POULSTRUP SØ
CHILDREN'S HOSPICE

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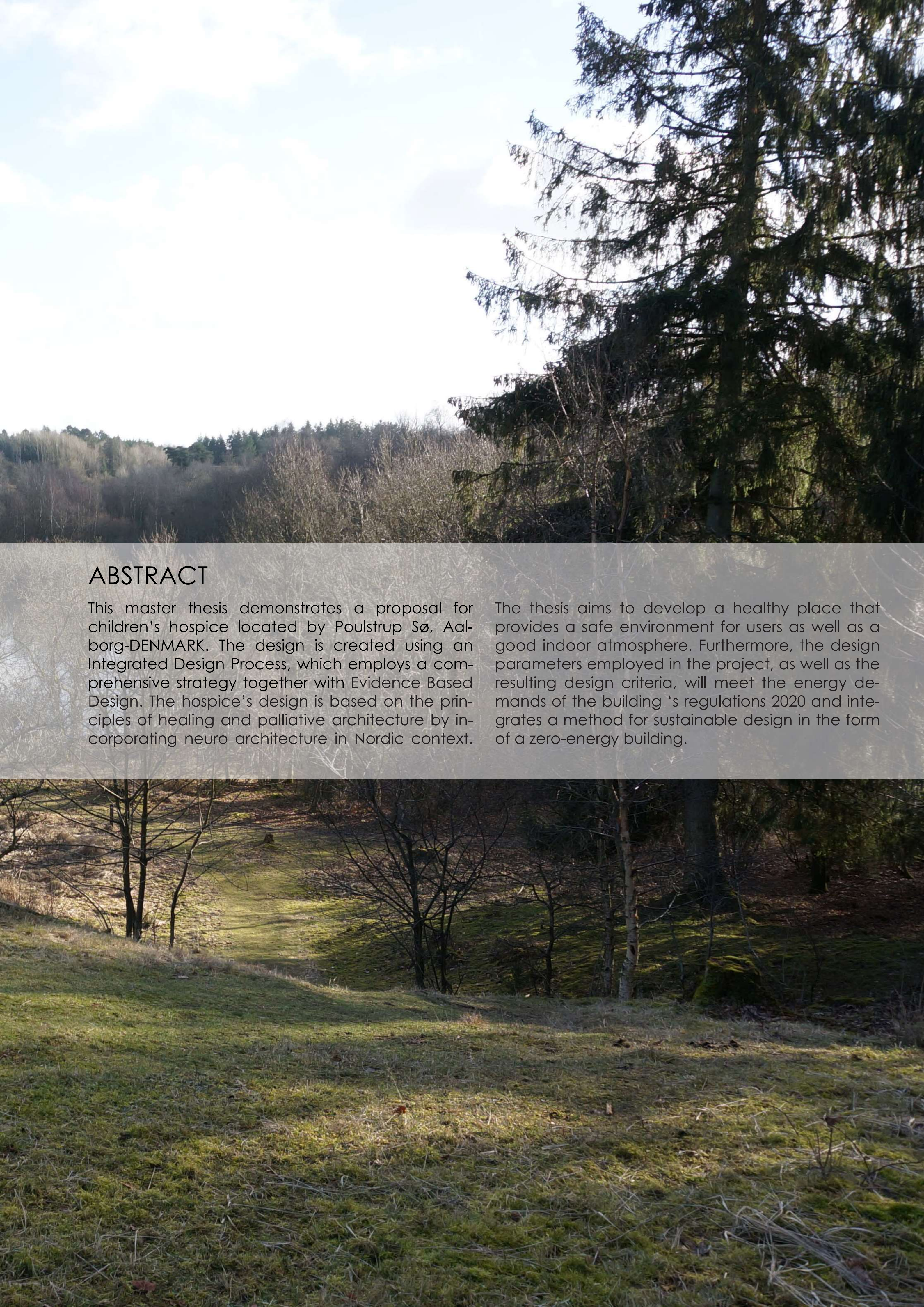


ABSTRACT

This master thesis demonstrates a proposal for children's hospice located by Poulstrup Sø, Aalborg-DENMARK. The design is created using an Integrated Design Process, which employs a comprehensive strategy together with Evidence Based Design. The hospice's design is based on the principles of healing and palliative architecture by incorporating neuro architecture in Nordic context.

The thesis aims to develop a healthy place that provides a safe environment for users as well as a good indoor atmosphere. Furthermore, the design parameters employed in the project, as well as the resulting design criteria, will meet the energy demands of the building 's regulations 2020 and integrates a method for sustainable design in the form of a zero-energy building.

READING GUIDE

This report is divided into chapters. Each chapter has a different focus and look into different aspects of the project. These are introduction, program, design process, presentation, epilogue, and appendix. The project's purpose and its issues are made clear in the introduction. Moreover, using the knowledge gained from this, key parameters were looked up in the program. The numerous design concepts were then formed from the initial thoughts, hand drawings, and ideas. The final design proposal was made based on the analysis and evaluations, and it was given in the presentation stage via conceptual diagrams, plans, detail items, sections, and visualization. The report comes to a close, and in the end, a reflection will evaluate the contentious features of the design, including its direction and the steps that led to its creation.

The finalized list of references and an illustration list are located at the end of the paper, which uses the Harvard referencing method. The list of illustrations, which includes a numbering system and a description of the sources utilized, contains a list of the illustrations.

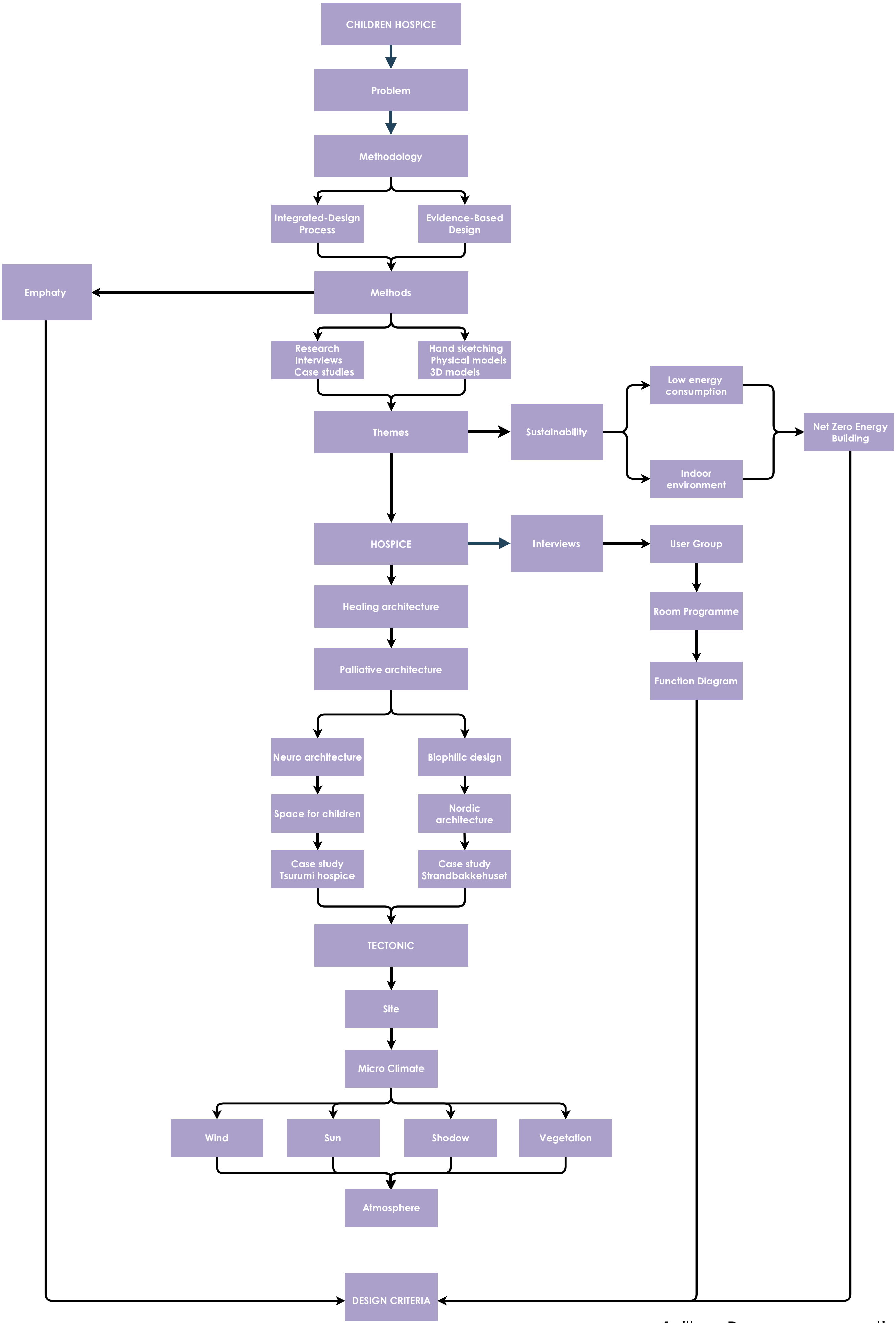
INTRODUCTION

The project aims to design a hospice for children who suffering from life-threatening illness at the age of 0 to 18 years old by focusing on healing architecture. The hospice is going to support six families. Children's Hospice for children with terminal illness and their families that serve as a center where they accommodate to acquire the care and assistance they need while undergoing palliative care. The purpose of the hospice is to create a place that can give more support to children and their families. Nurses and specialists can offer support for the children's physical and mental health which they and their families might be struggling with, during the difficult situation caused by the child's illness. The goal is to improve the quality of life and wellbeing for families while addressing the requirements of the staff.

The location of the site is Poulstrup Sø which is a breathtaking natural environment filled with lakes, marshes, grassland, and forest. The hospice's design incorporates a sustainable design strategy in form of net zero energy building with a focus on healing, palliative, and neuro architecture. The project will meet the energy requirements of the building regulation's 2020 requirements along with these design specifications with a tectonic-integrated approach.

PROBLEM

"How to design a children's and youth's hospice for the age group of 0 to 18 years old, in form of a zero-energy building, with a focus on healing & palliative architecture to support the patient in the stages of terminal illness, and how the architectural atmosphere can affect the sense of well-being, the human experience, emotions, behaviours and providing psychological solace."



1. ill. Program connection

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PROGRAM

METHODOLOGY

This thesis is based on the methodologies Integrated Design Process and Evidence Based design.

INTEGRATED DESING PROCESS (IDP)

The challenge of designing a hospice for children who suffer from life- threatening illness is to create holistic, sustainable designs. The integrated design process is employed in the creation of this thesis project. The Integrated Design Process is combining engineering and architectural knowledge in order to address complex issues related to building design. It goes beyond problem solving to incorporate all aspects of the design. The method is used to direct combination of various parameters of a design which is divided into five phases: The problem, analysis, sketching, synthesis, and presentation phase. The phases are interconnected making the process an iterative process allowing the workflow to go back and forth in between the different phases. Therefore, the design choices are being reviewed in light of new information and analysis.

Problem

The problem phase concisely prepares an outline for the given project. The starting point of the project, a design problem needs to be determined. It establishes the project's further direction and focus.

Analysis

The analysis phase includes a review of all the data that must be gathered before starting the sketching phase. Detailed information about the user's requirements for space, functionality, logistics, the room program, case studies, the sense of the place, special qualities of the area and architectural qualities will be obtained during the analysis phase. All these parameters are crucial when defining the design criteria that will incorporate sustainable and tectonic manner.

Sketching

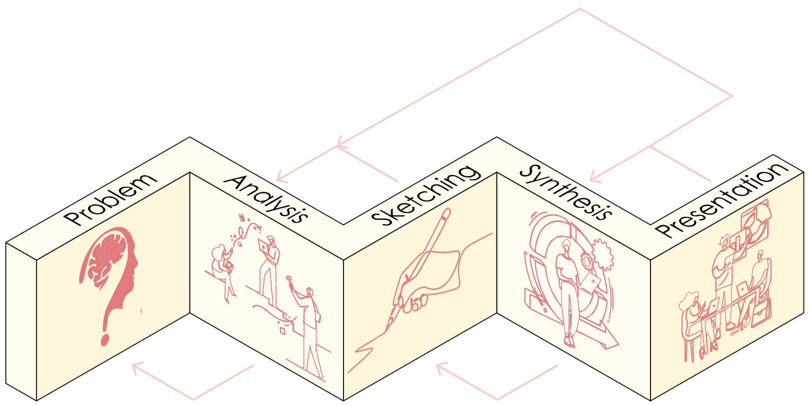
The sketching phase generates new creative ideas and solutions. During the sketching phase of the integrated design process, knowledge obtained from the architectural and engineering fields is combined for creating a high quality of architecture. This applies to fulfil the requirements and wishes for design criteria. In this phase allows us to create numerous sketches to address the various problems to optimize the ultimate and ideal solution, which will ideally emerge in the following phase, the synthesis phase.

Synthesis

As the design proposal moves through the synthesis phase, it approaches a final form in instances where the requirements in the goals and program are met. In this phase, the various project components are being optimized, and through calculation models is used to document the design proposal. Therefore, visual impacts, functional and technical solutions, and qualities have all been developed.

Presentation

The final phase, known as the Presentation Phase, entails the project's presentation through drawings in detail and illustrations. The project is presented in a way that makes it clear how the project's goals, design criteria, and target values have been met while also emphasizing all its positive attributes (Ring Hansen, Knudstrup 2005).



2. ill. Diagram illustrating the relationship between the various stages of the integrated design process (Knudstrup, 2005).

EVIDENCE-BASED DESIGN

WHAT IS IT?

The simplest definition of evidence- based design (EDB) is that it is the use of the best available knowledge to improve design decisions. A more formal definition was made by Kirk Hamilton, after examining evidence-based medicine including the ones made by David Sackett, leading to Hamilton writing the following (Hamilton 2009b).

> *"Evidence-based design is a process for the conscientious, explicit, and judicious use of current best evidence from research and practice in making critical decisions, together with an informed client, about the design of each individual and unique project (Hamilton 2009c)."*

Evidence-Based Design is a design process and not a product with ready-made answers to solve difficult design questions (Hamilton 2009b).

Architects have always used evidence in from of:

> *"Engineering science, statics and strength of materials, geometry, physis, soil mechanisms, construction law, and real estate economics, among the many disciplines founded on evidence (Hamilton 2009d)."*

Because EBD is a design process where the design choices are based on evidence. The evidence should be critically evaluated to make sure the best available credible evidence from various sources is being used. Meaning outdated data cannot be used and new information cannot be ignored. When used correctly it will ensure a high quality and that the project is relevant at the time it is being design (Hamilton 2009b).

PROCESS & METHODS FOR EVIDENCE-BASED DESIGN

The research in evidence-based design can be divided into three main types of research.

The research made by others and collected by the design team, that is then used to develop concepts.

New study that is needed to answer an important question. The research is performed by the design team or and partner collaborating with the team.

The last type of research is gathering research on the performance of the project upon completion.

A model for evidence-based design was made by D. Kirk Hamilton for his former firm WHR Architects of Huston and Dallas. It is a nine-step model. Because this project is an academic project the model is tweaked a bit see Figure #: (Hamilton 2009a)

This project is based on a combination of Integrated design process and evidence-based design process. The base is the IDP where the step from the method of EBD has been attached. EBD is primarily use in the analysing and sketching phase to make concepts based on evidence-based design choices (Hamilton 2009a).

1. **STEP:** Identify the Client's Goals. **Identify the User's Need.**	Note most important and facility-related global and project-based goals	Research, Casestudies and interview
2. **STEP:** Identify the Firm's Goals. **Identify the Group's goal.**	Understand the groups strategies, project, and evidence-based design objectives	Problem
3. **STEP:** Identify the Top 3-5 Key Design Issues.	Narrow the possible choices; work on high impact decisions	Palliative architecture,Net Zero Energy, and Design for
4. **STEP:** Convert Design Issues to Research Questions	Reframe statement of design issues to become research topics	Sub-questions
5. **STEP:** Gather information (Benchmark Examples, Literature Sources, Internal Studies)	Infinite possibilities must be narrowed; limited perspective must be expanded	Interviews Research and Casestydies
6. **STEP:** Critically Interpretation of the Evidence	No direct answers; requires open-minded creativity, balance, and critical thinking	Design perameters
7. **STEP:** Create Evidence-Based Design Concepts	Based on creative interpretation of the implication of research findings	Sketching and Documenting
8. **STEP:** Develop Hypotheses	Predict the expected results of the implementation of your design	
9. **STEP:** Select Measures	Determine whether your hypothesis is supported	

3. ill. Evidence-Based Design 9 step-model Hamilton, (Watkins 2009)

METHODS

-Research

-Interviews

-Case studies

-Physical models

-Hand sketching

-3D modelling

THEMES

EMPATHY

What is empathy from a nursing perspective?

Empathy is described as the ability to experience another person's emotions. It is widely recognized as an important part of therapeutic and supportive relationships (Mason-Whitehead, Bryan et al. 2008). The term empathy has been associated with ability, attitude, interpersonal process, trait, sensitivity, and perceptiveness (Kunyk, Olson 2001). The key element of empathy is to see the world as others see it, to be non-judgemental and understanding the feelings of others, and being able to communicate the understanding of these (Mason-Whitehead, Bryan et al. 2008).

Carl Rogers described the ability to empathise as:

> *"to assume, in so far as he [sic] is able, the internal frame of reference of the client, to perceive the world as the client sees it, to perceive the client himself as he is seen by himself, to lay aside all perceptions from the external frame of reference while doing so and to communicate something of this empathic understanding to the client.*
> *(Mason-Whitehead, Bryan et al. 2008)*

Why empathy is important for this project?

The reason empathy is an important part of this project is because of the users, in particular the patient and their families that are in a difficult situation. So, to be able to design a building for them and the staff. We must understand the emotional situation they are in. The frustration, the anger, the sadness and in some cases the grief.

But reading what a nurse reports it is like working in a children's hospice. She speaks about the assumptions she meets when she tells them where she is working. "it must be devastating working with children that is terminal ill" but she explains that the reality is that 80% of the children comes to hospice for the relief and or are in a transition in life where there is a special need for care and attention, but they go home again. So, on a children's hospice it is much more about the lived life than death (Jannie 2021).

So, the building should be able to contain all these emotions.

HOSPICE

The term "hospice" has its linguistic origins in the Latin word Hospes, meaning either traveling guest or a traveller's host. A hospice is a place of palliative care for terminal ill and dying people (Lutz 2011).

HISTORY IN GENERAL

For centuries religious institutions took care of the dying. Mainly the those with limited resources and no family members. It is believed that crusaders in the 11th century were the first group to setting up homes for terminal ill people. I the 14th century the Knights Hospitaller provided a hospice-like facility providing refuge for travellers and care for terminally ill. (Lutz 2011)

The development of the concept of hospice was reeling on specific religious orders and their health and survival. Through the Middle Ages the number of religiously administered hospices increased. In the 3 to 4 centuries the religious branches withered in their influence and with it the hospices. (Lutz 2011)

In the 18th and 19th centuries further development of hospice and palliative care continued to have ties to the religious organizations. The care of travellers became less, and the focus shifted towards patients with 1 or 2 diagnoses in common. In 1879 the Irish Religious Sisters of Charity opened Our Lady's Hospice in Dublin, Ireland. they took care of thousands of patients, most of them dying from tuberculosis or cancer (Lutz 2011).

