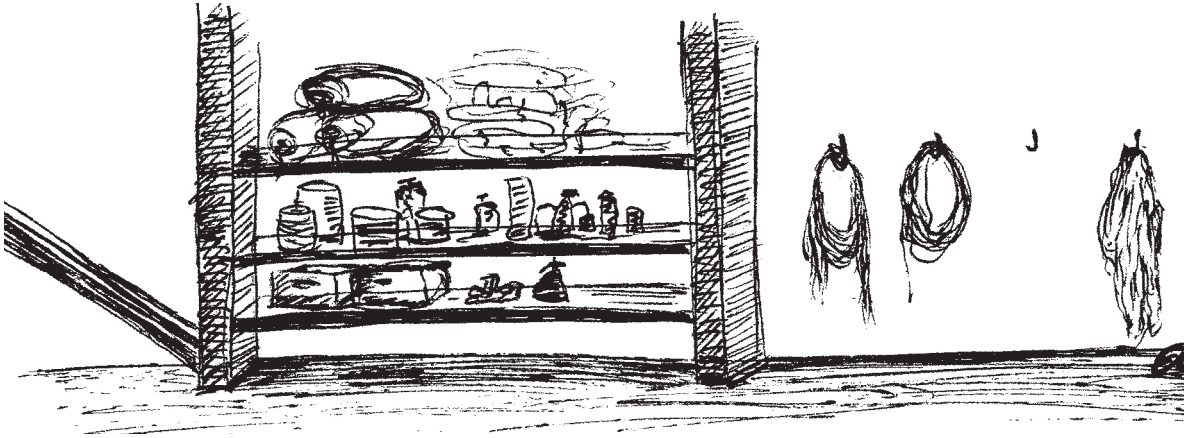


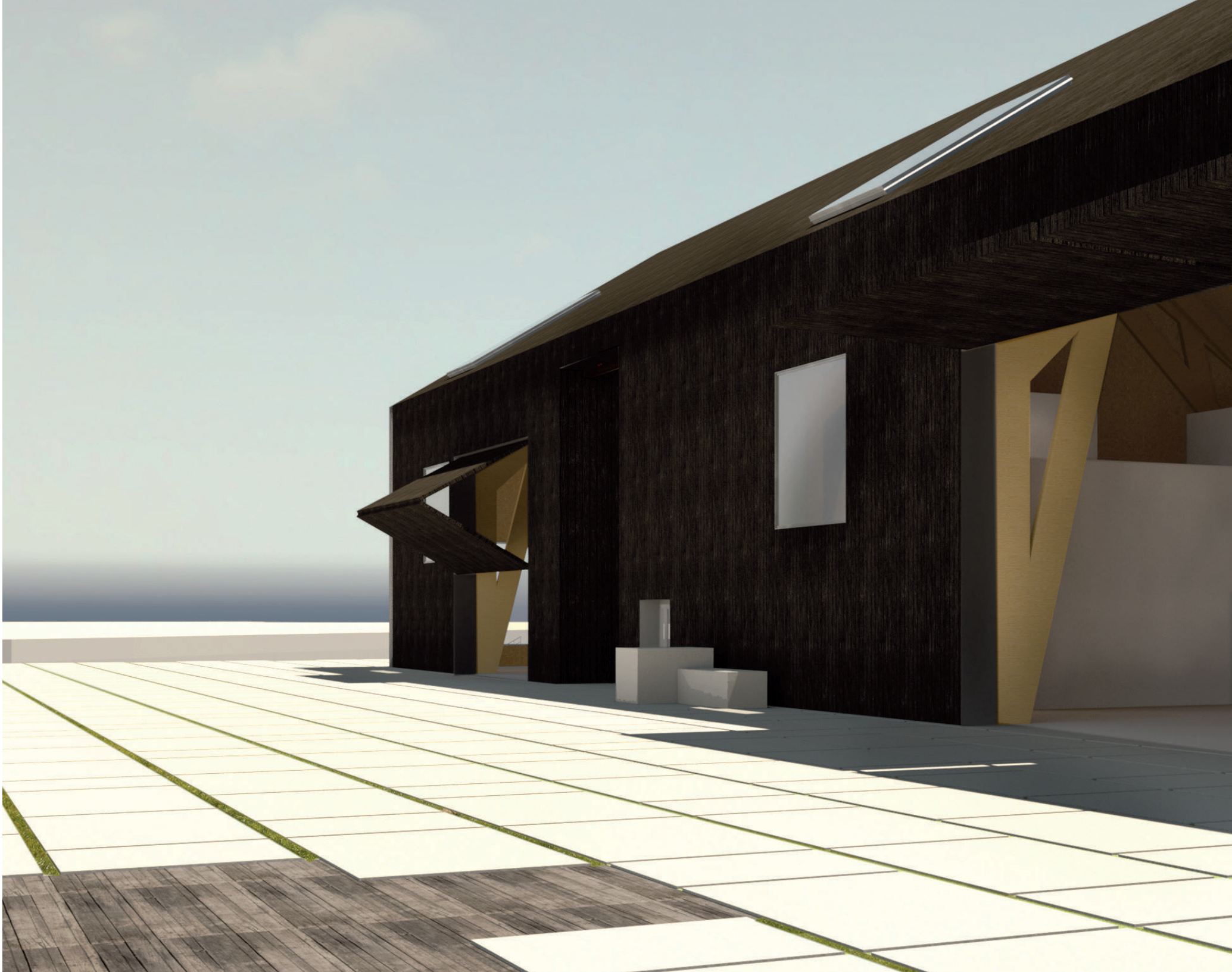
ATMOSPHERE AND EXPERIENCE

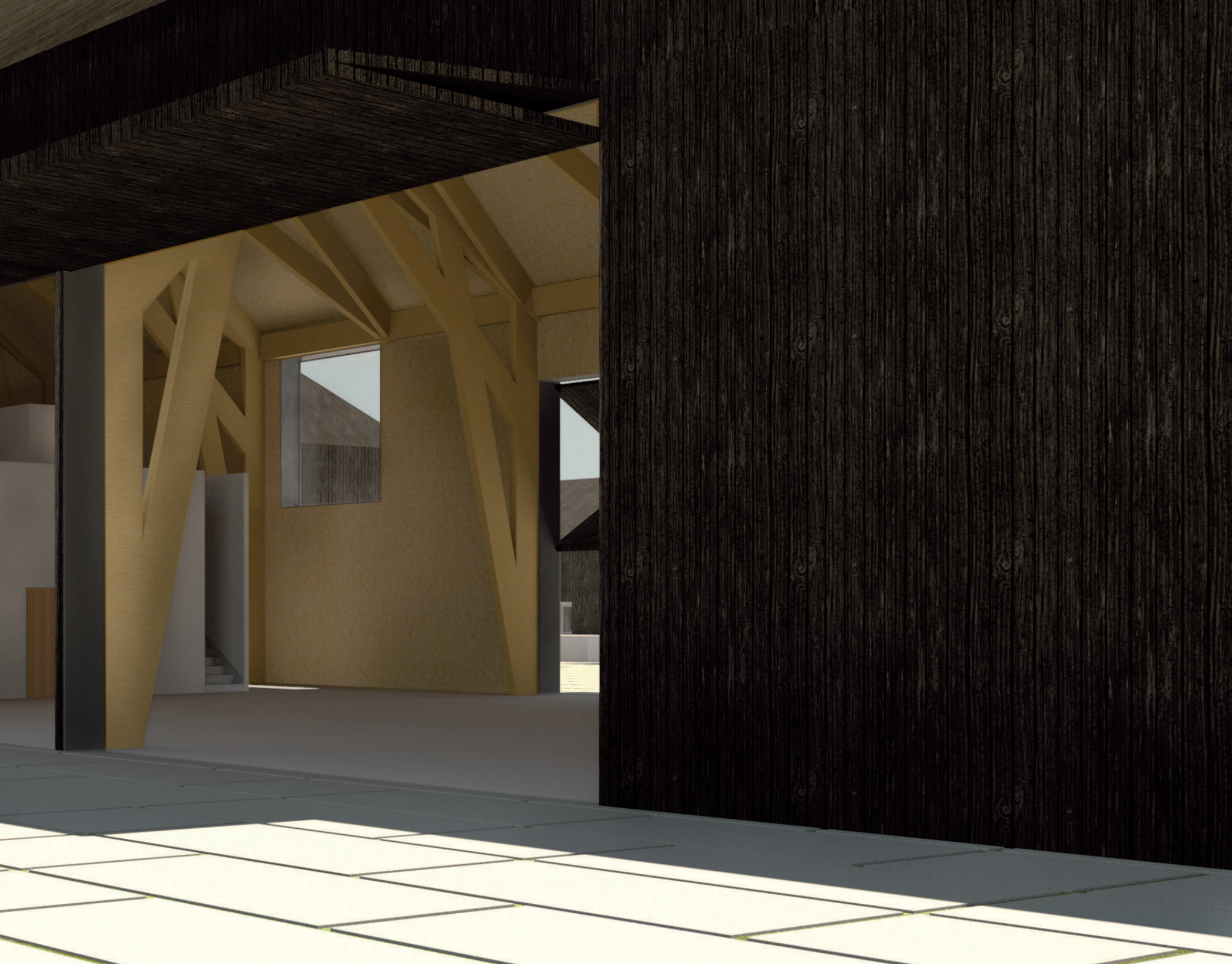
The tectonic aspect to the structure. The frames and trusses are visually creating smaller spaces underneath, and the concrete core are helping with creating different experienced spaces. The frames are placed with a width span, which makes the elements larger and therefore more distinctive, which helps in the way of perceiving and feeling the structure, as it becomes a more comfortable working area when the human body can relate to the surroundings.

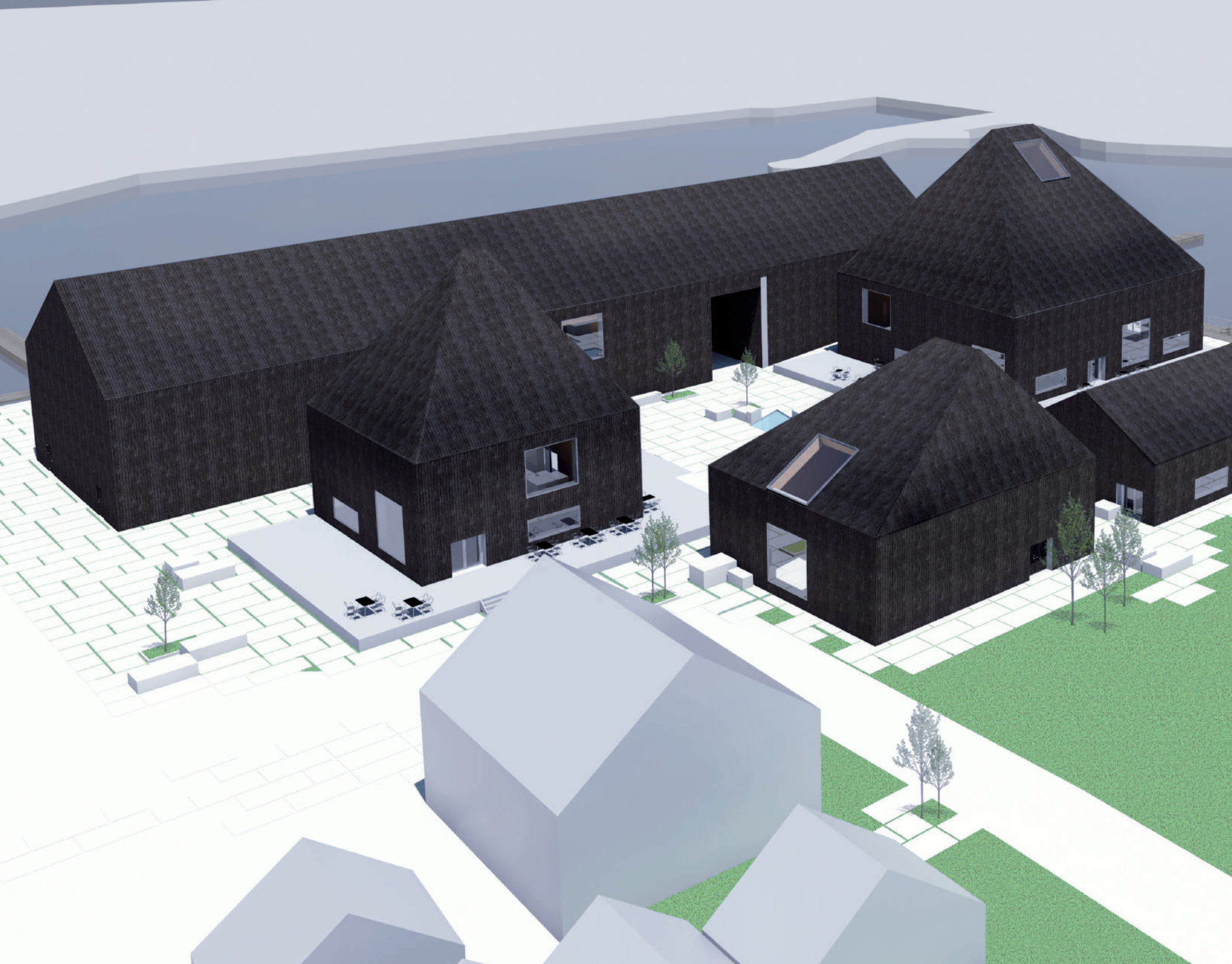
The Atmosphere there have been aiming for is calm and relaxing but still functional and rough, this counts no matter the functions. The area are for relaxing and recreation. A place where people are having the time to help each other and interact without any stress elements by the design. That is also why there are used a small spectra of materials. The materials supports the perception of the space, and makes the functions easy readable in order give the visitors the best experience of the building, and make them feel comfortable.

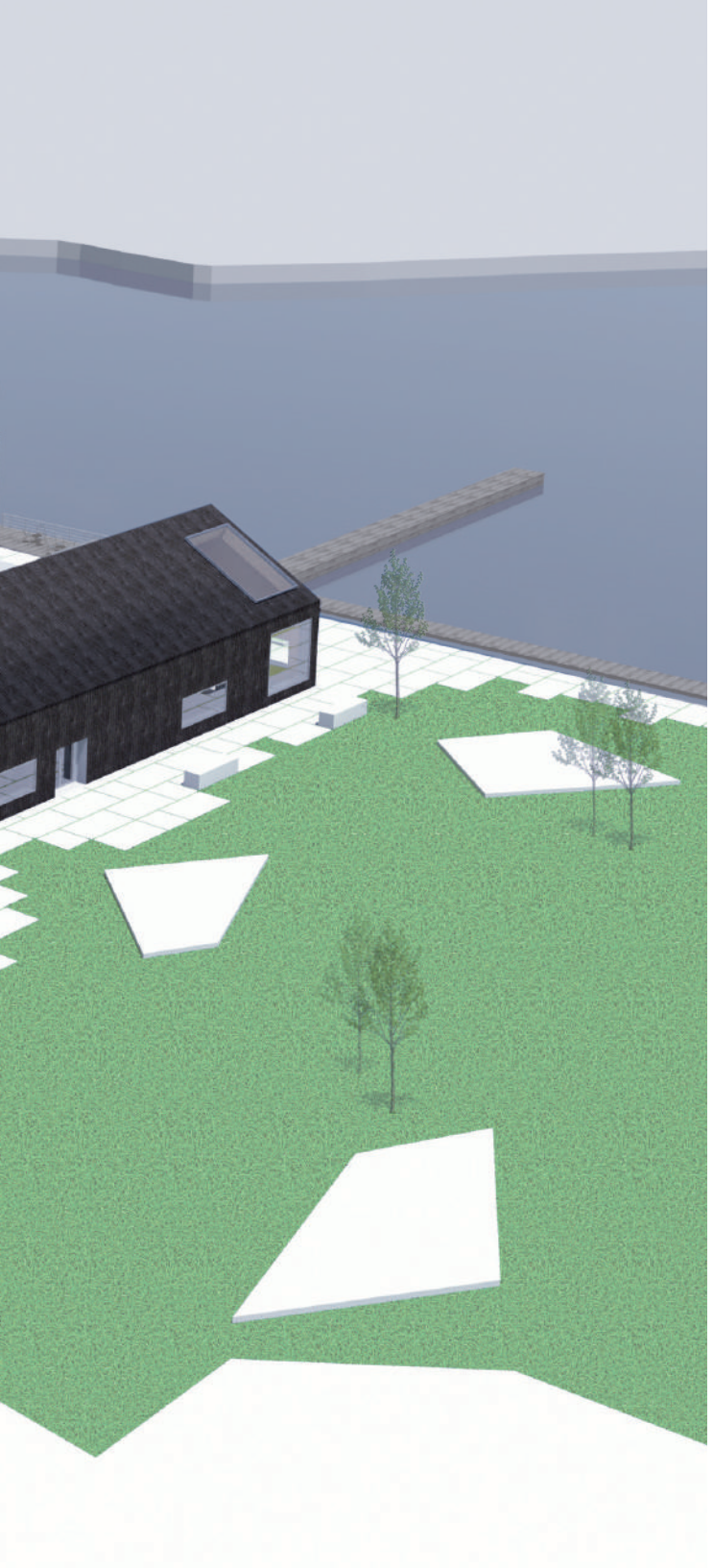
The experience of each building as the functions are different but also activity level and decorative elements are giving each space its own identity. In the design, the added elements such as tools and equipment, are a natural element in the overall design, instead of hide it away, it becomes the frames of personal areas in the public space, another way of visitors and users to relate to the design and functions.









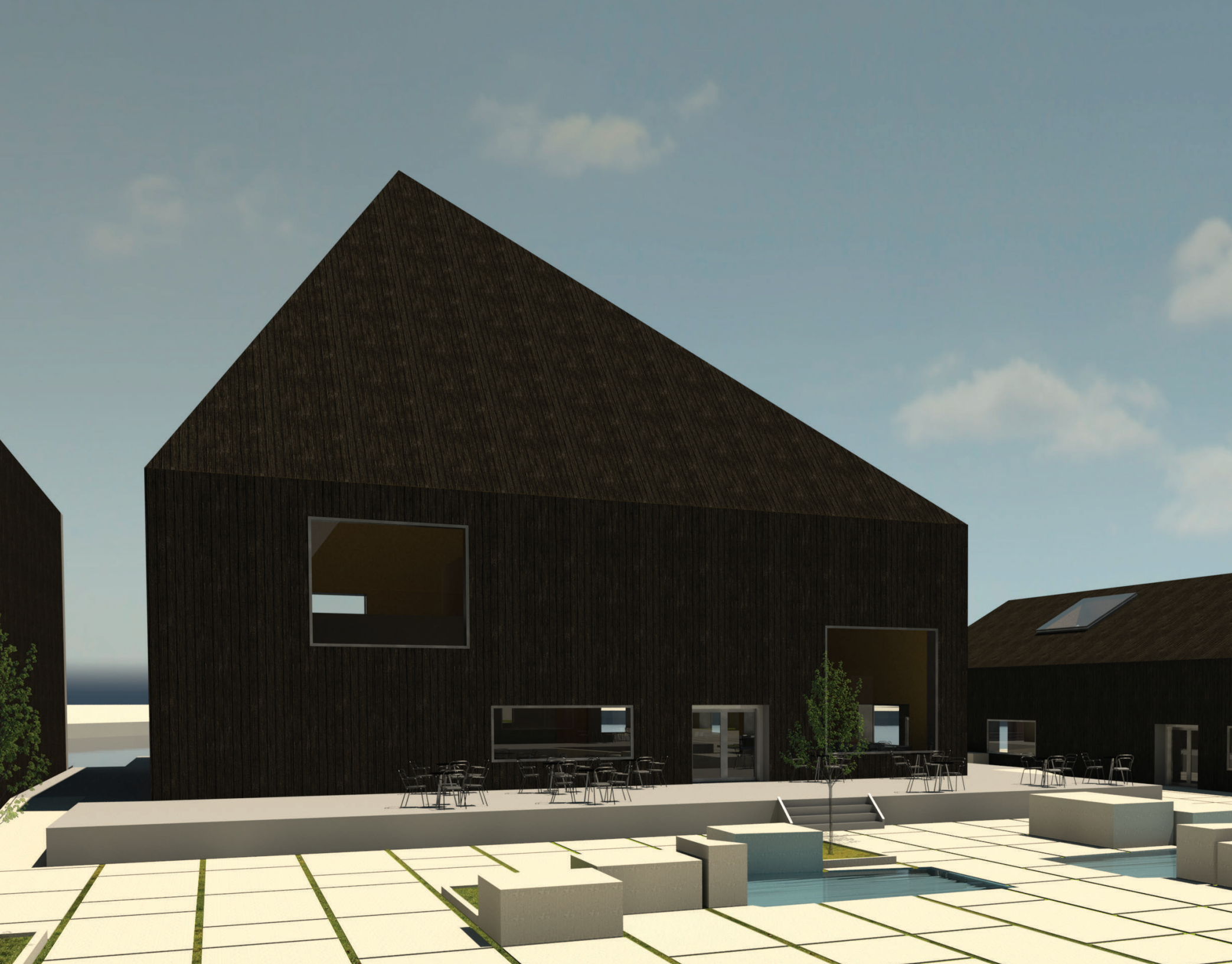


FACADES

The roof shape are and wall heights are creating a hierarchy, and an easy understandable read of functions. The highest buildings indicate public functions and lower buildings, such as the toilet building are the more semi private area, as it is only for sailors. The roof shape are defined by the inner core, and reflect the placement and shape of the core. This gives an individual expression in the hierarchy.

The windows are another way of showing the hierarchy. They are the framing the nature and life; high windows are giving the rooms light and visual qualities in deep rooms. The lower windows are for spaces that are more intimate. All windows are placed in a height where it is possible to use the window as an informal area, this detail are mostly addressed to children and young people.

