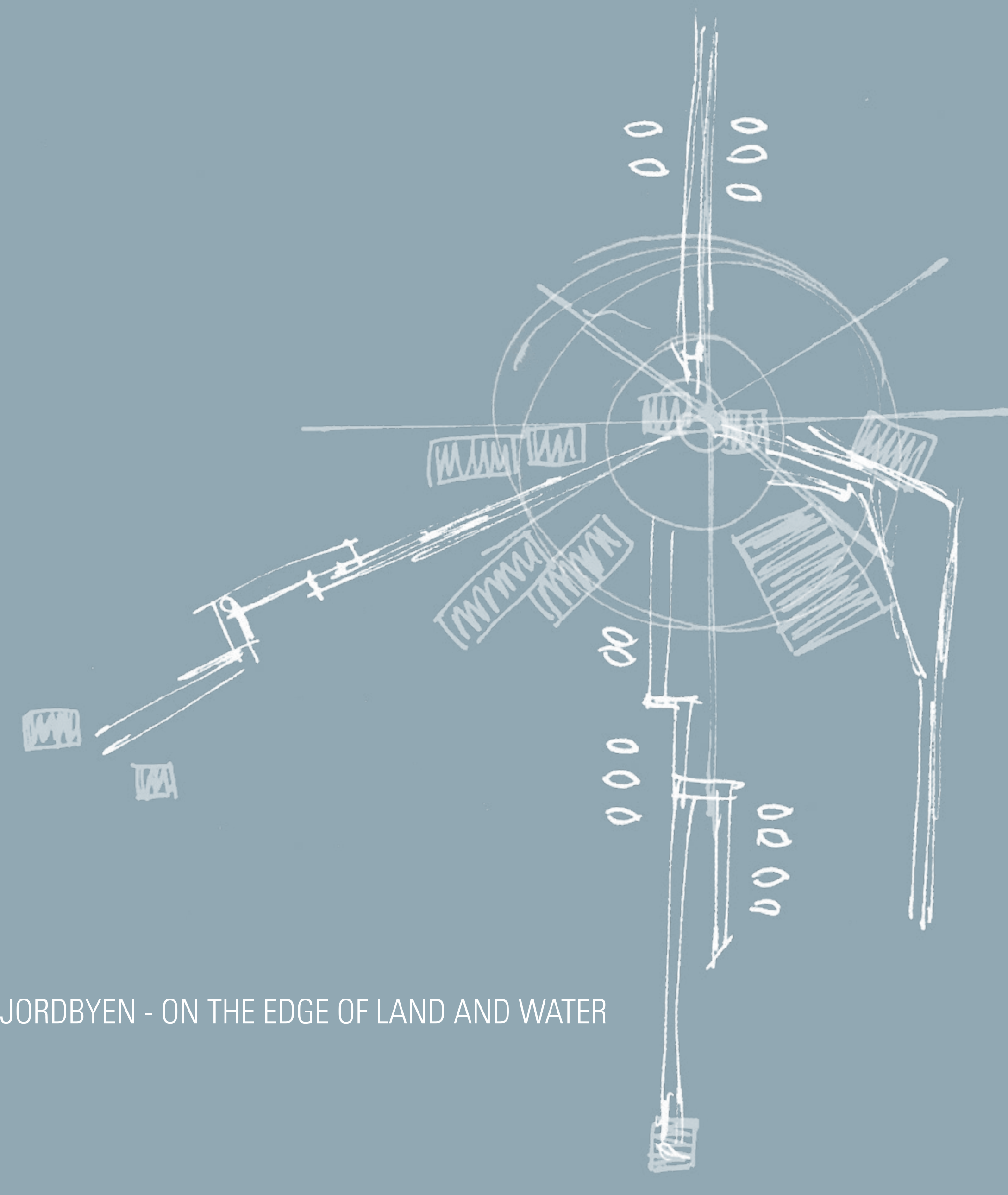


FJORDBYEN - ON THE EDGE OF LAND AND WATER

FJORDBYEN

ON THE EDGE OF LAND AND WATER

Master thesis

Theme: Potentials in peripheral areas of Denmark

School of Architecture, Design, and Planning
Aalborg University
Denmark

Architectural supervisor:
Claus Kristensen, associate professor & architect maa

Technical supervisor:
Christian Frier, associate professor & PhD in Engineering

Project period: February 3rd - May 28th 2014

No. of prints: 10
No. of spreads: 117
Appendix: 14
Enclosed content: CD

Preface

This master thesis is completed by Tim Faldov and Christina Thomsen at The School of Architecture, Design, and Planning at Aalborg University. The project extends from February 3rd – May 28th 2014.

The theme of this master thesis takes point of departure in the local potentials in the peripheral area Thisted, Denmark. The architectural focus is the design of a new centre of maritime activities on the harbour front that seeks to enhance the qualities of the area and the unique location close to the water sea to create synergies between land, country, and water, thus, introducing an urban scale to the design. The technical approach to the project is a tectonic focus upon structure and details.

The project is supervised by associate professor and architect maa, Claus Kristensen, and associate professor and PhD in Engineering, Christian Frier.

Christina Thomsen

Tim Faldov

Abstract

In recognition of the on-going transition of the peripheral areas in Denmark this project attempt to build upon the unique potentials found at Sydhavnen in Thisted. The intention of this project is to create a social gathering point *Fjordbyen* - a village of maritime houses placed on the edge of land and water.

Located in proximity to the marina the project aims to enhance the local maritime community and preserve the extraordinary view toward Limfjorden to create a foundation for bringing people together at Sydhavnen.

Fig. 1.0: Visualisation of Fjordbyen at sunset

TABLE OF CONTENTS

01 | Introduction **7**
Motivation & intentions 7
Approach 8

02 | Project Brief **13**
Thisted harbour front 14
Place 18
Typologies, access, and climate 26
Inspiration 28
Hammerhavn multihus - bornholm 30
Sejlklub - vædbæk 32
Integrated facilities 34
Space planning 35

03 | Concept **40**
A human perspective 40
On the edge of land and water 42
Walking the landscape 43

04 | Presentation **44**
Architectural design 44
Fjordbyen 46
Arrival 50
Boat hall 54
Race lounge 58
Structural metaphor 60
Structure 61
The detail 65
Workshop 66
Restaurant & clubhouse 68
Changing rooms & maritime store 72
Boathouses 74
Arrival from the sea 76
Urban design 78
Recreational activities 82
Cable park 86
Winter scenario 88
Materials 90
Sustainable intentions 92

05 | Design process **97**
Process of integrated design 97
Process of concept development 98
Orientation, views, and proximity 100
Structural concepts - the structural narrative 104
Structure 106
Detailing the structure 107
Detailing the joint 108
The freestanding columns 109
Exterior expression 110

06 | Concluding Perspectives **113**
Conclusion 113
Reflections 115

References 116
Illustrations 117
Appendix A 118
Appendix B 125
Appendix C 130

01 | INTRODUCTION

MOTIVATION & INTENTIONS

Thisted municipality has been listed as a peripheral region since the Danish municipal reform in 2007. This political definition tends to have a rather negative connotation. The campaign *Stedet Tæller* by Realdania describes the situation of the peripheral areas of Denmark:

"The Danes are moving away from the peripheral areas. ... At the moment the peripheral areas find themselves in a historical transition. A transition that requires innovation but also opens up new opportunities. Although the population is moving increasingly to the larger cities it does not mean that the peripheral areas have nothing to offer."
- Stedet Tæller 2014

The Realdania campaign suggests that the peripheral regions should focus on the potential of a place to enhance the qualities and improve the conditions for life locally in order to benefit residents and visitors.

With roots in the peripheral Denmark it is our personal believes and experience that these areas have a great deal of potential and quality, which is the motivation of the project theme. The acknowledgment of the on-going transition combined with a positive engagement are our qualified attempt to change the negative perception of the peripheral areas.

The main objective of this project is to develop a design proposal to house the various maritime activities in the local area. The location of the project is at Sydhavnen in Thisted - a unique piece of land surrounded by Limfjorden. However, the area lacks attention. Thus, it is our intention to create an attractive and a social gathering point, *Fjordbyen*, and thereby contribute to the positive development of Sydhavnen.

Fig. 1.2: The view toward Limfjorden

APPROACH

MOVING FROM THEORY TO PRACTICE

Thoughts of practice

The transition from studying architecture to practicing architecture approaches and so the inevitable questions impose: *What have we learned? What are our competences? What does it mean to have a degree in architectural engineering?*

Several academic notions and terms have been introduced during our studies. The objective of the master thesis is to demonstrate the ability of integrating architectural design with technical solutions. Furthermore, the project is based on relevant theories, skills, and learning outcomes from the master's curriculum (Study Guide 2014). However, the master thesis is also about demonstrating the ability to find the correct balance between the project scope, the visions, the learning goals, and the limitations. The academic focus of this project is the tectonic architecture, which provides a guideline for the project scope and the technical focus.

TECTONIC ARCHITECTURE

The beautiful structure - the structural beauty

The tectonic term derives from the Greek word *Tekton* meaning carpenter or builder. Today, the notion of tectonic architecture is becoming more complex but a consistent aspect of the tectonic understanding is the poetic of construction (Frampton, 1995). The complexity of tectonic architecture arises as the notion *'poetic construction'* can be interpreted in various ways. Roughly speaking, *'poetic'* covers the aesthetical, emotional, and unmeasurable values, whereas the *'construction'* is the evidential counterpoint relying on concrete measures and structural principles. The real challenge is to find the correct balance between poetic and construction. The Danish architect, Anne Beim, discusses the current role of an architect in her book, *Tectonic Visions in Architecture*. She argues that the balance between poetic and construction is shifting to favour the poetics, which means a lack of technical understanding that makes it difficult for the architect to bring the architectural idea from the drawing board to the construction site. (Beim, 2007)

Refining the detail

With the main architectural idea in mind, whether it is a certain atmosphere, an experience, a gesture, or a narrative, the architect must be able to work with a variety of aspects to bring the idea to the light of the day. To create architectural experiences through structure, materials, light, metaphors, details, etc. is a way of communicating architecture, an architectural narrative that signifies tectonic quality. The architect's ability to refine an architectural idea, whether it is a detail in the urban scale, the architectural scale or the structural joint, is a unique competence – to refine the architectural detail and add value even on the lowest budget.

The architectural theorist Christian Norberg-Schulz describes the notion of *Genius Loci* as the spirit of the place in his book, *Genius Loci: Towards a Phenomenology of Architecture*. The book discusses the importance of understanding the context that you are working within (Norberg-Schulz 1991). However, there are several aspects one must recognise in order to understand the context.

The physical context

The first step to really understand the site and its context is to experience the place. The physical presence allows you to use your senses and relate to the place - a relation that the modern technologies are not able to imitate. The benefit from experiencing the site and context allows you to gather inspiration and see potentials, qualities, and challenges that are unique for this particular location. Norberg-Schulz states:

"Visualization of space can occur in two ways: either in representing the given in a corresponding architecture or in complementing the given by adding that which the environment lacks."
- Norberg-Schulz 1996

In other words the quote tells us that the surroundings should give guidelines for the architecture thus build on the existing qualities or challenges of the space to avoid the building becoming a detached object – therefore the importance of understanding the spirit of the place.

The human context

As you recognise the potentials and challenges of the place you become able to understand the relation between the local people and the place. Potentially, the attention to the human scale would allow the new building to contribute to the local community and vice versa – in other words the link to the everyday life would help people familiarise and relate to the place.

The changeable context

The changeable conditions of the Nordic climate are the main reason to build. The shelter and safety from nature is a necessity (Norberg-Schulz, 1996). The strong reliance on the built environment is why the people within a Nordic context have great appreciation of their home – an additional value that makes the home more than just a roof over your head. The changeable conditions have also forced the architecture to equally adapt. Considerations of form, materials, building traditions, light, and orientation must be taking into account and perform during warm and light summers and cold and dark winters. Pitching roofs, draining, and insulation are a few of the technical aspects that are important to consider, and hereby it introduces the notion of passive strategies in sustainable architecture.

SUSTAINABLE ARCHITECTURE

Even though sustainable architecture is not the primary focus of this project it is a motivation for integrated sustainable aspects of the design process in order to strive for an in-depth and comprehensive architectural design.

Sustainable thinking

In response to the previous dialogue about Nordic architecture the following quote by cand.polyt. in Architecture, Hanne Tine Ring Hansen, implies that the architectural understanding continues to develop:

"… good architecture was a building that was suitable for its environmental context – one that would adequately protect the inhabitants from the climate. More recently it is the environment that has been seen as needing protection."
- Hanne Tine Ring Hansen 2013.

The fact that the built environment covers approximately 50% of the total energy consumption in the western world justifies the present and future sustainable development (Hansen et.al 2007).

In any case the built environment will continue to exist but the changing architectural design parameters will need the architects to use the sustainable aspects in the design. Architect, Lars Juel Thiis, states:

"The architecture of the Future is to be formed not by the constraints of sustainability, but the potentials of sustainability."
- Lars Juel Thiis 2013.

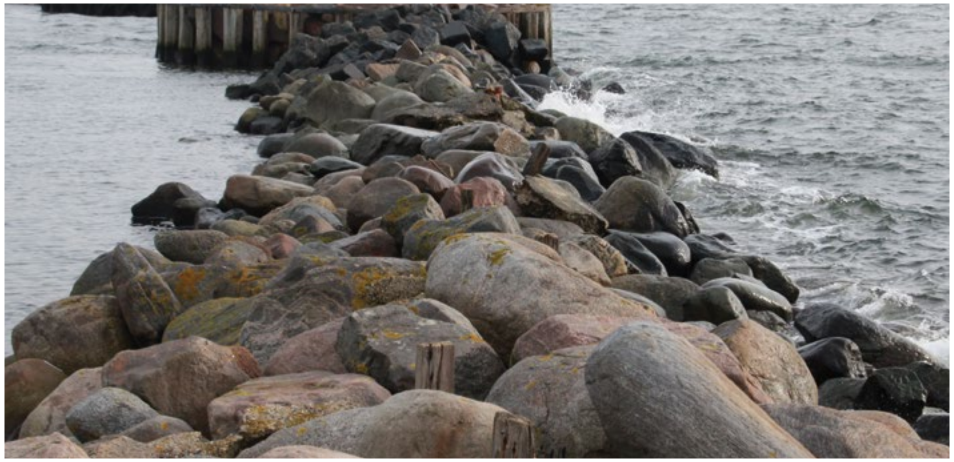
In this respect it is important to remember that sustainable architecture just like any other notion of architecture relies on integrated solutions where technical, economical, functional, social, and aesthetical aspects are combined to form a whole. In the same way as materials, orientation, light, openings, etc. are considered within the notion of Nordic architecture these aspects are equally important to the sustainable understanding and should be a natural part of the early design phase.

From theory to practice

The discussion of the different notions of architecture has made it possible to begin answering the question of what we have learned as well as understanding our gained competences. The many notions, methods, tools, and studies come together to form a toolbox of fundamental knowledge that is necessary to make informed decisions in a multidisciplinary profession. As Vitruvius states in his *Ten Books on Architecture*:

"The architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgement that all work done by the other arts are put to the test." - Vitruvius 1960.

In other words it is our job as architects to judge what is the correct combination of knowledge for any given project – as the discussion has showed that the different aspects of architecture cannot be separated but must be combined in the best possible way. Thus, the noblest competence to possess is the ability to see the potentials and challenges in order to create the most value for the project and for the people affected by them. Without labelling a project as either tectonic, Nordic, or sustainable the branches of architecture should come together in a natural way.









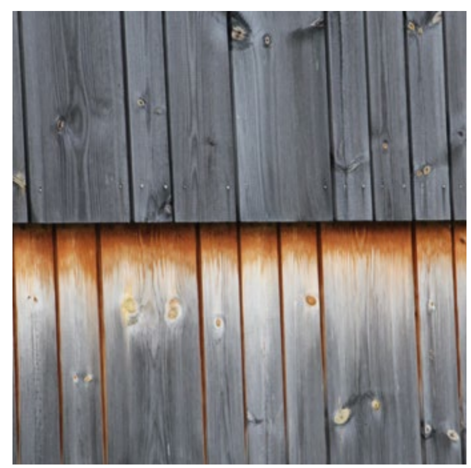


Fig. 1.3: Mood board

The architectural gesture of structure, materials, light, nature, joints, textures, patina, and protection in a Nordic context.

02 | PROJECT BRIEF

ANALYSIS

IMPRESSIONS & INVESTIGATIONS

This chapter will cover several aspects to form the basis for the project design. The analysis will focus upon the specific site to investigate the challenges and the potentials of the physical environment and develop a contextual understanding. The site analysis is followed by case studies of recreational and maritime environments to gather inspiration of similar environments. Finally, the chapter will present the idea of the integrated club facilities, a list of functions, and the relations between spaces.

Content

Part 1: *Thisted harbour front – present and future perspectives*
Part 2: *Place – registrations of challenges and potentials*
Part 3: *Understanding the context – typologies, access, and climate*
Part 4: *Inspiration – recreational activities and architectural means*
Part 5: *Common maritime facilities – community and gathering*
Part 6: *Space planning – functions and organisation*

Fig. 2.1: Picture of Thisted marina

THISTED HARBOUR FRONT

PRESENT AND FUTURE PERSPECTIVES

Local enthusiasm

The harbour front has a central location in the commercial area in Thisted. The town of 13.067 inhabitants (Danmarks Statistik 2014) can be divided into three main areas – the southwest, northeast, and the midtown including the harbour front. The southwest and northeast areas have evolved around the town centre and incline along the hillside providing the residential area with extraordinary views toward the harbour front and Limfjorden.

A growing interest and focus upon recreational activities and urban planning have initiated a debate and teamwork between the municipality and the local enthusiasts to uphold the future development of Thisted. In 1974, the town council proposed the first comprehensive attempt of urban planning influenced by local involvement. The proposal suggested establishing residential areas, parks, open-air baths, and sport centres. (Andersen et al. 2002)

In November 2012, the town council made a new initiative and a proposal for local plan changes was published. The proposal describes how Sydhavnen should evolve with approximately one hundred new residential units (Thisted Kommune 2012). In response to this, 108 pages of objections from the local community were received during February 2013. The objections concern that a new residential area will result in poor views for the surrounding buildings, the area will seem less public, and the unit price will be unrealistic (Indsigelser til lokalplan 2013). On the other hand, the objections seem to have a common interest in seeing Sydhavnen develop. One of the locals, Per Hammershøj, states:

"…if something, other than in my favour was to be built I will make my peace with that - as long as something happens to make the area complete. We do not need yet another period of years without the area being finalised."
- Per Hammershøj 2013

Fig. 2.2: Map of Thisted town centre

THISTED HARBOUR FRONT

PRESENT AND FUTURE PERSPECTIVES

A recreational coastline

As a response to the objections, the town council invited the residents of Thisted municipality to participate in a workshop during the summer of 2013. The workshop was arranged as a proposal for the Realdania campaign, *Stedet Tæller*. Local enthusiasts participated to discuss ideas for the future planning of Thisted. The ideas were recapitulated in an urban strategy to enhance the recreational activities along the coast.

Thisted is located along Limfjorden and the unique opportunity to create synergies between land and water is the main ambition for the urban vision. The intended synergy between land and water occurs with the variety of recreational experiences and maritime activities along the coastline. (Thisted Kommune 2013) This project will take the urban strategy into account, as the site Sydhavnen is the primary node that connects the western and eastern coastline.

Fig. 2.3: Map of Thisted and Limfjorden

Regional qualities

Due to geographical and climatic conditions in the region of Thy investigations show that the area already had an enhanced focus upon maritime activities. The current situation of the peripheral areas of Denmark calls for an increased focus upon the use of local potentials (Realdania 2014). The illustration 2.3 indicates other positive developments in Thy with maritime activities and recreational use as the common factor. This project aims to approach the future development of Sydhavnen in Thisted in relation to the regional context to supplement the other qualities and experiences in the area, thus, creating synergies to favour both locals, visitors, and potential new residents.

Hanstholm:

Currently, the future plan for Hanstholm is to largely expand the harbour and ferry terminal. A realisation of this expansion would mean European recognition as a leading fishing port and easy access for tourists by a connection to Norway. (Hanstholm Havn 2014)

Klitmøller – Cold Hawaii:

The geographic and climatic conditions in Klitmøller are particularly suitable for wind and water sports. Since the best international windsurfers competed at the PWA World Cup in September 2010 Cold Hawaii has been recognised worldwide. The prestigious event has been a recurring event since 2010. (Cold Hawaii 2014)

Vorupør:

The small town is recognised as a lively beach town on the west coast of Denmark. The beaches are in particular suitable for bathing and leisure time. (VisitThy 2014)

Thy National Park:

The area was appointed a national park in 2008. Thy National Park covers an area of approximately 24,000 acres and stretches 12 kilometres along the western coastline of Thy. Since the inauguration new paths and viewpoints has been implemented in the park to ensure the preservation of the nature for great outdoor experiences. (Danmarks Nationalparker 2014)

Thisted:

Thisted is the largest town within the municipality and has a lot to offer. However, parts of the harbour front needs attention in order to make use of the existing qualities and potentials. Even though, proposals for new initiatives have been suggested, there is still no clarification of the future development of Sydhavnen.

Fig. 2.4: Map of the regional area Thy

PLACE

REGISTRATIONS OF CHALLENGES AND POTENTIALS

Approaching the site

The proximity between the town centre and the harbour front allows the people to use the area on an everyday basis but as the seasons experience a change of character so does the harbour and the activities adapt.

The central pier is still used for shipping and similar commercial use, although, not to the same extent as earlier. Despite a growing focus on recreational use, several industries have also found its place on the harbour front of Thisted. The expanding butchery covers most of the eastern part of the harbour front and brings a lot of activity to this area every day. To the west along *Kystvejen* you sense the everyday bustle of a new medical centre, shops, fast food, and the gas station.

In between the daily chores you can find the local refuge that once was a vibrant fishing port. Today, the area hums with activity and the atmosphere of old boats, primitive angling, and the original boathouses stand in clear contrast to the modern architecture. The natural presence of the wind is translated into sound as you hear the wires beating against the masts. If the weather permits it you will see the plastic chairs and wooden benches fighting for a spot in the sun.

The transition from industrial to recreational use is present. Green areas with benches and barbeques, a new square with open-air concerts, cafés, restaurants, and ice cream shops are mingling in between the commercial area and the marina.

Fig. 2.5: Pictures from Thisted harbour front

PLACE

REGISTRATIONS OF CHALLENGES AND POTENTIALS

On the edge of land and water - a place to settle?

As you follow the pavement along the harbour front you will eventually approach Sydhavnen. The quay and moorings indicate that the sailing club is at the end of the road but suddenly the pavement ends. As you intersect with the asphalt on *Sydhavnsvej* the road seems to be reserved for cars and you begin to question if you are approaching a private area. The quite atmosphere dominates and only a few boats in the water are moving to the rhythm of the waves. The broken UV-index measure on the cloudy day indicates how the club is in hibernation mode.

The clubhouse appears to be hidden behind the boathouse and the vegetation. As you approach the back of the sailing club you will actually see some activity for the first time. Sailors preparing their gear for the upcoming season and old wooden boats being nursed and getting ready for their second maiden voyage imply that spring is coming. Soon, the marina will be filled with boats and the atmosphere will change. Even on a cloudy day, the marina is a place with a sense of optimism and the proximity in the northeast corner of Sydhavnen is without doubt a strong quality.

This location becomes a metaphor for having the horizon of the water in front of you with Limfjorden in the corner of your eye. It seems like a natural place to settle the new maritime facilities – nested in the corner between the marina and the untouched open landscape – on the edge of land and water.

Fig. 2.6: Historical pictures from Thisted harbour front

Fig. 2.7: Pictures from Sydhavnen

PLACE

REGISTRATIONS OF CHALLENGES AND POTENTIALS

Walking the landscape - lack of invitation?

As you pass by the clubhouse the landscape opens up - Limfjorden appears in the horizon. No doubt - this scenic view is another great quality for Sydhavnen. Although, the pavement changes from asphalt to grass your curiosity lure you to continue to walk along the coast. The ground becomes more and more bumpy as the embankment is made of large rocks that makes it difficult to come close to the water. Reaching the west side of the site, it once again lacks an invitation to inhabit the area. *Kystvejen* with its more heavy traffic bends away from the site toward the town centre and creates a strong boundary to the site. As you turn around you are met with a view toward the large deserted parking area and a three meter high embankment of contaminated soil. Obviously, the area needs attention.

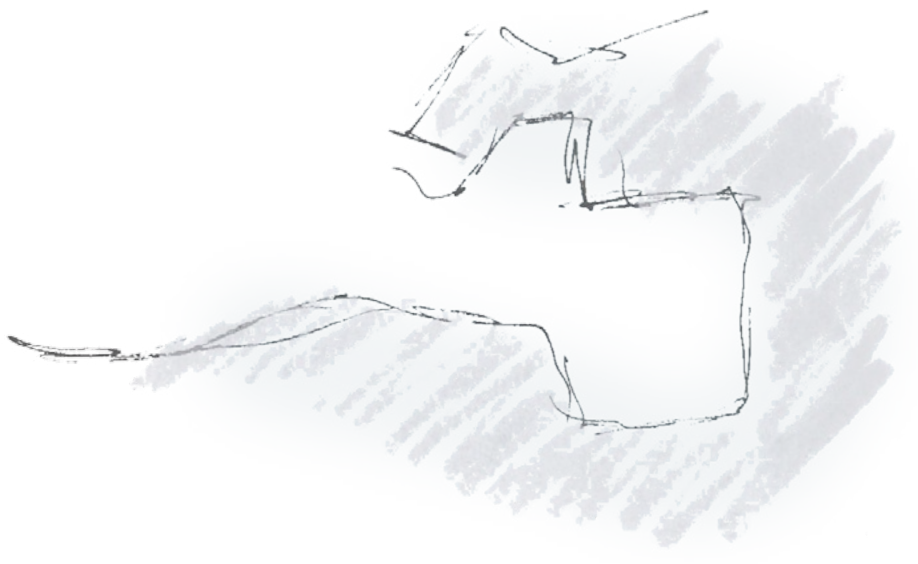
The unique location close to the fjord should invite to a nice walk along the coast. Instead, the area is difficult to inhabit and inaccessible for bikes, strollers, wheelchairs, and skaters, thus, the site becomes detached from the rest of Thisted harbour front. Other parts of the harbour front make room for activities and recreational experiences. These existing qualities and the unique potentials found at Sydhavnen must be united to form a coherent and inviting harbour front in Thisted with the new maritime facilities as the central node to complete the vision of the recreational coastline.

Fig. 2.8: Picture of the landscape at Sydhavnen



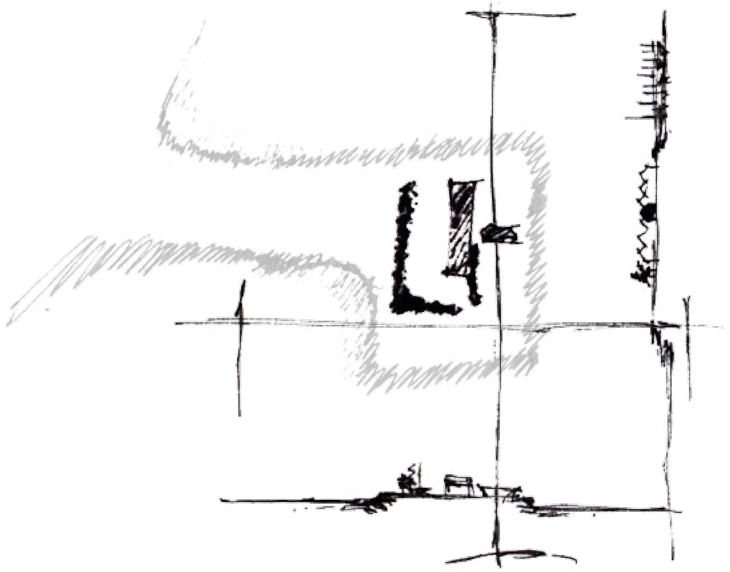


Fig. 2.9: Pictures of the coastline at Sydhavnen



(2.10) Limfjorden - a natural boundary of the site *(2.11) Edges and typologies on the site - a private atmosphere*

(2.12) The edge of the site *(2.13) Untouched open landscape along the coast*



(2.14) The open landscape - sections through the site (2.15) The marina - a dynamic organism

(2.16) Movement on the site - heavy traffic and pedestrians (2.17) The qualities of the site - proximity to the marina in the northeast corner and the open landscape and scenic views toward Limfjorden

UNDERSTANDING THE CONTEXT

TYPOLOGIES, ACCESS, AND CLIMATE

Typologies and access

The buildings along the harbour front have a natural direction toward the water due to either logistics or the visual connection to the water. The butchery to the east covers a large area of the harbour with a dense building mass. As the industry is growing it has been proposed to expand the eastern part of the harbour front into the water.

Large parts of the western harbour front have undergone a revitalisation during the last decades. Thus, this side of the harbour front is characterised with modern point volumes with enough distance in between to form squares, recesses, and open areas. The two larger building volumes close to Sydhavnen house a supermarket, a restaurant and brewery, a pharmacy, and medical treatment. These functions provide daily activity of the area close to Sydhavnen.

The existing commercial part of the harbour is located on the pier inside the harbour and continues to have a central location. The open space allows easy access to and from the water. As oppose to the surrounding part of the harbour, the commercial area has not undergone a revitalisation.

Fig. 2.18: Diagram of typologies and access

Climate

The distance to the surrounding buildings leaves Sydhavnen exposed to both wind and sun. The wind rose indicates western wind as the most dominating direction in this area and the location on the outer part of the harbour leaves Sydhavnen particularly exposed to the wind. In periods with wind coming from the east, the harbour front will be bothered by the smell from the nearby treatment plant.

The climatic registrations are a part of the initial analysis of the area, which influence the planning and organisation in an early stage and is incorporated as a passive strategy.

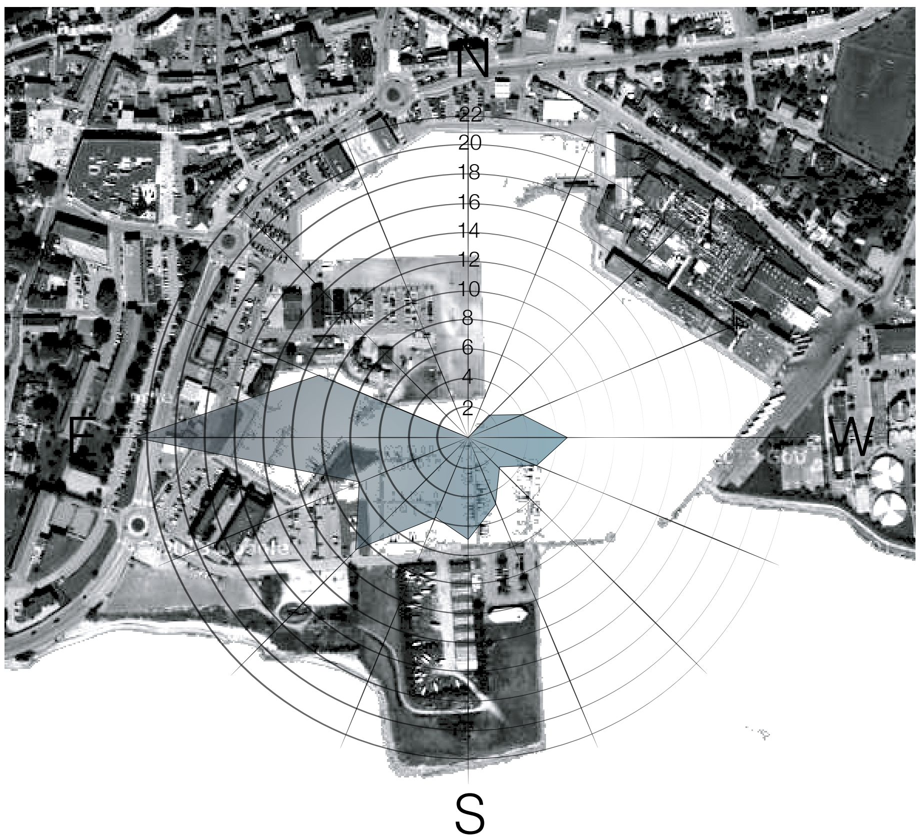


Fig. 2.19: Diagram of wind speed m/s and wind directions on an annual basis

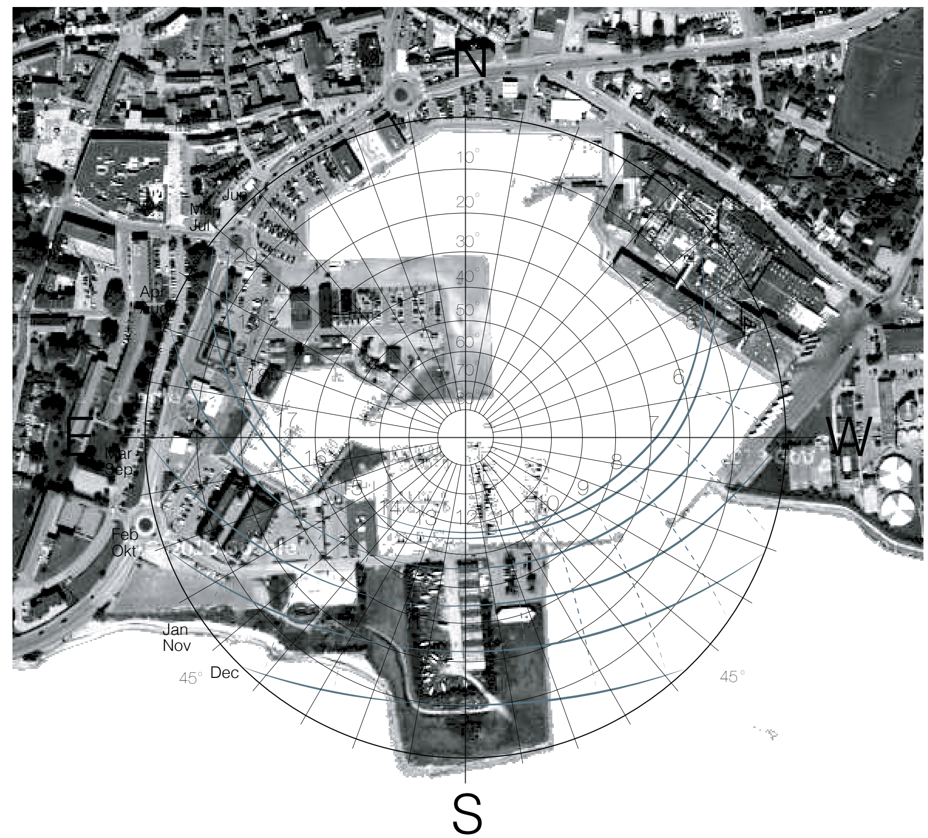


Fig. 2.20: Diagram of sun paths at latitude 56°27'00"N on an annual basis

INSPIRATION

RECREATIONAL ACTIVITIES AND ARCHITECTURAL MEANS

The previous parts of the analysis have established a consensus to see Sydhavnen develop in the near future. Despite the noticeable location and great potentials the dead end road and the poor guidance leave the area with an illegible and private atmosphere.

The intention of designing a new maritime clubhouse is to create modern and integrated facilities for the different maritime sports that contribute to the existing maritime atmosphere on Thisted harbour front and make an attractive and encouraging recreational environment for club members, local residents, and visitors of all ages. The maritime activities can more or less be considered as optional and social activities, which makes it relevant to study what characterises a good recreational environment.