In the 20th century the British nurse and social worker Cicely Saunders who devoted her life to care of terminal ill patients, got her medical degree in 1957. Which she used to achieve her palliative goals. Sounders is known as the developer of the first modern hospice. St Christopher's, in London in 1967. The hospice treated patient with all diagnoses, any religious belief and of any social class (Lutz 2011).

DENMARK

The first modern hospice in Denmark is the Sankt Lucas Hospice which was founded in 1992 (Christiansen, Timm 2019). There are 19 regular hospices in Denmark 2023 (Hospiceforum b) and two Children's and youth's hospices the first one is Lukashuset, which is located in the capital of Denmark Copenhagen and the other one is Strandbakkehuset which is located in Midtjylland in the town of Rønde (Hospiceforum a).

PALLIATIVE ARCHITECTURE

To understand palliative architecture here is the definition of Palliative care.

> *"Palliative Care refers to care of the patient with active, progressive, far-advanced disease in a multidisciplinary approach, for which the focus of the care is to optimize quality of life (Palliative Care. 2007)."*

The discipline of creating Palliative architecture focuses on how context, architecture and interior can affect and strengthen humans affected by life-threatening illness, their relatives, and the staff. It is a question of creating space that will support the palliative care for the patients. In this project it is based on the project called "Arkitektur og Lindring" where they have defined some design-principles for palliative design (REHPA, Signal Arkitkter et al. 2017a):

Functionality can be divided into accessibility, way finding and orientation, security and technical equipment, flexibility, work access and workflow. Which are all parameters that effect the everyday life of patients and staff (REHPA, Signal Arkitkter et al. 2017e).

Location and accessibility of the institution should be easy for relatives, this is important because it may affect the frequency of visits (REHPA, Signal Arkitkter et al. 2017e).

A good accessibility will help people with walking disabilities. The design of the accessibility needs a large amount of focus. Often the patients are weakened, which mean they might be bed laying or have walking disabilities. This is affecting eyelevel and there by the viewing field. So, the focus should also be on giving these patients views to the outside by lowering the windows or increasing the height of the windows (REHPA, Signal Arkitkter et al. 2017e).

The building needs to have a focus on navigation and wayfinding. It needs to be easy to avoid it becoming a stressful situation. Research conducted in hospitals have shown that it is easier to navigate in a building with a simple floorplan than complex floorplans. It easier to navigate in a building with 90 degree corners than a more complex building with 45 degree corners. Where it is harder to orientate it can be beneficial to locate the staff's workstation. An example could be by the entrance (REHPA, Signal Arkitkter et al. 2017e).

For wayfinding it can be useful to use landmark in form of photos, art or furniture can be helpful. Light settings can also be used as an element of wayfinding. Especially in the night-time. Studies show that when designing smaller parts of the facility floorplan in circular, H-shape, L-shape, or squared and additional sensory stimulation facilitates a better wayfinding than floorplans with long corridors. It also helps to have visual connections, few doors, unique characters and reference point. The way finding can also be enhanced by unique sounds, light level, colour or large signs with text, icons and pictures. And to differentiate similar rooms the interior can enhances the rooms function (REHPA, Signal Arkitkter et al. 2017e).

In case of a patient passing the institution need facilitate that the coffin can be carried out. Preferably directly to the hearse (REHPA, Signal Arkitkter et al. 2017e).

Safety and technical equipment. The building need to be able to facilitate critical equipment such as respirator and oxygen supply (REHPA, Signal Arkitkter et al. 2017d).

Flexibility is an important feature. Experience in hospices and similar institutions shows that flexibility in interior and the use of a room can be a strength in everyday life. In many of the institutions the mantra is often "life should be lived, until you die". So, the building should be able to facilitate many different types of events such as birthdays, music evenings, celebration of holidays and the ritual of singing a dead person out of their home (REHPA, Signal Arkitkter et al. 2017c).

Work conditions and work procedures. A big part of the work in a facility like a hospice demands knowledge sharing and exchange experiences between co-workers. So, the building needs to facilitate confidential conversations between co-workers (REHPA, Signal Arkitkter et al. 2017b).

Studies show lifts and other devices can prevent injuries due to having to lift patients. This gives better work conditions and more energy to focus on patients (REHPA, Signal Arkitkter et al. 2017b).

Light sound, air quality, and temperature

The light conditions can have a large impact in the healing process. But it is not only the daylight factor it is also about the quality of the light. Some research shows that access to direct daylight in the bedrooms can because if you cannot get out off the bed you still have access and can follow the time of the day. Daylight also has a positive effect on sleep. Artificial light can also be used in the palliative care (REHPA, Signal Arkitkter et al. 2017g).

Sound can be roughly divided into two categories noise and sounds. This means the acoustic conditions are very important, so creating the right conditions can minimize risk of stress and increase the quality of the indoor climate conditions. On the other hand, sounds can be used in palliative care to relive patients from pain with sound stimulation (REHPA, Signal Arkitkter et al. 2017b).

Good air quality and ventilation opportunities are necessary and will increase the indoor climate quality and this will decrease the risk of nausea for patients (REHPA, Signal Arkitkter et al. 2017f).

Temperature. For all the residential areas it can be beneficial that the user is able to control the temperature themselves. This will give the user a sense of control and at the same time make it easier for the user to feel comfortable. This goes for all the rooms that are used by individual users. In case of death turning the temperature low can give the relatives more time to say their goodbyes (REHPA, Signal Arkitkter et al. 2017f).

Nature is about creating recreational spaces and view. The recreational areas are for the patients to have sensory experiences, smell, taste, hearing, and touch. This could be a garden where the plants are lifted of the ground to give better accessibility to patients in beds or wheelchairs. While the views focus on the connection to nature. Some patients might not be able to go outside but with view to nature the distance to nature feels smaller (REHPA, Signal Arkitkter et al. 2017h).

Private life and relations. Private life is about having your own room a single room. Which makes family visits more intermit not having to think about other patients in the same room. At the same time, it makes it easier for staff to have confidential conversations with the patient in a single room (REHPA, Signal Arkitkter et al. 2017i).

Social rooms. Different social relations require different levels of privacy and communal feeling. And a variation in size and interior. Try to avoid long hallways as this can have a negative influence it is better to have some kind of transition zones and living areas. Having a shared kitchen ensures interaction between patient's relatives and staff which enhance the feeling of wellbeing (REHPA, Signal Arkitkter et al. 2017j).

Atmosphere. Patients go to a palliative care centre to get some relieving from their pain. The building should support happiness and wellbeing for the patients and relatives. This can be achieved by creating a homely atmosphere (REHPA, Signal Arkitkter et al. 2017n).

Research reviles that on children's section in hospital shared kitchen facilities enhance the communal feeling. In general the shared areas should be focusing on the homely atmosphere as well (REHPA, Signal Arkitkter et al. 2017k).

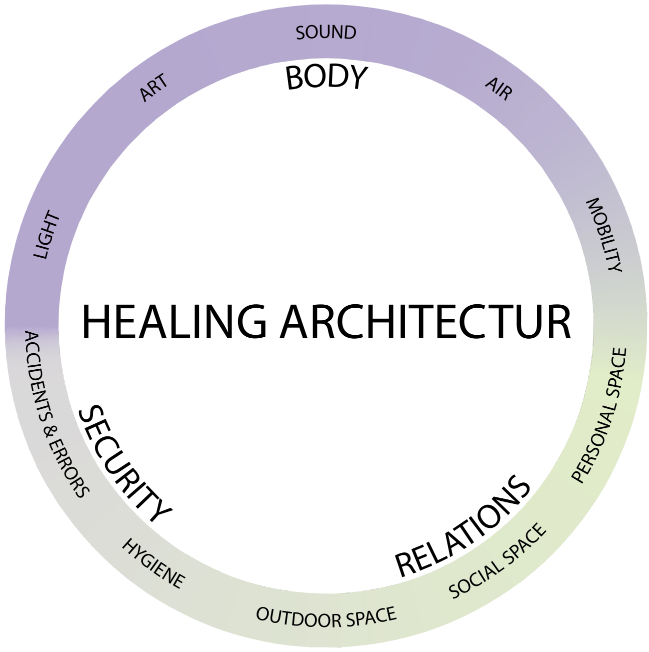
The clinical part of the facility needs to be kept to a minimum so it is mostly part of the staff area and only where it is necessary. Because a too clinical environment can prevent the homely atmosphere (REHPA, Signal Arkitkter et al. 2017k).

Art looks have a positive effect for the patients. Colours and pictures looks to have a calming effect for children and young people when sad, or stressed (REHPA, Signal Arkitkter et al. 2017l).

Reflection, religion and farewell

The building have to facilitate space to reflect on life and give space for the existential question of life and death. Often it is the patient's room where the relatives say their farewell to the dead patient. This is also where the dead is placed in the coffin before being singed out of the building (REHPA, Signal Arkitkter et al. 2017m).

A study conducted in England describes the issues of creating a multireligious room. The design of this room focused on creating a pleasant and welcoming atmosphere. The issue is the attempt to incorporate flexible use of religious symbols which in reality is not working for the relative. So, because of the multi religious society we live in the building should instead facilitate a non-religious room which has the pleasant and welcoming atmosphere (REHPA, Signal Arkitkter et al. 2017m).



4. ill. The illustration showing the design parameters of healing architecture

HEALING ARCHITECTURE

Healing architecture is a term used in healthcare design especially hospitals. A Danish research project called "Helende Arkitektur" has been made as a scientific literature study. The purpose of the study was to figure out how the physical frames effect the healing process of a patient and moreover how the architecture effects stress reduction and optimization of wellbeing for patients, relatives, and staff. The result of the study is a presentation of a selection of scientific research results which is relevant in spatial and architectural design of hospitals (Frandsen, Mullins et al. 2009a).

What is healing architecture?

It is a design concept with the vision of architecture affecting the human well-being as well as the architecture can strengthen and progress the healing process for the individual human. Not that the architecture by itself can be healing but that the architecture can supports the healing that takes place both physically and psychologically through the architectural design in form of the quality of daylight quality, the atmosphere of the room, colours, sound and the opportunity for privacy and safety (Frandsen, Mullins et al. 2009c).

In the presentation they present a model for healing architecture. The model is divided into three primary levels the physical framework, the factors, and the consequences. The focal point of the model is the factors. These are the parameters that can be tweaked up or down affecting the physical framework and the consequences physiologically, psychologically, and economically (Frandsen, Mullins et al. 2009c).

There is a total of ten factors that are split into three main sections Body, Relation, and Safety (Frandsen, Mullins et al. 2009b).

BODY

This is the factors that relate to the human body and its senses. Light and art refers to the sense of sight, sound the sense of hearing, smell the sense of smell, and movement the kinesthetic sense (Frandsen, Mullins et al. 2009d).

Light is described a daylight and artificial light which patients, staff and relatives are in during the day and in sometime at night. The use of light as a treatment is also included in the research.

When asking staff and patient what element or properties of the physical environment is most important for their well-being or their job satisfaction. The most prominent answer is daylight and windows. And the study shows that room with no window and daylight is discomforting, and staff become concerned for their own health (Danish of Ministry 2020).

Daylight is important for circadian rhythm for both old and premature born children. It is both about the amount of daylight and the intensity of that light. For prematurely born children it increases the activity level of the child. It also affects the sleep quality. For the best condition the light level at night should be lowered significantly. The combination of day and night condition will give longer sleep periods and deeper sleep and fewer movements for children and premature born children.

Light can also be used as therapeutic stimulus. Light with a high intensity has can be used to treat depression. This type of treatment has the most effect if used early in the morning.

Studies also show there is a relation between daylight and hospitalization time and deathrate in hospitals. The study shows that patient with south oriented patient rooms had a significant shorter hospitalization the patient in north oriented patient rooms. The same result was the case for deathrate in hospitals.

Pain and stress can also be positively affected by daylight and direct sunlight. This has been proven and patient that has gone through back surgery. This study shows that patient in west oriented room had 46% more light than patient in more dark rooms toward east. This affected the amount of painkillers used meaning patient in rooms with more light used 22% less painkillers.

For the staff the light plays a big role in making fewer mistakes when writing journals and decreasing the amount of incorrect medication. So having good light condition in medicine room and office spaces is important (Frandsen, Mullins et al. 2009d).

Art. In the research art is seen as individual visual, tactile or auditory works of art. Meaning paintings, sculptures, installations etc. including colours.

Art has a positive effect as a distraction in relation to pain treatment but also on general well-being as a sensory stimulus or mental distraction. Colours can be part of the artwork or the art by itself in form of colour combinations. Art also works well at as part of way-finding systems.

It is beneficial to integrate art into the architectural planning from the beginning.

The research found that there is very little existing scientific documentation of measurable or experienced effect of the relation between healing and art. But the research has included some literature the point out the possible effect of art in relation to the healing process. The relations are described by three articles with the following outcome.

The first article describes that it seems to have a calming effect on aggressive children and young people using colour schemes combined with murals. It has a positive therapeutic effect to use playful art in the interior compared to a traditional with painted room.

The second article point to the use of visual and auditorial art as having a positive effect as a pain distraction. The article documents the use of video material of nature landscape in pain treatment.

The third article describes a combination of an image of a nature landscape and auditorial recordings of nature sounds in pain treatment as well. This seems to have the same positive effects as the use of visual art (Frandsen, Mullins et al. 2009f).

Sound. When sound is used as distraction in e.g., pain treatment. But sound can also be noise which can have the opposite effect sleep disturbance and stressing (Frandsen, Mullins et al. 2009g).

The World Health organization WHO has made recommendations regarding sound level in hospitals. These guidelines are as follows:

> *"The LAmax (Fast) of soundevents during the night should not exceed 40dBA indoors. For wards in hospitals, the guideline values indoors are 30dB LAeq, together with 40dB LAmax at night. During the day and evening the guideline value indoors is 30dB LAeq. Since patients have less ability to cope with stress, the LAeq level should not exceed 35dB in most rooms in which patients are being treated or observed* (Berglund, Lindvall et al. 2000)

The research refers to general sound level measured in either decibel dB(A) or reverberation time. At the same time sound is also a distractor auditive or audio visually which is described as the experience.

The research shows that the general sound is much louder than the recommended values. When it comes to sleep it is an important part of the healing process but the sound level is also to high at night time. This is typically caused by the technical equipment.

But sound in form of music or hearing protection is proven to have a positive effect on pain. Meaning sound or the absence of noise helps the healing process.

Sound also affects the privacy and confidential conversations and the working environment and performance regarding the staff (Frandsen, Mullins et al. 2009g).

Air is the atmosphere surrounding us which is composed by various gases. The human body receive air through temperature and smell. But there is very little research in the healing effects of air in architecture.

Air does affect our comfort and well-being. The wrong temperature or unpleasant smell can cause great discomfort. Patient with specific illnesses or medication can be particularly sensitive to smells. To prevent the discomfort of smell hospitals are recommended to select a good ventilation system and use of material that does not absorb the smell.

Research shows air also can be used in stress relieving of patients. Research documented at a dentist using orange-scented essential oils had a calming effect on patients (Frandsen, Mullins et al. 2009g).

Movement. The research shows there is two factors that affect the how you navigate a building like a hospital. It is the plan solution and sign for wayfinding. If the buildings plan solution becomes to complex it can cause stress for the users and have economic consequences in form of lost time and efficiency for staff.

When it comes to the plan solution the most important aspects are a simple and uncomplicated plan. A method called "Interconnection Density" (ICD) is used to calculate the complexity of a plan. This is done by calculating the average amount of options in what is defined as choosing point in the plan solution. But the ICD-number is not the only factor. Research also shows that if the corner angle of the plan solution is 45 degrees the plan becomes more complex to navigate than a plan with parallelised (Frandsen, Mullins et al. 2009e).

RELATION

This is the main section focus on the relation between the space and the human interaction and relation. Define on the basis of both spatial and relational scale the relation factors have been sub-categorised into **personal space** referring to close and private space around the individual, **social space** referring to social and private spaces for interaction between people, and **outdoor space** referring to the human and building relation to the close context (Frandsen, Mullins et al. 2009h).

Personal space. The personal space refers to privacy for the individual patient relative and staff. There are many ways of creating privacy physically or just giving the opportunity to choose whether to engage in a conversation. Privacy is also important for the relation of the users and the confidentiality. The research does not show any particular ways of solving privacy.

The research shows that people prefer a single patient room over a shared patient room.

the relation between patients and relative was found to have a high impact on the patient surviving a serious illness. As this relation seem to be motivating the patient to become well.

When it comes to examination and treatment the relation between patient and staff should be undisturbed and in privacy. It needs to be a room of confidentiality which is best established in a private patient room (Frandsen, Mullins et al. 2009i).

Social space. The research defines social space as the human interaction and communication on a private and public level. Different types of interaction and form of communication requires different types of spaces and environments. From this perspective the research looks at what requirements the relations set to the physical environment and its architectural design, but also how the environment and its architecture design affect the human relations.

The literature used in the research, is divided into for categories the relation between patient and relatives, patient and patient, patient, and staff, and then all three users.

The social relation between patient and the relatives is an important aspect socially and psychologically. Providing single patient or family room ensures a larger feeling of private life and confidentiality.

The patient and patient relation with space for social talk and more confidential conversations. The study shows that the relation between patients can help the feeling of anxiety, fear, and stress, and it can reduce the hospitalization time.

The multi patient rooms allow for more social and confidential conversations between patients (Frandsen, Mullins et al. 2009k).

Outdoor space. The research shows that the opportunity to have visual connection and the ability to stay in a green environment with trees and other vegetation seems to have a positive effect on the human's wellbeing both physically and psychologically.

When it comes to stress the research points to an experimental study where people experienced visual connection to nature environment and a city environment of different types. The study compares the subjects' responses both physiologically and psychologically. The physiological measurements in form of electrical impulses in the brain and heart rhythm and the psychological in form of the subject's psychological state. The result confirmed that the nature environment had a calming affect on the subjects. Higher alpha-rhythm in the brain, a lower heart rate and a psychological indication of better mood calmer and more relaxed.

It is not clear if visual connection to nature has a positive effect on concentration.

Stimulating patients with pictures, video material or views through windows to a nature environment worked as a distraction and affected the experience of pain in a positive way. One of the studies measured the subjects experienced pain. The subjects were inflicted with pain while watching a video of a natural environment. The result was a significant higher pain toleration and a substantial longer stamina in relation to the pain than the control group.

Another thing the ability to orient oneself to the environment outside the hospital and be able to relate to time and place. Here windows and daylight are important. This was confirmed by studying and evaluating the preferences of different rooms. The difference was the window placement, and the views were variating. It was a preference to have long distance views and view to the sky. The rooms where the windows were located to high or with no view to the outside environment gave the same as a room with no windows.

When it comes to gardens in relation to hospital it seems affect mood and atmosphere positively, being more relaxed and calm and for some even refreshing and revving strength. It also helps on the thought process of processing difficult question and emotions. The use of the gardens is affected by their placement e.g., if it is located close to functions like a cafe it will be used more frequently. The garden also needs to have easy access for all users with or without disabilities and preferably without any assistance.

The important elements of the garden are trees, plants, and flower. Then the sensory experience comes next where smells, sound like birds singing, and the tactile part where touch is being used, sun and shade is also big part of the sensory experience (Frandsen, Mullins et al. 2009l).