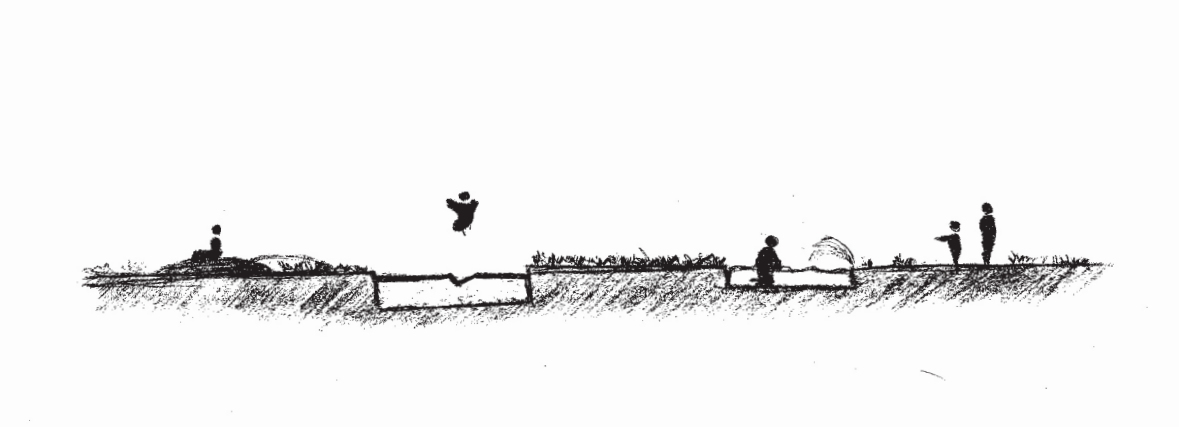
The origin design of the windows comes from the gates in the boat hall. Where the design a simple and clear, with the square opening that can transform indoor and outdoor area to one space. The windows are the thin boundary between outdoor and indoor. The openings are also a contrast to the buildings dark serial cladding. The openings are showing the warm and calm interior.



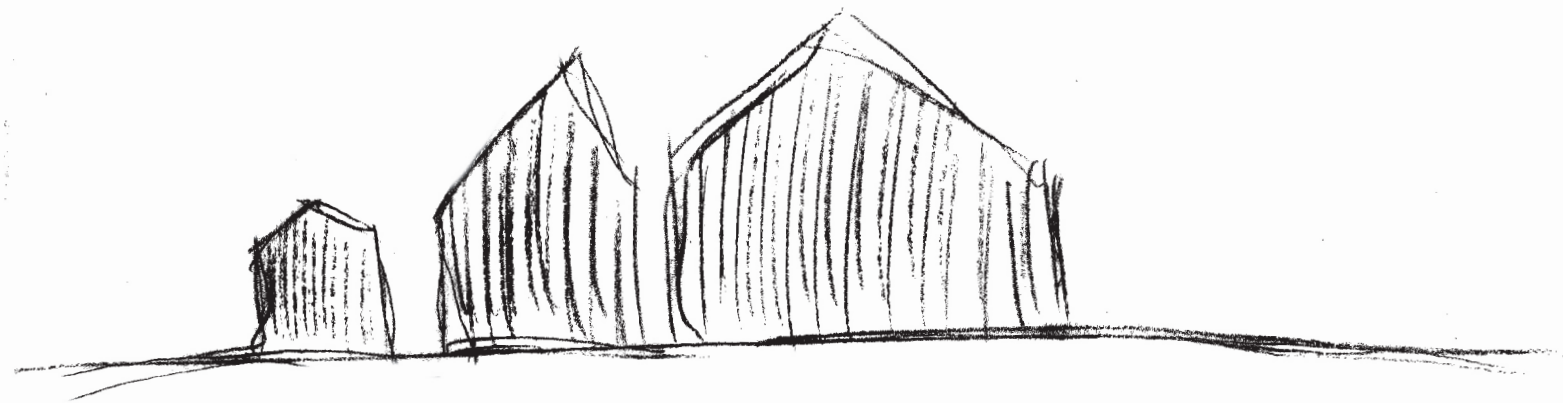
PUBLIC AREAS

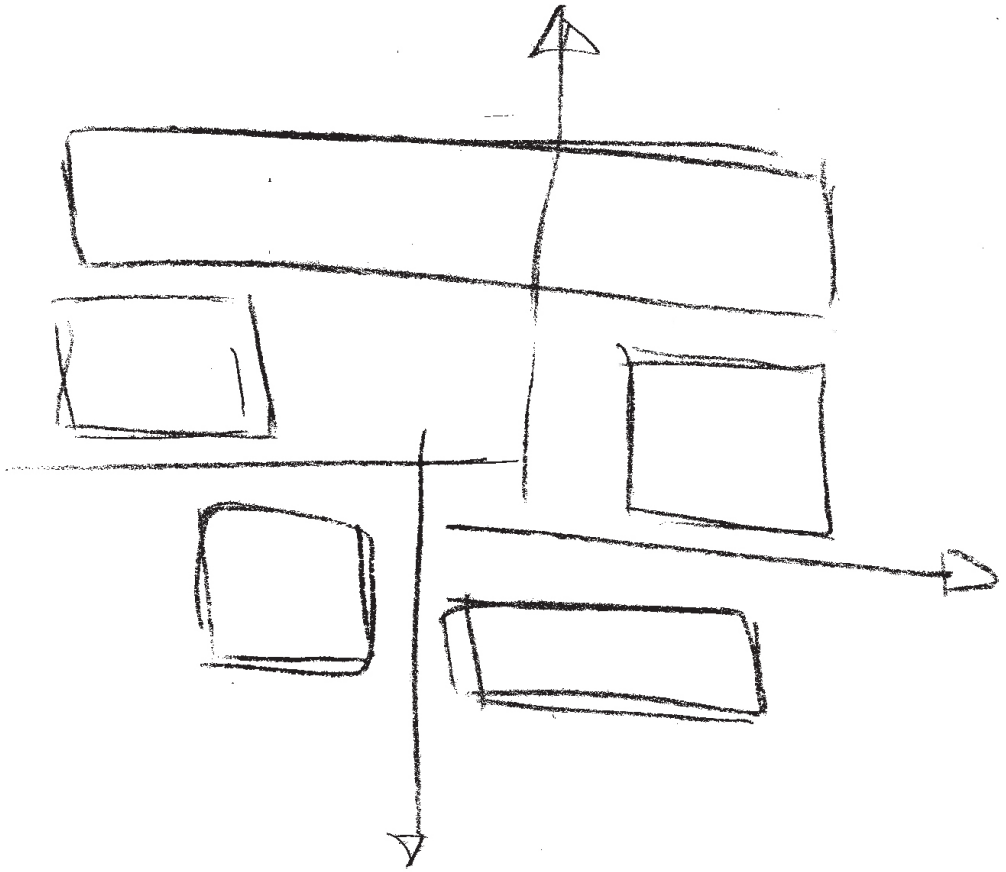
The common area, centred between the buildings, becomes the outer core. This core works as a gathering point for visitors, no matter where they are entering. This space also gather the functions in a visual matter. The building facades are allowing visitors to have an idea of the functions inside the buildings. The main idea is to create soft boundaries, between public and semi-public functions. Further, the activity level in this area are diverse, as it is used for people going from A to B, others stop and spend time and relaxing on the benches and playing in the water mirror. Mostly the idea of the outer area are to make visitors curious and create an interest in the marina society, where everyone are welcome.

There are different outer door public areas despite the common area between buildings. There also are the area in front of the boat halls that can be used for practical or cultural purposes. On the opposite side of the site, there are a green are with relaxing elements and terraces with grills. This is more to the visitors that are planning to stay for a period of time. From the green area the Auto camper parking, are placed with a view over the marina and the fjord, this area have a relation to the public buildings in the same way as the piers and sailors have.



DETAILING





DIVITION OF FUNCTIONS

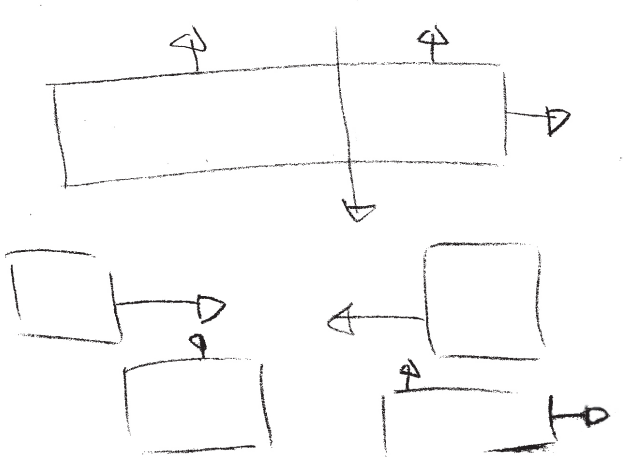
During the program there are analysed on Limfjorden, Thisted and the marina. The functions are determined from the analyses of what the marina and sailors have of wishes.

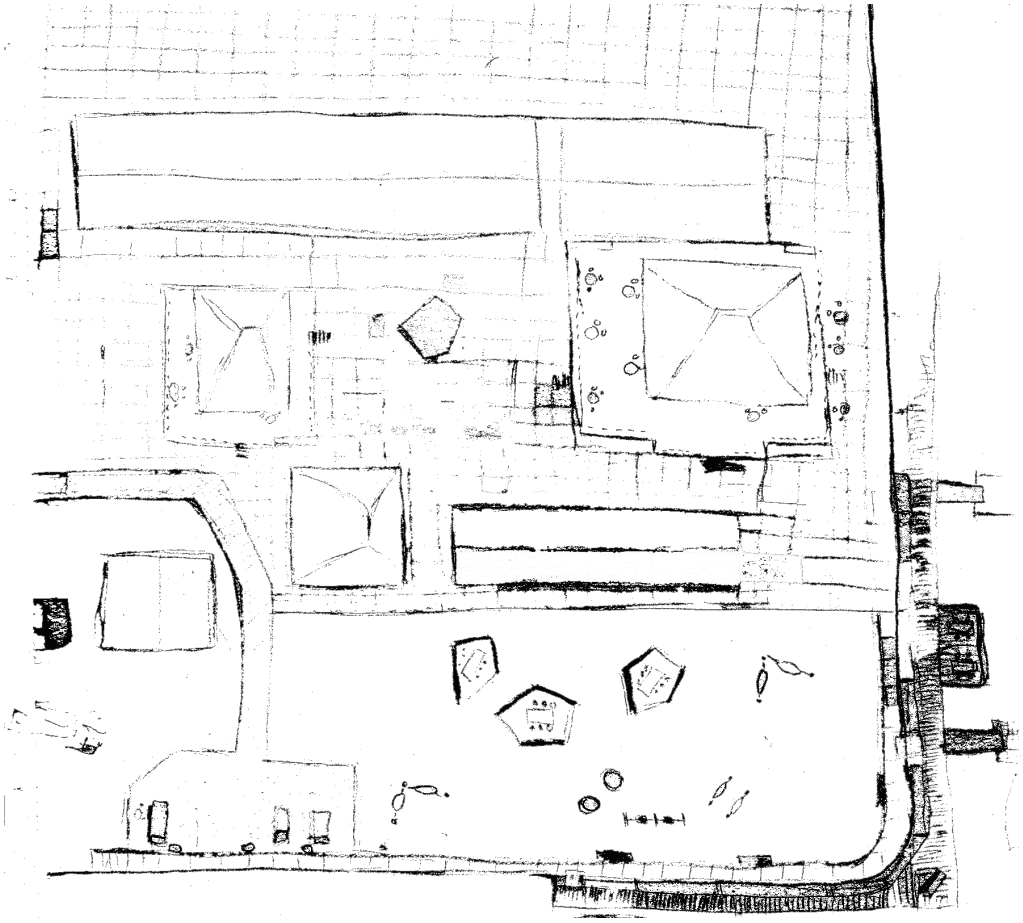
When designing it has been important that the building design is not standing as a barrier between the water and city life, but instead is an area with interesting views and accesses to common areas where people can interact with each other. The area should be a place where people goes to when out walking the dog or entering because the harbour because of the qualities that the design can offer.

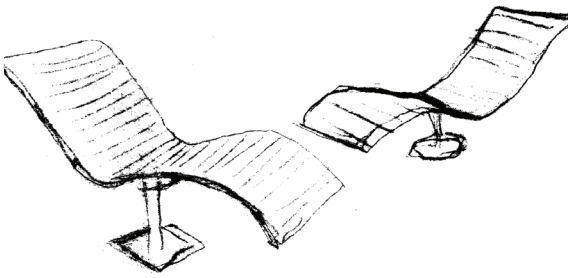
It was quickly decided that the function should not be under one roof, as this will enforce the barrier and with a majority of marina functions the building risk being semi-public to the sailors, and the citizens will feel it as private. Therefore, the functions are divided in to separate buildings. The division are set according to the view lines and entrance lines that there already are on the site.

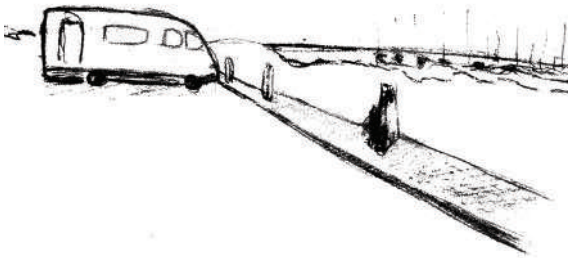
The separate buildings are creating an outdoor area where the building walls are embracing the space and making it sheltered from the wind that can be at the coast. This space are the heart of site, therefore the functions inside the buildings will primary be orientated to this area, and secondary towards the water or city.

Further, the division are creating smaller and informal outdoor areas between buildings. This way the visitors are have the opportunity to interact with each other when passing through the area. The areas should express a place where visitors are felling welcoming and wants to stay, and use because of the qualities and opportunities that the design are giving to the city and the marina.

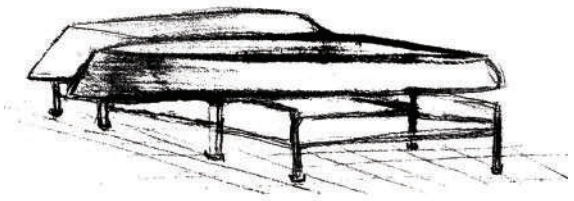


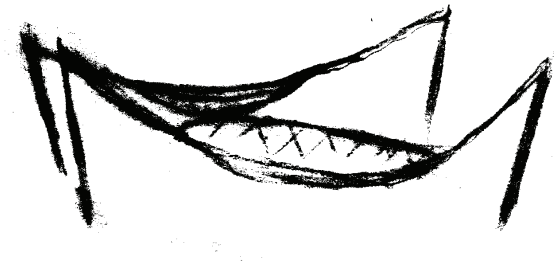






OUTDOOR AREA – FIRST HAND IMPRESSION





There are different outdoor areas, as these benefits from the qualities of the nature and the site, with water on three sides of the project site.

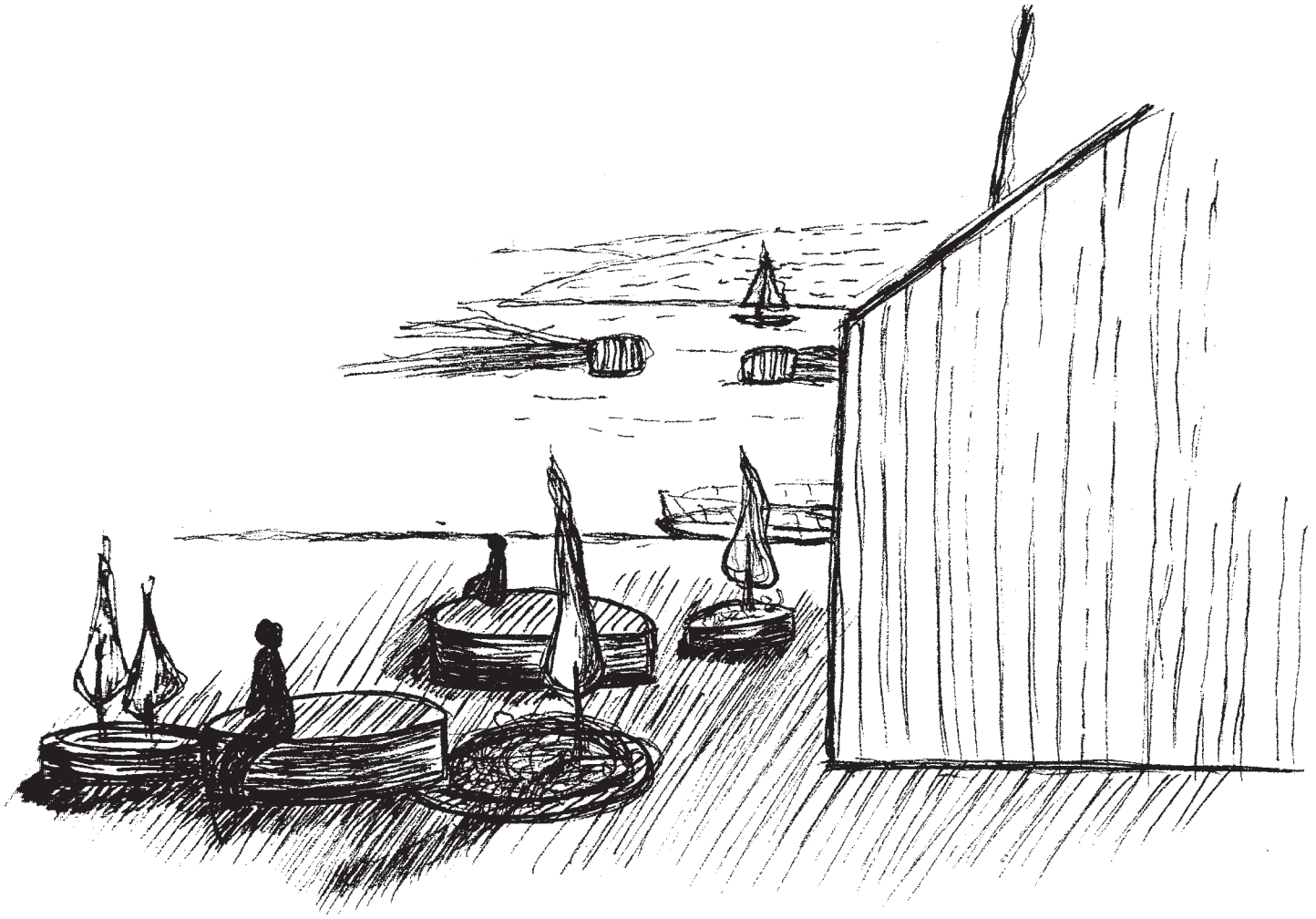
Auto campers are traveling in the same way as sailors, they have their second home with them around, they want to exploit the country, and the only different from sailors are that auto campers have wheels. This is the reason why there also are an area for them to park and stay if they want to. The Auto campers are using the same facilities as boats, and by letting them be a part of the sailor community. The placement of the auto camper parking are a bit isolated from the common area, on the edge pier, this way they have the same terms of privacy and qualities as sailors. Further, the parking area are multifunctional, as during winter season it will be used for boat storage. Which also are the reason for the placement near the small sheds.

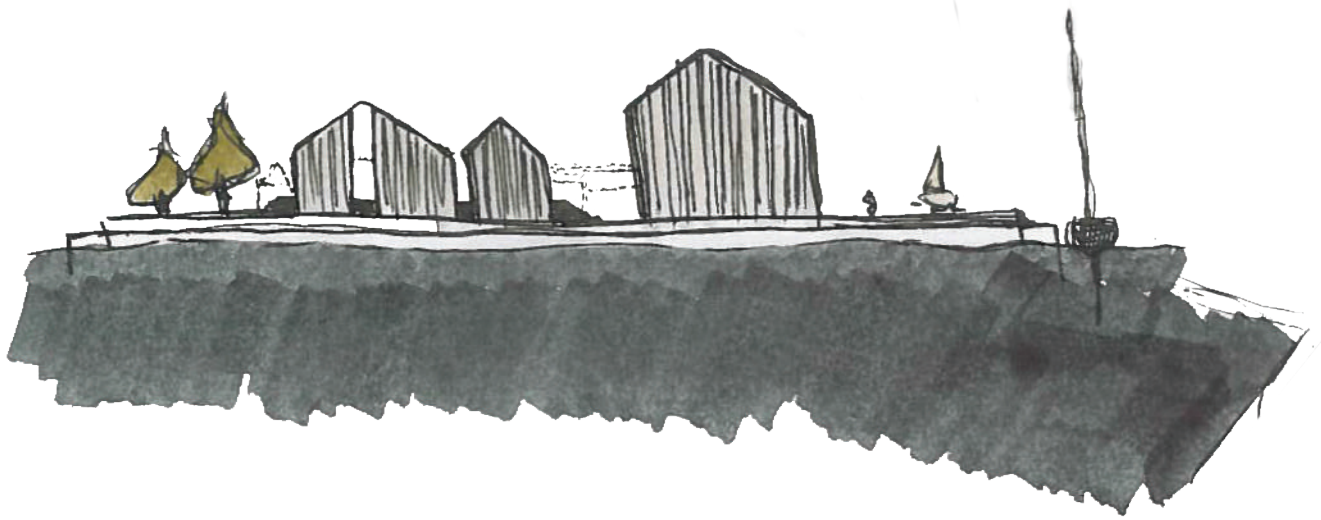
Between the common area and the auto camper parking the recreational area with relaxing elements such as, grill terraces, hammocks and armchairs. This is also, where it is possible to create a playful environment, where children can exploit and have fun.

The area between the buildings is the common area where all kind of people can interact with each other. The area are inviting for stay, with the spontaneous benches rising from the concrete floor coating with random grown Lyme grass in-between, the centre are marked by the water mirror in the middle.

Outside the workshops, there also are a useful area, not only with the tripods for masts and dinghies, but also with the cultural events as it is possible to rise a tent or use it as a marked, depending on the event and need. The area are design with the concrete that differs from the normal asphalt road, this design element indicate the multi functionality.

The piers are divided in two elements. From the project side and down to the fixed wooden pier, and further down to the pontoon piers. This division between the two piers are of two reasons. The first are to make the pontoon piers semi-public compared to the public fixed piers. The second is that most sailors prefers to lay at a pontoon pier when the water rises, and they do not have to go at check the tether.

