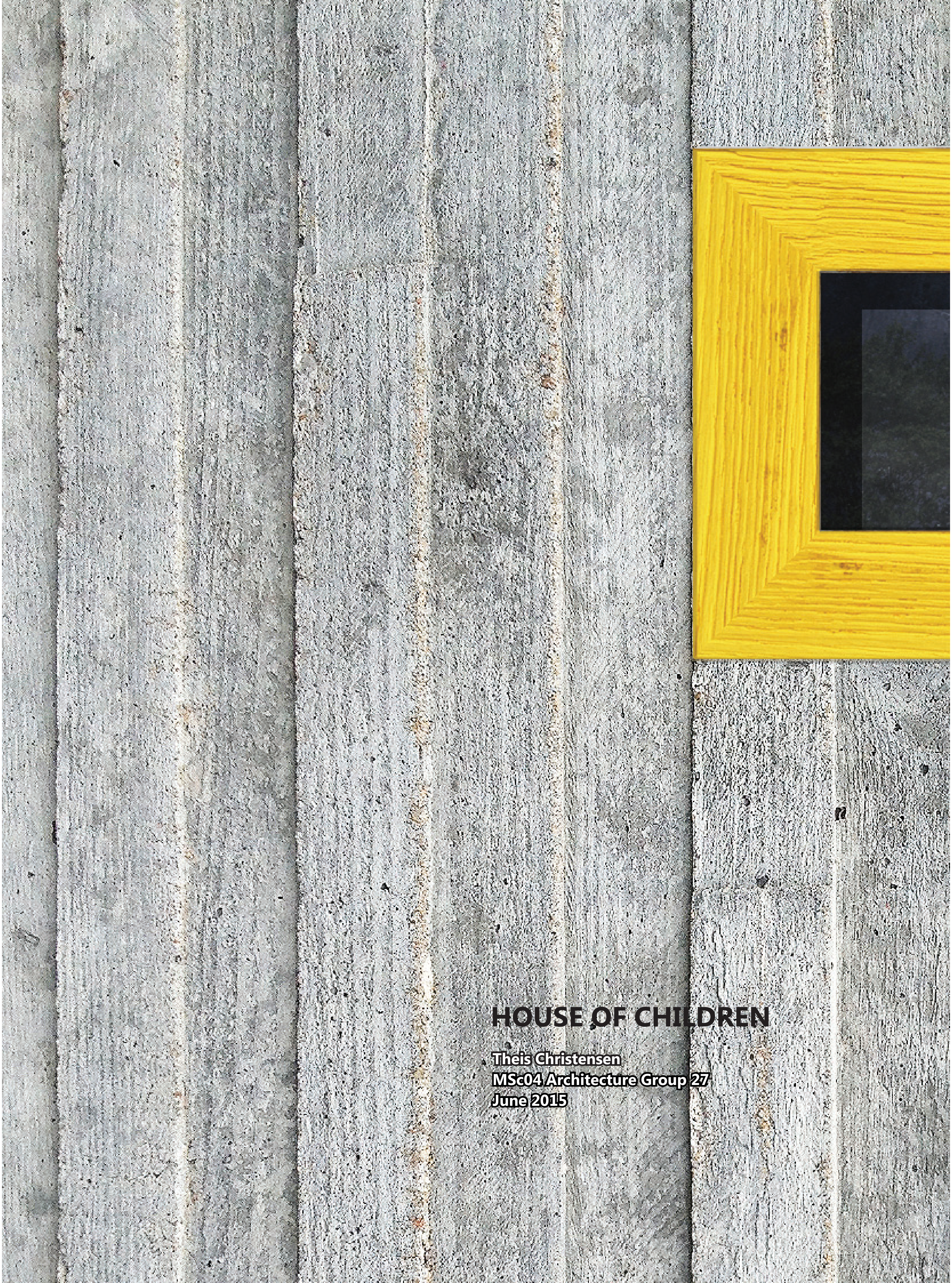

HOUSE OF CHILDREN

Theis Christensen
MSc04 Architecture Group 27
June 2015

Ill. 1. Frontpage illustration

HOUSE OF CHILDREN

THEME
Healing architecture, Tectonic

INSTITUTE
Aalborg University, AAU
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SUPERVISORS
Lars Brorson Fich
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PROJECT PERIOD
02.02.15 - 27-05.15

EDITIONS
7

PAGES
132

PROJECT TEAM
Group 27

Theis Christensen

PREFACE

The project, House of Children, is created by group 27, MSc04 2015 of Architecture and Design, Aalborg University. The focus of the semester have been healing architecture and tectonic with focus on children. On the project site, located South of the new super hospital a clearing in lundby bakker has been used for the new patient hotel.

The projects objective is to create, a patient hotel where parameters according to healing architecture is used to minimize the hospitalization time. Another objective the project aims to fulfill is to create a project with design principles from tectonic architecture and its honesty.

The group has been supervised by architectural supervisor Lars Brorson Fich and technical supervisor Christian Frier,. Their help and guidance during the semester project is greatly acknowledged.

A special thanks goes to Kristian Larsen which provided the group with an example of his book Arkitektur, krop og læring

ABSTRACT

The house of children is attending the problem with the missing patient hotel in the development of the super hospital of Aalborg. Furthermore it attends the problem with children's health and their social wellbeing while being hospitalized. The project will attempt to solve this by the use of the integrated design process, considering technical, aesthetical and functional parameters.

The building site, is located in Lundby krat, it is surrounded by dense biodiversity, which creates the boundaries for the building, as the area is protected. Considering the architectural expression, the project aims to implement thoughts of tectonic, Nordic architecture, brutalism and healing architecture. There is found inspirations in the works of Friis&Moltke due to their approach tov materials.

The project explores the possibility of minimizing the hospitalization time for each person, introducing the principles of healing architecture. This is done to service as many patients as possible, but also to avoid removing children from their familiar surroundings for a longer period, as this could be a large stress factor, and lengthen their hospitalization time.

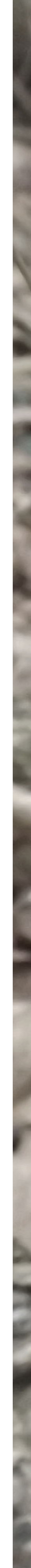
Another aspect of the project is the feeling of being safe. This is exemplified in the development of an internal garden, accessibility and the opportunity to be close to doctors, nurses and therapist in the tower block of the design

The project explores the use of timber frames as the main structural principle for the design. They will be visible and integrated, used for sitting, or defining the window areas. Technical, the frame will be explored due to its benefits versus a regular beam and column.

GUIDE OF READING

The project is divided into six segments with the following order: program, presentation, detailing, drawings, conclusion and in the end an appendix. The project initiates with the program, which will concern theme analysis and all of the contextual analysis. This creates the basis of the development of the design process. This is followed by the presentation, where the project is presented by renderings, text and sketches. Afterwards the detailing section would take the project even more into details.

In the end a conclusion will be made, here it is found out if the project where a success and created the wanted ideology of the project. In the appendix section different technical calculations, communications from interviews and a list of initiatives to create a good environment for children will be located.



Ill. 2. Mossy log

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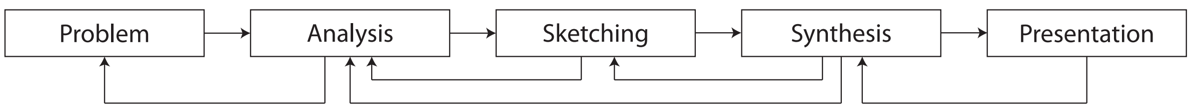
INTRODUCTION

The immigration to the city from the suburbs is an enduring theme and the tendency seems to continue, this gives problems regarding the capacity of the new hospitals, as they quickly risk being undersized, like the existing hospitals. The municipality has no plans regarding the build of a patient hotel to support the hospital in Aalborg, which is also a great disadvantage for the long-term patients. [Nielsen, H.F., 2014, sunhed pp. 6]

Shortening the amount of time a patient is hospitalized would solve this problem. This can be done by introducing healing architecture to a future design, by controlling; light, environment, orientation, sound, expression and the possibility to be safe and private. This approach is proved to be effective according to tests and analysis, but it may differ, as there are many parameters that define the quality of the healing process. [Frandsen, A.K. et. al., 2011, pp. 188]

Being hospitalized can be a hard period in every person's life, but especially if you don't understand what is going on around you. This is the daily life of kids and their parents being hospitalized. Kids are isolated from their normal social frames, which leads to stress and psychological issues of being misplaced. The task is therefore to create a patient hotel that meets the children's social needs and a place that relieves the parents for some of their concerns by creating an everyday life as close to what people are used to [App 1]. This is coherent to theory of healing architecture as we here is working with the psychological and physiological aspects. How can architecture create social frames, and secure the children's psychological and physiological wellbeing and in the end minimize the hospitalization time. The project should also seek to incorporate the parents' needs under their or their childrens hospitalization, and giving them the possibilities to exchange experiences with other parents to process their experience.

METHODOLOGY



Ill. 3. Integrated design process [Knudstrup, 2005]

The main method there will be used during the report is the Integrated Design Process (IDP defined by Mary-Ann Knudstrup in the book Pandoras Boks [Knudstrup, M-A. 2005, pp. 13-29] the IDP is an iterative process where which are divided into 5 different phases, from problem to presentation. The phases have influence on each other and create looping sessions, to secure the implementation of both aesthetical and technical aspects.

The problem phase is where a given problem is defined according to the project. It is here an understanding of the problem is achieved.

The analysis phase is where relevant subjects are being analyzed for further use in the sketching phase, this analysis phase contains; site analysis, theme analysis and case studies.

Site analysis is analyzing all the parameters that concern the location of the site, climate, contextual and comfort.

Theme analysis is where any given theme that may concern the project is described, in this case the main topics are; healing architecture, and psychological issues concerning the healing process.

Case studies of relevant projects is analyses, in relation to the group own project.

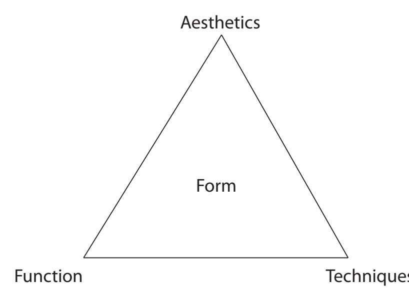
The sketching Phase concerns, modelling, digital and graphical tools which is used to study the technical, aesthetical and functional aspects. This leads to the development of architectural potentials according to the project, and takes the idea from concept to a design solution.

The synthesis phase is where technical and aesthetical solutions meets and creates and symbiotic whole, and lifts the design proposal to a higher level of quality.

The presentational phase is where the project is communicated through the productions of posters, pictures, etc.

The triangle of Vitruvius is introduced to the project displaying the relationship between aesthetic, function and technical parameters'. It perceives to reach a perfection of form within building [Lauring, 2014]

Throughout the report, the Harvard method concerning references will be used. It will be listed on the literature list. Furthermore the illustrations are numbered and referred to the illustration list.



Ill. 4 Vitruvian triangle [Lauring, 2014]

SITE ANALYSIS

Following section would contain, the analysis of the site, giving different information concerning the location of the site and its surroundings. It will analyze the close contextual area, defining, functions, infrastructure, which then leads to vegetation, noise and the topography in the area. This is done as it all could have possible influence on the future design. Therefore this section is also concerning climatic analysis including, temperature, wind, sun angle and the amount of direct sun.

To experience the site and to get a feeling of what the site is capable of, there is created a serial vision according to Gordon Cullen' theory about sensing the place; this is done to describe the environment. The section ends with a summary of the most important considerations that will continue into the design process.

Ill. 5. Fungus Lundby bakker

INTRODUCING THE SITE

LUNDBY BAKKER

To understand an analysis is made to investiagte the different qualities and restrictions of the site. The placement of the site should related to a natural and calm environment, according to a healing process [Frandsen, A.K. et. al., 2011, pp. 185].

The location of the site is placed in Lundby bakker near Gistrup, which lies a few hundred meters south of the new super hospital. The site is surrounded by forest and has a single highway passing by the site towards the hospital. The site is characterized by its high diversity nature and an open area with grass, which gives the possibilities to implement a design into the nature with a minimal impact on the surrounding. It is important that the site is capable of embracing the inhabitants and makes them feel safe; it should give the users the possibilities to occupy the nature and integrate with it, in their healing process.

As an architectural aspect, Gistrup city is in a new development. Here renovation is preferred as there are a huge amount of water reservoirs and preserved nature [Kommuneplan, 7.9.N1, 2014], which has to be taking into considerations. A new city square is also in the developing phase to help the different parts of the city. The existing settlements have an architectural expression like a typical newer suburban city, with low dense housing and a minimal of industrial buildings. This gives the area a romantic identity of family, neighbourhood and friends. [Kommuneplan, Gistrup. 2004]

Ill. 6. Location of Site

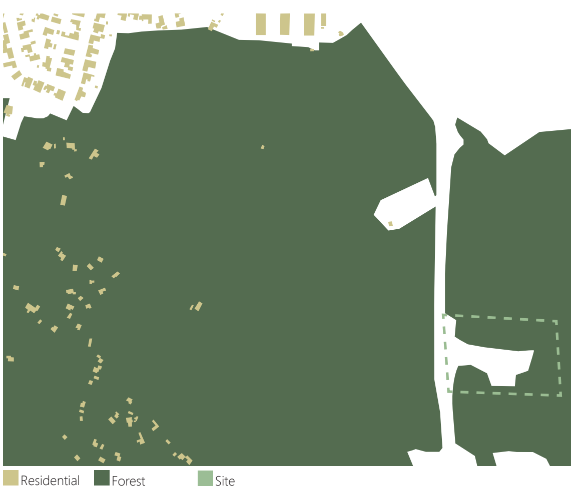
CONTEXT

REGIONAL FUNCTIONS

Ill. 7. Regional functions

The site is located in the northern Jutland, close to Gistrup city which is a suburban to Aalborg. It lies in an area defined by small hills, forest and green environment. The site has a good connection to Gistrup and Aalborg due to a highway that passes by the site, more importantly it has a great connection to the future super hospital located north of the site beside Aalborg campus. Aalborg is capable of providing the inhabitant with several different functions, considering; cultural, religious and commercial functions, which all can be reached within ten minutes by car.

LOCAL FUNCTIONS



Ill. 8. Local functions

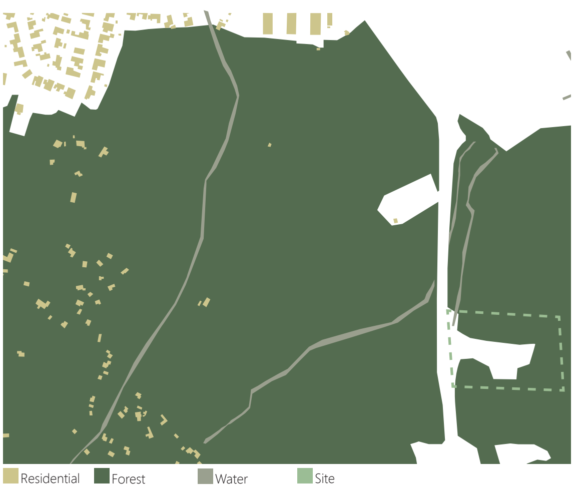
There are not many different functions at the site as it is placed in Lundby bakker which is a preserved dense nature area, but the functions available in the area are characterized by mostly housing, with a small amount of commercial and industrial buildings. They are found to the northwest of the site in Gistrup, which is a typical suburban city to Aalborg. Cultural and educational functions are also present in the local area, as well as other public functions.

The pulse of the city life and its functions are distanced from the building site, which encourage to slow pace and recreational areas, which a healing process can benefit from.

LOCAL INFRASTRUCTURE

Ill. 9. Infrastructure

LOCAL VEGETATION AND WATER



Ill. 10 Local vegetation and water

Easy access to the site is important, therefore is the local infrastructure analyzed. The sites location next to the highway Hadsundvej allows an easy access to the proposed project area. Hadsundvej is the main vehicular road to Aalborg, Gistrup and the new super hospital at the northwest. There is a single bus stop near the site; this gives possibilities for future development of the connection between the hospital and the patient hotel. Beside the main road, there is a network of smaller dirt routes, which is providing access for the small housing buildings, which is spread in the forest.

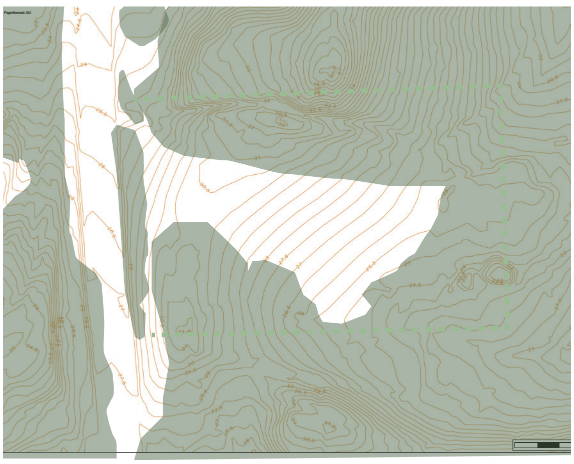
Pedestrians and bicycle has the opportunity to access the site in multiple ways, as there are many smaller paths in the surrounding forest, as the forest are being used as a public space, where it is possible to bike, walk and run. The accessibility has to be maintained throughout the project.

To maintain this open feeling of being a part of the forest it is important to consider more than one entrance to the site, which should compared to the small path in a forest. It

The site is surrounded by the forest Lundby Bakke which is a high diversity forest. To the east of the site there is a large area of crop fields showing that the country side is a large part of the area. The area includes a large amount of water reservoirs and small creeks and brooks. The municipalities' local plan states that the area is a nature conservation area [Kommuneplan, 7.9.N1, 2014] therefore it is important to apply for a new local plan if the build should be realized.

SITE CONDITIONS

TOPOGRAPHY AND VEGETATION



Green area   Trees

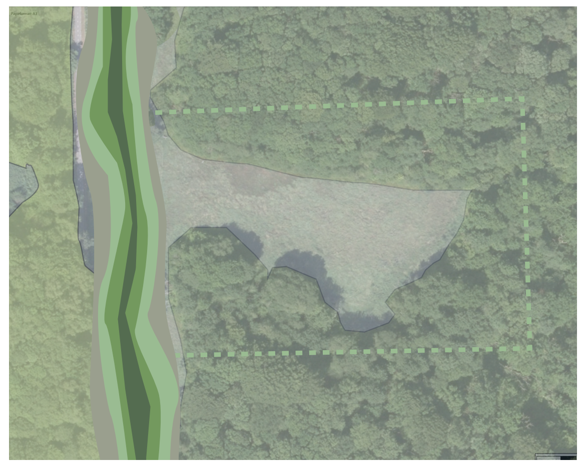
Ill. 11. Topography and vegetation

The site is located at the countryside a distance away from the urban context; this is reflected in the topography and in the vegetation. The site has a flat even central surface with a slightly slope towards east, with smaller hills raising around it, creating a natural protection and defining a clear entrance of the area to the west. This gives possibilities to implement the landscape into the design of the project.

As described, the site is located in Lundby Bakker with dense bio diverse nature. The biodiversity is dictating the site as it is a huge part of the site, but there is a natural clearing, at the centre of site where grass and natural planted saplings is the dominating vegetation.

The terrain at the site is workable, and there is no need to do large adjustments, it is also important to maintain as much as possible of the existing nature due to strict regulations from the municipality as we are working in a protected area. To maintain a recreative area and to keep nature as a close element in the healing process, it is important to minimize the buildings impact on this.

NOISE



< 75 dB   70 - 75 dB   65 - 70 dB   60 - 65 dB

Ill. 12. Noise [Miljøministeriet, 2012]

A single source of noise pollution is located to the west of the site, as the main highway Hadsundvej runs here. Being the only road Hadsundvej must be seen as the main pollution source, with an average amount of vehicular traffic, causing around 65 Db. [Miljøministeriet, 2012]   The surrounding trees at the site is capable of enlarging the amount of noise due to the possibilities of reflecting and splitting the noise into a broader pollution. There is some reduction on the site to the east as the topography has a positive impact on the noise pollution, due to a small hill close to Hadsundvej.

As there is a decent amount of noise pollution at the site by Hadsundvej, and several factors that could affect this it is important to consider the placement of the building on the site, to create the most comfortable environment for future users.

CLIMATE CONDITIONS

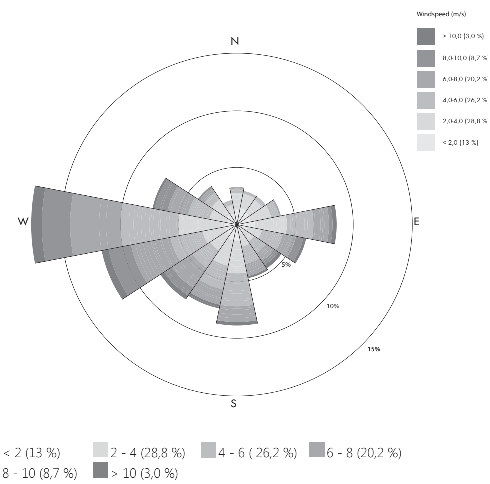
Weather conditions in Denmark are varying. Therefore it is important to consider these changes when designing a building, to avoid unsatisfying indoor and outdoor climate in a project.

The wind speed at the site can be intense, and with a wind speed from west that easily can reach 10 m/s it is a huge factor according to outdoor comfort, and therefore it is important to consider these when designing the project. The measurement is from the weather station at Aalborg airport. This could lead to a small margin of error, due to the change of location and environment. When considering the building site, it is surrounded by tall dense biodiversity, which potentially is capable of sheltering the building from the wind.

The solar conditions are highly dependent on the seasonal basis, as the location is on the northern part of the globe. The average amount of daylight is spanning from 6 hours in the winter period to 18 hours during summer. This is caused by the rotation of the globe and leads to a change in sun angle, spanning from 6 degrees to 58 degrees. It is not every hour of daylight there are direct sunlight, and it should not be seen like this as there often are clouded or diffuse weather conditions.

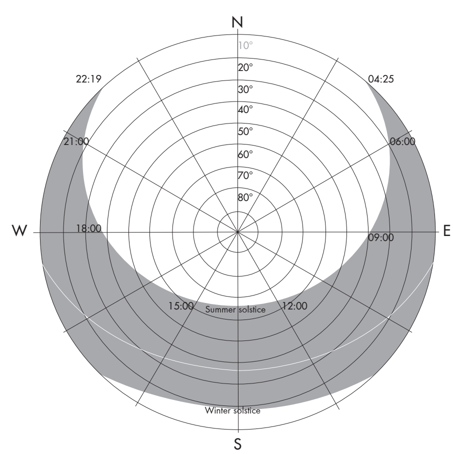
The analysis exemplifies that there is a need to consider the wind situation, when designing and outdoor space to secure optimal comfort for the users. The placement of the site also implies the possibilities to obtain passive solar heat mainly during the summer months.

WIND



Ill. 13. Wind [Enviroware, 2012]

SUN



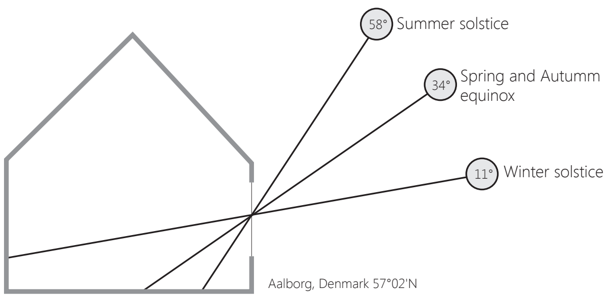
Ill. 14. Sun [Gaisma, 2014]

SOLAR ANGLE

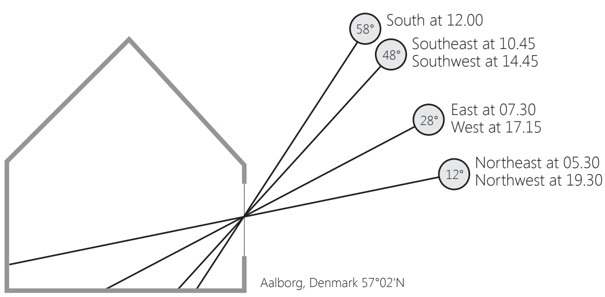
The angle of the sun differs because of the rotation of the globe; this has an impact on how long the sun would travel into a room and on the cast shadows from the surroundings. When looking at the solar angel in June month it is measured that the angle differs from 12 degrees in the morning to 58 degrees when the sun is at its highest. This could potentially create some shadows in the morning and in the winter months.

The shadows are analyzed at three different hours 9:00, 13:00 and 17:00 this is done in two different times a year, one during winter and the other one during summer. It shows that shadows have an impact to the site, as there is tall vegetation surrounding the site.

From this it is amplified that, there is a need to reduce the amount of shadowing. It can be solved by placing the functions strategically at the site or to raise the critical functions from the ground. This gives a better possibility to obtain the needed daylight in the building.