SAFETY

Safety is the safety of patients and staff. The factors of this main section are **hygiene**, and **errors and accidents** (Frandsen, Mullins et al. 2009j). The hygiene factor is spatial aspects related to the reduction of hand, water, and airborne infection (Frandsen, Mullins et al. 2009m). While errors and accidents are the spatial conditions related to physical injuries to patients and staff but also treatment and care errors that can take place in a hospital environment (Frandsen, Mullins et al. 2009n).

Sub-conclusion: The chapters Healing and Palliative Architecture are focusing on different building types under the same topic architecture and health care. The healing architecture has a primary focus on hospitals, while the palliative architecture focuses on hospices only and point out some of the aspects that should be considered differently, as a hospice is not treating the illness. But focuses on palliative care to relief the patient from pain in this case a children's hospice. As it is children the parents can also get help with difficult conversations and just be relief from some of the everyday tasks in a normal household, and just focusing on being a family.

The two themes should not be seen as a recipe but rather as aspects that will affect the architecture and the experience of the design.

INTERVIEW

Interview at Strandbakkehuset full interview in appendix 1. The purpose of the interview was to learn about children's and youth's hospices in Denmark as it is a quite new typology.

The interview was constructed as a qualitative interview. The question was made beforehand. Additionally, questions were asked during the interview. The information from the interview have been divided for a logical explanation of the following categories' users, relation between staff, patients and relatives, facilities, common area and treatment facilities.

Users

At Standbakkehuset they are allowed a maximum of 4 families at a time. The patients are in the age group of 0-18 and they move into the patient apartments with their relatives. These families are very diverse, but they all have in common that they have an ill child. The illness can be a terminal illness or a life-limiting illness. This may course disability or a chronic disorder, syndrome that means you have different life conditions than others. So, the illnesses that the children are suffering from spanning wide which mean the families have a vast variety of needs. 80 % of the patients go home after a stay at Standbakkehuset.

The facility has a total of 13 nurses and there are always at least two nurses on duty. They work in 8-hour shifts. The staff furthermore consists of a pedagogue, a physiotherapist, a social worker, a psychologist, a priest, and a music therapist. Beside the staff there is some collaborators form outside the facility play heroes, hospital clowns and a lot of volunteers who offers a variety of service support.

Relation between staff, patients, and relatives

As a patient and relatives there is a minimum of 2-3 weeks on how long you have to stay at the hospice, the reason for this is that the staff, patient and relative have time to form a relation. And the length of the stay depends a lot on the patient's situation.

The residential apartments are divided into two rooms that are the patient's room and the family room. The staff always have access to the patient's room. The staff only have access to the family room when invited by the relatives to give the relatives a safe space.

Facilities

The building can be divided into four types of zones. Staff zone, common area, residential apartments, and treatment zone. The staff zone which contains office area, medicine room, and a small changing room, is the zone for staff only. The common area is like a buffer zone that serves as a multipurpose zone. The residential zone is private and serve as the treatment area for the patient. The treatment zone is focusing on giving the right facilities to help relief the patients.

Common area

The Hjerterum is the large common area that serve as a room for play, conversations, and social activities. They use it for group singing in the morning.

All the hallways serve as common area that are light and airy. In these areas there is also a lot of seating for conversations and reading.

The kitchen is also a very important room for social interaction. There is no kitchen in the patient family apartments to force the interaction between families and staff. The staff also uses the kitchen as their break room enhancing the interaction.

Treatment facilities

The treatment facilities include quiet room, wellness room, sensory room, and therapy room. The treatment facilities are not for treating the illness. It is part of the palliative care to treat pain in any form physical, neurological, psychological or any other type of pain.

USER GROUP

The user groups are defined based on the interview conducted at Strandbakkehuset,

5. ill. Patient diagram

Patients

The patient is a child or young person in the age group of 0-18 years old who has life-limiting or a terminal illness. It means that they have a need for interdisciplinary and specialized palliative care. The patients should have a feeling of home away from home.

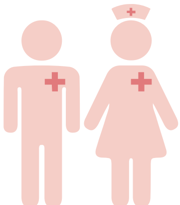
During the time at the hospice, they can get treatment from hospital- or general practitioner.

6. ill. Relatives diagram

Relatives

The relatives have a need for relief and the interdisciplinary care, nurses, physiotherapist therapist, social worker, psychologist, and priest. They have an understanding of the child's or young person's condition and know the purpose of palliative care and the purpose of the stay in general.

The hospice should facilitate break from everyday life. Having someone to talk to about the illness and the situation of having a child or young person with a life-limiting or terminal illness in the family. This could be staff from the palliative team, social worker, or the other families.



7. ill. Staff diagram

Staff

The staff is divided into palliative team, social workers, priest, pedagogues, music therapists, kitchen staff, and building caretakers.

The palliative team consists of specialized nurses, therapists, physiotherapist, and psychologist. Their job is to give the patients the palliative care needed by the individual patient caused by their illness. Furthermore, they also serve as relation to the families to have conversation or giving the families tools to help the ill child or young person.

The social worker and priest does not do any palliative care but is part of staff to help with the difficult and sensitive conversations.

Pedagogues job is entertaining more mobile patient or sibling.

The music therapist's job is to entertain and teach rhythmics.

The kitchen staff provide food for the patients twice a day breakfast and lunch.

The building caretakers is the person responsible for maintaining the building. The facility needs to provide office space, workshop for tools and space to repair materials and equipment, and gardening equipment.

NEURO ARCHITECTURE

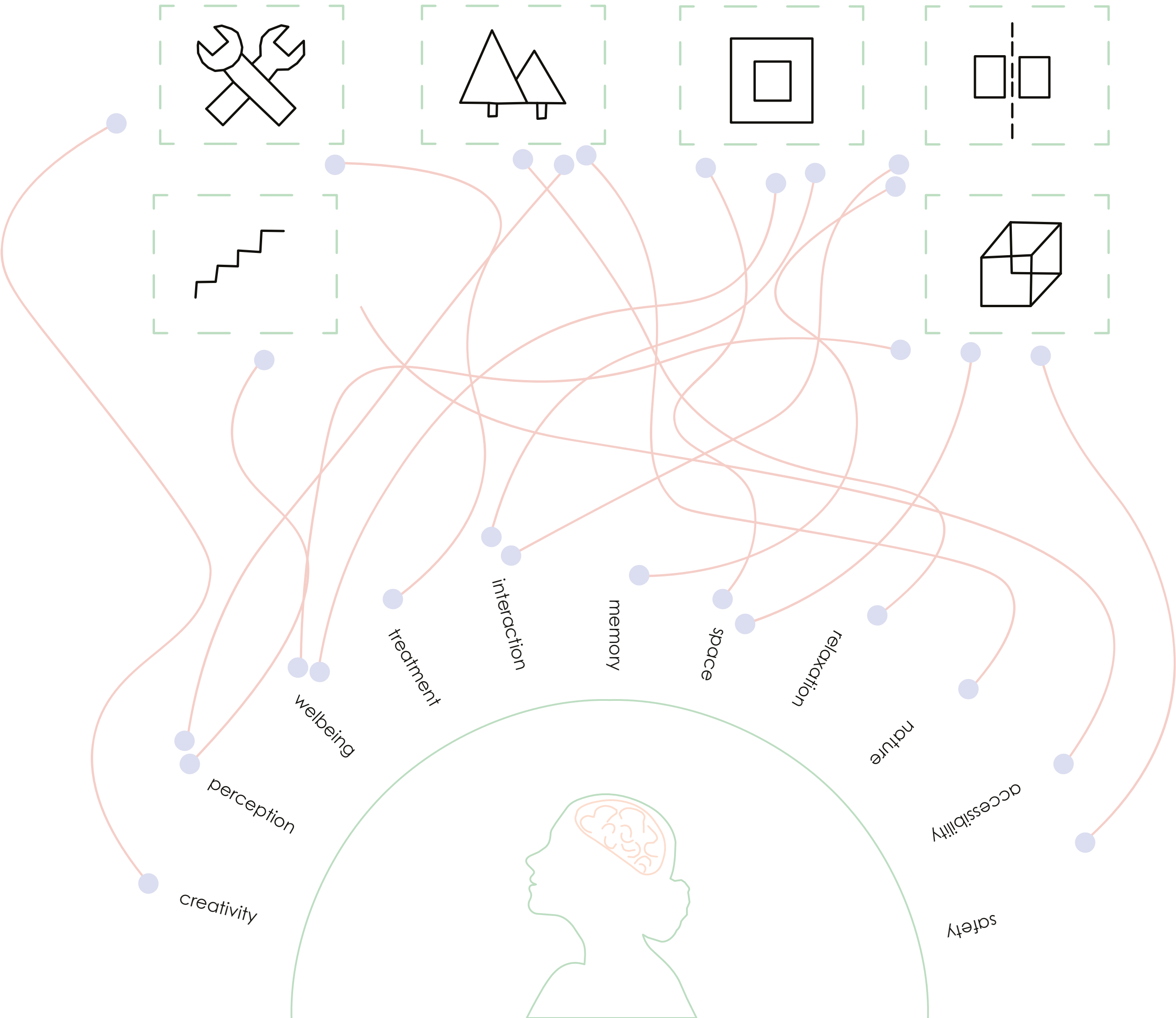
A new field called "neuro-architecture" focuses on how human brain dynamics are affected by behavior in and interaction with the built environment. It blends architecture, environmental psychology, and neuroscience. Others also define the topic of neuro-architecture as one in which neuroscientists and architects work together to investigate how people interact with their surroundings scientifically. Azzazy et al. (2021) claim that the main purpose of neuro-architecture is to investigate how the architectural environment affects the neurological system. Neuroscience can enhance the design process, design strategies, and inform rules that eventually improve human health and well-being in the future based on our growing understanding of how the brain perceives its environment (Wang, Guilherme Sanches et al. 2022).

Neuroarchitecture, to put it simply, is the variety of responses that users' brains generate while they are present in a specific setting. These neurol responses have a direct impact on users' attitudes and behaviors in any space, both in the short and long term. These outcomes can be assessed by analysis:' 1) brain stimuli (in areas of the brain that are active during the period that the user is in the environment); 2) the responses produced by the brain in that environment; 3) vital signs that change in the environment (for example, heart rate) (Migliani 2020).

Studies conducted in this context examine how people react to and perceive different spaces. One of the research that exemplifies this is 'approach-avoidance decisions in architecture' (Vartanian, Navarrete et al. 2013). The emphasis has been on the impact of ceiling height and perceived enclosure on aesthetic assessment of spaces. Researchers were also interested in how perceived enclosure and ceiling height affected people's decisions about whether to enter or exit those areas Besides, curvilinear, and linear spaces were also tested (Vartanian, Navarrete et al. 2015). The results indicated that, curvilinear forms are perceived to be softer and more pleasant, while angular forms are perceived to be tougher and more serious (Vartanian, Navarrete et al. 2013). Rooms with high ceilings are more favored. Participants would consequently be more inclined to consider rooms with higher ceilings to be beautiful than spaces with lower ceilings. In addition, the height of ceiling preferred is 0.61 meters higher than the standard and they liked higher ceilings for listening in particular compared to reading, dancing, eating, and chatting (Vartanian, Navarrete et al. 2015). They were more inclined to consider beautiful open spaces than enclosed ones, as well as more likely to avoid enclosed than open spaces when they enter the spaces (Vartanian, Navarrete et al. 2015).

When designing spaces based on neuroarchitecture for children, one such factor takes the need for belonging in humans into account. Children must experience a sense of belonging in their environments in order for their brains to respond optimally to stimuli. It is quite important when creating environments where children feel belonging like home. Utilizing furniture suitable for children and enabling quick access to interesting objects for example, curves would be more appealing than corners, which evoke feelings of danger, making them fearful and reactive in children hospice (Migliani 2020).

When creating high ceilings are suitable for the most creative tasks, open spaces than enclosed spaces, curved surfaces of the walls instead of sharp lines, have a calming influence on people's minds. Resulting from this, the program will be formed to meet the demands of the users.



8. ill. The diagram illustrating the impact of architectural elements on neuro architecture.

SPACES FOR CHILDREN

Children's spatial perception has recently been given more consideration in the process of designing spaces for children. This is important because it affects how well spaces meet functional needs and produces positive feelings in the mind. The perception of scale plays a key role in space. The way a person perceives their surroundings depends on the spatial scale, as well as the observer's height and vantage point. For example, nursery schools have been designed using children's drawings as inspiration. Furthermore, the scale and size variations have been considered in the design process. A view of the outside environment and access to daylight are both provided by house-shaped windows, which are specifically created at the appropriate height for children's scale to be used as benches (Angelaki, Triantafyllidis et al. 2022).

"Children had a formal sense of their school building as a rectangular block with which they had a physical relationship in terms of shape and scale." (Dudek 2005)

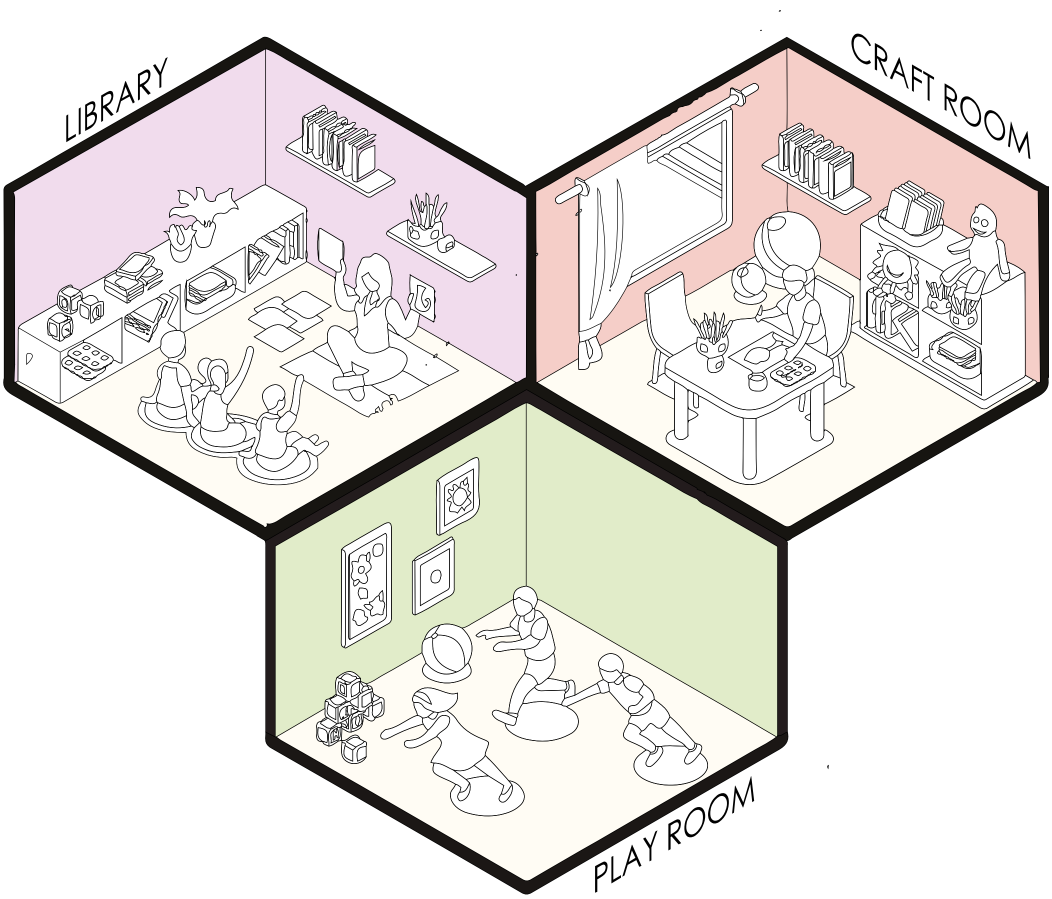
The element of light is also essential attribute of designing spaces for children, providing functionality and comfort, particularly when combined with natural light. The improvement of visual stimulus perception, mental health, and higher performance are all associated with more daylight exposure and it provides for children the opportunity to interact with light.

The haptic perception that dominates in children means that their spatial cognition is based on their sense of touch and their ability to distinguish between the various objects in space that are within their reach, which is related to the perceptual difference between children and adults. Children often approach the objects in their immediate surroundings based on their scale.

The elements of shadow and contrast are important because they help define the form and size of these elements. The result of light in space is a shadow. Space is a place where darkness and light coexist and complement one another. The size and density of the shadow inform the viewer about the scale and distance between the objects in the room. Shadows can also be used to improve an existing atmosphere for children. (Angelaki, Triantafyllidis et al. 2022)

Children do not see or perceive their surroundings in the same way that adults do. The one thing that all children have in common is that no two are alike. As a result, no two interactions with a child are the same, and the ways in which a child uses space on a daily basis may vary significantly. The ability to change and adapt to any circumstance is a requirement for spaces. In addition, adaptability and openness is important, the spaces provide access to nature and must be open for regulating social interactions because children are not supposed to be confined to the boundaries of conceptions of space (Dobbins 2018).

Sub-conclusion: When designing spaces for children, the attention should be paid to respect for children's spatial perception. It has an impact on spaces meet functional needs and provides sentiments in the mind. The right scale, daylight, shadows and contrast, open spaces for social interactions all will be considered. For example, the scale, children frequently use the magnitude of objects in their immediate environment to determine how to approach them.



9. ill. The diagram showing the spaces for children.

TECTONICS

Tectonic theory is an integrative philosophy that analysis the intertwined relationship between structure, construction, space, atmosphere and function. Architectural tectonics tries to establish a connection between the intended use of space and the reality of the construction required for it to exist (Schwartz 2017) . The tectonic technique involves creating atmospheres, human senses and experiences without compromising the structure and construction values when delving deeply into. Tectonic in architecture must be formulated around utilitas, firmitas, and venustas (functional, technical, and aesthetical) that is according to Vitruvius who was a Roman architect, writer and engineer (Schwartz 2017). The interaction of the three terms which results in the sense of wholeness, is crucial for the creation of high-quality architecture and engineering.

1- Utilitas: Spatiality - Accessibility – Utility

Utilitas refers to the functional qualities of the building and it focuses on the buildings ability to respond to the needs from the occupants. (Lauring, Micheal, Marsh 2008)

2- Firmitas: Robustness – Adaptability - Patina

Firmitas is related to the technical qualities of the building, and it addresses the physical, functional and aesthetic strength and durability of the materials, constructions and technical installations. (Lauring, Micheal, Marsh 2008)

3- Venustas: Daylight – Experience - Character

Venustas is about architecture"s aesthetic conditions and sensual aspects of the building. It handles the design in its entirety with the details. (Lauring, Micheal, Marsh 2008).

Sub-conclusion: One of the design factors in this project is the tectonics generated by construction; it establishes a connection to tectonic design that aids in comprehending the form and is influenced by the joints that make the shape obvious. Therefore, it is important to these three parameters must interact in a way that gives the impression of wholeness. Tectonic is related to the atmosphere and spatial experiences of users with a holistic manner and it is not only the structure.

10. ill. The diagram illustrating Vitruvius triangle.

NORDIC ARCHITECTURE

Nordic architecture has been characterized by modernism, simplicity, minimalism and functionality, and represents a natural way of life, one that allows us to stay connected to nature even in an urban context.

A wide range of architectural concepts and styles are embraced by Nordic architecture, which offers novel perspectives with a renewed sense of the importance of architecture as a means of cultural expression and creation (Blog B2B 2017).