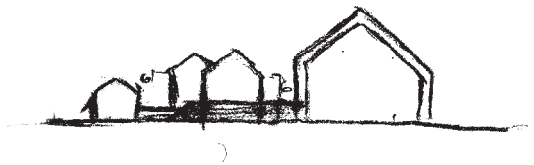


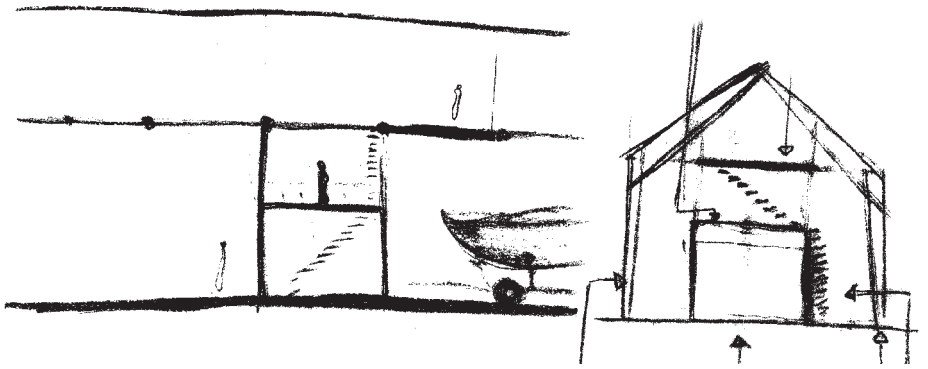


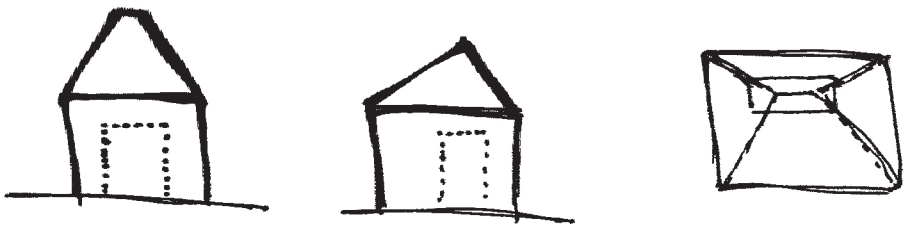
FORM - DUO PITCHED ROOF

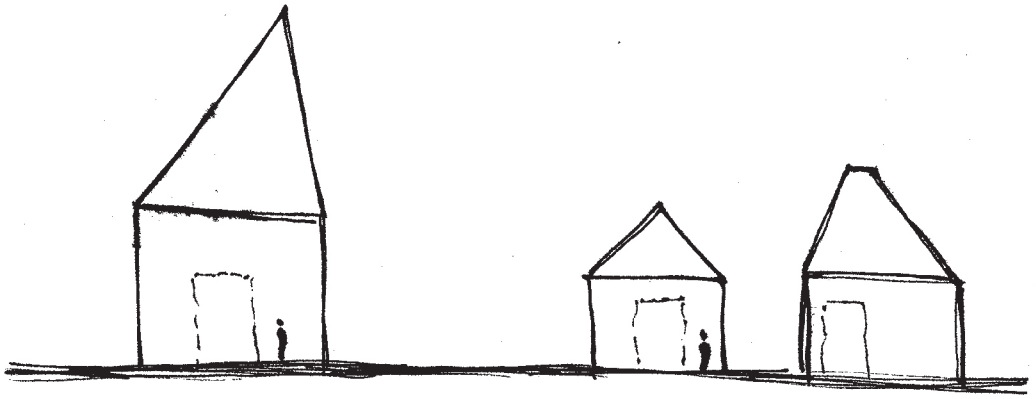
The idea behind the pitched roof was the primary design criteria, as the inspiration are from the old traditional boathouses. Where the use of pitched roof are reflected in the inner visible structure and the honesty in the use of material. The design is about functionality, where the tools, spare parts and equipment are not hidden away, but are laying or hanging from the structure and it is okay to get paint stains. All of the use will contribute to the history of the building.

The inner expression will be honest and rough, but yet simple and calm. From the outdoor the duo pitched roof are an easy readable shape. In the design the duo pitched roof are used for the boat hall and the toilet facilities. Both buildings are mostly marina related, and therefore it seems natural to apply the duo pitched roof. There also are a hierarchy in the roofs, in order to show the primary public functions on the project site, the hierarchy are also determined by the volume and height that the inner functions needs.





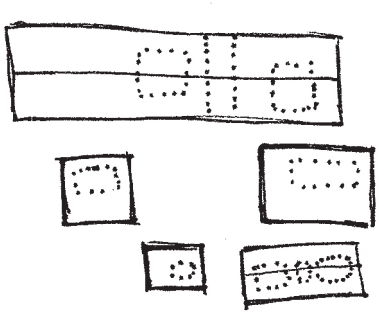


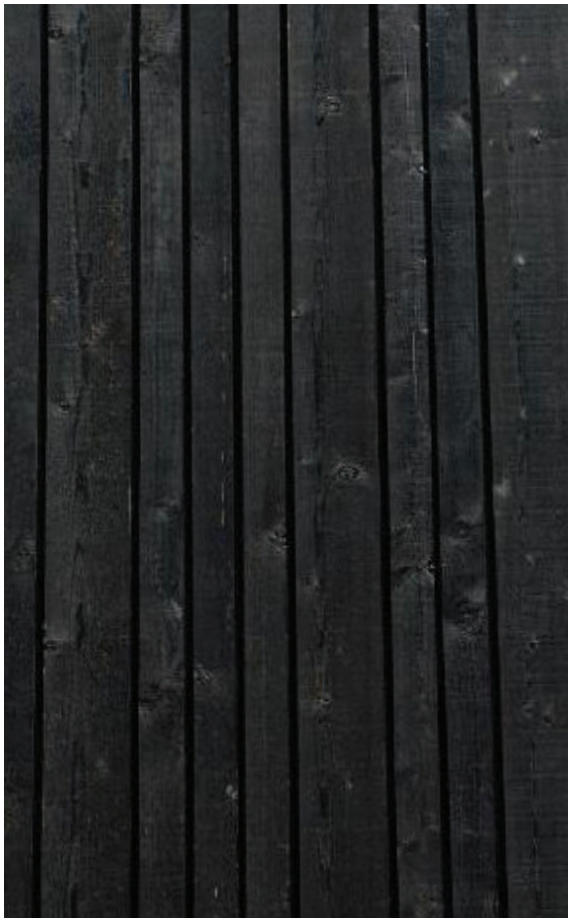


FORM - QUATER PITCHED ROOF

The remaining buildings are having another type of pitched roof. The quarter pitched roof are generated by the duo pitched roof but are following another design parameter. The roof slopes are defined by the placement of the core, where the roof ridge follows the length of the core. Hereby the individual identity are created. The same principle of hierarchy are to be found in the remaining buildings, where similar function have similar expression and hierarchy according to the public use.

The experience of the inner room that the quarter pitched roofs are shaping can be dramatic because of the different roof angles. The exposed structure and the room height and the inner core are highlighting this dramatic expression, but this is calmed by the materials and the use of light that, gives the room more complexity, in the meaning of light of shadow that makes the focus on the calm feeling and the framed views.
The two roof expressions makes it easy for the visitor to read and understand the hierarchy of the functions. This makes also stages the primary public functions such as Restaurant, boat halls and shop.

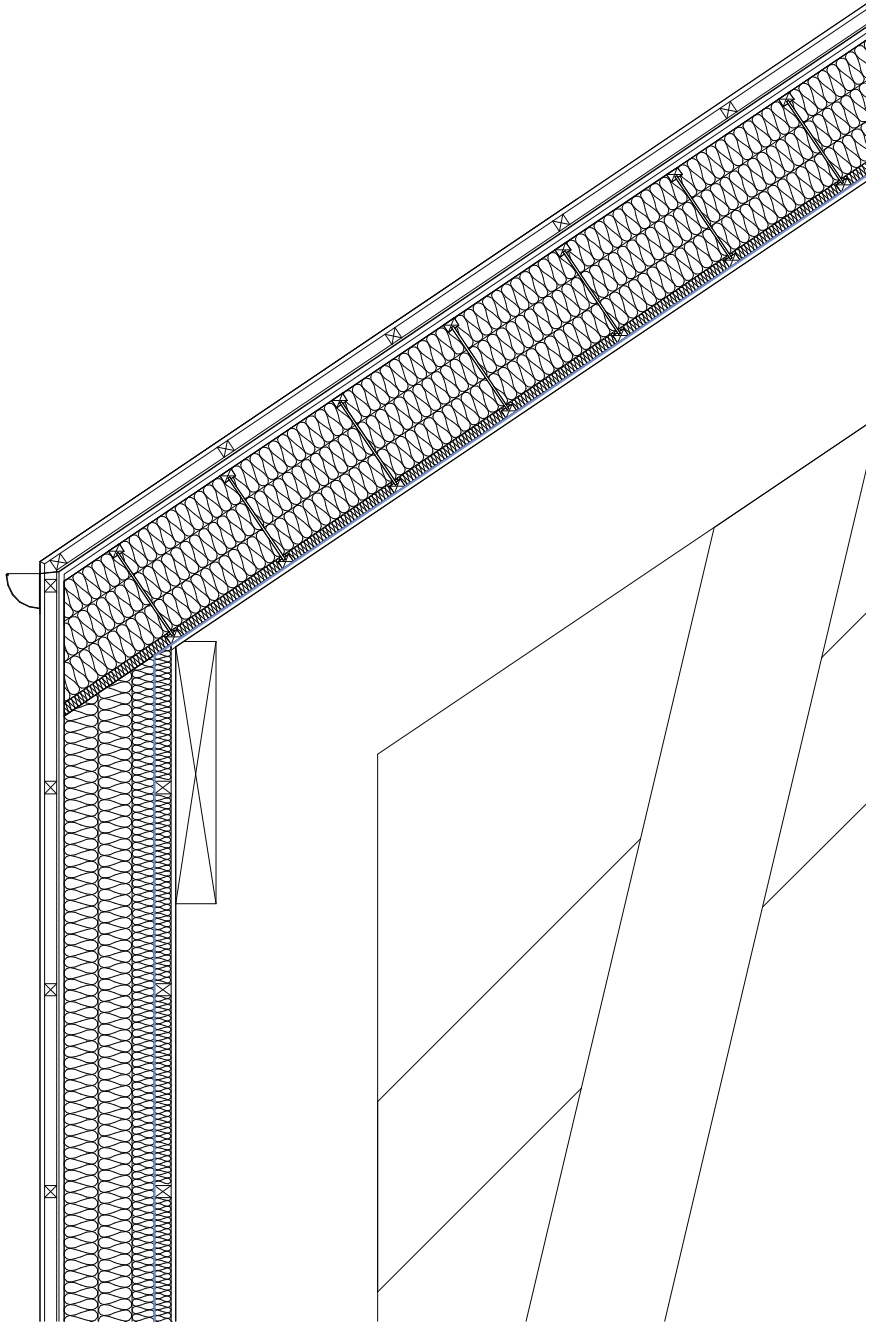




MATERIALS

The use of materials are identical in all the buildings.
The materials are inspirited by the Nordic use of wood, with a contrast of concrete and vegetation to soften this. For outer cladding on both walls and roof, there are used black vertical wood panels, with a small diversity in the thickness of the panels. For the outer flooring there are cast concrete in dimensions of 3x1.5m. The cold and rough expression are soften by wild grown Lyme grass. Further as a contrast to the dark wood and the concrete there are on the interior walls used OBS boards, which is recycled wood. These boards are adding a warmth to the room and the expression of the building will be an outer shall embracing the warm inner, with a more closed inner core of concrete. The materials plays with the perception of warm and cold, and the association that this creates.

The materials are also adds a certain roughness to the simple structure. The roughness allows the rooms to be used, and the use are contributing to the history of the buildings. It is a fine line between messy roughness that leads to discomfort for visitors and the clear roughness, where visitors have affiliation to the buildings, where they can feel at home and welcoming.



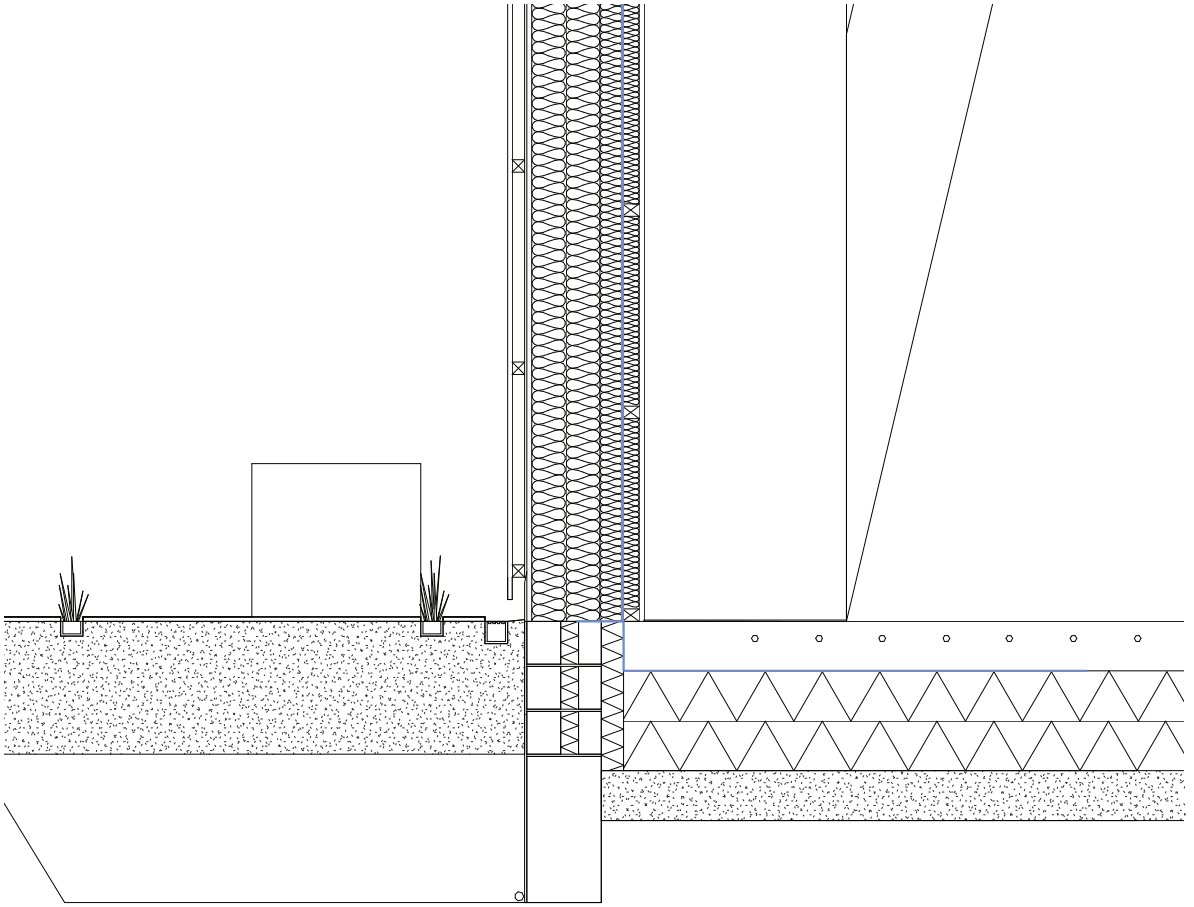
Roof
21mm wood panels
50x50mm battens ventilation
10mm panel, water exit
2mm roof felt
22mm wind plaster
25x25mm battens, ventilation
500mm insulation, Finn joist I profile distance: 600mm
Vapour barrier
22mm OBS boards
Barring structure

Wall
21mm Wood panels
50x50mm battens with air gap
10mm panels, water exit
22mm wind plaster
400mm insulation, 400x75mm battens
Vapour barrier
75x50mm battens, insulation
21mm OBS boards
Barring structure

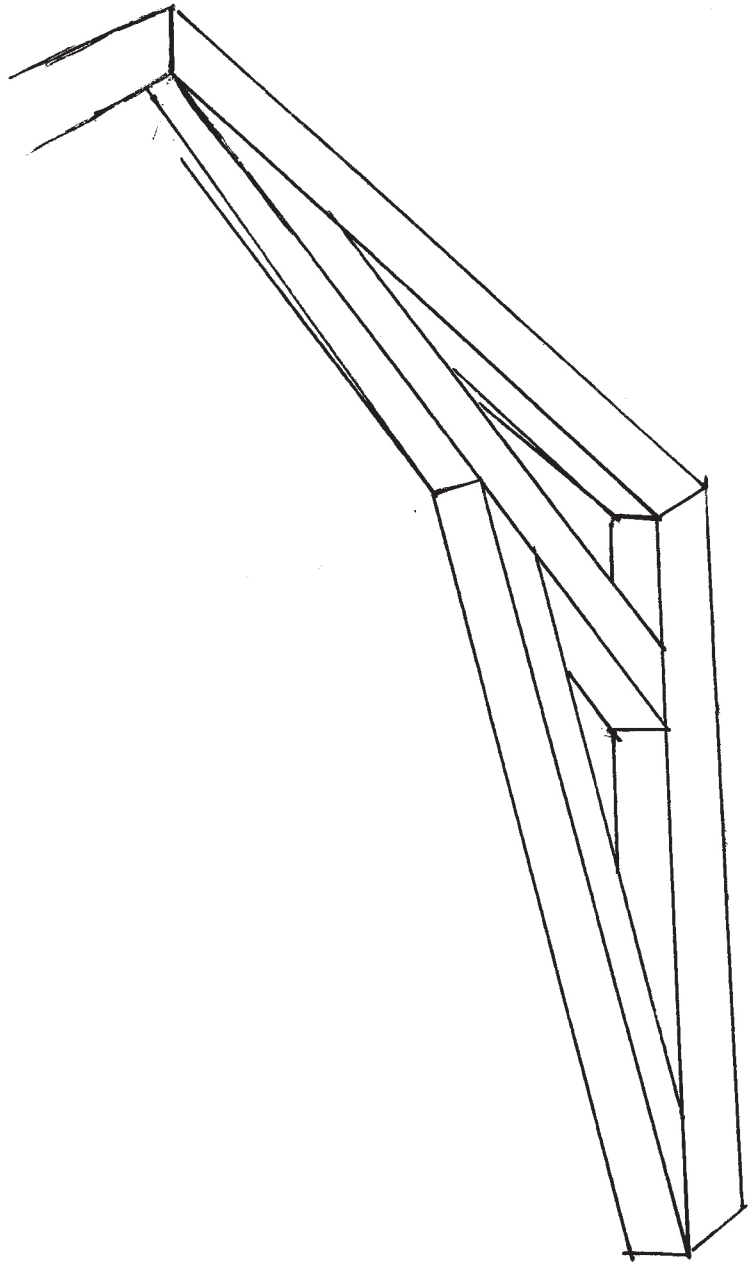
Foundation
10mm Plinth plaster
330x190 mm Leca insulation block
330mm concrete

Floor
100mm hard insulation
220mm concrete with floor heating
Radon barrier
2x 220mm hard insulation
220mm compressed sand deck

BUILDING DETAILS



The building envelope are design after estimated thicknesses of insulation for Building regulation 2020. The bearing elements are visible from the inside, which gives that the envelope and roof a placed outside the structure. Which makes it a light construction. The envelope design are also working as roof, for the continuous expression from outside.



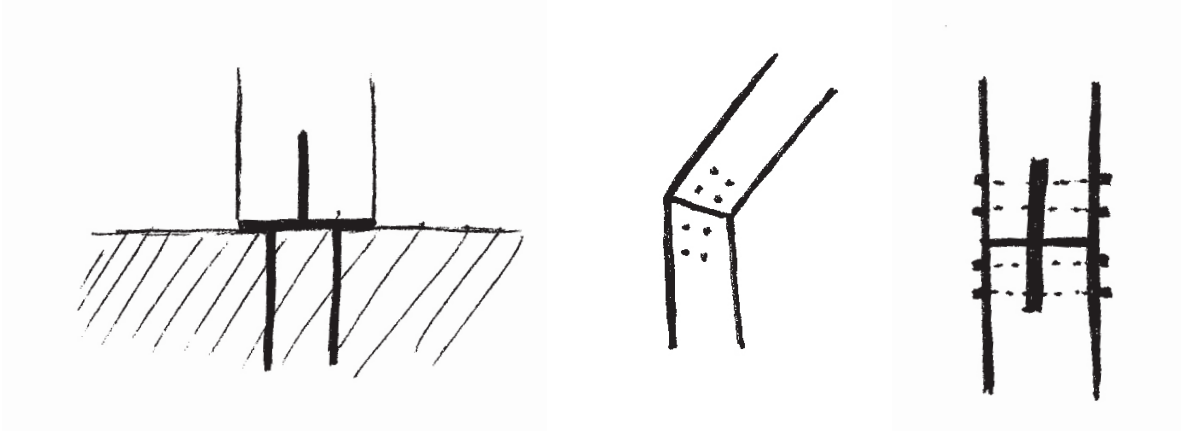
STRUCTURE AND JOINTS

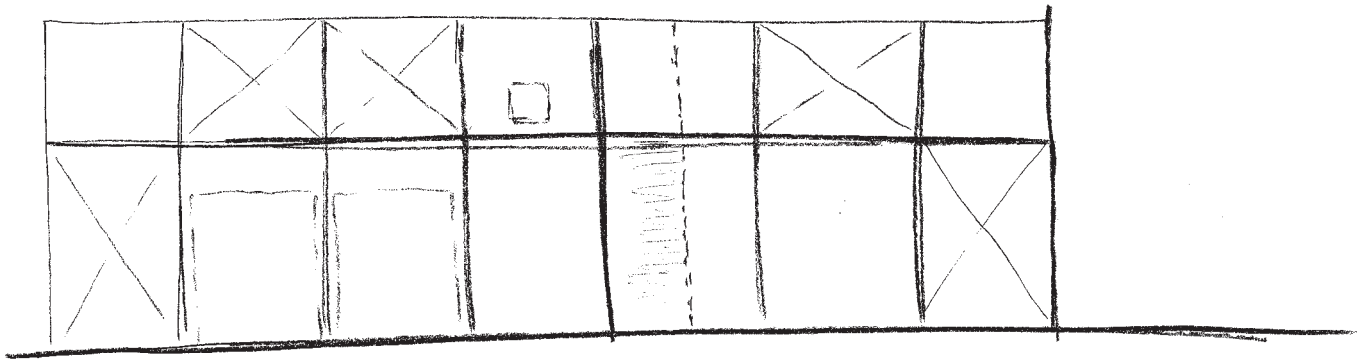
For the structural element, the focus is on the boat hall. The overall idea of the structure are from the traditional boathouses, but with adjustment to fulfil the physical criteria as the volume and height requirements.