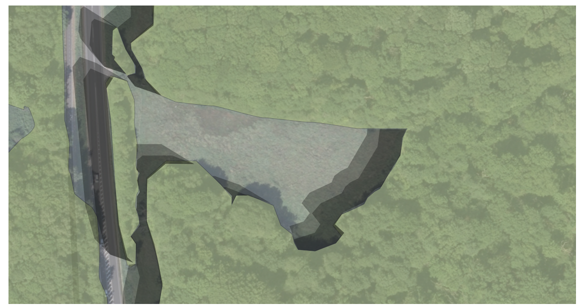


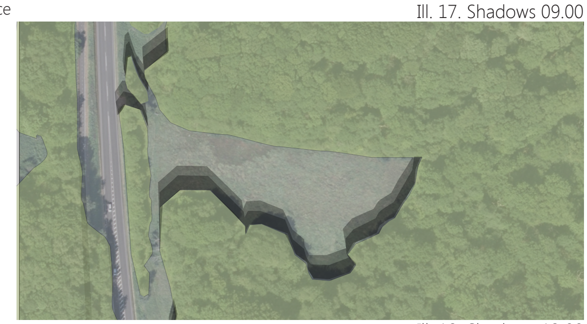
Ill. 15. Solar angle according to seasons [Bejder, 2014]

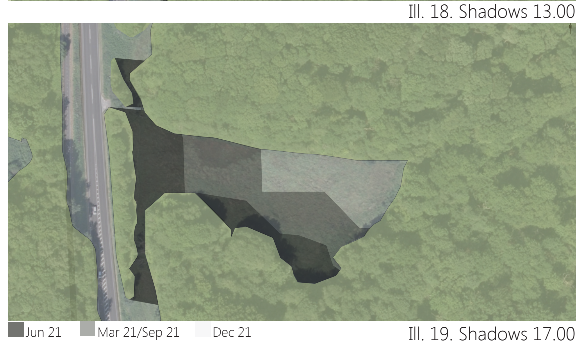


Ill. 16. Solar angles on June 21th [Bejder, 2014]

SHADOWS


Ill. 17. Shadows 09.00


Ill. 18. Shadows 13.00



Ill. 19. Shadows 17.00

SERIAL VISION

CHARACTERISTICS OF SITE

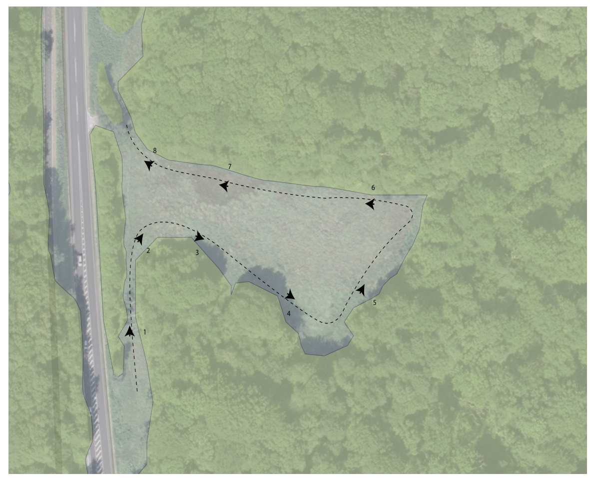
A serial vision has been created according to Gordon Cullen thesis about sensing the place [Cullen, G, 1995 pp. 17-19]. Normally it will be used in a city to sense the body's reaction to changes in spaces, but in this case it will be used in the nature, at the location of the site. This is done to document the surroundings, and to get a feeling of the site. The city in this case is the forest.

When moving around on the site it is clear, that the open area is a clearing in the forest, that have been used by the local farmer to put his rams on grass, and to fertilize the area for future plants and trees.

When moving over the hill and further into the side (ill. 21.2) it shows the sloping topography towards the west.

The current state of the site can be described as an open area in development, due to the future plans of natural spreading vegetation, seen in small saplings growing all around. These are still young and able to move and replant, for a future sustainable area.

The affect of the hill according to the noise pollution is clear, when moving around on the site, as it is not possible to register any noise pollution when standing on the western end on the site.



Ill. 20. Serial vision on Site


Ill. 21.1


Ill. 21.5


Ill. 21.2


Ill. 21.6


Ill. 21.3


Ill. 21.7


Ill. 21.4


Ill. 21.8

SUMMARY OF SITE ANALYSIS

SUBCONCLUSION

During the site analysis it is expressed which potentials the site is capable of but also which challenges there must be taken into consideration when designing a building project that relates to it.

The analysis of the function near the site shows that it has the identity of a suburban city, and that the site is distanced from this by forest, which gives the benefits of feeling to be one with nature. To maintain this open feeling it is important to consider more than one entrance to the site. It is also important to consider the possibility to interact with the nature throughout the design.

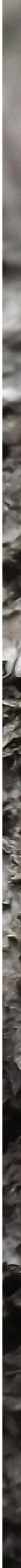
The area encourages to create recreational areas within the site as a part of the building, due to its surroundings and placements and the possibilities to use this in a institution should be investigated. The main road Hadsundvej must be taken into account as noise pollution can occur.

The site is surrounded by dense forest and small brooks and creeks which are protected by the municipality, therefore it is important to minimize the impact on nature when designing, the project. Topographically the locations is a hilly landscape which creates a natural shelter to the area, and gives the possibility to interact with it

According to the wind conditions on the site it show that, it is a factor that has to be worked with on the site as it can be quite intense from the west, and that there is a possibility to introduce alternative energy productions according to sun during summer.

Because of the sites surroundings there can be some issues with shadows in lower heights to the south of the site due to the suns seasonal angle. Therefore this must be taken into consideration when placing the functions at the site.

The entire site is conserved; therefore it is important to develop a new local plan for the area, which gives the needed permission to build.



THEME ANALYSIS

This section contains, the theme analysis regarding theoretical subjects such as Healing architecture and the pedagogical approach to architecture. Tectonic will also be investigated through this section and explained how it would be used during the project. The theme analysis will also be discussing the local perspectives according to what the municipality wants for the area. Other subjects discussed are Nordic Architecture, case studies and a definition of how much influence the hospital should have on the patient hotel.

A specification of the user groups will also be defined throughout this chapter which has been defined as healthy parents and kids versus ill parents and kids.

Ill. 22. Fungus on log

HEALING ARCHITECTURE

INTRODUCTION

Healing architecture is a design concept which represents a vision to optimize the humans' wellbeing and to promote the healing process. The thought is not that architecture itself should be able heal, but it should be a factor that is capable of supporting the healing process, through thoughts about; design, daylight quality, sense of space, colours, sound and the possibility to be private and secure. Through evidence based design, these different factors are being put into numbers that makes it possible to measure a progress; it shows that it is strengthening the healings process, which helps shortening the hospitalization time. [Frandsen, A.K. et. al., 2011 pp. 5-9]

These factors that are mentioned will be divided into three overall factors; body, relations and security where this project mainly will be working with body and relations, considering light, art, sound, air and movement. It will also consider the possibilities to design a floor plan which takes account to give the user the possibility to stay in three different types of rooms; personal room, social room and outdoor spaces. The benefits of each of these parameters will be discussed in this section, but what they all have in common is that they support the healing process considering different repercussions according to physiological, psychological and economical consequences.

Ill. 23. Super Hospital Aalborg

BODY

The following section will consider the factors that have an impact on the body, physiological and psychological, which are experienced with our senses.

Light – The access to daylight is an important factor according to the healing process, as it has an positive effect on several repercussions points such as; pain, sleep, stress, depression and mood. These factors all helps to support the healing process and to give a better experience of the hospitalization period. This is documented through several investigations; where patients and employees express their concerns about, the lacking of windows and daylight, and the fact that they point it out to be one of the main reasons of a bad health. [Macnaughton et al., 2005; Symon et al,. 2007; Verderbe, 1986 cited in Frandsen, A.K. et. al., 2011 pp 32-33, 35]

Art – can be used as a distractor, and to minimize stress, it can materialize in painting, sculptures, installations etc. The art can be visual, tactile or audiative. It can be expressed in the colours of the rooms. It is used in quite rooms, where it helps to pacify outraged children, contra bare white walls [Glod et al., 1994 cited in Frandsen, A.K. et. al., 2011 pp. 65]. Art is a broad subject, and its applications in the healing architecture are just as wide.

Sound - Can have a healing effect when used as a distractor, but it can also have a damaging effect when it is experienced as noise from a road or from technical equipment etc. Therefore it is important to have this in mind when designing to secure the acoustically quality according to its healing performance as it then will have a positive impact on patients, sleep, pain, stress, personal room and the staff's psychosocial working environment. [Frandsen, A.K. et. al., 2011 pp. 75]

Air– Is one of the most unexplored aspects of the healing architecture. But people tend to be bothered if the air is to hot or it smells, this can be avoided by good ventilation and a regular cleaning. Some smells seems to have a positive effect according to stress like an orange [lehrner, J. et. al., 2000 cited in Frandsen, A.K. et. al., 2011 pp. 109]

Movement – in a building or orientation in a larger complex building, can often be hard and lead to stress and a waste of time. To prevent this, the most optimal solution would be to organize the floor plan in such way that makes it clear, where each individual are supposed to go. This could be done by introducing a signage system. The ability to move around when hospitalized is also an important factor for the healing process.

RELATIONS

At a large institution as a patient hotel or a hospital is, it is important to be able to have different types of rooms which have different private constellations. This is important to secure the patients privacy, their social spaces and the outdoor spaces.

Personal room – The importance of a private space, is about having the possibilities to be yourself, and not feeling that your weak moments are being exposed. It can be defined as four walls that surround an individual, or it can be a space where a person has the choice to be social. There are is no clear answer to if the patient prefers the one from the other. It depends on the giving situation, but it is clear, that everybody wants to have the possibility to retreat at some point. [Frandsen, A.K. et. al., 2011 pp 131]

Social room – Having social rooms in floor plans, gives the possibilities to interact with other humans, to share their experience, to comfort each other, or to create new bonds to other person which are in the same situations as you. There are four types of relations that should be considered, Patient to relatives, patient to patient, patient to staff and how the design can meet these relations. [Frandsen, A.K. et. al., 2011 pp 155]

Outdoor spaces – It seems that access to nature and green environments has a positive influence on physiological and psychological aspects of the healing processes according to stress, concentration, pain, hospitalization time, orienting and satisfaction. It also shows that outdoors spaces are an important space, for both patients, but also the staff and the relatives. This helps reducing the amount of stress but also tends to be a private of social space. [Frandsen, A.K. et. al., 2011 pp 185]

SUMMARY

It can be said, that the first section with factors concerning the body, is roughly about stimulating the body and mind, through senses and feelings. There are different parameters that can be changed, according to different factors. It shows that the healing process is coherent with a complex set of different parameters; and when optimized is having a positive effect on the hospitalization time. The privacy constellations, is having an impact on the stress level, it is therefore important to give the possibility to vary the needs of privacy to the environment that suits the actual stress level, to provide the best conditions for a fast healing process.

PEDAGOGIC AND ARCHITECTURE

GENERAL THOUGHTS

It is described in the earlier section that a healing process can benefit from different approaches concerning different factors which have an influence on the physiological and psychological aspect of the human body. The following section will concern pedagogically thoughts about architecture, and what consequences architecture could have when considering; activities, roles and togetherness.

The main task is to create a patient hotel with children as its main priority, it is therefore important to consider some of the pedagogical thoughts behind institutionally buildings. This is done to secure, a correct programming of functions in the different social rooms, where kids are observers or active in their role of the room. Institutions are public facilities, which are defined by, political, economical, ideological and professional interest in children. All children in Denmark are being educated in this institution, through their younger years. [Gulløv, E., Højlund, S., 2005 pp. 21] The question is what does these rooms mean for our social development, and what does it mean to be hospitalized in a patient hotel which takes this into account, how does it affect the psychology of the child and does it have a positive effect according to the hospitalization time?

It is stated through the problem formulation, that kids being hospitalized, are severed from their normal social frames and kids on their own age. This could potentially have a negative effect on the child's psyche. This is backed up through experience by psychologist Birgit Lundager at the children's department at Aalborg hospital north during an interview [App 2]. As stated through the healing architecture section the hospitalization time and psychology are dependent of each other, therefore it is important to create an environment that is based on

Father daughter Ill. 24.

Playroom Ill. 25.

pedagogically thoughts and gives the possibilities to interact with others when hospitalized. This could be done through visual contact and activities, but is must be defined in the architecture according to a pedagogical approach. Birgit Lundager has been a part of a group which had the task to predefine an optimal psychological environment for the new developments of furture hospitals [App 1] The result where a list of important considerations.

In general institutions organize meetings between people, and the different spaces are codified to arrange who meets who. It is a series of different spaces with different predefined parameters; it could be the room, the size of the room or the interior of the room that defines which activities that fits to each space. This draws some parallels to the principle of the healing architecture according to room, colour, tactility, and daylight. Some of the most important theories are to define the roles of the inhabitant which can be done; an example could be to round the corner of walls and to lower the temperature in the taps to secure the children for accidents, you will have to think in the height of a child [Gulløv, E., Højlund, S., 2005 27-30].

There are two different pictures of kids, one which represents them as uncultivated where the institutional goal is to educate. There other is a more romantic picture which sees the child behaviour as a part of nature and it have to learn to coexist by itself. This leads to an open plan solution where it is up to each individual to decide where they want to be in the room and what they want to do there or it could it could be a seen in a priority of natural materials, or nature like playgrounds. From this perspective the child will keep its unspoiled creativity and fantasy to define his or hers own role and to define which function he or she will put into a room. In this point of view the room and its architecture can be seen as a silent pedagogical assistant. It is in this kind of pedagogic up to the individual to know what types of activities that is valued and relevant. These rooms are predefined for some different functions, but it is also a scene for the social battle of the right to define an areas function. This is an important educational learning at the playground which helps define the hierarchy at the playground and later on helps defining your social life. [Gulløv, E., Højlund, S., 2005 pp. 35]

On this basis you can say that a room and its materiality have a pedagogical force, but children cannot be passively educated by space and people alone, they will have to learn their own social skills. This leads back to the main problem: that it is very important to maintain kids' socialization during hospitalization to maintain their psychological wellbeing and to minimize the time of hospitalization.

SUMMARY

Through this section it can be concluded that pedagogical thoughts about architecture has a relation to the thought about healing architecture in a physiological and psychological manner. When considering the psychological aspect it is concluded that the effect of a child's socialization can affect the hospitalization time. It is also important to think as a child when designing space for children, defining some parameters, but also give the children the possibility to occupy the space on their own and to put their own identity to the space. This will in the end give the kids the possibility to create their own secure place among other kids and to develop their social skills in the battle for the right to define spaces with architecture as a silence pedagogue.

TECTONIC ARCHITECTURE

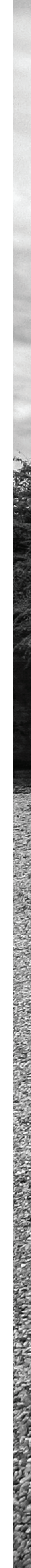
INTRODUCTION

Tectonic is the expression of honesty, it seaches for truth and honest in the different scales of architecture. It should be implemented from the conceptual idea to the realization of the final project. It tends to have a truth and clarity to materials, and it is easy to read the structures and to locate how the forces run through the it. This aids to create a room with something "more" a spatial quality and drives the inhabitants to experience the architecture. (Sekler 1965 pp. 89-96). A building can vary between honesty of construction and to the clarity of the expression this can be done as long the eastehtic coherence between the two is existing. All parts of the design should expressa clarity and contribute to the whole design. [Frampton, K., Cava, J. 1995 pp. 1-27]

There are many phases in a design process, it is therefore important that every tool is used as tectonic is the search of completeness and spatial quality, this leads to an integrated approach to tectonic. Integrated tectonic, is giving the architect the possibility to introduce different parameters, such as technical, and aesthetical functions, along the development. This put the architect in the position of the "Arkitekekton" or master builder [Frampton, K., Cava, J. 1995 pp. 4]

the project want to work work with concrete and its honesty from a tectonic point of view and by this create spatial quality throughout the project. The project will also consider the site and try to implement it in the design of the building, as;

> "*The material, cast in place concrete, gives new meaning to the detail. The interaction between form and material moves the fertile detail from the realm of a production sub specie utilitatis to a production of sub specie aeternitatis. It is construed as a "ruin" loaded with memories before time. It becomes a perfect detail for the architecture*" (Frascari 1984 pp 23-37)



Ill. 26. Brion Cementary Carlo Scarpa

Ill. 27. Reclaimed Wood

THE IMPORTANCE OF A TACTILE ENVIRONMENT

Corresponding to the earlier pedagogical discussion concerning architecture as a silent pedagogue, we can relate materials and their tactility to the problem. As it is through this (tactile sense) the child "feels the world" and find security. Contact has a comforting feeling and has an influence on the child' feeling of being secure. This is not something parents' thinks about, but when the child cries we touch it, lifts it and cuddles it. This all helps to make the child feel secure. [Buhl, D.K, 2009]

We feel with our skin. The skin registers; heat, cold, contact and pain. This is because of the connection from skin which is connected with muscles and nerves, which tells the brain the something is affecting the body from the outside, like a hug. Children at the age of one, has a tendency to put things into their mouth, this is because they literally tastes the world with their lips and tongue. [Buhl, D.K, 2009] When the child is older it is experience the world through its feet and hands. It is also proven that the children learn faster by touching. [Vestergaard, L, 2015]

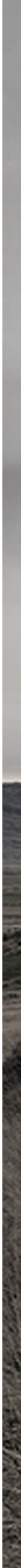
It must therefore be concluded, that tactile material is important for a safe environment, a learning environment and it can also be used to guide children around, as they refer a specific location to a particular tactile material

NORDIC ARCHITECTURE

Like tectonics, Nordic architecture has at its core value in honesty to materials, and it attempts to maintain simplicity in the structural element of a building, as it should be clear in its idiom. Nordic architecture is very aware of its surroundings and uses the nature as an inspirational source. It is defined according to its location rather than a formalistic approach.

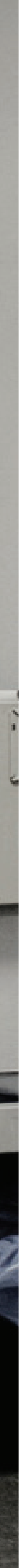
As being bound to its location in Denmark, there has been a tendency to exaggerate every little bump in the flat landscap. This is e.g. seen in the building of old churches, as they are placed at the highest point, and then stretches towards the skies. This has something to do with religion, but defiantly also something with visibility. It can therefore be said that Nordic architecture is bound to traditions. Nordic architecture also has a traditionally approach to the amount of daylight in the northern countries, as this differs greatly, therefore the manipulation of light is an important aspect in Nordic design, as this is defining spaces and atmospheres.

It is wished during this project to work with, the traditional materials located in the area, and to be honest to these. Another wish is also to work with this exaggeration of the nature that is a part of the site, and try to work with it, in a monumental way. This leads to the study of architectural brutalism, which had its traditions back in the 60'ies and 70'ies in Denmark by architects such as Friis & Moltke.



Ill. 28. Snaefellsstofa Visitor Center

Ill. 29. Hospital corridor



HOSPITAL VS. HOTEL

It is important to define how integrated the hospital should be with the patient hotel, according to the inhabitants feeling of being home. This leads to a definition of being home and according to [Heidegger, M., 2000; Norberg-Schulz, C., 1992 cited in Martinsen, K., 2005 pp. 135] then we can describe home as:

- To live, to dwell, to remain
- The usual, what we are familiar with
- To be in Domestic peace
- To be free, i.e. Protected from danger and fenced, so that we can be at peace
- To care, to take care of, so that something is fertile and can grow
- To spare, i.e. Leave alone, free to evolve and be themselves
- To protect each thing in its essence

This is a very important aspect as this feeling of being home helps to secure the individual from the public space, according to the theory of Healing architecture. It must be the individual's choice whether he or she will invite strangers into his private space, in this case the hospital. The hospital should though be a part of the hotel, but not as a visual and active part. There will be nurses, and embryologists, and they will have a consultations office in the complex to service the hotel. According to the more technical parameters, the hotel should be able to supply the different hotel rooms, with oxygen when needed and similar installations. The main thought is though that the hospital and its installations should be as invisible as possible to secure the feeling of being home.

USER PROFILE

SPECIFIC LIVING CONDITIONS

Two different types of user group will be used during this project, it will concern; parents and their children. And each group will be subdivided into smaller segments, as there are two scenarios; being ill or being healthy. The different groups have different needs, according to playground area, the possibility to observe while being hospitalized and to participate and interact with other in the same situation. The aim is to create a building complex that makes this possible and meets the demands from the different groups.

Ill. 30. Family

CHILDREN AGE 3-8 YEAR, HEALTY

Children are the top priority in most cases. When healthy they are happy and joyful and full of energy, investigating the environment, and creating their own playful games, establishing hierarchy at the playground and learning how to commit to the society. It is here important to create the frames, that secures the kids, it is preferred that, their location is placed away, from noise, roads and pollution.

CHILDREN AGE 3-8 YEAR, ILL

It another case where the child is ill, the healing of the child will be prioritized, to minimize the hospitalization time. This is done so the child as quick as possible can return to its habitual environment. During the hospitalization it is preferred that the environment feels like home both physiologically and psychological. [App 1]

PARENTS, HEALTY

Hard working, problem solver, an inspiration for their kids when healthy. This is the life of a parent; they are creating the frames of the family life, with the children as their main priority. When a child then gets ill for a longer period, the parents is forced to leave their usual frames to secure their child's wellbeing during hospitalization. Just like the above it is preferred that the new environment is similar to the feeling of being home.

PARENTS, ILL

An ill parent often attempts to keep the daily life on track, but when hospitalized it could be a huge stress factor, not being able to secure the frames for the children, and therefore lead to a longer hospitalization time according to the theory of healing architecture.

SUMMARY OF THEME ANALYSIS

SUBCONCLUSION

In a healing process it is an important part to consider the physiologically and psychologically aspects, as these are coherent with the hospitalization time. These can be optimized, by using the principles of healing architecture. This concerns different parameters that affect the human body, such as light, sound and art. Another aspect is the relations the user gets in each room, as it is important to be able to move from public to private. The social aspect is very important as relations create happiness which in the end leads to a better psychological state.

In connection with the healing architecture, pedagogical thought are further investigated. It is concluded, that architecture can act as a silent pedagogue, defining a space for the children where it is possible for them to know that it is a save and free place for them to play and socialize. The architecture should centralize the children, as it makes the pedagogue/parents able to observe them developing their own social ranks and spaces, and only step in if needed

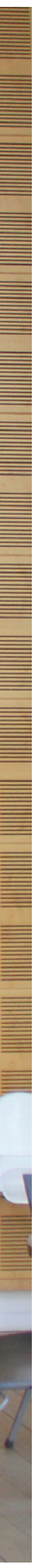
The theme analysis also defines what tectonics is according to the group, and clarifies a direction for the design process, as it is wanted that the project should imbue honesty and clarity to the materials and the construction.

This should relate to the different types of user groups, which have specific demands to what they want to feel at home and to be able to relax during their stay at the patients' hotel. According to this it is also important to define how much of the hospital should affect the hotel, where is the limit that defines the feeling of home contra the feeling of an institution.

The project should also achieve a Nordic approach to architecture, relating to the contextual- surroundings, materials, traditions and climatic changes. It is also important to be able to manipulate the decent daylight in Denmark to create different atmospheres for different functions.

Finally it is important to explore the possibilities of integrating tactile materials in the project as a educating and artistic element

Ill. 31. Ronald Mcdonald house



CASE STUDY

RONALD MCDONALD HUS

Name: Ronald McDonald House

Location: Juliane Maries Vej 12, 2100 København Ø

The main idea about the Ronald McDonald fond hotel is to create a place for families which are in need of a place to stay during long hospitalization time of the children due to different types of illness and complications, such as cancer and neonatal children.

Since the opening in 2002 there have been housed more than 1500 families in the family hotel with an average of four weeks. In these four weeks family life is different from what the family are used to, therefore the thought behind the Ronald McDonald house is to maintain the feeling of close relations to something that is similar to the familiar environment. It also gives the possibility to share experience with other families and to seek support from them.

The Ronald McDonald House itself, has around 12 families at a time with a preoccupation at 98 % Each family has its own place with, bathroom facilities. The family shall by itself provide any shopping, cooking, cleaning of own room and laundry services. When the family is concerned, it can be safely and liberating to have its own routines between the visits to the hospital.

The hart of the house is a large, open kitchen, where the families have a private fridge, freezer and colonial cabinet, and where it is able to prepare dinner together with others. In addition the house has several rooms with television, common dining room, computer café and playing rooms for the children. This gives the families the possibility to interact with the staff, volunteers or other families. [Ronald Mcdonald Huset, 2002]

INPUTS FOR THE PROJECT

The Ronald McDonald House illustrates the way of thinking, which is appreciated in the group' future project, and enlightens the quality about it. It is therefore important to bring this into the project. It is important to create spaces that give the families the possibility to be social a share experience and to create frames that make them feel at home.

CASE STUDY

IN THE STEPS OF FRIIS&MOLTKES BRUTALISM

Location: Østjylland

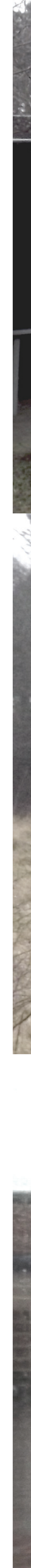
The company Friis & Moltke was founded by Knud Friis and Elmar Moltke in 1954, and is today one of the leading architectural companies in Denmark and Scandinavia, Where they with simplistic, modern and functional design has made their name synonymous with quality. [Friis & Moltke]

During the 60'ies and 70'ies Friis & Moltke where defining brutalism in Denmark. In general brutalism can be described as massive, intimidating, geometrical, and rustic, but it was actually created from a social utopian ideology [Brutalisme, 2014]. In the hands of Friis & Moltke it became something more. The senses are activated during materiality, the spatial quality is dramatized throughout differentiation of room heights, but also the approach to nature is an important aspect.