Nordic countries have a diverse climate with seasons that ranging from the cold, long and dark wintertime to the light-filled, moderately sunny warm summers. The challenging circumstances have resulted in simplicity of form and function, to clean lines and stylish practicality (Blog B2B 2017). Earlier vernacular structures were built in a simple way using locally sourced materials. Scandinavian architecture obtained natural materails directly from surrounding landscape the reason is that nature is close to people even in urban surroundings. Nordic Architecture can be defined integration with the nature, simplicity in design, utilization of natural light, merging structure with the surrounding environment and incorporation of functionality and comfort. Simple and minimalist design is the defining characteristic of Scandinavian architecture (Sustainable 2019).

“Scandinavian architecture in its various stylistic traditions was for a long time deeply concerned with the metaphorical use of materials” (Porphyrios, 1982)

Scandinavian architecture considers how spaces are utilized and strives to incorporate comfort.

Natural light enhances happiness, productivity, and general well-being. The role of large windows is to let natural daylight in and allow a clear view of the outside environment. Wooden construction is common which makes the interiors cozy and welcoming atmosphere and provide the integration of the structures into the surroundings. Light and neutral colors are typically used, which enhances the amount of natural light that enters the room (Thomann 2022).

Sub-conclusion: When creating an architectural project in Nordic context, all these aspects must be considered in the design that mentioned above. For example, nature is an important factor so it would be efficient use locally sourced materials, merging structure with the surroundings environment, having a simple and minimalist design. Utilization of daylight, the color and texture should be also considered when still being in connection with its surroundings.

11. ill. The image of Nordic architecture.

BIOPHILIC DESIGN

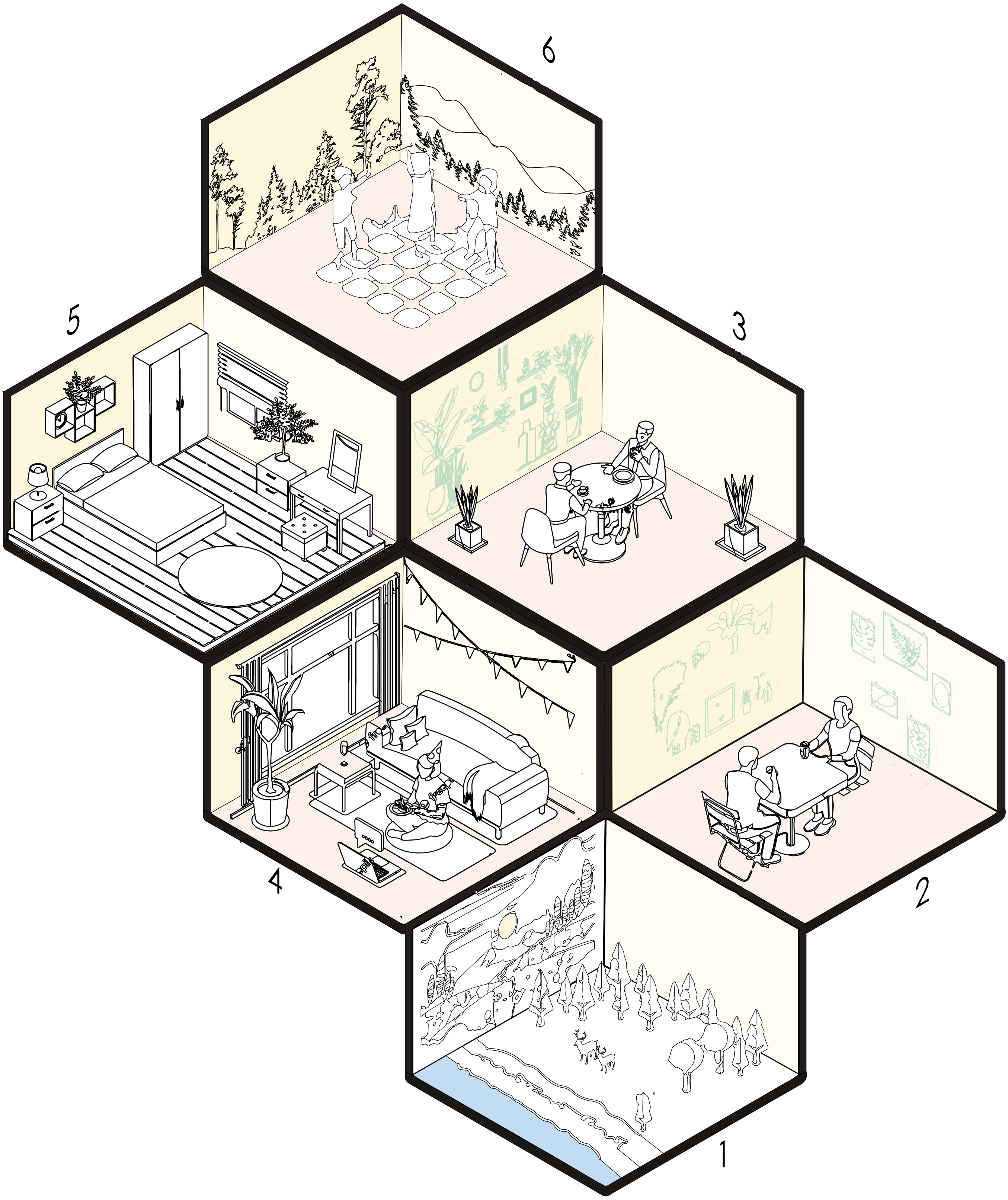
Biophilic design can be defined as biophilia applied to the design and development of human-built environment. Biophilic design thus derives from a basic understanding of human evolutionary biology and how our inherent human inclination to affiliate with nature that even in the modern world continues to be critical to people's physical, performance and mental health and wellbeing (Kellert 2018). This can be explained that biophilic design is a way of creating a good habitat and atmosphere for people, even in a hospice, hospital or health care facilities. There is evidence that interacting and exposing people with natural environments can help patients recover faster, can also boost their productivity that are offered by a natural environment. Furthermore, spending time in biophilic environments can soothe, reduce pain sensitivity, increase confidence, and provide many other medical benefits. Additionally, biophilic design aims to maintain the productivity, functionality, and adaptability of natural systems (Bailey 2021).

The fundamental categories of our biophilic design framework are represented by three different types of nature experiences. **Direct experience of nature** refers to contact with natural environmental features such as natural light, air, plants, animals, water, landscapes, fire and ecosystems. **Indirect experience of nature** refers to contact with images of nature, natural materials, colours, shapes and forms that evoke and mimic nature. **Experience of space and place** providing spatial features characteristic of nature that have advanced human health and well-being, such as open views and places for retreat and refuge within organized diversity, clear pathways with natural waypoints and cultural and ecological elements that help develop attachment to place (Polvi Zackary Bryson, Ganem Coutinho et al. 2021).

Designing with a biophilic approach, in Kellert's opinion, requires consideration of both context and cultural context. The six elements of biophilic design are as follows:

1. Environmental features. Characteristics and features of the natural environment such as sunlight, fresh air, plants, animals, water, soils, landscapes, natural colors, and natural materials such as wood and stone.
2. Natural shapes and forms. The simulation and mimicking of shapes and forms found in nature. These include botanical and animal forms such as leaves, shells, trees, foliage, ferns, honeycombs, insects, other animal species, and body parts. Examples include tree-like columns rising in a building interior to support a roof that projects the feeling of a forest canopy; building shapes that simulate the appearance of bird wings; ornamentation suggestive of a natural shape like a crystal or geological feature.
3. Natural patterns and processes. Functions, structures, and principles characteristic of the natural world, especially those that have been instrumental in human evolution and development. For example, designs that stimulate a variety of senses, simulate the qualities of organic growth, facilitate the organization of complexity, or reflect the processes of aging and the passage of time.
4. Light and space. Spatial and lighting features that evoke the sense of being in a natural setting. These include natural lighting, a feeling of spaciousness, and more subtle expressions such as sculptural qualities of light and space, and the integration of light, space, and mass.
5. Place-based relationships. Connections between buildings and the distinctive geographical, ecological, and cultural characteristics of particular places and localities. This can be achieved through incorporating geological and landscape features, the use of local and indigenous materials, and connections to particular historic and cultural traditions.
6. Evolved human relationships to nature. Basic inborn inclinations to affiliate with nature such as the feeling of being in a coherent and legible environment, the sense of prospect and refuge, the simulation of living growth and development, and evoking various biophilic values (Architect 2012).

Sub-conclusion: When designing in Nordic context, biophilic can be a good example because biophilic design has a direct impact on user's spatial experiences and connection with nature. All these given parameters to work with that has an influence on healing architecture when creating a healthy environment for children.



12. ill. The illustration showing the six elements of biophilic design according to Kellert.

TSURUMI Children's Hospice

Tsurumi Children's Hospice is located within Tsurumi Ryokuchi Flower Expo Memorial Park in Tsurumi Ward, Osaka, and Japan's first community-supported hospice for children. The vision is to assist children who are suffering from life-threatening or life-limiting illnesses and their families by cooperating with them as friends where they are in their second home. The hospice is open and serves as a center where children in the facility can play with nearby children. It gives an opportunity to the families to interact with the community daily and establishes a base from which the entire neighborhood can support the children and their families.

The hospice is facing the large garden that is bathed in the sunlight with a table where the families can watch their children play in the small garden. It is a peaceful place where you can retreat for a while also keeping an eye on everyone else. There are not only to be unhurried like a home, but also to have a range of areas, scales, and places like a village. Without being isolated, each location has a connection to the others.

The hospice consists of six houses with wood- frame structure that are connected by a "space of the street". There are many different types of rooms in each of the houses, including playrooms, music rooms, living rooms, kitchens, and bedrooms. It is a lot of fun and happiness to walk through the "space of the street" in these houses. Furthermore, you can take a break or even hide and cry in one of the many small hangout areas and gardens of different sizes and shapes in between the houses.

There are different types of materials are used to the intention of emphasizing the gentle touch and the joy of discovery such as wood, soft materials, metal. The residents can unwind and experience nature as it is all year round thanks to the deep eaves facing the courtyard that block out the summer's intense sunlight and the "space of the street," which brings a pleasant breeze to flow through (Abdel 2021).

Sub-conclusion: when designing for children, how the space gives a feeling like a home. The functional needs of the places are crucial and create happy feelings in the mind. Because children have a strong preference for haptic perception, their capacity to discern between different things in space and their sense of touch serve as the foundation for their spatial cognition.

STRANDBAKKEHUSET

Strandbakkehuset is a competition project to design a Children's and youth's hospice as an extension to Hospice Djursland which is a traditional hospice. The competition was won by the Danish architect firm Aart and contractor CJ Group in 2019. Strandbakkehuset is the second children's and youth's hospices in Denmark and the first new build children's and youth's hospice in Denmark. The facility was taken into use December 10th, 2020.

Hospice Djursland and Standbakkehuset is situated on a small hill which is giving the building a wide perspective view towards south. Standbakkehuset is in close connection with nature. This connection is further strengthened by the open facade that frames the nature from both the family apartments and in the social area where the openings are part of the separation of the family apartments. This separation is further strengthened by the displacement facade breaking it into smaller volumes that enhances the sense of human scale.

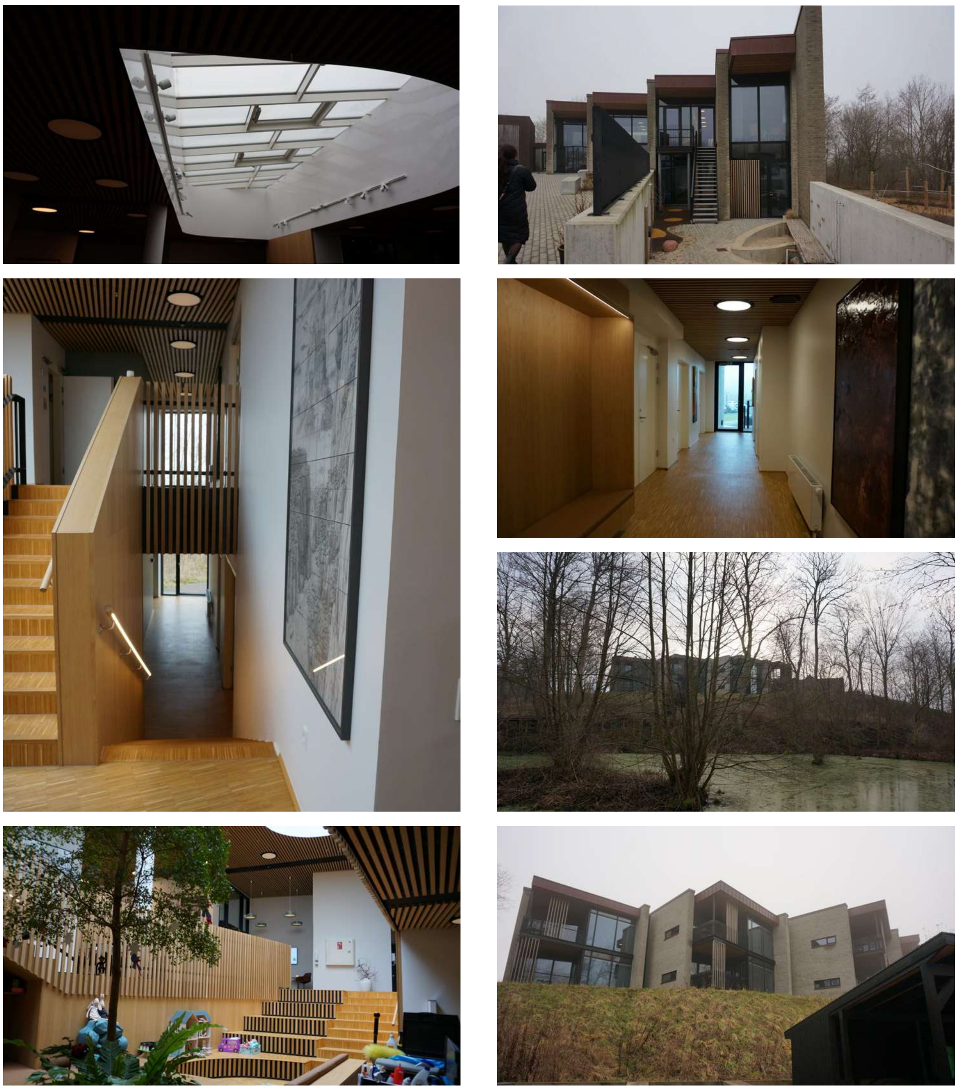
The building is divided into three zones which are staff, family residential and shared functions that are all connected by the "Hjerterum" in English the heart of the building. This room serves as a communal area which has a large skylight, lights up the rooms. Moreover, from the heart of the building, there are visual connection with the nature.

The staff area is an open office landscape which breaks down the barrier between families, visitors, and staff, because there is no physical barrier making interaction with the staff easier.

The kitchen space serves the families and the staff as the only kitchen in Strandbakkehuset this also helps the families and the staff bond. The family apartments are divided into the child's bedroom and the family bedroom. Makes it possible for the staff to take care of the child without disturbing the parents.

Sub-conclusion: The mantra of Strandbakkehuset is "life, play and relief" there has been a large focus on creating space that allows the patients and their families to do all of these thing. This is done by creating an environment that facilitates communal living, private life, and settings for new relation in between families, families, and staff. At the same time facilitating a working environment with focus on palliative care. Which is all part of the healing and palliative architecture.

In addition, there is a large focus in how the building meet the ground and how they have managed to give the building a feeling of human scale inside and outside the building.



13. ill. The images of Strandbakkehuset

SUSTAINABILITY

Rapid urbanization, social inequality and climate change are three global megatrends that will put humankind to the test during the next decades. Therefore, sustainability will be critical in developing to identify solutions that will allow humanity to survive in these increasingly difficult circumstances. It is crucial that the idea of sustainability must permeate every aspect of how we design our environments and conduct our lives (Ramboll). As a result, it is important to approach the project with a sustainable manner that can both provide a place to recover and one that doesn't worsen the world's climate issue.

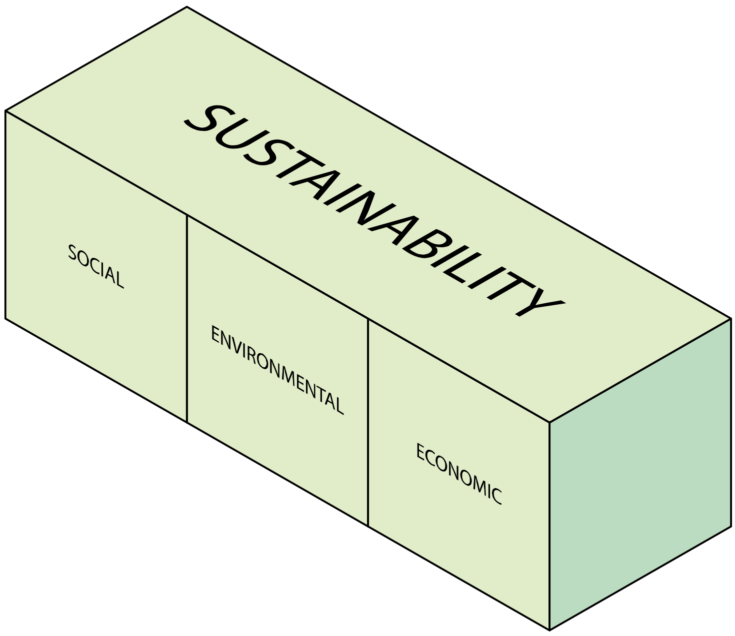
The most famous definition of sustainability originates from the United Nations' report Our Common Future, in which sustainable development is defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their needs' (UN World Commission on Environment and Development, 1987, Chap. 2), (Stender, Walter 2019). Moreover, sustainability consists of three elements that are environmental, economic and social sustainability.

Social sustainability has been characterized as a strategy for developing sustainable effective places that encourage wellness, by understanding what people need from the places they live and work. Social sustainability integrates physical and social domain design, including social amenities, systems for citizen participation, and spaces for people and places to develop. It also includes right infrastructure to support social and cultural activity (Lauring, Michael 2019). Furthermore, Social sustainability focuses on human lifestyles,experiences and behaviors, societies interacting with each other. Users have equal possibilities to access to resources.

The term "**environmental sustainability**" refers to live within the limits of our natural resources. We must make sure we are using our natural resources, such as materials, energy sources, and land, responsibly if we want to live in an environment that is truly sustainable. It focuses on reducing the "footprint" of the built environment on fossil fuels and CO2 emissions, energy consumption and make the building more energy efficient to meet the energy demand, include renewable energy sources. The selection of materials and their properties is crucial when designing a sustainable building with lower emission levels.

Economic sustainability necessitates the efficient and responsible use of building resources so that it can run in a sustainable manner and regularly make an operating profit (Jones, Allen)

The focus of the thesis will be social sustainability by considering spaces for children to evolve, everyday life like home, social interrelations, and sense of belonging. Furthermore, environmental sustainability will also be considered due to energy efficiency, renewable energy sources and appropriate material selection for indoor climate.



14. ill. The diagram illustrating three elements of sustainability.