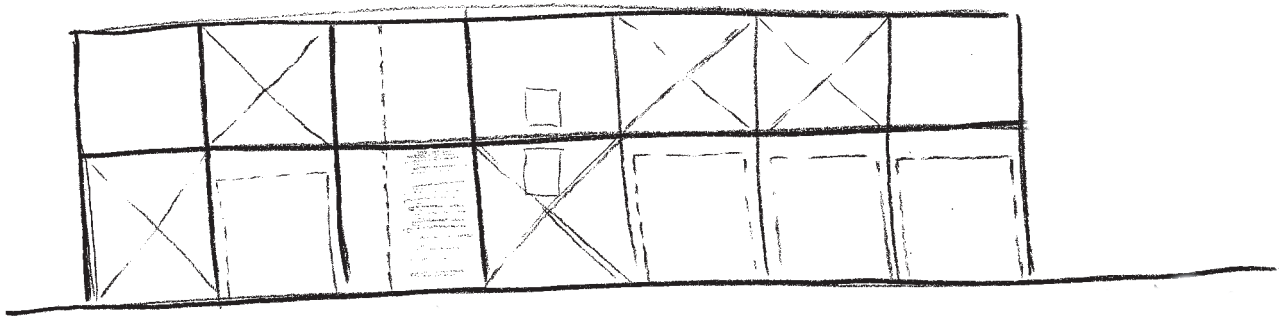
The structure are a frame structure with a crossed inner frame. The inner frame are to reinforce the outer frame elements, but it does also have an aesthetical purpose. Normally, frames with a distance of 2-3 meters would have been enough, because the entrance for the boats are in the gable. But in this design the boat gates are in the facades and therefore the span between frames are 9 meters, which means that the structure needs secondary elements that can help with the stability. Therefore there are implemented a trusses structure in the roof between transverse beams in the roof ridge and top walls. Along with winds cross the structure, are able to handle the large span. The frame structure are working as one element, while the trusses and beams are individual elements.

The material chosen for the structure are glue laminated, GL32h. this material are one of the highest in the class and are stronger than Construction wood. From an aesthetical point of view, it might have been more honest with construction wood, but the glue laminated along with the OBS boards makes it talk the same language of expression, and gives it the right roughness for the working area.

The joints between each element are a steel plate, which is placed in the end of the elements, in a cut out grove and fixed by bolts. This principle are a simple and elegant solution, it does not disturb the structure and makes it look like one whole element, only revealed by the thin lines of steels and the bolts. The same principle are used in the joint between frame and ground.







There have been made some hand calculations on one of the most critical elements. Because of the large span between the frames, the most critical element is estimated to be the transversal beams.

By the calculation of loads [Annex A], the beam dimensions can be calculated. The values that are affecting the beam are the loads; dead load, the snow load and the wind load, in the load combination the snow load are the dominating load.

The calculated loads are:

Dead load of roof	3.70kN/m and 0.3kN/m2
Dead load of beam	7.76kN/m and 0.86kN/m2
Snow load	11.43kN/m and 1.27kN/m2
Wind load	10.90kN/m and 0.883kN/m2
Total load combination	33.51kN/m and 3.723kN/m2

There are two results as the kN/m is for one element and is used in the calculation of dimensioning the beam. The kN/m2 are used in calculation of the whole structure, this is calculated in the FEM program "Robot"

In the calculation of the beam dimension, it is necessary to know the "Serviceability limit state, SLS", which is the comfort factor of the maximum displacement of the element. In addition, the "Ultimate limit state, ULS", which is the maximum number of displacement before the element breaks. The calculation can be found in Annex B

The result of dimensioning the beam is 1000x185x9000mm

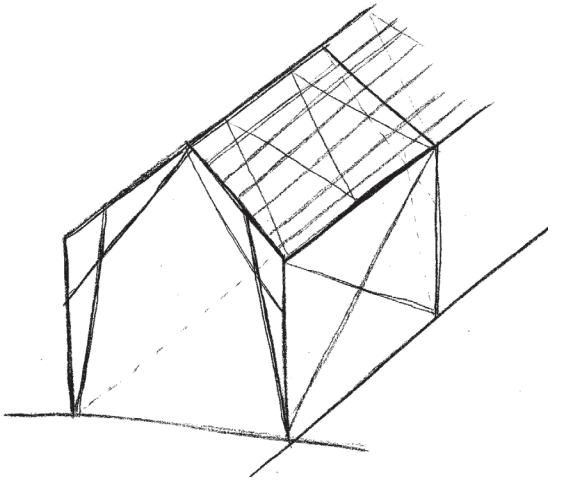
Another calculation that could have been made where the column dimensioning, but in this case the columns are a frame structure and therefore the result would be misleading. The frame structure are working as one whole element and thereby each elements are benefitting from each other. That is the reason for why the column would be "over dimensioned".

In order to calculated and understand the whole structure, and see how the elements are working together. The structure are built in "Grasshopper", which is a plugin program for "Rhino". The program gives a visual impression of how the forces are affecting the structure, by tension and compression.

This model is imported to the program "Robot", where the exact results can be extracted, and all the elements of the structure will be dimensioned according to the ration. The ration indicates how used the elements are, the closer to one the better, $0.1 < \text{ratio} < 1$. This means that if on element are 0.9 it is best possible utilized.

Dimensions of elements extracted form Robot:

Beam: 1200x185x9000mm
Outer frame: 900x185x8000/1082mm
Inner frame 600x185x9760/1204mm
Trusses: 900x185x1112mm
Wind cross: 40x40(x4) x1303mm



CONCLUSION

The challenge of designing an attractive area with functions that pleases the users and visitors. IT should be a design where the sailors can feel like home and the citizens can feel welcome. It is all about using the qualities of the site to create an area with room for diversity. There are different types of sailors and they all have different need and wants, the same counts for the citizens that have different criteria for the use of the harbour area.

The key point from the beginning and have been continuously throughout the project. It is principle of the traditional boathouse, which have the functional aspect as a main principle along with the constructional perspective, this relates to the Nordic architecture. The honesty in construction and materials have also been condition from the beginning. Further, the point of helping people to interact, are important, the idea was to create an area where the sailor society belongs but where the citizens a welcomed, it demands the acceptance of diversity and promote the life along the water even more than it is today. It should be an experience every time the visitors entering the project site, no matter the reason and background for visit.

The solution to the design parameters became a simple and easy readable plan, where the material and shape of the buildings are continuously, with a twist of individual identity and expression, enforced by the hierarchy according to public or semi-public. The materials are in contrast between the exterior and the interior. Outdoor the material are strict vertical wood cladding and hard concrete that are soften by the wild growth Lyme grass in the groves. This stands in a contrast to the inner core, where the walls a having a warm and soft wood, and a soft looking concrete are used for the flooring and core of the building.

The idea is to soften the barrier between the city and the water, by designing rooms that can be multi-functional, both indoor and outdoor. The main multi-functional building are the boat hall with the surrounding area. The purpose of the boat hall is that in the periods where it is not used for storage of boats, it will transform to cultural house, with room for markets, concerts, theatres or town festivals. The large gates will transform the enclosed indoor to an open and functional outdoor area.

REFLECTION

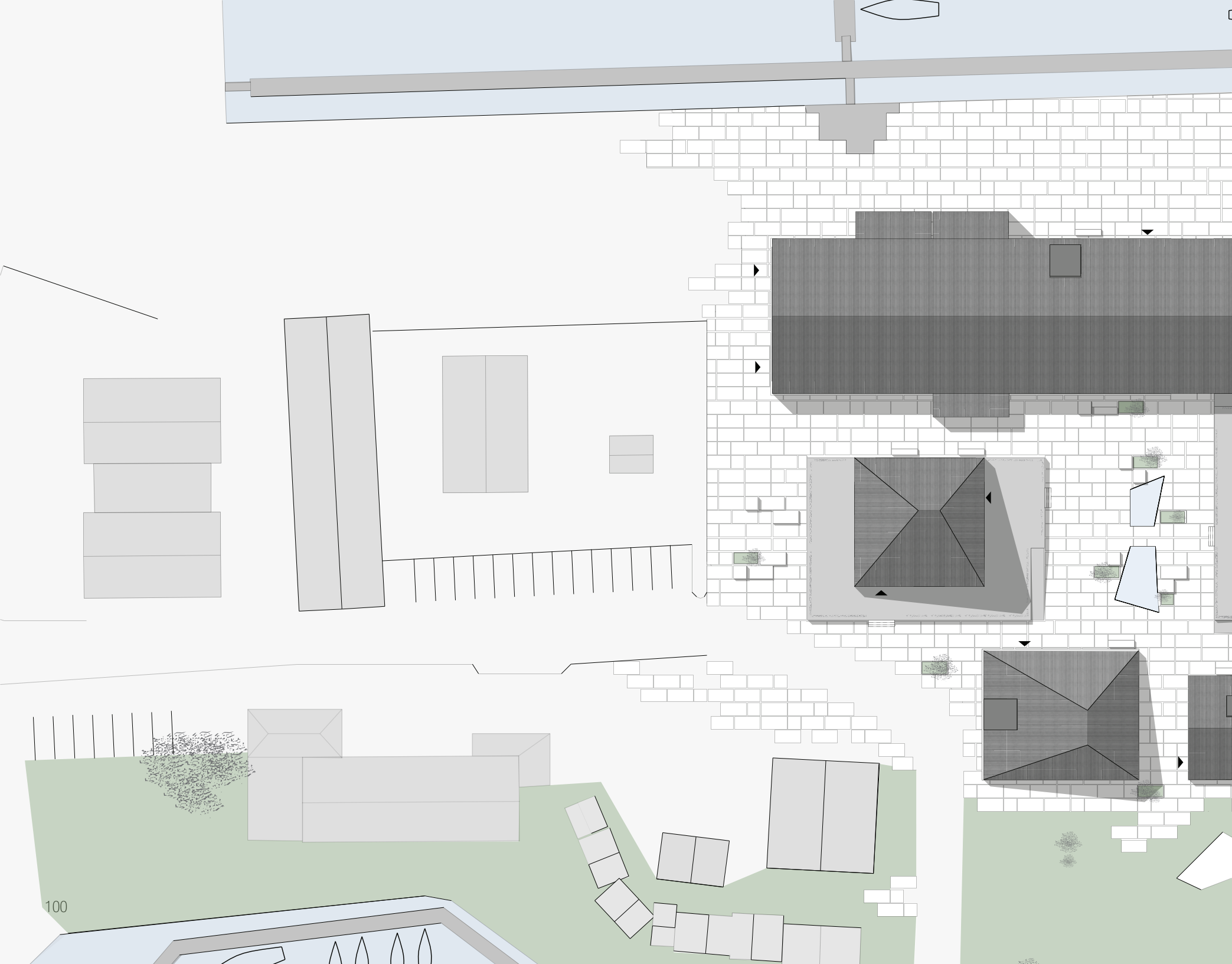
When reflecting on the project, there may be areas that needs more work, if there had been more time, and the focus were extended to a more general sustainable approach. Where the focus would be passive strategies in relation the daylight factor and indoor climate. Combined with hybrid ventilation and with the concrete core as a centre element in the solution.

Another design element that would have added quality to the first floors i When reflecting on the project, there may be areas that needs more work, if there had been more time, and the focus were extended to a more general sustainable approach. Where the focus would be passive strategies in relation the daylight factor and indoor climate. Combined with hybrid ventilation and with the concrete core as a centre element in the solution. In this term, the windows are also an important factor to implement, especially when they are so large, the focus will be on how to open them. In addition, the shading should be incorporated in the overall design and become a part of the external wall, with the same principle as the boat hall gates.

Another design element that would have added quality to the first floors in the building is balconies. Balconies would be a semi private are, connected with the semi-private first floors. Further, the gables of the duo pitched roof have even more potential to become two storeys, and dividing the large uniform wall.

The last thing work further one would be the structure in the quarter pitched roofs. They should be designed with similar considerations as the duo pitched buildings. The design should be in a way so that the felling and experience of the room became even more in human scale, so that the visitors are finding it easier to relate to the shape, expression and feeling of the place.
n the building is balconies. Balconies would be a semi private are, connected with the semi-private first floors. Further, the gables of the duo pitched roof have even more potential to become two storeys, and dividing the large uniform wall.

DRAWINGS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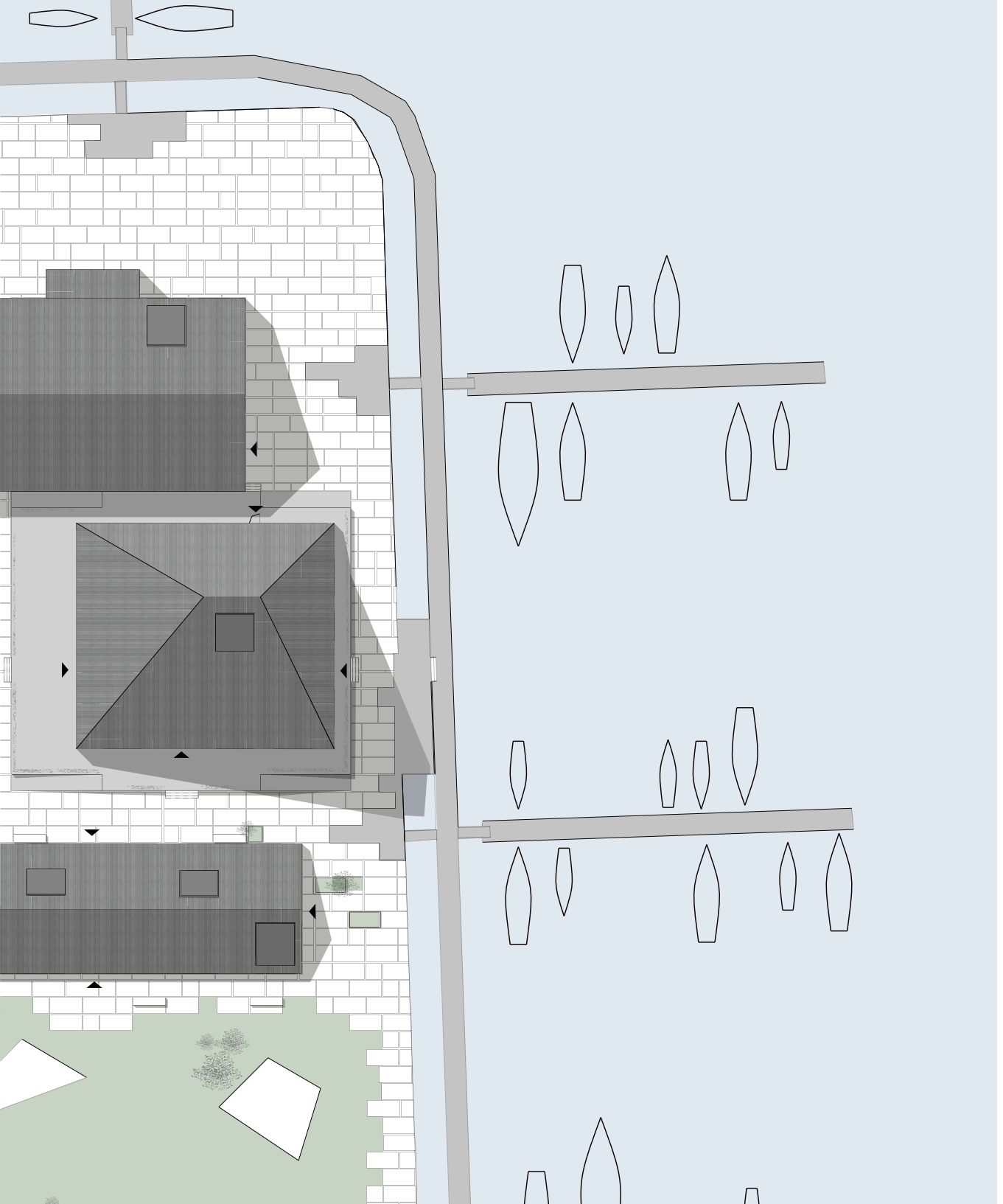
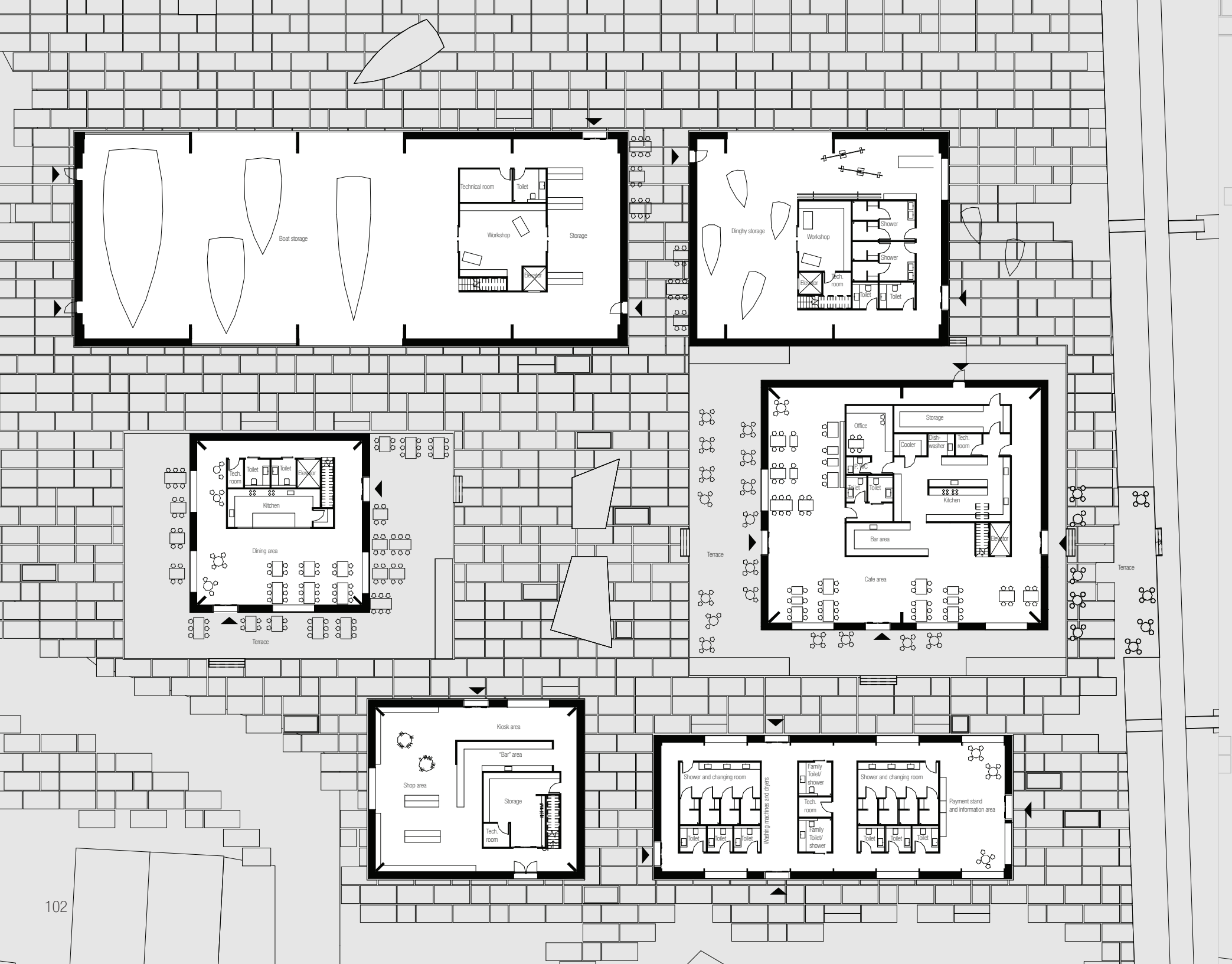
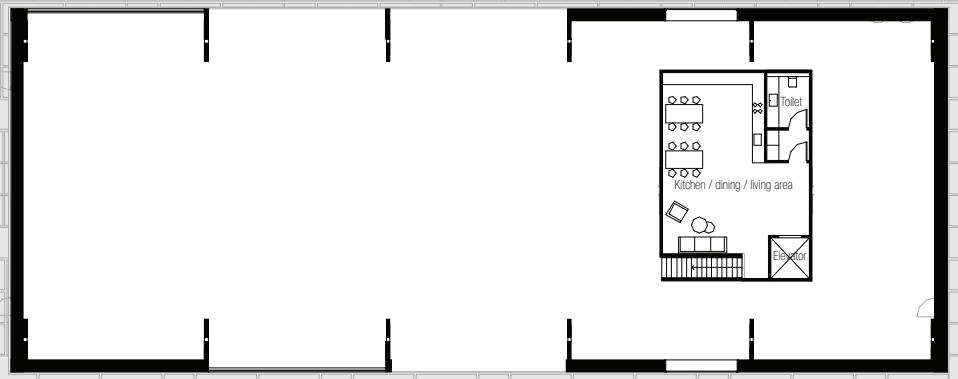
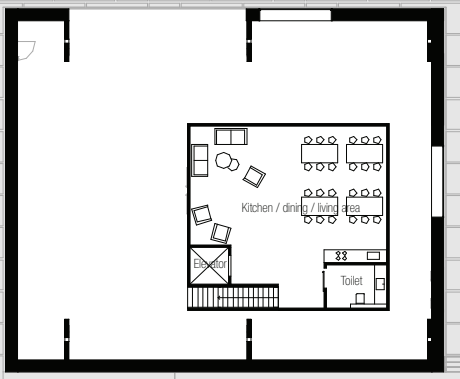
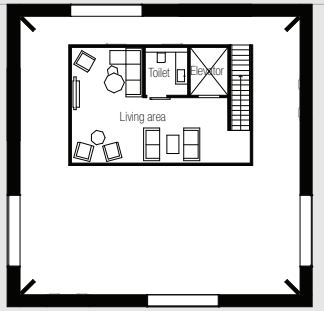
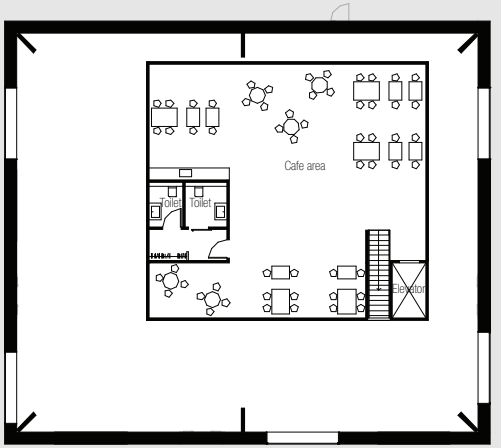