These different aspects and problematic where creating the base for a study trip, to investigate how they could be solved and to see what is necessary to have in mind when designing a project that relates to this. The three different projects that are being investigated is the summer houses near Helgenæs, the Entrepeneur School in Ebeltoft and Bøgehøj also placed in Ebeltoft. Which are build from 1963 to 1971

INPUTS FOR THE PROJECT

This coexisting with nature and the love to the tactile materials, is a very important part, and it should also be an important part of this project, as children in the age 3-8 years, is developing their senses and catalogue of how different things feels. This is a way for architecture to interact with people, and to stimulate. This is consistent with the principle of healing architecture and the pedagogical thought concerning architecture as the silent pedagogue, as the materiality and its tactility can guide and define spaces, inviting for residing or encourages for movement. It is also important during this project to be deliberate about the surroundings and especially the nature, as it should be and implemented part of the design, and that it should help defining the rhythm of the building. As frascari stated that the project should be able to act as a ruin within the terrain. (p. 28)



Ill. 32 Summerhouse Helgenæs

Ill. 33. Entrepreneur School Ebeltoft

Ill. 34. Bøgehøj Ebeltoft

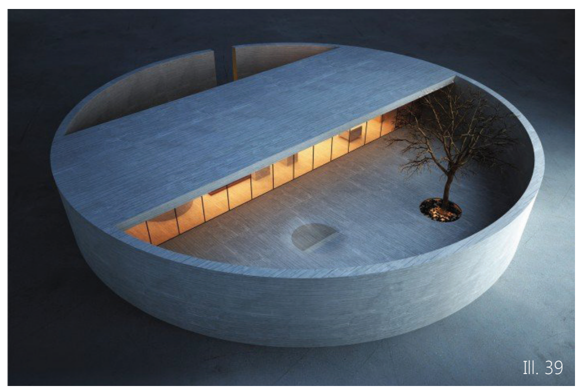
INSPIRATION

EXTERIOR AND INTERIOR


Ill. 35


Ill. 38


Ill. 36


Ill. 39


Ill. 37


Ill. 40


Ill. 41

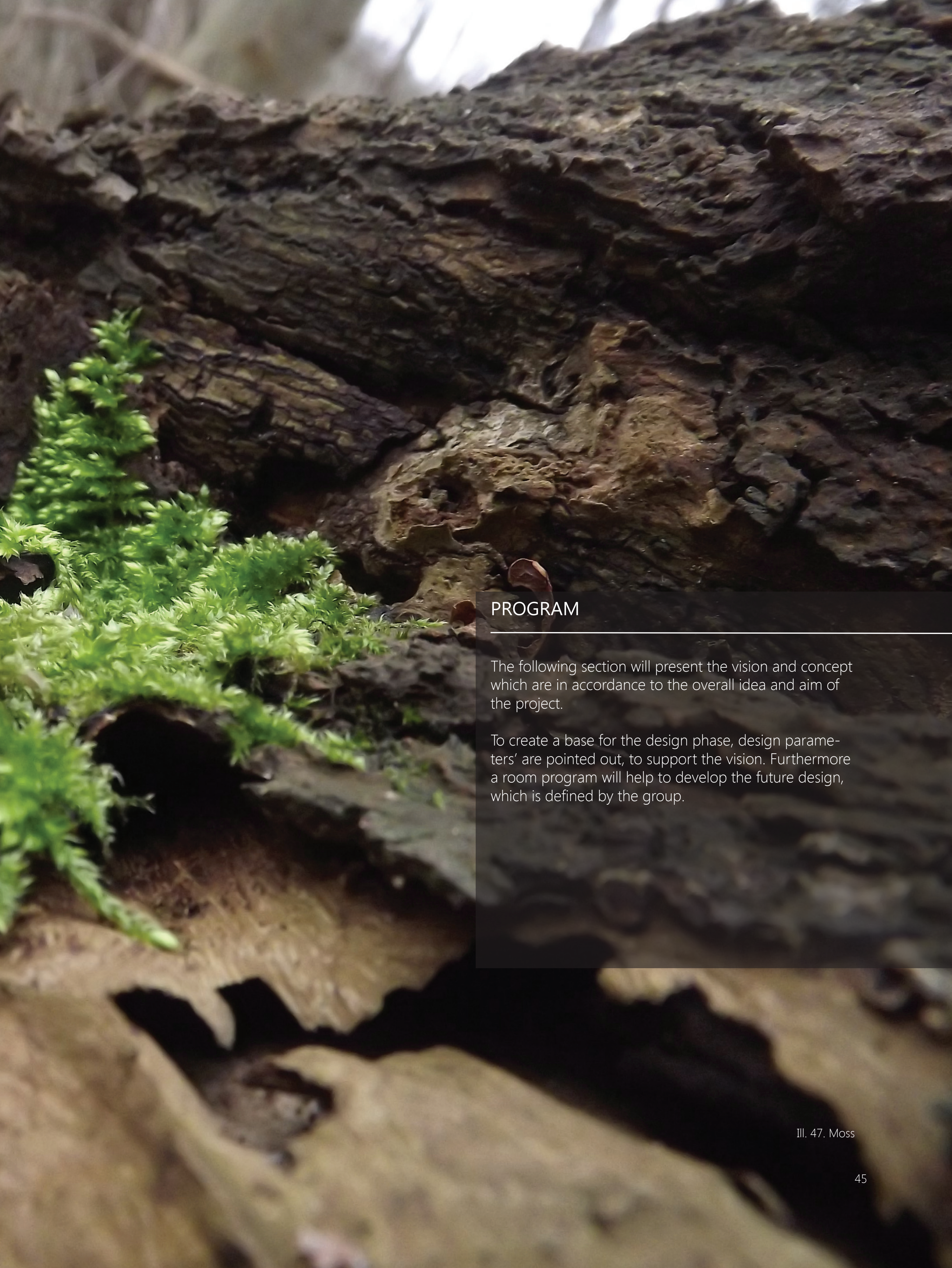

Ill. 42


Ill. 43


Ill. 44


Ill. 45


Ill. 46



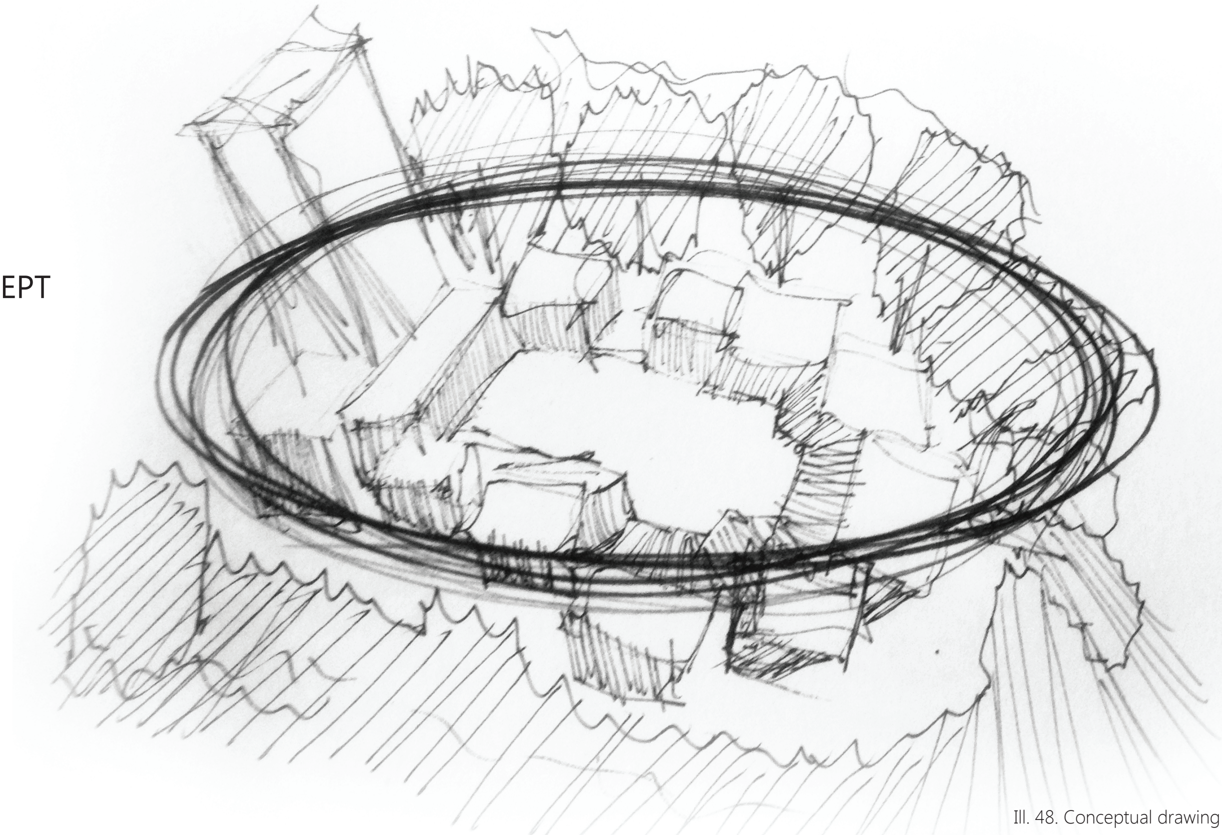
PROGRAM

The following section will present the vision and concept which are in accordance to the overall idea and aim of the project.

To create a base for the design phase, design parameters' are pointed out, to support the vision. Furthermore a room program will help to develop the future design, which is defined by the group.

Ill. 47. Moss

CONCEPT



Ill. 48. Conceptual drawing

The site is located in a preserved area, it is therefore wished to occupy the clearing as this allows us to use it for dwelling and it makes us able to maintain as much of the nature as possible on site. This boundary of trees creates a natural secure area, this should be reflected in the building design, to give the demanded security of the project, therefore a circular shape with an internal clearing is preferred.

This relates to the groups intention of working with the site and not against it, to have a Nordic approach towards the project. As found out in the analysis the proposed design should be capable of creating different functions concerning the settings of privacy. These different functions should create a hierarchy in the design, giving the possibilities to create different spatial qualities. From the entrance of the site the functions should graduate from public to common and in the end private. This is important as it prepares the users in their transfer from the exposed outdoor to the intimate private housing unit.

The main part of the building should be kept in one level, to address the possibility of having a disabled as a guest in the patient hotel. But the building should also interact with the nature, therefore a tall building part should be placed to the west rising above the treetops creating a landmark of the area, this also underlines the graduation of the functions in the complex as the tower will contain the public functions, and speak another language compared to the ground floor.

ing

VISION

The project aims to develop a patient hotel with the focus on children and their families, by using the principles from healing architecture and having pedagogical thought in mind to decrease their hospitalization time. Tectonic is introduced as a main design factor throughout the project where honesty, Nordic architecture and brutalisme is the focal point.

Furthermore there will be a tactile approach to the materials where the inspiration comes from Friis&Moltke .

DESIGN PARAMETERS

To cover all of the different parameters, they are divided into three groups, covering functional, technical and aesthetic parameters. These are used to start up the design phase and to evaluate the ideas.

As pointed out in the problem statement, the building must be able to implement the thoughts of healing architecture. This should be done with a tectonic approach to architecture. This is done to secure an optimized hospitalization and an aesthetical design.

The living conditions for the families must be satisfied during their stay. This should be done to minimize stress and is done by creating spatial quality that reminds them of home. Furthermore it is important to be social and to share experienced with others, therefore it is important to have areas that are capable of socialization, where the main focus is on children and their social development.

The green environment on the site appeals to a wide user group and has a positive effect on the hospitalization time, it is therefore important to consider this in the design development and to use it instead of dismissing it.

Nordic architecture and a brutalistic approach should be an inspirational source for the overall design.

TECHNICAL PARAMETERS

Construction principles
Tectonic approach

FUNCTIONAL PARAMETERS

Compact dwellings
Feeling like home
Differentiation between private and public areas
Safety and comfort
Contemporary plan design
Visual connection in the public spaces

AESTHETIC PARAMETERS

Attractive green areas
Appealing to all groups of users
Bright and spatial
Nordic tactile materials

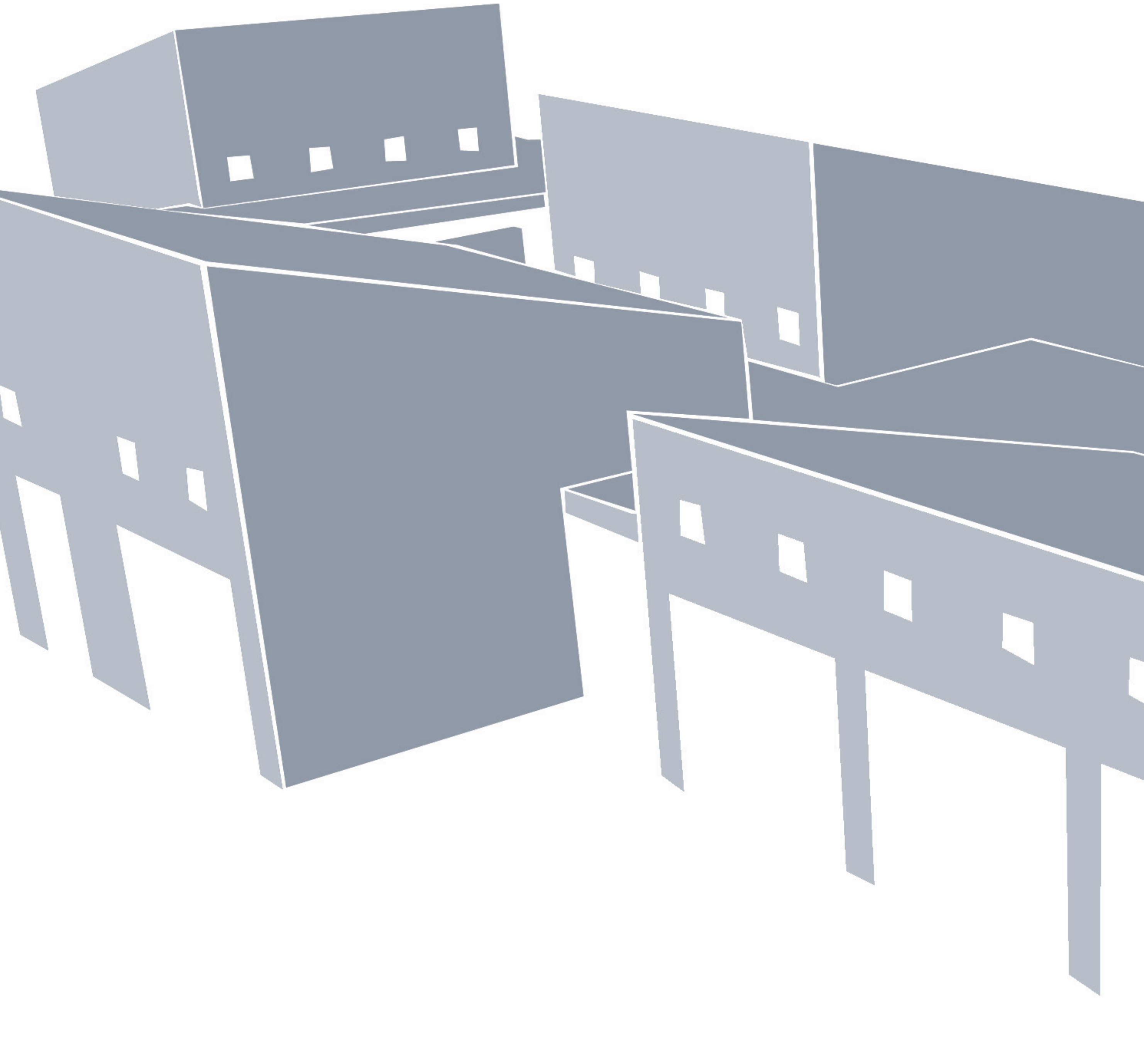
ROOM PROGRAM

The building will contain many different functions, servicing the hotel guest and the employees during their day. The functions will give the inhabitants the possibility to live a daily life as close as possible to their own, regarding their needs and giving them the possibility to do their own laundry and to cook with others. The dwellings will have access to all of the common rooms in an open plan solution. This gives the inhabitants the possibility to visually overlook the area. From the common facilities there will be access to outdoors spaces and playgrounds.

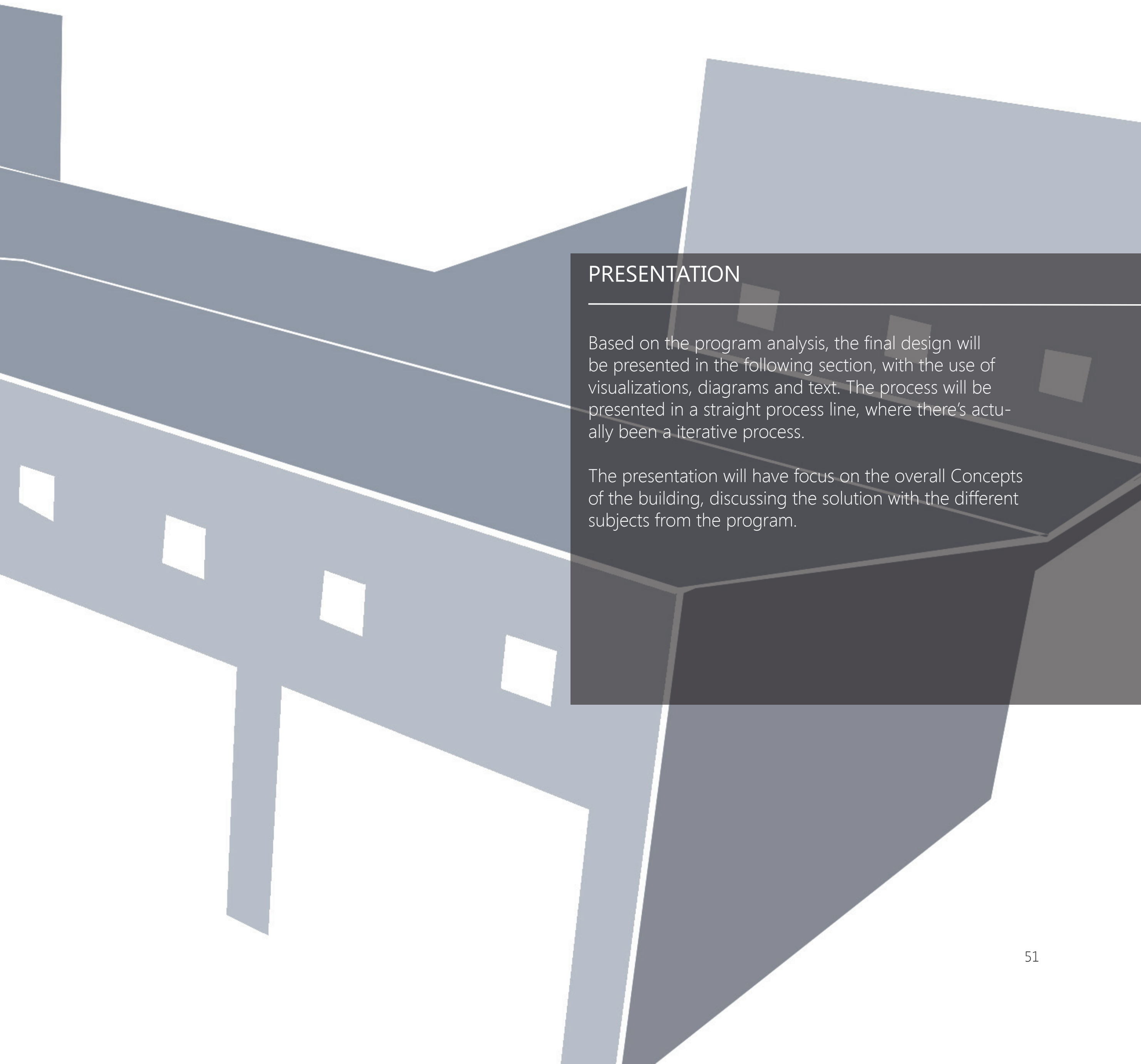
The building will also include more administrational functions such as offices and meeting rooms for the employees in the complex. And as a general thought the inhabitants should not be shielded from the outside world, therefore most of the outdoor area is public.

				Daylight	Nature	Tranquility	Internal visibility	Outdoor acces	External visibility
Privat functions	bedroom	10	1-3 P	High	High	High	Low	Low	Low
	Toilet	5	1-2 P	Low	Low	Medium	Low	Low	Low
	Tea kitchen	5	1-3 P	Low	Low	Medium	Low	Low	Low
	Living room	10	1-3 P	Medium	Medium	Medium	Low	Medium	Medium
Public functions	Loundryroom	50	5-10 P	Low	Low	Low	Medium	Medium	High
	Common kitchen	200	30-40 P	High	High	Low	High	High	High
	Common playroom	250	30-50 P	High	High	Low	High	High	High
	Common Livingroom	250	30-50 P	Medium	Medium	Low	High	Low	Medium
	Toilet	50		Low	Low	Low	Medium	Low	Low
	Common diningroom	250	50-80 P	High	High	Low	High	High	Medium
	Music room	80	10-15 P	Low	High	Low	Medium	Low	Medium
	Activity room	100	10-15 P	Low	Medium	Low	Medium	Medium	Medium
	Sense room	80	5-8 P	Medium	High	High	Medium	High	Low
	Spaces for movement	indefinite		High	High	Low	High	High	High
	Outdoor area	indefinite		High	High	Medium	High	High	High
Administrational functions	Offices	50	5-10 P	Medium	Medium	High	Medium	Low	High
	Reception	20	1-2 P	Low	Low	Low	High	High	High
	Technical	35		Low	Low	Low	Low	High	Low
	Meeting room	25	8	Low	High	Medium	Low	Low	High
	Changing room	50	15	Low	Low	Low	Low	Medium	Low

High priority ■ Medium priority ■ Low priority ■



Ill. 49. Building silhouette presentation



PRESENTATION

Based on the program analysis, the final design will be presented in the following section, with the use of visualizations, diagrams and text. The process will be presented in a straight process line, where there's actually been a iterative process.

The presentation will have focus on the overall Concepts of the building, discussing the solution with the different subjects from the program.

Ill. 50. View from the forest

MOTIVATIONAL FACTORS

Throughout the analysis we were presented for the future problem of having to few hospital beds at the new super hospital in Aalborg. To prevent this, a new patient hotel for long term patient can be placed to support the super hospital, in this case a patient hotel for children and their families.

For children families the most important parameter in their healing process is to feel safe and secure, but also their comfort is an important aspect. The intention is to create an environment that creates the closest feeling of being home, which means both social, spatial and the quality of moving from public to private environments, this is done by introducing "Healing architecture", tectonic and Nordic architecture and brutalism

Brutalism is introduced as an inspirational source due to its idiom, as it has references towards nature and give the quality of introducing a tactile material which can be paired with the softer and warmer tactility of wood. Brutalism also have the quality of recognitions, as its simple shapes and forms are easy readable for the users.

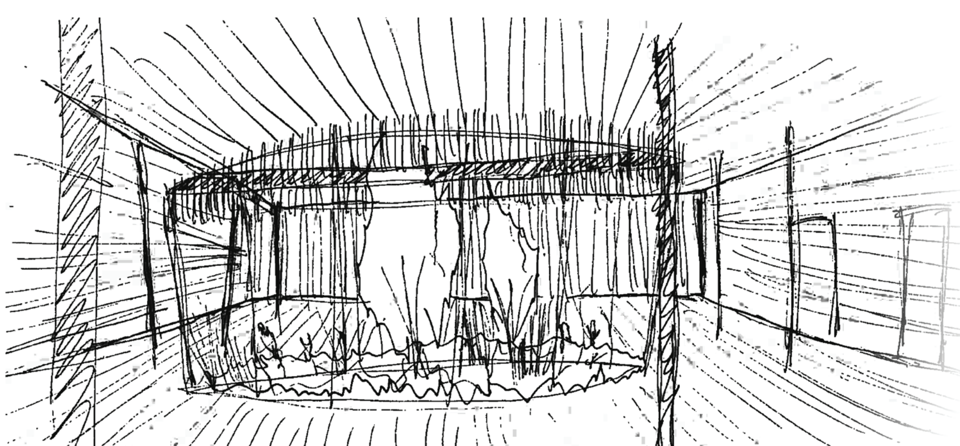
When discussing materials with different tactile appearances it gives a larger set of variations in the materials, and helps keeping the amount of different materials to a minimum, different tactile appearances can be, rough, smooth, fractured etc. It will be used to determine different functions and to create different feelings around the complex.

As the building is placed in Lundby krat it has to take the nature preservation of the area into consideration. Therefor it is important to implement this in the building and to embrace it, by inviting the nature into the complex, and to play with the surroundings

In the end the project should achieve all this to minimize the hospitalization period for the children and their families. This generate a quick healing process, giving the possibility to service a larger amount of users, throughout the year, giving the optimal support for the main hospital.

Important aspects:

Security
comfort
the feeling of home
social
materials
brutalism
nature



Ill. 51. sketch internal garden

PLANS

GENERAL THOUGHTS

The overall plan is created from a grid system laid out on the site. This is done to secure a monotonic idiom concerning both aesthetical and structural throughout the complex.

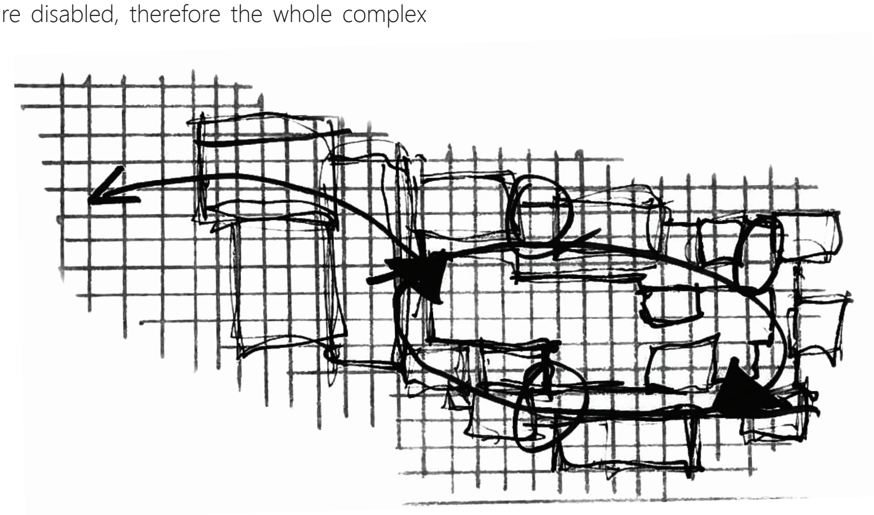
Different functions, mixed between common and private, will be placed in a circular formation connected by a hallway. This defines an internal garden, which creates the needed access to an outdoor space, without reducing the safety of the complex.

A tower is placed at the western end of the complex raising 32 meters above the terrain. It will function as a landmark towards the hospital creating a visual connection. Between the building and the tall natural surroundings. Public functions and administrational function will be located here, due to the graduation from public to private.

Next to the tower a kindergarten is placed, to introduce life to the area, as it gives the inhabitants the possibility to associate with others, but also to suppress the feeling of being sick and isolated.

The plan have to take accessibility into considerations, as it is very important to be able to move around, even though you are disabled, therefore the whole complex and the internal garden is kept in one level except of the tower, where a staircase and an lift is servicing the various floors. This one level plan gives a level difference towards the east of 2 meters; this is levelled by the creation of a bastion to maintain the accessibility to the forest.

as there are many different functions placed in units around the complex, there is a need for an hallway that combines these. The project seeks to design this in such a way, that it can be used for more than just a transit zone, this is done by implementing small socialization areas and introducing an area in front of each housing units which belongs to the users of the homes..



Ill. 52. plan sketch

Staff lockerroom
Waiting area
Reception
Toilet
Office
Workshop area
living area
living area
living area
Toilet
Toilet
Flowerbed
Playing area
living area
Toilet
Pedagogue lounge
Toilets
Laundry room
Coat racks and entrance hall
Common area
Common livingroom
bushes
Playing area
Playing area
Common kitchen
Flowerbed
Flowerbed
bushes
Large playground
Flowerbed
Flowerbed
Toilet
living area

Ill. 53. Ground/situation plan

Ill. 54.Interaktion

INTERAKTION

INFORMEL MEETINGPOINTS

To develop the social stimulation in the building, one focus has been to create an interaction between stab, guests, the hospitalized and their families. This is done by introducing informal meeting points and crossroads, by using the area of the hallways. The areas are created by the use of the grid system displacing the units from each other.