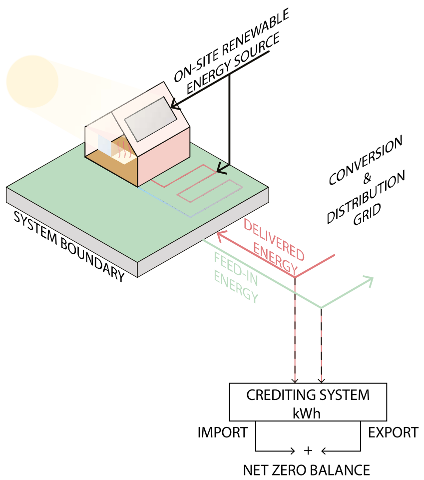
NET ZERO ENERGY

Because of climate changes Denmark has a goal to reduce the production greenhouse gases. The first goal is set to be reached by 2030. The goal is to reduce the emission by 70% compared to the emission in 1990, and by 2050 Denmark aims to achieve climate-neutral society. This is cause by the Paris Agreement to limit the global temperature to 1,5 degrees Celsius (Danish of Ministry 2020).

The Danish building regulations of 2020 is at this point still voluntary. But the requirements that must be reached is an energy consumption limited to 20 kWh/sq. m/ year for residential, dormitories, hotels and building a like. While other buildings that are not residential have a required limited energy consumption of 25 kWh/sq. m/ year (Bygningsreglementet 2023a).

Net zero energy (Net ZEB) is a concept of energy balance. The building is seen as the system boundary which is characterised by load and the generation of energy. The load is not only covering the energy demand but also the efficiency of the technical installations. The generation of energy also includes the losses in relation to storage and conversion.

The renewable energy sources on-site include passive and active measures. Passive inform of passive solar gains through windows and active strategies being heat pumps either atmospheric or ground sours, but it also includes electricity that can be fed back to the grid. The grid is a general term for all the various supply systems the building may be connected to. The energy by the grid to the building is called delivered energy. While it is call feed in energy when it is the energy from the building into the grid. The credit system is used to convert different physical units into metrics this could be primary energy or equivalent carbon emission. This is done to evaluate the energy chains efficiency.



15. ill. The diagram illustrating the distribution of energy.

INDOOR CLIMATE CONDITIONS

Thermal comfort is determined by calculating the Predicted mean vote PMV and predicted percentage of dissatisfied PPD. Furthermore, the Danish Building Regulations has the following two recommendations. For non-residential buildings a maximum of 100 hours above 26 degrees and 25 hours above 27 degrees will usually meet the provision. While for residential buildings it is recommended a maximum of 100 hours above 27 degrees and 25 hours above 28 degrees will usually meet the provision (Bygningsreglementet 2023b).

Atmospheric comfort. According to guidelines in the Danish Building regulation there is the requirement to ventilation in hospitals that the CO2 concentration needs to be kept under 900ppm. But there is not a minimum required ventilation for hospitals and healthcare buildings. So, the rule used in residential buildings will be applied. §443-446 is sating a minimum of 0,30 l/s sq. m. in the entire building except for bathrooms it is 15 l/s and for toilets it is 10 l/s (Bygningsreglementet 2023e).

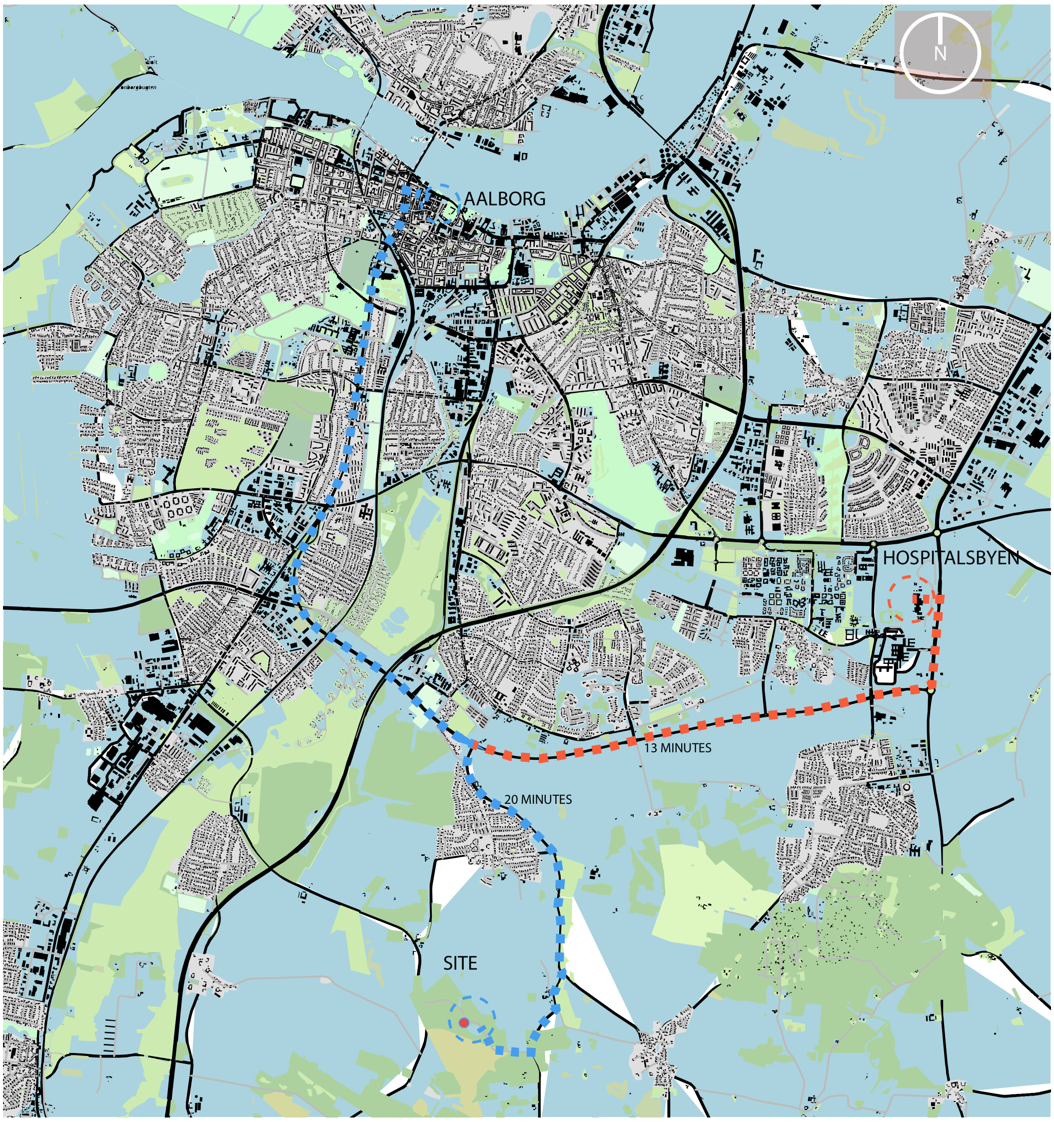
Acoustic comfort for residential and other building with accommodation is cover by the Danish Building Regulations in §369-373 (Bygningsreglementet 2023d).

Visual comfort including daylight. Regarding visual comfort the Danish Building regulation §378 stats that all rooms of longer occupation should have windows that insure visual contact to the context. Windows and shading need to be designed and executed so the visual connection are maintained.

§379-381 The daylight needs to be sufficient in all rooms of longer occupation. This can be documented with the 10% role, or with daylight calculations that document minimum of 300 lux or more in at least half of the relevant floor area (Bygningsreglementet 2023c).

SITE ANALYSIS

MAPPING



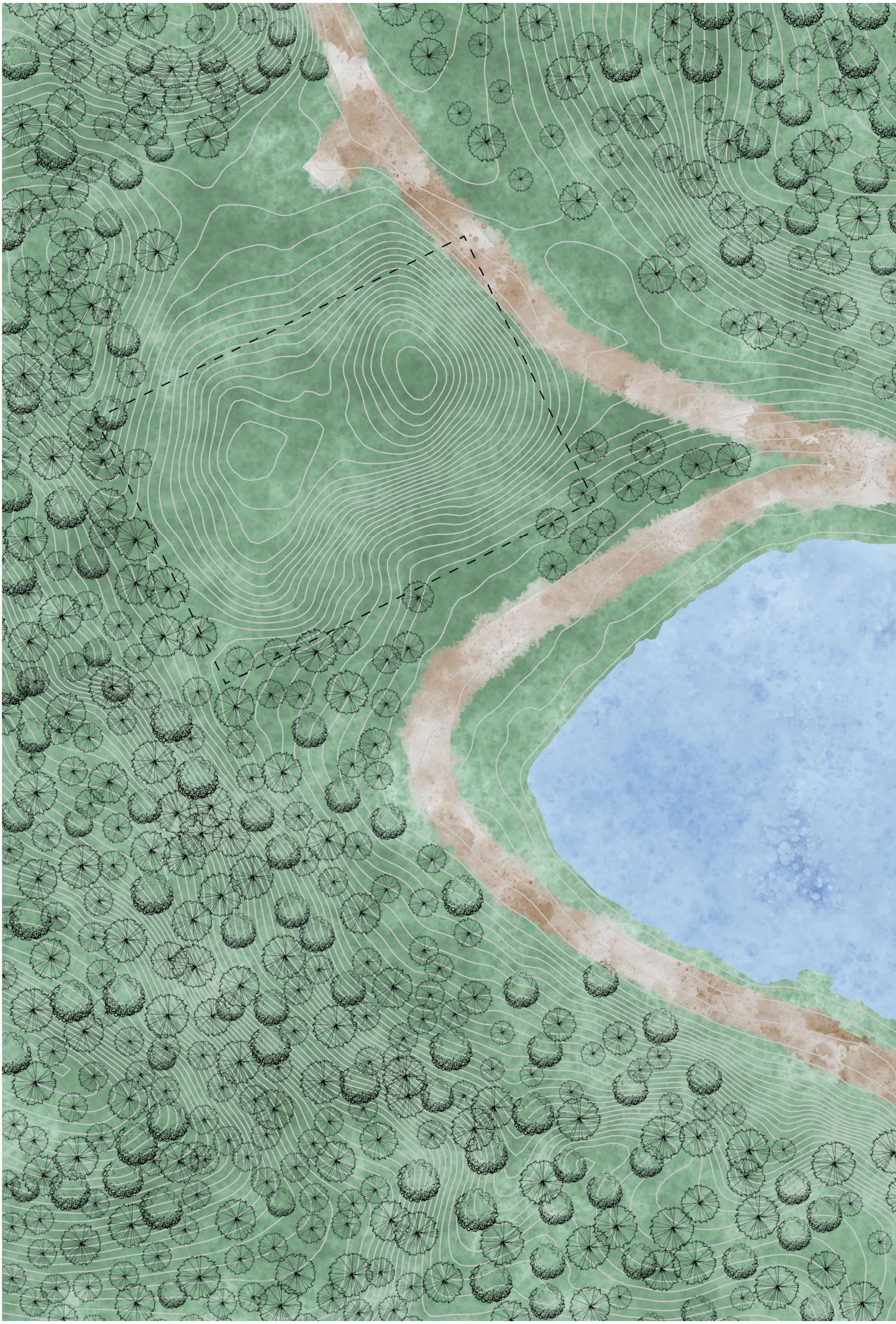
16. ill. Map showing location of site in relation to Aalborg

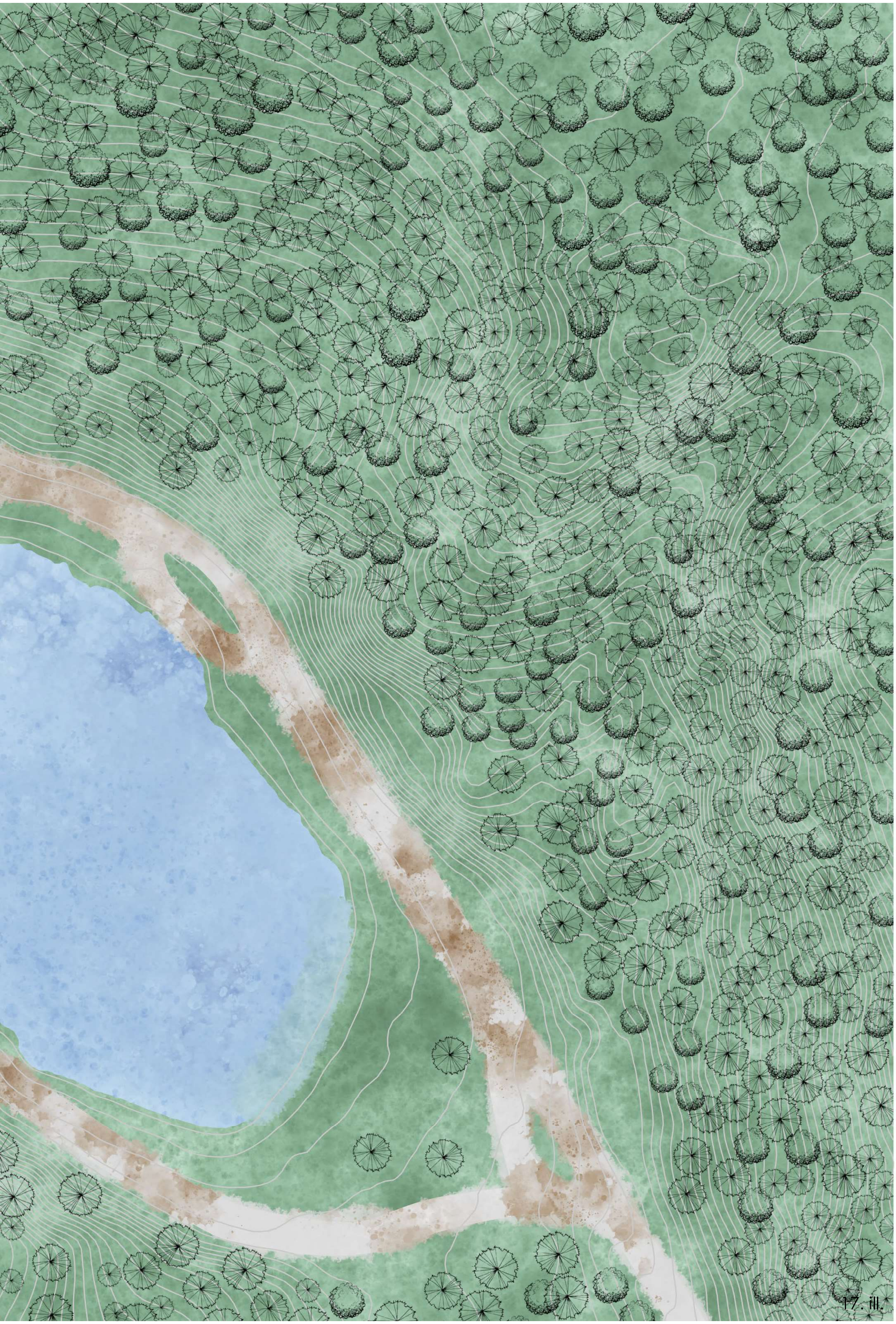
VEGETATION

Poulstrup Sø contains a wide range of plants that surrounded by more dense vegetation. The area's forests consist of tree species such as oak, beech, rowan, aspen, birch, beaver aspen, red spruce, and Norway spruce. In contrast to the noise, the vegetation creates a quiet and peaceful environment. Towering trees with crowns, bushes, and shrubbery are the defining features of the area, giving it a natural and unmaintained appearance. Kuma himself refers "a forest of deciduous trees, where you can enjoy sunshine filtering through." This light filtering enhances the spiritual nature of the space, due to the constant changes in light quality throughout the day (Schwartz 2017).

On the other hand, vegetation allows improving the architectural and environmental quality by lowering the temperature in its surroundings, the air quality, incrementing biodiversity and solar shading thanks to its cooling and refreshing capacity, beside an aesthetical value. For instance, the plants absorb solar radiation and reduce the warming up of hard surfaces, great quantities of solar radiation are adsorbed for the growth of plants and their biological functions, thus regulating the local climate. It shields against wind and humidity during the winter, whereas in the summer, it shields interior spaces from excessive heating by obstructing solar radiation (Perini, Magliocco 2012).

Additionally, vegetation must be considered in the hospice when creating healthy indoor environment for occupants, the vegetation must be integrated in the building to increase their productivity and visual quality that a natural environment provides.





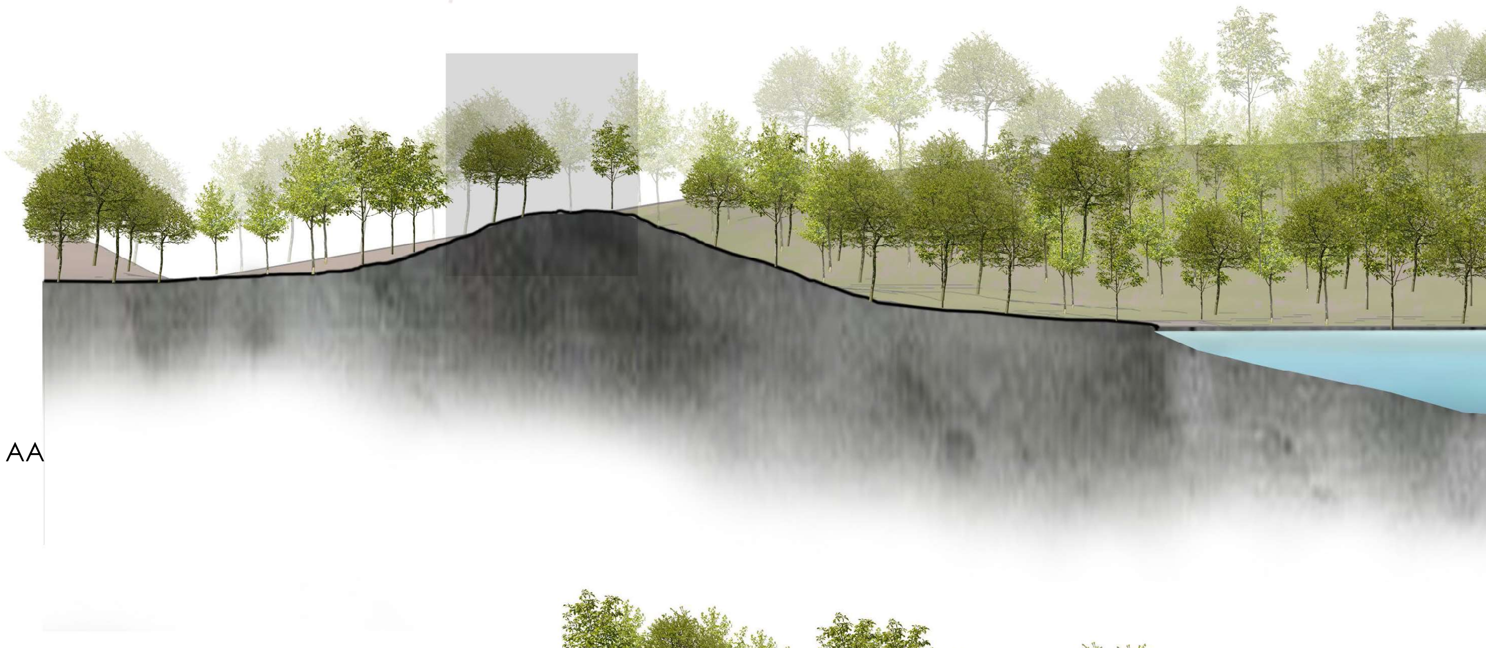
17. ill. Site map

THE SENSE OF PLACE

A large part of the area consists of the original Dall heath. The hilly landscape was formed during the last age more than 1000 years ago, where discharges of molten sand laid the foundation for the later heath. There is remains form the ice in the form of large stones and lead bubbles from the Scandinavian bedrock (Enjoy Nordjylland 2021).