Openness - Invitation - Gathering

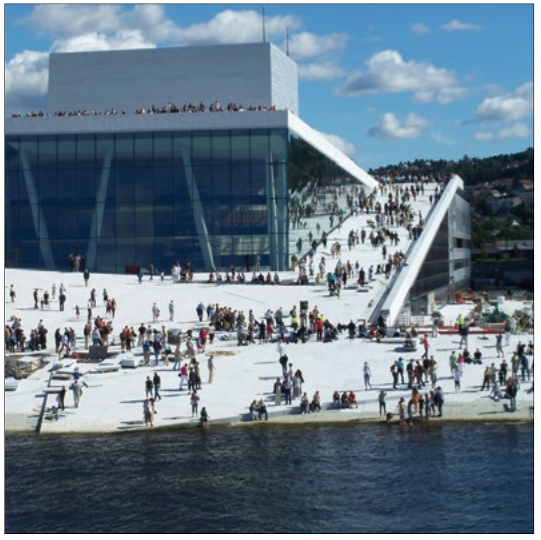
In order to design a pleasant environment that encourages to pass, to stay, or to perform any kind of activity it is necessary to consider how the area opens up and invites you. The need for having an overview and not being taken by surprise is crucial, however, this does not necessarily mean a large amount of windows or a large open square. The proportions of a building, the distance between functions and areas of interest, and the direct path of movement are elements to be considered. (Gehl 2003)

A pleasant environment is also characterised by the atmosphere of the place. Whether it is a public or a private area, the atmosphere of the place will affect the human behaviour and the optional and social activities. The pictures show different atmospheres and physical environments that encourage to some kind of human activity and as architect Jan Gehl (2010) states: *"… a positive spiral where one plus one can equal more than three…"* to support the old saying where good people are more will come.

Jan Gehl states in his book *Life Between the Houses*:

"…through planning it is possible to influence the patterns of activity and to provide the outdoor activities with good or poor conditions…"
- Gehl 2003

In order to investigate this interaction between the outdoor activity and the built environment some existing maritime environment and the architectural means have been studied.



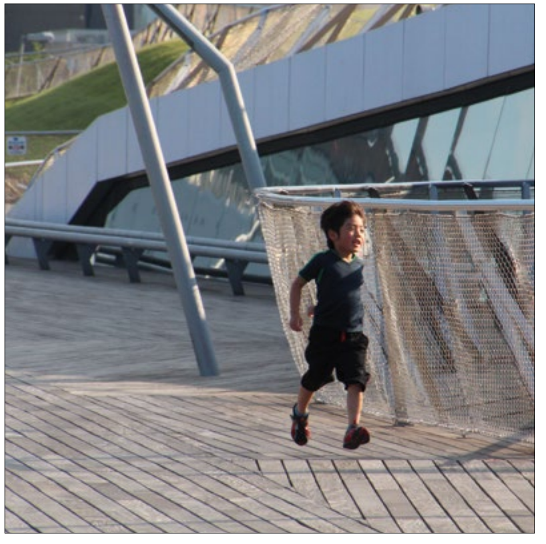


Fig. 2.21: Recreational environments in proximity to the water

HAMMERHAVN MULTIHUS - BORNHOLM

CUBO ARCHITECTS | 175 M^2 | YEAR: 2012


Fig. 2.22: The relation to the historical surroundings

The gesture

The multi house in Hammerhavn, Denmark, is located within the historical area surrounded by Hammershus and Hammerknuden. The location and the visual connection to the area are the main concept of the project by CUBO architects. In between the existing harbour and the boat houses there are three small houses build with strong reference to the traditional maritime building typology. They house a multifunctional space, the club Sæne Bådelaug, a harbour office, kiosk, and changing facilities. The architectural idea was to arrange the houses in proximity to each other. (Archdaily 2014)

The plan (Fig. 2.23) indicates how the angles and the façade openings are carefully designed in order to preserve the view of the harbour and create an open and visible space. As you approach the hoses the kiosk and harbour office open up to inform the visitors and to give them an overview. The composition of the three houses directs you into the central outdoor space together with the pitching roof to guide your perspective toward the historical attractions and the surrounding landscape. The arrangement and shape of the houses make the spaces inside and outside flexible as the season changes. (Archdaily 2014)

Proximity

The existing buildings are of great importance to the environment and activities on the harbour. The wooden sheds patinate over the years and create an intimate environment with small niches and corners sheltered from the wind. In the same way, the three new houses create attractive outdoor spaces that can be used throughout the day. Thus, the building typologies interact with the existing building scale and the atmosphere in the area is maintained. This fulfils the intention of creating an environment for social gathering at the harbour where the visitors and the locals are able to meet. (Bornholms Regionskommune 2014)

Materials and detailing

The structure is a light wood construction cladded with untreated Azobe wood on the façades and the roofs. The gutter has been carefully hidden to maintain a clear architectural and contemporary interpretation of the traditional building typology of the small-scale houses with pitching roofs. The homogeneous Azobe cladding on the facades and the roofs provide the three small houses with a sculptural appearance towards the sea and enhance the quiet and comfortable atmosphere. (Mulighedernes Land 2014)

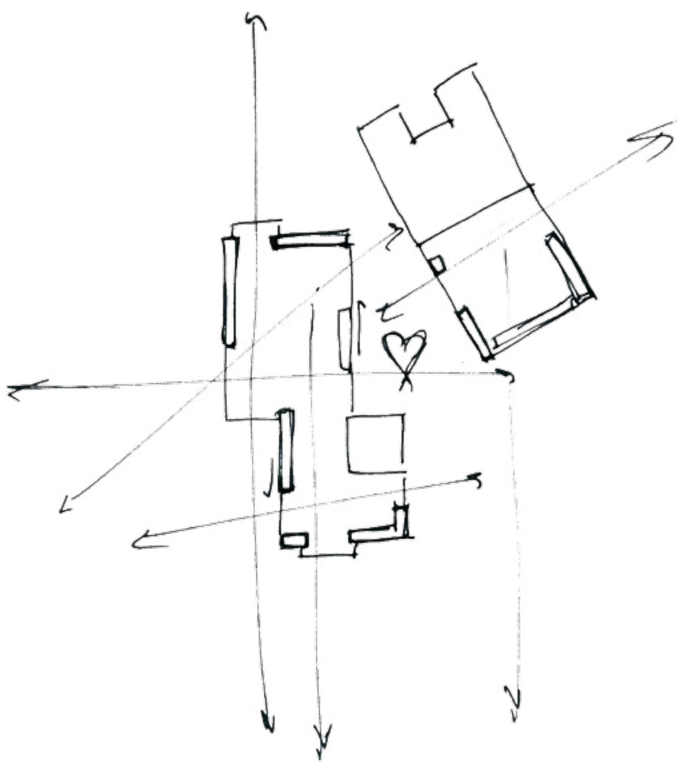


Fig. 2.23: Plan drawing - organisation and views

Fig. 2.24: Multi house in Hammerhavn

SEJLKLUB - VÆDBÆK

TEGNESTUEN VANDKUNSTEN | 1200 M² | YEAR: 1990

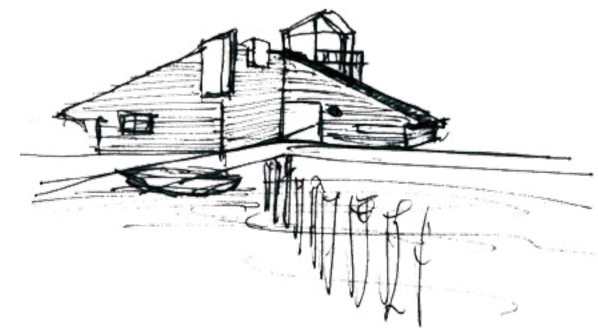


Fig. 2.25: Perspective of the clubhouse

The gesture

The maritime clubhouse in Vedbæk is located north of Copenhagen and stretches along the marina. A total of seven houses are strategically placed in relation to the functions to ensure the optimal facilities for the divers, surfers, and sailors. The houses also include a storage space for gear, boathouses, the senior yacht club, a restaurant, a marina office, and meeting rooms used by the local clubs. (*Vedbæk Havn* 1991)

Proximity

Even though, the houses are divided and located along the marina the architectural expression and typology still allow the houses to interact with each other and define the outdoor spaces and views in between. The strong building volumes with pitching roofs are orientated toward the marina, thus, framing the inspiration for the design to emphasise the surroundings. The dense building volumes become a resembling of the boat hull with the low stern combined with balconies and flagpoles. This enhances the maritime environment together with the dark exterior and round portholes. (*Vedbæk Havn* 1991)

The seven houses become an extension of the boat piers and create an outdoor space in between to highlight the transition from land to water. (Træbranchens Oplysningsråd 1994)

Materials and detailing

The construction is a lightweight wooden structure covered with black tarnite plates on the façades and black felt roofing. The buildings are raised from the ground due to the tides. Although, some of the houses have more than one storey, the roof comes down to the human eye level and reduces the buildings to interact with a human scale. (*Vedbæk Havn* 1991)

The maritime character of the exterior continues for the interior design of the restaurant to contribute to the maritime experience. The large overhangs and the separation of the building volume encourage an intimate atmosphere and frame the views toward the marina. (Træbranchens Oplysningsråd 1994)

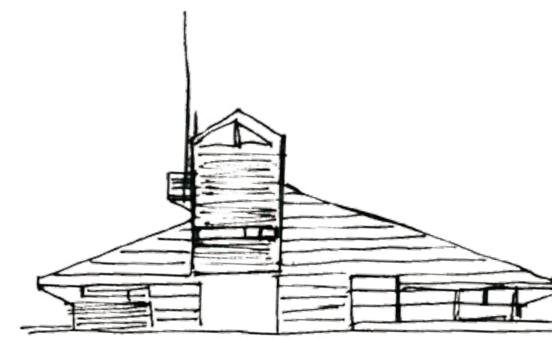


Fig. 2.26: Clubhouse west elevation

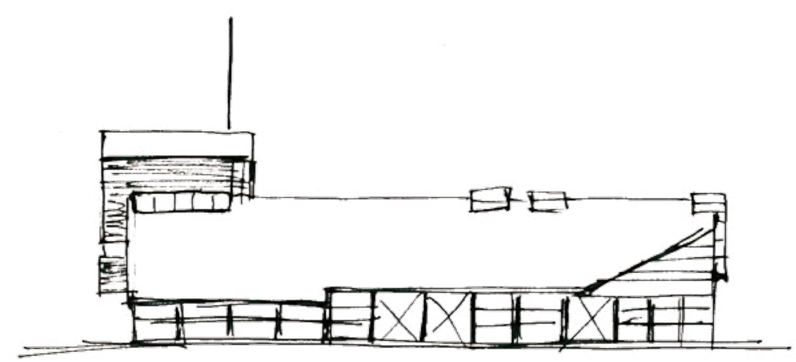


Fig. 2.27: Clubhouse south elevation

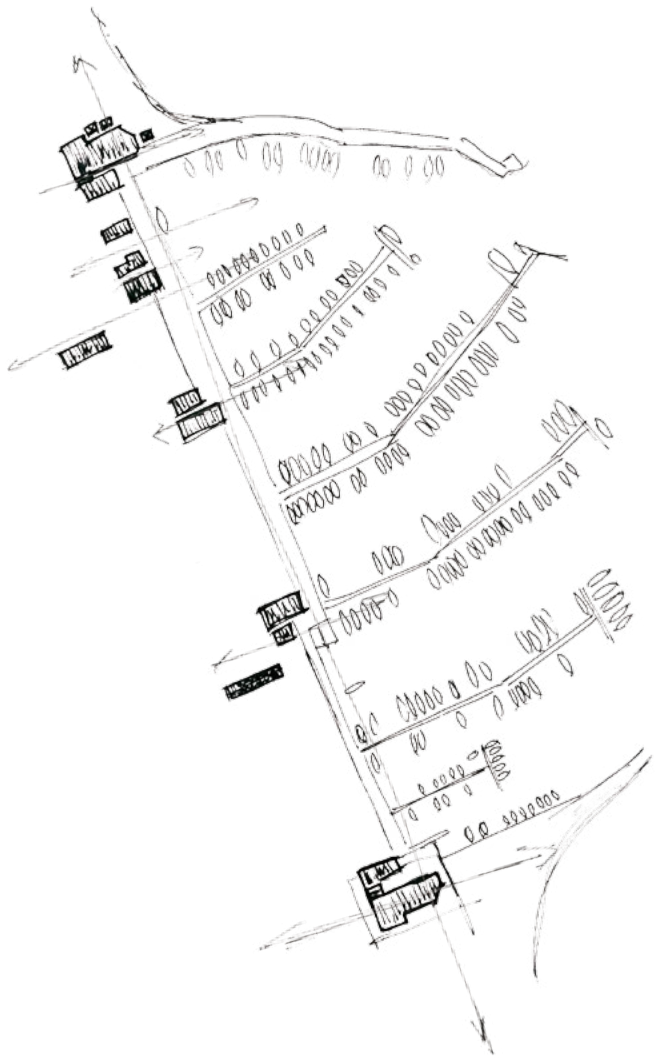


Fig. 2.28: Master plan - the architecture as an integrated part of the marina

Fig. 2.29: Clubhouse at Vedbæk marina

INTEGRATED FACILITIES

COMMUNITY AND GATHERING

The clubhouse in Vedbæk shows how several maritime sports can be gathered to benefit from one another by sharing facilities, operational cost, maintenance, and experiences.

The same approach will be used in this project to rethink the future development of the various maritime clubs in Thisted. As the population in the peripheral areas of Denmark decrease, the need for reconsidering the physical environment increases. Economic sustainable perspectives have led to the centralisation of several public functions such as health care and municipality services – and Thisted is no exception. This project attempts to gather the maritime clubs to benefit from the close connection to Limfjorden with a social and economic sustainable perspective in mind. Potentially, this strategy would strengthen the relations among the clubs and continue to make the different sports more attractive and interesting also for new members.

Studies were made in order to develop a project brief for the new common facilities. A meeting with Simon Kristensen, the chairman of the existing sailing club, contributed to at more in depth understanding of the functional demands. Simon Kristensen confirmed a vision for a future expansion as the number of members is stagnated while current members simultaneously are getting grey-haired. However, he states: *"…future positive developments require new young enthusiasts"* (Kristensen 2014)

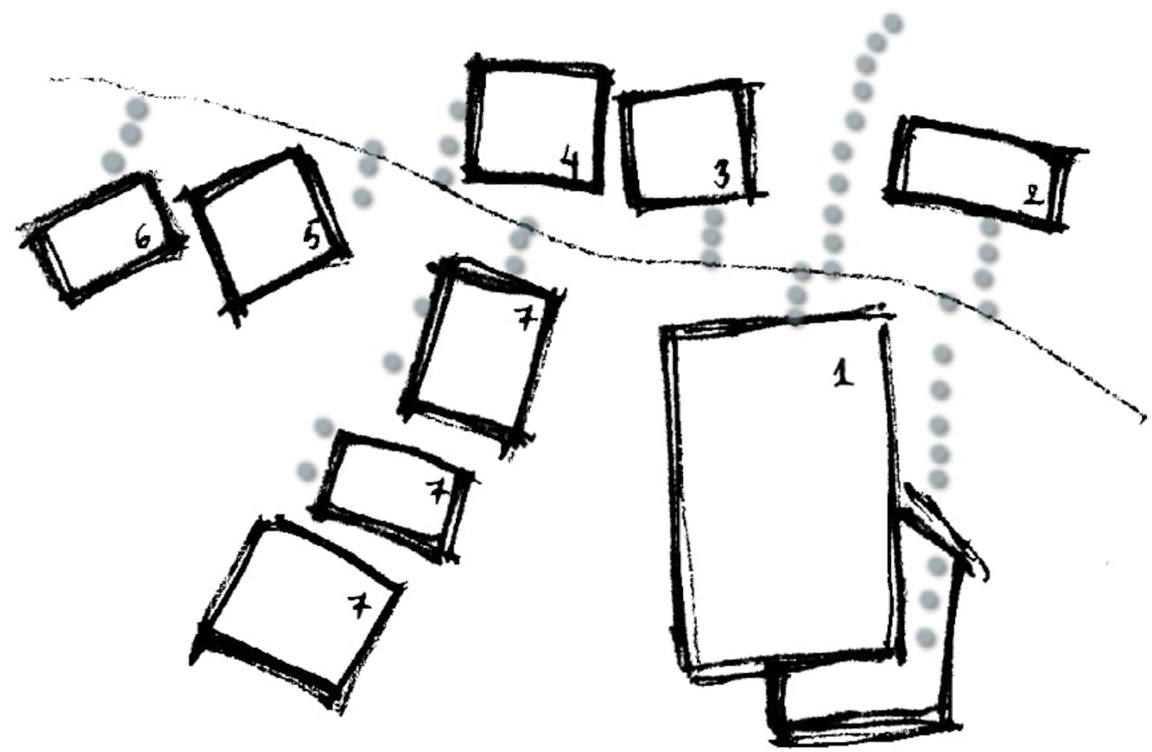


Fig. 2.30: Diagram of functional relations

SPACE PLANNING

FUNCTIONS AND ORGANISATION

(1) BOAT HALL	Size m²	User load	Amount	Functional demands	Spatial qualities and potentials
Boat hall	900	50	1	- Clearance height: 12 meters for professionals (boat and mast) - Clearance height of less than 12 meters must be clearly marked. - Direct ground level access. - In proximity to the slipway. - Must appear as a workspace. - The interior light must provide comfortable work light. - Possibility of hanging the sails in the ceiling. - Sufficient space for maintenance and sailing preparation. - Robust and non-slippery floors. - Possible heating, minimum 5°C. - Short distance to meeting rooms and race lounge.	- The use of materials and the atmosphere must reflect the function and robustness. - The space must have an added value to be more than just an industrial hall. - The openings in the façade should contribute to the transparency and visibility for passers-by. - The necessary large dimensions should be utilised as a point of orientation/landmark to contribute to the surroundings - also from a distance. - A visual connection between the boat hall and race lounge should contribute to the spatial relation and atmosphere to “shorten” the distance between the spaces. - The tribune should be a pleasant area to stay for a longer period of time, thus, sun, shadows, and wind should be taken into account. The tribune must be a combination of patios, steps, and setting to encourage for various uses.
Race lounge & tribune	80	40	1	- Clear view toward Limfjorden and the on-going races. - Direct access to the outdoor tribune.	
Meeting room	40	20	1	- Flexible walls and seating arrangement. - The space should be able to adapt to board meetings, educational use for the local schools, strategy meetings before races, and for media and press during large events.	
Offices & kitchen	80	5	1	- Minimum of four workstations. - Comfortable work light and indoor climate.	
Toilets	16	-	3	- Accessible for disabled.	
Print & storage	5	-	1		
Technical room	2	-	1	- Ventilation and exhaustion according to demands.	

(2) WORKSHOP

	Size m²	User load	Amount	Functional demands	Spatial qualities and potentials
Workshop	85	10	1	- Sufficient space for three wooden boats under restoration. - Heated space for a pleasant room temperature during wintertime. - Lockable racks for gear, tools, and materials. - Compressor for divers.	- The openings in the façade should contribute to the transparency and visibility for passers-by. - Gear and tools should be visible and a natural part of the interior expression.
Kayak & diving storage	70	8	1	- Dimensioned to fit the length of a two-person kayak. - Entrance dimensioned to fit the total width of one person and one kayak. - Possible heating, minimum 5°C. - Racks to support oxygen cylinders. - Sufficient area in front of the entrance to manoeuvre the kayak.	
Technical room	1	-	1	- Ventilation and exhaustion according to demands.	
Fresh water clearning area (outdoor)	-	-	-	- Short distance to workshop. - Sufficient area to fit trestles for preparation and cleaning of kayaks and diving equipment.	

(3) CLUBHOUSE

	Size m²	User load	Amount	Functional demands	Spatial qualities and potentials
Kitchen and dinning	70	35	1	- Flexible seating arrangement.	- The space should have a welcoming and cosy atmosphere that encourage social gathering and sharing experiences.
Living room	35	15	1		
Toilets	16	-	3	- Accessible for disabled.	
Laundry	14	6	1	- Drying racks and table.	
Technical room	1	-	1	- Ventilation and exhaustion according to demands.	

(4) RESTAURANT	Size m^2	User load	Amount	Functional demands	Spatial qualities and potentials
Dinning area	100	60	1	- Direct access to outdoor dinning area. - Flexible seating arrangement. - Proper dinner lighting.	- As many tables as possible should have a view towards the water. The dining area should open up towards the outdoor. - The dining areas (inside and outside) should be a pleasant place to stay for at longer period of time. Sun, shadows, and wind should be considered. - The restaurant should be designed in response to the maritime atmosphere and have a central and visible location. - The openings in the façade should clearly mark the entrance space.
Kitchen	30	8	1	- Non-slippery and easily cleaned flooring. - Interior design according to optimal kitchen regulations.	
Dishwashing	6	2	1	- Non-slippery and easily cleaned flooring.	
Storage	15	-	1	- Non-slippery and easily cleaned flooring. - Easy accessible for goods reception. - Cold and dry storage	
Cloakroom	2	-	1	- Close to the main entrance. - Hanger rails.	
Guest toilets	10	-	2	- Accessible for disabled.	
Staff toilet	3	-	1		
Technical room	1	-	1	- Ventilation and exhaustion according to demands.	

SHELTER AND CABLE PARK	Size m^2	User load	Amount	Functional demands	Spatial qualities and potentials
Shelter	20	10	1	- Wood stove - Benches	- A meditative view towards Limfjorden. - Wood stove to contribute to a cosy atmosphere.
Kiosk	35	2	1	- Opened during the summer. - Cable park booking and rental.	- The houses should relate to the casual atmosphere.
Toilets	16	-	2	- Short distance to the cable park and playgrounds. - Accessible for disabled.	
Storage	10	-	1	- Racks and hanger rails for cable park gear.	

(5) CHANGING ROOMS	Size m²	User load	Amount	Functional demands	Spatial qualities and potentials
Changing rooms	80	25	2	- Gender specific. - Non-slippery and easily cleaned flooring. - The windows should be placed minimum two meters above outside ground level to secure privacy. - Lockers for temporary use. - Large floor space for wetsuits and clothes. - Furnished with benches. - A minimum of three showers. - Floor heated space for a pleasant room temperature.	The use of materials should be considered to avoid a practical and clinic expression within the whole building. The high windows should be dimensioned to bring in as much light as possible. The openings in the façade should clearly mark the entrance space. The openings in the workout should have views toward the surroundings/nature.
Sauna	20	10	2	- Gender specific. - Wooden interior.	
Toilets	20	-	2	- Gender specific and accessible for disabled. - Non-slippery and easily cleaned flooring.	
Entrance & lockers	20	-	1	- Approximately 60 personal lockers for members. - Non-slippery and easily cleaned flooring.	
Drying room	8	3	1	- Heated space for gear and wetsuits. - Sufficient amount of hanger rails. - Non-slippery and easily cleaned flooring.	
Workout	50	15	1	- Training equipment - For multipurpose usage.	
Technical room	5	-	1	- Ventilation and exhaustion accordingly to wet rooms, saunas, and workout spaces.	

(6) MARITIME STORE	Size m²	User load	Amount	Functional demands	Spatial qualities and potentials
Store	70	10	1	- Maritime supplies. - Store fixtures.	- The openings in the façade should contribute to the transparency and visibility for passers-by. - The openings in the façade should clearly mark the entrance space.
Offices & information	20	4	1	- Two workstations. - View toward the arrival area and marina. - Comfortable work light and indoor climate.	
Staff room	20	4	1	- Kitchen and table. - Access to outdoor space.	
Staff toilet	4	-	1	- Accessible for disabled.	
Storage	12	-	1	- Available for stock.	
Techincal room	1	-	1	- Ventilation and exhaustion according to demands.	

(7) BOATHOUSES	Size m²	User load	Amount	Functional demands	Spatial qualities and potentials
Boathouse A	230	-	1	- Dimensioned to fit as many boats as possible. - Sufficient storage space for gear and masts. - Possible heating, minimum 5ºC. - Direct ground level access. - Robust and non-slippery floors. - Easy access with a trailer. - The entrance areas must be dimensioned accordingly to boat dimensions. - The interior light must provide comfortable work light.	- The boathouses must have a maritime expression to relate to the function and the marina. - The openings in the façade should contribute to the transparency and visibility for passers-by and makes it possible to use the houses for events during summer.
Boathouse B	170	-	1		
Boathouse C	300	-	1		

Total: **2.693m²**

03 | CONCEPT

A HUMAN PERSPECTIVE

ARCHITECTURE FOR PEOPLE

The analysis of the context, site, and users indicates how the community and the proximity are qualities at Sydhavnen in Thisted. The case studies have showed some examples of great maritime environments with community and proximity as important factors to the physical environment and the social activities. Both cases pay particular attention to the human scale, thus, the fundamental vision and the design parameter for this project are to work in proximity to the human scale in every scale.

"…to become a good architect you need to care about humans, because architecture is meant to be used and is the framework of the human life."
- Ralph Erskine, 2000

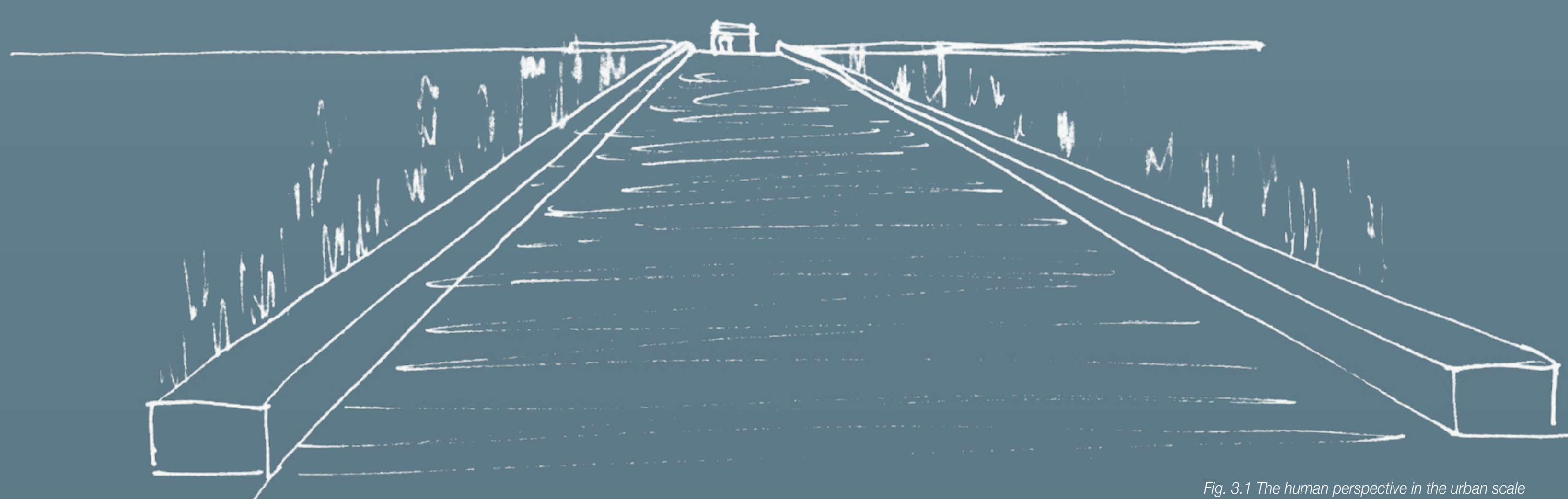


Fig. 3.1 The human perspective in the urban scale

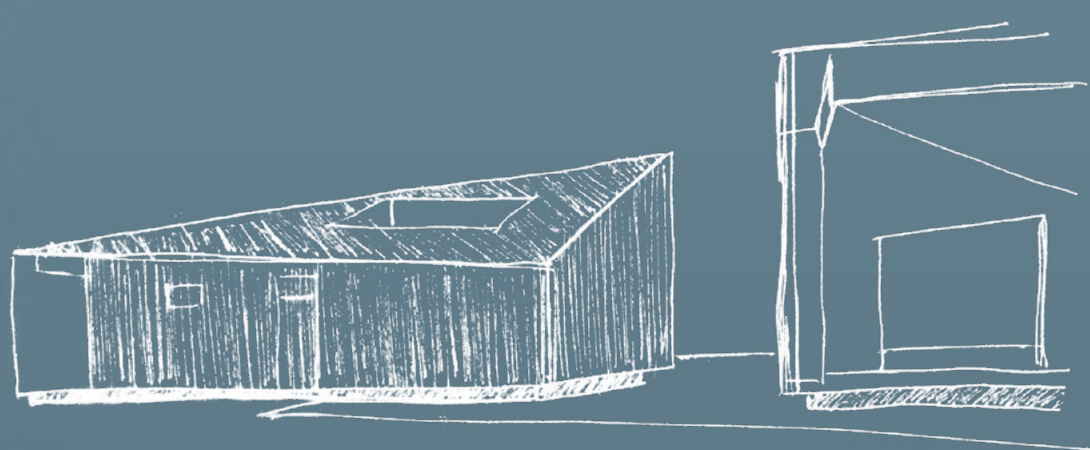


Fig. 3.2: The human perspective in the architectural scale

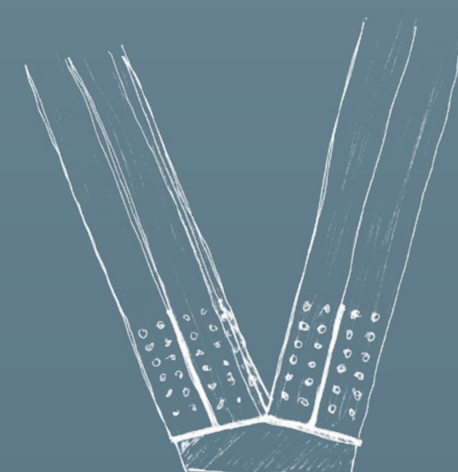


Fig. 3.3: The human perspective in the detail

ON THE EDGE OF LAND AND WATER

Settled in the northeast corner Fjordbyen embraces the maritime environment at the marina and becomes the social gathering point.

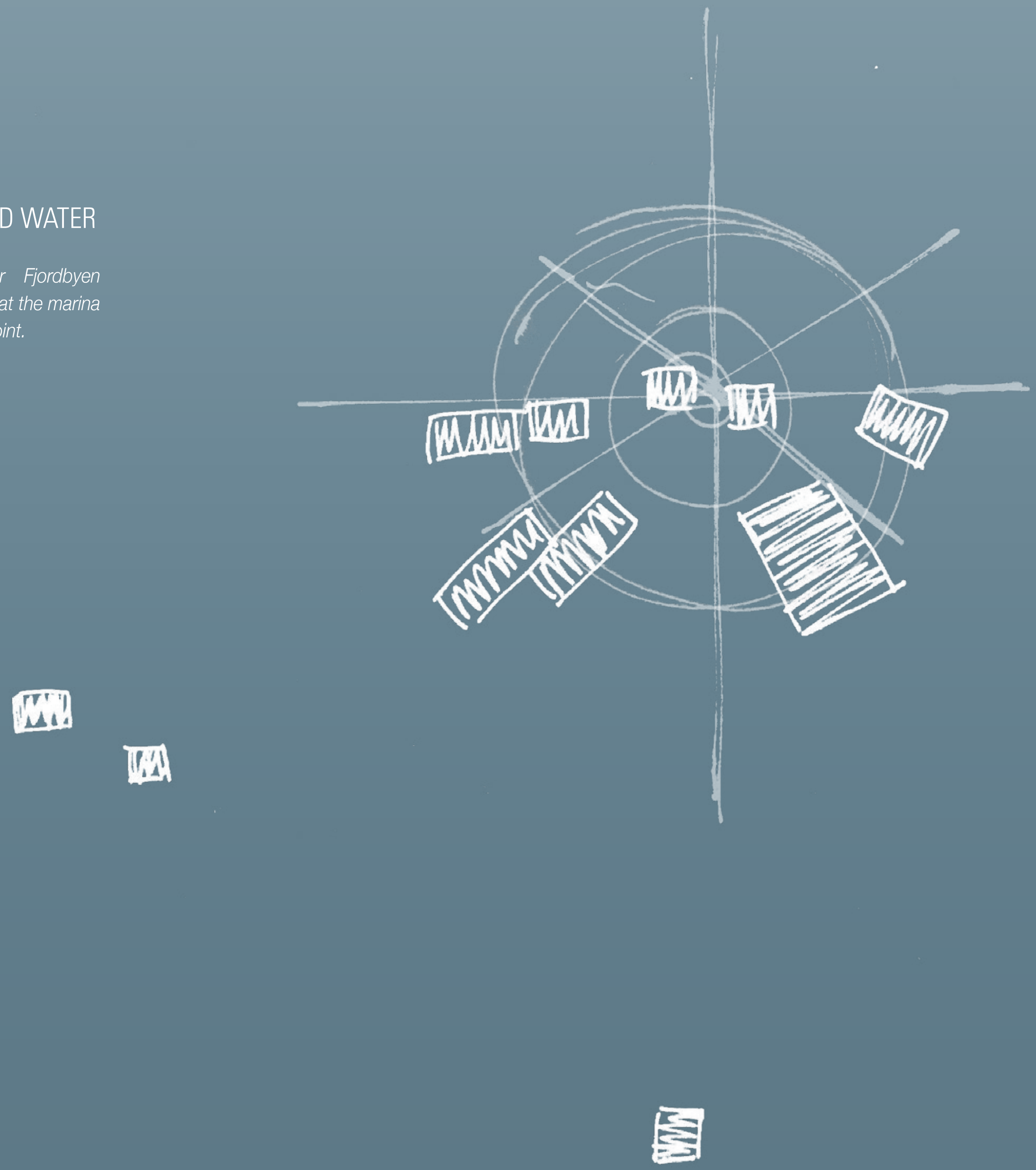


Fig. 3.4: Conceptual diagram

WALKING THE LANDSCAPE

The boardwalk is an interpretation of the marina and becomes an urban invitation to inhabit the landscape and walk along the coast.