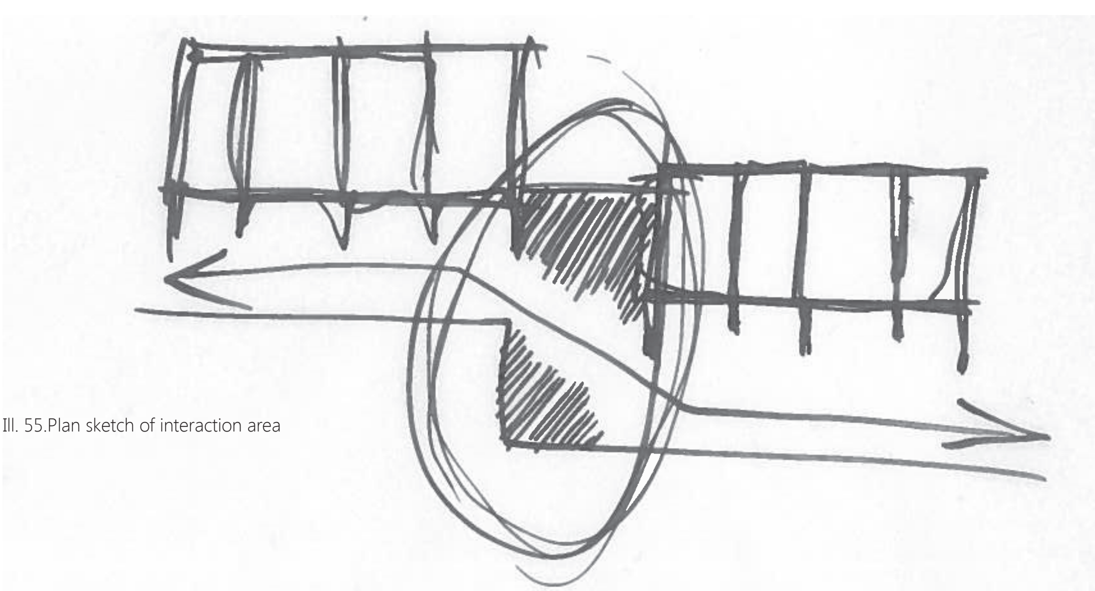
When displacing the elements we create a new spatiality in between, giving rooms for meeting, playdates, recreativity and philosophy. The hallway should be seen as the main artery of the people flow around the building. This means that people at some point will interact with other people in the hallway, and the creations of these informal meeting points gives them the possibility to do so, and by this creating relationship between stab to patient, patient to patient and patients to guests in a non-stressful environment.

The area itself will have two different functions, as the idiom towards the surrounding forest will have the identity of either a play area or a meditational area. Here the other functions towards the internal garden will be the meeting point which is defined by a beam of light and a cosy set of furniture's, which correspond to the surrounding tactility of the room.

.

The idea is that parents with their kids, meets informal and develops relationships, and after a while the children retrieves to play in the other end of the room, letting them socialize without their parents interfering. This allows the parents to discuss their situation with each other and gives them a moment to process the situation without worrying about their children.

Peoples are by nature gregarious and it is often seen that people attract other people, so in theory this should create a great net of different relations and keep the social isolation to a minimum in the complex.



Ill. 55.Plan sketch of interaction area

NEIGHBOURHOOD

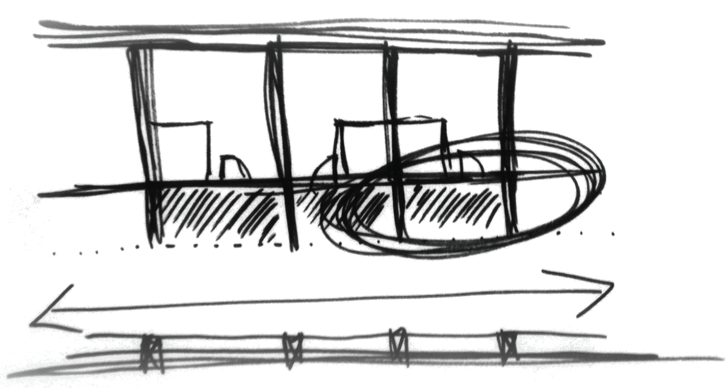
NICHES AND OWNERSHIP

Throughout the plan every housing unit will be placed next to each other; this puts the thoughts towards row houses. To identify each housing unit they received a small area in the hallway which will be defined by the already existing walls in the housing unit. This niche will function as a modern front yard, which gives the possibilities to décor the area as the inhabitants please, and gives them ownership of the area.

This solution, gives the possibilities to identify a specific housing units, as the personalities of the inhabitants of each unit will be illustrated in these niches. Besides creating a personal space it also creates an area where small meetings can find place, and neighbourhood can occur.

It is well known fact that kids have different personalities, some of them are active and extrovert while some of them is shy and introvert. This is a question of psychological manner, but the niches takes this into account as they provides a safe zone for the shy children where they can play and watch people passing by without becoming uncomfortable. On the other half the niches is exposing the shy children for the more extrovert children that would seek a fellow companion during their hospitalization period by walking on the hallways. This creates relationship on the children's behalf.

More practically the niches can be used by the parents to showcase their personalities and therefore helping the kids to find their way home when they have been out playing, which gives the parents a feeling of security for their children.



Ill. 56.Plan sketch of niches

Ill. 57.Niches


Ill. 58.Guidance by light


Ill. 59. Common kitchen


Ill. 60. waiting area tower

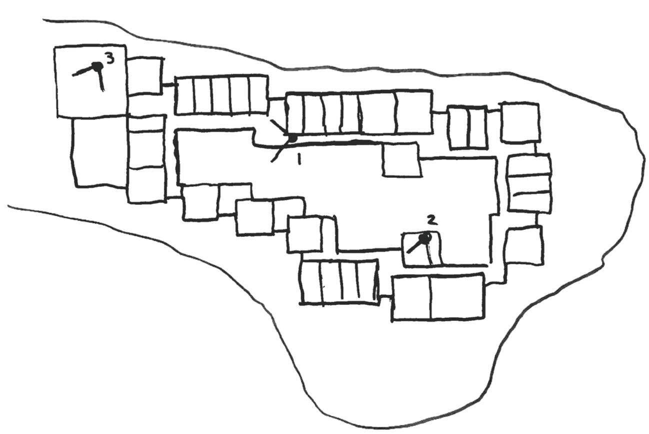
EXPERIENCE THE DESIGN

GUIDING, COMMON ROOMS AND THE TOWER

When walking around the building complex different experiences are revealed. You can either choose to walk along the hallways, viewing the internal garden from different angels, and let you guide by the light (ill. 58) which are painting the walls. This use of light, gives the possibility to create some flow in the building at guides people around, by the use of their curiosity. Another work tool that is implemented in the building is guiding by view, and in the combination with light, this creates a hallway full of life, which is important to the social aspect when being hospitalized.

From the hallway it is possible too either walk into a housing unit, or guide yourself into the larger common rooms, where the functions span from a common kitchen to a common living room (ill 59). Here it is possible, to sit and eat, with other families, or staff which are in the same troubled period of their life as you. This helps to minimize the stress as it is possible to share experience, but also to shear the workload of keeping a household on track like having "friendship" family where you are alternately cooking dinner.

When moving on into the tower block, then you will have the opportunity to take the elevator to the desired floor from here on you will enter a double height room (ill. 60), where a large window section will fill the room with light. In this double height room is it possible to have small informal meetings, with others, while you wait for a therapy session. As longer you get up in the tower, the more view over the tree landscape you get.



Ill. 61. placement of views

ACCESSABILLITY

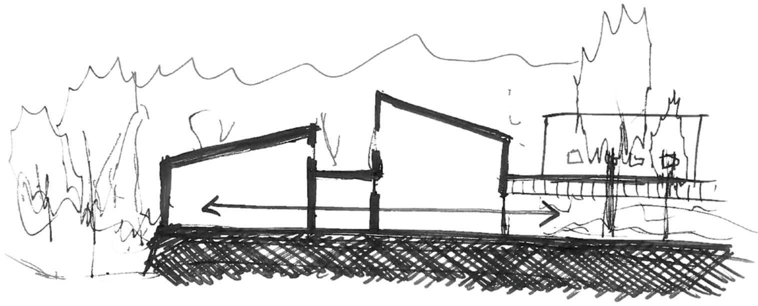
DISABILITY ACCESS

The design have to take accessibility into considerations, as it is very important to be able to move around, even though you are disabled, therefore the whole complex and the internal garden is kept in one level except of the tower, where a staircase and an elevator is servicing the different levels. This one level plan gives a level difference towards the east of 2 meters; this is levelled out by the creation of a bastion to maintain the accessibility to the forest.

Being able to move around as a disabled person, also gives the joy of being independent of others, which is a huge comfort factor and security factor for the hospitalized. Beside the fact the plan is in one level, the whole building have been made accessible for manoeuvring a wheelchair around in the different rooms.

As the building complex relates to the hospital, there is a chance of having some of the equipment occupying the building, it is therefore important to make sure that the dimension is capable of these. The public area and the hallway is capable of having beds transferred around as the doors has a minimum width of 115 cm. The elevator is also capable of carrying two hospitals beds at a time because of its dimension. [HFB, 2012/2013]

When moving around in a wheelchair, it is important to maintain a turning area of 1.5 meters to increase the comfort of the users; this is implemented both in the housing units and in the dimensioning and placement of the hallways and the common rooms. [HFB, 2012/2013]



Ill. 62. Sketch accesability

Ill. 63. section accessability

Ill. 64. Tower presentation

TOWER BLOCK

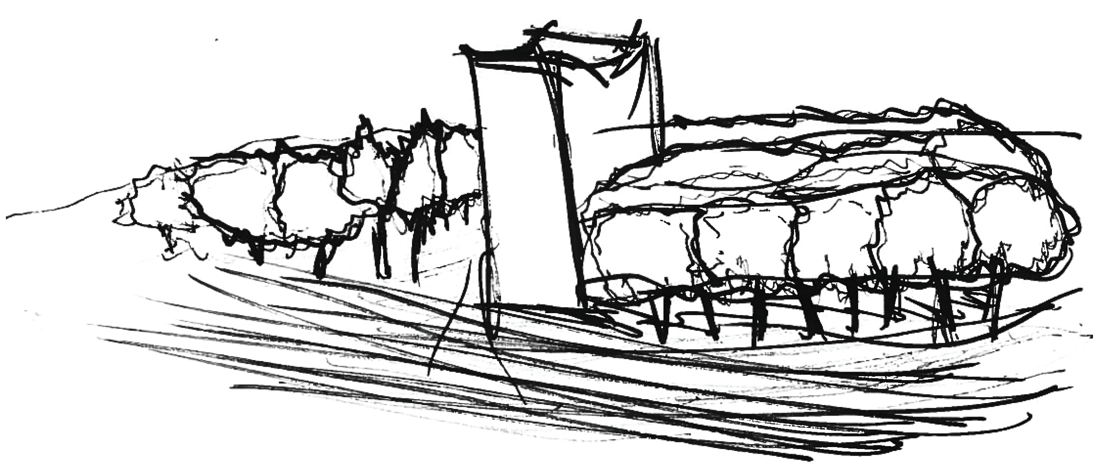
LANDMARK

The first thing that will meet the users when approaching the patient hotel is the tower block; it is here the main entrance of the complex is placed

The tower contains the public functions such as treatment rooms, entrance hall and offices. Having these functions close is a very important aspect of the project, as it gives the staff the possibility to be a part of the daily life at the patient hotel, and to interact with the hospitalized, creating relations instead of being a stranger in a coat. This will benefit to a lesser stressful environment for the patient when they attend consultation.

The reason to make a nine storeys high tower block in the middle of a protected nature area, where to work against the tall trees that is dominating the surroundings, but also to create an overview of the treetop landscape, as this will be used for therapy creating a Zen like sense room, where the outside is isolated from you and the only thing you should concentrate on, is the movement of the tree crowns and their silent whistles. Every level of the tower has two treatment rooms and associated offices, which are connected with a common waiting and playing area. There is a connection from one level to the level above as the deck is withdrawn from the other creating a double height room, improving the spatial quality of the room and creating visual connecting.

The towers idiom is also different from the rest of the building; this is because it is reflecting its functions which differ a lot from the more private part of the complex. as the functions is this different it is also important to let the users know this, and distance them a little from it, as it is not intended, that the hospitalized should occupy it, unless they have an errand. This shift in idiom it underlines the barrier between home and institution and must be maintained to maintain the feeling of being home when living in one of the housing units.



Ill. 65. Sketch landmark

INTERNAL GARDEN

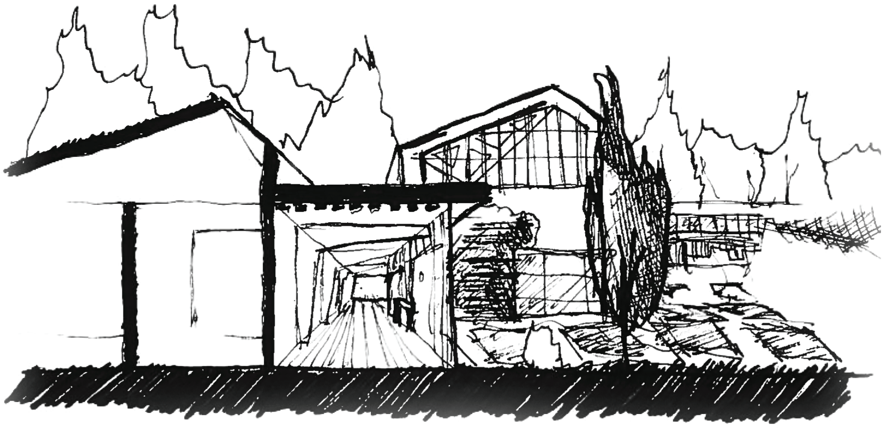
SENSE, NATURE, PLAY

An internal garden is created to provide the complex with a safe environment, for children. The adjoining hallway, defines the garden space, and gives the possibility to observe the garden from different position in hallway.

The garden is designed to create a clearance during hospitalization time, where the patients can refuge to. Here the senses will be stimulated, by the beauty of nature. Beside the nature there will be installed primitive climbing and balancing games for children. All these different functions will be combined by the in situ casted concrete tiles

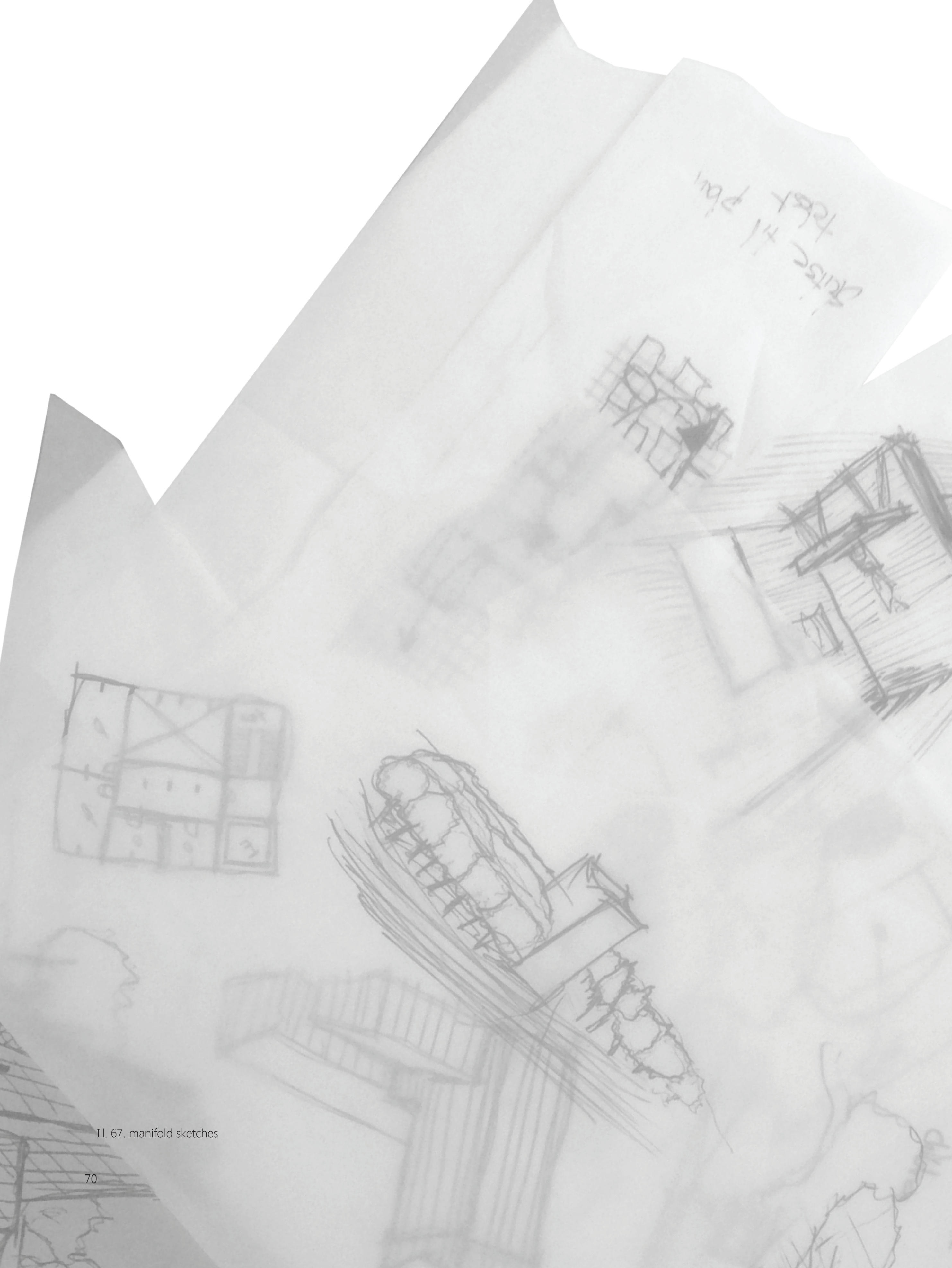
Another important aspect of this outdoor space is also to provide it with a shelter, this is located in the western part of the complex, It lie in connection with one out of three wooden terraces. Here it is connected to the kitchen giving the inhabitant the possibility to arrange barbeques and to enjoy the nature but also to socialize. Even though the garden is sheltered from the wild nature, you have the feeling of being a part of the surrounding forest, as the treetops are visible in a 360 degrees angle when standing in the centre of the garden. Furthermore it is possible to have different views through the complex towards the surroundings creating a visible connecting to underline the feeling of being in the forest.

This accessibility to a safe nature environment should invite the children to be physically active, and to stimulate their senses, which should minimize passivity as children can run and jump from concrete tile to concrete tile, hide in the bushes or splash in the water mirrors. In the end this has a positive influence on the hospitalization, due to a positive impact on their psychological wellbeing.



Ill. 65. Sketch garden and hallway transition

Ill. 66. Sketch garden and hallway transition



Ill. 67. manifold sketches

DETAILING

In last section the project were presented, the following section will then go further down in its explanations of the different design solutions, such as the shape of the building, the division om the internal garden and the development of the bastion.

Technical consideration according to the structure of the building and its stability will also be discussed during this section, alongside the design solutions.

SHAPE

UNITS, ROOF

The general idea with the shape of the units was to develop different boxes that fitted into a modular system and which reflected its privacy function in its size. The boxes should be simple in its idiom as, it should have easy readable geometrical shapes due to the inspiration of the brutalist period.

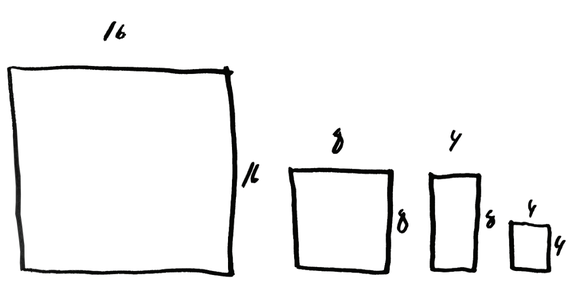
Building up the complex in this modular way gives the possibility to create spaces in between the functions and to create unofficial meeting places as stated earlier, but it also gives the possibility to reuse the structural system throughout the complex.

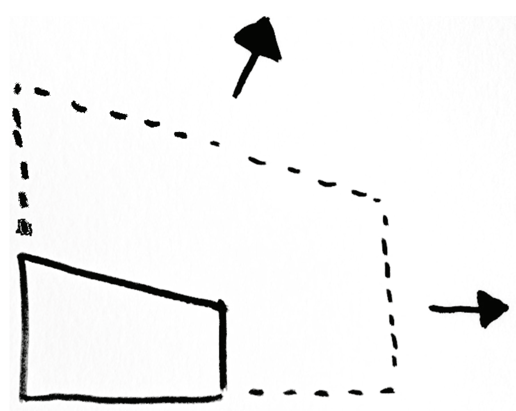
The modular system is exemplified by squared bases; this shape is not satisfying, therefore an iteration is further needed. This resulted in a division of the modules dividing it into two segments, a base and a top.

Through an investigation of size and shape of the top a common idiom of the boxes where discovered which puts the thought towards the earlier design demands concerning the simplicity of the shape and the created spatiality. Furthermore the final top is capable of being used for the different sizes of bases

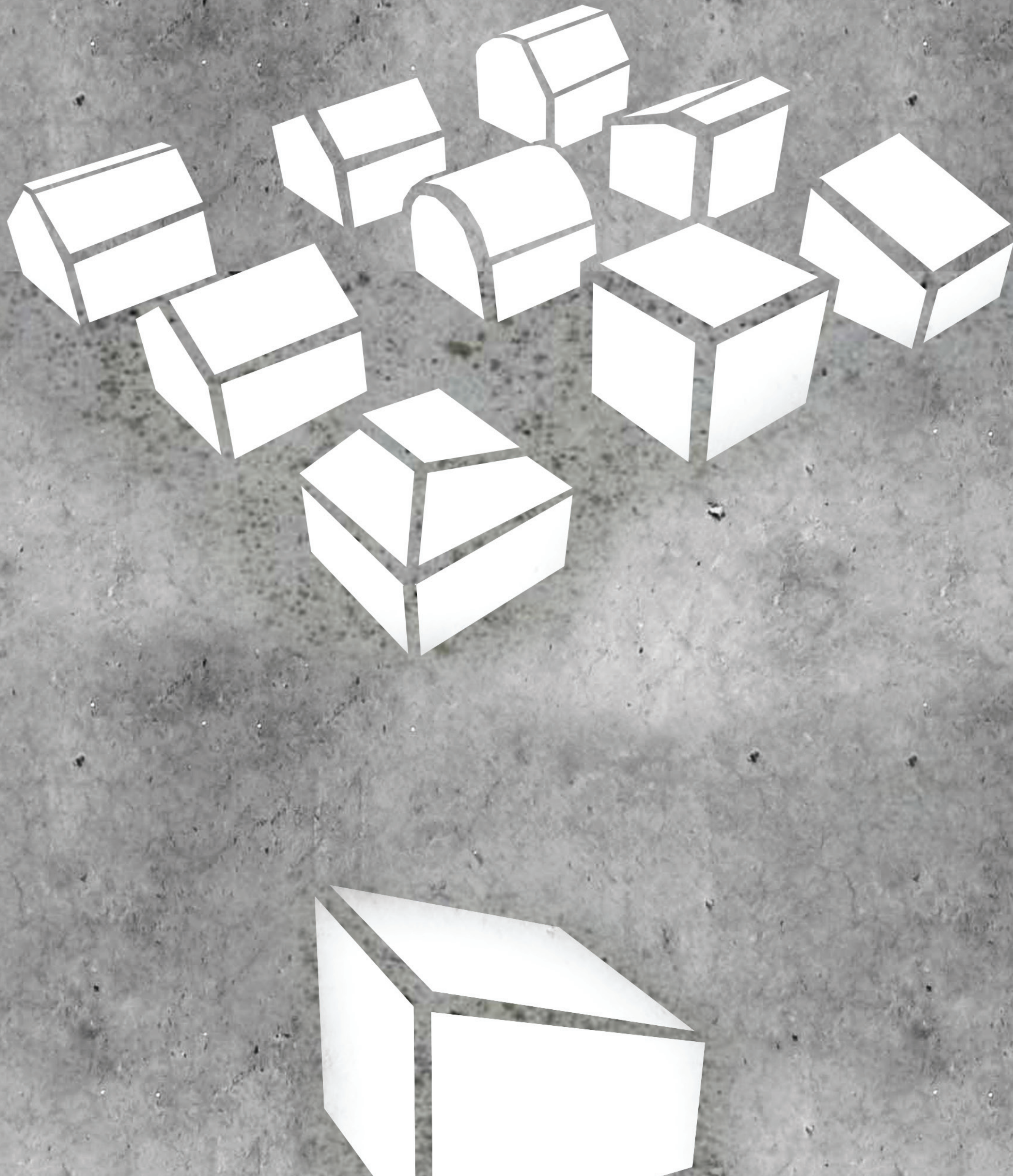
The final roof shape that has been elected is the half pitched roof, and it will be used in the entire complex, except for one irregularity at the tower, here the roof will be made of two inverted half pitched roofs.

The chosen shape is simple in its idiom, but also massive due to the large surface areas, this gives it a monumental expression where the material is the domination aspect, it has a continues expression throughout the whole building design which creates a similarity and helps the users read the building more easily as the size defines the functions privacy. This helps them to orientate themselves in the complex and prevent a stressful situation of not knowing several parts of a large building complex.