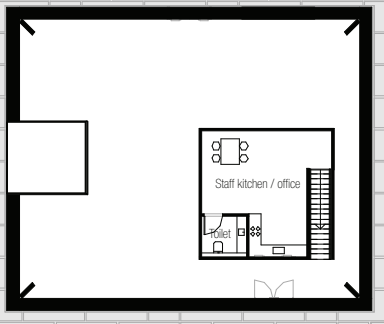

Boat storage
Technical room
Toilet
Workshop
Storage
Elevator
Dinghy storage
Workshop
Shower
Shower
Elevator
Tech. room
Toilet
Toilet
Tech. room
Toilet
Toilet
Elevator
Kitchen
Dining area
Terrace
Office
Storage
Cooler
Dish-washer
Tech. room
P. WC
Toilet
Toilet
Kitchen
Bar area
Elevator
Cafe area
Terrace
Terrace
Kiosk area
"Bar" area
Shop area
Storage
Tech. room
Shower and changing room
Toilet
Toilet
Toilet
Washing machines and dryers
Family Toilet/ shower
Tech. room
Family Toilet/ shower
Shower and changing room
Toilet
Toilet
Toilet
Payment stand and information area

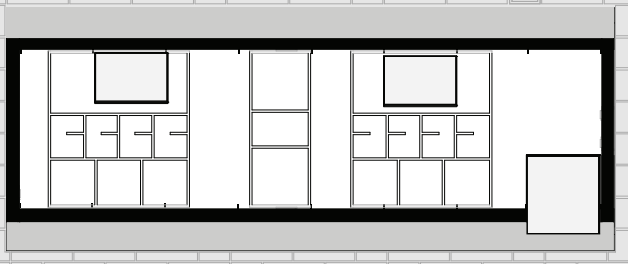

Toilet
Kitchen / dining / living area
Elevator

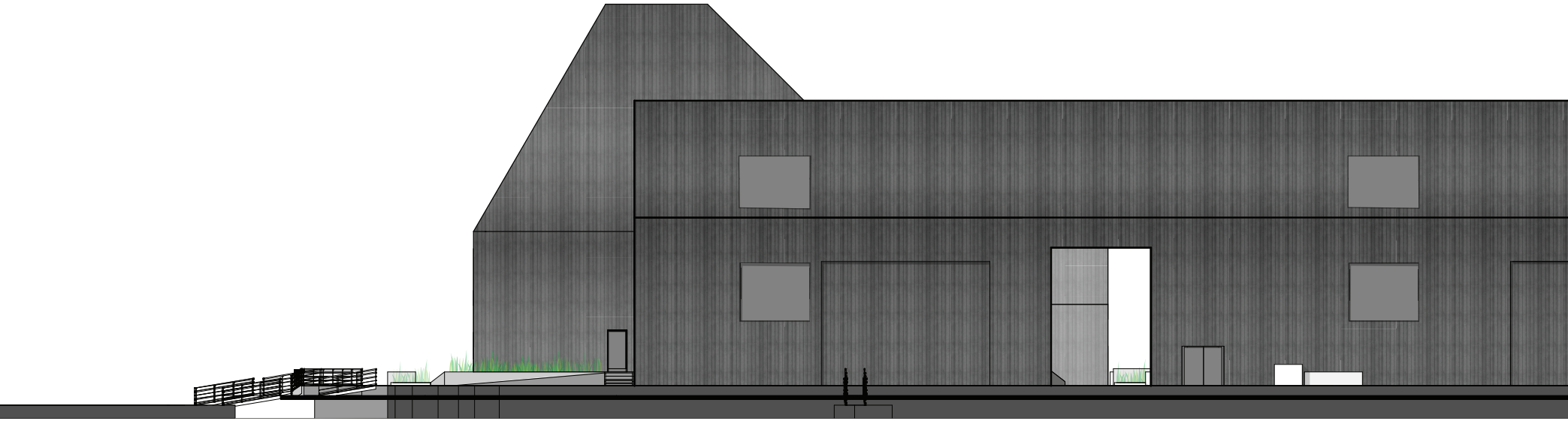

Kitchen / dining / living area
Elevator
Toilet

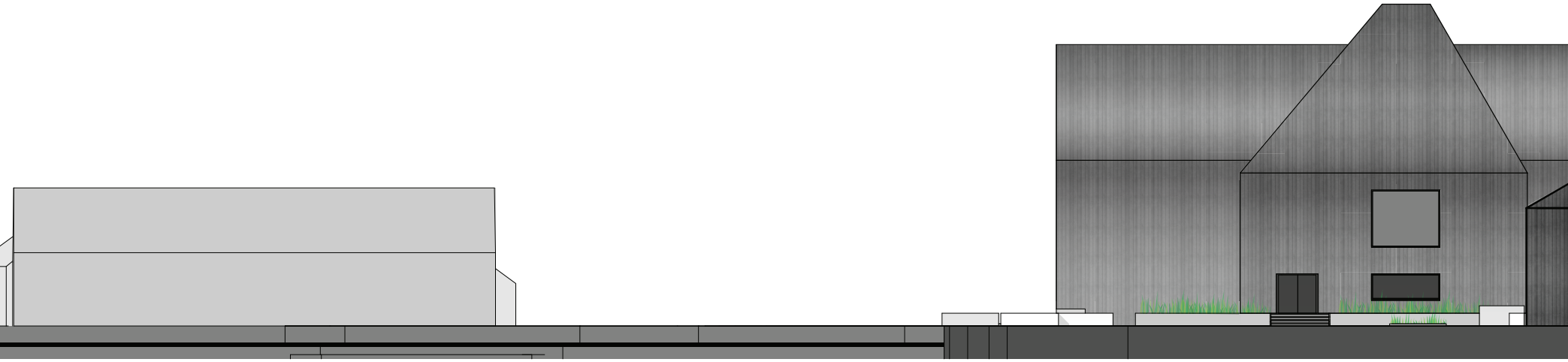

Toilet
Elevator
Living area