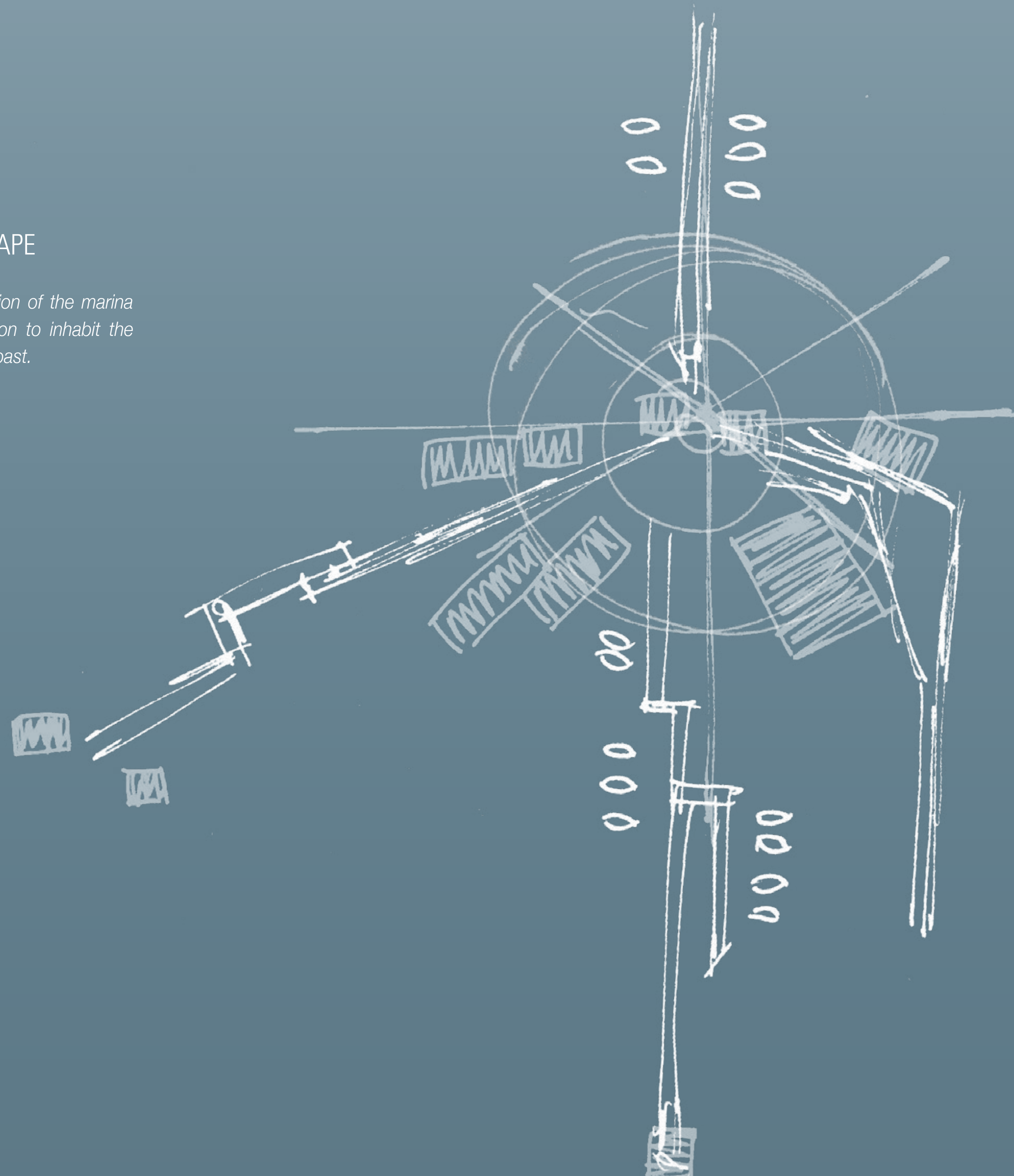


Fig. 3.5: Conceptual diagram

04 | PRESENTATION

ARCHITECTURAL DESIGN

MASTER PLAN // 1:1000

Architectural design

Part 1: Fjordbyen
Part 2: Boat Hall
Part 3: Workshop
Part 4: Restaurant & clubhouse
Part 5: Changing rooms & maritime store
Part 6: Boathouses
Part 7: Arrival from sea

Urban design

Part 1: Master plan
Part 2: Recreational activities
Part 3: Cable park
Part 4: Shelter
Part 5: Winter scenario

Materials and detailing

Part 1: Materials
Part 2: Wind studies
Part 3: External shading
Part 4: Solar cells
Part 5: Reuse of rainwater

Fig. 4.1: Master plan 1:1000

FJORDBYEN

ON THE EDGE OF LAND AND WATER

The concept of gathering around a centre is the main architectural idea of Fjordbyen. The location in the northeast corner and the subdivision of the functions allows the nine houses to stretch from the central location into the open landscape. Thus, the proximity between the facilities and water is obtained to ensure optimal conditions for the users so the architecture contributes to the existing maritime environment.

Located on the edge of land and water, the social functions become the central gathering point at the marina surrounded by the water and the boathouses to meet both sailors and non-sailors. As you find yourself in the centre of Fjordbyen the houses begin to open up and frame the scenic views toward the open landscape and Limfjorden in the horizon.

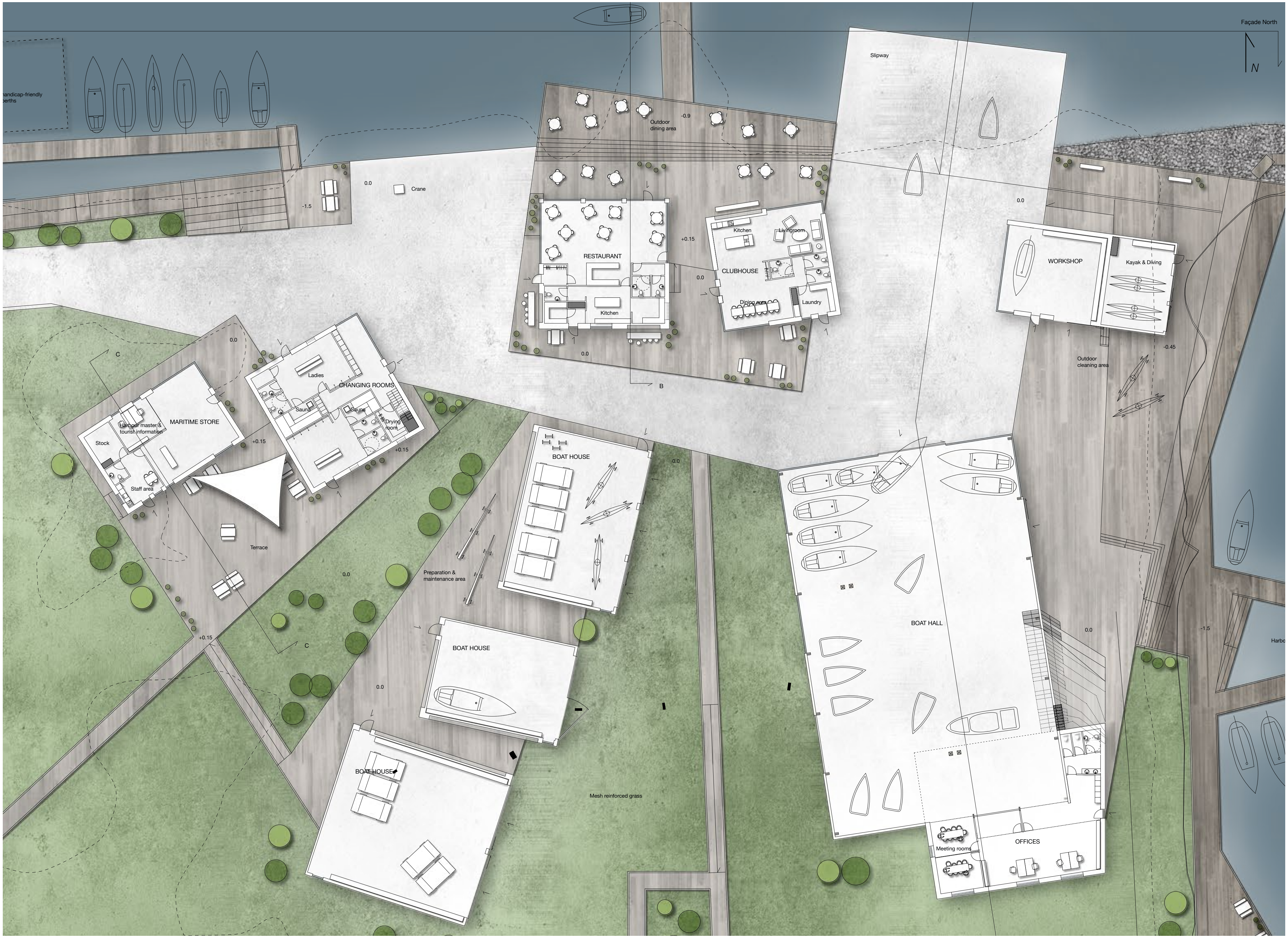
Fig. 4.2: Visualisation of Fjordbyen

FJORDBYEN

GROUND FLOOR // 1:500

The village of houses and their organisation define the outdoor spaces. The large openings in the façades contribute to blur the boundaries between the interior and exterior. The niches enable the users to inhabit the outdoor space as their sport requires and encourages for social interaction between club members and visitors. The niches designed for more permanent stay are characterised by the timber terraces surrounding the houses while interacting with the water. The houses shield the niches from high wind speed without blocking the sun to create a pleasant environment for different activities. The large terrace outside the maritime store and the tribune on the east side of the boat hall invite you to stay and sit down for a longer period of time with the furniture and large steps. The spaces around the boathouses and workshop are easily inhabited by the sailors and rowers when they should prepare their gear and for the passers-by to see. Along the façade of the restaurant and the clubhouse, members and visitors are invited to sit down and observe the activities at the marina and to interact with each other – and as the weather changes during the day, other spots in the sun will appear.

Fig. 4.3: Ground floor 1:500



Façade North
N
handicap-friendly berths
Slipway
Outdoor dining area
-0.9
0.0
Crane
-1.5
RESTAURANT
Kitchen
+0.15
CLUBHOUSE
Kitchen
Livingroom
Dining area
Laundry
WORKSHOP
Kayak & Diving
Outdoor cleaning area
-0.45
B
C
MARITIME STORE
Harbour master & tourist information
Stock
Staff area
CHANGING ROOMS
Ladies
Sauna
Sauna
Drying room
+0.15
Terrace
BOAT HOUSE
Preparation & maintenance area
BOAT HOUSE
BOAT HOUSE
BOAT HALL
Mesh reinforced grass
Meeting rooms
OFFICES
-1.5

ARRIVAL

A WELCOMING GESTURE

As you approach the area you are met by the small-scale houses, pitching roofs, and large façade openings that welcome, invite, and guide you into *Fjordbyen*. The concrete pavement makes it easy to navigate the boats but also allows pedestrians to move around. The pavement runs parallel to the water on the left and is outlined by the houses to highlight that you are walking on the edge of land and water. The visible location of the public functions and the large openings in the façades makes it easy to orientate and guides you to the entrance.

The traditional wooden boathouses are interpreted into a clear and characterful expression with a concrete base lifting the house from the ground and with robust materials to patinate in the rough climate. The simplicity of the architecture adds a level of modesty and allows the maritime activities to become the focal point. The low houses and the pitching roofs guide your perspective toward the large boat hall that you sense in the background to emphasise the walk towards the boats.

Fig. 4.4: Visualisation when arriving at Fjordbyen

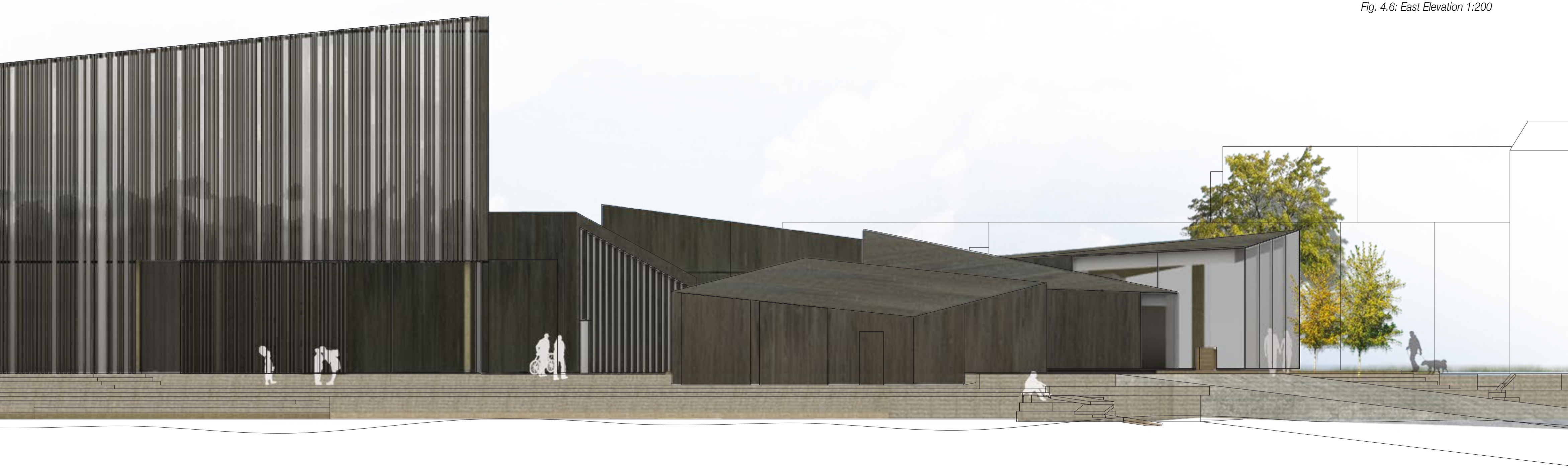

FJORDBYEN

NORTH ELEVATION // 1:200

EAST ELEVATION // 1:200

Fig. 4.5: North Elevation 1:200

Fig. 4.6: East Elevation 1:200



BOAT HALL

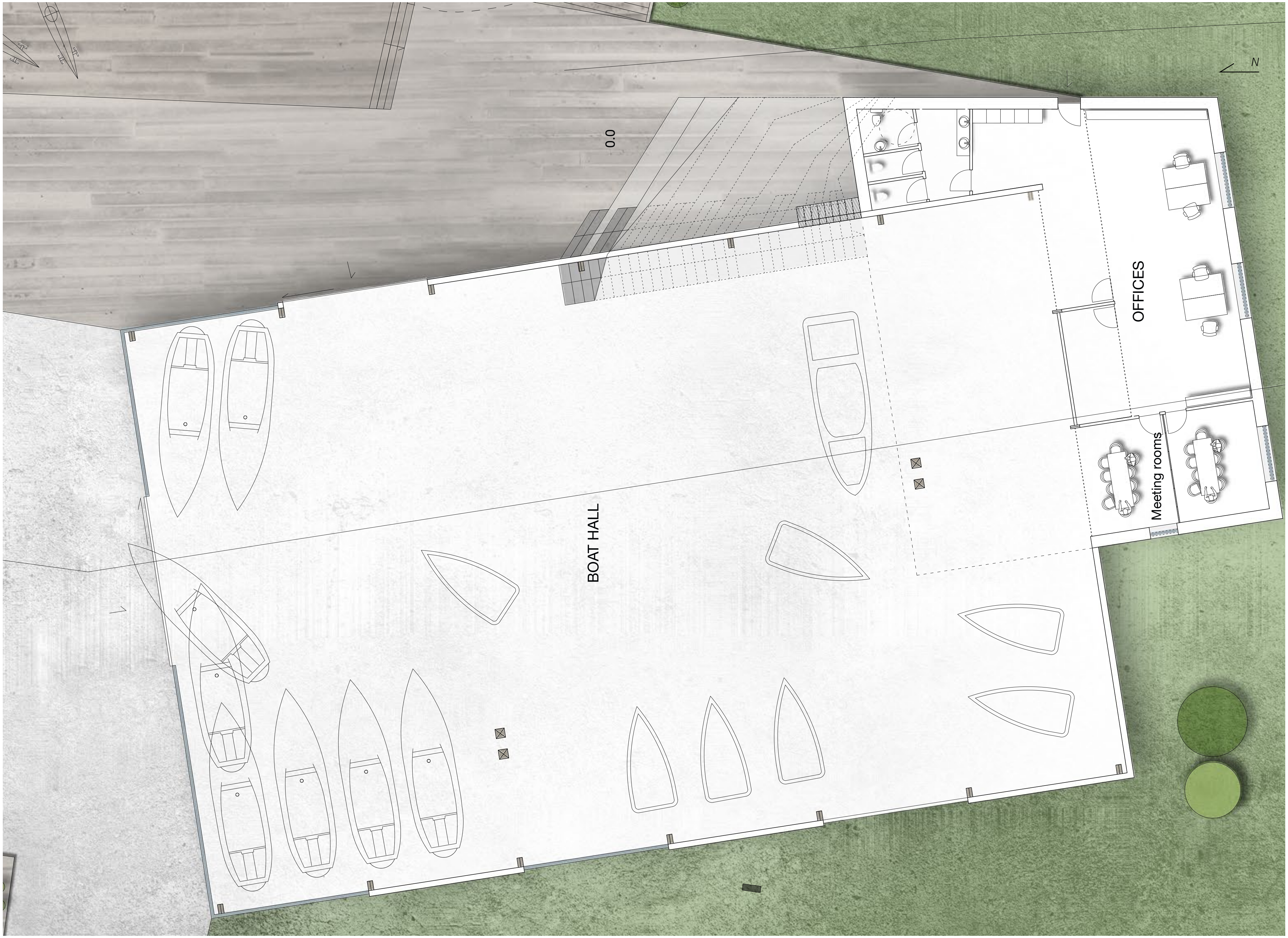
ROBUST & ELEGANT

The oak and steel frames are stabilised by the freestanding columns, the wind crosses, and the roof plate *'stretching'* the translucent polycarbonate to give the impression of the boat mast, booms, and wires that sets sail. The exposed structure contributes to the spatial experience of the large space and tells a narrative of the maritime environment where the use of material strength and the level of detailing is what characterise the functional, the technical, and the aesthetical qualities. The texture and tactility of the warm oak columns highlight the contrast of the dark steel beams and the rough concrete floor and creates a robust yet elegant expression of a working space refined with details and small architectural gestures.

The level of detailing and the exposed columns, which subdivide the depth of the space in modules, scale down the proportions of the large boat hall. Furthermore, the rhythm of the exterior wooden cladding allows different amounts of light to pass through the translucent polycarbonate and blurs the transition between the interior and exterior.

Fig. 4.7: Visualisation of the boat hall interior


DEN
296
SEIKO



N
0.0
OFFICES
BOAT HALL
Meeting rooms

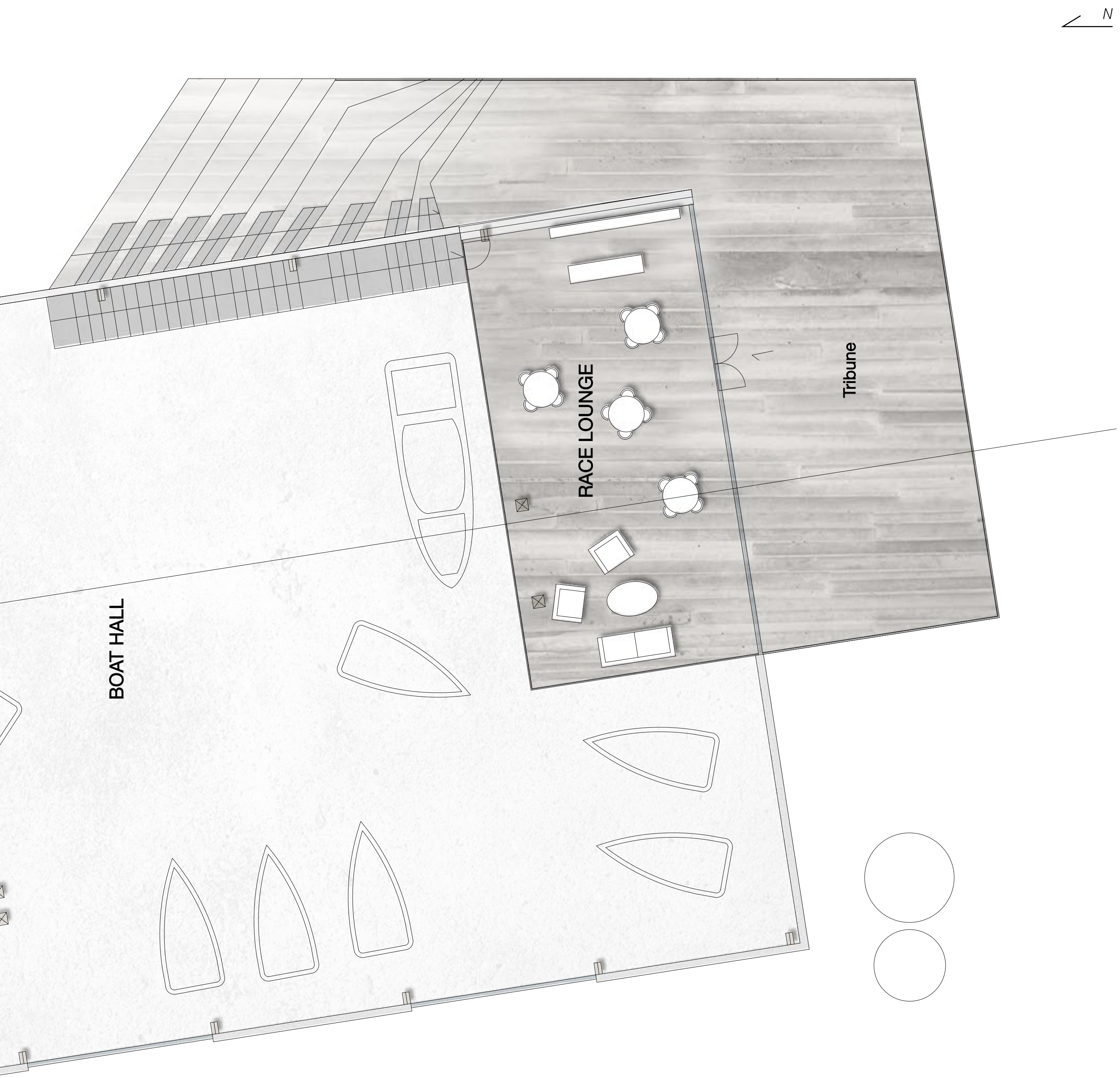


Fig. 4.8-4.9: Ground floor and first floor 1:200

BOAT HALL

GROUND FLOOR & FIRST FLOOR // 1:200

The plan of the boat hall indicates the location of the freestanding columns, which divides the space into the 12 meters high room facing the slipway and the lower back area to house a variety of boats. Thus, the columns become an indicator for the sailors when they navigate around the large floor area within the space. The large glass openings and the use of polycarbonate stage the activities and boats and create a visual connection between the interior and exterior space.

The direct connection to the offices and meeting rooms is important to strengthen the relation between the users by sharing the facilities on an everyday basis. The office space is mainly to be used by the administration and the broad members, however, the club members use the meeting rooms for race preparation and knowledge sharing. The flexible space can be used during larger events and races and for educational use for the local schools and youth clubs.

From the offices and meeting rooms you experience the scenic view of the landscape and Limfjorden in the horizon. The boat hall is connected to the race lounge on the first floor by the extensive staircase in the southeast corner that runs along the façade on both the inside and outside - only separated by the large window. The opening allows visitors to sit on the outside and observe the activities going on in the boat hall. From the race lounge, you have a visual connection and overview of the boat hall in the direction of the fjord and a direct connection to the outside tribune where the sport and activities in the fjord are in focus. The tribune wraps around the eastern corner of the boat hall where you can stay sheltered from the west wind.

The large gate in the northern façade is facing the slipway to allow easy access to the water. The smaller boats and dinghies can use the minor gate towards east. When the gates are open in the northeast corner, the front space of the boat hall will float together with the outdoor space toward the workshop together defining an outdoor space and increase the area of working space, which is protected from the wind.

RACE LOUNGE

SECTION A-A // 1:200

Fig. 4.10: Section A-A 1:200

Fig. 4.11: Visualisation of race lounge interior

STRUCTURAL METAPHOR

THE NARRATIVE OF CONSTRUCTION

The structural principle of the boat hall arrives from the metaphor of the mast as both a structural, functional, and aesthetical element of the boat. The freestanding columns, the exposed structure, and the translucent polycarbonate create an interpretation of the mast, the booms, and the wires that sets sail. The freestanding columns become a spatial and structural element of the interior and tell a narrative of the maritime environment.

Fig. 4.12: The metaphor of the mast and sail

STRUCTURE

THE GLOBAL STATIC SCHEME

The dimensions of the boat hall with the 12 meters ceiling height and the 25 meters span made it interesting to investigate the structural dimensions as well as the material combination and subsequent aesthetical considerations.

Due to the functional demands of the boat hall, a simple construction principle has been used. The frame structure allows a large manoeuvring area and a free ceiling height of 12 meters. The aesthetical considerations of the structure were to combine the usage of different material strengths – like for the boats – and to refine the level of detail in the joints as a part of the architectural experience.

The span of 25 meters makes it an advantageous to use steel beams, which is why a slender I-profile was chosen as the transversal beam to obtain the downward forces in the *z*-direction (Fig. 4.13) and distribute the forces to the heartwood oak columns. Together the steel beams and wooden columns form a frame structure with pinned joints that is simply supported. The seven frames are stabilised by the freestanding columns in the *x*-direction and the wind crosses in the *y*-direction and ceiling. The illustration 4.14 shows the loads applied to the structure – here illustrated as load per meter distributed on the beams and columns.

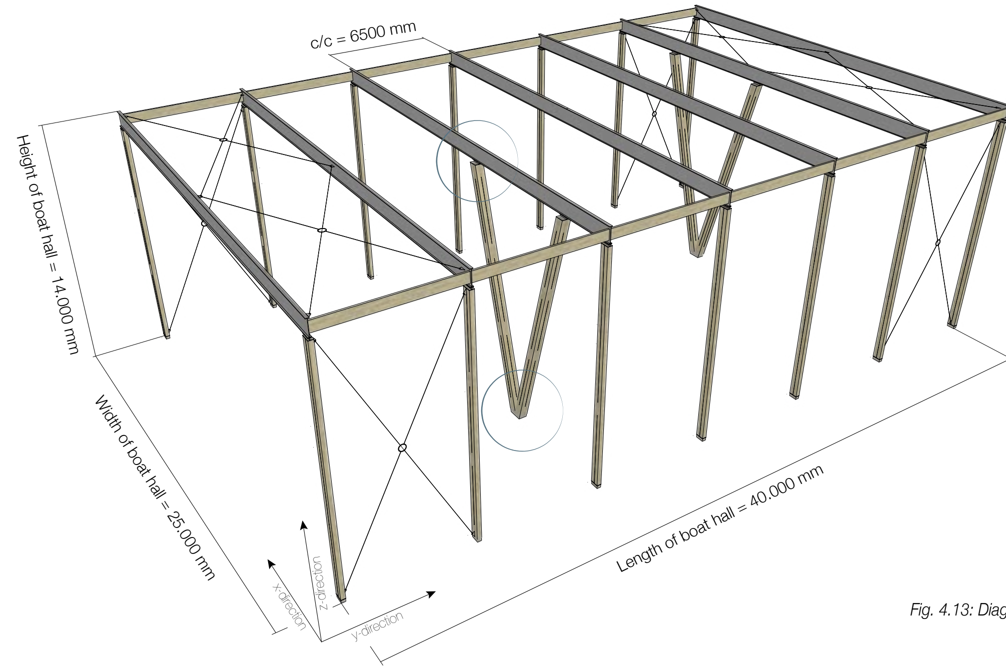


Fig. 4.13: Diagram of boat hall structure

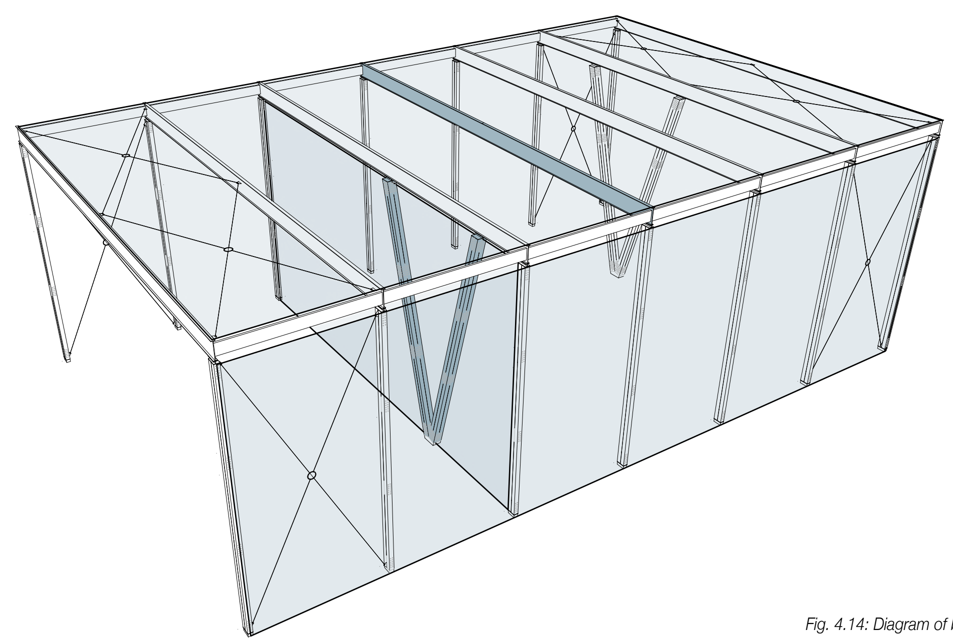


Fig. 4.14: Diagram of boat hall structure

STRUCTURAL DEVELOPMENT

INITIAL CALCULATIONS

As mentioned, the interesting investigations were the dimensioning of the structural elements due to the room proportions and the structural influence of the freestanding columns.

The development of the structure started with some initial calculations of the load obtained by the structure and the deformation of both the steel beam and wooden column. This was done to get a normative basis for the further process and a better understanding of the global system. The calculation deals with the permanent load, the snow load, and the wind load. The payload is not calculated, as you cannot walk on the roof. Due to the focus upon the influence of the freestanding column, the wind load is only calculated on the façades.

In addition, the service limit state (SLS) and the ultimate limit state (ULS) are calculated for both the beam and for the column. Illustration 4.15 shows the profile cross section of the calculated elements. All calculations can be found in Appendix A on page 118.

Wooden column (46mm x 46 mm)
The maximum carrying capacity of the wood column is calculated to 1237 kN in the ULS. The load is calculated to 180 kN
Criteria for a break has been proven by Pd ≤ F => 180 kN ≤ 1237 kN

Steel beam (267mm x 750mm)
Acceptable deformation: 25m / 400 = 62.5 mm
The deflection for the beam is calculated to 5.98 mm.

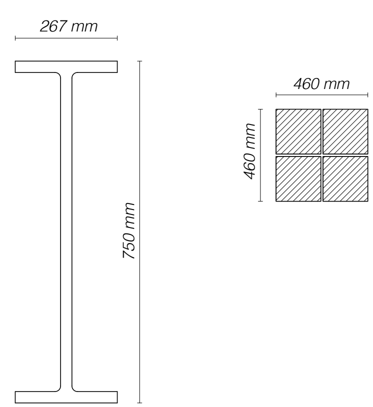


Fig. 4.15: Cross sections of structural elements

STRUCTURAL DEVELOPMENT

THREE-DIMENSIONAL PARAMETRIC MODELLING

The structure is modelled in the software Grasshopper as a three-dimensional parametric model to have the opportunity to regulate various parameters during the design process. The illustrations show some of the parameters that have been adjustable in the model. Illustration 4.16 and 4.17 differ in the amount of frames and illustrations, 4.18 and 4.19, regulate the different locations and the angles of the freestanding columns. Furthermore, the structural dimensions and the material values were adjustable.

The normative values from Appendix A were introduced in the software Karamba to verify our initial assumptions about the design and to demonstrate the structural deformation. By specifying the correct material profile and the corresponding material values, the software is able to calculated to dead load of the structure.

In addition, the permanent load from Appendix A was converted from load per m^2 to load per meter and distributed onto the beams and then applied into Karamba. Afterwards, the snow load and wind load were applied separately to the structural model for evaluation of their effect on the structure. Thus, the software gave an indication of how the global system behaved, where the tensions and compressions occurred, and the maximum deformation – based on the characteristic values. In the structural development the software Karamba is a design tool, which can be used in the iterative process to give an instant guidance of how the structure behaves.

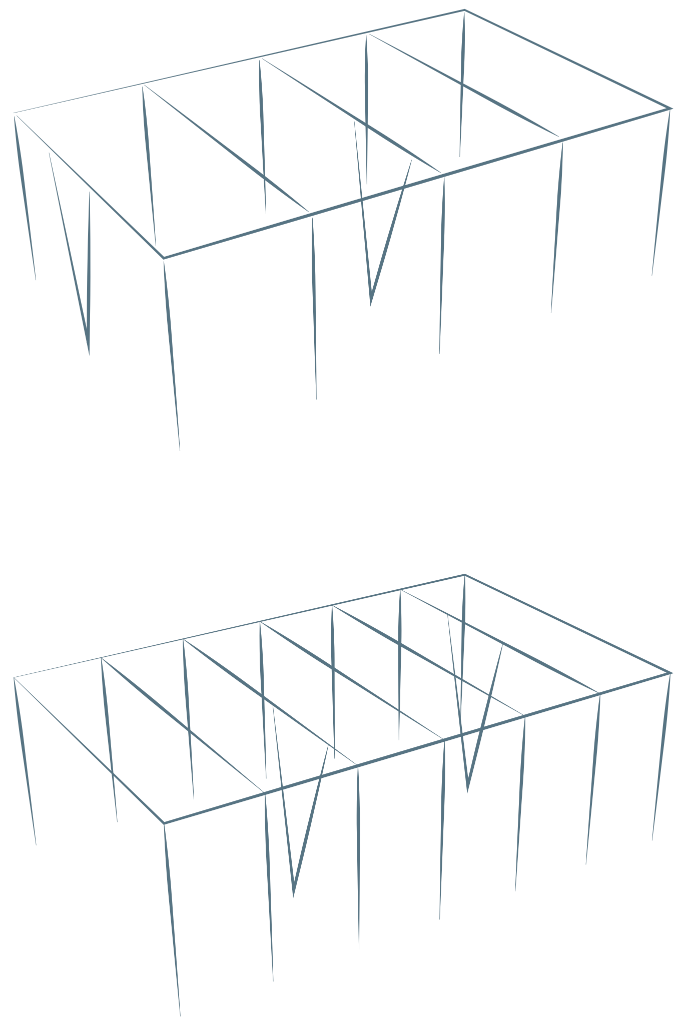


Fig. 4.16-4.17: Controlling the amount of structural frames

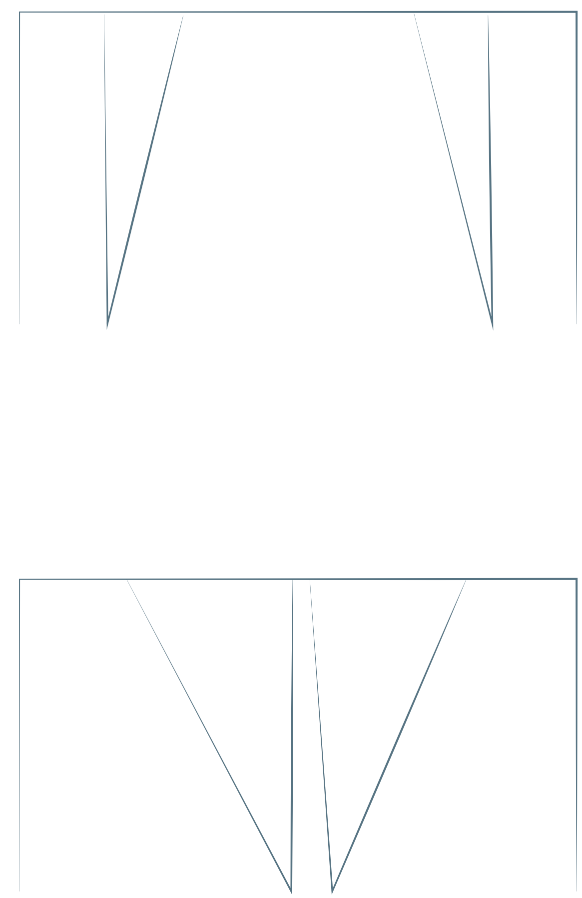


Fig. 4.18-4.19: Controlling the location and angle of the freestanding columns

STRUCTURAL DEVELOPMENT

STRUCTURAL ANALYSIS

The model is imported to Robot Structural Analysis to verify the spatial stability of the structure. As illustration 4.20 shows, Karamba does not enable the possibility of applying pinned joints because the beam will behave as it was dividing into three separate elements. Therefore, the four upper joints are fixed to get a useful result.