Ill. 68. sketches of size



Ill. 69. idiom study of the roofs

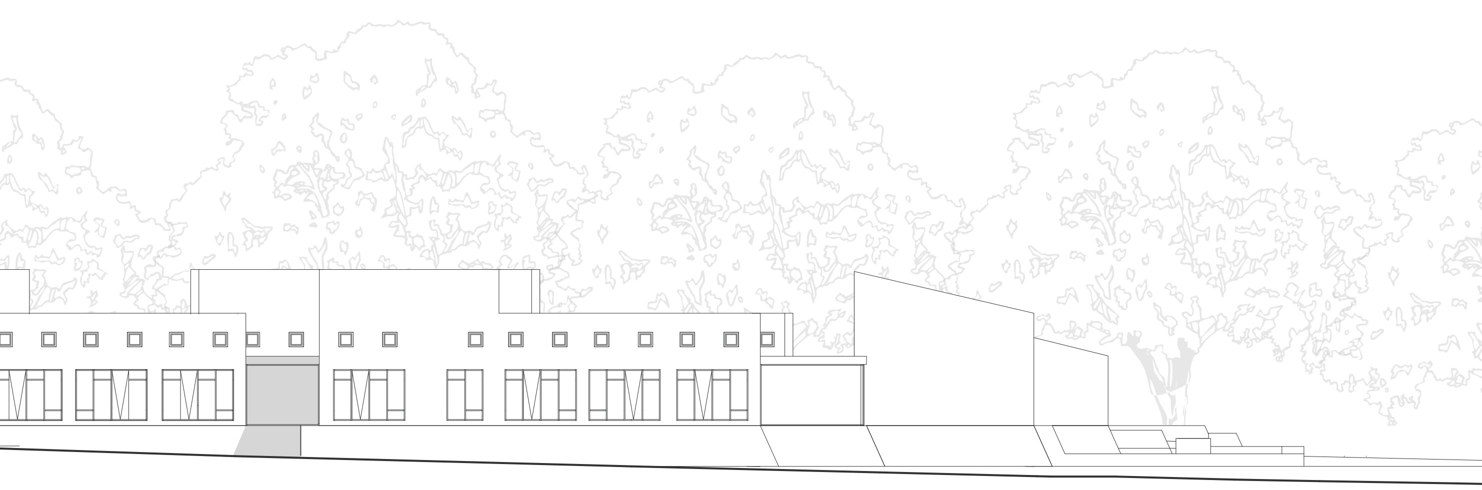
FACADES

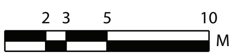
BUILDING FACADE EXTERIOR

This section shows the overall idiom of the exterior building facades. and gives an idea of the scale versus the surroundings.

Ill. 70. South facade

SOUTH





Ill. 71. North facade

NORTH

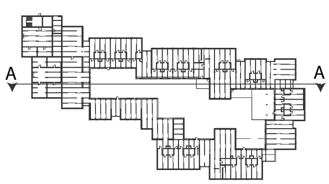
Ill. 72. West facade

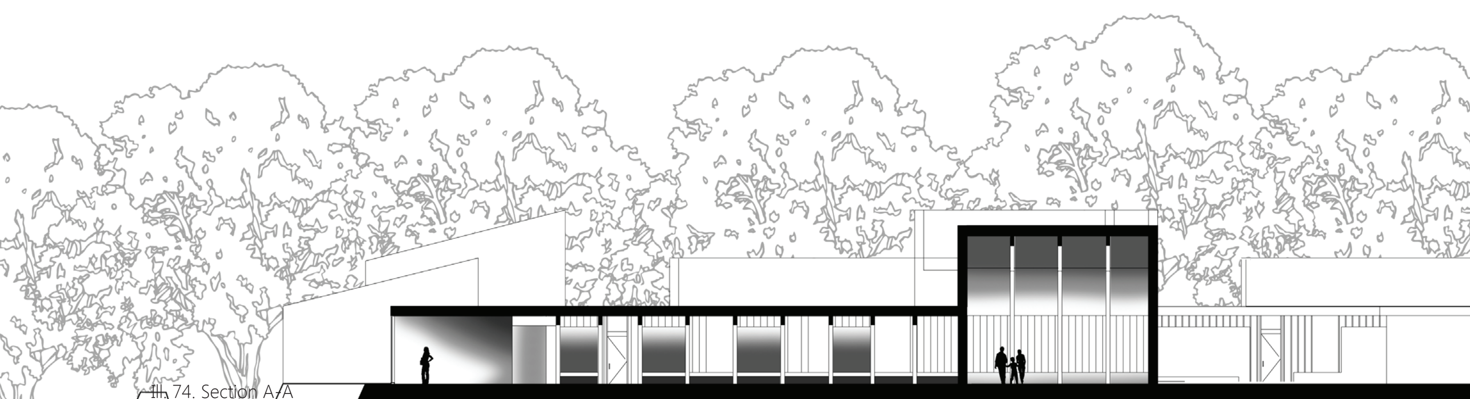
EAST

Ill. 73. East facade

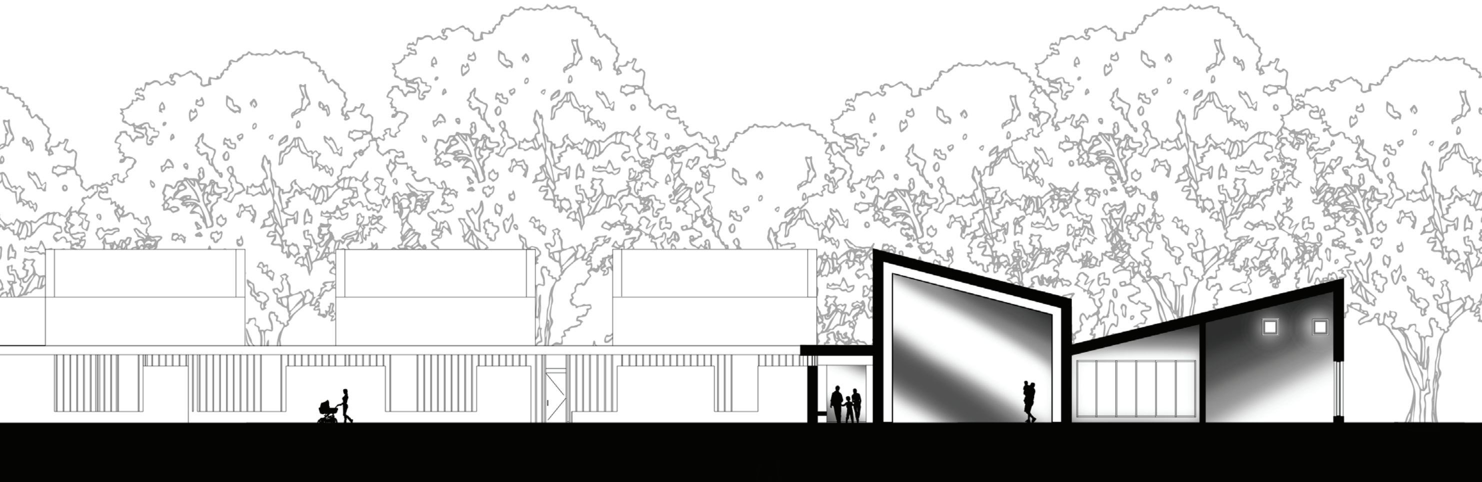
BUILDING SECTION

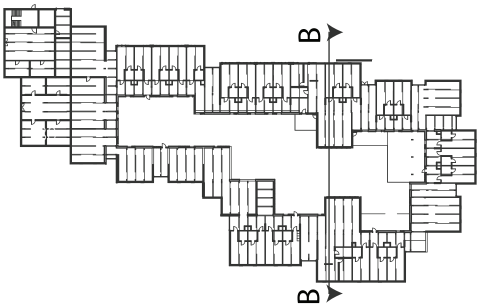
The following pages will illustrate the spatiality of the building complex and illustrate the one plan level in the internal garden by the use of sections

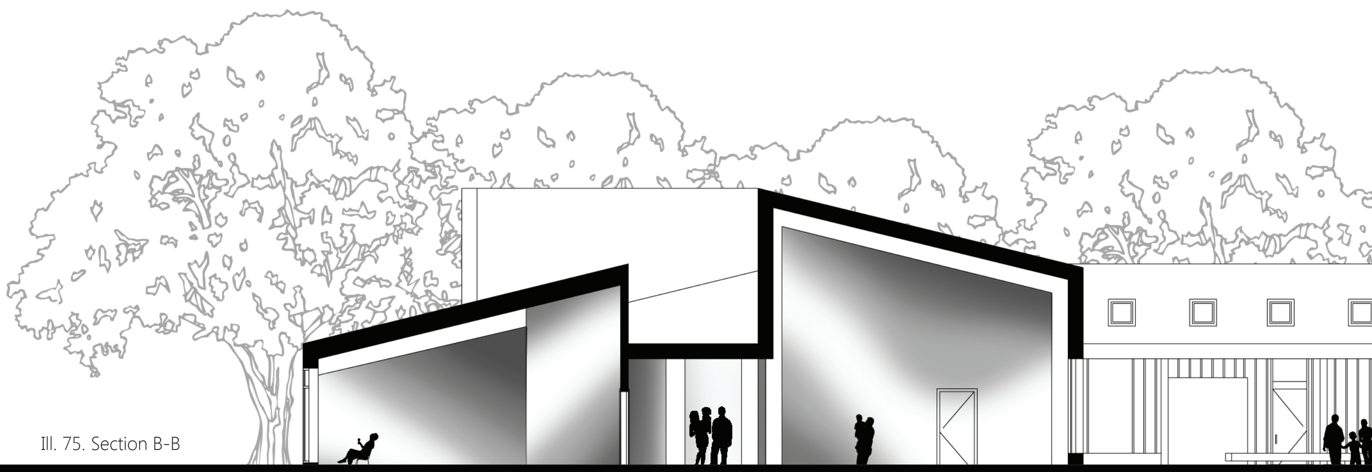




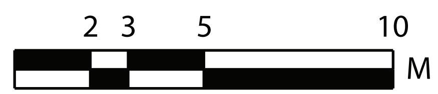
Ill. 74. Section A-A







Ill. 75. Section B-B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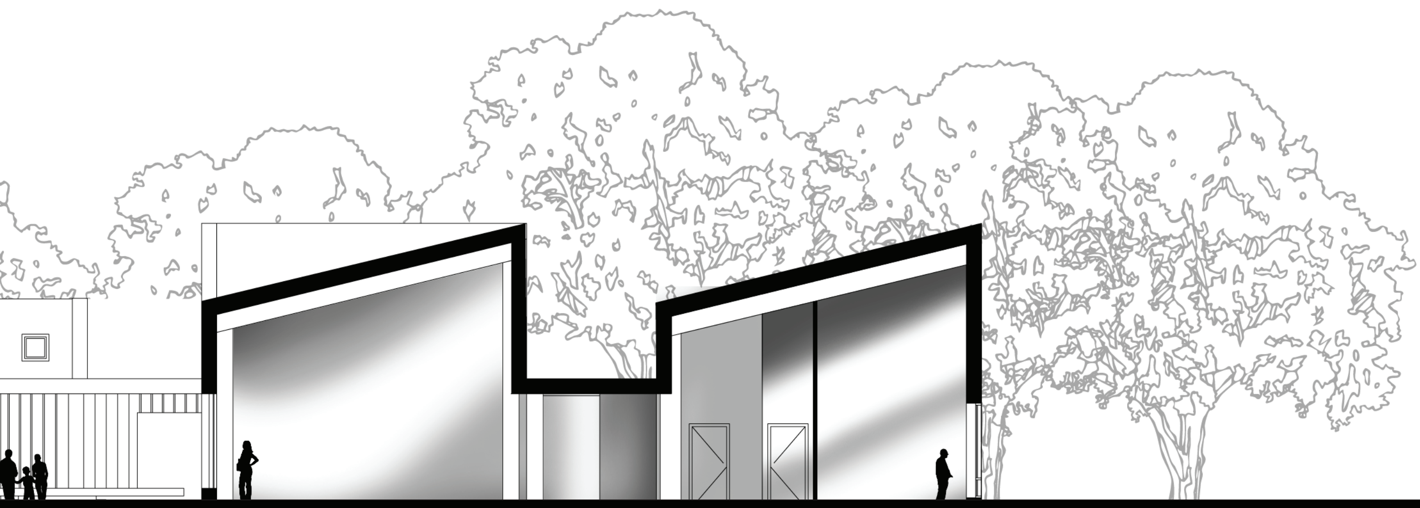
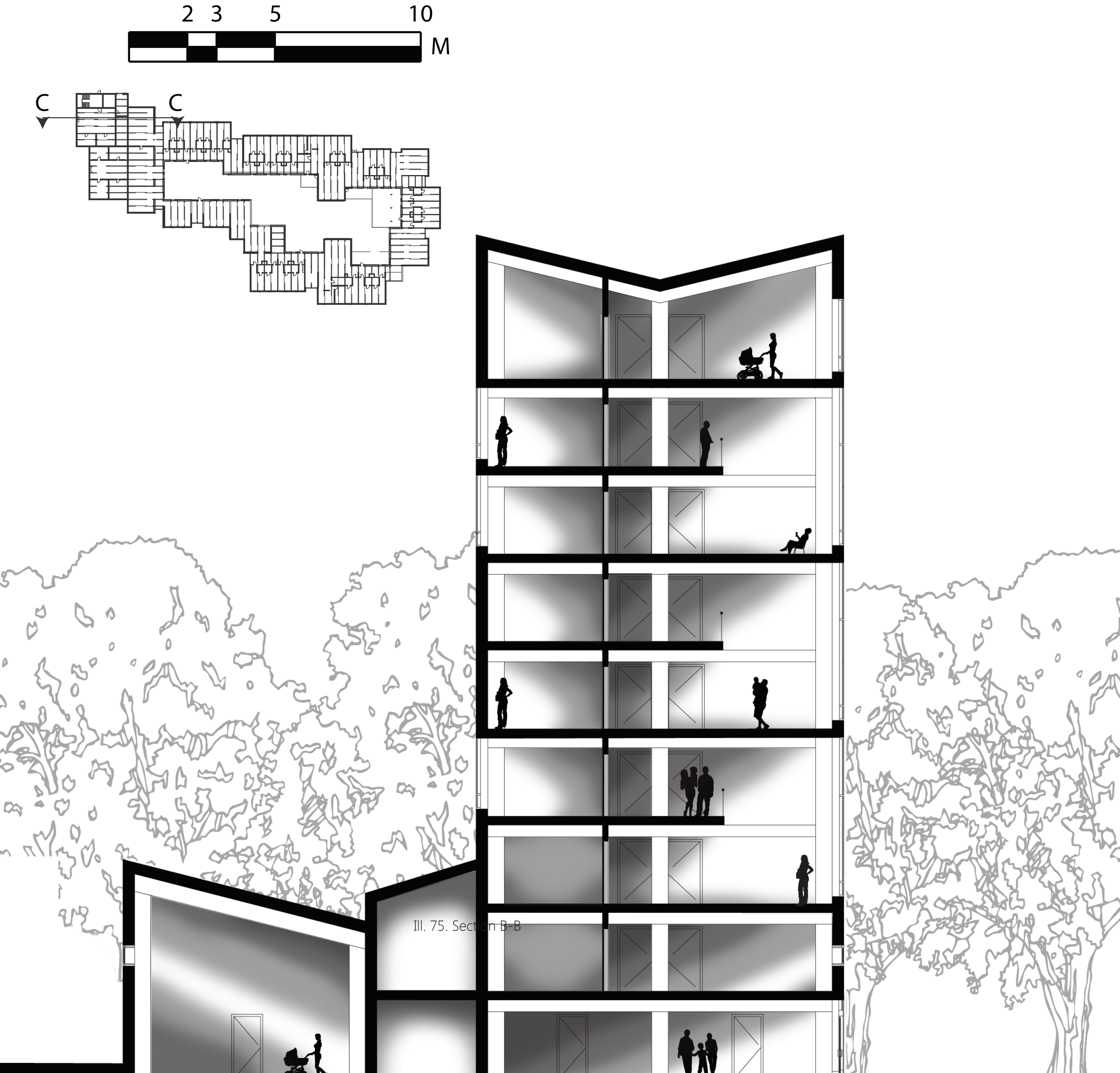




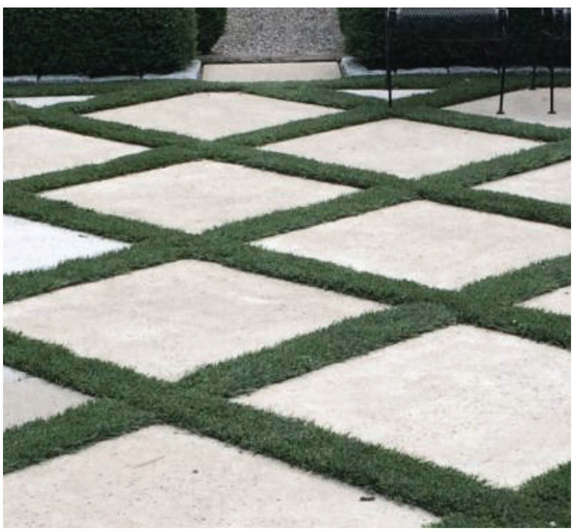
Ill. 75. Section B-B

Ill. 76. Section C-C

Ill. 77. Section D-D


Ill. 78. lavander


Ill. 81. Primitive playground


Ill. 79. Concrete tiles


Ill. 82. Private spaces


Ill. 80. Water mirror


Ill. 83. Art

INTERNAL GARDEN

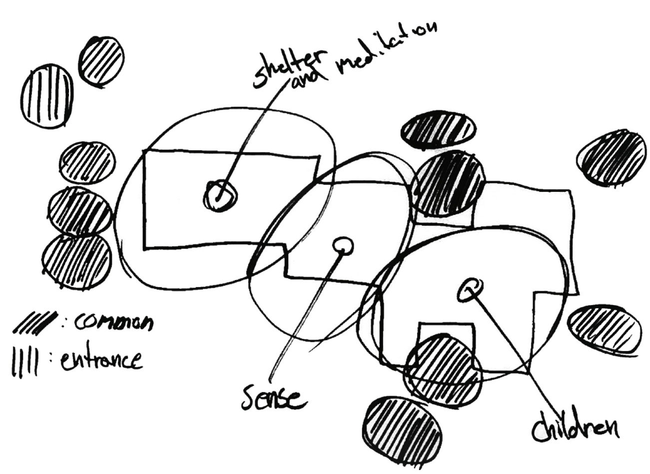
DIVISION AND FUNCTIONS

At first the internal gardens boundary is created by the surrounding functions, but it has to be divided into smaller segments, to relate to the human scale and the clarity of the area. This division is done by analysing the location of different functions throughout the complex. Here it is seen that there is a concentration of common functions to the east, therefore this segment will be the area of the playground. To the west, the space is near the entrance and the size of the area invites for meditation and privacy and the main idea is that people can retrieve to this area in small groups to be private when having visitor and just to be alone for a while.

The area in between should be a transition between the two, it should combine the high pace with the low pace functions. There for it has been giving the function of the sensing garden, which can be used either as an advanced playground or as a meditational area, listening to the purling water or smell, see and touch the different plants and textures

These borders are only conceptual and should therefore only be followed as guidelines throughout the development of the areas. The areas should contain the different functions and elements, to support the creation of a healing environment in the forest where the user group is children and their families. Different elements has been chosen to be implemented in the garden; water, shelter, nature, sensing, primitive playing ground.

The main expression that is wanted is a cultivated complex that has been overtaken by nature, to illustrate safe boundaries in a stress less environment, the feeling of being on a vacation in another world. This feeling has its inspiration from the surroundings



Ill. 84. Division of spaces

Puplic | Common | Private

Wall

Ill. 85. Smooth white oak

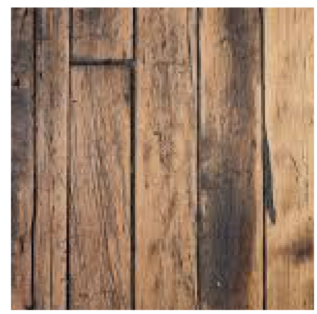
Ill. 89. Rough concrete

Ill. 92. timber tile rough

Floor

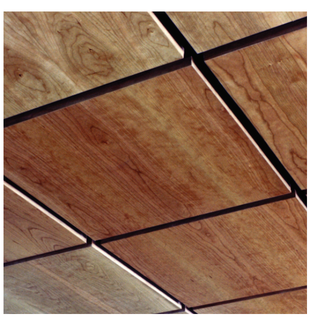
Ill. 86. parquet

Ill. 90. Concrete floor



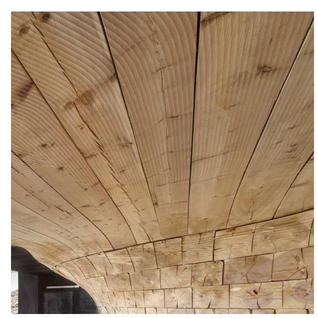
Ill. 93. reused timber floor

Ceiling



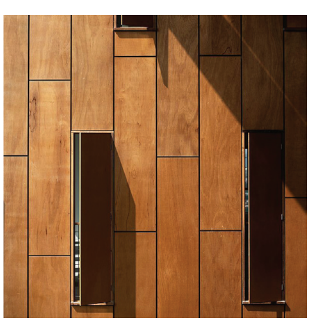
Ill. 87. Smooth roof tile

Ill. 91.Lamellas Ceiling



Ill. 94.Snøhetta reindeer pavilion

Exterior wall



Ill. 88. timber cladding

MATERIAL

MATRIALITY AND TACTILITY

Touching the different materials, throughout the complex has been an inspirational source, therefore it is important to consider the different materials, and their expression, materiality and tactility; how does it feel, is it rough, smooth, cold or warm. Can those basically thoughts be implemented in the design, defining different areas, functions or maybe guiding people around the complex towards their destination, creating a hierarchy between the different zones. The idea is that the more public the function is the more sophesticated material textures. There have been sought inspiration in the works of Friis and moltke's brutalistic period in the 1960'ies where they paired up concrete with timber, and then added a strong colour to give some depth towards the large areas of façade.

Another aspect is also the pedagogical qualities a material can have, both conserning children and adults. As being a kid you learn through your senses, therefore it is very important to introduce this to the design, as this could define some zones which is pleasant to occupy and play in and most importantly is readable for the childrens senses. It also helps creating architecture in the height of a child which is important when creating a childrens patient hotel

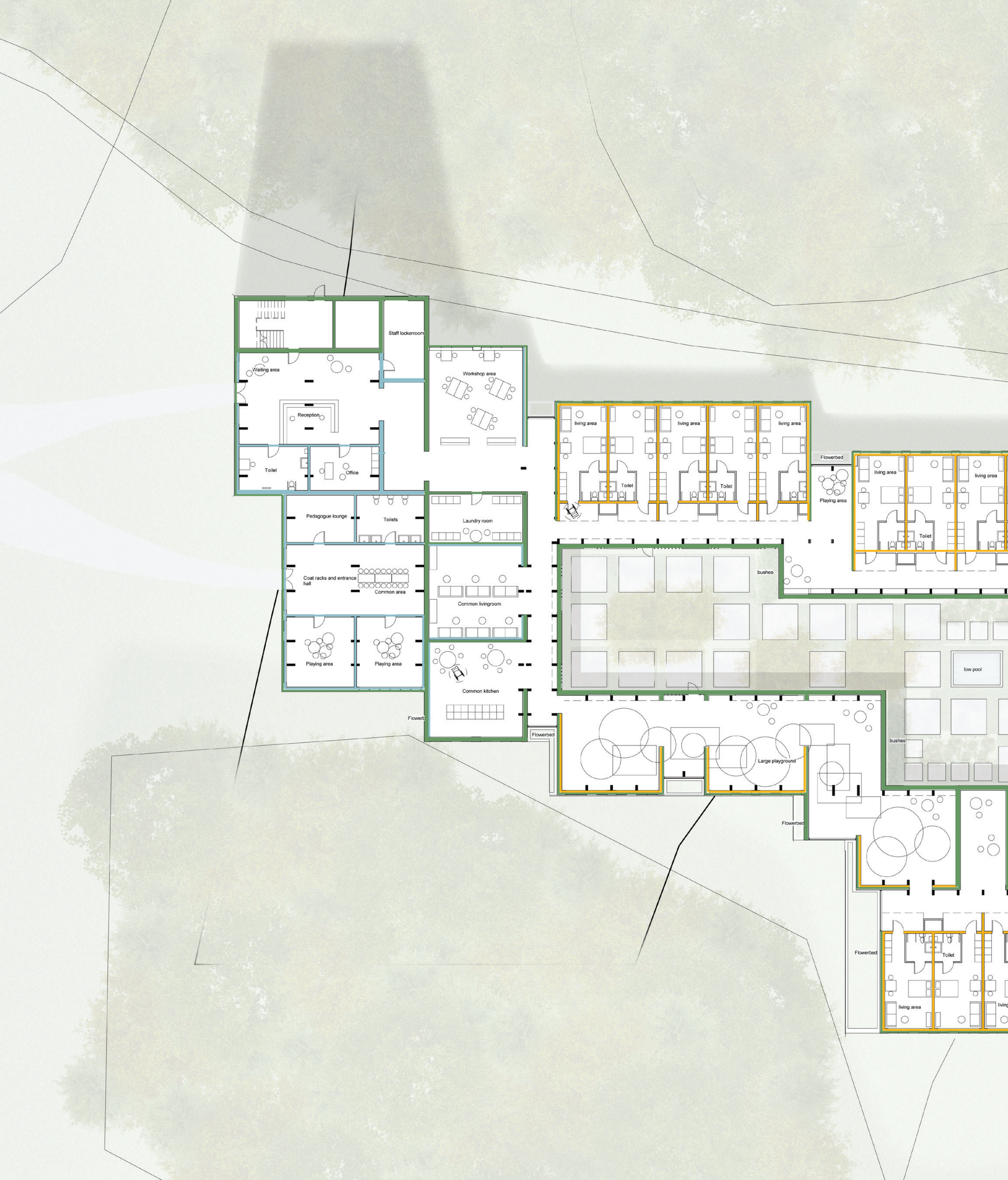
This concern of materials, gives another dimensions towards creating the optimal spatial experience for each function throughout the complex. This helps defining what types of function and what set of rules there are allowed. This means, there are not any confusion, the parents are aware of the location of their children which in the end provide safety, a non-stressful environment and at the same time stimulate the childrens senses and let them learn through the tactility of the materials. A study of different materials will be used throughout the design, are prepared. It addresses the main use of concrete and timber

Concrete, has the ability to be sculptured into nearly anything which means, it gives a huge variety in tactility, as it can span from smooth to rough to organic. This will be used as the main material for the outer wall and the inner bearing walls, in this case the form work of the concrete will be exposed both outside and on the inside letting people touch and feel the material.

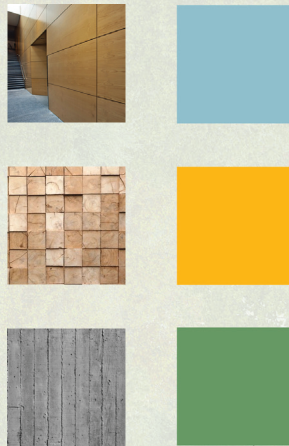
Compared to concrete, timber has a warm comforting feeling in its materiality. Timber can also vary in colour and tactility. another important quality it has, is that it illustrates the history of its use, as timber adepts to humans and their needs.