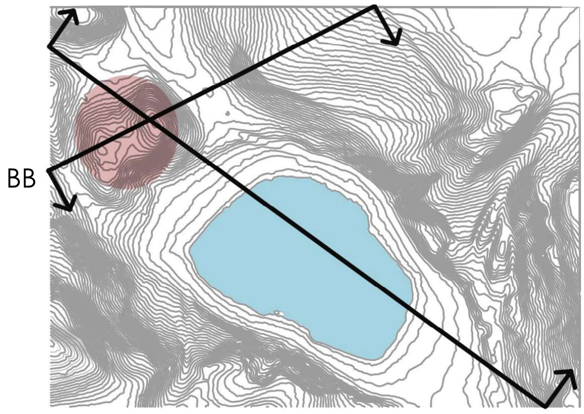
Poulstrup Sø is a stunning natural area with numerous lakes, marshes, grassland, forest, and scrub that is situated between the hills. Poulstrup Sø has an impressive atmosphere due to its bush-covered hills and majestic towering trees with crowns that reflect light and create sparkles on the forest floor. It is easy to explore among other things, the well-marked walking paths both for hiking, mountain biking and horse riding. There is also a fenced area intended as a dog park and plenty of good seating options with tables and benches.

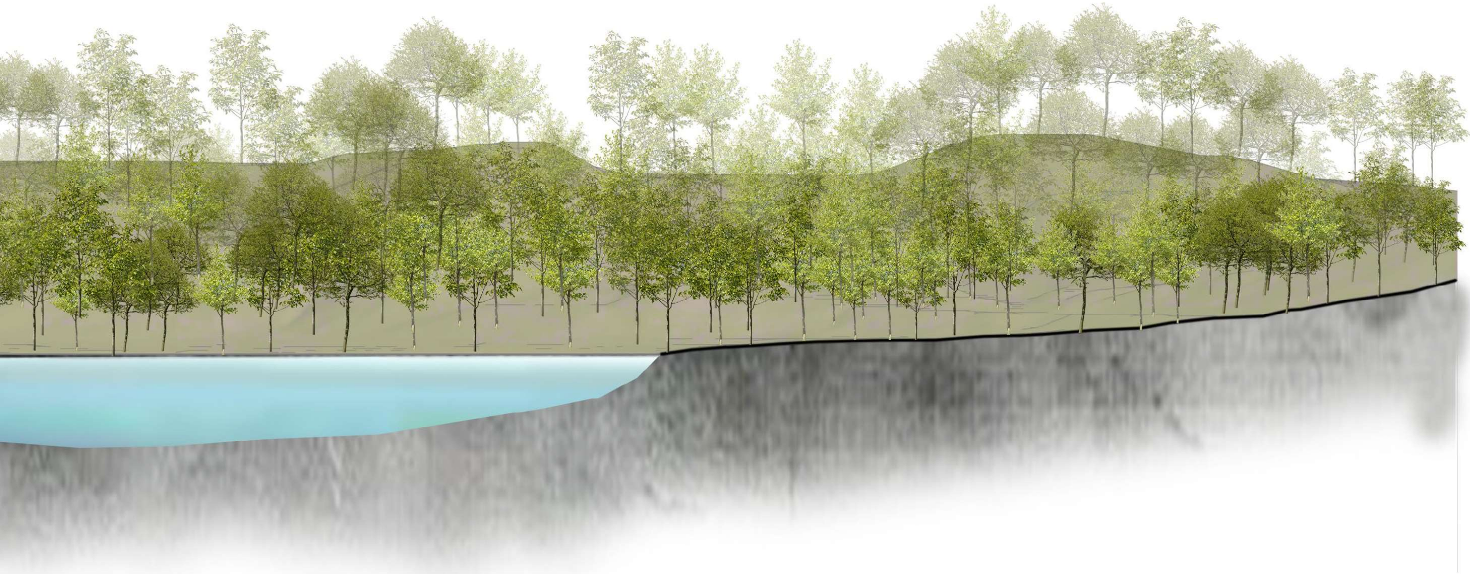
While approaching the chosen spot for children hospice, there is a beautiful view of the lake to the



south. The area is surrounded by alleys of tall trees, which give it a vibrant and airy appearance. The chosen location consists of hilly landscape and situated quite high above the lake which provides a clear appearance towards the lake and allows to discover the surroundings and the sun to shine. The western side of the location is covered with towering trees and evokes a natural fence to the site. The swaying of the tree leaves against the wind creates a calm, peaceful and quiet atmosphere to the surroundings.

The northern side allow the landscape and paths to seep through the location, which takes on the character of a clearing in the forest and the topography slopes down slowly towards the stone covered path where people access to the lake. The site towards east is rising to a hill then suddenly the terrain slopes downward that separating the location from the dense forest. A path runs just below it, and beyond it, the tree density increases as the land slopes upward.





18. ill. Site section AA and BB 1:1000

MICROCLIMATE

WIND

Effectively utilizing natural ventilation requires an understanding of wind directions during the warmer months. Efficient natural ventilation lowers humidity, cools the area, and improves thermal comfort, therefore the wind-rose analysis is one of the important parameters to be considered.

DEC- FEB WIND ROSE

Looking at winter season, the wind rose indicates that the wind is blowing from the west and south-west to the east and north-east. The site towards west is surrounded by primarily deciduous trees and creates a wind barrier throughout the winter.

MARCH- MAY WIND ROSE

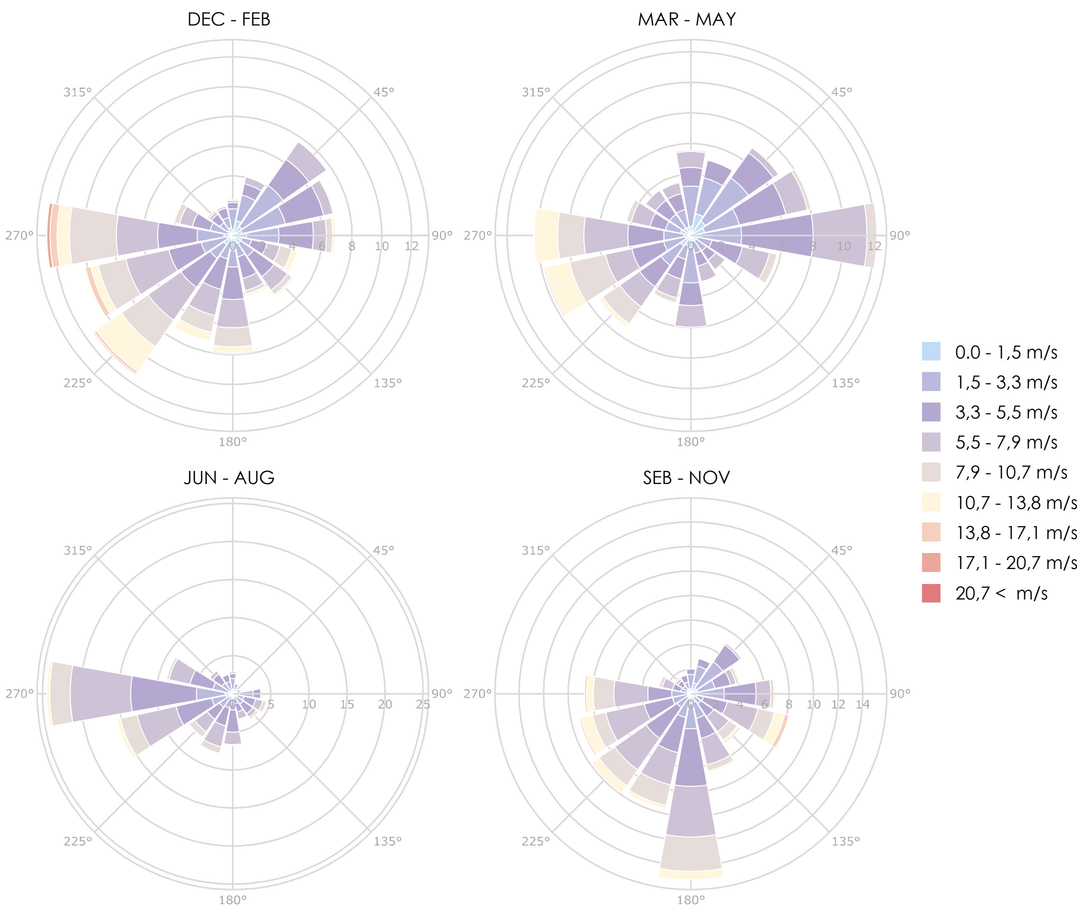
During the spring, the wind is more dominant from east, and it picks up its speed from west. Towards the south and east, there is a slight dominance. The site is open to east and south therefore higher temperatures in spring days the wind reduces the indoor environment and adds fresh and clean natural air to the indoor area.

JUN- AUG WIND ROSE

In the summertime of the year, the wind comes from west and south-west. During the summer, the building's ventilation and interior air circulation will be impacted by the direction and speed of the wind in the outdoor environment. It is a key to solve natural ventilation problems based on wind direction. It can be useful by enhancing indoor air quality and user's comfort.

SEB- NOV WIND ROSE

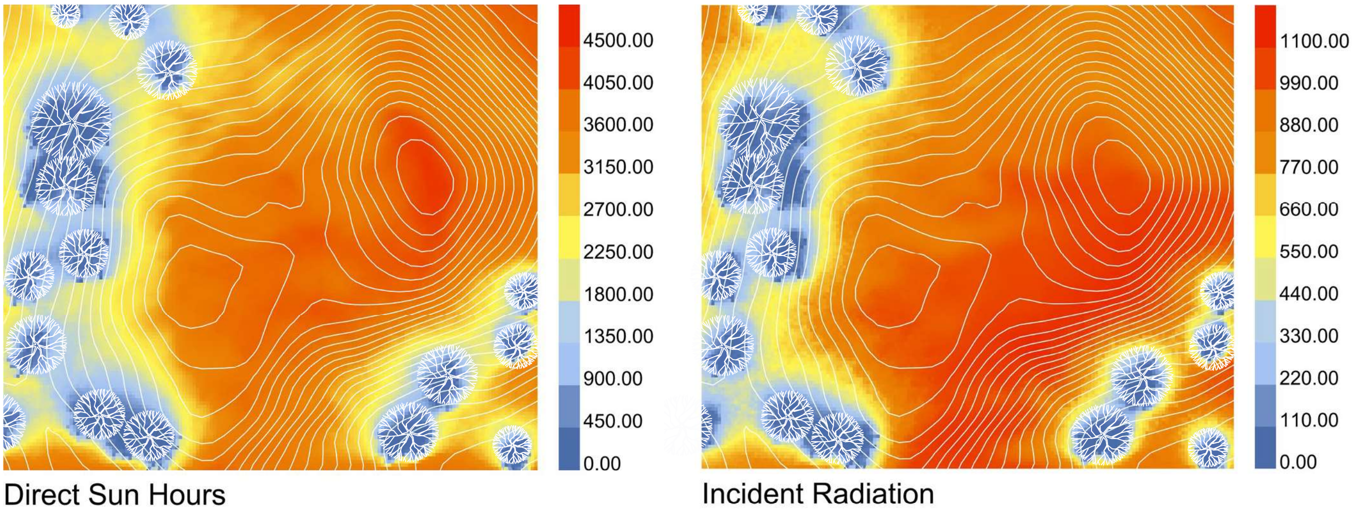
The wind picks up speed during autumn, with stronger winds coming from south. In the autumn, sheltered outdoor spaces are more necessary because of the lower temperatures. This provides it to shape outdoor functions and activities according to the user's needs.



19. ill. The diagram showing wind rose for each season.

Sun analysis give a deeper understanding and comprehensive picture of how the sun affects the chosen spot for hospice. It allows us to assess the impact of shadows cast by surroundings such as trees and land features. During the winter, the days are shorter, with sunrise at 8.00 a.m. and sunset at 4:00 p.m. Long summer days are also experienced in Denmark, where sunrise and sunset occur at 3.00 a.m and 10:00 p.m, respectively. From the sun diagram, it indicates that the sun is only by 9 degrees above the horizon in winter and it reaches 56 degrees above the horizon in summer (Betti, Tartarini et al. 2022).

The chosen site that is open to the sun provides to work with both direct and diffuse daylight. Direct sunlight is determined how much heat energy the sun delivers to the interior space throughout the day and year. It means that, more heat gain is preferred during the winter when the sun is lower, while the sun is in a higher position less or no heat gain is preferred during the summer. A thoughtful approach to architectural design is necessary in summer with a consideration of allowance, diffusing, shading, and reflecting (VELUX, 2021).



20. ill. The diagram showing direct sun and sun radiation.

SHADOW

A special combination of light and dark exists in shadows. Light and shadow are basic and interconnected, having greatly influenced how we see space and time. Since that people presently spend the majority of their time indoors, it can be beneficial to integrate the augmentation of time orientation into lighting design to help people feel more connected to nature's light-dark rhythms (Angelaki, Triantafyllidis et al. 2022). Therefore, while orienting the building, a shadow analysis is quite important since it has an effect on massing and orientation. It provides how much solar enters to different parts of the site. Shadow analysis significantly influence the mass and direction of the building and the site in terms of topography effects, tree effects, and other factors. Passive strategies might be used for maintaining outdoor comfort for example shading can be integrated to the outdoor spaces.

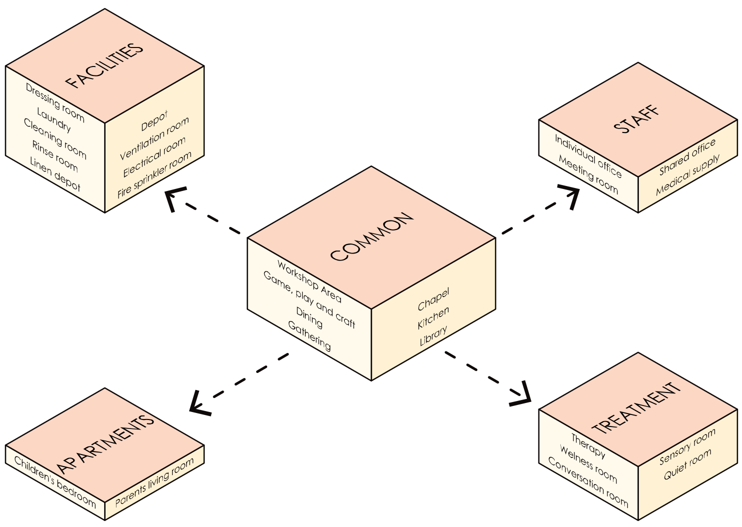
ROOM PROGRAMME

ROOM	AMOUNT	AREA	TOTAL AREA	CAPACITY	AIR CHANGE
APARTMENTS				**3-6**	
Childrens bedroom	6	25	150	1	
Parents/Living room	6	20	120	2-5	
Bathroom	6	10	60		
Visitor room/staff accomedation	3	15	45	2	
SOCIAL					
Gathering area	1	70	70	40	
Games/Play/Craft	1	40	40	6-12	
Library area	1	30	30	1-12	
Chapel	1	20	20	1-12	
Kitchen/dinning room/meeting area	1	70	70	40	
Workshop area	1	40	40	1-12	
Toilet	2	5	10		
TREATMENT					
Therapy room	1	20	20	2-4	
Wellness room	1	25	25	2-4	
Sensory room	1	25	25	2-4	
Quiet room	1	10	10	2-4	
Conversation room	1	20	20	2-6	
Toilet	2	5	10		
STAFF					
Individual office space	2	10	20	1	
Shared office area/Arrival entrance	1	40	40	2-6	
Meeting room	1	20	20	10	
Medical supply/Medicine room	1	15	15	2-3	
UTILLITIES FACILLITIES					
Laundry room	1	15	15	1-2	
Cleaning Room	2	5	10	1-2	
Sterilisation room	1	10	10	1-2	
Linen depot	1	10	10	1-2	
Ventilation room	1	30	30	1-2	
Electical room	1	10	10	1-2	
Depot	2	35	70	1-2	
Fire sprinkler room	1	20	20	1-2	
TOTAL			1068		1388,4
OUTDOOR FACILLITIES					
Playground	1		0		
Car parking	12		0		
Bike parking	17		0		

TEMPERATURE		LIGHT	ORIENTATION	VIEW	ATMOSPHERE	EXPLANATIO
Self regulated	18-21		west/north west	Forest	Calm, Difuse light, Homely	
Self regulated	18-21		west/north west	Forest	Calm, Difuse light, Homely	
Self regulated	20-21					
Self regulated	18-21		west/north west	Forest	Calm, Difuse light, Homely	
Central control	21		View to lake		Open, Social	
Central control	21		North east		Creative, Active, Playful, Joyfull	
Central control	21		East		Quiet, Calm,	
Central control	21		Buffer		Quiet, Calm,	
Central control	21		South east	lake	Open,Social, Enjoyment,	
Central control	21		Buffer			
Self regulated	19-22		south west		Quiet, Calm	
Self regulated	19-22		south west		Relaxation, Quiet	
Self regulated	19-22		south west		Experience,	
Self regulated	19-22		south west		Relaxation, Quiet	
Self regulated	19-22		south west		Safe, Calm	
Self regulated	19-22		south west			
Self regulated		300 lux	North		Calm, Quiet	
Central control		300 lux	North		Openess, Social	
Self regulated		300 lux	North		Openess, Productivity	
Central control			Buffer		Organized	
Central control	19		Buffer		Hygienic, Organized	
Central control	19		Buffer		Hygienic, Organized	
Central control	19		Buffer		Hygienic, Organized	
Central control	19		Buffer		Hygienic, Organized	
Central control	19		Buffer			
Central control	19		Buffer			
Central control	19		Buffer			
Central control	19		Buffer		E	
			south east	Next to lake		DESIGN
			North			
			North			

21. ill. Room program

FUNCTION DIAGRAM



22. ill. Function diagram

DESIGN PARAMETERS

Accessibility
– connection outdoor with indoor
Spaces for children(spatiality)
– playful environment, social interaction
Flexibility
– Utilizing spaces efficiently
Simplistic plan solutions
– simple to understand and navigate
Openness
– inviting and calm environment

Sustainability
- healthy indoor environment
Low energy consumption
– passive and active strategies
Construction
– structural integrity
Adaptability
– adapt to climate
Materials
– local sourced materials
Facilities
– care possibilities