In contrast, the software Robot Structural Analysis enables us to verify the three-dimensional stability of the structure. All joints are pinned (Fig. 4.21), thus, the freestanding tilted columns create a disc effect, which stabilises in the *x*-direction. Likewise, the wind crosses have the same effect in the *y*-direction and the wind cross gives the third disc effect in the ceiling. All together, these factors create the three-dimensional stability and counteract any rotation.

The results from Robot are based on the permissible values and on the load combinations. The dominant load is found to be the snow load due to the large roof surface that only inclines five degrees. The permissible values and the load combination are used to find out how the structure behaves with pinned joints in order to read the utilization degree for each structural element.

In this project, we delimit ourselves from calculating the dimensions of the elements and the deformation once again. This could be done through the final calculations in which values from Robot could be included to detect any incorrect entries and readings in the program.

In contrast, we examine the element utilization degree to evaluate on the aesthetic considerations. The utilization degree of an element must be between 0 and 1. If the value moves toward 0 it becomes more and more over-dimensioned. If the value exceeds 1 the material yield point is reached. The following values are readout from Robot:

Wooden column in the façade (23mm x 46mm): 0.17
Freestanding wooden column (46mm x 46mm): 0.10
Steel beam (267mm x 750mm): 0.39

The values indicate that the elements in wood and especially the freestanding columns can be dimensioned differently. However, our wish for a distinctive and exposed structure in the room is essential for the columns to remain over-dimensioned. The design process reflects the iterations between initial calculations, the use of digital tools, and the aesthetic considerations necessary for the integrated design process.

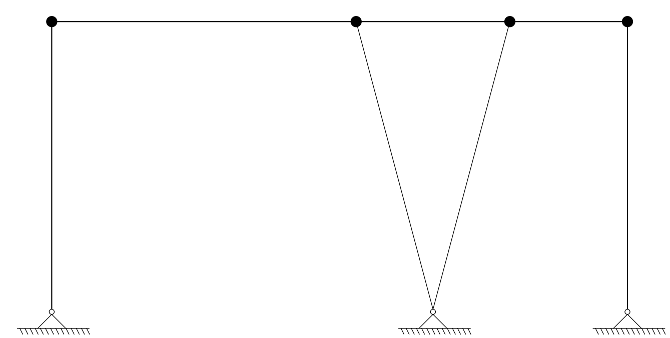


Fig. 4.20: Static scheme with fixed joints

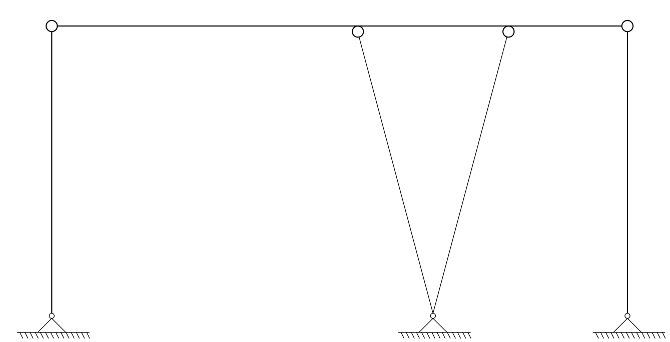
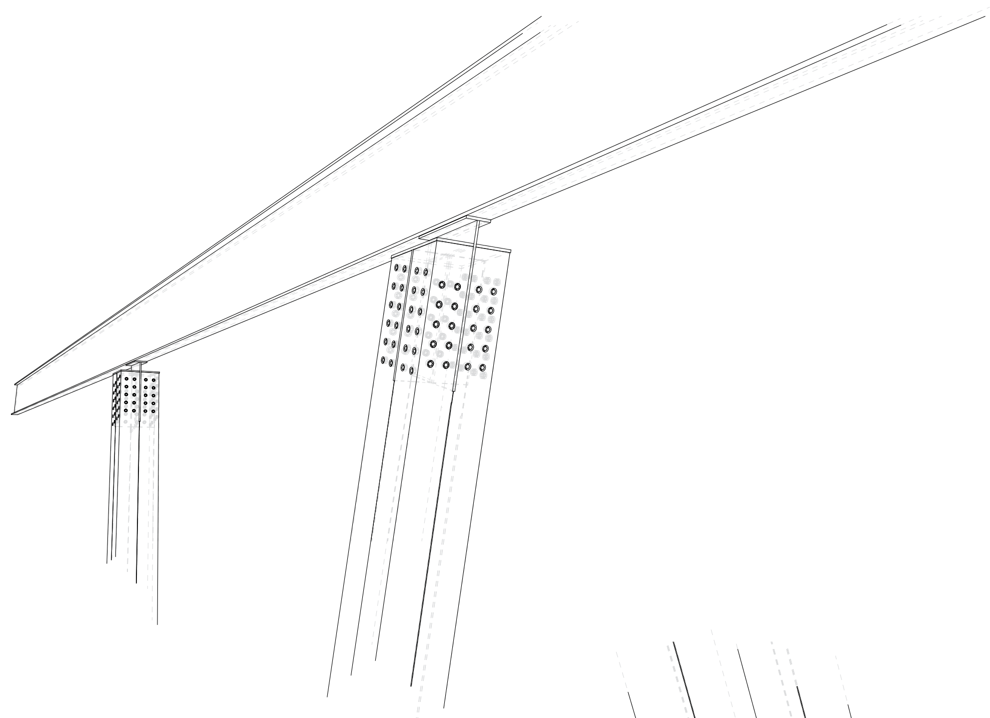


Fig. 4.21: Static scheme with pinned joints

STRUCTURE

THE DETAIL



The structure reflects the composition of material strength found in the maritime environment. The simple principle of the hall structure is refined through the level of details. The exposed structural expression considers the textural and tactile expression of the warm oak columns and is articulated through the contrast to the dark and the elegant steel beams. The modest joint between the beam and the column allows the elements to characterise the spatial experience of the space.

The freestanding columns mark themselves by the location and the oversize dimensions and become the main spatial element of the interior. Lifted on the plinth, the heartwood is not in connection to the water but still grounded to the concrete floor. The four combined heartwood columns come together to strengthen each other and are fixed to a steel plate with bolts immersed in the wood.

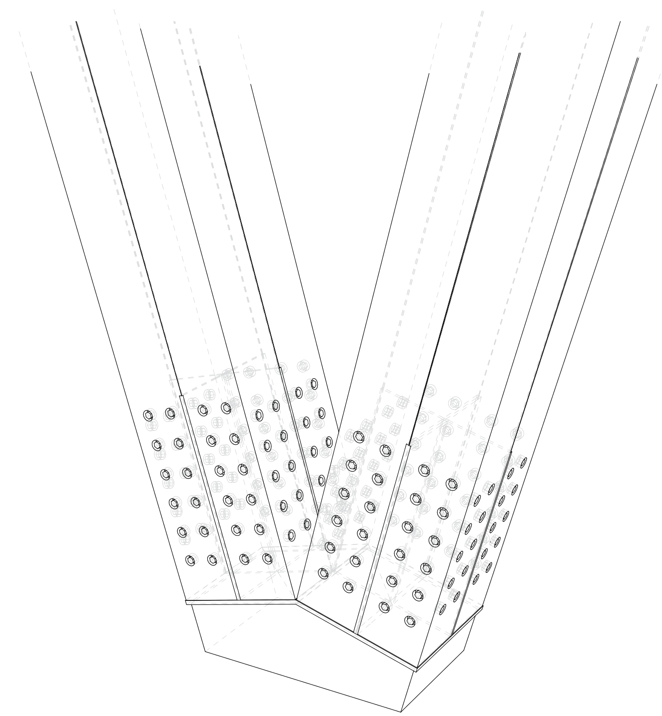


Fig. 4.22-4.23: Isometric drawings of structural joints in top and base of the freestanding columns

Fig. 2.24: Platform coming down to the water

Fig. 2.25: Storage of paddles

WORKSHOP

SHARING KNOWLEDGE

The workshop space initially works as a united space for restoration of the boats and on the same time it will contain the old wooden ships while they are going through restorations. The workshop is lowered towards east for the kayak and the diving storage to be in short distance of the water as the users have a lot of heavy equipment to carry.

The architectural idea of the space is to use it as an exhibition space of the old ships as they are prepared for their second maiden voyage. A space where the visitors can observe and talk to the owners and learn about the restoration or get in dialogue with the local sailors sharing knowledge and experiences from their life at sea. In order to articulate this potential, the large window opening towards west and south is designed to create a visual connection to the indoor activities.

Fig. 2.26: Ground floor 1:200

N
0.0
WORKSHOP
Kayak & Diving
-0.45
Outdoor
cleaning area

RESTAURANT & CLUBHOUSE

SOCIAL GATHERING

The restaurant and the clubhouse are located in the centre of *Fjordbyen*, which you will pass every time you move between the other houses. From here you have a clear overview in every direction - also from the inside through the large façade openings. Along the façades, the visitors and the members are invited to sit down the niches in the exterior wall and on the furniture. Wind studies and a diagram of shadows can be found on page 100 and 101, respectively. The zone of the social gathering inside and outside the houses is characterised by the pavement, which changes from concrete to the azobe timber terrace surrounding the social gathering point. Toward the marina, the pavement steps down and thereby allow people to come close to water and to the boats in the marina.

The organisation of the space allows the dining area to get a 180 degrees view. The pitch roof is shaped to support the direction toward the marina. The kitchen and other rooms are arranged in the back of the house in proximity to the concrete pavement where goods will be delivered. The restaurant is a public place with the maritime atmosphere in focus – a casual environment for social gathering and for a nice meal. In the evenings, the large window openings will light up the area and reflect the activity and the atmosphere of the interior space.

The clubhouse is the main assembly room for the club members where they gather and share their experiences from the water. The house can be equally used by professionals, youth members, and visiting sailors. The facilities are in proximity to the slipway, the boat hall, and the workshop allowing you to follow the activities that goes on and the people that comes and goes at *Fjordbyen*.

Fig. 4.27: Ground floor 1:200

Fig. 4.28: Visualisation of outdoor spaces surrounding the restaurant and clubhouse

RESTAURANT & CLUBHOUSE

SECTION B-B // 1:200

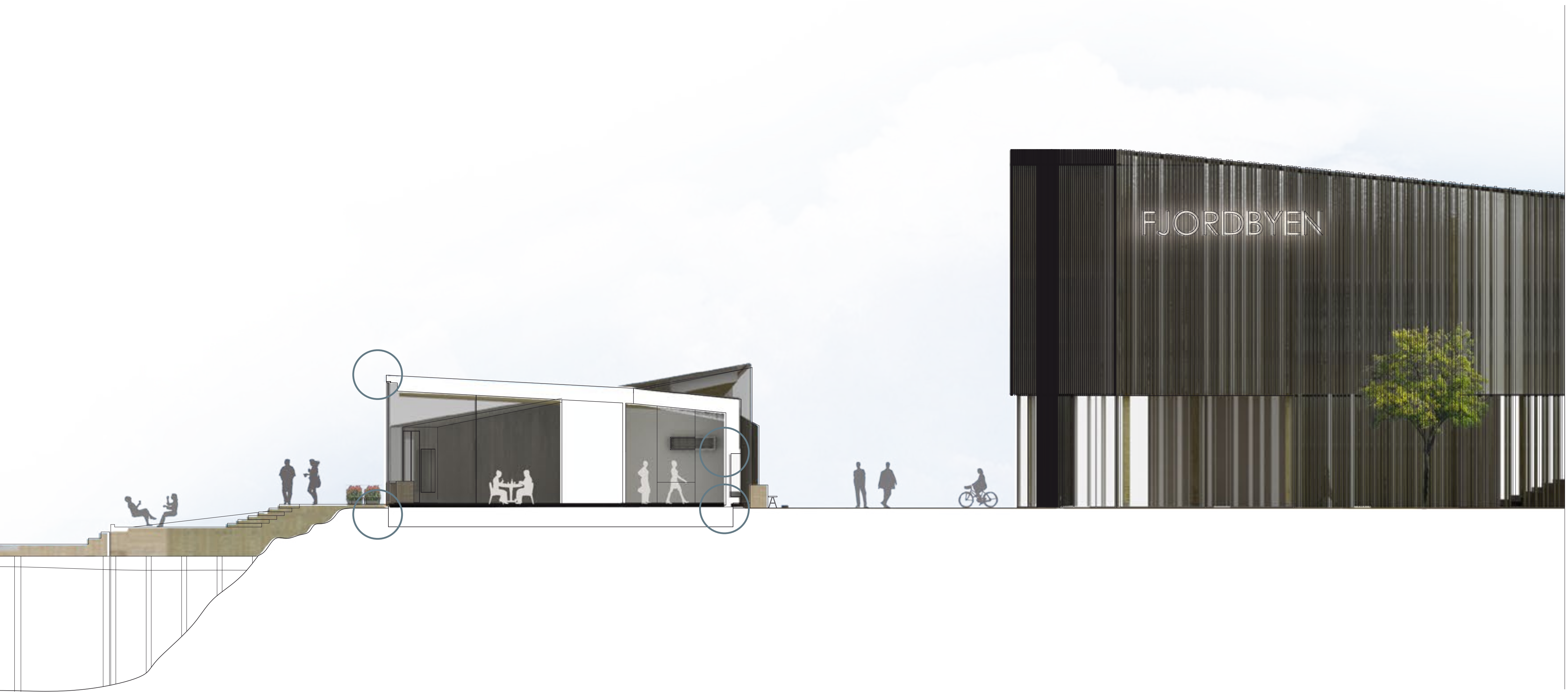


Fig. 4.29: Section B-B 1:200

RESTAURANT & CLUBHOUSE

TECHNICAL DRAWINGS // 1:20

Specifications on page 125-127 (Appendix B)

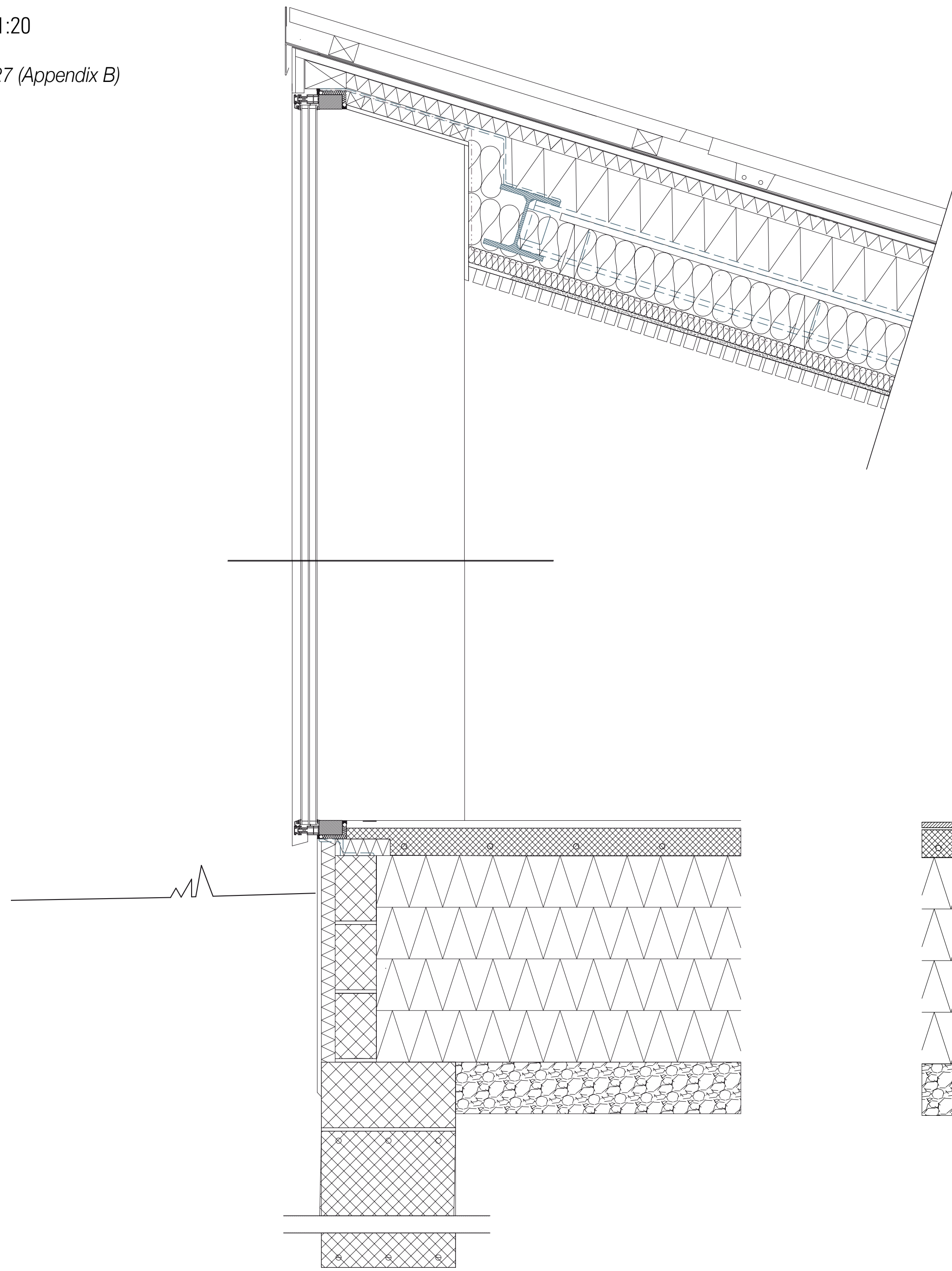


Fig. 4.30: Technical drawing of roof, base, and window head and sill 1:20

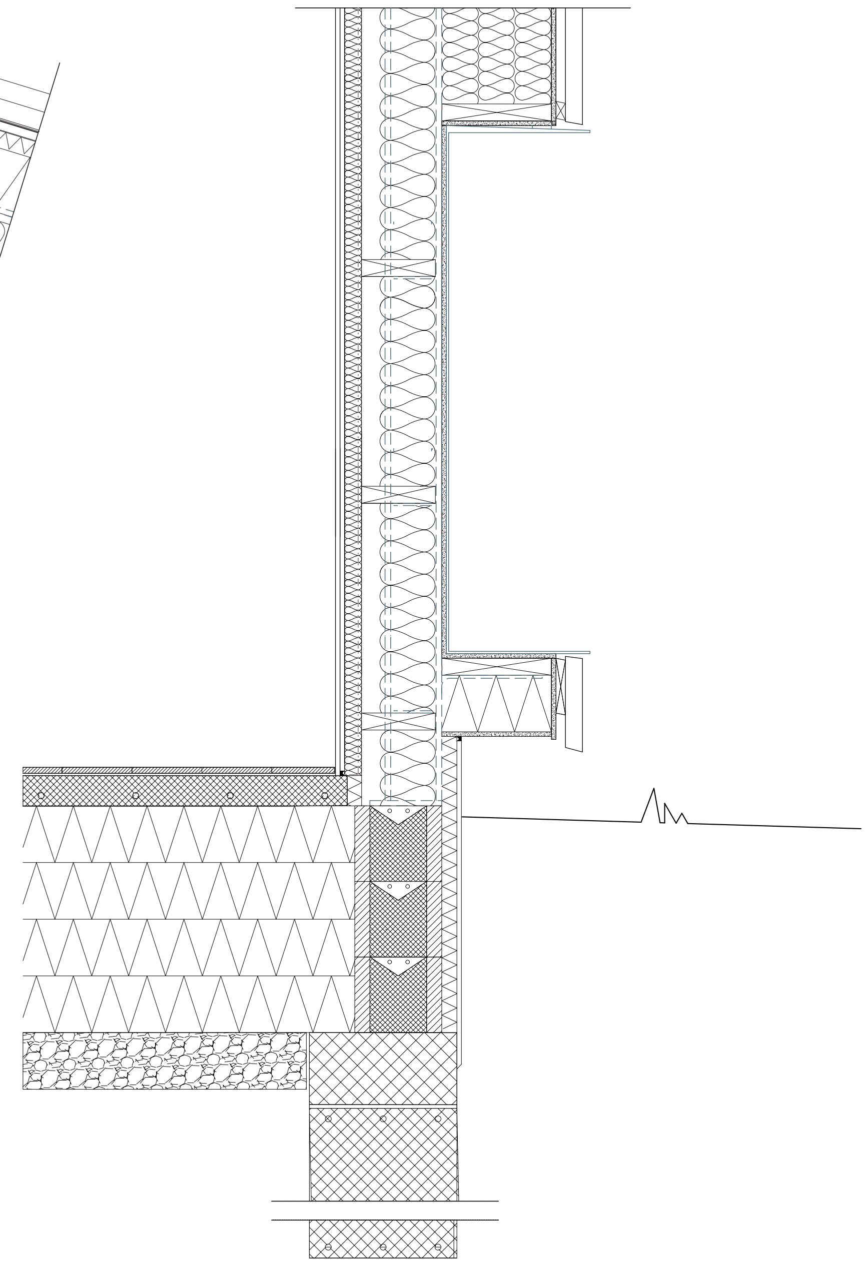
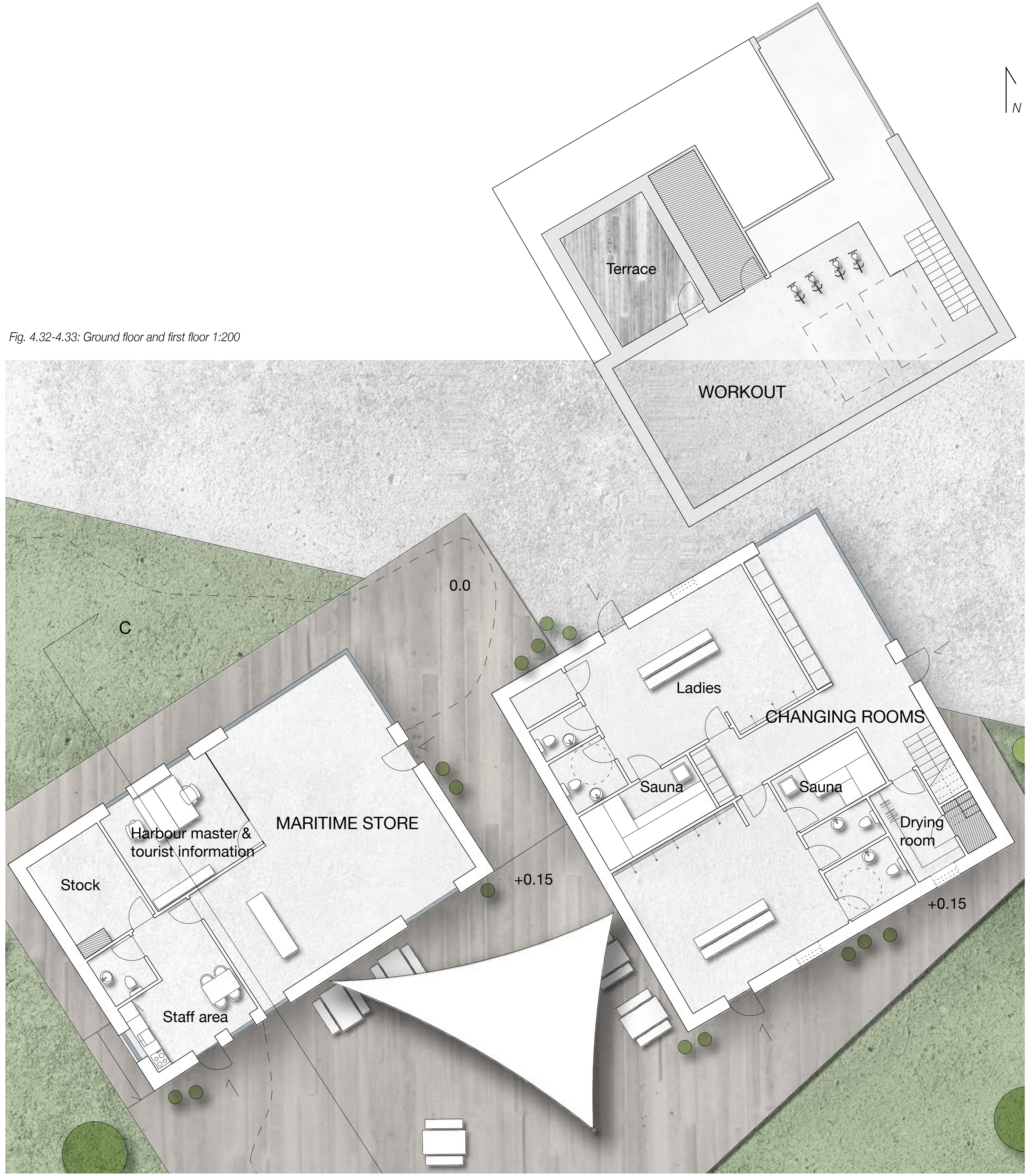


Fig. 4.31: Technical drawing of exterior wall and integrated bench and base 1: 20

CHANGING ROOMS & MARITIME STORE

GROUND FLOOR AND FIRST FLOOR // 1:200

Fig. 4.32-4.33: Ground floor and first floor 1:200



The two houses are the first you meet when you approach the site from the town centre. The apparent location allows the offices of the harbour master and tourist information to become visible for people passing by. At the same time the staff has a nice overview of the area and the marina. Again, the large openings become guidance for passers-by and the transparency allows both people on the inside and on the outside to follow the on-going activities. The large terrace facing south is in direct connection with the staff area and surrounds the houses to characterise the space as a place where you can stay.

The changing facilities have fewer openings in the façade and the smaller window openings are located two meters above the ground to ensure privacy. On the first floor, the large room is the workout space for the club members to exercise and prepare for races. The space has a direct access to an outdoor terrace. The downstairs drying room is for the club members to hang their wet gear.

CHANGING ROOMS & MARITIME STORE

SECTION C-C // 1:200

Fig. 4.34: Section C-C 1:200

BOATHOUSES

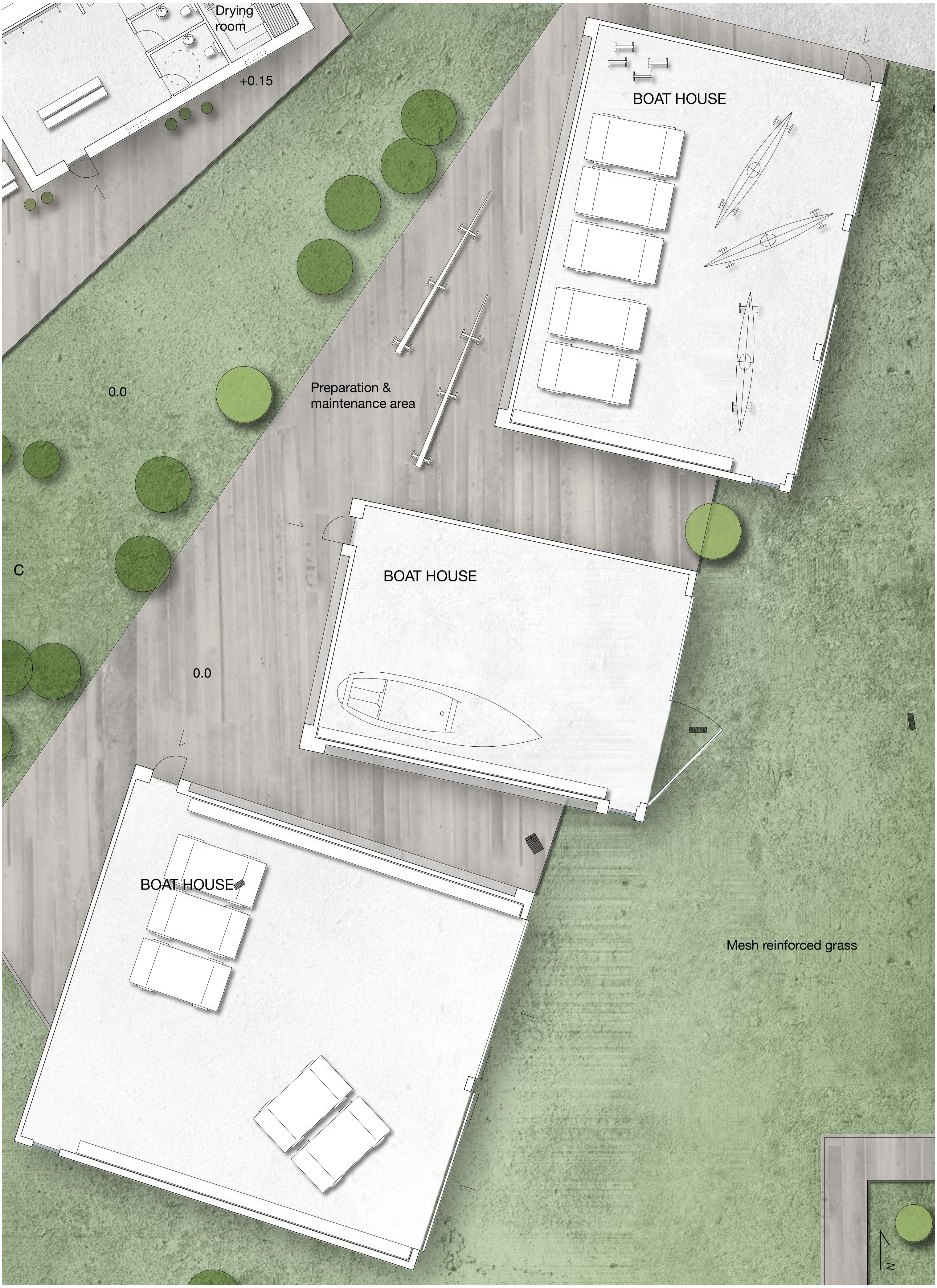
GROUND FLOOR // 1:200

The three houses are in short distance to the boat crane and to the slipway and thereby ensure an easy navigation of the boats on land. The gates are arranged to the east side of the houses where the pavements change from timber and concrete to mesh reinforced grass.

The three boathouses are primarily for boat storage during wintertime, however, the spaces should also be used when the boats are in the water during summer. The plan shows how the spaces could be used by the kayak rowers for preparing and maintenance and for storage of the boat supporting racks. During summertime, the houses could also be used for larger events and races or for club events as the façades toward east can open up for activity inside and outside the houses.

Instead of combining the houses in one, the square meters are divided into three houses with different proportions to house the various kinds of boats. The thickness of the exterior walls is increased for the mast storage built into the wall and likewise, the terrace in between the houses can be used for preparation and maintenance. One façade in each house is cladded with polycarbonate and becomes an interpretation of the large boat hall. The translucent façade allows light to come through while the activities become visible from the outside.

Fig. 4.35: Ground floor 1:200



Drying
room
+0.15
BOAT HOUSE
0.0
Preparation &
maintenance area
C
BOAT HOUSE
0.0
BOAT HOUSE
Mesh reinforced grass
N

ARRIVAL FROM THE SEA

AN URBAN LANDMARK

When darkness falls the luminous effect of the boat hall becomes an architectural and urban gesture in the surroundings. As a metaphor of the lighthouse, the gloving boat hall will lead you the way to the marina.

The apparent location in Thisted will make the boat hall visible as you approach the town from *Kystvejen* or the town centre. As you approach the marina by sea, the northern façade of the boat hall opens up to welcome the sailors.

Fig.4.36: Visualisation of Fjordbyen at sunset

04 | PRESENTATION

URBAN DESIGN

MASTER PLAN // 1:1000

The concept of the urban design is characterised by the extensive boardwalk that allows you to inhabit the area and the nature close to Limfjorden. The boardwalk is made accessible by foot, by bike, or in a wheelchair to invite for all kind of activity and use. Thus, the boardwalk becomes an urban gesture that guides you to move along the coast. This is designed to be able to use the natural potential of the site.

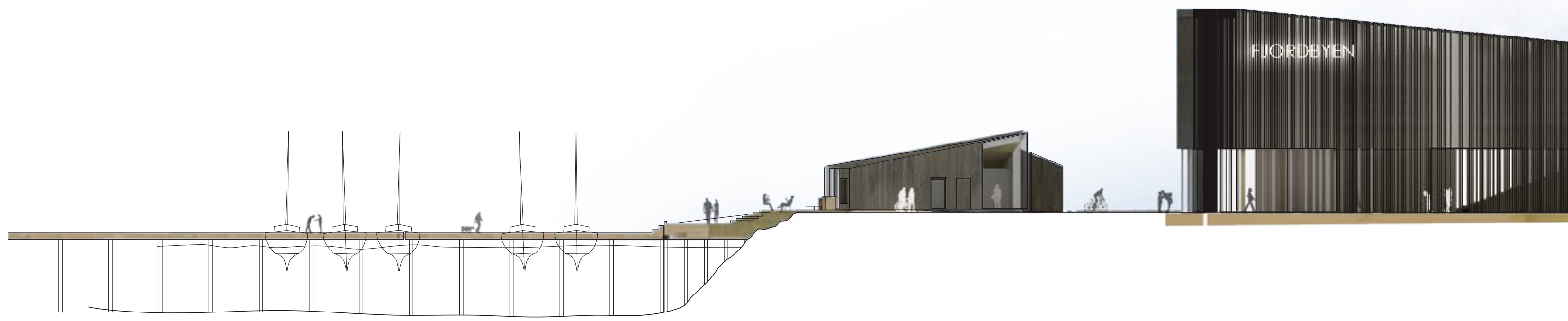
Before the existing paths curved away from the site - now the boardwalk becomes the node and the focal point that connects the walking paths. The master plan shows how the boardwalk becomes an urban element as it narrows into straight paths following the water and widens out creating an area for recreational activities. Towards east the coastline becomes the pier for the extension of the marina and floats in between *Fjordbyen* encouraging for different activities and social interactions.

During wintertime the boardwalk becomes an interpretation of the marina that allows the boat to be staged on land in the same way as it is during summer. The winter scenario is presented on page 88.

Fig. 4.37: Master plan 1:1000

LANDSCAPE

CROSS SECTION D-D // 1:500



LANDSCAPE

LONGITUDINAL SECTION E-E // 1:500

Fig. 4.38: Landscape cross section 1:500

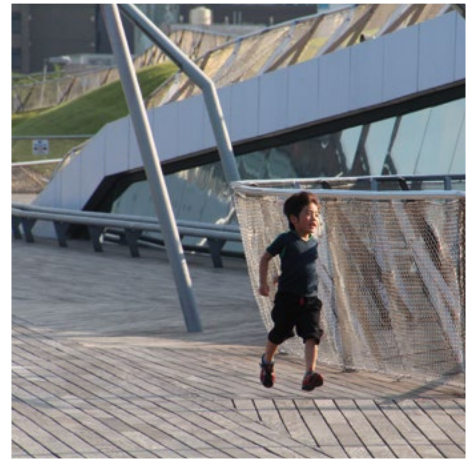
Fig. 4.39: Landscape longitudinal section 1:500

RECREATIONAL ACTIVITIES

SECTION OF MASTERPLAN // 1:500

The intention for this area of Sydhavnen is to activate the space with a variety of creational activities. The plan shows how the boardwalk widens up to surround the playing field and branches down to the beach. The boardwalk will change character and become an large urban scale furniture for relaxation, skaters, children with scooters, runners, etc., thus, allowing the space to adapt to the user needs.

The west part of the site is designed with two and three storey holiday units for rent. The subdivided building volumes preserve the views toward the water and create intimate green outdoor spaces in between. The buildings shield for the west wind and create a boundary to the heavy traffic on Kystvejen. The area is hidden behind the vegetation in proximity to the town centre and parking lot.