The analysis will focus on different parameters such as age, tactility and expression of the materials. This is a theoretical material study, in real life, the different materials will be merged more together to define areas even more, instead of being strictly controlled.

on the next page a plan with the the division of the wall materials is made, it will concern the materials in the different rooms. (ill. 95)



Ill. 95. Distribution of materials



DN
Flowerbed
living area
Meeting, consultation area
Toilet
Playing area
Common livingroom
Terracce
Common kitchen
low pool
bushes
Meditational area
Terrace
Terracce overhang
Workshop area
Terracce
Flowerbed
196

FACADER

INNER, OUTER AND TOWER

A facade should express the soul of the building it should reflect the indoor and outdoor functions and it should furthermore interact with its surroundings. It is the first thing the users see and the last thing when they leave.

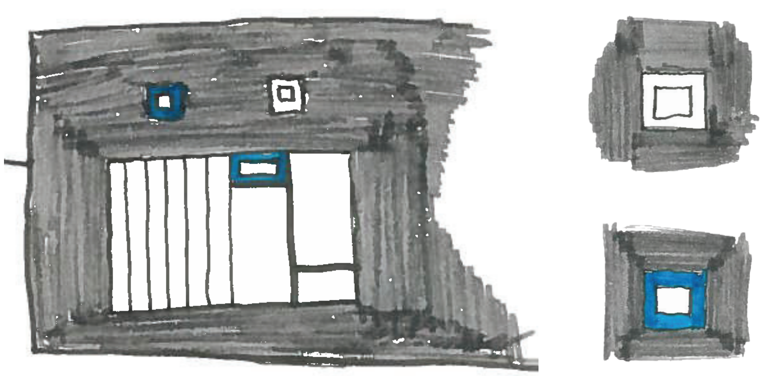
Brutalism tends to have concrete as the dominating material in the facade, with small windows. This will be used in a re-interpretation of the period. The project is divided into three different facades; inner, outer and tower facades.

The idea with the inner façade, was to keep it as open as possible, as the overview of the internal garden is an essential design parameter, but the problem was also, how is it possible to monitor the garden without feeling monitored? The solution for this was to vary the height of the facade; this creates a hovering effect of the roof. The location of these variations is determined by the location of the structure throughout the complex, to avoid having a frame misplaced in the window and by the inner function. After considering the amount of the sun, another iteration where made, and lamellas were introduced in the inner façade inspired by Avar Aalto, just as openings were created to give undistracted views from the niches.

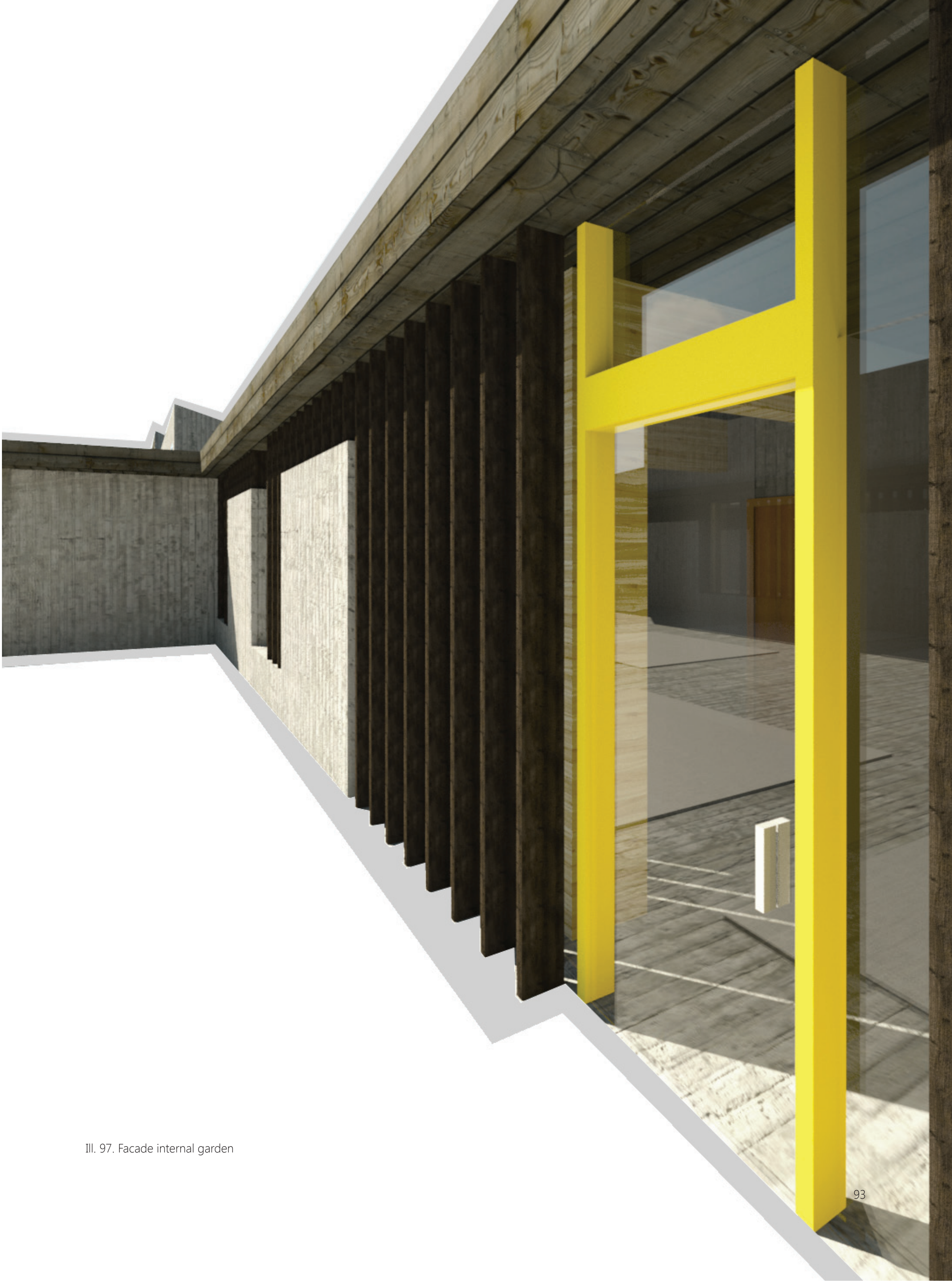
The outer facade is compared to the inner facade even more dominant, drawing parallels towards the forbidden kingdom in china, fortress on the outside, but another society on the inside. The idea for the outer facade, were to divide a large window into smaller segments, and to work with this division to create a form and shape that both aesthetical, functional and economically makes sense. This creates the base of the outer façade. At the top of the façade, smaller windows are placed in a single line, creating an optical illusion of a very large and dominating wall.

To soften up this grey and black facade, bright colours are added to the smaller windows and the element in the glass facade, this help giving the facade a whole new dimension, but it also creates associations to children and it corresponds well to positivity. The colours can be used further for the entrance and doors in the complex guiding the users.

As the tower is completely build in wood, except for the concrete core, the facade cladding is also timber elements, laid in a shifting system up through the facade, the elements dimensions corresponds to the window and can therefore shift according to the inner functions, this gives a changing expression in the facade, which speaks another language compared to the other facades. This change in design language is illustrating the difference between the public functions in the tower and the more private functions on the ground floor of the complex.



Ill. 96. Exterior facade suggestion



Ill. 97. Facade internal garden

Ill. 98. Bastion

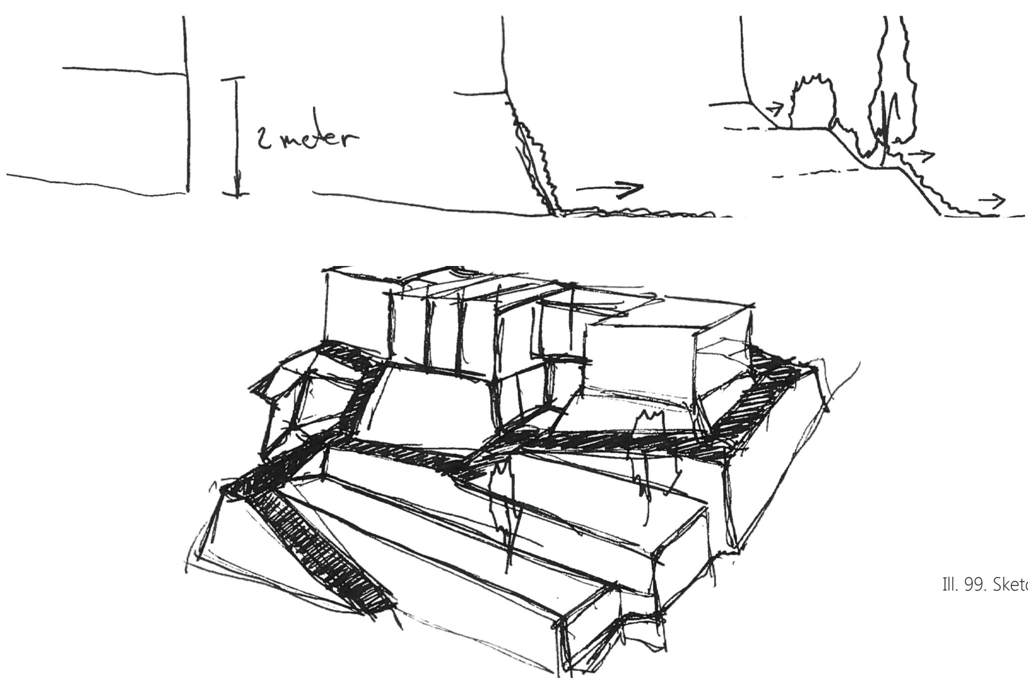
BASTION

BINIDNG THE AREA TOGETHER

The price for introducing accessibility in the building complex is a level difference towards the east; this barrier does not correspond to the idea of interacting with the surroundings, and prevents the user from occupying the nature. It is therefore needed to process this area further

With inspiration from Frederiksberg castle and its garden, an iterative process where made. The bastion should be capable of transferring the users safely towards the lower level, therefore a ramp is included in the design which meets all of the demands according to rise percent (Sbi, 2014,) By introducing different function to the bastion, it will increase in volume but it will also become something more than just a transfer zone letting people go from a to b. These functions should follow the height of the ramp; this creates a series of plateaus, and can be occupied by the inhabitants of the building. These plateaus should have different functions, like the internal garden, except for the playground. At the bottom of the bastion a water mirror is placed, this softens the massive concrete, but also to illustrate the use of the local water reservoirs.

This stepping down in size and shape is also a picture of the decrease in scale, function and the sophisticated idiom. It would therefore be a natural to have the same decreasing aspect in the biodiversity; the nature will therefore be invited into the complex creating a symbiosis of the two worlds, and binding them together. This prepares the users for their next experience.



Ill. 99. Sketch bastion

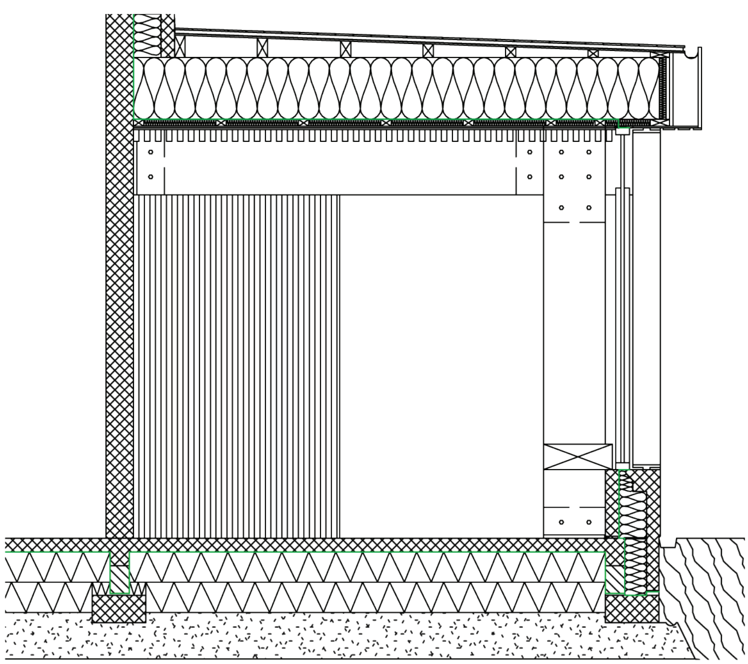
CONSTRUCTION DETAIL

ROOF

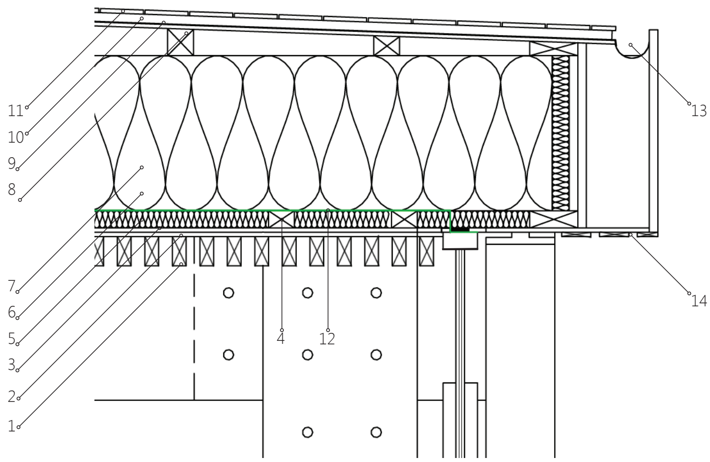
1. Strip of wood 40x85mm, cc 80mm
2.Acoustic board 12,5mm
3.Obs board 12,5mm
4.Batten of wood 50*75mm, cc 600mm
5.50mm of insulation
6.450mm of insulation
7.Beam of wood 450x54mm, Finnjoist I-beam
8.Batten of wood with 12,5mm Obs board in a 2 degree angle
9. Asphalt 2mm
10. Strip of wood 25mm
11. Profil panels of wood 12x125mm
12. Vapor barrier
13. Gutter
14. Profil panels of wood 12x85mm

FLOORING AND FOUNDATION

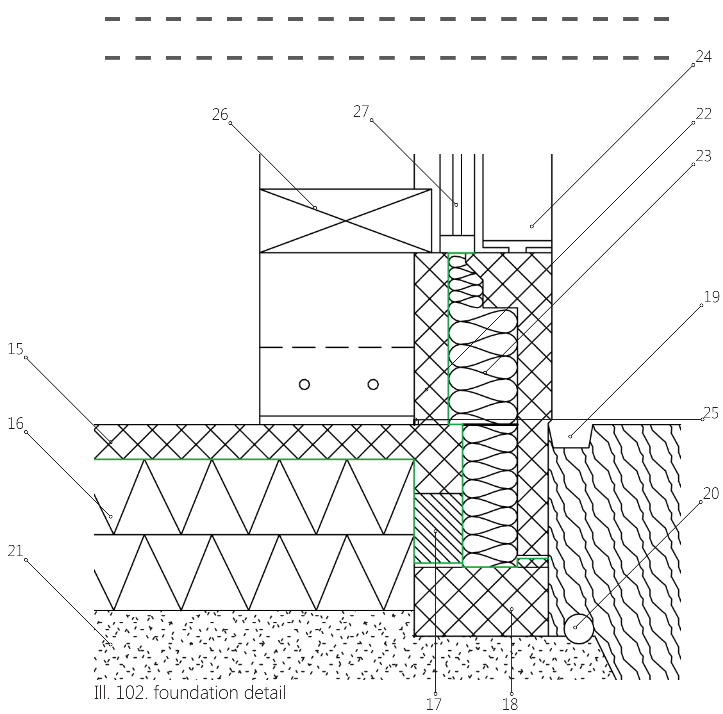
15. Concrete flooring 100mm
16. 2x220mm of insulation
17. Foamglass block 140x190mm
18. Foundational concrete
19. Ground gutter
20. Drainage
21. Compressed sand deck
22. Cast concrete 100mm
23. 200mm of insulation
24. Lamellas 40*280mm
25. Rubber crevice
26. Horisontal beam of timber 185*500mm
27. Window



Ill. 100. Hallway technical section



Ill. 101. Roof detail



Ill. 102. foundation detail

CONSTRUCTION

FRAME, HAND CALCULATIONS AND ROBOT

FRAME

Alongside the aesthetic parameters from previous section, technical considerations have been made according to the structure and its stability. It is decided that the structure should be simple in its expression to interact with the idiom of the building design. A structural system consisting of frames is chosen, as it works well together with the grid system, and it gives the possibility to create a continuous expression throughout the design both considering the tower block and the smaller units.

A frame structure has the capability to obtain forces down through its columns dividing the forces out on the whole structure. and placed statically with bearing walls the construction will be able to obtain forces from all directions and therefore achieve stability (Ill. 108)

A parametric model of the frame were built in grasshopper, where preliminary loads, section and materials where applied to the structure from an aesthetic point of view. From here; different sizes of frames where analysed based on the volumes at the ground level.

The biggest deformation of the different structures were found, this is our critical element, and we must assume if this is capable of resisting the loads, then the rest also will. The element is located in one of the housing units, as this will be the complex with the largest area, and hand calculations were made on this scenario.

It should be said, that focusing on a single segment of the whole building gives us a fake result, as the building is more complex than a mono-pitched squared box. This will have an influence on the wind load as the area will vary from our controlled environment. Therefore the load calculated in the hand calculation (App 3) should be seen as an indicative result

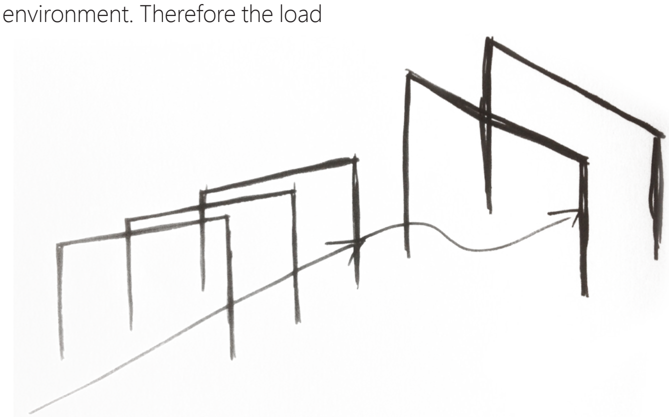
The project seeks to investigate the difference in calculating on a beam and column versus a frame structure. What is the difference in the division of loads, does it has a positive impact according to the dimension of the timber elements? These questions are answered in the hand calculation and the robot analysis in (APP 3, 4)

ROBOT

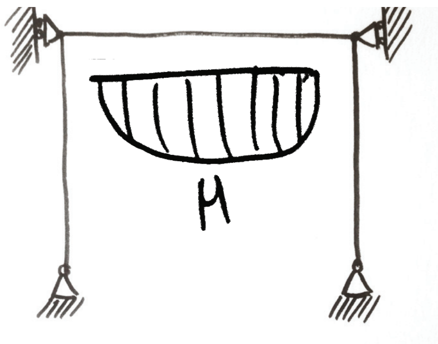
A robot model of the structure where made to analyse frame structure. This were done according to the loads and dimensions from the hand calculation. This makes it possible to compare the two results, but before this is done, robot should be configured correct

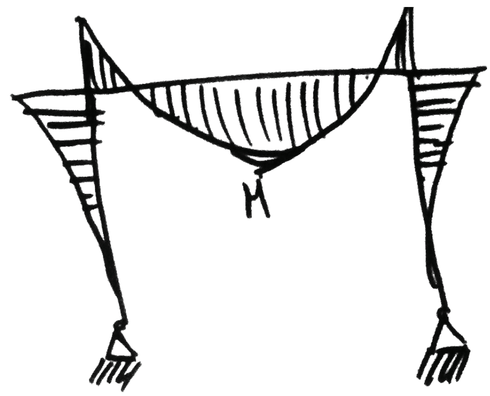
The model is build up in robot where decision considering the load combination, classification, duration of loads, and the dimensions of the beam should be made. Afterwards it is ready for calculations

Robot shows that the construction has over dimensioned elements when using the result from the hand calculation, due to the utilization ratio. This is because the frame structure is a self-supporting system which distributed the forces in its structure (Ill .105) this will be further explained in the (APP 4) but you can see the before and after result of a frame structure and a separate structure to the right (ill.103) . the two robot results is also illustrated (Ill. 105,106,107)



Ill. 103. frame system sketch





Ill. 104. forces diagram for beam, column and the frame

Member		Section	Material	Lay	Laz	Ratio	Case
1 Timber Member	OK	185*567	C24	48.88	149.80	0.05	4 COMB1
2 Bjælke_2	OK	185*567	C24	45.34	154.41	0.08	4 COMB1
3 søjle_3	OK	185*567	C24	36.66	112.35	0.07	4 COMB1

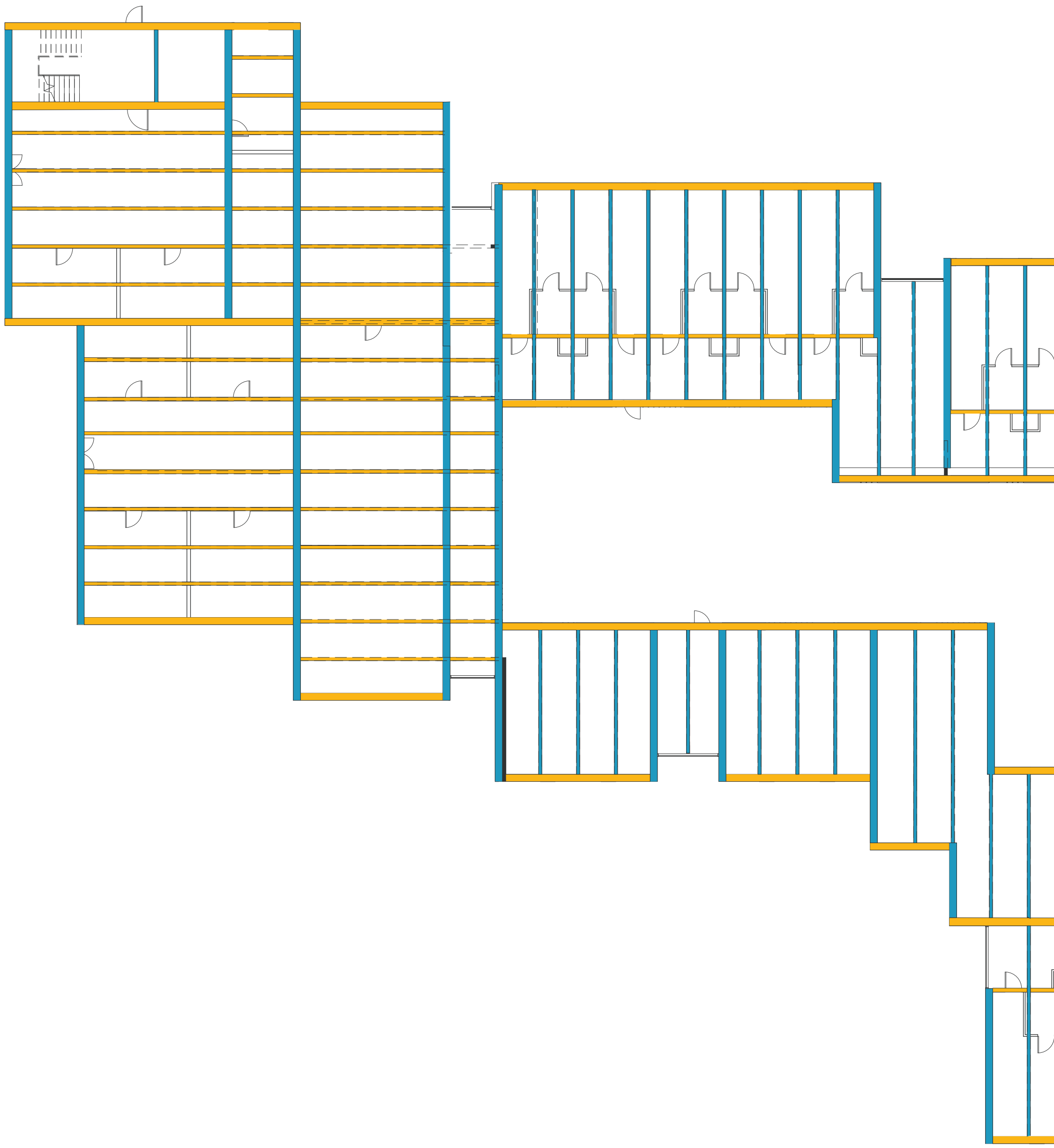
Ill. 105. Robot result with dimension from hand calculations

Case 4 (C)	COMB1		
Sum of val.	-1,58	35,83	-0,00
Sum of reac.	-1,58	35,83	-139,89
Sum of forc.	1,58	-35,83	139,89
Check val.	0,0	0,00	0,0
Precision	2,10646e-014	1,20641e-028	