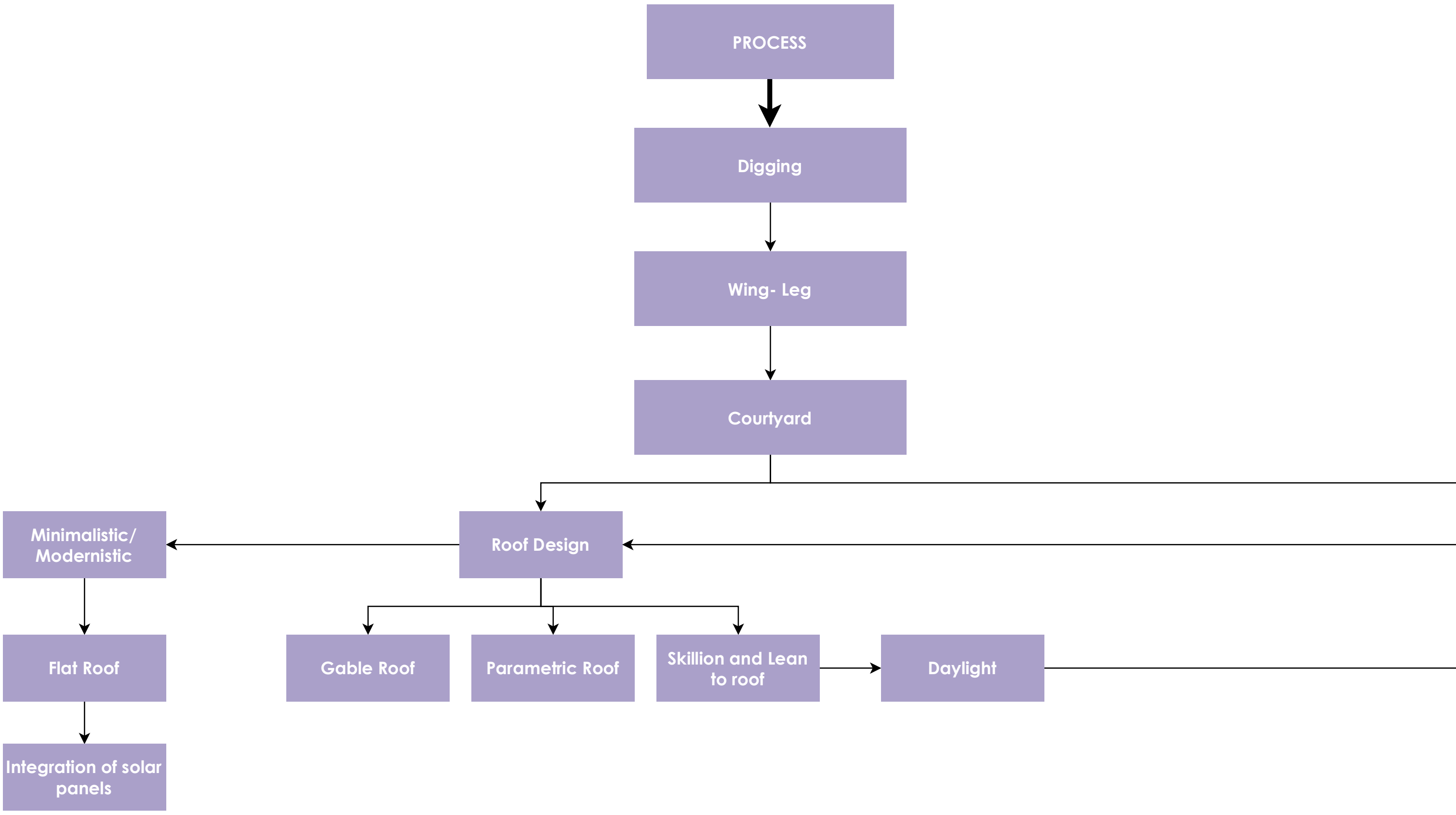
Daylight
– Contrast, colours, and shadow
Atmosphere
- perception and feelings
Human experiences and scale
– sensory experiences
Integration of greenery
– biophilic design
Proportions

23. ill. Design parameters

DESIGN-PROCESS

DESIGN PROCESS

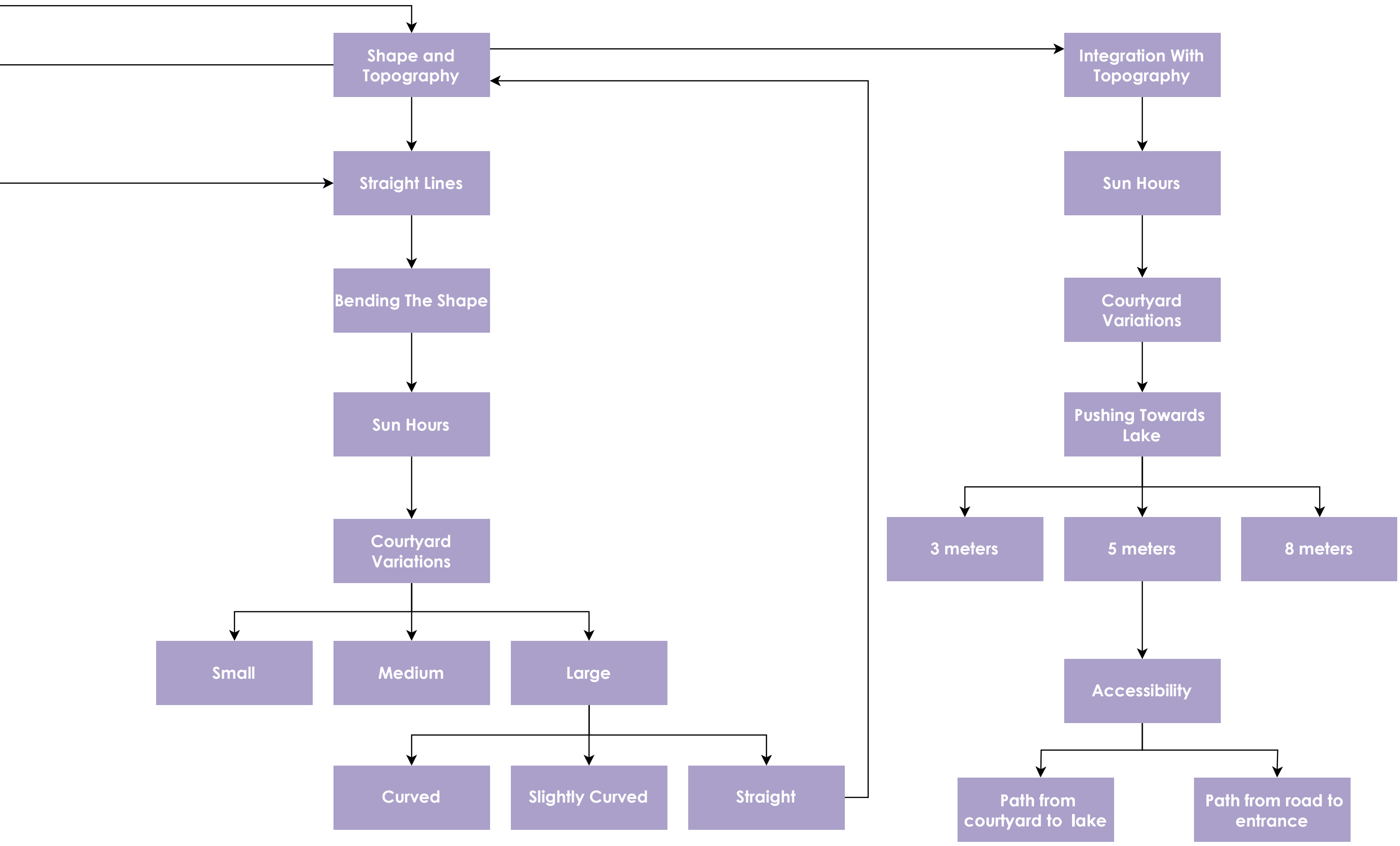
This part of the report is describing the design process. The design process used in this project is built on the base of being an iterative process, the Integrated Design Process by Mary-Ann Knudstrup. It means that the design process is built up like a timeline showing the decision making during the process and how this affects the design. The process is divided into different phases. Each phase has a small sub-conclusion with an illustration of the design at this stage of the process, so it is possible to follow the process and see the evolution



of the design.

The figure# is a simplified illustration of the process with only the arrows as indication of the direction of progress.

The timeline figure# is illustrating the phases of this part of the report in a linearly progression from star to presentation.



24. ill. Development of the design process.

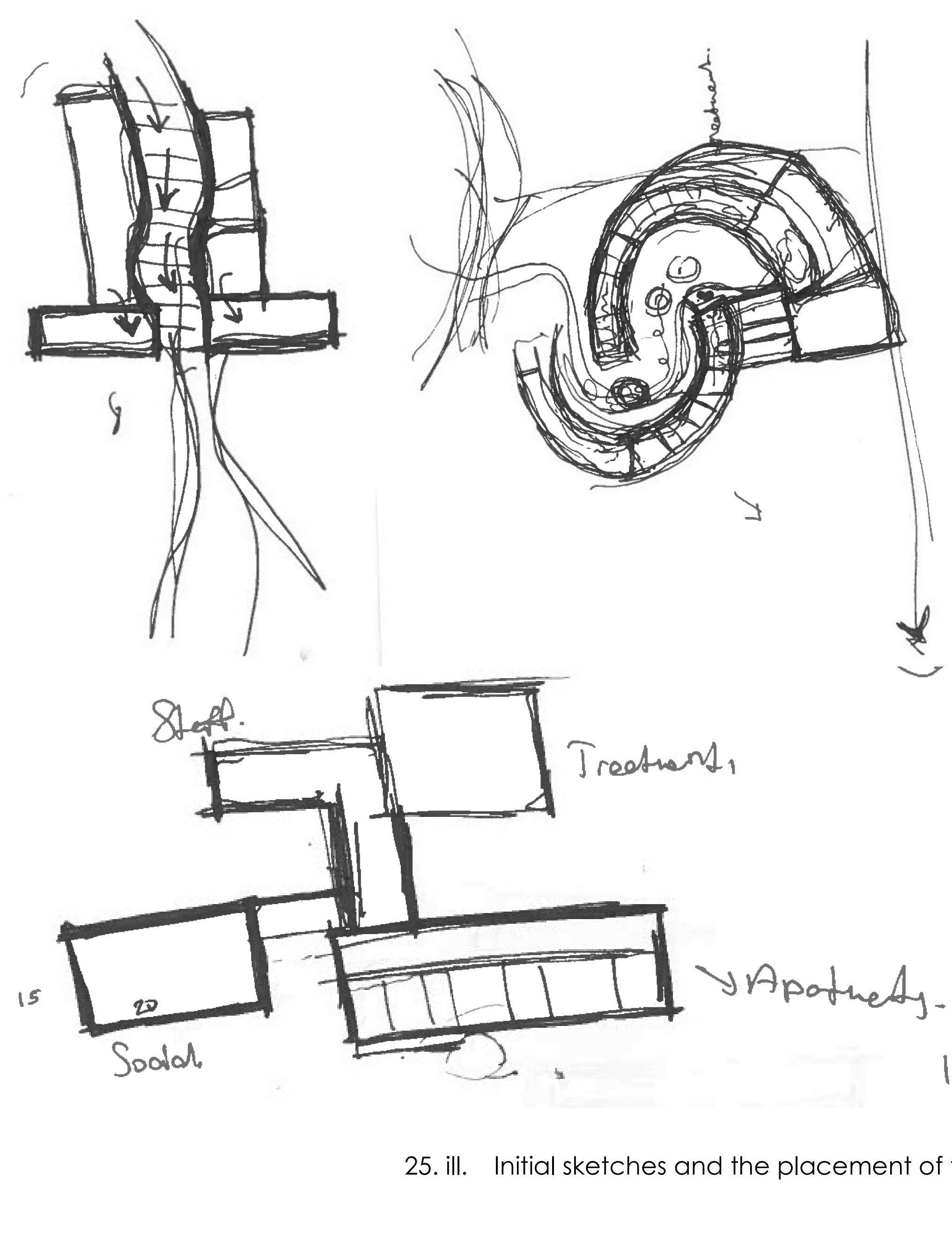
Considerations during the process

During the process the design parameters have impacted the design in various ways. Some of the parameters have had a larger impact than others during the different phases of the process. Initially the focus was on the parameters under functionality and as the process evolved the parameters from beauty is impacting the design more and more and the same for the durability parameters. As the level of the detailing is increased some of the parameters are given more focus but all parameters have impacted the design in some way.

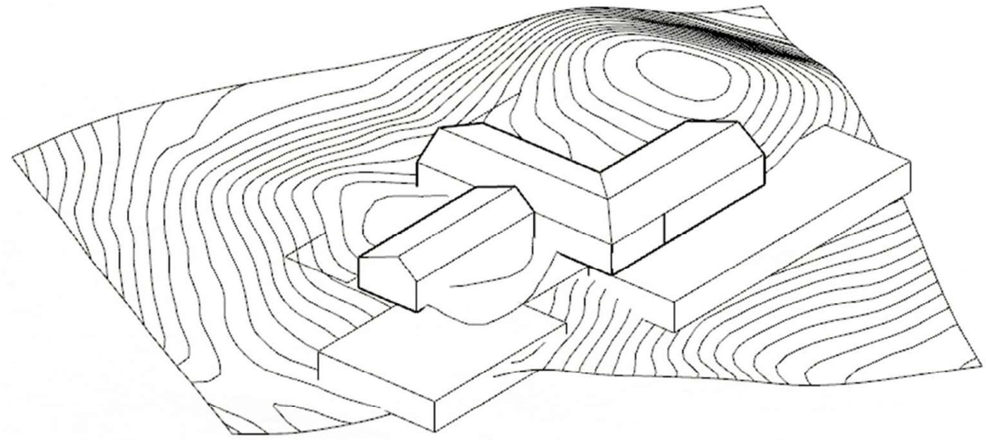
INITIAL VOLUME STUDIES

Physical models and initial sketches were used to study the scale of the site, as well as comprehend the various essential functions, sections of the context, and potential relationships between the volume and these elements.

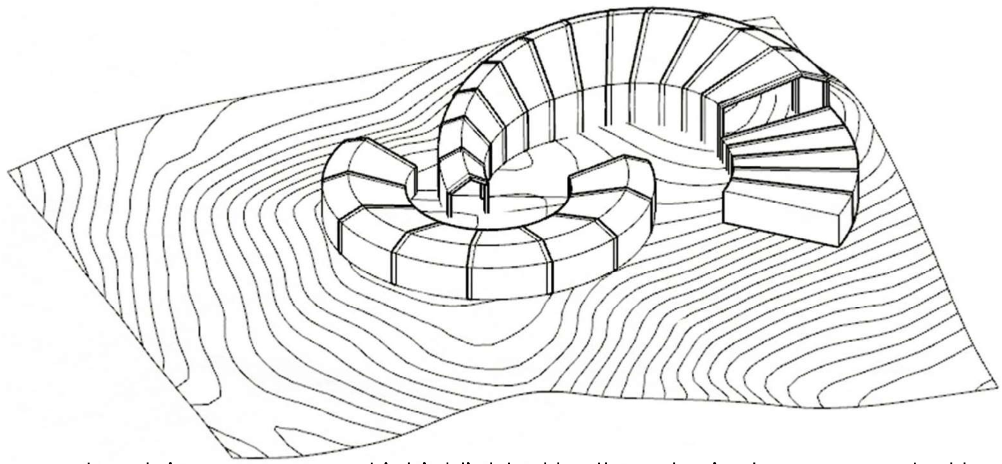
As getting closer to the location of the Childrens Hospice, sloping terrain in general represents with different design approaches and challenges. As a result, it has become a defining component in the project by allowing for multiple approaches, burying itself in the earth or even overlaying it while still maintaining its slope. As demonstrated below, getting initial ideas of these options, three concepts developed through these approaches to interact with the terrain. As a part of the process, the square meters specified in the room programme were put on the site to comprehend the building's floor area and provide a general notion of the height required to achieve the requirements in the room programme.



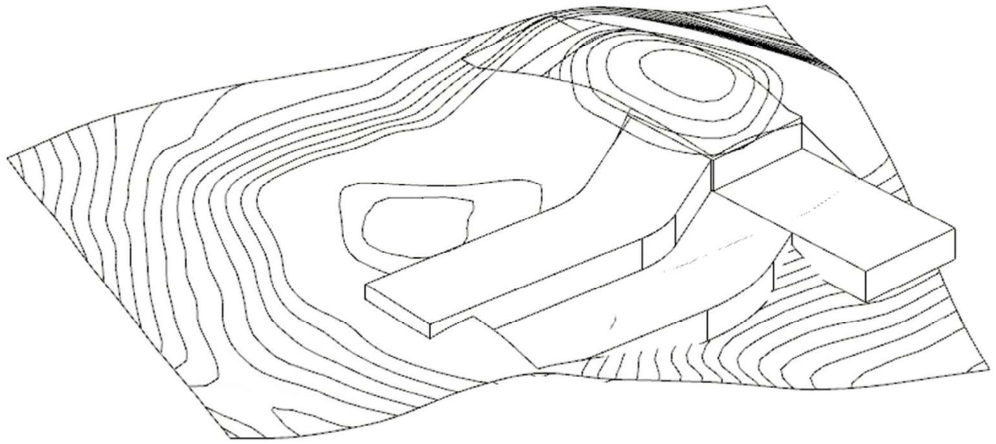
25. ill. Initial sketches and the placement of the functions.



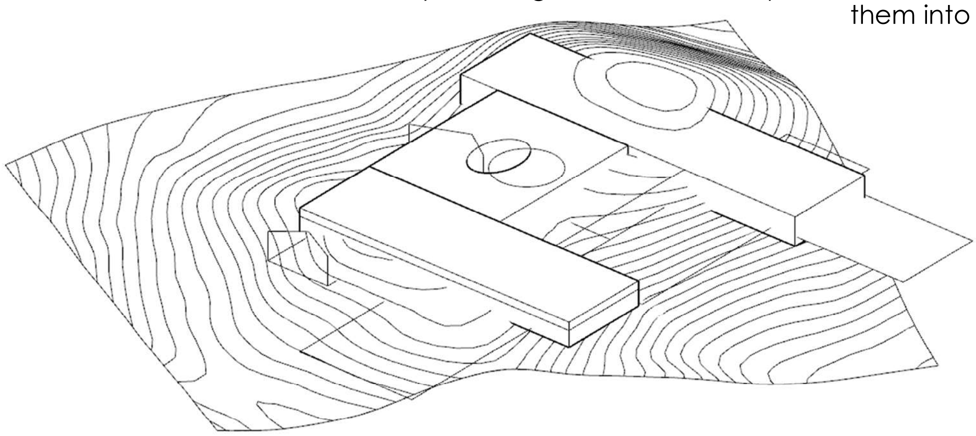
26. ill. Volume is subdivided into different functions that are social, private, staff and social



27. ill. The courtyards inner movement is highlighted by the spherical space created by the entwining of two similarly shaped circular masses.



28. ill. The formation of various volumes by stacking the masses on top of one another and integrating them into the topography.

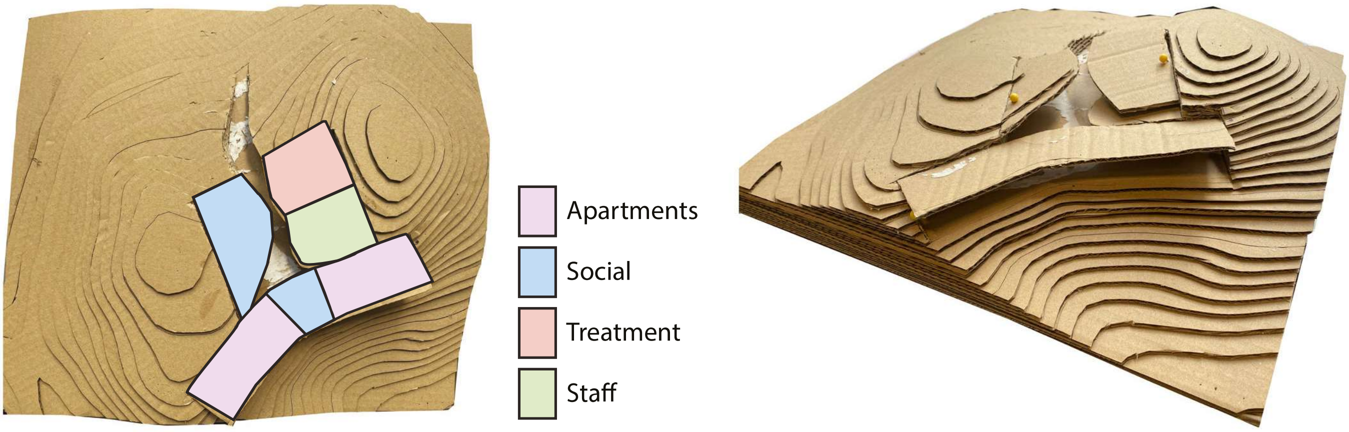


29. ill. Embedding geometry into the terrain towards the lake.