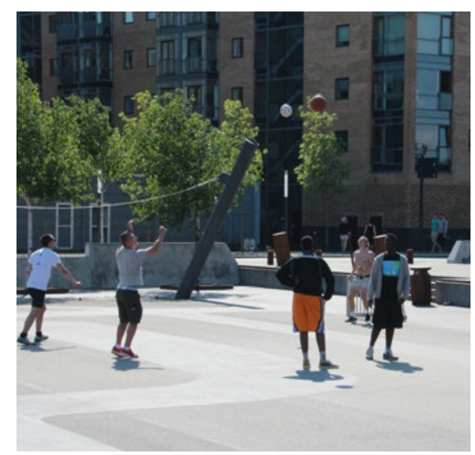


Fig. 4.40: Pictures of recreational activities intended at Sydhavnen

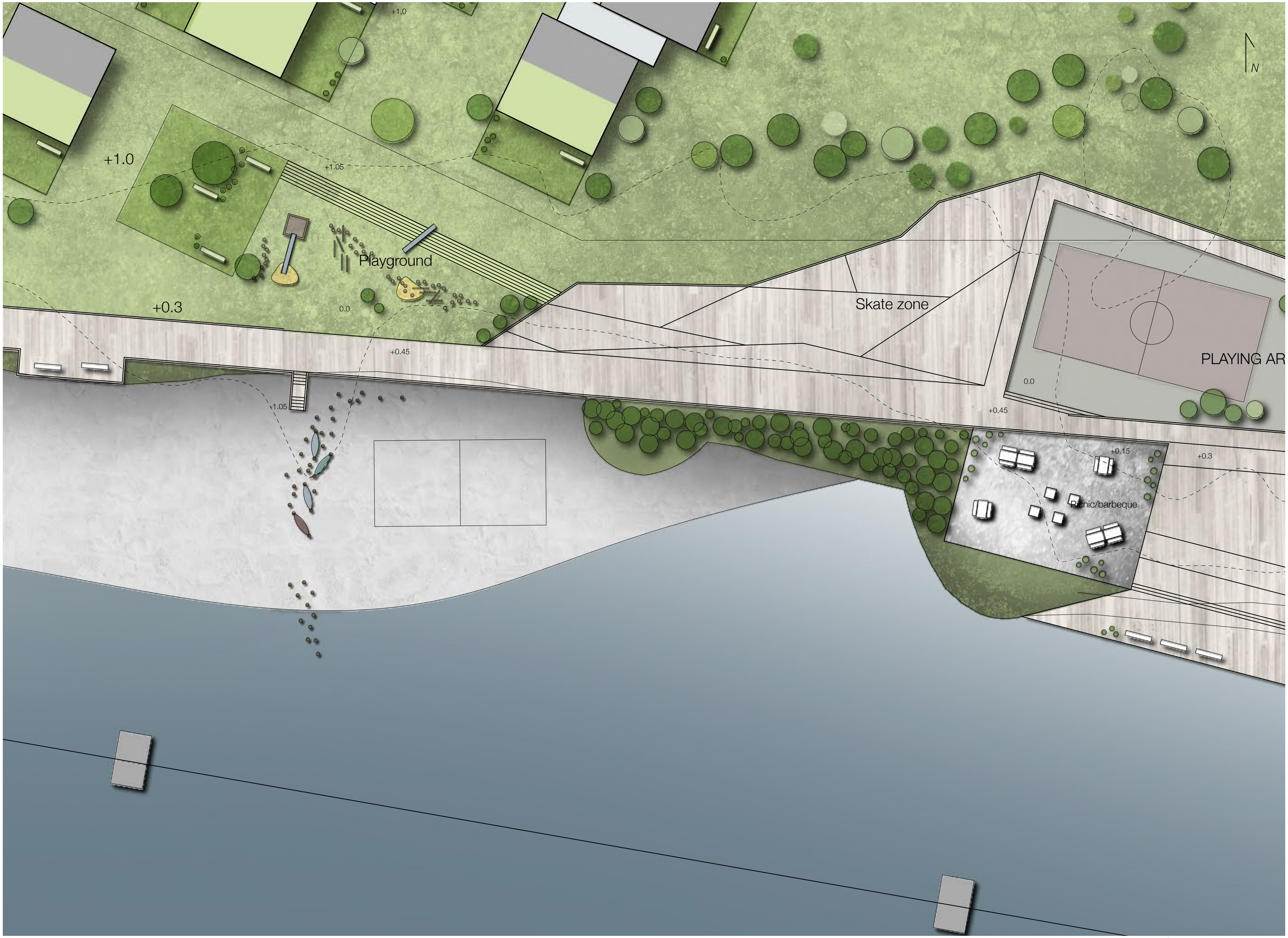


Fig. 4.41: Section of master plan 1:500

CABLE PARK

SECTION OF MASTERPLAN // 1:500

Water activities such as cable carks are getting more and more popular. A mechanism will replace the need for a speedboat to drag the water-skiers and wakeboards around in the water. Today, cable parks are being installed in urban environments all over the world, as wakeboarding will become a part of the Olympic games in the future. The installation presents a unique opportunity for using the potential of Limfjorden and the small bay of Sydhavnen and can be used by members and as well as visitors.

In proximity to the other recreational activities on the south coast of Sydhavnen, the cable park will contribute to the lively yet casual atmosphere. The surfers in Klitmøller will be able to practice disregards of the wind conditions.

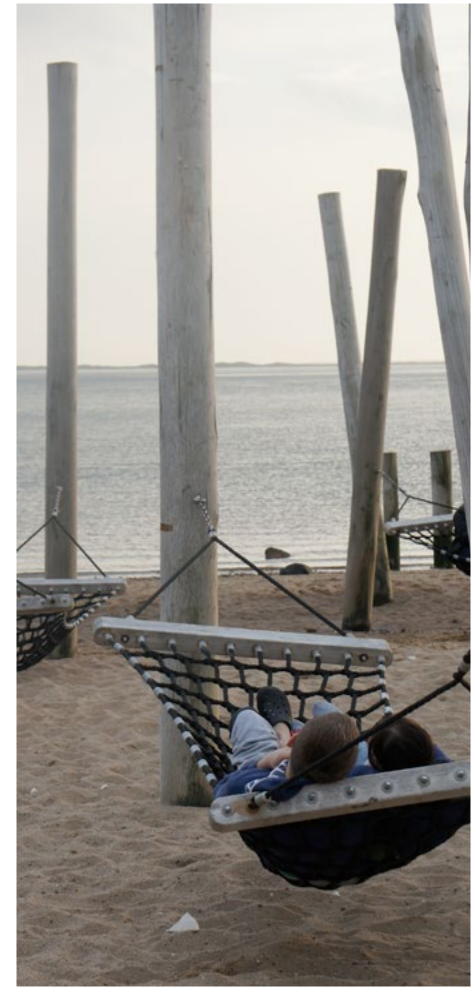


Fig. 4.42: Pictures of intended activities in proximity to the cable park

Fig. 4.43: Section of master plan 1:500

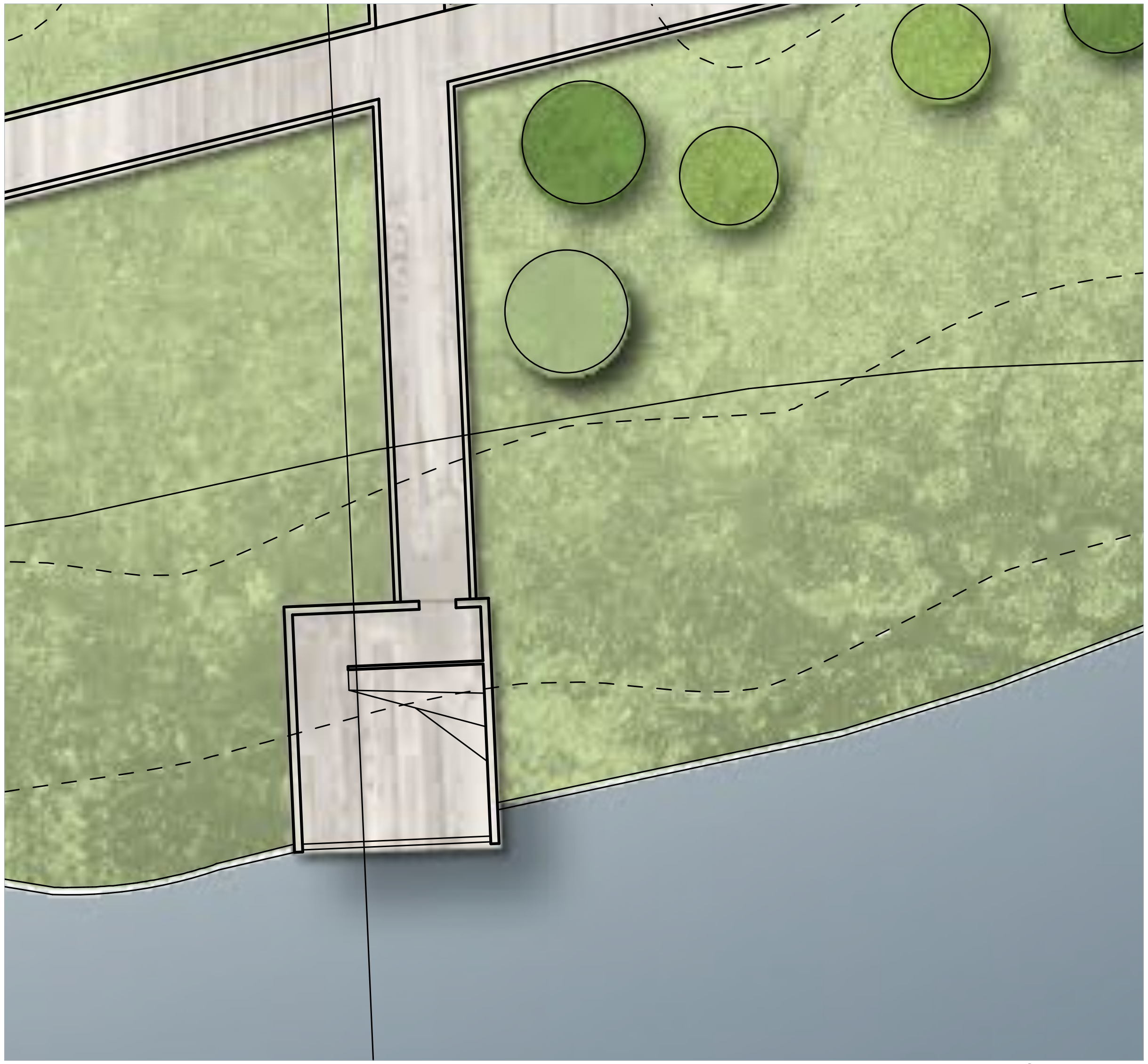


Fig. 4.44: Ground level 1:200

SHELTER

GROUND FLOOR // 1:200

On the detour of the boardwalk the small house becomes a pavilion where you are able to turn your back on the town and enjoy a close up framed view of the fjord. The house becomes a shelter from the climate where you experience the rough whether while sitting in a warm and protected atmosphere.

Fig. 4.45: Visualisation of shelter interior

WINTER SCENARIO

WINTER PLAN // 1:1000

The concept of the boardwalk becomes an interpretation of the boat pier in the marina. During wintertime, the area along the boardwalk will be lined up with boats while waiting for spring to arrive.

The outdoor storage space is a supplement to the boat hall and boathouses, however, the boat is designed to be outside regardless of the weather. The largest yacht might also not fit into the indoor storage space. The reference picture from the sailing club in Ho Bugt shows how the boats can be staged on land in an organised way.

Fig. 4.46: Boat storage on land - Ho Bugt sailing club

Fig. 4.47: Winter plan 1:1000

MATERIALS

AESTHETIC AND TECHNICAL CONSIDERATIONS

The materials used in Fjordbyen are carefully selected in order to create and sustain the maritime atmosphere. The use of wood is essential in the design both in the façade, in the interior spaces, and in the urban design due to aesthetical and technical potentials as a simple cotemporary interpretation of the traditional wooden boathouse.

The façades and on the roofs are cladded with kebony treated timber to avoid the material to decompose without using chemicals. The boardwalk is design with azobe wooden boards to give a robust expression and allows the material to patinate. Inside the houses, the ceiling is cladded with wooden battens to create a warm contrast to the clean white walls and concrete flooring.

The polycarbonate used in the boat hall and boathouses is applied as a reference to the maritime environment, even though, it is an unseen material on the harbour front in Thisted. The material is easily applied to the large area on the façades. With the low U-value, the material contributes to insulate the otherwise unheated space. The translucent material gives the interior spaces a pleasant and diffuse working light and creates spatial and visual qualities.

The concrete pavement allows the sailor to navigate easily around inside as well as outside. The concrete is also used to raise the wooden structure inside the boat hall from floor to protect the material from getting wet and gives the interior space a robust expression to withstand the wear of the users.

The exposed oak columns and the steel beams inside the boat hall are combined to use the strength of the materials to create a robust yet elegant structural expression emphasising the maritime narrative of the boat mast.

The open landscape is covered with lyme grass that floats in between the houses to invite the nature in and to blur the edge of the concrete pavement. The high grass comes close to the houses and erases the boundary between the buildings and the landscape.

The combination of materials emphasises the atmosphere of the maritime environment and the level of details defines the interior and exterior spaces and encourage to social activities to create a pleasant and attractive area in Thisted.

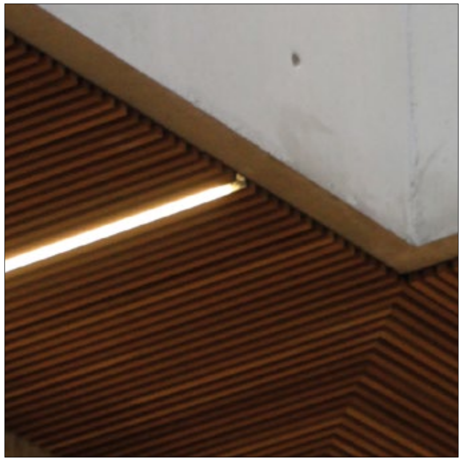


Fig. 4.48: Mood board of materials, textures, and colours

SUSTAINABLE INTENTIONS

PASSIVE STRATEGIES

Wind study

As mentioned in the analysis, the area is highly exposed to the wind. Even though, the wind is an important factor for the maritime activities it is also important to create niches between the buildings with low wind speeds. The small houses and the exterior wooden cladding will slow down the wind instead of accelerating it.

In order to verify these thoughts, the organisation of the buildings has been tested in the software Vasari. The wind data for the site is used to simulate the wind in a three-dimensional environment housing the building volumes. The result of the final simulation is showed in Fig. 4.50. The areas of interest are the microclimate around the restaurant and the space between the boat hall and workshop. The results are only indicative because vegetation and exterior materials are not affecting the simulation. The previous iterations are further discussed in chapter 5 - Design Process.

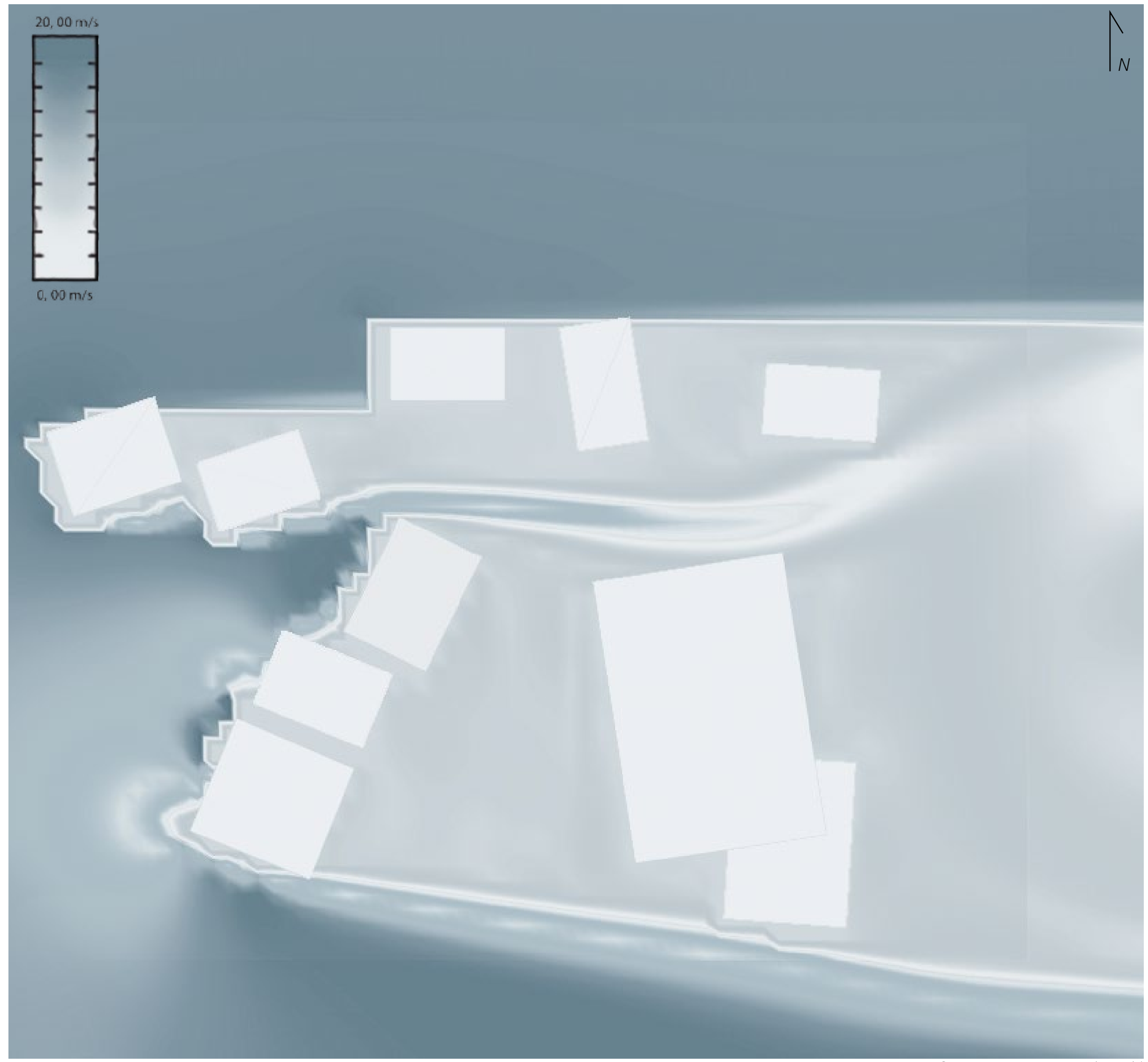


Fig. 4.49: Simulation of west wind (20 m/s)

SUSTAINABLE INTENTIONS

TECHNICAL DRAWING // 1:20

Specifications on page 128 (Appendix B)

External shading

As a reference to the changeable maritime atmosphere, the exterior expression of Fjordbyen also tries to adapt to the use, climate, and seasonal changes. The idea of a manually controlled shading system allows the users to interact with the building expression according to their needs. The drawing illustrates how the shutters are attached with a hinge at the top and two brackets along the vertical side of the window frame to fix the shutters in position when opened and closed (Fig. 4.51). The passive strategy allows the users to shade for the high and warm summer sun while the low sun during the winter comes through the glass.

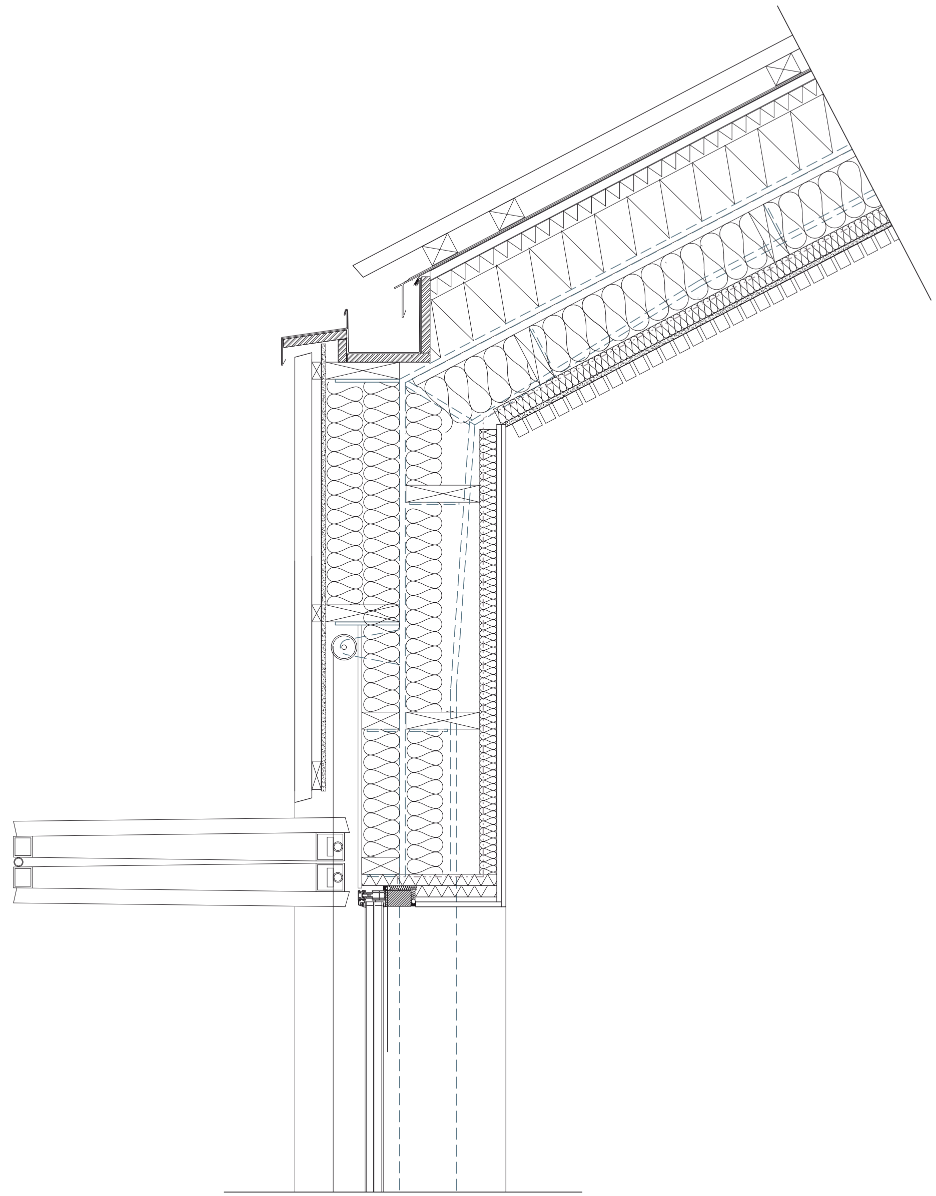


Fig. 4.50: Technical drawing of window head, external shading, and hidden gutter 1:20

SUSTAINABLE INTENTIONS

TECHNICAL DRAWING // 1:20

Specifications on page 129 (Appendix B)

Solar cells

The project has integrated solar cells as an active strategy to meet with the 2020 standards. The large surface on the boat hall provides a suitable slope toward south without any shading from the context. The drawing shows how the solar cells are integrated in the roof (Fig. 4.52).

The optimal slope of 38° is not possible. Therefore, the utilisation of the solar cells will be approximately 85%. (Viva Energi 2014) The produced electricity will be used for interior and exterior lighting. In a broader perspective, the implementation of active strategies could reduce the payback time of the project.

Reuse of rainwater

Another sustainable strategy of the project is the reuse of rainwater to benefit the environment and the users of the club. The rainwater is collected from the roofs and drained through the hidden gutters and downpipe to an underground tank. The water is stored to use for cleaning the boats and gear as well as for toilet flushing and even also for the washing machine.

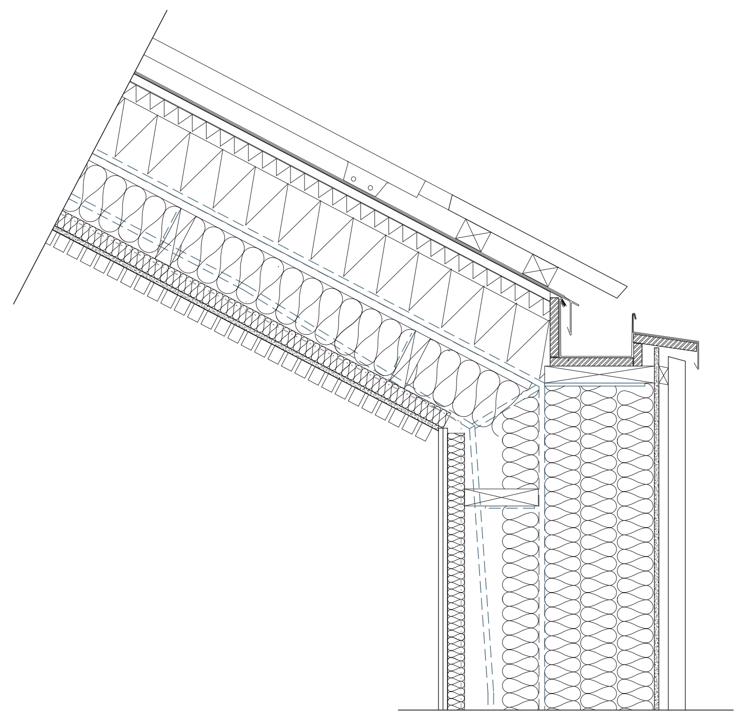


Fig. 4.51: Technical drawing of roof with integrated solar cells and hidden gutter

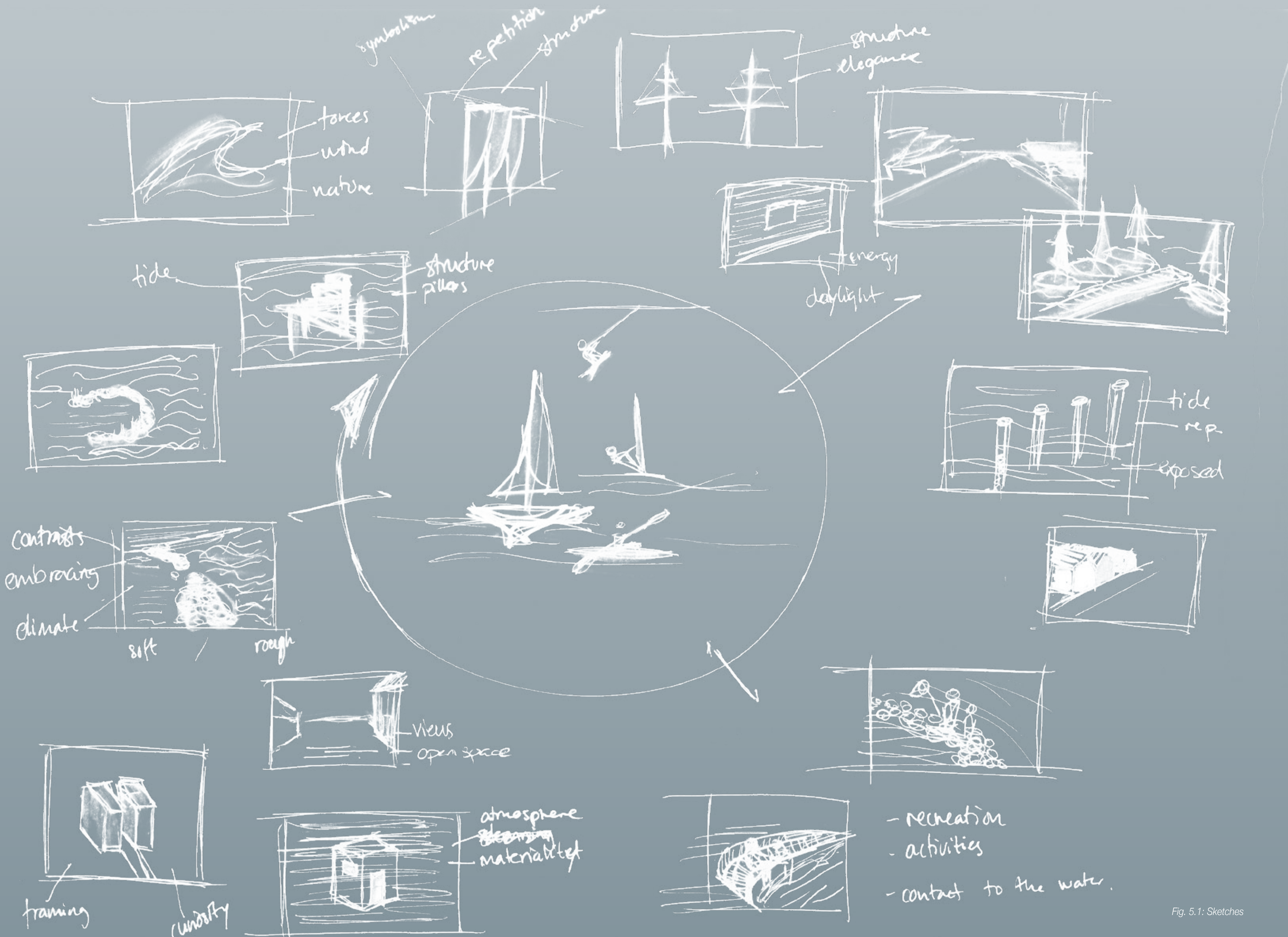


Fig. 5.1: Sketches

PROCESS

OF INTEGRATED DESIGN

The integrated design process

As a response to the academic objective of the master curriculum, the integrated design process will be discussed and illustrated in the following chapter.

The integrated design process has been introduced as a usable method in the various stages of the design at The School of Architecture, Design, and Planning at Aalborg University. The educational approach aims to provide the students with a professional design language and the ability to solve complex projects in teams. Through the integrated design process the students learn to combine the architectural and the technical aspects in the early stages of design – as demonstrated in this project. Through several investigations and design iterations – analogue and digital – the projects reach a high level of architectural and technical quality and a more comprehensive result. (Knudstrup 2004)

The integrated design process is not a linear progression through the stages of the design, therefore, the process of a project can be illustrated in several ways. Architect maa Mary-Ann Knudstrup has divided the merging phases of the design into five steps. (Fig. 5.2)

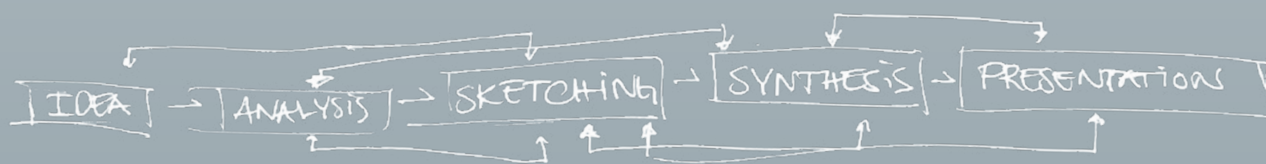


Fig. 5.2: Sketch of the integrated design process

Problem/idea: The purpose of the project is established. This could be a problem one must solve or a potential possibility to emphasise depending on the projects.

Analysis: The analysis is the basis for the project including research of site, context, climatic relations, rules and regulations, theories, functionality, user involvement, infrastructure, future development of the area etc. The essence of the analysis is collected as the project programme and the team will be able to list the aim and the main focus of the project.

Sketching: An equal concern to architectural and technical investigations will characterise the sketching phase. In this part of the process it can be a complex challenge to find the balance between aesthetics, function, and technique. An important aspect of this phase is to be creative and investigate a great variation of ideas and concepts in order to find the best possible solution.

Synthesis: Every aspects of the design should eventually come together and the project will evolve to a stage were aesthetics, function, and technique will complement each other in the best possible way.

Presentation: A successful final result will respond to the aim of the project were both architectural and technical qualities will be explained through final descriptions, drawings, and illustrations.

PROCESS

OF CONCEPT DEVELOPMENT

Throughout the process, the notion of *'skitserende programmering'* has be used and has allowed us to adapt the space planning according to user needs, climate studies, spatial experiences, etc. The observations and on-going investigations have developed over time into the final concept.

The idea of having Limfjorden in the corner of one's eye at all time was a potential that we wanted to implement in the concept from the beginning. The following sketches show the idea of the framed views (Fig. 5.3).

The architectural idea of subdividing the functions was also in our minds from the early stages of the project as an attempt of approaching the human scale in the architectural concept (Fig. 5.4).

The initial space planning clearly showed the importance of the distance to the water in terms of logistics. The idea of working on the edge of land and water was developed to meet both functional needs and aesthetical qualities. This determined the location of the building site (Fig. 5.5).

The diagram of relations (p. 34) derived from a discussion of the relation between the functions in the different buildings, the distance to the slipway, and the area of arrival from *Sydhavnsvej* (Fig. 5.6).

The organisation of the several buildings was based on an idea of having a centre of rotation, which the buildings could gather around. Thus, it is a wide range of buildings gathering or deriving from a common focal point. (Fig. 5.7) In order to gather the paths of the area in the northeast corner, the idea of the boardwalk was developed to make Sydhavnen more accessible. The urban element had the potential of complementing the niches and areas of activity in between the house and in the area of the Cable Park. Thus, it becomes a physical connection of the paths leading up to Sydhavnen (Fig. 5.7).

Fig. 5.3: Sketch of a framed view

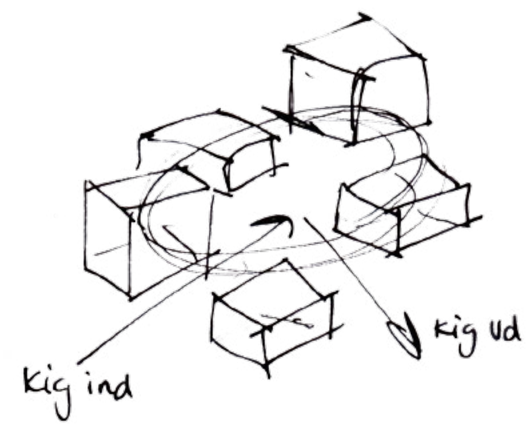


Fig. 5.4: Sketch of a series of buildings surrounding a centre

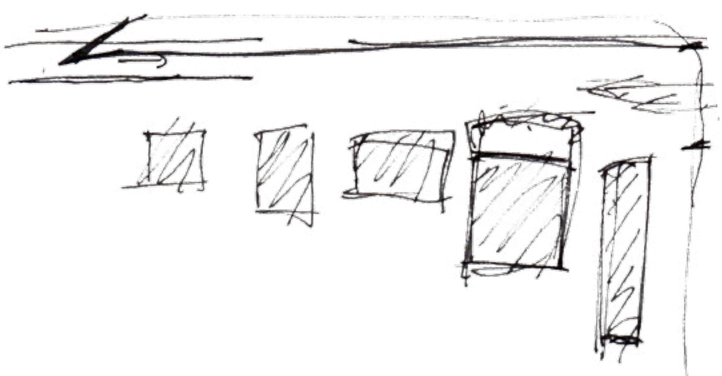


Fig. 5.5: Sketch of a series of buildings surrounding a centre

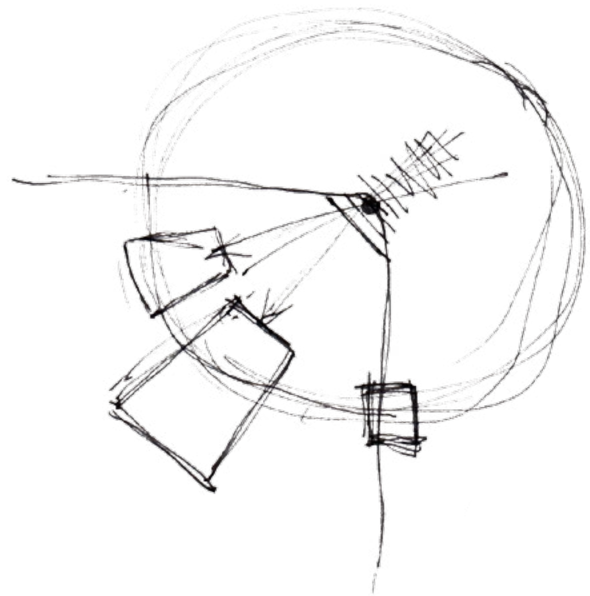


Fig. 5.6: Sketch of logistics and proximity considerations

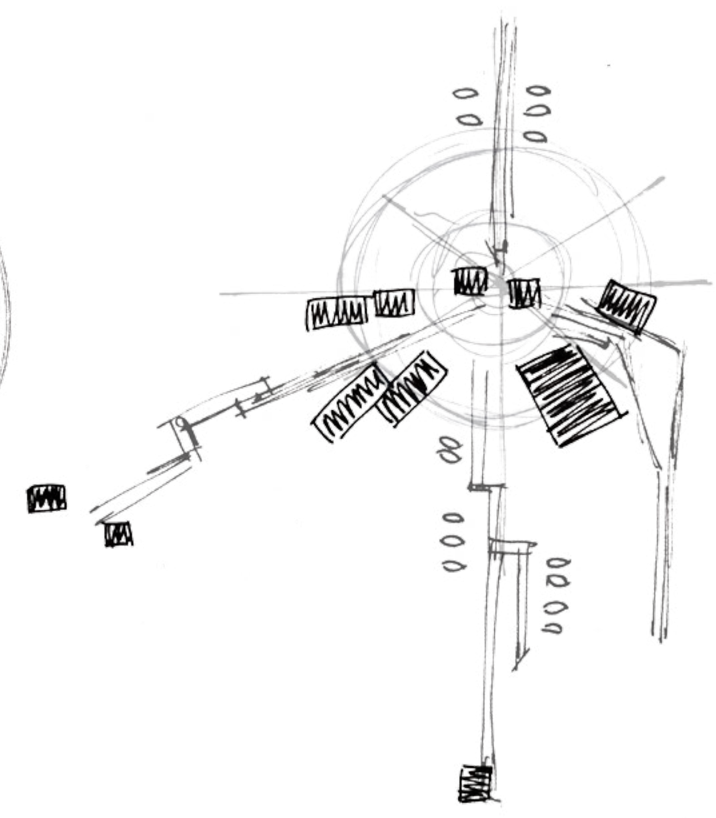


Fig. 5.7: Sketch of architectural concept

PROCESS

ORIENTATION, VIEWS, AND PROXIMITY

As the architectural concept was developed, the work of refining the buildings began. Throughout the process, the project has dealt with the word, proximity, and the following illustration will show some of the tests that have been made.