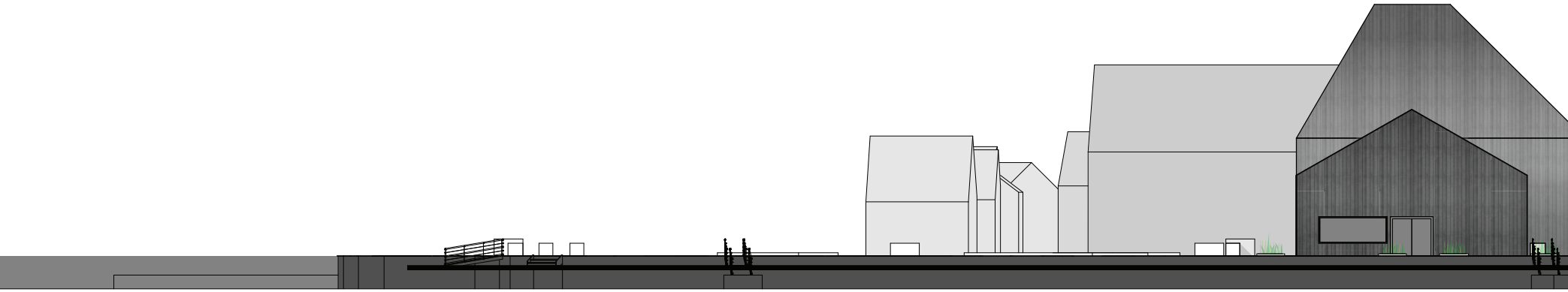

Cafe area
Toilet
Toilet
Elevator

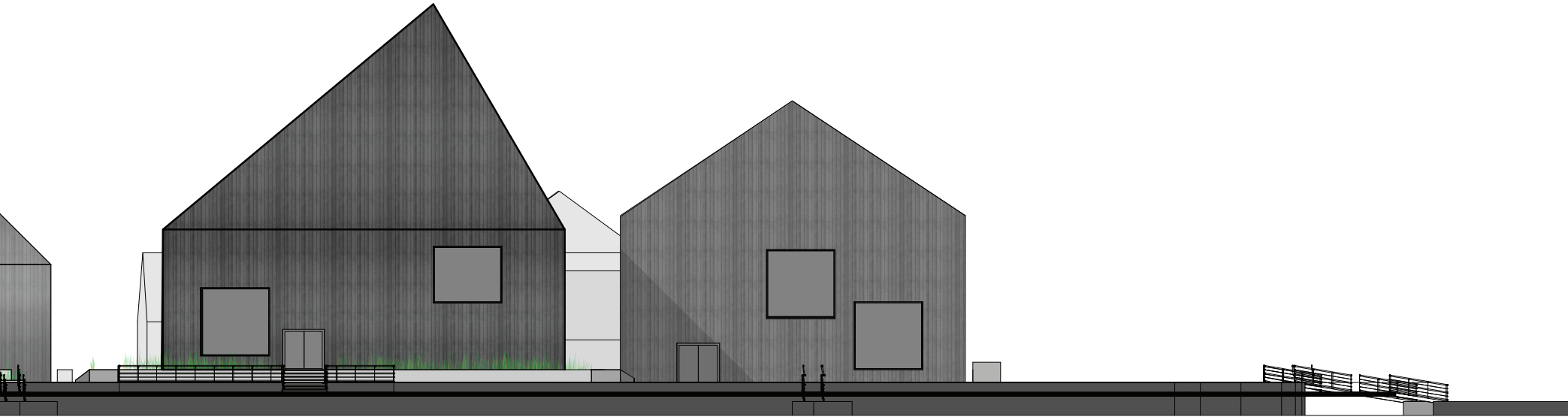

Staff kitchen / office
Toilet

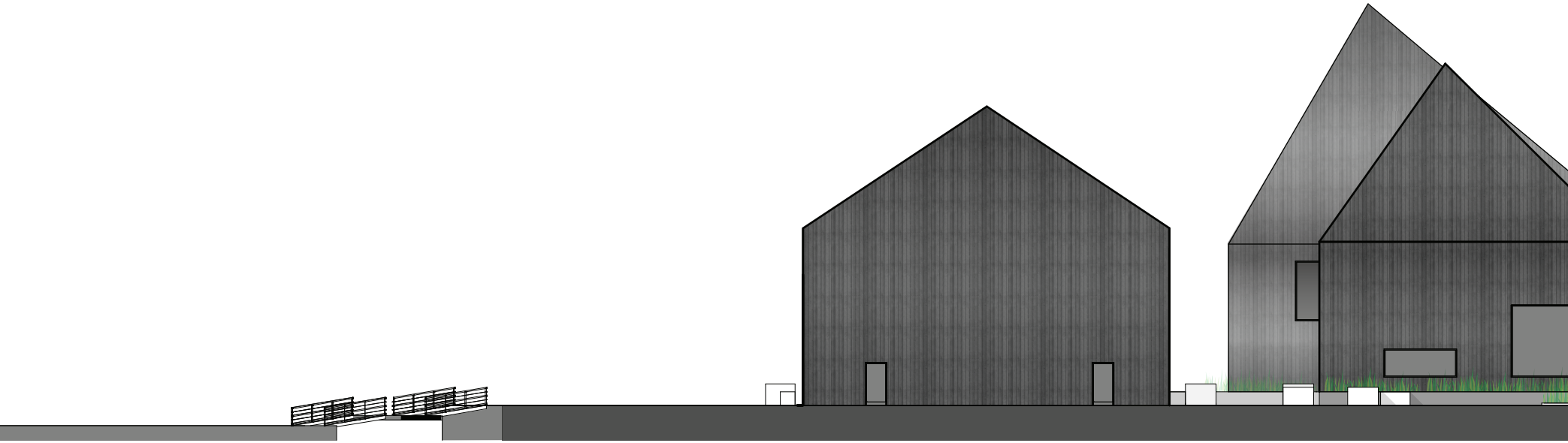


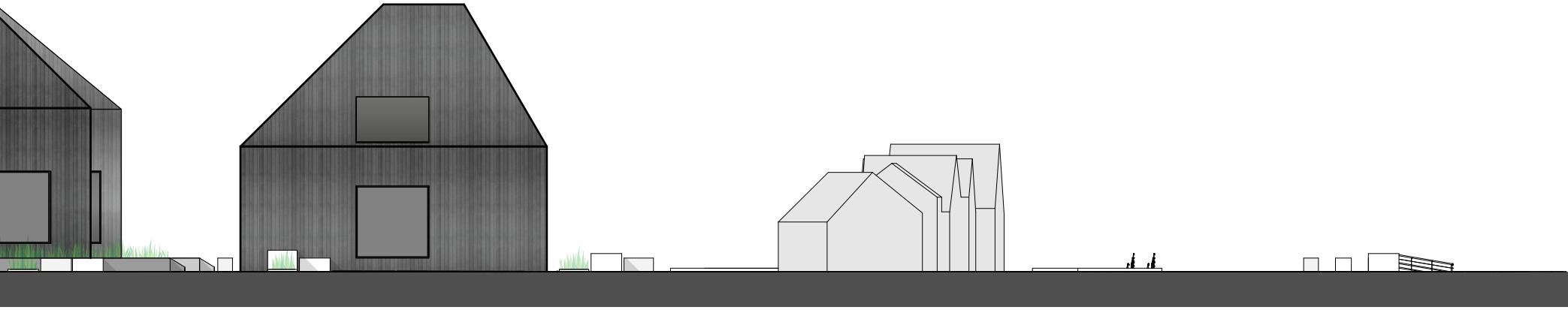


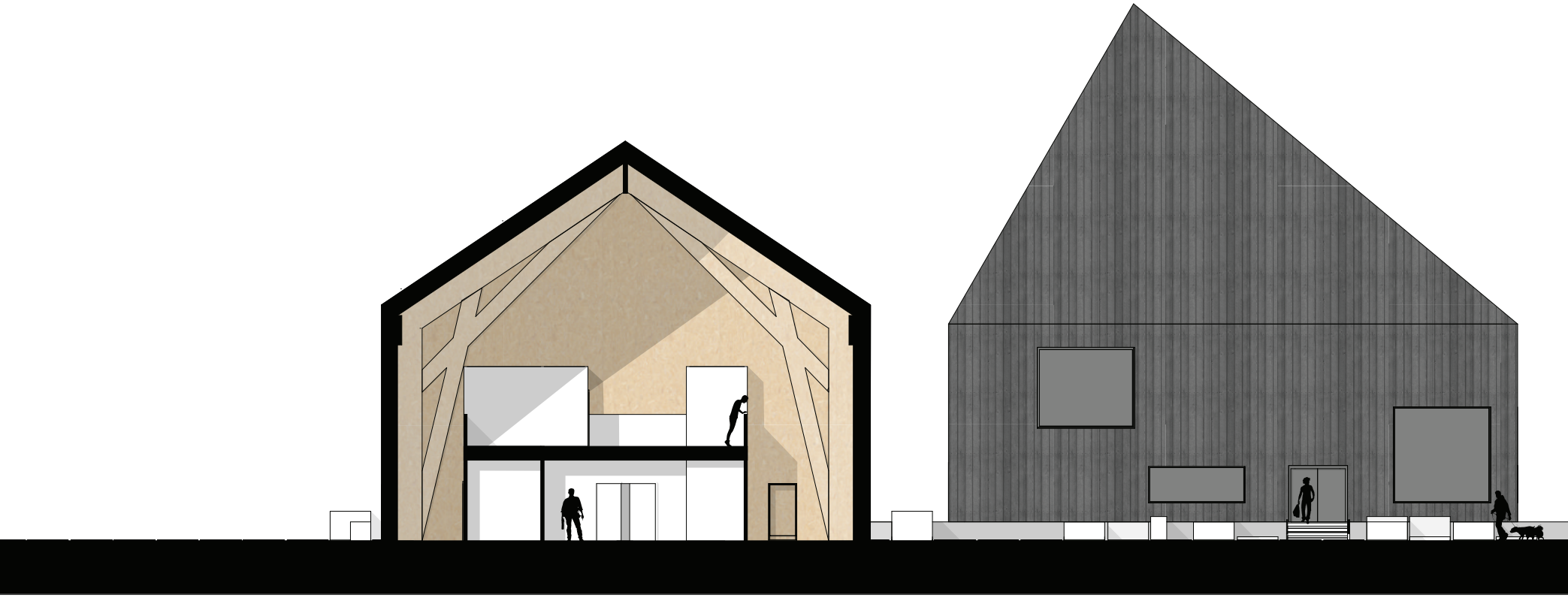


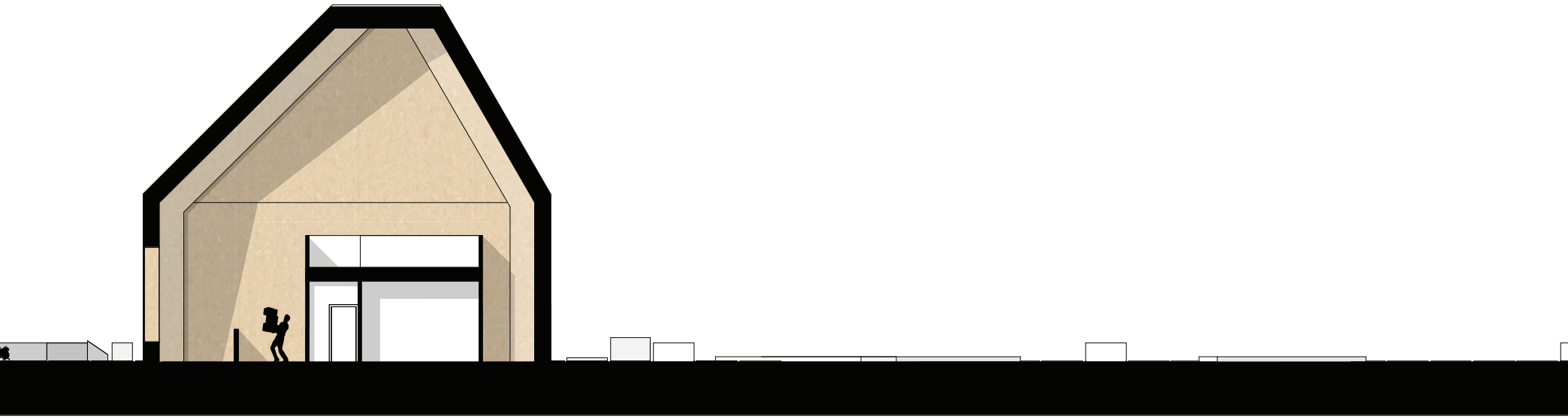


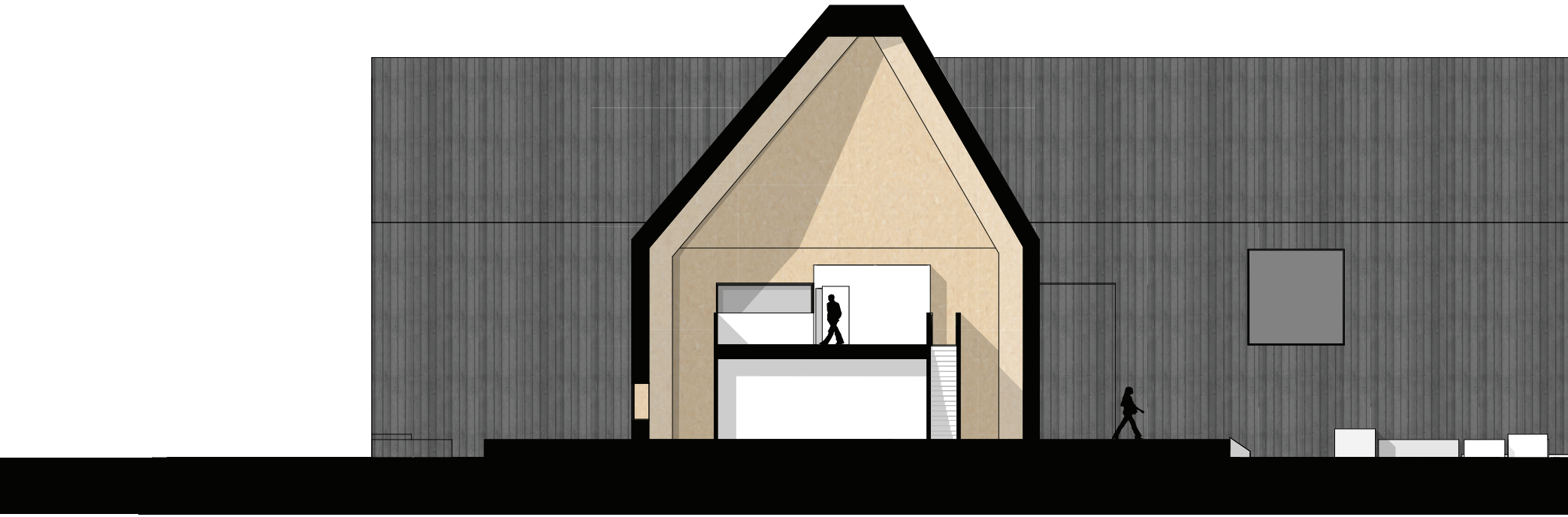


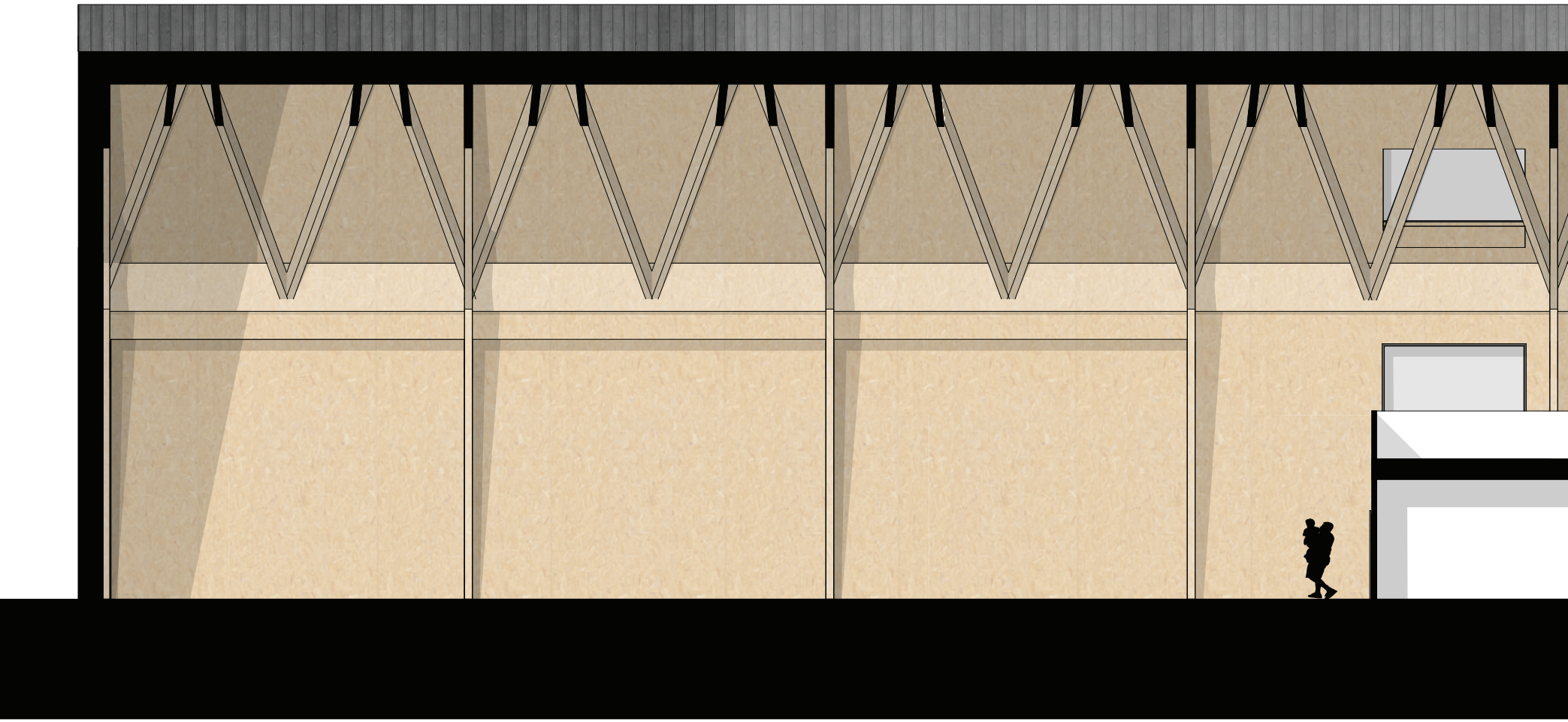


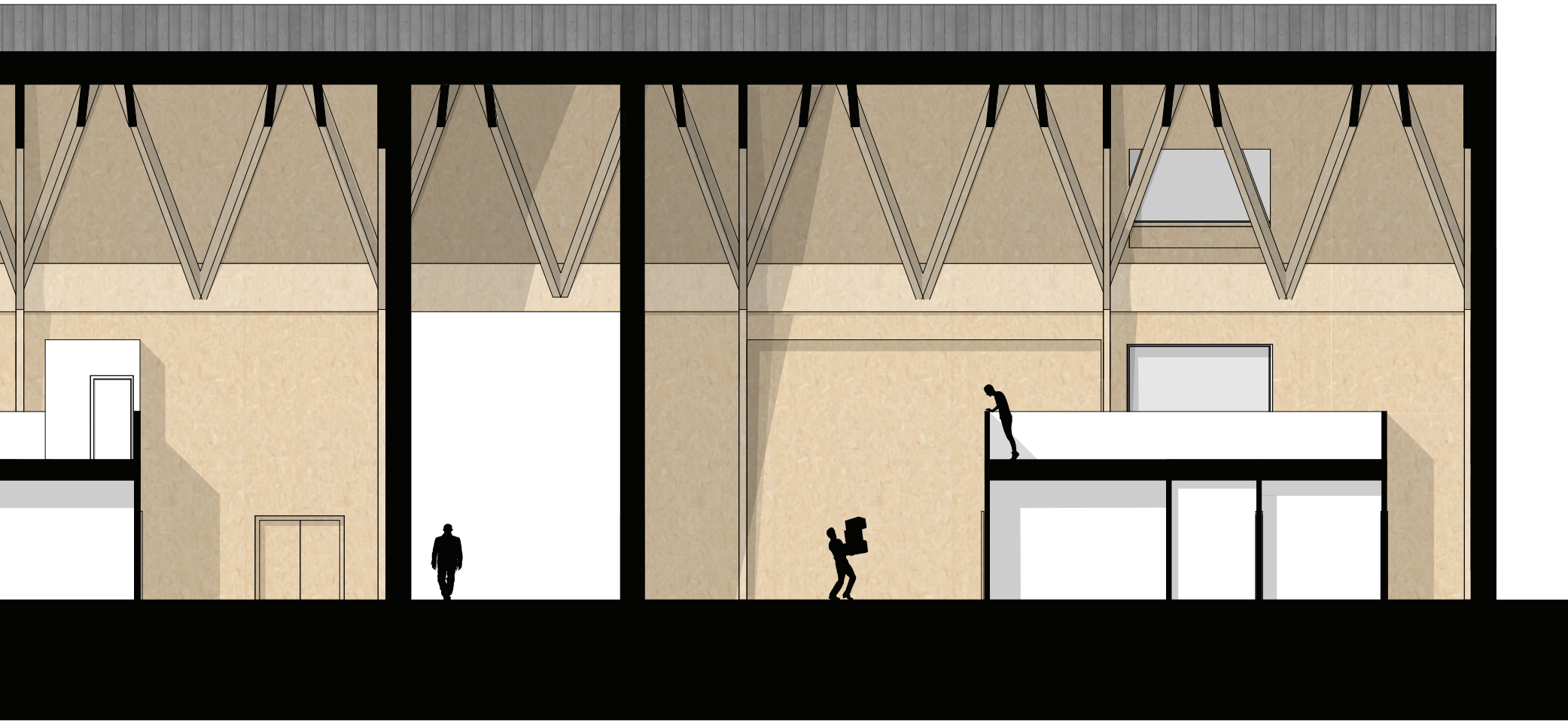


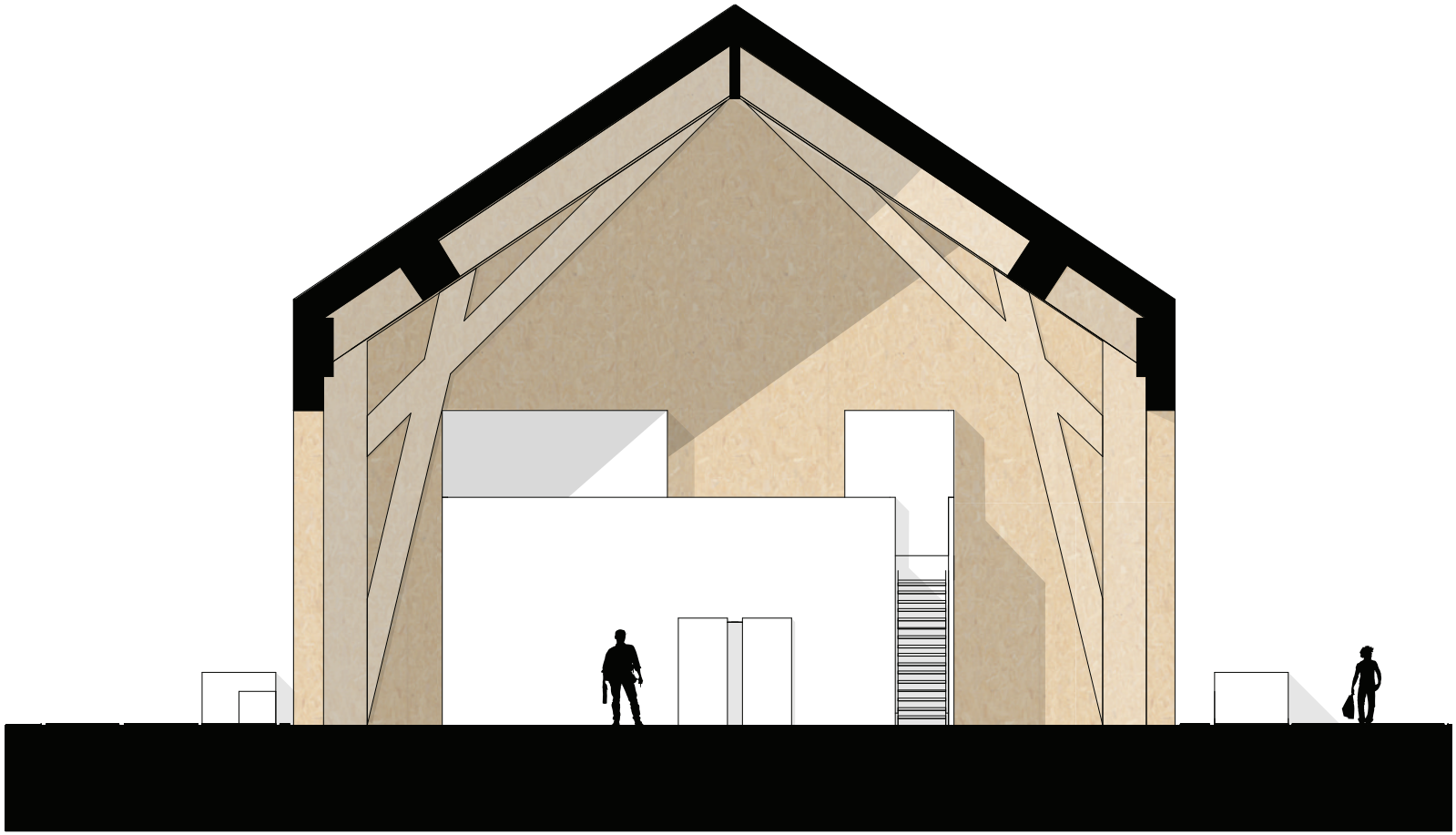


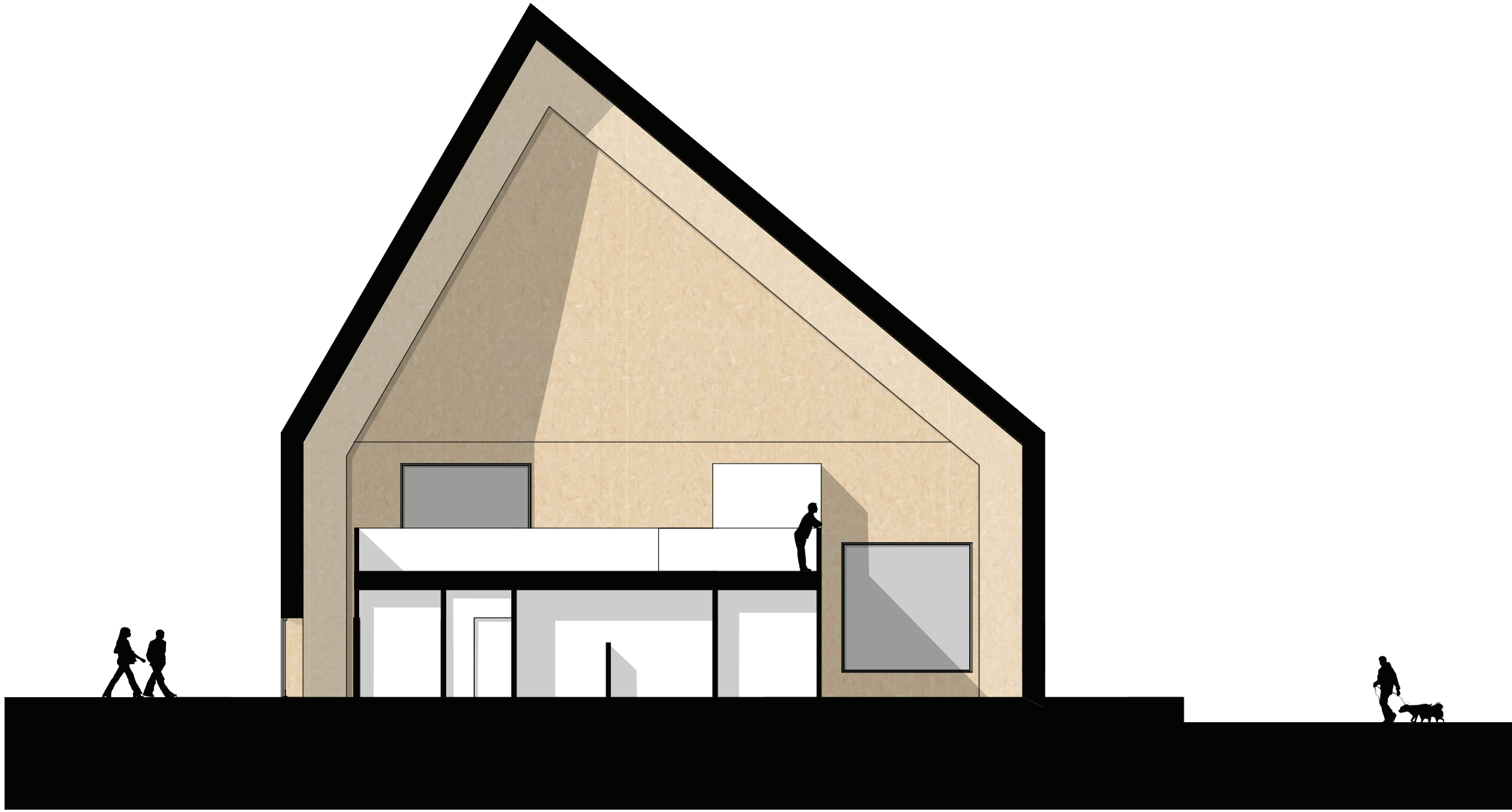












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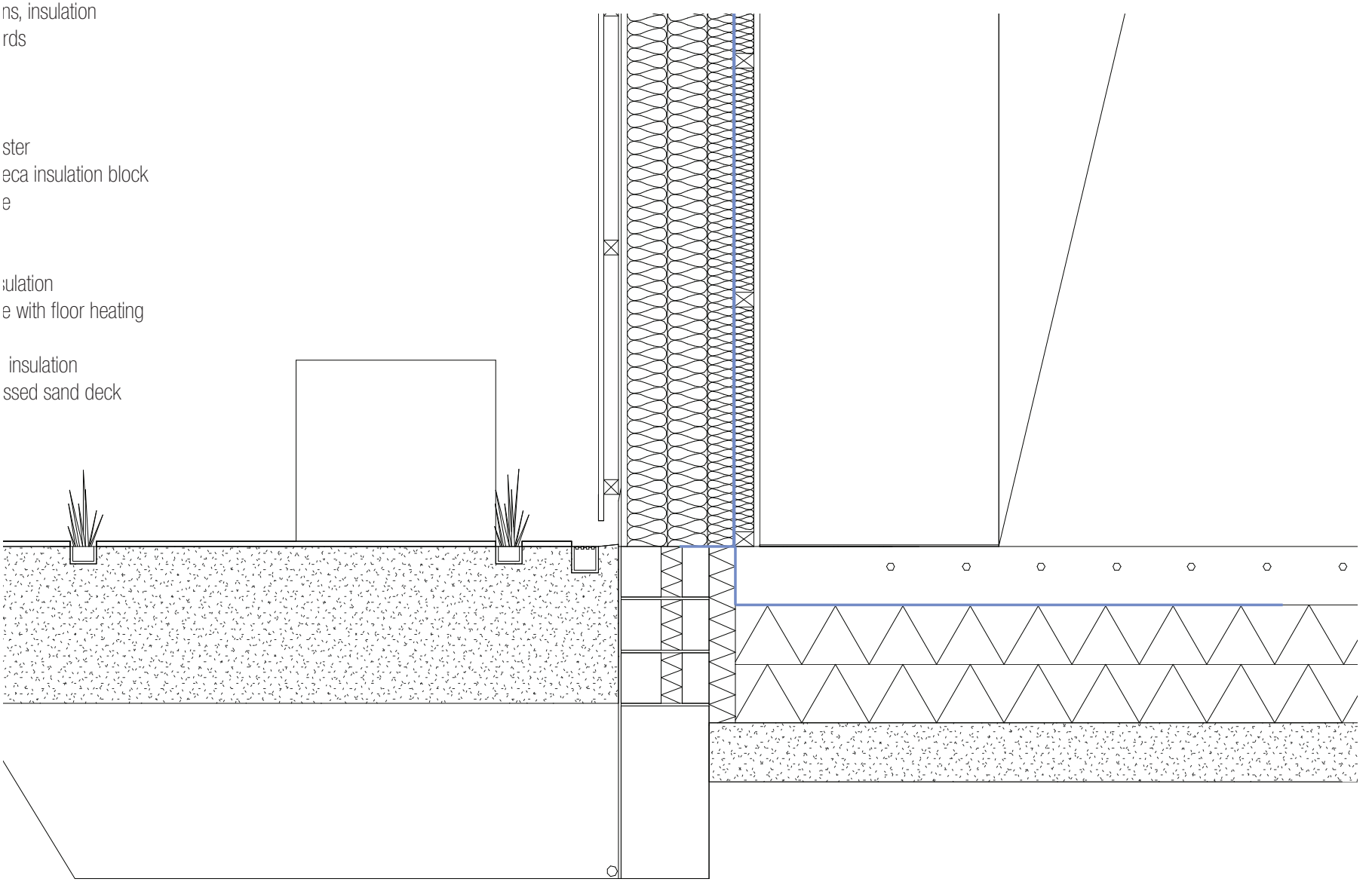

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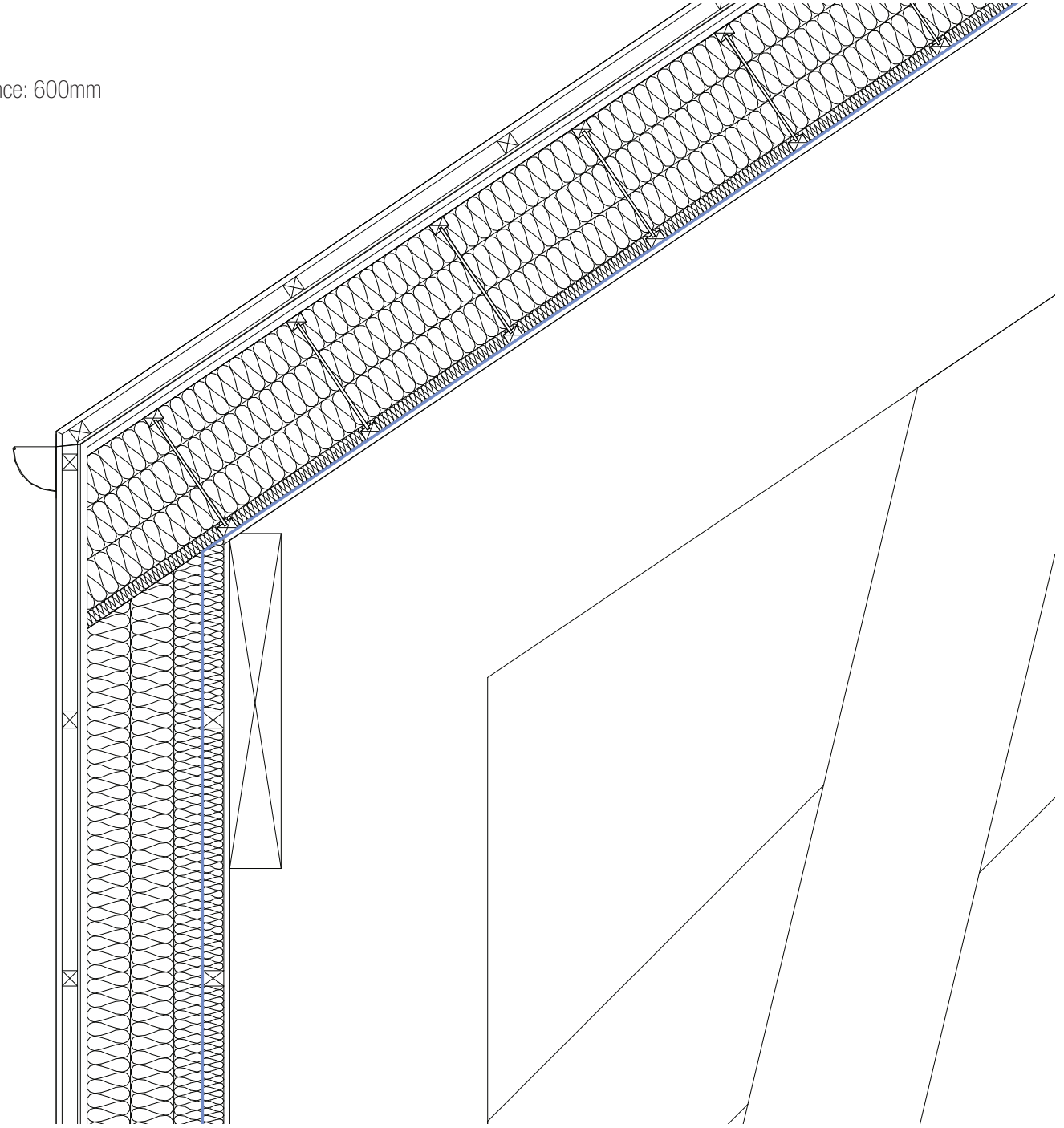

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ILLUSTRATIONS

Unless otherwise is noted, the illustrations are the authors own.