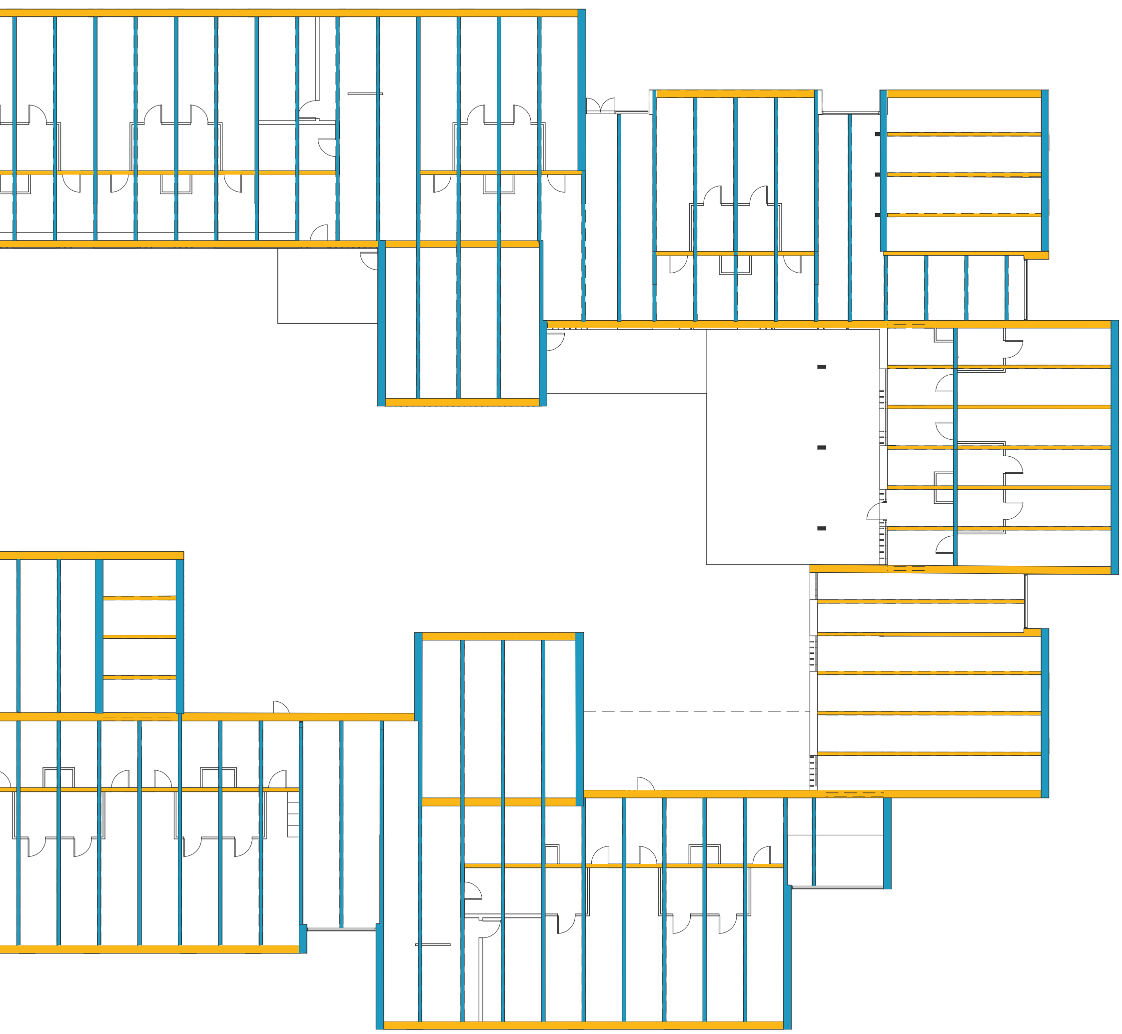
Ill. 106. Robot result - reactions

Member		Section	Material	Lay	Laz	Ratio	Case
1 Timber Member	OK	140*367	C24	75.51	197.95	0.17	4 COMB1
2 Bjælke_2	OK	140*367	C24	70.05	204.04	0.22	4 COMB1
3 søjle_3	OK	140*367	C24	56.63	148.46	0.22	4 COMB1

Ill. 107. Robot result - final dimensions



Ill. 108. diagram that shows stability in the structure



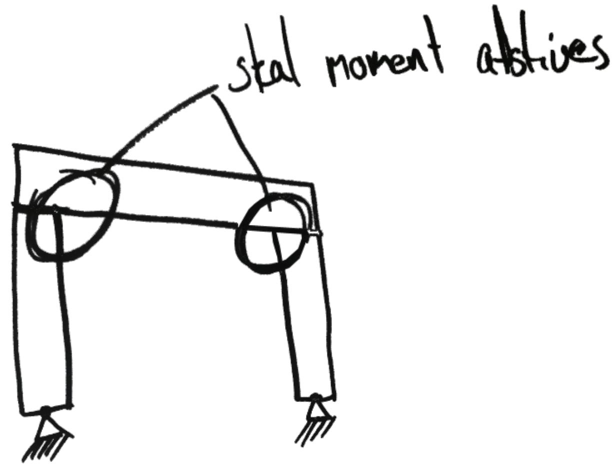
JOINTS

SUPPORTS, AND RESTRAINS

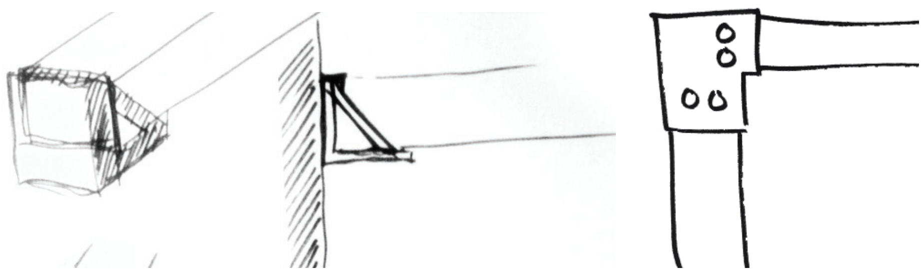
Tectonic has been a part of this project, working with the thoughts of truth to material, structure and the adoring of joints. As the structure in the design is simple humble and barely changes throughout the plan, it needs a joint that is identical in its idiom both aesthetically and technically.

The frame structure is hinged in the two bottom point. it is a rigid structure that resist moment forces. This should therefore be implemented in the creation of the joint. There was a desire to provide the frame structure with an exterior, visible joint that is capable of resisting the moment forces. But as it was realized during the process, steel is not that good of withstanding heat that is accumulated during a fire, and the structure would therefore weakens fast during a fire. This left the design with two options, one was to create the joint out of wood, and the other was about covering the steel with the timber elements to use the timbers own natural protection against fire.

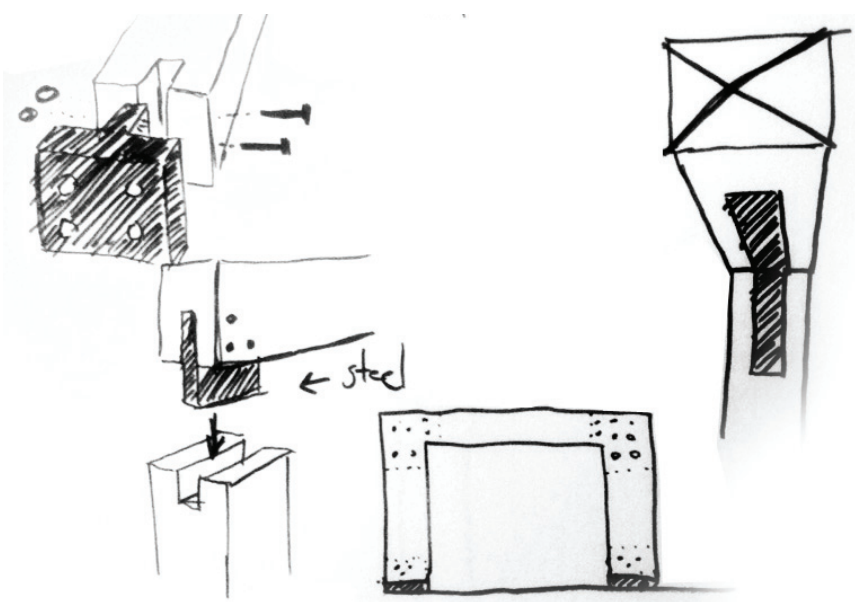
To avoid having a too heavy timber joint in the structure design, it was chosen to fit the joint in between the timber elements, protecting the steel structure with the surrounding timber. This solution also gives the possibility of showing the joint in a much more delicate way, as it would be possible to view a small slice of metal between the timber elements. To fasten the steel joint to the timber elements, steel bolts are penetrating the whole sandwich construction and bolted together on both sides. (Ill 111)



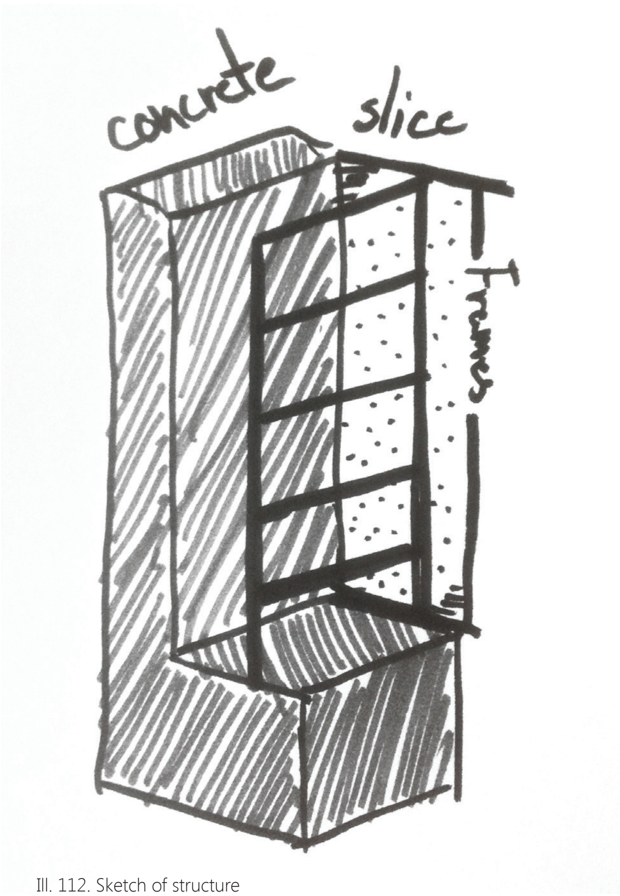
Ill. 109. Free body diagram



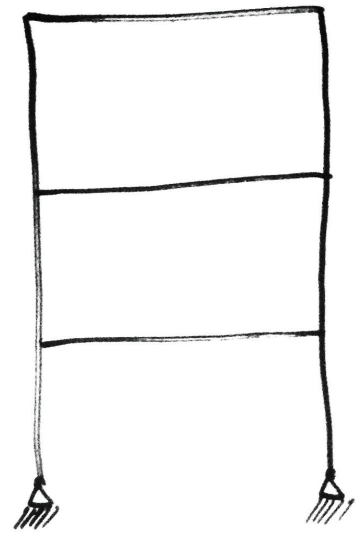
Ill. 110. Different exterior joints

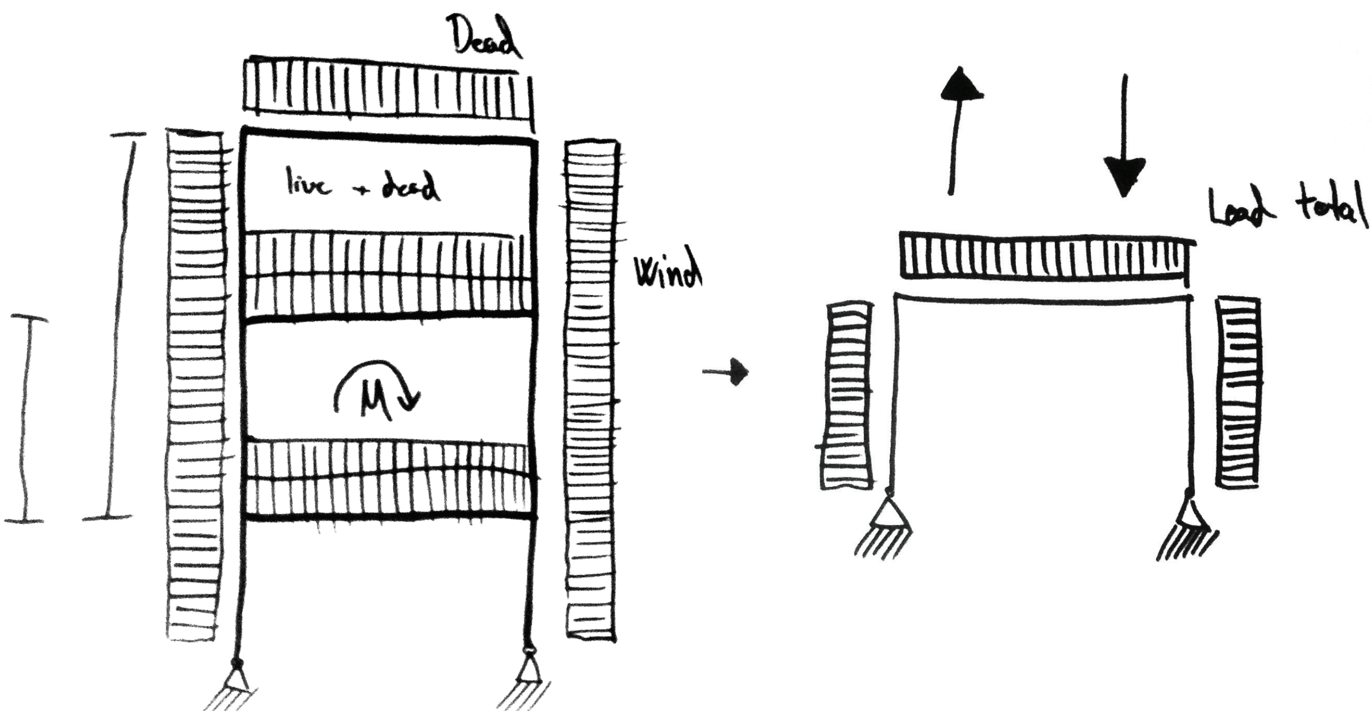


Ill. 111. Interior and final joint



Ill. 112. Sketch of structure


Ill. 113. Free body diagram tower



Ill. 114. Forces diagram

TOWER

CONCEPTUAL THOUGHTS

One of the key words to dimension a tower block must be simplicity. Basically the tower block in this case consists of several frames stabled on top of each other (ill. 112, 113). The characteristic and designed permanent loads, wind, snow and live are then applied to the whole structure.
As the tower block consists of stabled frames, we want to dimension the one frame with the largest load, which is the bottom frame; this is due to the increasing amount of forces that is transferred from the structure above (Ill. 114). The construction will be pinned in the bottom and then be made resistant to moment in the top and the joining of stabled frames.

When calculating the loads it is a little different from the other calculation. Because of the building height the consequence class is set to high CC3 which has an influence on the different partial coefficients according to the permanent and variable loads. This in the end helps us over dimension our construction

Another aspect that is changed is the fact we have to apply live load to the construction and that we now are calculating on a tall building which will change the way we calculate wind loads. When this is taken into consideration, the calculations should be the same as earlier

When all loads are decided the following diagram can be established, our goal is to find the amount of moment forces the lower frame should be able to resist. This is done by multiplying the half of the height above the bottom frame with the amount of loads (ill. 114).

If the moment then is multiplied with the length of the beam element in the frame, we will get a new force diagram of the frame where the direction of forces is changed. (ill. 114).

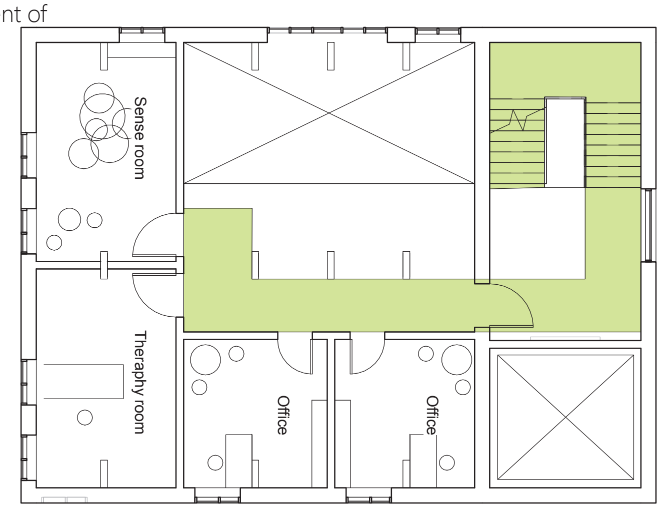
EMERGENCY PLAN

IN CASE OF FIRE

Escape routes, doors and other openings are placed according to the fire demands. The distance can in this project exceed the allowed 25 meters from a person to an opening towards the outdoor; in this case this will be compensated for, by having wider doors and escape routes in comparison with the number of users, and there is an internal garden that gives the users the possibility to escape to a safe section. The plan of the building is suitable for dividing the complex into smaller fire cells and sections, which gives the users the possibility to escape to a safe place in case of fire. In the critical rooms concerning common kitchen is there a minimum of three escape doors. (BR15 2014,)

When considering the tower, the concrete core will be one big escape zone, and as the tower is above 22 meters the elevator also will functions as an elevator for the firefighters and is well dimensioned to bring the needed equipment. The staircase is dimensioned to 1.5 meters instead of the demands of 1, 3 meters. There is no need for two escape stairs as the number of people won't excess the limitations of the staircase, and the distance to this won't exceed 25 meters. In the concrete core windows will be placed to make it possible to be visible for the firefighters. From the staircase a door directly towards the outdoor is placed in the level of the topography. (BR15 2014,)

A fire plan has been made and it shows the placement of the escape routes, see (ill. 115, 116)



Ill. 115. Fire plan tower

Ill. 116. Fire plan ground level

ASSESSMENTS

The objective in this project was to create new boundaries for a patient hotel, which embraces children and their relatives and their psychologically and physiologically disorders. The main vision for this project was to lower the hospitalization time. This gives the project the possibility to investigate in children's social, and physiologically problematics when being hospitalized. This resulted in a development of a design solution that encourages to socialize and to be active.

In the design solution, there has been a showdown with the old norms when thinking of a patient hotel. The hallways have been implemented in the functions instead of just being and transition between them. Now it exalts the quality of the overall impression, as it has been giving the function of being there area where relations occurs. The feeling of being on an institution has been removed, and replaced with the comforting feeling of being home, as to minimize stress. Being home equals to the feeling of being safe and secure. Therefore this aspect has been a huge part of the project, it is seen in the internal garden, the accessibility and in the nearness of the medical staff that is placed in the tower block.

The project has been divided into different privacy zones, this is done to degrade the pace of the environment and to prepare the inhabitants for their next experience. It is also done to create a barrier between the feeling of home and the feeling of being to a consultation in the tower block.

Tall biodiversity surrounds the complex, but the project embraces this by inviting the nature to grow on the facades to create the illusion of being a ruin within the landscape, with a single tower growing like the trees towards the sky's creating a view over the treetops, that can be used for meditation and sensing. This symbiosis with the surrounding nature is a very Nordic approach to architecture and brutalism, which is the idiom of the building due to the tactility of concrete and that it is collaborating with the nature, the pedagogic approach and the feeling of being safe.

The structure and the construction of the complex is simple and visible in its expression, the same elements are consistent throughout the building design which creates an easy readable construction in a tectonically manner.
Materials in the design has been a dominating factor according to pedagogies it has been used as a silent pedagogue shaping the children's behavior and guiding them through the different functions of the complex, by letting them touch and feel different materials and textures. This is done as young children are learning through their senses.

To finally conclude on this project it can be said, that the project in theory achieved to implement the thoughts of healing architecture, pedagogic, tectonic, Nordic architecture and brutalism, to minimize the hospitalization time for children and their relatives. The real result though might not be the same as there are many parameters to this issue, and the only way to analyse the results is to ask the patients or to observe the hospitalizations, and use those answers to create evidence-based results. But from the already existing result that this project is made from, we must assume that this is successful.

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Ill. 47-77: Own illustration

Ill. 78. Lavander, 2014. Available at: https://atthemanse.files.wordpress.com/2014/07/doriss-lavender-e1405433539524.jpg [18-05-2015]

Ill. 79. Concrete tile, 2014. Available at: http://www.hartstonetile.com/wp-content/uploads/2014/03/

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Ill. 80. Water mirror, 2015. Available at: http://www.friis-moltke.dk/getimagevarintranet.asp?id=1585&w=724&h=543&type=D [18-05-2015]

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Ill. 84: Own illustration

Ill. 85. Smooth white oak. Available at: http://www.elmwoodreclaimedtimber.com/sites/default/files/styles/hero_image/public/hero-gallery/White-Oak-Paneling_1.jpg?itok=hNg0BzHx [20-05-2015]

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Ill. 95-115: Own illustration

APPENDIX

1 - Helbredende psykologiske faktorer i forhold til børn og unge
2 - Cd including
    - Drawings
    - Interview with Birgit Qvist Lundager
    - Handcalculation
    - Robot Analysis file
    - Master thesis report
3 - Hand Calculation
    - Loads
    - Loads combination
    - Beam dimensioning
    - Column dimensioning
4 - Robot analysis of the frame structure
    - redimensioning
    - conclusion

PSYCHOLOGICAL FACTORS

Helbredende psykologiske faktorer i forhold til børn og unge

Tryghed
= normalitet, hjem — lighed, "børnehøjde" og plads til overnatning af mindst en' forældre på stuen samt fællesrum med plads til besøg af hele familien medtænkes i afdelingernes udformning og indretning.

Fællesskab
= almengørelse af sygdom som almindeligt forekommende (du er ikke alene) og mulighed for at finde støtte i fællesskabet = afdelingernes udformning og indretning lægger op til, at fællesskab mellem børn, forældre og personale er prioriteret i form af eks. fleksible stuer med skydedøre og gode fællesrum.

Nærhed
= Alle typer personalegrupper er synlige og opleves tilgængelige, så børn/unge og forældre oplever en fortrolighed ved kontakt.

Ro
= alle syge børn og unge har i forskellig grad brug for skærmning og er sarte overfor overstimulering = afdelingernes udformning og indretning giver mulighed for at være alene med en' forældre.

Leg og bevægelse
= afdelingernes udformning og indretning fremmer leg, bevægelse og aktivitet (og minimere passivitet) Der er mulighed for at være udendørs.

Lys
= fremmer optimisme, giver energi = lyse rum og mulighed for at være udendørs.

Neonatal børnene har i særlig grad behov for ro og skærmning ligesom det også i forhold til disse børn er vigtig med forældretilstedeværelse

Psykologgruppen, børneafdelingen, Ålborgsygehus.

CD

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HAND CALCULATION

LIMITATIONS

The structure of the roof isn't detailed according to load; therefore it is set to a standard value of 0.3 KN/m2 this is due to the focus on the bearing elements. The hand calculations are made on the basis for a separated structure and at first dimensioned according to this. Another more crucial mistake is that, when calculated on the columns in the common room, the loads from the smaller housing complex were used. This is not correct, but it is assumed that the construction is over dimensioned by the use of these, as there is a large difference in the surface area, the bigger area, the bigger load.

FREE BODY DIAGRAM

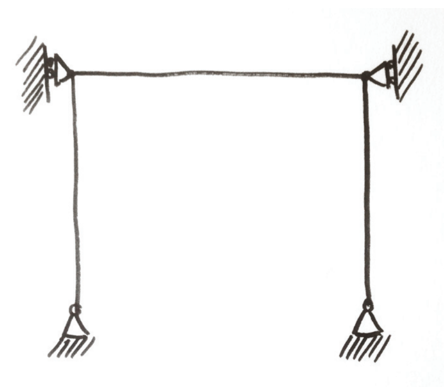
The structure will be considered in a two dimensional point of view, as the project is working with frames, distanced two meters from each other. The frame consists of a beam and two columns, anchored in two points. Both of these are a hinged supports this gives the structure the possibility to rotate around the y-axis, and eliminate their bending moments.

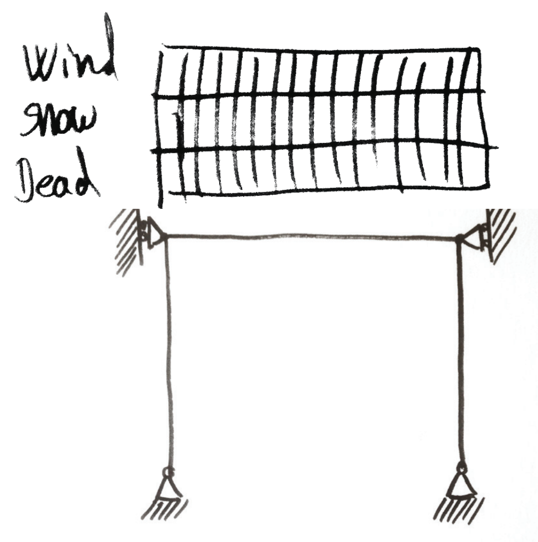
LOADS

In the following part, the different loads will be hand calculated and a combination of these will be made with the dominating load. Formulars and numbers have been found using Eurocode: DS-EN_1991-1-1,1-3,1-4.