Wind - the microclimate

The software allows us to study the building volumes in relation to the wind data measured at the site. By rotating and moving the individual buildings we can study how the behaviour of the wind. Based on the site analysis and site visit we knew that the site is highly exposed to wind. The main design parameter was to observe as low wind speeds as possible in the area around the restaurant and the niches between the houses to optimise the conditions for the outdoor stay and activities.

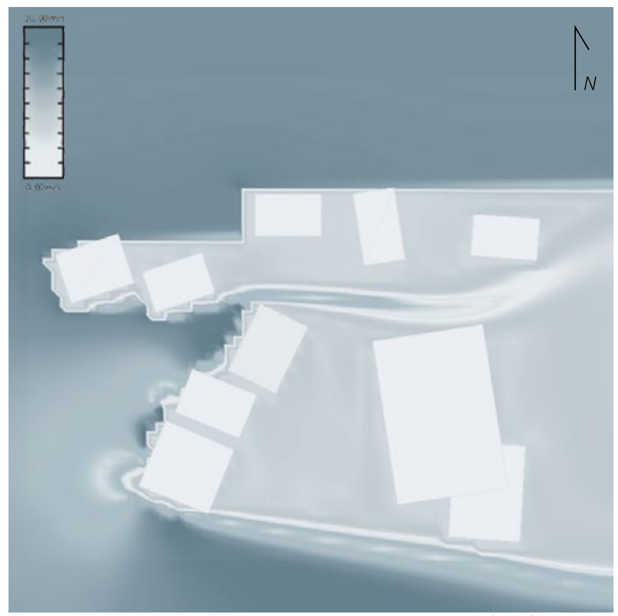


Fig. 5.8: Wind simulation (20 m/s) from west

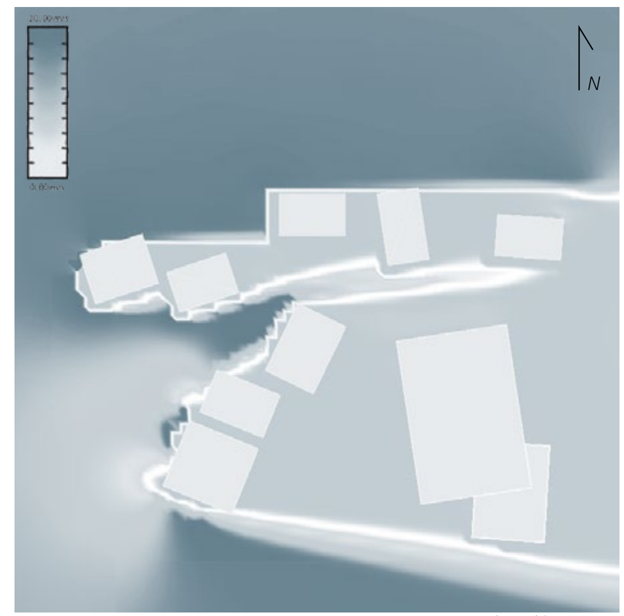


Fig. 5.9: Wind simulation (20 m/s) from west

PROCESS

ORIENTATION, VIEWS, AND PROXIMITY

Shadows - the microclimate

Likewise, the studies of the sun and the shadows were made in order to make a pleasant outdoor environment. Although, the two main social functions are placed toward north, the studies show how the low buildings and the distance between them allows the sun to reach all niches at some point during the day.

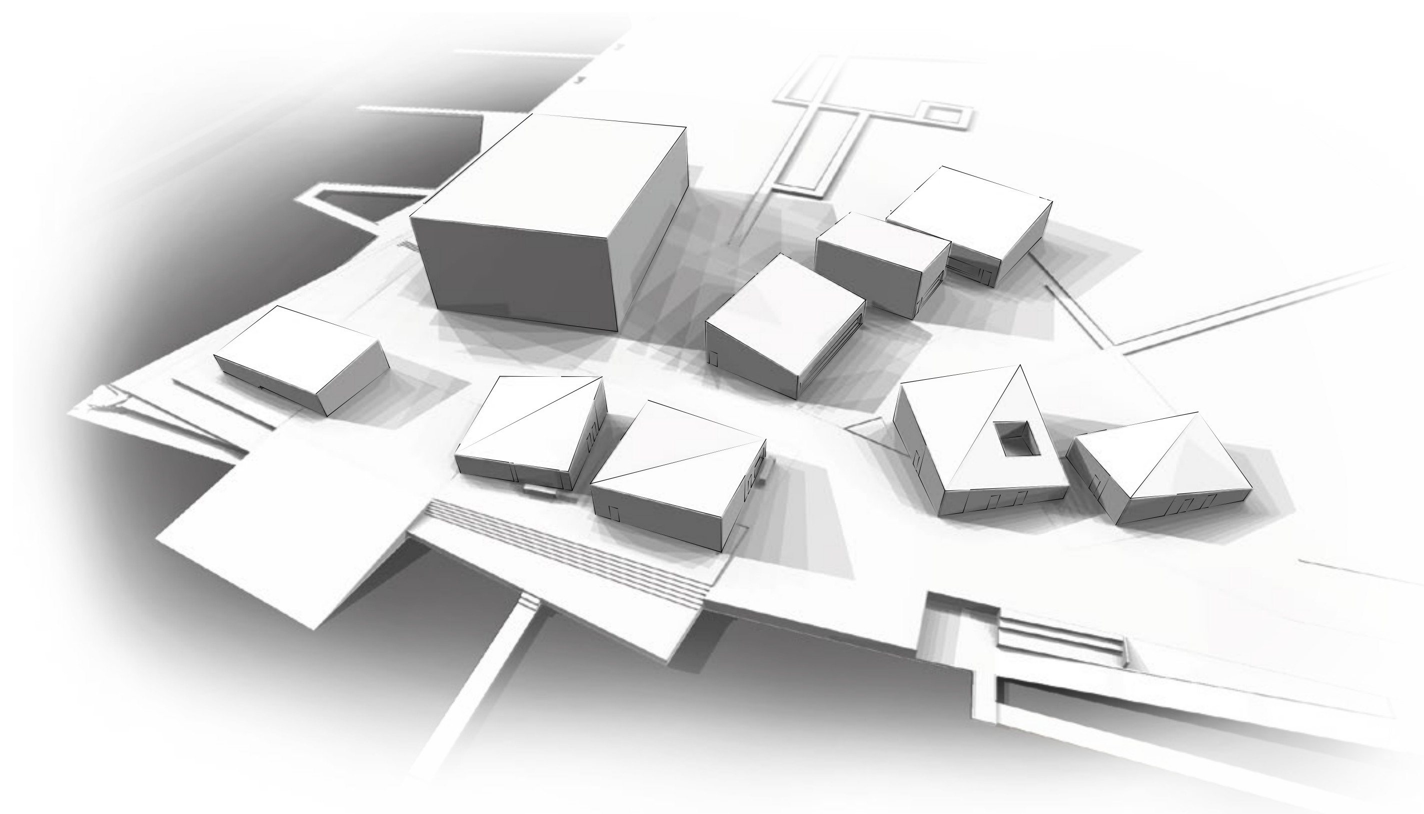
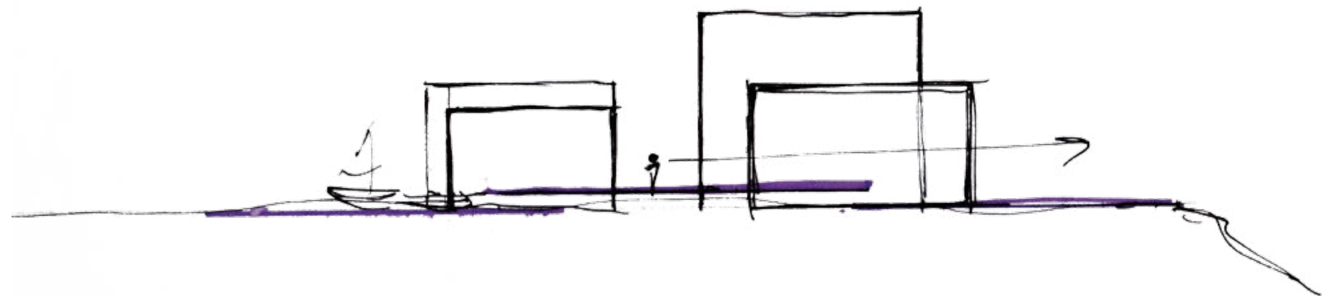


Fig. 5.10: Shadow studies

PROCESS

ORIENTATION, VIEWS, AND PROXIMITY



Framed views

The outdoor spaces are an important aspect to the users of the new maritime facilities. In order to arrange the functions, some logistic studies were made to minimise the distance between the slipway and boat hall and to incorporate thoughts about goods reception, sufficient space of manoeuvre of the boats, and fire and safety strategies.

Proximity

The concept of gathering the buildings around a centre makes it possible to get a clear overview of the buildings. Furthermore, the organisation allows us to use the architecture to frame the extraordinary views toward Limfjorden, thus, having the horizon in corner of one's eye at all time.

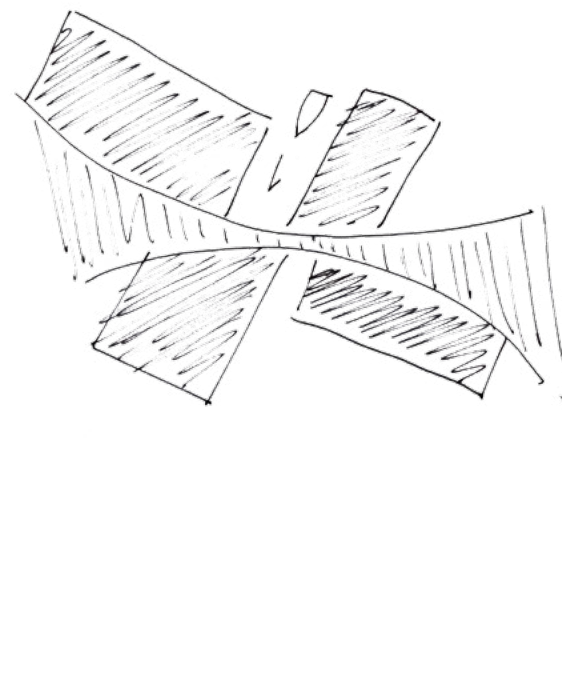


Fig. 5.11: Sketches

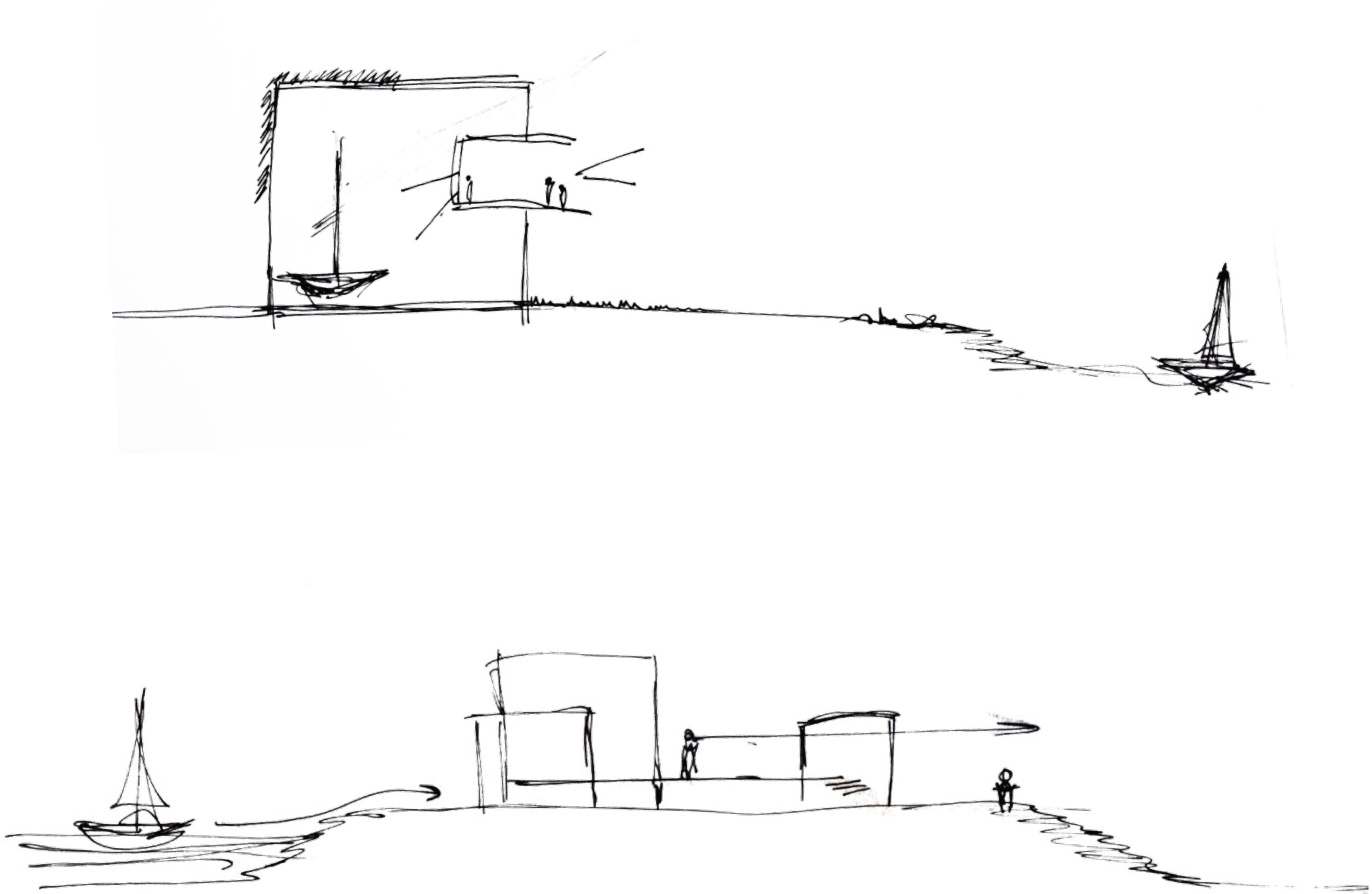


Fig. 5.12: Sketches

PROCESS

STRUCTURAL CONCEPTS - THE STRUCTURAL NARRATIVE

The wave

The fascination of the natural forces and principles of the wave were studied along with the experience and narrative of the soft curve of the water. The sketches show how the principle of the wave could be developed in the structural expression in one or more buildings.

Counterbalance

The maritime principle of the counterbalance and the relation between wind, boat, and sailor were the idea of this study. Thoughts of utilising cables for pull and timber or steel for pressure were investigated. The studies allowed us to see the potential of the cables as stabilising wind crosses due to the large scale of the boat hall.

Wooden pier

The maritime interpretation of the wooden pier is the idea of a comprehensive timber structure with attention to the joint and tools of traditional craftsmanship.

Fig. 5.13: Pictures of metaphores

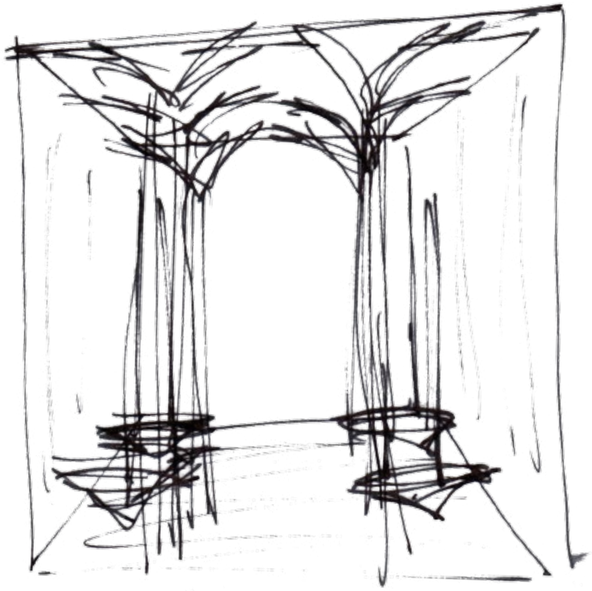
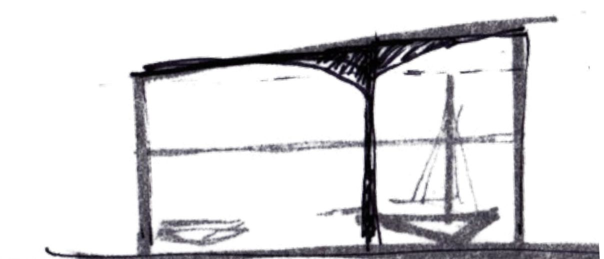
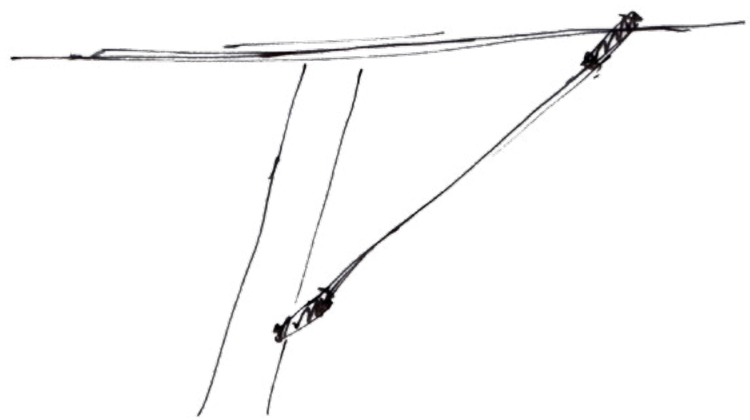
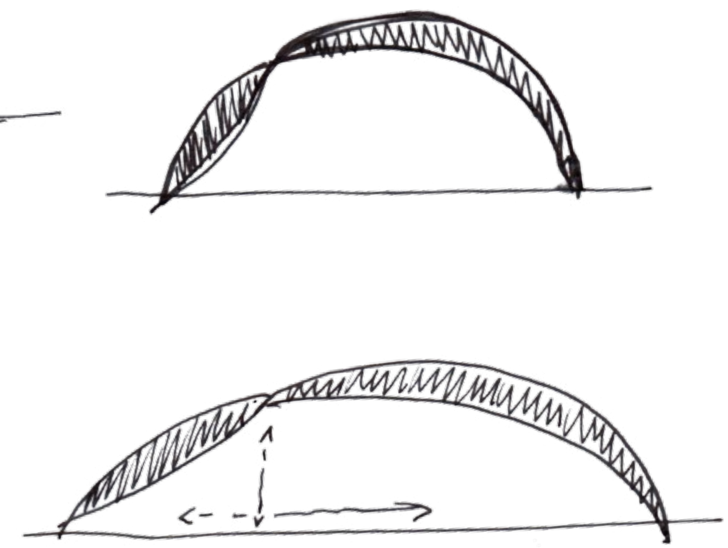
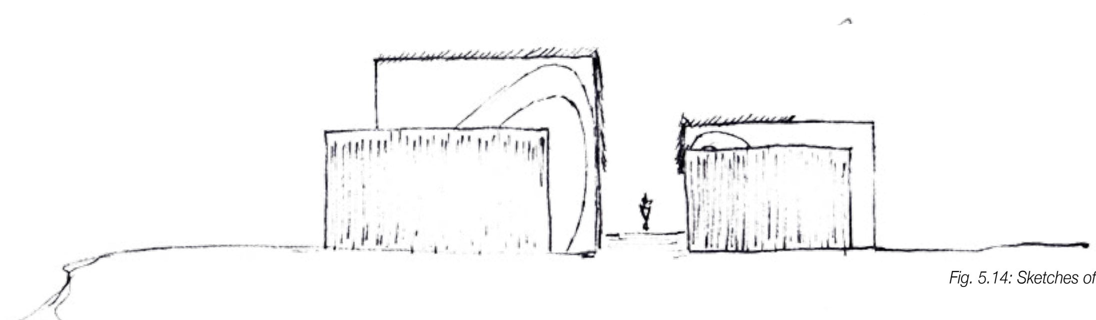






Fig. 5.14: Sketches of metaphores

PROCESS

STRUCTURE

The structure of the boat hall has been the primary technical focus of this project. Thus, the design have been through several iterations. The three-dimensional static scheme should consider the large span as well as the proportions to fit the total height of the boats and the masts.

As the interpretation of the mast was developed to function as both a spatial and structural element several studies and calculations were made. The illustrations show how a HEB steel section is running in the middle of the room to minimise the thickness of the roof. By implementing the steel the freestanding wooden columns were exposed within the space. Together with the vertical contributed disc from the race lounge the columns would be able to resist twisting at stress loads.

The iteration of the race lounge was made to contribute to the spatial experience of the boat hall. An extensive floor slab would lift the lounge above the floor of the boat hall. The second set of freestanding columns was implemented to add dynamic and counteraction to the spatial experience. This iteration also tested the façade elements by tilting the columns and working with a three-dimensional structure instead of the frames.

As a result, the façade began to work with the same structural expression as the freestanding columns. However, the studies showed the need for wind crosses in the first and last module of the ceiling therefore the principle of using wind crosses as stabilising tension elements were followed through within the whole static scheme to replace the tilted columns in the façade. This solution considers the strength for the individual material and the interplay and joints become a metaphor for the maritime environment.

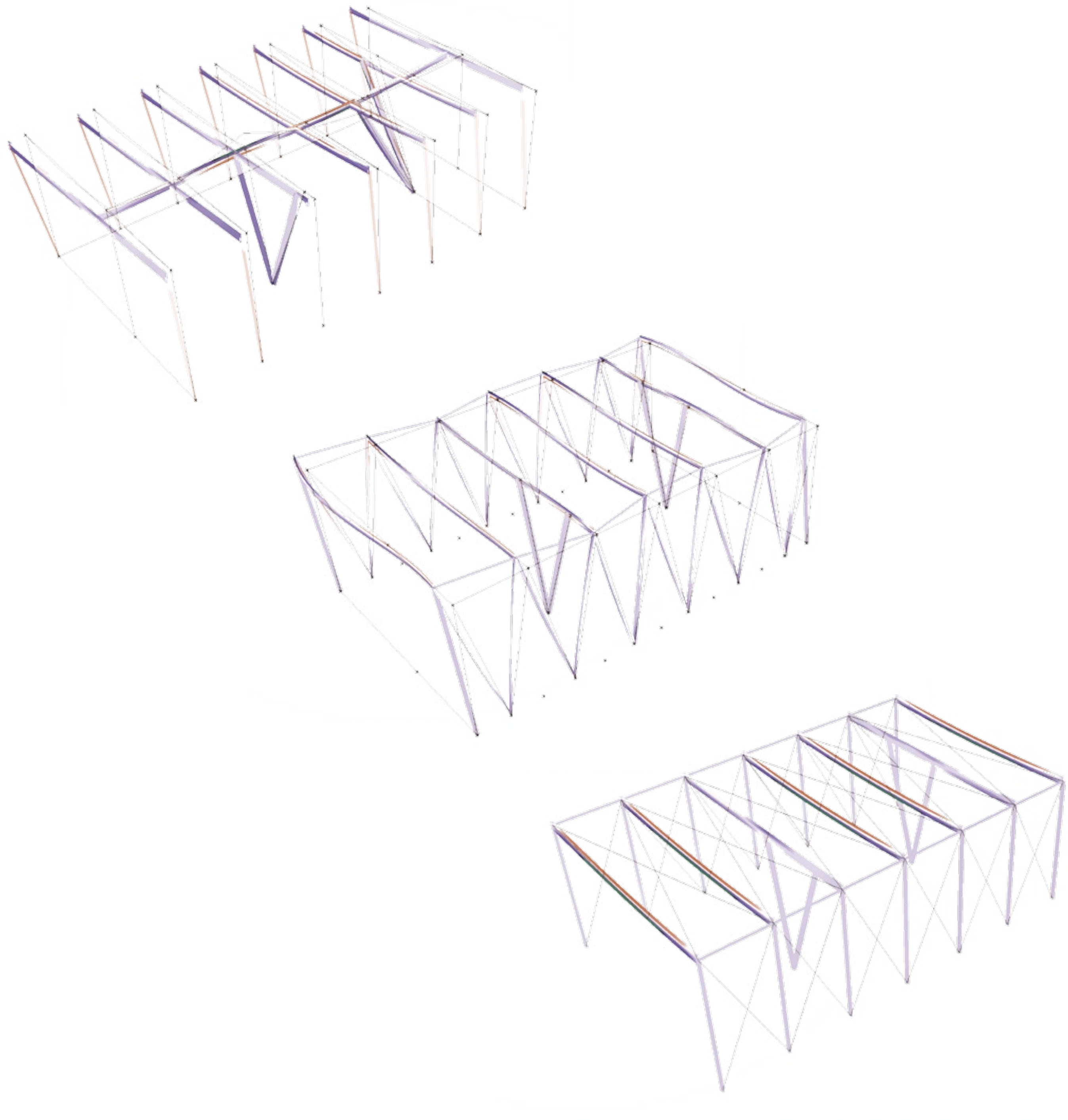


Fig. 5.15: Diagrams from Karamba

PROCESS

DETAILING THE STRUCTURE

Composite material

Several thoughts have concerned the material composition of the structure. This iteration shows how timber and steel combined as a composite material arrived from the idea of utilising the different strengths and aesthetical qualities of the materials as found within the maritime gear. The composition of timber and steel would allow the use of heartwood as columns and support for the thin steel element.

Timber structure

The idea of a comprehensive wooden structure, which should be jointed to support one another, was tested. The picture shows a physical model to test this principle.

Timber structure and steel joints

Having a primary wooden structure and introducing the strength of the steel in the joints contributed to the level of details and the material and structural experience within the boat hall as the joining highlighted the transition between different materials. The idea of combining the aesthetical and technical qualities was analysed even further and became the principle of the joints in the final design.

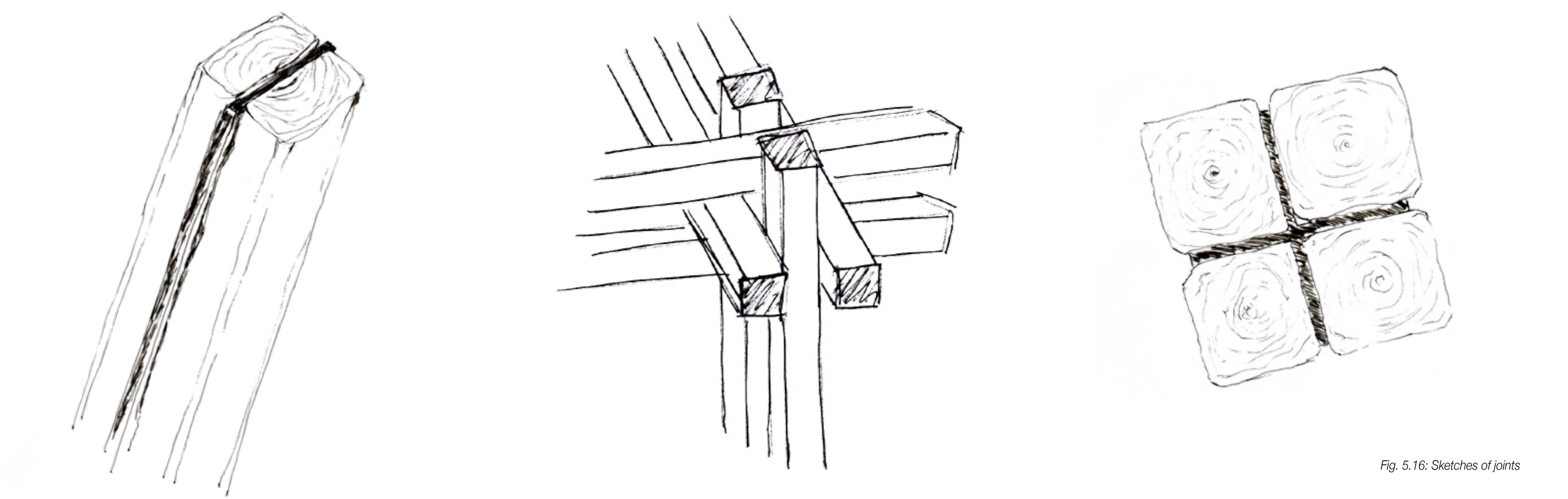


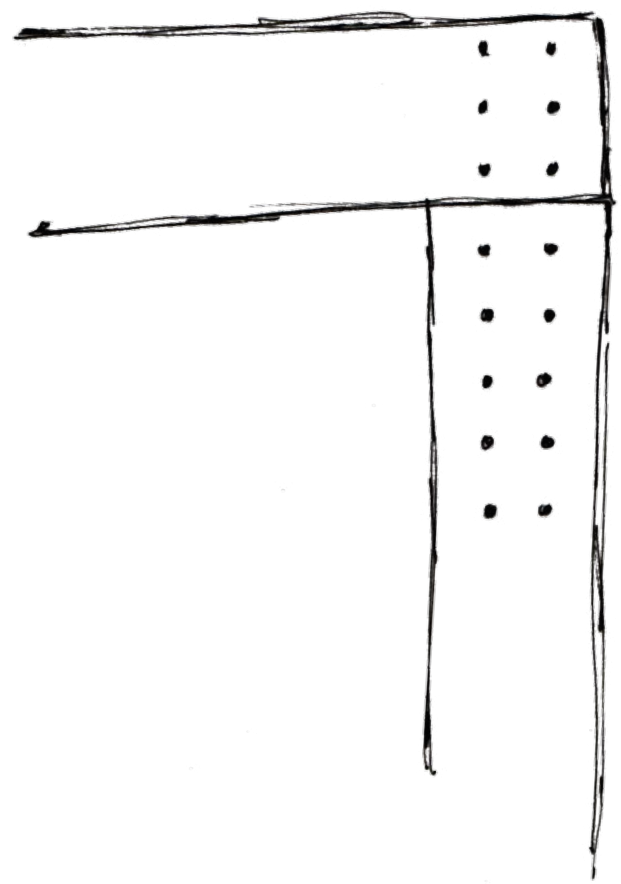
Fig. 5.16: Sketches of joints

PROCESS

DETAILING THE JOINT

As mentioned, the idea of the joint was to highlight the transition of elements and to use materials to express structural and material honesty.

The illustrations show how the joint of timber and steel have been tested as fixed and pinned joints. As a part of this iteration, the aesthetical expression was discussed along with the technical possibility of the joint in a global static scheme.



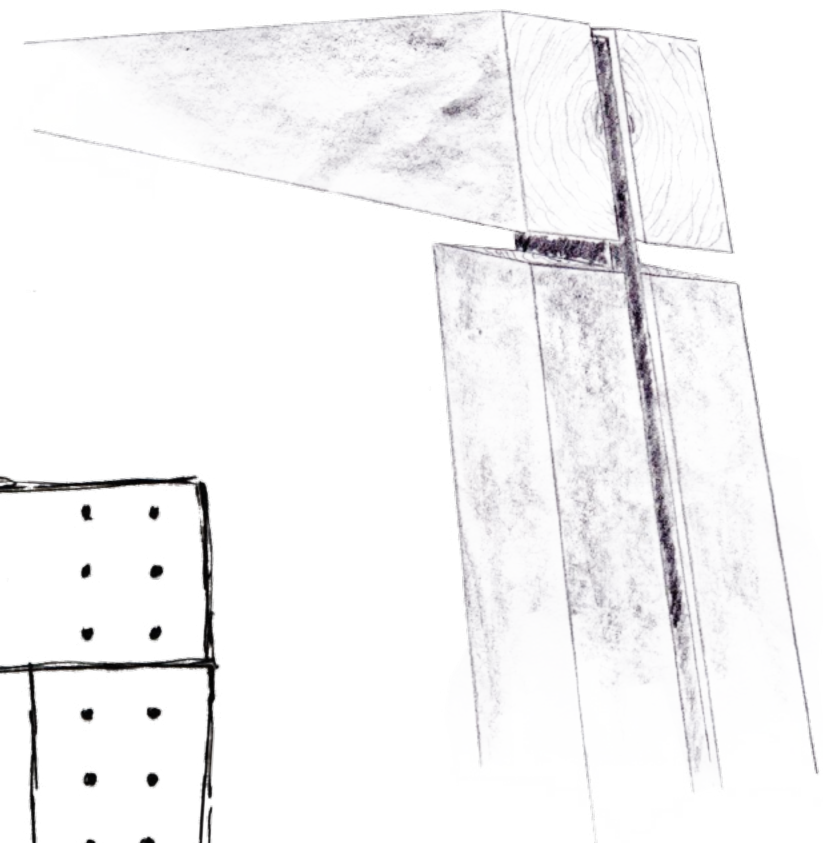


Fig. 5.17: Sketches of joints

PROCESS

THE FREESTANDING COLUMNS

The structural and spatial elements subdivide the large space into the 12-meter high space nearest to the main entrance and the rear end of the boat hall with a room height less than 12 meters for the smaller or unrigged boats.

Structural analysis with the software Karamba and Robot Structure allowed us to test several parameters. The ability of calculating the deflection of the columns enabled the discussion of the accurate position of the top and the bottom joints together with an aesthetical evaluation.

Fig. 5.18: Diagrams from Karamba of the freestanding columns

PROCESS

EXTERIOR EXPRESSION

The exterior expression of the boat hall was developed along with the interior expression and rest of the building volumes. Due to the need of a direct access level the idea of a continuing pavement was tested as an integrated part of the boat hall – even as a part of the façade expression. The idea was to create a direct and visual connection between the slipway and the boat hall.