Ill. 01.1 Methodology , IDP
Ill. 01.2 - 01.8 Nordic architecture inspiration
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http://hdrcreme.com/photos/35725-An-old-boathouse
http://inhabitat.com/striking-rustic-boathouse-made-with-re-

claimed-materials-in-norway/naust-paa-aure-by-tyin-tegnestue-5/
http://www.greenstylegallery.com/attractive-wooden-boat-old-style-summer-house-design-in-norwegian/relaxing-nuance-inside-furniture-for-living-room-small-space-wooden-boat-house-near-river-in-norwegian/

Ill. 01.9 Vitruvius triangle
Ill. 01.14 - 01.19 Spatial Inspiration
http://www.dailyarchdesign.com/home-decoration/remodelista/
http://pioneermillworks.com/galleries/restaurant-gallery
http://www.dailyarchdesign.com/home-decoration/remodelista/
http://www.christopher-egan.com/projects/hamilton-park-west
http://www.greenstylegallery.com/attractive-wooden-boat-old-style-summer-house-design-in-norwegian/relaxing-nuance-inside-furniture-for-living-room-small-space-wooden-boat-house-near-river-in-norwegian/
http://www.vermonttimberworks.com/wp-content/uploads/2013/07/educational-billings-farm-lobby2.jpg
http://www.christopher-egan.com/projects/hamilton-park-west

Ill. 01.20 Sustainability Inspiration
Ill. 01.23 - 01.28 Pictures from a sailors life

Ill. 01.29 Air foto of the harbor area
http://www.thisted.dk/~/media/Tekniskforvaltning/sekretariat/pdf/kortinfofiler/skraafotos/thisted_havn/09%2007%202010%20057%20jpg.ashx

Ill. 01.30 - 01.35 Context diagrams
Ill. 01.36 Sun angle during the year
Ill. 01.37 Sun angle at 9 am
Ill. 01.38 Sun angle at 12am
Ill. 01.39 Sun angle at 3pm
Ill. 01.40 Wind rose,Thisted
http://thymoellen.dk/vindens-energi-lidt-vindteori/vindrose/

Ill. 01.41 Climate scheme per month. Thisted
Ill. 01.42 View over Limfjorden. Thisted
Ill. 01.43 - 01.48 Thisted Marina
Ill. 01.49 Air foto of the cargo pier as it is today
http://www.thisted.dk/~/media/Tekniskforvaltning/sekretariat/pdf/kortinfofiler/skraafotos/thisted_havn/09%2007%202010%20073%20jpg.ashx

Ill. 01.50 -01.56 Pictures from the cargo pier, the place
Ill. 01.57 - 01.60Horsens marina clubhouse

https://plus.google.com/photos/105991280081994355527/albums/5986674992648229889/5986675355936973890?authkey=CO2zseTX6OSCmwE&pid=5986675355936973890&oid=105991280081994355527

https://plus.google.com/photos/105991280081994355527/albums/5986674992648229889/5986675329017980818?authkey=CO2zseTX6OSCmwE&pid=5986675329017980818&oid=105991280081994355527

Ill. 01.61 - 01.62 Functions program
Ill. 01.63 - 01.64 Functions program

Sketches and illustrations in Presentation, Detailing and Annex are the authers own.

ANNEX

ANNEX A

LOAD CALCULATIONS

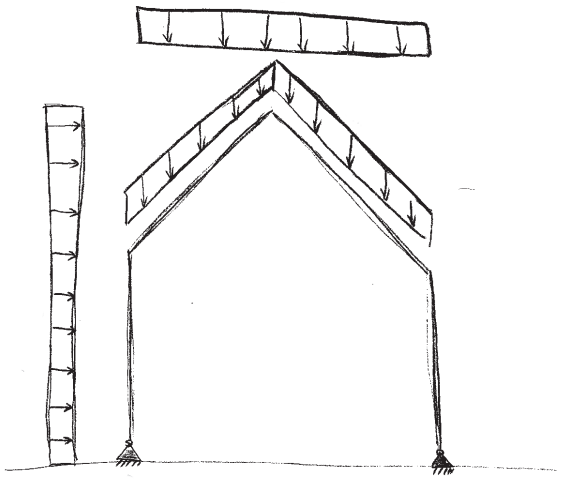
Help from Euro code 1991 1-4 makes the following calculations and the related annex, also Teknisk Ståbi have be used for looking up values. The Load combination are made with the dead load, snow load and wind load.

Basic Information of the beam:

Number of elements (beams) in building length, $N_{elements}$ 7

Length of each beam, 9000mm

Total length of building, $l_{total,build}$ 72000mm



Dead load of roof P_{roof}

Information to further calculation:

Self-load for light roof are estimated to 0.3kN/m2

Length of roof over element, l_{roof}10800mm

Area of half roof

$A_{1/2roof} = l_{total,build.} \cdot l_{roof}$ 777.6m^2

Dead load of half roof,

$P_{1/2roof} = A_{1/2roof} \cdot 0.3kN/m^2$ 233.28kN/m

Roof area over element,

$A_{roof,element} = A_{1/2roof} \cdot N_{elements}$ 111.09m^2

$P_{roof,element} = A_{roof,element} \cdot 0.3kN/m^2$ 3.70kN/m

$P_{roof,total} = (A_{1/2roof} \cdot 2) \cdot 0.3kN/m^2$ 51.84kN/m

Snow load, P_{snow}

Information to further calculation:

Form factor, μ_i 0.8

Exposing factor, recommended, C_e

1

Thermal factor, recommended, C_t

1

Characteristic terrain value, recommend 0.9kN/m^2

$S_0 = \mu_i \cdot C_e \cdot C_t \cdot sk$ 0.72kN/m^2

Total snow load of half the roof

79.98kN/m

Total snow load on element, $S_{0,element}$

11.43kN/m

Total snow load on roof, $S_{0,roof}$

79.98kN/m

Which gives a total of 1.27kN/m^2

Wind load, P_{wind}

Calculation of Basic wind speed, Mean wind velocity, Wind turbulence, Peak velocity pressure, wind pressure on surface and wind forces.

Basic wind speed, v_b

$$v_b = C_{dir} \cdot C_{Season} \cdot v_{b0}$$

EC 1991 1-4 page 18, formula (4.1)

Information to further calculation:

Wind speed, according to distance to the sea, 24m/s for all of Denmark, unless the area are less than 25km from the sea, then it is 27m/s, v_{b0}.

Direction factor (VSV), C_{dir}

0.9

Season factor, (March / October) C_{season}

0.9

$v_b = C_{dir} \cdot C_{Season} \cdot v_{b0}$ 21.87m/s

Mean wind speed, $v_{m(z)}$

EC1991 1-4, page 19 formula (4.3) and (4.4)

$$v_{m(z)} = C_{r(z)} \cdot C_{0(z)} \cdot v_b$$

Information to further calculation:

Orography factor, recommended, C_0

1

Roughness factor, $C_{r(z)} = k_r \cdot \left| \frac{z}{z_0} \right|$

Building height, z 12m

Terrain factor, depending on z_0, $k_r = 0.19 \cdot \left(\frac{z_0}{z_{0,II}} \right)$

Roughness length, $z_{0,II}$ (constant) 0.05m

Roughness length, z_0 0.05m

Minimum height, z_{min} 2m

Maximum height, z_{max} 200m

EC1991 1-4 page 20, table 4.1

$k_r = 0.19 \cdot \left(\frac{z_0}{z_{0,II}} \right)$ 0.19

$C_{r(z)} = k_r \cdot \left| \frac{z}{z_0} \right|$ 1.04

$v_{m(z)} = C_{r(z)} \cdot C_{0(z)} \cdot v_b$ 22.77m/s

Wind turbulence, $I_{v(z)}$

$$I_{v(z)} = \frac{\sigma_v}{v_{m(z)}} = \frac{k_l}{\left(C_{o(z)} \cdot \left| \frac{z}{z_o} \right| \right)}$$

Information to further calculation:

Turbulence factor, k_l

1

Orography factor, recommended, C_0

1

Roughness factor, z_0

0.05

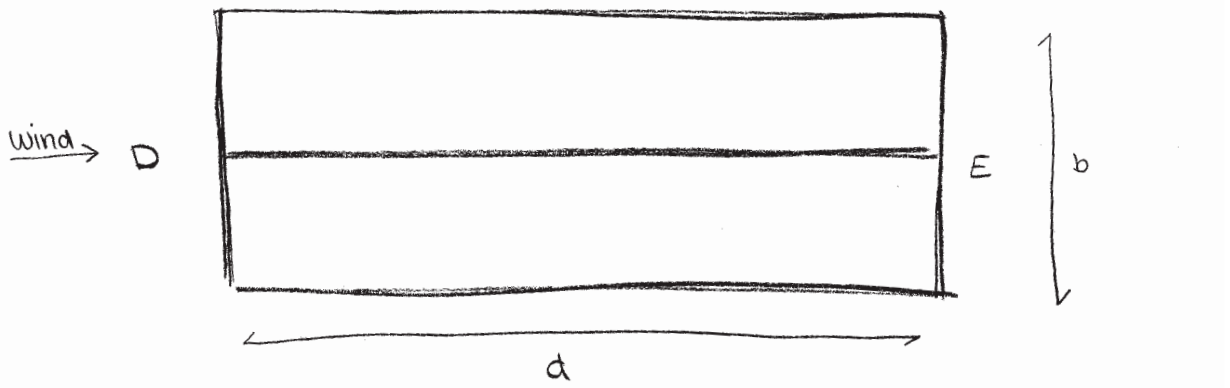
National annex and EC1991 1-4, page 19

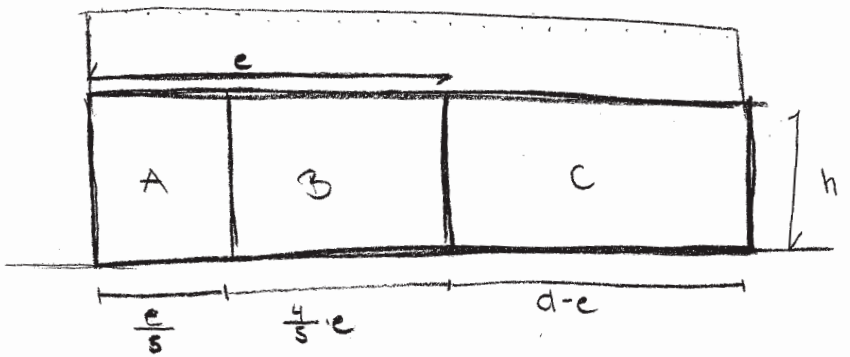
Standard deviation, $\sigma_v = k_r \cdot v_b \cdot k_l$ 4.16

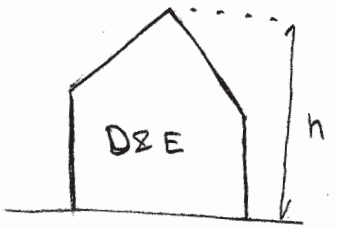
$\frac{\sigma_v}{v_{m(z)}}$ 0.18

$$I_{v(z)} = \frac{\sigma_v}{v_{m(z)}} = \frac{k_l}{\left(C_{o(z)} \cdot \left| \frac{z}{z_o} \right| \right)}$$

0.18


wind
D
E
b
d


e
A
B
C
h
e/5
4/5 · e
d-e


D & E
h

Peak velocity pressure, $q_{p(z)}$

$$q_{p(z)} = (1+7\cdot I_{y(z)})\cdot\frac{1}{2}\cdot\rho\cdot v_{m(z)}{}^{2} = C_{e(z)}\cdot q_p$$

Information to further calculation:

Air density, recommended, ρ

1.25kg/m^3

Exposure factor, $C_{e(z)} = \frac{q_{p(z)}}{q_p}$

2.5

Mean velocity, $q_p = \frac{1}{2}\cdot\rho\cdot v_b{}^{2}$ 298.94kg/m^3

EC1991 1-4, page 23 table 4.9 and 4.10

$$(1+7\cdot I_{y(z)})\cdot\frac{1}{2}\cdot\rho\cdot v_{m(z)}{}^{2}$$

0.7kN/m^2

$C_{e(z)}\cdot q_p$

0.7kN/m^2

$q_{p(z)} = (1+7\cdot I_{y(z)})\cdot\frac{1}{2}\cdot\rho\cdot v_{m(z)}{}^{2} = C_{e(z)}\cdot q_p$ 0.7kN/m^2

Wind pressure on surface, w_e

$w_e = q_{p(ze)}\cdot C_{pe}$

Information to further calculation:

Height of façade, h_f 6m

Height of gable, h_g 12m

Length of building, d 72m

Cross wind dimension, b 18m

Factor e_{wall} either b or 2h which ever is smaller
12m

Factor e_{gable} either b or 2h, which ever is smaller
18m

Peak velocity pressure, q_p 0.7kN/m^2

Reference height for external pressure, ze

Pressure coefficient for external pressure, c_{pe10} find number in table by calculate the ration of h/d for each case (façade and gable) EC1991 1-4 page 37, table 7.1

Façade h/d
0.08 <0.25

Gable h/d
0.17<0.25

Wind pressure on each zone of wall [kN/m^2]

Façade and gable C_{pe10} A:-1.2
B-0,8 C:-0.5
D:0.7 E;-0.3

$w_{e,A} = q_{p(ze)}\cdot c_{pe10,A}$ -0.89

$w_{e,B} = q_{p(ze)}\cdot c_{pe10,B}$ -0.59

$w_{e,C} = q_{p(ze)}\cdot c_{pe10,C}$ -0.37

$w_{e,D} = q_{p(ze)}\cdot c_{pe10,D}$ 0.52

$w_{e,E} = q_{p(ze)}\cdot c_{pe10,E}$ -0.22

Wind pressure on each zone of roof [kN/m^2], with 30degree angle

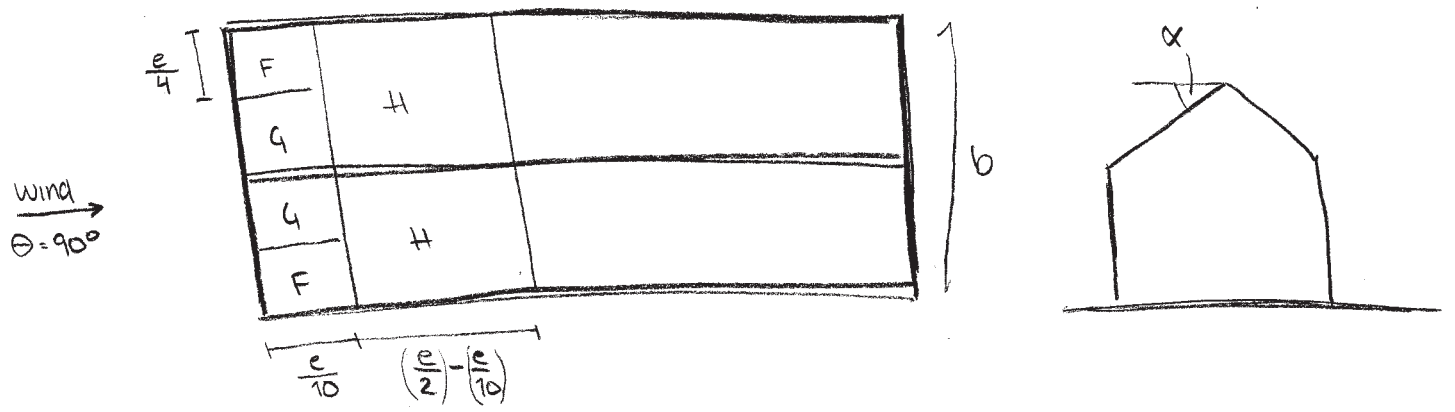
Roof C_{pe10} F: -1.1 G: -1.4
H: -0.8 I: -0.5

$w_{e,F} = q_{p(ze)}\cdot c_{pe10,F}$ -0.81 kN/m^2

$w_{e,G} = q_{p(ze)}\cdot c_{pe10,G}$ -1.03 kN/m^2

$w_{e,H} = q_{p(ze)}\cdot c_{pe10,H}$ -0.59 kN/m^2

$w_{e,I} = q_{p(ze)}\cdot c_{pe10,I}$ -0.37 kN/m^2


wind
θ = 90°
e/4
F
G
H
G
H
F
b
e/10
(e/2) - (e/10)
α

Wind forces, F_w

$$F_w = C_s C_d \cdot \sum w_{e,zone} \cdot A_{ref,zone}$$

Structural factor, recommended, C_sC_d

1

EC1991 1-4, page 28

Areas for each of the zones $A_{ref,zone}$ [m^2]

Areas of Facades:

$$A_{ref,A} = \left(\frac{e_{walls}}{5}\right) \cdot h_f$$ 14.4m^2

$$A_{ref,B} = \left(\frac{4}{5} \cdot e_{walls}\right) \cdot h_f$$ 57.6 m^2

$$A_{ref,C} = \left(d - e_{walls}\right) \cdot h_f$$ 360 m^2

Areas of Gable:

$$A_{ref,D} = (b \cdot h_f) + \left(\frac{1}{2} \cdot (h_g - h_f) \cdot b\right)$$ 162 m^2

$$A_{ref,E} = (b \cdot h_f) + \left(\frac{1}{2} \cdot (h_g - h_f) \cdot b\right)$$ 162 m^2

Areas of Roof:

$$A_{ref,F} = \left(\frac{e_{roof}}{4}\right) \cdot \left(\frac{e_{roof}}{10}\right)$$ 8.1m^2

$$A_{ref,G} = \left(\frac{e_{roof}}{4}\right) \cdot \left(\frac{e_{roof}}{10}\right)$$ 8.1 m^2

$$A_{ref,H} = \left(\left(\frac{e_{roof}}{2}\right) - \left(\frac{e_{roof}}{10}\right)\right) \cdot \left(\frac{1}{2} \cdot b\right)$$ 64.8 m^2

$$A_{ref,I} = \left(d - \left(\frac{e_{roof}}{2}\right)\right) \cdot \left(\frac{1}{2} \cdot b\right)$$ 567 m^2

Wind forces, $F_{w,zone}$ [kN]

Facades:

$$F_{w,A} = C_s C_d \cdot \sum w_{e,A} \cdot A_{ref,A}$$ -12.76kN

$$F_{w,B} = C_s C_d \cdot \sum w_{e,B} \cdot A_{ref,B}$$ -34.01kN

$$F_{w,C} = C_s C_d \cdot \sum w_{e,C} \cdot A_{ref,C}$$ -132.87kN

Gables:

$$F_{w,D} = C_s C_d \cdot \sum w_{e,D} \cdot A_{ref,D}$$ 83.71kN

$$F_{w,E} = C_s C_d \cdot \sum w_{e,E} \cdot A_{ref,E}$$ -35.87kN

Roof:

$$F_{w,F} = C_s C_d \cdot \sum w_{e,F} \cdot A_{ref,F}$$ 6.58kN

$$F_{w,G} = C_s C_d \cdot \sum w_{e,G} \cdot A_{ref,G}$$ -8.36kN

$$F_{w,H} = C_s C_d \cdot \sum w_{e,H} \cdot A_{ref,H}$$ -8.27kN

$$F_{w,I} = C_s C_d \cdot \sum w_{e,I} \cdot A_{ref,I}$$ 209.27kN

$F_{w,total}$ For whole construction

-394.26kN/m (-3.56kN/m^2)

$F_{w,roof}$ Only roof -262.48kN/m

$F_{w,element}$ one element -7.15kN/m

Conclusion is that there are more pull effect on the surfaces. Which makes sense, as the wind side are the gable and therefore the area a relatively low according to the remaining surfaces, which will be the leeward side. This does not mean that the wind load should not be taking in consideration, because pull can be just as powerful as pressure.