DEAD LOAD

The roof structures dead load is 0.3 kN/m2 (limitations), but the dead load of the structure is still needed it is therefore calculated for each element by the use of the equation (ill. 3) this is then added to the 0.3kN/m2 which gives a total dead load of: 900mm*185mm*8830mm*510kg/m3*9.82kN/m2 = 7.65kN/m2





$$G = h \cdot w \cdot l \cdot \rho \cdot e$$

Where:

$$h = height\ of\ element = 900mm$$

$$w = width\ of\ element = 185mm$$

$$l = length\ of\ element = 8830mm$$

$$\rho = densit\ of\ material = 510 \frac{kg}{m^3}$$

$$e = gravitational\ constant = 9.82 \frac{kN}{m^2}$$

Ill. 3

SNOW LOAD

By the use of the equation from (ill. 4) the snow load is determined. And because the angle of the roof is less than 30 degrees the total snow load is:

0.8*1.2*1*0.9 = 0.864kN/m2

$$S_0 = \mu_i \cdot C_e \cdot C_t \cdot S_k$$

$Where:$

$\mu_i = form\ factor,\ depending\ on\ roof\ angle\ \alpha$

$0^\circ < \alpha < 30^\circ = 0.8$

$30^\circ < \alpha < \frac{60^\circ = 0.8 \cdot (60 - \alpha)}{30}$

$\alpha > 60^\circ = 0$

$C_e = Exposure\ factor = 1.2$

$C_t = Thermal\ factor = 1$

$S_k = Characteristic\ terrain\ value = 0.9 \frac{kN}{m^2}$

Ill. 4

WIND LOAD

Basis wind speed velocity

The basis wind speed velocity can be defined as the connection between direction and seasonal parameters; it defines the basic velocity in ten meters height over ten minuts. Which in this case is defined by the formel (ill. 5) at the result is:

24m/s*1*1 = 24

$$v_b = c_{dir} \cdot c_{season} \cdot v_{b0}$$

$Where:$

$v_{b0} = avarage\ wind\ speed\ Denmark = 24 \frac{m}{s}$

$c_{dir} = direction\ factor = 1$

$c_{season} = season\ factor = 1$

Ill. 5

Main wind velocity

Defining the main wind velocity on the building is done by defining roughness of the terrain. This is found by giving the terrain a category 1-4 where one is described as sea or flat area, without any vegetation and type four is an area where 15% is covered with buildings that exceeds and average height of 15meters. In this case the site is located in a category three. And as the site is located in the center of Jutland we must assume that the basic wind speed value is 24m/s by this it is possible to calculate the main wind velocity from the formula (ill. 6):

vm(z) = 0.55*24*1= 13.18m/s

$$v_m(z) = Cr(z) * C_0(z) * v_b$$

$Where:$

$C_0 = orography\ factor = 1$

$C_r(z) = roughness\ factor$

$C_r(z) = k_r * In(z / z_0) = 0.19 * ln(5.4m / 0.3) = 0.55$

$z = building\ height = 5.4m$

$k_r = terrain\ factor$

$k_r = 0,19 * (z_0 / z_{0,III})^{0,07} = 0.19(0.3/0.3)^{0.07} = 0.19$

$z_{0,III} = roughness\ length = 0.3$

$z_0 = roughness\ length = 0.3$

$z_{min} = minimum\ height = 5m$

$z_{max} = maximum\ height = 200m$

Ill. 6

Turburlence intensity

When calculating on wind it is important to take its turbulence intensity into consideration, it is a factor that defines the spread of the wind divided by the mean velocity, which is: 13.18m/s. by this the wind turbulence is calculated from the following (ill. 7 p. 110):

Iv(z)=0.35

Peak velocity pressure

Wind is capable of creating gust for a short period of time or also called peak velocity pressure, which gives a peaking pressure on the facades that needs to be put into the overall equation of calculating the windloads. This is calculated by the formula (ill. 8) and the result is:

qp(z) = 0,43kN/m2

Wind pressure on surface

Defining the wind pressure on any given facade of the construction is possible by multiplying the peak pressure with a form factor that is decided by the form of the construction; in this case a mono-pitched roof. It is also defined by the location on the surface, where the wind is striking, and the angle of the roof. As wind is affecting the surfaces in different areas, is important to take this into consideration which is done to according (ill. 9). The pressure of the different zones are calculated by the formular (ill. 10)

Afterwards it is possible to calculate the different areas of the different zones, and then calculate it with the wind pressure and a structural factor to get the wind force of each zone (ill. 11). The sum of the zones equals the final wind load of the construction = -2.51Kn/m2

by isolating a building element from the complex, we gain some false results, and we therefore assume that the real results is greater than calculated, since the selected section actually has a larger area that affects it and its different zones. this causes a change in the distributing of areas and forces.

$$I_v(z) = \frac{\sigma_v}{v_m}(z) = \frac{k_l}{\left(C_o(z) * ln\left(\frac{z}{z_0}\right)\right)}$$

$$\begin{aligned}
&Where:\\
&k_l = \text{turbulence factor} = 1\\
&C_o = \text{Orography factor} = 1\\
&z_0 = \text{roughness factor} = 0.3\\
&\sigma_v = kr * vb * kl = 0.19*24*1 = 4.56
\end{aligned}$$

$$I_v(z) = \frac{\sigma_v}{v_m(z)} = \frac{4.56}{13.18m/s} = 0.35$$

Ill. 7

$$qp(z) = \left(1+7*Iv(z)\right) * 0.5*\rho*vm2(z) = Ce(z) * qp$$

$$\begin{aligned}
&Where:\\
&\rho = \text{air density} = 1.25kg/m^3\\
&C_e(z) = \text{exposure factor} = 1.2\\
&C_e(z) = \frac{q_p(z)}{q_p}
\end{aligned}$$

$$\begin{aligned}
&q_p = \text{basic velocity}\\
&q_p = 0,5 * \rho * v_b^2 = 0.5*1.25kg/m^3*24^2 = 360kg/m^3
\end{aligned}$$

$$\begin{aligned}
&q_p(z) = \left(1+7*I_v(z)\right) * 0.5*\rho*v_m^2(z) = 0.43\\
&q_p(z) = Ce(z) * q_p = 0.43
\end{aligned}$$

Ill. 8

$$w_e = q_p(z_e)*C_{pe}$$

$$\begin{aligned}
&Where:\\
&z_e = \text{reference height for external pressure}\\
&C_{pe} = \text{Pressure coefficient for external pressure}
\end{aligned}$$

Ill. 10

$$F_w = C_s C_d * \Sigma w_{e,zone} * A_{ref,zone}$$

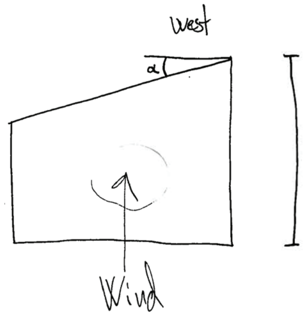
Where:

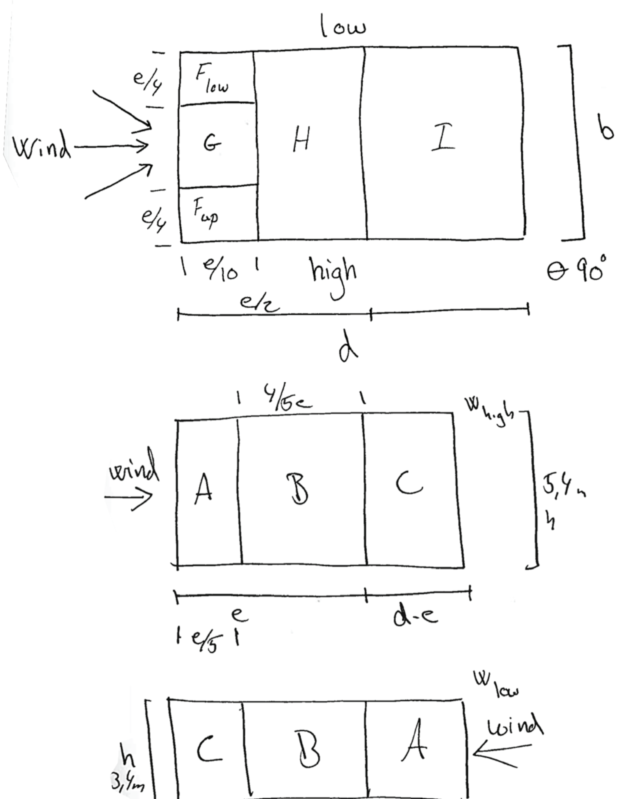
$C_s C_d = $ *Sttructural factor* $= 1$

$w_{e,zone} = $ *Wind pressure on surface*

$A_{ref,zone} = $ *area of zone*

Ill. 11





Ill. 9

LOAD COMBINATION

From earlier section, the three different loads; wind, dead and snow load were found, now I want to find out how they combined are affecting the construction. This is done by creating a load combination. It is done by the use of the following formula (ill. 12). In Denmark, the dominationg load is snow load, and the non-domination is wind. To combine the loads it is needed to decide the partial coeffienct that needs to be multiplied with each load, to "over dimension" these. The partial coeffienct are found in "Teknisk ståbi" page 163, Table 4.1 - formula 6.10b2. The final result for the load combination is:

(1*1*7.65)+(1*1.5*0.16)+(1*1.5*0.3*2.51)= 9.02kN/m2

BEAM DIMENSIONING

When dimensioning a timber beam, you need to make some choices concerning the type of timber, the consequence class and the beams environment concerning the conversion factor that is needed when going from characteristic to designed numbers. In this case GlueLam 32 h is choosen and its concequence class is 2. The dead load has already been calculated. the only thing that is missing is our conversion factor that is found by the formula (ill. 13) which is:

0.462/1.3=0.355

SLS (servicability limit state)

The first step is now to find our SLS (serviceability limit state), which is done by defining the maximum allowed deformation of the beam found by the formula (ill 14). From here it is possible to determine the minimum moment of inertia that is needed to comply the maximum deformation (Ill. 15). By the use of (Teknisk ståbi p. 318 table 7.6) a dimension of the beam is found with a corresponding inertia, it must though be higher than the already found inertia; this makes it possible to calculate the deformation from the chosen dimension (ill 17).

Which is = 17.63mm

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

$$Where:$$
$$K_{FI} = consequence\,class\,CC2 = 1$$
$$\gamma_{G,j} = dead\ load\ coefficient = 1$$
$$G_{k,j} = dead\ load = 7.65$$
$$\gamma_{Q1} = dominating\ load\ coeffiecnt = 1.5$$
$$Q_{k1} = dominating\ load = 0.16$$
$$\gamma_{Q,i} = non-dominating\ load\ coeffienct = 1.5$$
$$\Psi_{o,i} = reductionfactor = 0.3$$
$$Q_{k,i} = non-dominating\ load = -2.51$$

Ill. 12

$$Consequence\,class, CC2 = 1$$
$$Dead\ load\ beam = 7.35\frac{kN}{m2}$$
$$Length\ of\ beam = 8830mm$$

$$GluLam, GL32h:$$
$$Strength\ figures:$$
$$f_{m,d} = 32MPa$$
$$f_{v,k} = 3.8MPa$$
$$f_{c,90,k} = 3.3MPa$$
$$E_0 = Stiffness,\ fiber\ direction = 13700$$
$$\rho = Density,\ mean\ value = 510\frac{kg}{m^3}$$

$$k_d = \frac{k_{mod}}{\gamma_m} = 0.355$$
$$k_{mod} = 0.462$$
$$\gamma_m = 1.3$$

$$p = load\ combination\ without\ dead\ load\ ofbeam = 7.41$$

Ill. 13

$$U_{max} = \frac{1}{500} \cdot L = \frac{1}{500} \cdot 8830 = 17.66mm$$

Ill. 14

$$I = \frac{5 \cdot p \cdot L^4}{384 \cdot E_0 \cdot U_{max}} = \frac{5 \cdot 7.41 \cdot 8830^4}{384 \cdot 13700 \cdot 17.66} = 2426 * 10^6 mm^4$$

Ill. 15

$$Beam\,dimensions$$
$$Width = 160mm$$
$$Height = 567mm$$
$$Moment\ of\ inertia.l_y = 2430 \cdot 10^6 mm^4$$
$$Resistance\,moment.W = 8560 \cdot 10^3 mm^3$$

$$\rho_{12} = mean\,density\,GluLam = 510 \frac{kg}{m^3}$$
$$V = volume\,of\ beam = 0.8m^3$$
$$e = acceleration\,of\ gravity = 9.82 \frac{kN}{m^2}$$
$$Dead\ load\,, G = \rho_{12} \cdot V \cdot e = 4.01 \frac{kN}{m}$$

$$Bending.U$$
$$U = \frac{5 \cdot \rho \cdot L^4}{384 \cdot E_0 \cdot I} = \frac{5 \cdot 7.41 \cdot 8830^4}{384 \cdot 13700 \cdot 2430 \cdot 10^6} = 17.63mm$$
$$U_{\max} \geq U$$
$$17.66 \geq 17.63 \qquad OK!$$

Ill. 16

ULS (Ultimate Limit state)

Earlier we calculated the deformation (SLS) for our chosen beam, now we want to find out if it breaks when it is deformed by the load. This is done by a ULS (Ultimate limit state) calculation. To avoid the breaking the tensions has to be smaller than the designed strength figure for glulam (ill 17)

To do this, the first thing is to calculate the designed strength figure by the formula (ill 18) by the use of the characteristic strength figures of the materials. Then we calculated the conversion factor Kd for both permanent and variable loads. Then we are able to calculate our designed strength figure, which are:

Fmd(V)=20.8MPa
Fmd(P)=11.52MPa

As we are adding the forces in a 90 degree angle on the beam, we must assume that the most possible break in the beam will happen by moment forces. Therefore we will calculate these (ill 19). and the result is:

Mmax(v)=82.2kN/m
Mmax(p)=74.54kN/m

It is now possible for us to calculate our tension of the beam when the loads are applied it is done by the formula (ill. 20) and the results for the two load cases compared to the designed figure are as follows:

$$\sigma_V \leq f_{md,V} = 9.6MPa \leq 20.82MPa \qquad OK!$$

$$\sigma_V \leq f_{md,V} = 8.71MPa \leq 11.37MPa \qquad OK!$$

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

Ill. 17

$$f_{md,V} = f_{mk} \cdot k_d \cdot k_h = 32 \cdot 0.65 \cdot 1 = 20.8MPa$$

$$f_{md,P} = f_{mk} \cdot k_d \cdot k_h = 32 \cdot 0.36 \cdot 1 = 11.52MPa$$

$$f_{mk} = 32$$

$$k_{d,V} = \frac{k_{mod,V}}{\gamma_m} = 0.65$$

$$k_{d,P} = \frac{k_{mod,P}}{\gamma_m} = 0.36$$

$$k_{mod,\,V} = 0.846$$

$$k_{mod,\,P} = 0.462$$

$$\gamma_m = 1.3$$

$$k_h = height\ effect,\ h > 600mm = 1$$

Ill. 18

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

$$q_V = sum\ of\ Variable\, and\ permenant\ loads = 8.43\frac{kN}{m}$$

$$q_P = sum\ of\ permenant\ loads = 7.65\frac{kN}{m}$$

$$l = length = 8.83m$$

$$M_{max,V} = \frac{1}{8} \cdot q_V \cdot l^2 = \frac{1}{8} \cdot 8.43\frac{kN}{m} \cdot 8.83m = 82.2\frac{kN}{m}$$

$$M_{max,P} = \frac{1}{8} \cdot q_P \cdot l^2 = \frac{1}{8} \cdot 7.65\frac{kN}{m} \cdot 8.83m = 74.54\frac{kN}{m}$$

Ill. 19

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

$$M_V = \ moment = 82.2 \cdot 10^3 \frac{kN}{mm}$$

$$M_P = \ moment = 74.54 \cdot 10^3 \frac{kN}{mm}$$

$$\text{W=}resistance\,moment = 8560 \cdot 10^3 mm^3$$

$$\sigma_V = \frac{M}{W} = \frac{82.2 \cdot 10^3 \frac{kN}{mm}}{8560 \cdot 10^3 mm^3} = 9.6 MPa$$

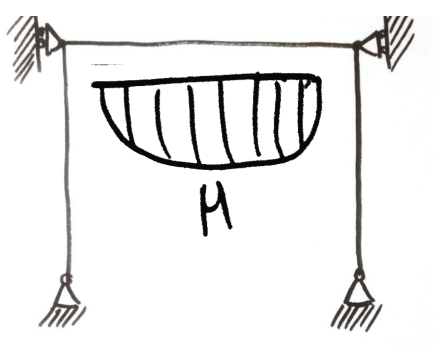
$$\sigma_V = \frac{M}{W} = \frac{74.54 \cdot 10^3 \frac{kN}{mm}}{8560 \cdot 10^3 mm^3} = 8.71 MPa$$

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

$$\sigma_V \leq f_{md,V} = 9.6 MPa \leq 20.82 MPa \qquad OK!$$

$$\sigma_V \leq f_{md,V} = 8.71 MPa \leq 11.37 MPa \qquad OK!$$

Ill. 20



COLUMN DIMENSIONING

From earlier section we were calculating on a beam, to dimension it. In the following section the focus would be on the column and its requirements. The tallest column in the common room on the ground floor is chosen, as it stretches eight meters up. The way to dimension the pillar is again to find the materials strength figures, but this time for columns which means pressure with the fibers and then decide the consequence class and calculate the conversion factor. (Ill 21)

The next step will be to calculate the slenderness ratio of the column as this tells us about the retio between the sectional height and the length of a column, this is used to find the column factor kc by the use of teknisk ståbi p 325, table 7.15. The slenderness ratio is found by the formula (ill 22) and the column factor is:

Kc=0.895

from here on the designed tension of the columns are calcultated for later use in the dimensioning. This is done according to the two different loadcases, permanent and variable+permanent. it is done by the following formula (ill 23) and the result is

Designed Tension P = 9.22MPa
Designed Tension V = 13.82MPa

As we now know our designed tension in the beam, it is possible to define the forces affecting our column by the loads from earlier. And then calculating the moments in the column, this is done by the formula (Ill 24) and the result for the two cases is:

Rp=22.14kN
Rv=40.91kN

It is wished to convert the result for the forces that is affecting the columns from kN to MPA this is done according to the following formula (ill 25) afterwards, it is possible to look at the ratio and see if the column is capable of resist the loads. (Ill 25) and the results show it is capable, but the ratio is very low, which is could be caused by the timbers ability to be strong when the forces are applied in the fibers direction.

$$Consequence\,class = 1(indoor)$$
$$k_{\mathrm{mod},P} = 0.462$$
$$k_{\mathrm{mod},V} = 0.692$$
$$\gamma_m = 1.3$$
$$f_{c,0,k} = pressure\,with\,the\,fiber = 29$$

$$k_{d,P} = \frac{k_{mod,P}}{\gamma_m} = \frac{0.462}{1.3} = 0.36$$
$$k_{d,V} = \frac{k_{mod,V}}{\gamma_m} = \frac{0.692}{1.3} = 0.53$$

Ill. 21

$$l_s = effective\,length = 8000mm$$
$$K_{rel} = determining\ factor = 0.056$$
$$h\ =\ height\,of\ section = 567mm$$
$$\lambda_{rel} = \frac{k_{rel}\cdot l_s}{h} = \frac{0.056\cdot 8000mm}{567mm} = 0.79$$
$$K_c = Column\ factor = 0.895$$

Ill. 22

$$\sigma = k_c k_d f_{c,0,k}$$

$$\sigma_P = 0.895\cdot 0.36\cdot 29MPa = 9.22MPa$$
$$\sigma_V = 0.895\cdot 0.56\cdot 29MPa = 13.82MPa$$

Ill. 23

$$R_A = \textit{load on column}$$
$$M_A = \textit{Moment forces in column}$$
$$q_{1,P} = \text{forces pr. m}^2 = 4.01kN/m$$
$$q_{1,v} = 7.41kN/m$$
$$l_1 = \textit{længden af bjælken} = 8.83m$$

$$R_A = \frac{1}{2}\cdot(q_1 l_1) - M_A\left(\frac{1}{l_1}\right)$$
$$M_{A,P} = -\frac{q_{1,P}l_1^3}{8\cdot(l_1)} = -\frac{4.01kN/m\cdot 8.83m^3}{8\cdot(8.83m)} = -39.10kN/m$$
$$M_{A,V} = -\frac{q_{1,P}l_1^3}{8\cdot(l_1)} = \frac{7.41kN/m\cdot 8.83m^3}{8\cdot(8.83m)} = -72.26kN/m$$

$$R_P = \frac{1}{2}\cdot(q_{1,P}l_1) - M_P\left(\frac{1}{l_1}\right)$$
$$R_P = \frac{1}{2}\cdot(4.01kN/m\cdot 8.83m) - \left(-39.10kN/m\left(\frac{1}{8.83m}\right)\right)$$
$$R_P = 22.14kN$$
$$R_V = \frac{1}{2}\cdot(q_{1,V}l_1) - M_V\left(\frac{1}{l_1}\right) =$$
$$R_V = \frac{1}{2}\cdot(7.41kN/m\cdot 8.83m) - \left(-72.26kN/m\left(\frac{1}{8.83m}\right)\right)$$
$$R_V = 40.91kN$$

Ill. 24

$$\textit{Conversion}$$
$$A_{total} = \textit{section area in mm} = 90720mm^2$$

$$\frac{R_{A,P}}{A_{total}}\cdot 1000 = \frac{22.14kN}{90720mm^2}\cdot 1000 = 0,24MPa$$
$$\frac{R_{A,V}}{A_{total}}\cdot 1000 = \frac{40.91kN}{90720mm^2}\cdot 1000 = 0,45MPa$$

$$\textit{strength verification}$$
$$0.24MPa < 1 \qquad OK!$$
$$0.45MPa < 1 \qquad OK!$$

Ill. 25

BUCKLING

The column is dimensioned and is capable of absorbing the added loads, but another aspect that is important to investigate is buckling, especially when the column effective length is tall. It is a lateral instability characteristic of slender element under axial compression and it occurs where there are small imperfections in the material and therefore causes it to deflect. This is a very essential when building with timber, because of the non-homogenous texture compared to steel.

The easiest and simplest way of finding out if the column has a chance of buckling is to calculate the maximum allowed height of the column by an edited version of Euler's formula (Ill 26)

The result is: 2832.55mm

$$P_{cr} = \frac{\pi^2 E_0 I}{l_1^2}$$
$$\textit{Where:}$$
$$E_0 = \textit{Modulus of elasticity} = 13700$$
$$P_{cr} = \textit{Critical buckling load} = 40.91kN$$
$$I = \textit{Moment of inertia} = 2430mm^4$$
$$l_1 = \textit{Effective length}$$

$$l_1 = \sqrt{\frac{\pi^2 E_0 I}{P_{cr}}} = \sqrt{\frac{\pi^2\cdot 13700\cdot 2430mm^4}{40.91kN}} = 2832.55mm$$

Ill. 26

Postlude

During the a later review of the handcalculation it is found out that the different loads are to high as the loads werent calculated as line loads. for more realistic results see excel files. (APP)

ROBOT STRUCTURAL ANALYSIS

In the hand calculation section the frame was divided up into columns and beams, but is this actually the correct way? A robot model was made from the frame structure built up in grasshopper. We assume that the beam and columns are a rigid system that is capable of obtaining bending moment from the one element throughout the rest of the structure. And we also define our frame as a two hinged framed running through two pinned joints at the bottom. A simple way to define where there is a need for extra material it to draw a parabola that connects the hinges. The corner points and the middle point of the rigid frame will need more material, as it is here there is a large bending moment. The rigid frame has the quality to span over a long distance as it utilizes the bending moments, compared to a single beam with the same dimensions.

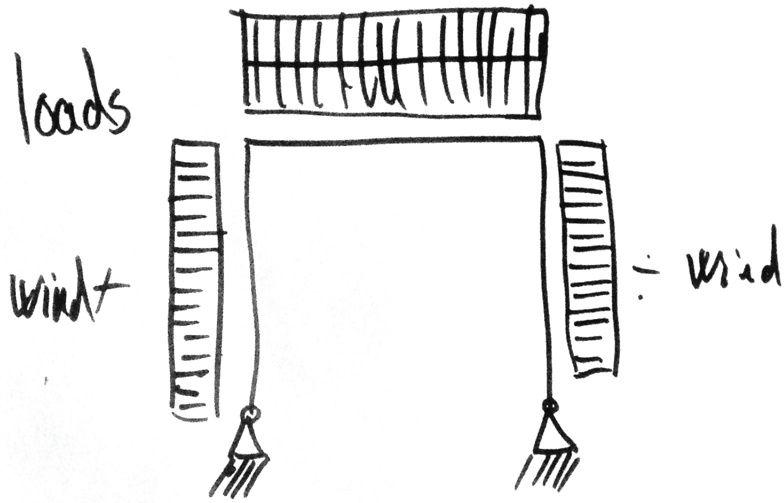
In robot, the different loads and supports are applied and a load combination is made. Basically the same thing we did in the hand calculation. Afterwards the structure is added a material with dimensions that correspond to the final dimension of the hand calculation.

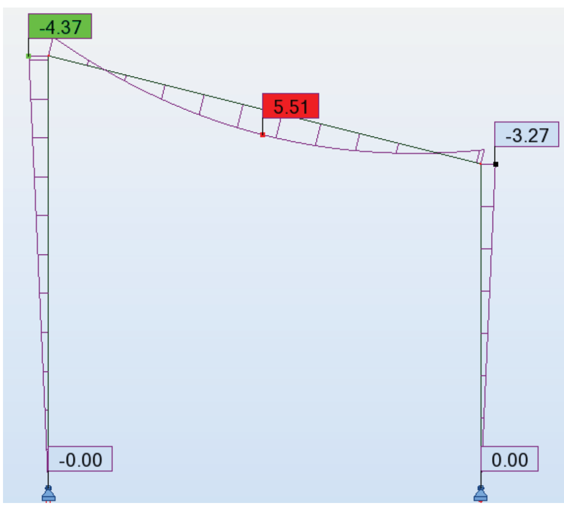
A calculation of this is made to see how well the material is utilized in a frame structure with the dimensions from the hand calculations. The result is that the construction is over dimensioned the utilization ratio should be between 0.1 and 0.9 in this case the result was below 0.1. The construction is also checked according to reactions, which should be equal to the forces. This is investigated to see if the forces are distributed correctly in the structure.

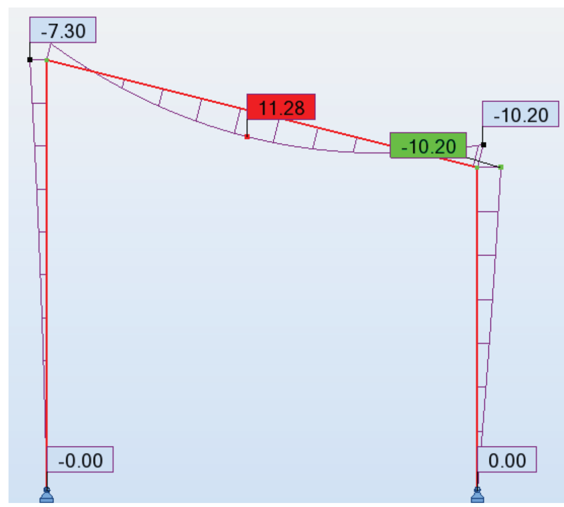
A new calculation was made, with new dimensions of the elements and this time, the ratio is between 0.1 and 0.9. The result is still quite low. This shows that the structure can be even more slender, but we also have to take buckling and deformation into consideration. Because if optimized to its full the deformation would be 33 mm which is too much. The final result is therefore chosen as a satisfying result.

It can therefore be concluded that hand calculation on two separate elements is not correct as the structure would not benefit from the strength in the rigid frame structure, where the forces is distributed equally out on the whole structure instead of a single element. It should also be said, that doing the hand calculations is a theoretical situation, in a real situation, and the construction would have to consider the amount of imperfection of the material, as this differs from timber to timber. Of course this difference can be reduced by using a homogeneous glulam beam, but there will always be a little imperfection that could weaken the construction compared to steel beams.

These imperfections are places where the column of the frame tends to buckle as this is the weak spots of the element. Therefore is it important not to increase the utilizations ratio to its maximum as this will increase the risk of buckling and deformation drastically and therefore not pass the SLS demands and in the end the structure would fail due to increase in the eccentricity of the loads cause by lateral buckling. This will in the end cause the columns to break.







Member	Section	Material	Lay	Laz	Ratio	Case
1 Timber Member	OK 185*567	C24	48.88	149.80	0.05	4 COMB1
2 Bjælke_2	OK 185*567	C24	45.34	154.41	0.08	4 COMB1
3 søjle_3	OK 185*567	C24	36.66	112.35	0.07	4 COMB1

Case 4 (C)	COMB1		
Sum of val.	-1,58	35,83	-0,00
Sum of reac.	-1,58	35,83	-139,89
Sum of forc.	1,58	-35,83	139,89
Check val.	0,0	0,00	0,0
Precision	2,10646e-014	1,20641e-028	

Member	Section	Material	Lay	Laz	Ratio	Case
1 Timber Member	OK 140*367	C24	75.51	197.95	0.17	4 COMB1
2 Bjælke_2	OK 140*367	C24	70.05	204.04	0.22	4 COMB1
3 søjle_3	OK 140*367	C24	56.63	148.46	0.22	4 COMB1