The diagonal transition between the materials in the façade was tested as an attempt to articulate the openings and visual connection from the outside and give the building volume a dynamic expression. An iteration of this idea was made to test the possibility of using the structure as an element in the exterior expression. The introduction of polycarbonate allowed the interior and exterior expression to be translucent.

The exterior wooden cladding was added to complement the surrounding buildings. Both the vertical and horizontal direction of the wooden cladding were tested.

Fig. 5.19: Sketch of exterior expression

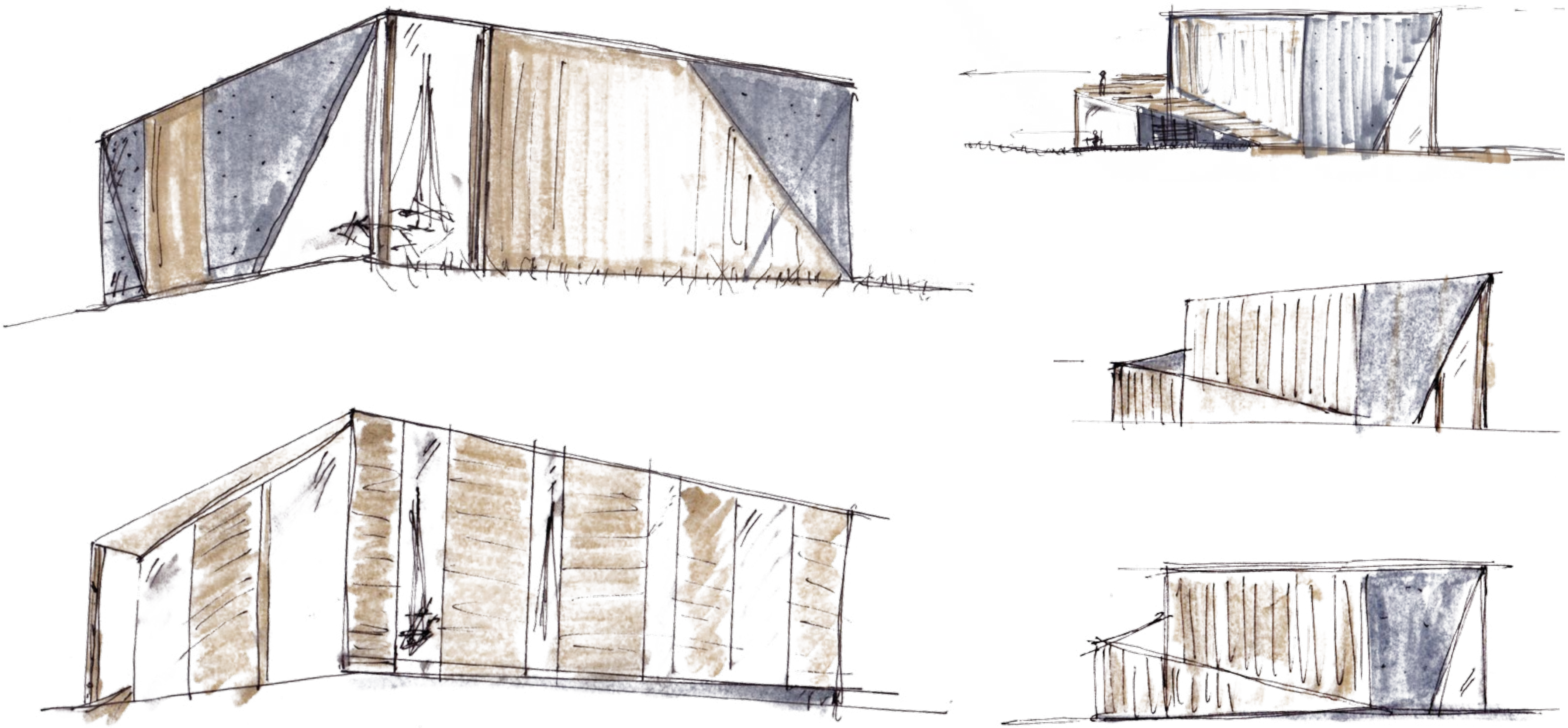


Fig. 5.20: Sketches of exterior expression

Fig. 6.1: Picture of Thisted marina

06 | CONCLUDING PERSPECTIVES

CONCLUSION

Refining the detail in every scale

The freestanding columns become the main spatial and structural element of the interior space in the boat hall. The composition of materials and the textural and tactile consideration reflect the aesthetical and technical treatment through the degree of details. The structure expresses robustness, elegance, and material strength as a metaphor of the boat mast and as a reference to the maritime narrative.

In response to the intention of *Fjordbyen* as a social gathering point, the main architectural concept - to gather around a centre – is applied. The concept is the basis for the decision of subdividing the functions into a total of nine smaller buildings that orientate toward each other and gathers around the social functions, the restaurant and the clubhouse. The houses frame the views toward Limfjorden and create niches for activities, which define the spaces in between the houses and in the transition from inside to outside. This indicates how the architecture completes the user needs for interior and exterior considerations to support the aspect of the maritime culture and sport.

The idiom is an interpretation of the old wooden boathouses. Pitching roofs, robust materials, the raised base, and the thoughtful detailing of the openings create a clear and characterful expression to invite, to welcome, and to guide you. At the same time, the simplicity adds a level of modesty, which allows the architecture to take a step backwards to make room for the maritime elements and the human activities taking place inside and outside the houses.

With the apparent location in Thisted the project has managed to attract attention from a distance. The proportions of the tall boat hall and the luminous effect in the evening become an architectural gesture to the surroundings and a reference to the lighthouse to safely guide you to your destination.

The atmosphere of the open landscape is complemented by the extensive boardwalk – an urban gesture that invites people to inhabit the space and at the same time stages the boats in the marina in the summer and on land during the winter. The variation of the boardwalk shifts from narrow paths to open terraces to meet with the water and generates different atmospheres along the coast. The change of character and experience create an area, which is adaptable to the user needs and allow them to occupy the space.

Proximity

The common point of departure for refining the structural detail, architectural detail, and urban detail has been the attention to the human scale. The focus upon proximity has been a consistent element throughout the analysis, the concept development, the design, and the detailing. The focus has enabled the project to relate to the potential of the place that is unique for this particular location.

That is why the scenic views toward Limfjorden is preserved to the south and *Fjordbyen* units and represents the environment at the marina in a modest yet characterful way toward north. The potentials and challenges of the place have been processed to create the intended proximity, which in our opinion is the foundation for bringing people together and eventually for developing the recreational environment that Sydhavnen should have – and as peripheral areas need.

Fig. 6.2: Picture from the site

REFLECTIONS

Project design

The transition of the peripheral areas in Denmark will continue in the years to come. The politicians are aware of the changes - now the words need to be put into action. The changes are also happening in Thisted. Therefore, the municipality needs to discuss the necessary steps that will form the future life in the peripheral areas. In this context, it is important as Realdania (2014) points out: *"to see the potentials rather that the problems."* – as this project contribute to.

Naturally, the design proposal for Fjordbyen does not solve all issues. However, it is a qualified proposal of how Sydhavnen in Thisted could develop because it takes point of departure in the unique local potentials and considers many of the wishes and suggestions made by the users of the harbour and the local residents. This is essential because the implementation and the criteria for success of a project like this rest upon the local community and enthusiasts. That is why we have tried to listen to and understand the wishes of the community but also relied on our professionalism in order to ask critical and constructive questions and raise awareness about the current and contemporary issues. Therefore, it is of our beliefs that a project like this is a contribution to a step in the right direction.

Design process

As mentioned in the introduction, this master's thesis and the transition of moving from theory to practice have made us reflect about our main skills and competences as architects. The ability to critically approach the projects, the surroundings, the limitations, etc. is important for us as individuals when we determine what makes a project unique. Moreover, in order to realise architecture the process takes detours in order to reach the destination.

Our judgement and need for gathering new knowledge will have to progress as the architecture develop. It is a process of lifelong learning that we must be aware of in order to make informed decisions with the right gut feeling. Thus, we are able to add value into the architecture to make it more that just a roof over our heads. This might be the most important overall learning from The School of Architecture, Design, and Planning.

REFERENCES

Literature

Andersen et al. 2002. *Thisted Købstads Historie – Mellem opbrud of tilpasning – Thy 1970-2000.* Vol. 3. Thisted: Forlaget Knakken

Beim, Anne. 2007. *Tektoniske visioner i arkitektur.* Kunstakademiets Arkitektskoles Forlag. København

Erskine, Ralph. 2000. *Quote in Byer for mennesker by Jan Gehl (2010).* Bogværket.

Eurocode 0. 2010. *Forkortet udgave af Euro Code 0 - Projekteringsgrundlag for bærende konstruktioner.*

Eurocode 1. 2010. *Forkortet udgave af Euro Code 1 – Laster.* 1st Ed.

Frampton, Kenneth. 1995. *Studies in Tectonic Culture – The Poetics of Construction in Nineteenth and Twentieth Century Architecture.* The MIT Press. Cambridge, Massachusetts.

Gehl, Jan. 2003. *Livet mellem husene – Udeaktiviteter og udemiljøer.* Arkitektens Forlag. København.

Gehl, Jan. 2010. *Byer for mennesker.* 1st Ed. København: Bogværket.

Hansen E.K. et.al. 2007. *LYS+ENERGI+ARKITEKTUR*. Arkitektskolen Aarhus, Institut for Arkitektonisk Design

Jensen, Bjarne. 2011. *Teknisk Ståbi.* 21st Ed. Valby: Nyt Teknisk Forlag
Madsen, Preben. 2010. *Statik og styrkelære.* 1st Ed. Valby: Nyt Teknisk Forlag

Norberg-Schulz, Christian. 1991. *Genius Loci: Towards a Phenomenology of Architecture.* Rizzoli

Norberg-Schultz, Christian. 1996. *Nightlands Nordic building.* MIT Press Ltd.

Study Board of Architecture and Design. 2014. *Study Guide MSc04 ARK S2014.* Department of Architecture, Design and Media Technology. Aalborg University

Træbranchens Oplysningsråd. 1994. *Det danske træhus – En Levende Tradition.* Viborg: Special-Trykkeriet.

Vitruvius. 1960. *The Ten Books on Architecture.* Dover Publications Inc., New York

Lectures

Hansen, Hanne Tine Ring. 2013. Lecture 2: *Methodological approaches to sustainable architecture found in theory. Architectural Concepts in integrated design*. Aalborg University, AD:MT

Thiis, Lars Juel. 2013. Lecture 4: *A multifuctional architectural environment. Architectural Concepts in integrated design*. Aalborg University, AD:MT

Thisted Kommune. 2013. *Stedet Tæller – Oplæg til Realdania: Hovedgreb_Kystvejen.* Thisted [18.11.2013]

Interview

Kristensen, Simon 2014. "Simon Kristensen." On *Thisted Sailing Club*, interviewed by Christina Thomsen and Tim Faldov (February 24). Recording on enclosed CD.

Internet

Archdaily. 2014. *Hammerhavn, project presentation.* Accessed May 24, 2014. http://www.archdaily.com/475411/hammerhavn-cubo-arkitekter/

Bornholms Regionskommune. 2014. *Hammerhavn projektbeskrivelse.* Accessed May 24, 2014. http://www.brk.dk/Indflydelse-Politik/Projekter/afsluttede%20projekter/Graniteventyret%20i%20Hammerhavn/Documents/vinderprojekt%20fra%20CUBO.pdf

Building Regulations. 2010. *Chapter 5.6.1, paragraph 1 and 2.* Accessed May 25, 2014: http://bygningsreglementet.dk/br10_04_id86/0/42

Cold Hawaii. 2014. *Klitmøller - Cold Hawaii.* Accessed February 26, 2014- http://coldhawaii.com/om/.

Danmarks Nationalparker. 2014. *Nationalpark Thy.* Accessed February 26, 2014. http://www.danmarksnationalparker.dk/Thy/.

Danmarks Statistik. 2014. BEF44: *Folketal 1. januar efter byområde.* Accessed February 27, 2014. http://www.statistikbanken.dk/bef44.

Hanstholm Havn. 2014. *Fremtidigsplaner for Hanstholm Havn.* Accessed February 27, 2014. http://www.hanstholmhavn.dk/fremtidsplaner.aspx.

Indsigelser til lokalplan nr. 1-007 Thisted Havn – Syd. 2013. Accessed February 4, 2014. http://issuu.com/simsoft/docs/indsigelser_sydhavnen_del_2

Mulighedernes land. 2014. Accessed May 24, 2014. http://www.mulighedernesland.dk/files/upload/2011_05_13_PM_Hammerhavn_konkurrenceresultat.pdf

Hammershøj, Per. 2013. I*ndsigelser til lokalplan nr. 1-007 Thisted Havn – Syd.* Accessed February 4, 2014. http://issuu.com/simsoft/docs/indsigelser_sydhavnen_del_2

Realdania. 2014. Press Release: *"26 projekter viser nye veje for mere livskvalitet i yderområderne"*. Accessed February 23, 2014. http://www.realdania.dk/filantropiske-programmer/samlet-projektliste/Stedet-taeller/nyheder/26udvalgteprojekter_230114

Thisted Kommune. 2012. *Teknisk Forvaltning, Thisted Havn – Syd, lokalplan nr. 1-007.* Accessed February 4, 2014. http://www.thisted.dk/~/media/BORGER/PlanlaegningByLand/Lokalplaner/1-007_Thisted%20Havn%20syd_FORSLAG.ashx

VisitThy. 2014. *Turist information.* Accessed February 26, 2014. http://www.visitthy.dk/danmark/thy-turistbureau.

Viva Energi. 2014. *Solar cells.* Accessed May 10, 2014. http://www.vivaenergi.dk/Placering_af_anlæg-96.aspx

Articles

Knudstrup, Mary-Ann. 2004. *Integrated Design Process in PBL.* In Kolmos et al (red): The Aalborg PBL model – Progress, Diversity and Challenges. Aalborg University Press, Aalborg University.

Vedbæk Havn. 1991. Vol. 35, no. 5, p. 242-247, København: Arkitektur DK

ILLUSTRATIONS

01 Introduction
Fig. 1.1: Own visualisation
Fig. 1.2: Photo by Mathilde Rødbro

Fig. 1.3:
1: Own illustration
2: Hansen, E. 2013. Lecture 2: Daylight, energy and architecture. Architectural Concepts in integrated design, Aalborg University, AD:MT [26.05.14]
3:http://1.bp.blogspot.com/_QJY8kBJFNps/S_Aff0snuOI/AAAAAAAAAaE/4ugwRLK9JbQ/s640/IMG_1479.JPG [26.05.14]
4.http://waveavenue.com/wp-content/uploads/2014/04/Laidback-Villa-Mecklin-in-Finland-by-Huttunen-Lipasti-Pakkanen-Architects12.jpg [26.05.14]
5. http://elizabethquigley.files.wordpress.com/2011/10/2726406370_c6df5f32e1_b.jpg [26.05.14]
6. http://huckberry.com/blog/posts/shelter-norwegian-boathouse [26.05.14]

7http://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&docid=b7aGqPWw-CzIgM&tbnid=nSOBzx-5iuP-7cM:&ved=&url=http%3A%2F%2Fwww.white.dk%2Fsystem%2Fresources%2FBAhbBlsHOgZmSSIxMjAxMy8wOC8xNS8xMy8zOC80Mi81NDlvSGFzbGVfSGF2bmViYWQwOS5qcGcGOgZFVA%2FHasle%2520Havnebad09.jpg&ei=P_qCU6rEKcfh4QT-julHoBw&bvm=bv.67720277,d.bGE&psig=AFQjCNGg3ZTyxPeMpUxOSYJd-uPkJGWlhw&ust=1401179072087249 [26.05.14]

8. http://elizabethquigley.files.wordpress.com/2011/10/2726406370_c6df5f32e1_b.jpg [26.05.14]
9. Own illustration

02 Project Brief
Fig. 2.1: Photo by Rene Thomsen
Fig. 2.2 – 2.4: Own illustration
Fig. 2.5:
1. Photo by Rene Thomsen
2. Own illustration
3. http://www.thisted.visbilleder.dk/Default.aspx?pr=101&n=81&img=17683&p=59
4. Own illustration
5. Own illustration

Fig. 2.6:
1. http://www.thisted.visbilleder.dk/Default.aspx?pr=101&n=81&img=17842&p=39
2. http://www.thisted.visbilleder.dk/Default.aspx?pr=101&n=81&img=17975&p=23[26.05.14]

Fig. 2.7:
1. Own illustration
2. Photo by Rene Thomsen
3. Photo by Rene Thomsen
4. Own illustration

Fig. 2.8: Photo by Mathilde Rødbro

Fig. 2.9:
1 – 5. Own illustration
Fig. 2.10 – 2.17: Own illustrations
Fig. 2.18: Own illustration
Fig. 2.19: http://www.windfinder.com/windstats/windstatistic_silstrup_thisted.htm[26.05.14]
Fig. 2.20: http://rum1.aarch.dk/index.php?id=132335[26.05.14]

Fig. 2.21:
1. http://www.infobuild.it/infobuild/archive.img/3dbddc17d682174ca84c422c81de13fcSnohetta100.jpg.jpg
2.http://www.google.com/imgres?imgurl=http://www.vibekeroennow.dk/wp00777b65_06.png&imgrefurl=http://www.vibekeroennow.dk/page18.html&h=600&w=800&tbnid=b4Xd8hdua0XPXM&zoom=1&tbnh=194&tbnw=259&usg=__4j-8HcU-jFVRqqIZJucSRcTTXqLs=[26.05.14]
3.http://b.bimg.dk/node-images/570/3/800x600-u/3570239-gratis-internet-i-mlleparken--.jpg [26.05.14]
4. Own illustration
5.http://a-a-ah.ru/data/place/m1/m1-1/1982/images/4e144dd019a7c001336819.550x340c.jpg?4407561c6c98f737fe1635b09bedafe0

Fig. 2.22 – 2.23: Own illustration
Fig. 2.24: http://www.traeprisen.dk/wp-content/uploads/2012/10/Hammer-Havn.jpg[26.05.14]
Fig. 2.25-2.28: Own illustrations
Fig.2.29:http://www.google.com/imgres?imgurl=http://www.arkitekturbilleder.dk/images/16i4.jpg&imgrefurl=http://mortenjust.com/huse/show_house.php?id=16&h=437&w=651&tbnid=kr0SDknPCanB1M&zoom=1&tbnh=184&tbnw=274&usg=__-5BSMlu-jCUZTlq39hEU66K9iT_Q=
Fig. 2.30: Own illustration[26.05.14]

03 Concept
Fig. 3.1 – 3.5: Own illustrations

04 Presentation
Fig. 4.1 – 4.23: Own illustrations
Fig.4.24:http://www.google.com/imgres?imgurl=http://media-cache-ec0.pinimg.com/236x/c1/1e/c6/c11ec69bd52f894a00f41ec0f9b30a2f.jpg&imgrefurl=http://www.pinterest.com/caralynlatimer/decking/&h=331&w=236&tbnid=RhzflHVlpzRK2M&zoom=1&tbnh=264&tbnw=188&usg=__vipxCiixt3oueatG3oAoS3DgbR4=[26.05.14]
Fig. 4.25: http://www.pinterest.com/pin/499829258616842473/
Fig. 4.26 – 4.39: Own illustrations

Fig. 4.40:
1. Own illustration
2. Own illustration
3. http://www.fdfhvidovre.dk/ingeborg/images/stories/Artikel_billeder/Ingeborg_borde_mod_vandet.JPG
4. Photo by Mette Grundtvig Ibsen
5. Own illustration
Fig. 4.41: Own illustration
Fig 4.42:
1. http://www.zhujee.com/wp-content/uploads/2014/02/22.jpg
2. Photo by Mette Grundtvig Ibsen
3. Own illustration
4.http://www.google.com/imgres?imgurl=http://www.aalborgcablepark.dk/files/cache/ad3e28143779af96faf50f601bebe741_f27.jpg&imgrefurl=http://www.aalborgcablepark.dk/billeder-video/&h=526&w=800&tbnid=ogKZSfA2qrhgxM&-zoom=1&tbnh=182&tbnw=277&usg=__WXg1TjeAEJuh1pvjDyrn6jdzyrk=
5http://www.google.com/imgres?imgurl=http://www.vibekeroennow.dk/wp00777b65_06.png&imgrefurl=http://www.vibekeroennow.dk/page18.html&h=600&w=800&tbnid=b4Xd8hdua0XPXM&zoom=1&tbnh=194&tbnw=259&usg=__4j-8HcUjFVRqqIZJucSRcTTXqLs=[26.05.14]

Fig 4.43 – 4- 45: Own illustration
Fig. 4.46: Photo by Mette Grundtvig Ibsen
Fig. 4.47: Own illustration
Fig. 4.48:
1: Own illustration
2: http://lignapal.files.wordpress.com/2012/07/pippy-oak.jpg
3: http://www.aa13.fr/wp-content/uploads/2014/02/non_program-jesus_torres-11-990x1487.jpg
4: http://www.haremoshistoria.net/noticias/hospital-del-puyo-pm-mt
5: Photo by Mette Grundtvig Ibsen
6: http://www.plataformaarquitectura.cl/tag/alemania/
7: http://myfancyhouse.com/wp-content/uploads/2013/05/Tranquil-Haus-Walde-by-Gogl-Architekten-6.jpg
8:http://www.archilovers.com/upload/StoryResources/0d3138b7e82c4a12a2a6ed22b03d02d5.JPG 9: http://www.ttesysteem.nl/tte_betonklinkers.html
10: http://www.pinterest.com/lrrchrd/passage/

Fig: 4.49 - 4.51 Own illustrations

05 Process
Fig: 5.1 – 5.12: Own illustration
Fig: 5.13
1: http://www.apartmentbarcelona.com/blog/wp-content/uploads/2014/05/Windsurfing.jpg
2: http://ru.fishki.net/picsw/062012/26/post/moment/moment-0008.jpg
3: Own illustration
Fig: 5.14 – 5.20 Own illustrations

06 Conclusion
Fig: 6.1 Photo by Rene Thomsen
Fig: 6.2 Photo by Matilde Rødbro

07 Appendix
7.1 – 7.12 Own illustrations

APPENDIX A

CALCULATIONS

Our design has been developed partly through parametric design scrutinizing, understanding of the construction, and utilisation of the potential of the materials.
The structural system of the boat hall is made by a traditional truss system in steel and vertical columns in wood. Wind crosses are used to stabilize the façade as a disk in the Y-direction. The frames are repeated in the total length of the hall. The wooden ‘V’ shaped columns support the beam in the opposite direction, the X-direction. The trapeze plates carry the roof and the polycarbonate in the façade. The material used for the steel I-profile is S275, whereas the C24 classified heartwood is used for the V-shaped columns and the columns in the façade.
All joints are calculated as pinned even though the combination of steel can obtain moment. This was chosen to freely design the transition between the column and the bar, and thereby, to raise the aesthetic quality more than to dimension it to be able to obtain the forces.

The parametric modelling provides the opportunity to combine several parameters in the geometric design regarding tectonic.
The calculations are made for quickly taking advantage of the qualities of the program combined with a basic knowledge of the main calculations principles. The programs we have used are Karamba and Robot Structure.

Karamba is an interactive, parametric finite element plugin for Grasshopper, which we use to analyse shell and beam structures and to determine stresses and strains in the structure. This is the same process as calculated manually where FEM helps you come-up with a solution faster and gives you the possibility to make more complex structures by modifying it live.

Robot is also a finite element, thus the interface is not as qualitative as Karamba. The Robot structure makes more precise calculations and therefore, the program is more relevant when verifying the initial calculations than calculations made in Karamba.

The greater advantage of FEM lies in the live continuous calculation and analysis of more complex designs where the output and the clear picture are somewhat more convoluted. Advantages are the integral of other structural, environmental, and acoustic parameters as being instructive.

BASIS OF THE CALCULATION
The dimension of the elements depends on the actual wind forces, building height, shape, and location, as well as how the loads have an effect on the structure. The hand calculations were performed in the initial sketching phase as a basis for calculating on the structure.
The calculations are based on the Boat hall with the following dimensions:

Height:	14 meters
Width:	25 meters
Length:	40 meters

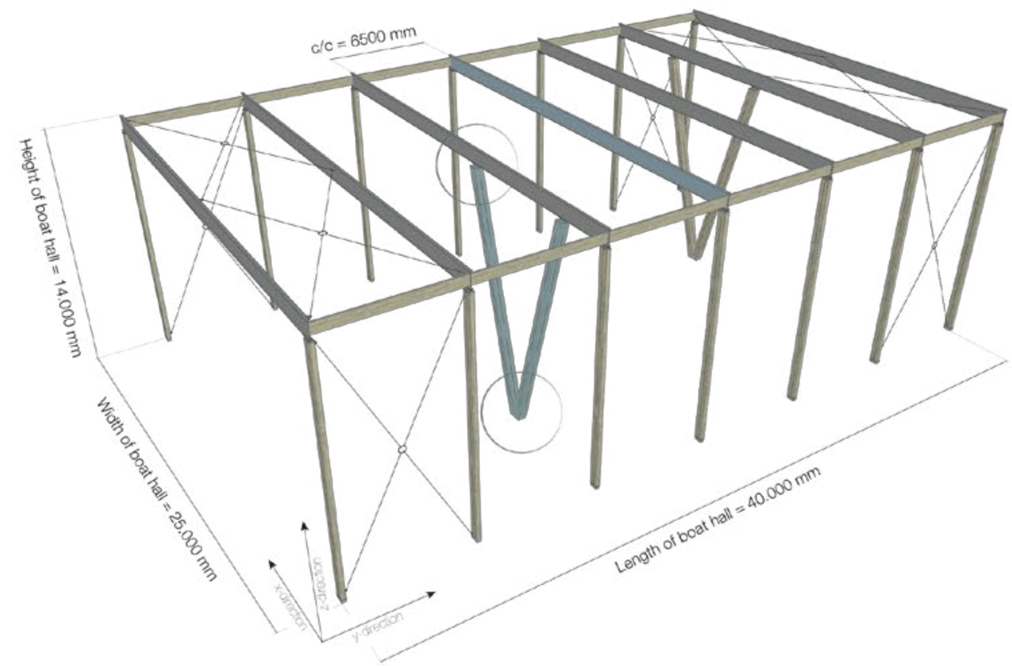


Fig. 7.1 Diagram of structure

PERMANENT LOAD

The permanent load is converted to kg/m^2 to use the permanent load in the Karamba and Robot structure. Subsequently, the load was inserted into a system configured in grasshopper. The characteristic value for the permanent load is calculated for each part of the roof construction.

Wood lamellae panel:	14.4 kg/m^2
Solar cells:	15.0 kg/m^2
Asphalt roofing:	10.2 kg/m^2
Trapez plate:	14.8 kg/m^2
Installations:	14.0 kg/m^2

The permanent load for the roof is calculated to: P = (14.4 kg/m^2 + 15.0 kg/m^2 + 10.2 kg/m^2 + 14.8 kg/m^2 + 14.0 kg/m^2) · 0.982 N/kg = 0.67 kN/m^2

SNOW LOAD

By flatting the structure of the roof to a lower angle it becomes more influent. It is a mono-pitch roof with an angle of 5 degrees. Furthermore, the snow load is a variable load and therefore, it only has a short-term affect on the structure. In Denmark the C_t deglaciation on roof is 1.0. The shape coefficient, μ, and the exposure coefficient, C_e is set to 0.8 because the building is nearly flat and it is located in a flat unobstructed area exposed to all sides. The terrain value, S_k is set to 1.0 kN/m^2. (Teknisk Ståbi, 2011 p.168)

The representative snow load is calculated by:

$$S = \mu \cdot C_e \cdot C_t \cdot S_k \qquad \text{(Teknisk Ståbi, 2011 p.168)}$$

$$S = 0.8 \cdot 0.8 \cdot 1 \cdot 1 = 0.64\ \frac{\mathbf{kN}}{\mathbf{m^2}}$$

This gives a calculated snow load of 0.64 kN/m2.

The snow load is transfered to the Karamba and Robot structure where the resulting force of the total roof is distributed on each of the I-profiles and thereby, it is calculated as a downward line load. The snow load is set in Karamba and Robot to demonstrate forces of the fractures.

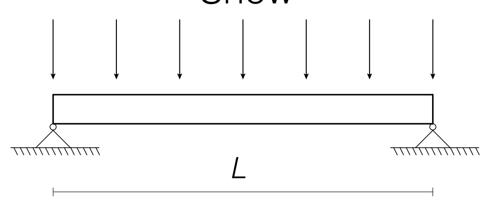


Fig. 7.2 Load pr. meter for snow

WIND LOAD

The wind load is calculated based on a basic wind speed, the basic velocity pressure, length of roughness factor, average velocity pressure, and turbulence intensity where the characteristic maximum wind pressure is defined as below.

Because of the exposed location of Sydhavnen the terrain factor is in the category 1; lakes or areas with negligible vegetation and without obstacles. The basic wind speed is set to 27 m/s due to a location closer than 25 km from the west coast of Denmark.

The wind speed pr. m^2 is defined as:

$$\mathbf{f_w} = \mathbf{q_{max}} \cdot \mathbf{c_d} \cdot \mathbf{c_p}$$

$\mathbf{q_{max}}$: Characteristic maximum wind pressure $\left[\frac{\mathbf{kN}}{\mathbf{m^2}}\right]$

$\mathbf{c_d}$: Construction factor

$\mathbf{c_p}$: Form factor wind

The characteristic maximum wind pressure is defined as:

$$\mathbf{q_{max}} = (1 + 2 \cdot \mathbf{q_p} \cdot \mathbf{I_v}) \cdot \mathbf{q_m}$$

$\mathbf{q_p}$: Peak-factor, set to 1.13 $\left[\frac{\mathbf{kN}}{\mathbf{m^2}}\right]$ [DS 410, 6.2(8)]

$\mathbf{I_v}$: Turbulence intensity

$\mathbf{q_m}$: 10 minutes average wind pressure $\left[\frac{\mathbf{N}}{\mathbf{m^2}}\right]$

The turbulence intensity is defined as:

$$\mathbf{I_v} = \frac{\mathbf{1}}{\mathbf{C_t}} \cdot \frac{\mathbf{1}}{\mathbf{ln}\left(\frac{z}{z_0}\right)}$$

$\mathbf{c_t}$: Topography-factor

z : The height of the construction above ground

z_0 : Length of roughness

The 10 minutes average wind pressure is defined as:

$$q_m = c_r^2 \cdot c_t^2 \cdot q_b$$

c_r : Factor of roughness
q_b : Basic velocity pressure $\left[\frac{N}{m^2}\right]$

The Factor of roughness is defined as:

$$c_r = k_t \cdot ln\left(\frac{z}{z_0}\right)$$

K_t = The factor of terrain for category I is set to 0.170 (DS 410, Table 6.1.2.1)

The basic velocity pressure is defined as:

$$q_b = \frac{1}{2} \cdot \rho \cdot v_b^2$$

ρ : Density of the air
V_b : Basic wind speed $\left[\frac{m}{s}\right]$

The basic wind speed is defined as:

$$V_b = C_{dir} \cdot C_{season} \cdot V_{b,0}$$

C_{dir} : Factor for direction of wind speed [DS 410, 6.1.1]
C_{season}: Factor for wind speed season [DS 410, 6.1.1]
$V_{b,0}$: Value for the basic wind speed sat to 27 $\frac{m}{s}$

The calculations are as follow:

$$V_b = 1 \cdot 1 \cdot 27 \frac{m}{s} = 27 \frac{m}{s}$$

$$q_b = \frac{1}{2} \cdot 1.25 \frac{kg}{m^3} \cdot \left(27 \frac{m}{s}\right)^2 = 456 \frac{N}{m^2}$$

$$c_r = 0.22 \cdot ln\left(\frac{14}{0,01}\right) = 1,59$$

$$q_m = 1.59^2 \cdot 0.170^2 \cdot 456 \frac{N}{m^2} = 33,3 \frac{N}{m^2}$$

$$I_v = \frac{1}{0.170} \cdot \frac{1}{ln\left(\frac{14}{0.01}\right)} = 0.81$$

$$q_{max} = (1 + 2 \cdot 1.13 \cdot 0.81) \cdot 33.3 \frac{N}{m^2} = 0.094 \frac{kN}{m^2}$$

The wind speed pr. m^2 is calculated to:

$$f_w = 0,094 \frac{kN}{m^2} \cdot 1.0 \cdot c_p$$

The form factor, c_p, is based on the extracted diagram.

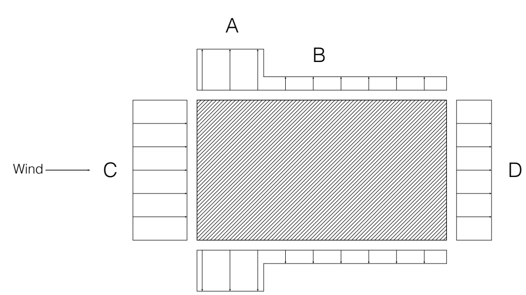


Fig 7.3 Diagram for wind

Wind on gable:	Wind on façade:
C: $C_{pe, 10}$ = 0,8	**C**: $C_{pe, 10}$ = 0,8
D: $C_{pe, 10}$ = -0.3	**D**: $C_{pe, 10}$ = -0.5
Area = 350 m^2	**Area** = 480 m^2

$$f_w = 0.094 \frac{kN}{m^2} \cdot 1,0 \cdot 0.8 = 0.0752$$

$$f_w = 0.094 \frac{kN}{m^2} \cdot 1.0 \cdot 0.8 = 0.0752$$

$$f_w = 0.094 \frac{kN}{m^2} \cdot 1.0 \cdot (-0.3) = -0.0282$$

$$f_w = 0.094 \frac{kN}{m^2} \cdot 1.0 \cdot (-0.5) = -0.045$$

C = 26.3 kN	**C** = 36 kN
D = -9.8 kN	**D** = -21.6 kN
Sum = 36.1 kN	**Sum** = 57.6 kN

(Eurocode 1)

The variable wind load is calculated to 0.103 kN/m^2 for the gable and 0.120 kN/m^2 for the facade at a height of 14 meters. The angled roof is not taken into consideration.

The wind load is transferred to the Karamba and Robot structure where the resulting force has been simplified by distributing the equilibrium equally between the two sides of the gable or the to sides of the facade (See the illustrations of the loads in the structure section). The wind forces are set to demonstrate the stabilising effect of the V-structure in a 3D environment.

LOAD COMBINATION

The following load combinations have been made for calculation where G is the gravity load, S is the snow load, V is the wind load, and K_{fi} is a safety factor relating to the consequence class CC2, medium risk of loss of life. K_{fi} is defined as 1 (Teknisk ståbi, 2011, pp. 162 & 314)

Dominating snow load:

$1 \cdot K_{fi} \cdot G$	$1.5 \cdot K_{fi} \cdot S$	$1.5 \cdot 0.3 \cdot K_{fi} \cdot V$

Dominating wind load:

$1 \cdot K_{fi} \cdot G$	$0 \cdot K_{fi} \cdot S$	$1.5 \cdot K_{fi} \cdot V$

A diagrammatical dimensioning of a steel beam in ULS and SLS was made to exploit the possibilities of grasshopper to operate life in the Karamba programme. The calculations are performed by guessing on cases and thereafter to show that the assumptions are correct. The data is transferred to the Karamba and Robot structure for a subsequent demonstration of the exploit condition for each of the elements.