Load combination

$$\sum_{(j\geq 1)} K_{FI}\gamma_{G,j}G_{k,j} + \gamma_p\rho + K_{FI}\gamma_{Q1}Q_{k1} + \sum K_{FI}\gamma_{Q,i}\Psi_{0,i}Q_{k,i}$$

Combination of dead load, dominating load and non-dominating load. The dominating load is snow load for Denmark and non-dominating is wind load. The accidentals load (γ_pP) are not taking in account for this formula.

$$\sum_{(j\geq 1)} K_{FI}\gamma_{G,j}G_{k,j} + K_{FI}\gamma_{Q1}Q_{k1} + \sum K_{FI}\gamma_{Q,i}\Psi_{0,i}Q_{k,i}$$

Information to further calculation:

Teknisk Ståbi page 163, table 4.1 – formula 6.10b[2]

Consequence class CC2, K_{FI}

1

Dead load coefficient (unfavourable), $\gamma_{G,j}$

1

Dead load, $G_{k,j}$ (one element)

11.47kN/m

Dominating load coefficient, $\gamma_{Q,1}$

1.5

Dominating load, Q_{k1} (one element)

11.43kN/m

Non-dominating load coefficient, $\gamma_{Q,I}$

1.5

Reduction factor, $\Psi_{0,I}$

0.3

Non dominating load, $Q_{k,I}$ (one element)

7.15kN

$$\sum_{(j\geq 1)} K_{FI}\gamma_{G,j}G_{k,j} + K_{FI}\gamma_{Q1}Q_{k1} + \sum K_{FI}\gamma_{Q,i}\Psi_{0,i}Q_{k,i}$$

31.82kN/m (one element)

24.06kN/m one element, without dead load of element ‘

3.536kN/m2 per element

45.54kN/m (Total roof)

0.673kN/m2 without dead load of element

Dimensioning of one of the most critical elements, vertical Beam over a large span.
Information to further calculation:

Calculating on a beam with a length, L 9m

Material, Glue laminated GL32h

$F_{m,d}$	32MPa
$F_{v,k}$	3.8MPa
$F_{c,90,k}$	3.3MPa
Stiffness in fiber direction, E_0	13700
Density, mean value, ρ_{12}	510kg/m^3
Consequence class, CC2	1

Conversion factor for dead load $k_d = \frac{k_{mod}}{\gamma_m}$

k_{mod}

0.462

γ_m

1.3

$k_d = \frac{k_{mod}}{\gamma_m}$ 0.355

(Teknisk Ståbi, page 315, tabel 7.1 and 7.2)

Load combination, with dominating snow load and without dead load of beam, p

24.06kN for one element (beam)

Calculating the Serviceability limit state, SLS
Using the maximum allow bending, U_{max}

$U_{max} = \frac{1}{500}\cdot L$ 18mm

Moment of inertia with the maximum allowed bending, I

$I = \frac{5\cdot p\cdot L^4}{384\cdot E_0\cdot U_{max}}$ 8335 10^{6}mm^4

ANNEX B

BEAM CALCULATION

Dimensioning of one of the most critical elements, vertical Beam over a large span. Information to further calculation:

Calculating on a beam with a length, L 9m

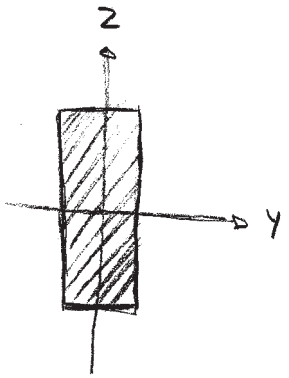
Material, Glue laminated GL32h

$F_{m,d}$	32MPa
$F_{v,k}$	3.8MPa
$F_{c,90,k}$	3.3MPa
Stiffness in fiber direction, E_0	13700
Density, mean value, ρ_{12}	510kg/m^3
Consequence class, CC2	1
Conversion factor for dead load $k_d = \frac{k_{mod}}{\gamma_m}$	
k_{mod}	0.462
γ_m	1.3
$k_d = \frac{k_{mod}}{\gamma_m}$	0.355

(Teknisk Ståbi, page 315, tabel 7.1 and 7.2)

Load combination, with dominating snow load and without dead load of beam, p

24.06kN for one element (beam)



Calculating the Serviceability limit state, SLS
Using the maximum allow bending, U_{max}

$$U_{max} = \frac{1}{500} \cdot L$$ 18mm

Moment of inertia with the maximum allowed bending, I

$$I = \frac{5 \cdot p \cdot L^4}{384 \cdot E_0 \cdot U_{max}}$$ 8335 10^6mm^4

From the calculated moment of inertia, the real inertia can be read in a table and thereby also finding dimension by choosing a higher inertia than calculated.

Chosen beam dimension

Width of beam	185mm
Height of beam	1000mm
Moment of interia, I_y	15400 10^6mm^4
Resistance moment, W	30800 10^3 mm^3

Teknisk Ståbi, page 318

Dead load of element (beam) $P_{element}$

Height of element, h	1000mm
Width of element, w	185mm
Length of element, l	9000mm
Density of material ρ_{12}	510kg/m^2

Conversion factor (kg/m3 to kN/m2), e 9,8kN/m2

$$G = h \cdot w \cdot l \cdot \rho \cdot e$$ 9.83kN/m

Calculating the bending in element, U and making sure that calculated bending are lower than the maximum allowed bending.

$$U = \frac{5 \cdot p \cdot L^4}{384 \cdot E_0 \cdot I_y}$$ 12.89mm

$$U < U_{max}$$

12.89mm < 18mm

Proven that the allowed bending are the highest.

Ultimate limit state, ULS
To prove the statement that tension is lower than force, there are calculated on the material strengthens; tension and the force the beam are exposed to.

$$\sigma \leq f_{md}$$

Information to further calculation:

f_{mk}	32MPa
$k_{mod,V}$	0.846
$k_{mod,P}$	0.462
γ_m	1.3
$k_{d,V} = \frac{k_{mod,V}}{\gamma_m}$	0.65
$k_{d,P} = \frac{k_{mod,P}}{\gamma_m}$	0.36

Height effect of beam, in this case h>600mm, k_h 1

Calculating the strength figure for glue laminated wood

$$f_{md,V} = f_{mk} \cdot k_{d,V} \cdot k_h$$ 20.82MPa

$$f_{md,P} = f_{mk} \cdot k_{d,P} \cdot k_h$$ 11.37MPa

Calculating Moment in order to calculate the forces that goes through the material

Maximum moment, for each load combination, M

$$M = \frac{1}{8} \cdot q \cdot l^2$$

Sum of variable and permanent loads, q_v

31.82kN/m

Sum of permanent load, q_p

11.47kN/m

$$M_{max,V} = \frac{1}{8} \cdot q_V \cdot l^2$$ 322.22kN/m

$$M_{max,P} = \frac{1}{8} \cdot q_P \cdot l^2$$ 116.10kN/m

Then the tension, σ can be found as the resistance moment, W are found by table in Teknisk Ståbi, page 318

$$\sigma = \frac{M}{W}$$

Moment variable, M_V

$322.22\ 10^3$ kN/mm

Moment permanent, M_P

$116.10\ 10^3$ kN/mm

Resistance moment

$30800\ 10^3$ mm^3

$$\sigma_V = \frac{M_V}{W}$$

10.46 kN/mm^2 – MPa

$$\sigma_P = \frac{M_P}{W}$$

10.46kN/mm^2 – MPa

Compare tension with strength.

$\sigma_V \le f_{md,V}$ 10.46MPa < 20.82 MPa

$\sigma_P \le f_{md,P}$ 3.77MPa < 11.37MPa

Proven that there are no bending moment, meaning that the beam and its material will not break at the given dimension and affected by loads.

Displacement in the beam
Making sure that the element are able to contain the vertical force, and therefore not having any displacement.

$$\tau < f_{v,d}$$

Shear force, τ

Cross-section area of the element, A 0.19m^2

$$\tau = \frac{3}{2} \cdot \frac{V}{A}$$

Information to further calculation:

The maximum displacement in material, $f_{v,k}$

3.8

$K_{d,P}$ 0.36

$K_{d,V}$ 0.65

Teknisk Ståbi, page 314-315, table 7.1-7.2

$f_{v,d,P} = f_{v,k} \cdot k_{d,P}$ 1.35

$f_{v,d,V} = f_{v,k} \cdot k_{d,V}$ 2.47

Displacement force, V

$$V = q \cdot \left(\frac{L}{2} - h \right)$$

Information to further calculation:

Dead load, q_p

11.47kN/m

Variable load (snow and wind), q_v

31.82kN/m

Length of beam, L

9m

Height of cross section, h

1m

$V_P = q \cdot \left(\frac{L}{2} - h \right)$ 40.13kN

$V_V = q \cdot \left(\frac{L}{2} - h \right)$ 111.38kN

Shear force that the element are affected by for each load case, τ

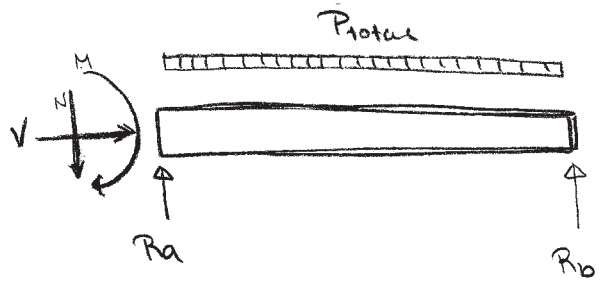
$\tau_P = \frac{3}{2} \cdot \frac{V_P}{A}$ 0.33MPa

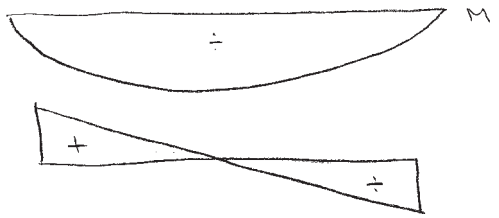
$\tau_P = \frac{3}{2} \cdot \frac{V_P}{A}$ 0.9MPa

Compare that the beam are able to contain the shear force that it is exposed of.

$\tau_P < f_{v,d,P}$ 0.33MPa < 1.35MPa

$\tau_V < f_{v,d,V}$ 0.9MPa < 2.47MPa





ANNEX C

ROBOT CALCULATION

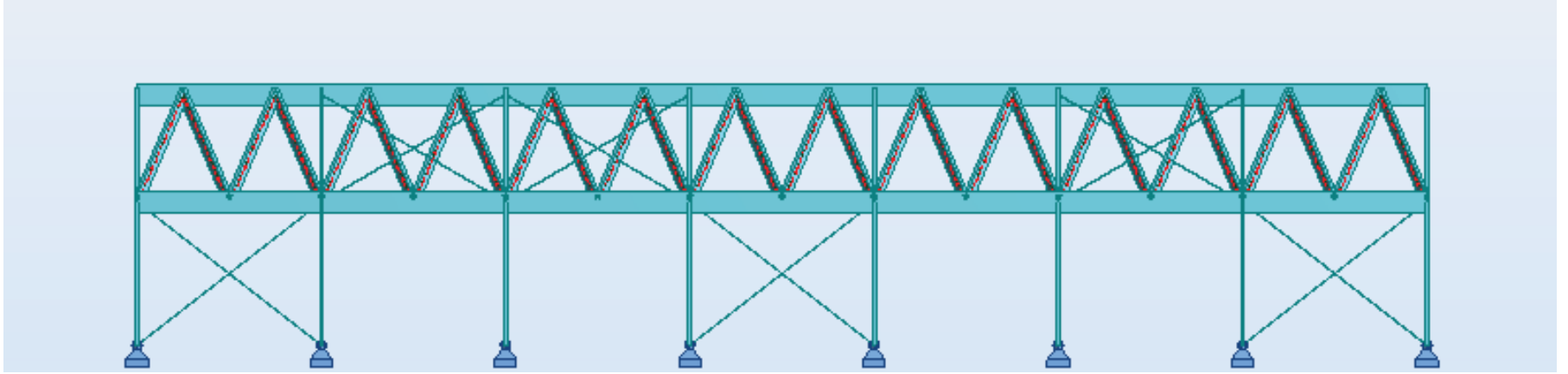
The structure are too complex to calculate and dimensioning by hand calculation, that is why the FEM program Robot, are used. The program are using the load combinations, the inputs of restrains and the supports among others.

The Structure was first built in the plugin program “Grasshopper” for “Rhino”, which is for a visual purpose but because it is possible to control the restrains and supports, and immediately be able to see how the structure reacts according to tension and compression, the program also reacts if the structure are hyper static, static or hypostatic. Basically the restrains and supports are defining degrees of freedom, hyper static can for example be the support of two hinges, static would be a slider and a hinge, and hypo static are two sliders meaning it is a mechanism as it can move.

Dimensions of elements:
Beam: 1000x185x9000mm
Outer frame: 900x185x8000/1082mm
Inner frame 600x185x9760/1204mm
Trusses: 900x185x1112mm
Wind cross: 40x40(x4) x1303mm (steel)

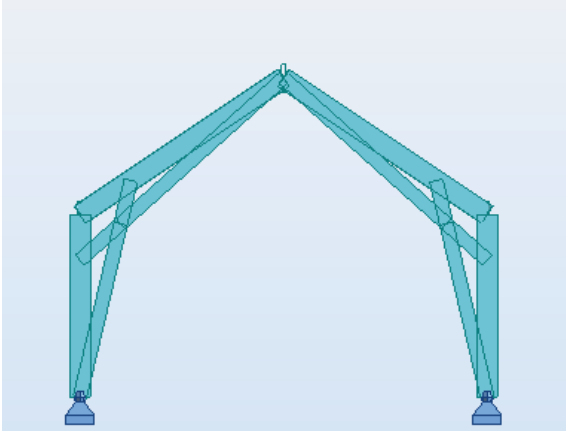
Maximal displacement: 13mm in x-direction (width of the building) and 47mm in the y-direction (the length of the building) worst impact case is the wind.

Normal force (beam) -56.88kN
Shear force TY -1.27kN
Shear force TZ 33.03kN
Bending moment MY -80.46 kN/m
Bending moment MZ -3.93kN/m



Ratio (beam)
Hand calculation: 0.81<1
Robot calculation: 0.20<1
Tension / strength = Ratio

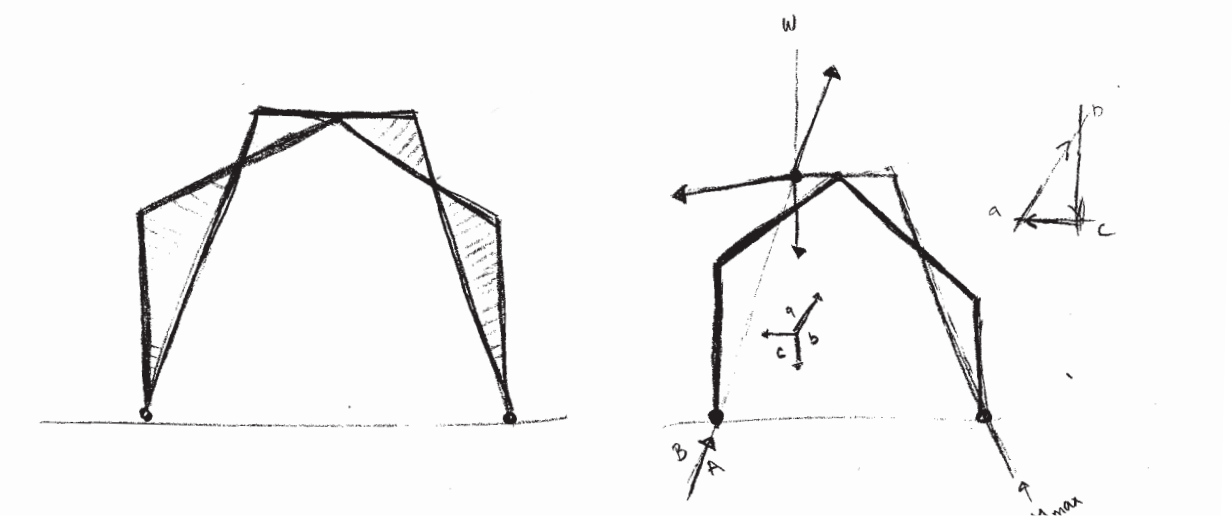
By compare the two numbers above, one can have the conclusion that when calculation on the beam alone it has nothing to collaborate with, unlike the robot calculation where the beam are collaborating with the rest of the structure, and thereby are not fully utilized, according to dimensions and material.

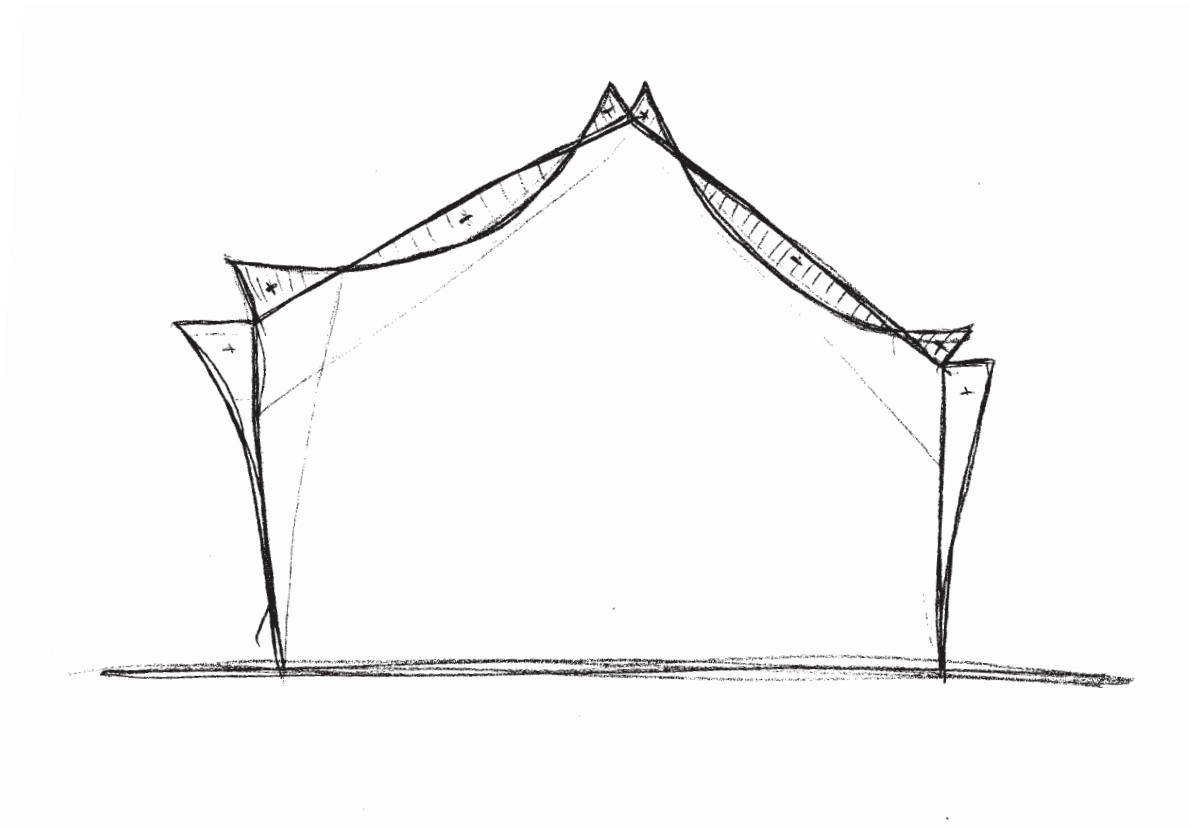


ANNEX D

FORCES DIAGRAMS

The two sketches are an illustration of the forces diagram for the frame structure. The diagram shows how the forces are affecting the structure, in this case only the outer frame. The first sketch are the shear force. The second is showing how the force are moving in the structure. And the third sketch are the bending moment in the frame structure.

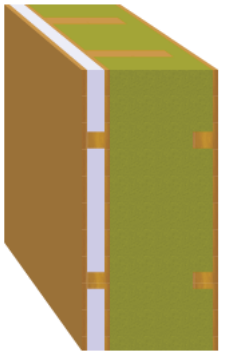




ANNEX E

U-VALUES

UDE



INDE

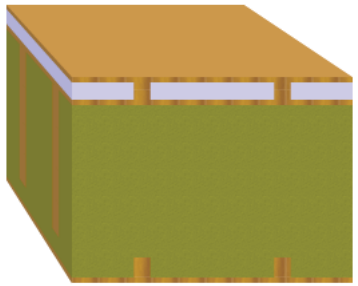
U = 1 / 9,73 + 0,000 + 0,000 = 0,10 W/(m²K)

U_{max} = 0,30 W/(m²K)

U = 0,10 W/(m²K)

	Producent	Navn	Tykkelse [m], antal	Lambda [W/(mK)]	Q	R [m²K/W]
	Rse (ude)					0,13
☑ 1	Generisk materiale	Træ 700 kg/m3	0,021	0,170	A	~~0,12~~
☑ 2	Inhomogent materialelag	bestående af:	0,065	0,894		0,07
	Generisk materiale	Ventileret lag	88,00%	1,000	A	-
	Generisk materiale	Træ 450kg/m3	12,00%	0,120	A	-
☑ 3	Generisk materiale	Vindpap (vindtæt afdækning)	0,002	1,000	A	0,00
☑ 4	Generisk materiale	Finerplade (OSB), 650 kg/m3	0,022	0,130	A	0,17
☑ 5	Inhomogent materialelag	bestående af:	0,150	0,054		2,80
	ROCKWOOL A/S	A-Murbatts	80,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 6	Inhomogent materialelag	bestående af:	0,150	0,054		2,80
	ROCKWOOL A/S	A-Murbatts	80,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 7	Generisk materiale	PE-folie (hæftet fast) 0,15 mm	0,000	0,170	A	0,00
☑ 8	Inhomogent materialelag	bestående af:	0,075	0,047		1,60
	ROCKWOOL A/S	A-Murbatts	88,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	12,00%	0,120	A	-
☑ 9	Generisk materiale	Finerplade (OSB), 650 kg/m3	0,021	0,130	A	0,16
	Rsi (inde)					0,13
			0,506			**7,86**

UDE



U = 1 / 12,46 + 0,000 + 0,000 = 0,08 W/(m²K)

U_{max} = 0,20 W/(m²K)

U = 0,08 W/(m²K)

INDE

	Producent	Navn	Tykkelse [m], antal	Lambda [W/(mK)]	Q	R [m²K/W]
	Rse (ude)					0,10
1	Generisk materiale	Træ 450kg/m3	0,021	0,120	A	~~0,18~~
2	Inhomogent materialelag	bestående af:	0,065	0,894		0,07
	Generisk materiale	Ventileret lag	88,00%	1,000	A	-
	Generisk materiale	Træ 450kg/m3	12,00%	0,120	A	-
3	Generisk materiale	Vindpap (vindtæt afdækning)	0,002	1,000	A	0,00
4	Generisk materiale	Finerplade (OSB), 650 kg/m3	0,020	0,130	A	0,15
5	Inhomogent materialelag	bestående af:	0,150	0,054		2,80
	ROCKWOOL A/S	A-Murbatts	80,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
6	Inhomogent materialelag	bestående af:	0,150	0,054		2,80
	ROCKWOOL A/S	A-Murbatts	80,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
7	Inhomogent materialelag	bestående af:	0,125	0,054		2,33
	ROCKWOOL A/S	A-Murbatts	80,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
8	Inhomogent materialelag	bestående af:	0,125	0,054		2,33
	ROCKWOOL A/S	A-Murbatts	80,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
9	Generisk materiale	PE-folie (hæftet fast) 0,15 mm	0,000	0,170	A	0,00
10	Inhomogent materialelag	bestående af:	0,075	0,047		1,60
	ROCKWOOL A/S	A-Murbatts	88,00%	0,037	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	12,00%	0,120	A	-
11	Generisk materiale	Finerplade (OSB), 650 kg/m3	0,022	0,130	A	0,17
	Rsi (inde)					0,10
			0,755			**12,46**