MAXIMUM DISPLACEMENT

In the serviceability limit state (SLS) it was assessed whether a possible deflection of rafters or beams was acceptable, providing the dimensions of size depending on the respective load cases. There is no requirement for the maximum deflection but merely guidelines where short-term deflection from the combination of wind and snow load of 1/400 of the span.

The deflection of the beam at the intended load is calculated in the limit state. First, a calculation of the maximum deflection of the beam is performed. This was done based on $\frac{l}{400}$, where the length, l, of the beam is in mm. The length of the I-profile is 25 meters.

The permissible deflection is: $u_{max} = \frac{l}{400}$ = 62.2 mm

DIMENSIONING OF THE I-PROFILE

Hereafter, a profile is chosen. The choice of steel beam is an I-profile of the type IPE750x173 with a thickness of 21.6mm. The beam has a simple support in both ends, thus an own load and snow load are calculated. The permanent load is calculated based on the load from the roofing and the own load of the steel beam. The wind load will not be calculated because it is not directional for fractions on the beam.

Data of material:

Strength class: DS/EN 10113, Steel type S27

$\boldsymbol{f_y} = 265\ MPa$

$\boldsymbol{E} = 0.21 MPa \cdot 10^6$

$\boldsymbol{I} = 1661.0 mm^4 \cdot 10^6$

$\boldsymbol{W} = 5402 mm^3 \cdot 10^3$

$\boldsymbol{\gamma_{m0}} = 1.10$

Application class:	2
Control class:	Normal

Dimensions:

h =	750 mm
w =	267 mm
l =	25000 mm
cc =	6.5 m

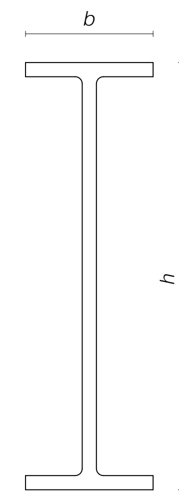


Fig. 7.4 Cross section for the I-profile

Load:

$\boldsymbol{p_{permanent}} = 0.67\ kN/m^2$

$\boldsymbol{q_{snowload}} = 0.64\ kN/m^2$

$\boldsymbol{g_{deadload}} = \frac{173.7\frac{kg}{m} \cdot 25 \cdot 7}{1000 m^2} = 30.4\ \frac{kN}{m^2}$

(The 173.7 kg/m is a material value for the steel profile)

Serviceability limit state (SLS)

Maximum deflection (Y):

Partial coefficients = 1.0

$\boldsymbol{Y} = (1.0\ \cdot 0.67\ kN/m^2) + (1.0 \cdot 0.64\ kN/m^2) + (1.0 \cdot 30.47\ kN/m^2)$ = 39.8 kN/m^2

The directional line load of each beam is calculated with a centre distance of c/c 6.5 meters:

$\boldsymbol{Y} = 39.8\ kN/\mathrm{m}^2 \cdot 6.5m = 258.8\frac{kN}{m}$

The immediate deflection of the I-profile:

$$\boldsymbol{u_{inst}} = \frac{\boldsymbol{5 \cdot P \cdot l^4}}{\boldsymbol{384 \cdot E \cdot I}}$$

P = line load of each beam
E = elasticity module for the steel type
I = moment of inertia = $\frac{1}{12} \cdot b \cdot h^3$

$$\boldsymbol{u_{inst}} = \frac{5 \cdot 258.8\frac{kN}{m} \cdot 25000mm^4}{384 \cdot (0.21MPa \cdot 10^6) \cdot (671.2mm^4 \cdot 10^6)} = 5.98 \text{ mm}$$

Because $u_{max} > u_{inst}$, the immidiate defection will not be greater than the acceptable deflection of 62.2 mm

Ultimate Limit State (ULS)

The maximum design moment (M_{Ed})

$$\boldsymbol{M_{Ed}} \leq \frac{\boldsymbol{W \cdot f_y}}{\boldsymbol{\gamma_{m0}}}$$

$\boldsymbol{W}$: cross section modulus

$\boldsymbol{\gamma_{m0}}$: Partial coefficient at normal control class
$\boldsymbol{f_y}$: the yield stress of the material

$$\boldsymbol{M_{Ed}} \leq \frac{5402mm^3 \cdot 10^3 \cdot 265MPa}{1.10}$$
$$= 1301390.9 \cdot 10^3\ N/mm$$
$$\approx 1301.4\ kN/m$$

Thereby, the maximum design moment of the beam load is 1301.4 kN/m.

The calculated load (q_{Ed})

$$\boldsymbol{M_{Ed}} = \frac{\boldsymbol{1}}{\boldsymbol{8}} \cdot \boldsymbol{q_{Ed}} \cdot \boldsymbol{l^2}$$

$\boldsymbol{q_{Ed}}$: The calculated load

The calculated load, $\boldsymbol{q_{Ed}}$, is isolated in the following formula and calculated:

$$\boldsymbol{q_{Ed}} = \frac{\boldsymbol{M_{Ed} \cdot 8}}{\boldsymbol{l^2}}$$

$$\boldsymbol{q_{Ed}} = \frac{1301.4\ \ kN/m \cdot 8}{25m^2} = 16.66\frac{kN}{m}$$

Criteria $\boldsymbol{q_{Ed}} \geq \boldsymbol{P_d}$ is demonstrated:

$$\boldsymbol{P_d} = \left(1.0 \cdot 0.67\frac{kN}{m^2} \cdot 6{,}5m\right) + \left(1.5 \cdot 0.64\frac{kN}{m^2} \cdot 6.5m\right)$$
$$= 10.6\frac{kN}{m}$$

$$\boldsymbol{q_{Ed}} = 16.66\ kN/m > P_d = 10.6\ kN/m$$

Critieria $\boldsymbol{q_{Ed}} \geq \boldsymbol{P_d}$ is met and thereby, a correct dimension of the steel beam has been stablished.

DIMENSIONING OF THE WOOD COLUMN

Due to the gathering of four columns, each one with the dimensions, 230 x 230 mm into a V-structure, the gathered column is simplified to one dimension. The assumed dimension is based on aesthetic considerations as well as the possibility of acquisition of the wooden columns for trade objectives. A steel bracket is placed along the column as well as at the bottom of the column for the columns to function as a gathered column. The brackets are indulged to the column as shown on page 65. There are no difference on the weaker and the stronger axis, as the profile is a square. The column is a simple supported, central loaded column.

Material data:	Construction wood C24
Application class:	2
Control class:	Normal

Dimensions:

h = 460mm
w = 460mm
l = 13000mm

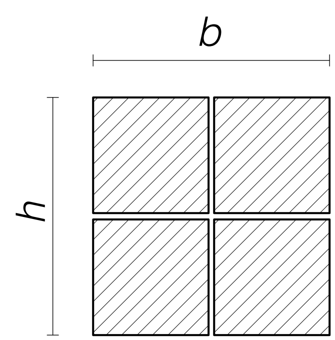


Fig. 7.5 Cross section for the V-shaped wooden column

Ultimate limit state (BGT)

The following strength conditions are wished fulfilled:

$$\boldsymbol{\sigma_{c,o,d}} = \frac{\boldsymbol{F}}{\boldsymbol{A}} \leq \boldsymbol{k_c} \cdot \boldsymbol{k_d} \cdot \boldsymbol{f_{c,0,k}}$$

$$\boldsymbol{F} \leq \boldsymbol{A} \cdot \boldsymbol{k_c} \cdot \boldsymbol{k_d} \cdot \boldsymbol{f_{c,0,k}}$$

$\boldsymbol{\sigma_{c,o,d}}$ = permissible stresses in MPa

F = permissible load in N

A = $211600\ mm^2$, cross sectional area of the column

$\boldsymbol{k_c}$ = column factor,

$\boldsymbol{k_d}$ = 0.444, conversion factor, determined from table 6.2, page 275 in "Statik og Styrkelære"

$\boldsymbol{f_{c,0,k}}$ = 21 MPa, characteristical strenght numbers, table 6.1, page 275 in "Statik og Styrkelære"

Slenderness of the column, $\boldsymbol{\lambda_{rel}}$, is calculated to determine the column factor, $\boldsymbol{k_c}$.

$$\lambda_{rel} = \frac{\boldsymbol{k_{rel}} \cdot \boldsymbol{l_s}}{\boldsymbol{h}}$$

$\boldsymbol{k_{rel}}$ = 0.059, the factor is found in table 6.3, page 283 in "Statik og Styrkelære"

$\boldsymbol{l_s = L = 13000mm}$, effective column length due to pinned joints a long the column.

h = 460 mm, cross sectional high

$$\lambda_{rel} = \frac{\mathbf{0,059 \cdot 13000\ mm}}{\mathbf{460\ mm}} = \mathbf{1.667}$$

Hereby, it is possible to calculate the carrying capacity for the permanent load and the variable load. First, the k-value where $\beta = 0.2$ is a coefficient, which take the load duration for the construction wood material into account.

$$\mathbf{k} = \frac{1}{2}\left(1 + \beta(\lambda_{rel} - 0.5)\lambda_{rel}{}^2\right)$$
$$= \frac{1}{2}(1 + 0.2(1.667 - 0.5)1.667^2)$$
$$= 0.824$$

$\boldsymbol{k_c}$ is calculated

$$k_c = \frac{1}{k + \sqrt{k^2 - \lambda_{rel}{}^2}} = \frac{1}{0.824 + \sqrt{0 - 824^2 - 1.667^2}}$$
$$= 0.440$$

The Ultimate limit state (F)

$$\boldsymbol{F} \leq \boldsymbol{A} \cdot \boldsymbol{k_c} \cdot \boldsymbol{k_d} \cdot \boldsymbol{f_{c,0,k}}$$

$$\boldsymbol{F} \leq 211600mm^2 \cdot 0.440 \cdot 0.444 \cdot 24.92MPa$$
$$\leq 1.237\ N \cdot 10^3$$

As a conclusion the maximum carrying capacity of the wood column is $\boldsymbol{F} = 1.237\ kN$

Demonstration of the column carrying capacity:

The own weight of the I-profile must be used.

This value is $\boldsymbol{g_{bjælke}} = 173.7 \frac{kg}{m} \cdot 25 = 42.6\ kN$

Permissible load combination p_d is determined:

$$\boldsymbol{p_{d1}} = 1.0 \cdot g \Rightarrow 1.0 \cdot 42.6\ kN = 42.6\ kN$$
$$\boldsymbol{p_{d2}} = 1.0 \cdot g + 1.5 \cdot S \Rightarrow 1.0 \cdot 42.6\ kN + 1.5 \cdot 91.4$$
$$= 179.7\ kN$$

$$\boldsymbol{p_d} = \leq F \Rightarrow 179.7\ kN \leq 1.237\ kN$$

VERYFYING A TIMBER MEMBER

The calculations are made in Robot, verifying the different members with the combinations of steal and timber profiles. The ratio estimates the use of the elements according to ultimate limit state. The ratio lies between 0.1 and 0.39.

ROBUSTNESS
EuroCode 0 – Dansk Annex, point out that a construction must be dimensioned and designed so as the expected application time at correct usage and maintenance is able to with stand the loads the construction will be exposed to. The construction must also have a satisfactory degree of resistance and resilience.

The crucial safety parts of the construction must therefore only be slightly sensitive to unintended effects and defects so no comprehensive failure of the structure will take place if a limited part of the structure fails.

The basic idea is to distribute the load over multiple items so a collapse in a collision will not occur. By considering the two V-structures as being the most exposed structures, it is estimated that there is a load transformation by removing those elements. The roof is constructed with a trapezoidal steel sheet to absorb large forces over long spans and thus secure against breakage by collision.

The tall, slim I-profile can be assessed to be in danger of a possible tilt. The elements can be remedied by inserting stabilizing elements between the flanges of the I-profile.

APPENDIX B

WINDOW HEAD AND ROOF // 1:10

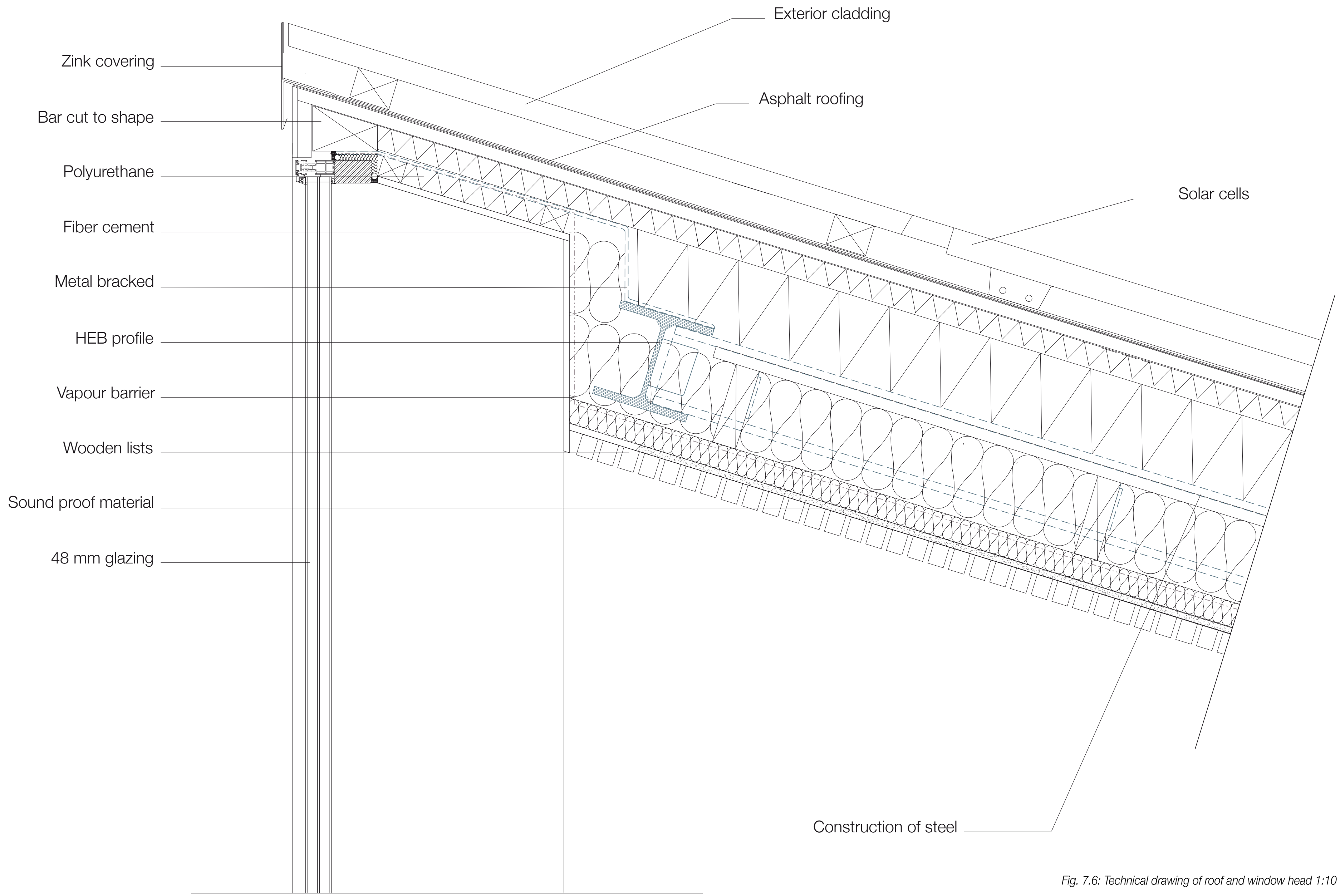


Fig. 7.6: Technical drawing of roof and window head 1:10

APPENDIX B

WINDOW SILL AND BASE // 1:10

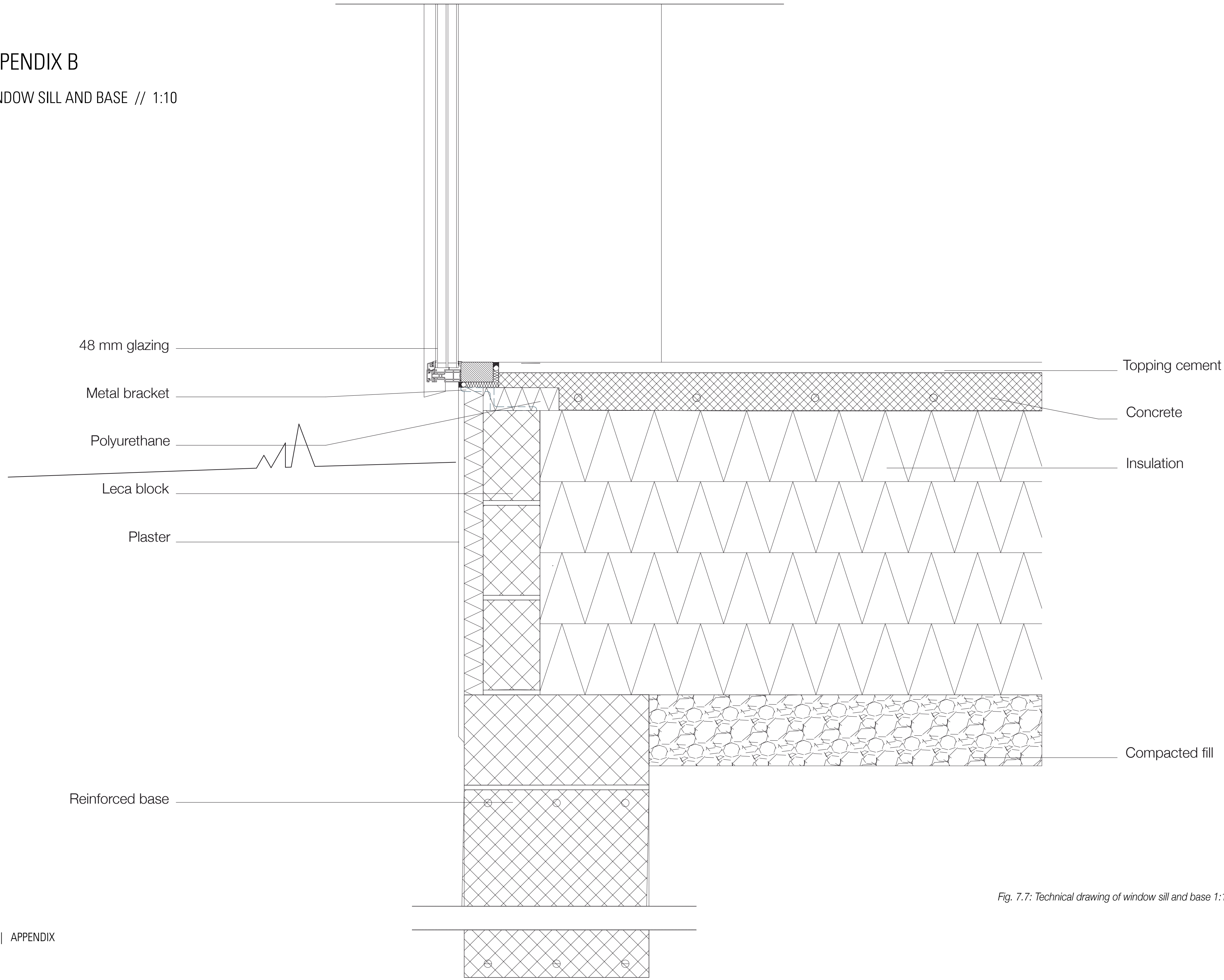


Fig. 7.7: Technical drawing of window sill and base 1:10

APPENDIX B

EXTERIOR WALL WITH INTEGRATED BENCH // 1:10

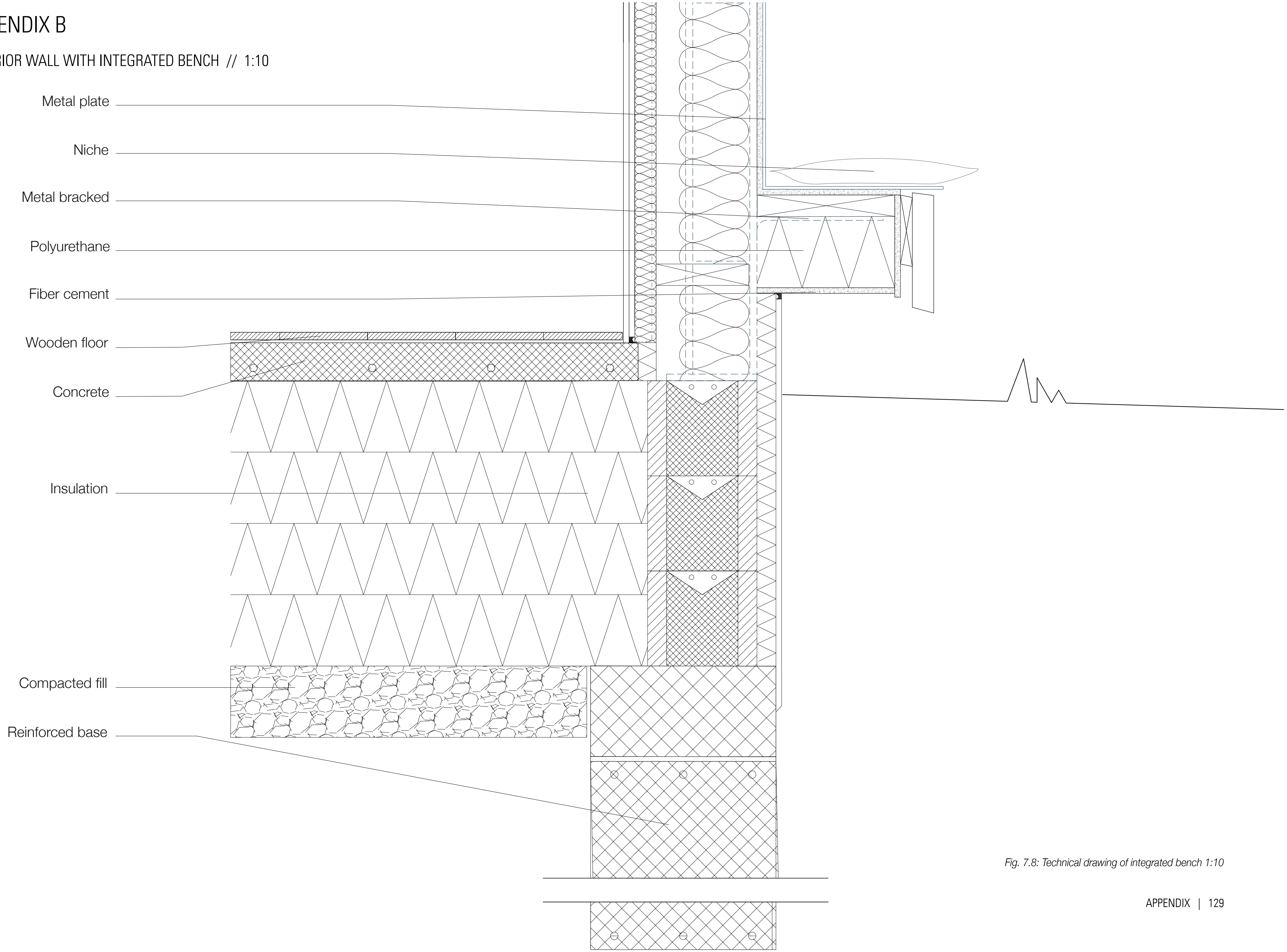


Fig. 7.8: Technical drawing of integrated bench 1:10

APPENDIX B

EXTERNAL SHADING // 1:10

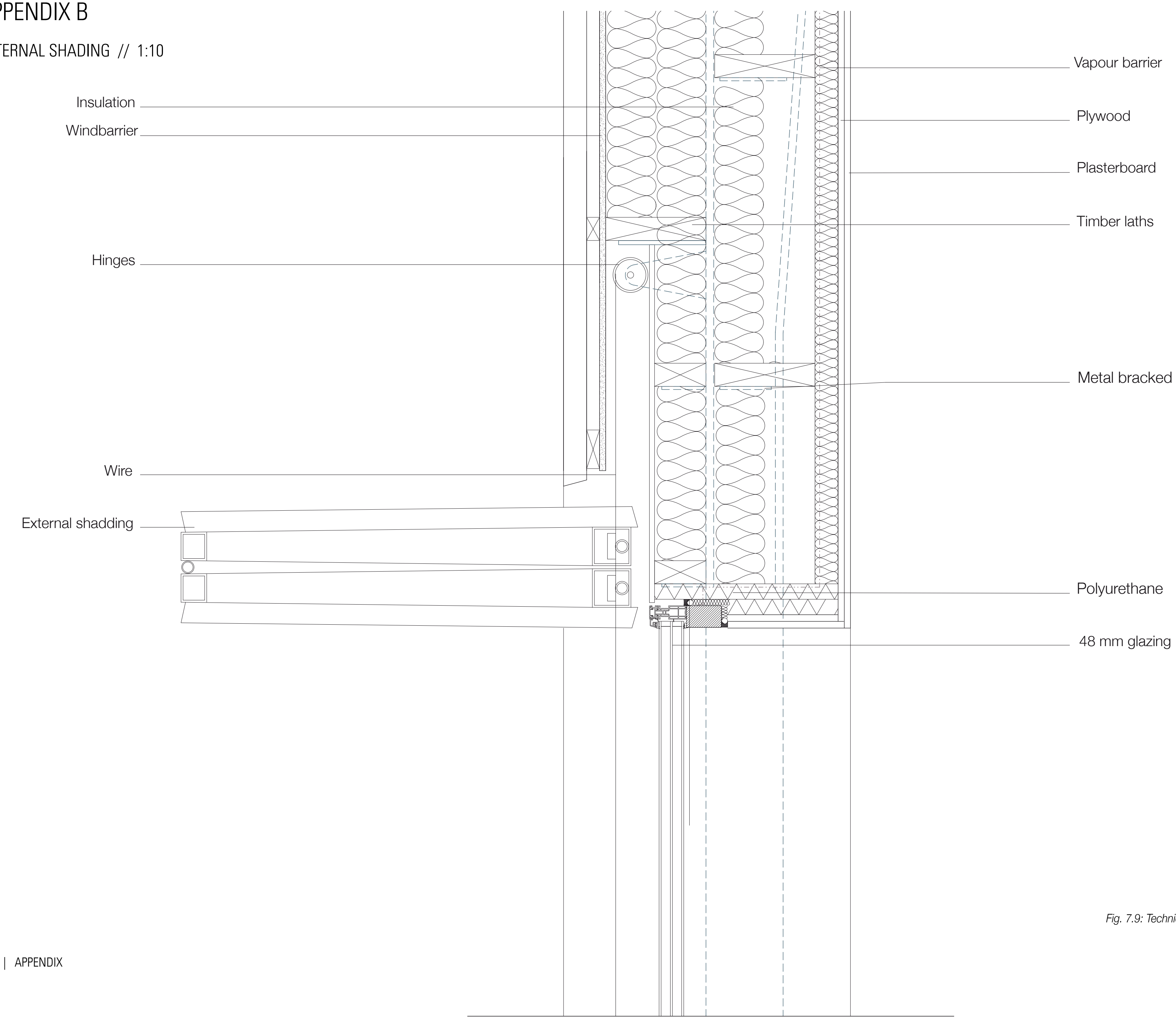


Fig. 7.9: Technical drawing of external shading 1:10

APPENDIX B

SOLAR CELLS AND HIDDEN GUTTER // 1:10

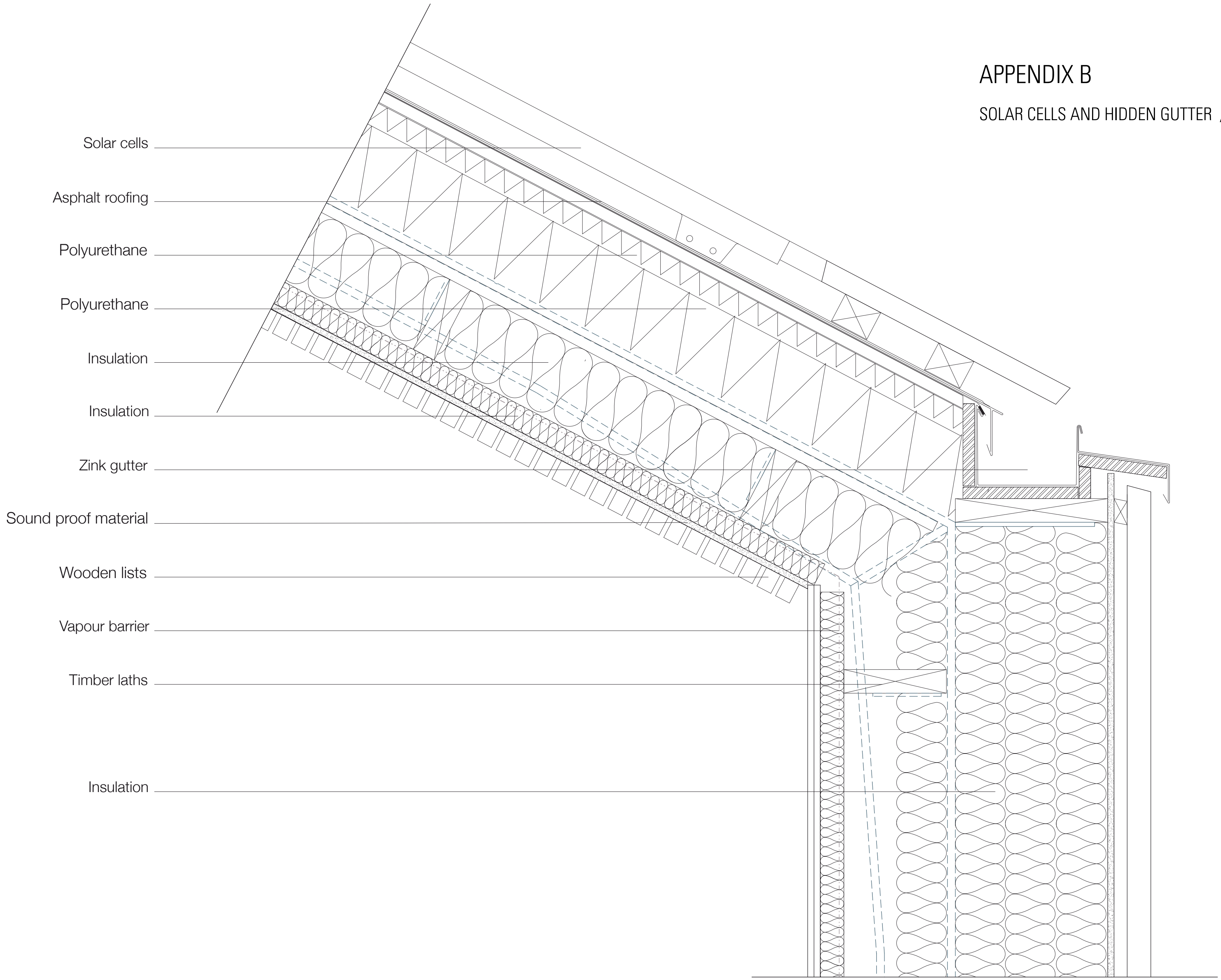


Fig. 7.10: Technical drawing of root with integrated solar cells and hidden gutter 1:10

APPENDIX C

FIRE AND SAFETY

Fjordbyen consists of subdivided houses allowing no escape routes to the outdoor space to exceed the limit of 25 meters. All escape routes are dimensioned to the maximum amount of people staying within the room.

The evacuation strategy for the building containing the changing rooms and workout space has a few conditions that need special attention. The workout space upstairs needs more than one escape route. A rescue opening is placed opposite to the staircase. The same rule is fulfilled in the changing rooms where the firebreak doors are implemented.

According to the Building Regulations 2010, Chapter 5.6.1, paragraph 1 and 2, the emergency rescue equipment should have access to any door with direct access to the ground level.

All doors in this project are located with consideration of the allowed maximum distance of 40 meters to navigable surface with a minimum width of 2.8 meters. The rescue opening in the workout space is in connection with a 4.0 meters wide paved area for fire rescue vehicles (Fig. 7.11).

Fig. 7.11: Ground floor escape plan 1:1000

APPENDIX D

TECHINCAL INSTALLATIONS

The illustration shows that spaces for the technical rooms and the ventilation are taken into account. Due to the subdivision of the functions, every building will have its own technical room with separate ventilation systems dimensioned to obtain the required air exchange.

The restaurant, changing rooms, and the workshop will need increased ventilation, therefore, demanding more space for the ventilation unit, which is implemented in the plan.

The high openings inside the boat hall and in the changing rooms utilise the principle of natural ventilation. The height of the windows makes it possible to use thermal buoyancy of warm air.

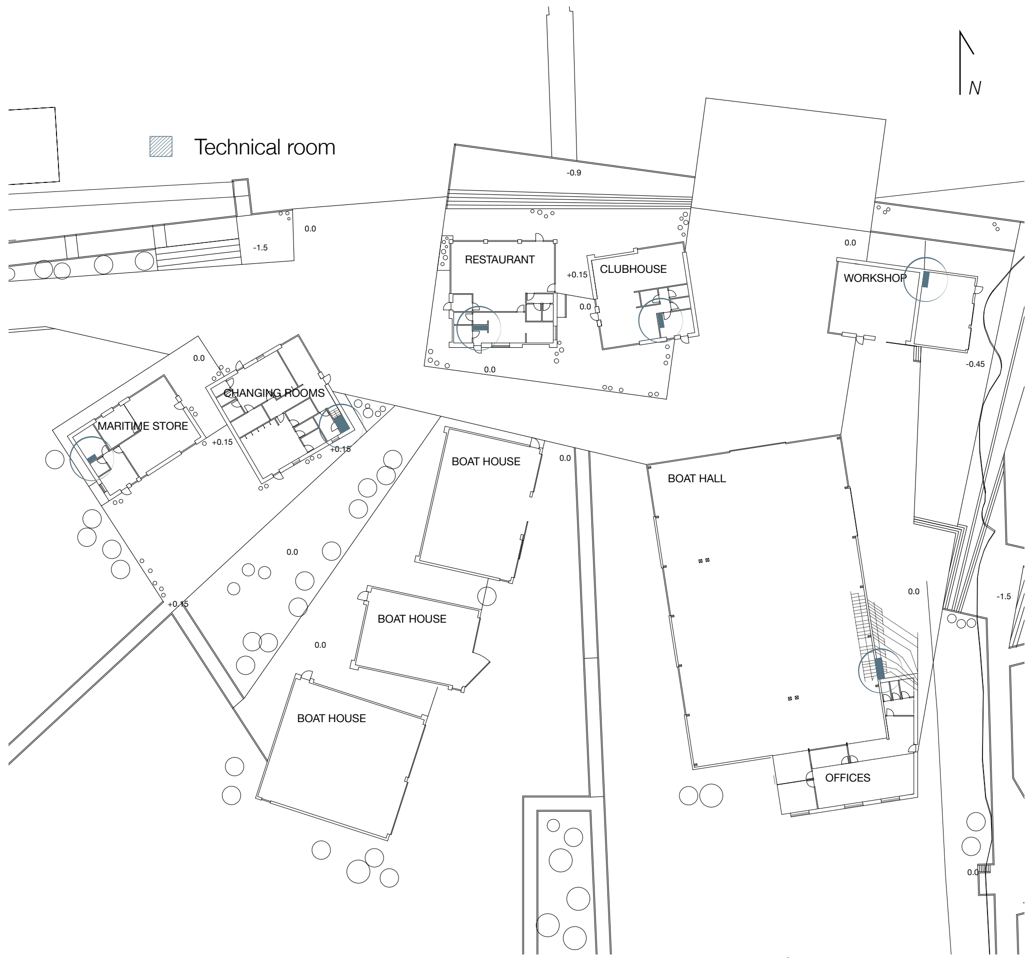


Fig. 7.12: Ground floor showing techincal installations 1:1000