CONCEPTS

DIGGING

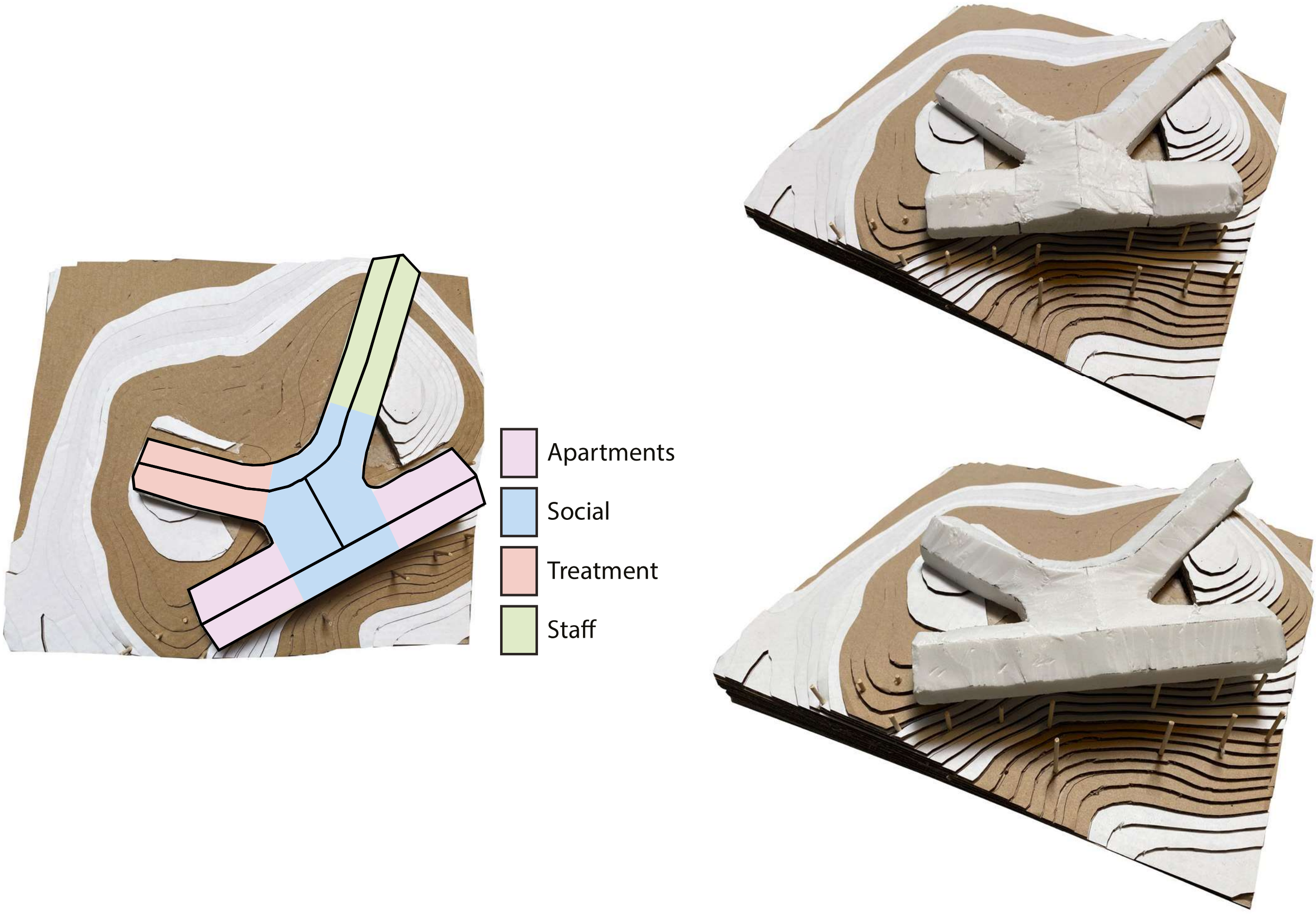
The idea of embedding in the topography that is called digging, how the volume can be integrated with the terrain instead of having geometric shapes and straight lines, natural shapes emerging from the topography. As opposed to merely setting the volume on top of the land, embedding it into the ground allows one way of the integration to the terrain. The volume becomes more rooted and responsive to the earth.



30. ill. Full embedding of geometri in topography

WING-LEG

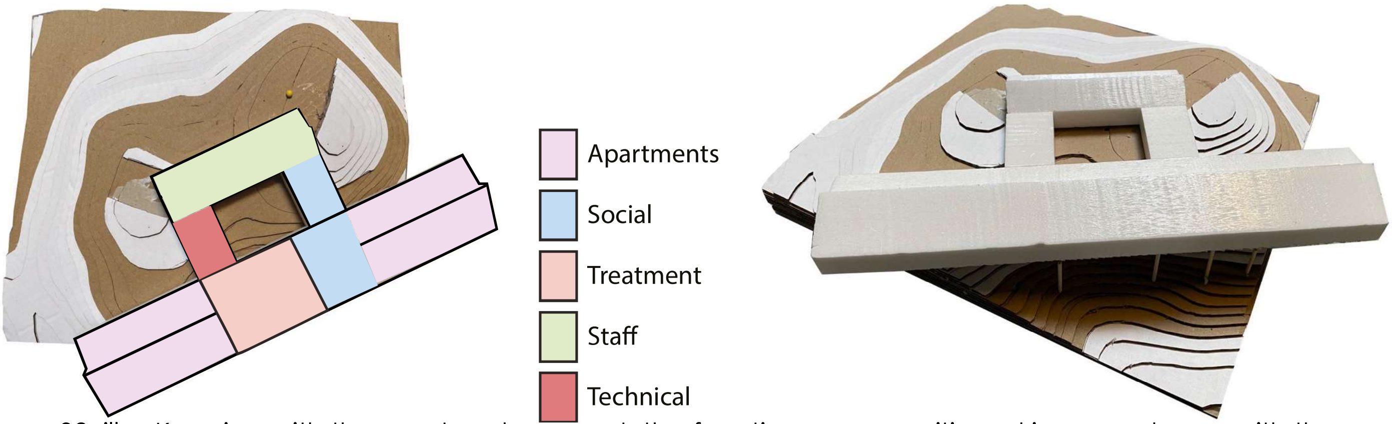
The concept of wing-leg is floating the volume above the ground. Half of the volume is anchored to the ground and other part of the volume is elevated on supports, whether on stilts, piers, or solid walls. Integrating with the terrain in this manner has the advantage of requiring a smaller footprint while minimizing topography disruption. This is another visual way to interact with the terrain.



31. ill. The concept of elevating the volume above the ground.

COURTYARD

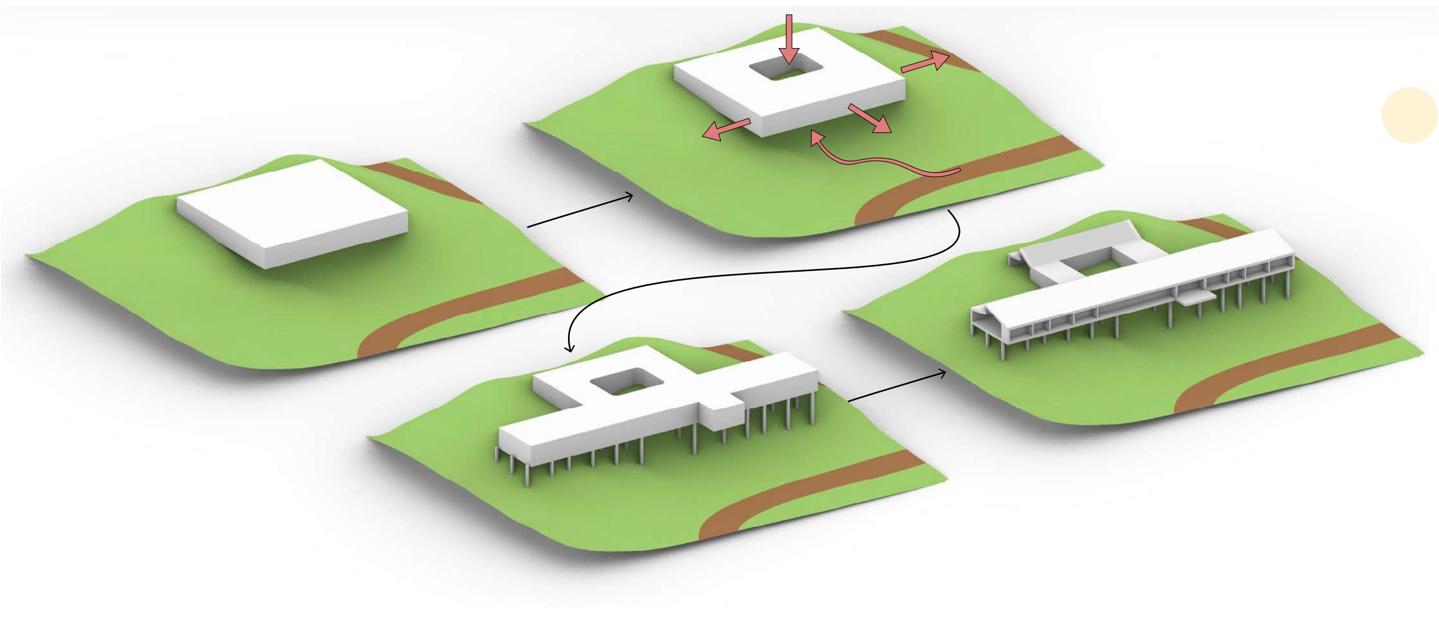
The final approach is keeping the idea of the floating volume above the ground with inserting a courtyard. Because the volume is lack of a visual connection to the lake. The courtyard becomes a direct transition from the building to the lake. In addition, it would be useful for users making courtyard as a meeting and gathering place or creating an alternate form of recreational areas such as sensory garden. For a thrilling and immersive experience, this produces spectacular overlooks under the structure and vistas of the surroundings.



32. ill. Keeping with the courtyard concept, the functions were positioned in accordance with the surroundings

SUB-CONCLUSION

According to the evaluations and assumptions of these concepts, the concept called courtyard is selected. The first approach embedded into the ground creates too much dirt and more earth must be excavated and hauled away, and thicker foundation walls are required to maintain the earth of the sunken building form. Besides this, it was found difficult to get enough daylight into the building and there is some limitations of views due to the placement of the functions. The second concept of floating the building above the ground, the patients do not have equal access to the functions. The placement of functions and volume creates too long corridors. In addition, under the structure cannot be used anymore. The chosen concept of courtyard gives a sense of integration with topography and direct connection from the building to the lake. Under the structure might be used as a path.



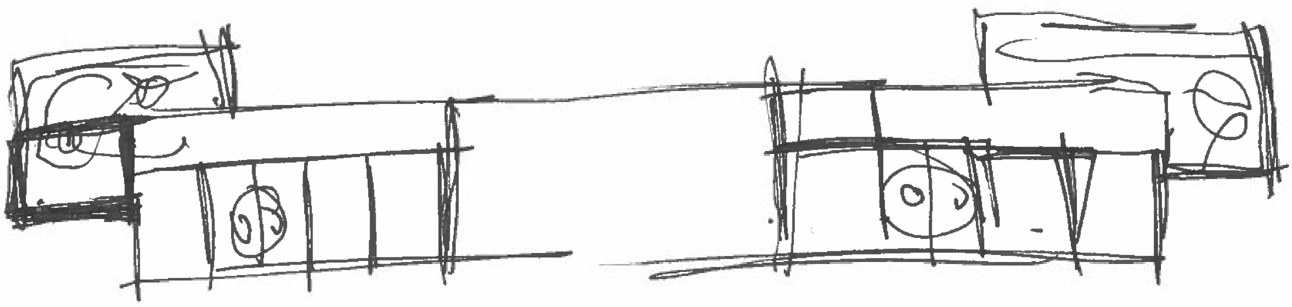
33. ill. Concept development 1

INITIAL PLAN STUDIES

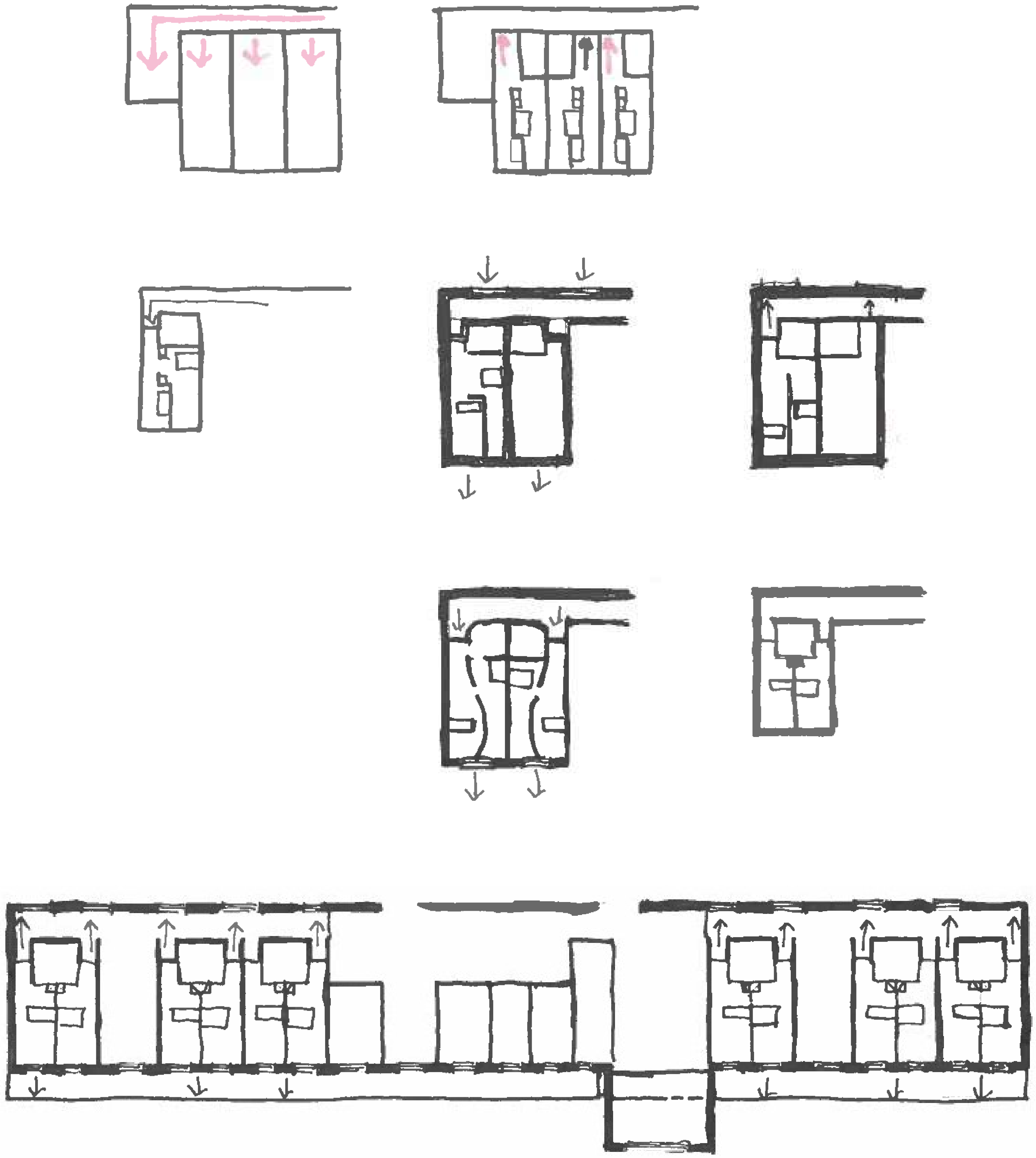
The earliest inquiries into how the hospice should be designed centred around the concept of flow through the courtyard. The next stage was to look into how this flow may be achieved within various plan. The arrangements and placement of the functions, staying within the idea of a building constructed with focus on a continuous flow around the courtyard. The earlier iterations indicated that it would be challenging to position all functions such that they face the lake without making significant adjustments to the site, functionality, and flow. The design direction’s strengths were combined to create an iteration that took site, functionality, and orientation into account. All units are divided into zones to make it easier to place the functions based the users experiences, private, semi- private, quite and noisy zones. Based on the knowledge about healing and palliative architecture, avoiding long corridors, apartments are divided into two zones. Patients’ rooms are oriented towards the lake. Giving the same accessibility for patients, the treatment and kitchen are placed in between the apartments and have the view towards the lake. The placement of the staff is considered to close to the entry where users get into the hospice. Some of social units are placed towards east having a view to the dense forest.

The concept of niches as semi-private rooms of varied sizes has been a key emphasis point throughout the plan’s revisions. Through iterations, it was considered that adding niches to the patient room’s entrance area would increase privacy and placing semi-private recessed niches opposite the patient room’s entrance creates semi- private spaces instead of having long corridors.

In addition to the concept of the room requirements, criteria were generated through analysis of an interview, appendix 1, with Lisbeth Refshauge Højer at Strandbakkehusset and the program’s description of research into healing and palliative architecture (Højer.2023). The facilities should provide space for both the patient and the family members, as the comfort of the family members affects how much they participate in daily care. Based on iterations, the idea was to give two access to the apartments, when nurses get in for the treatment not disturbing the patients. According to the first iterations, pushing the bathroom to the backside of the hallway and giving more spaces towards the lake but long room depth creates unpleasant spaces and making it challenging to fit in the required furnishings. In relation to the second and iterations, implementing the concept of niches is reducing the corridors inside the room, at the same due to the high depth of the room give issues more natural light get in.



34. ill. Placing the patient rooms towards the view and adding the common areas.



35. ill. Creating niches for patient rooms entrances and plan studies.

Circulation

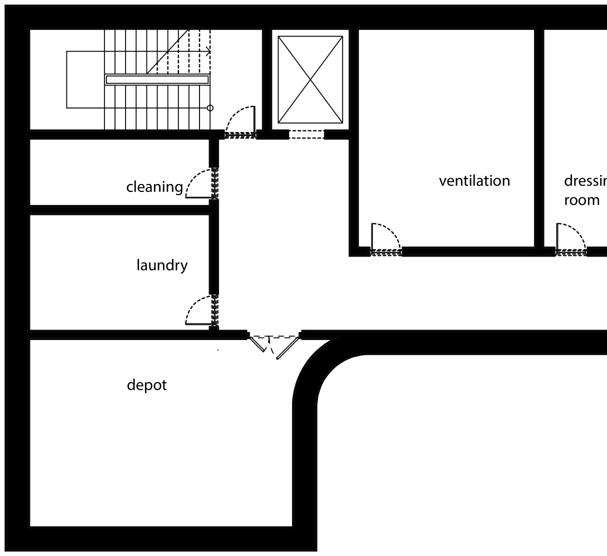
Apartments

Social

Treatment

Staff

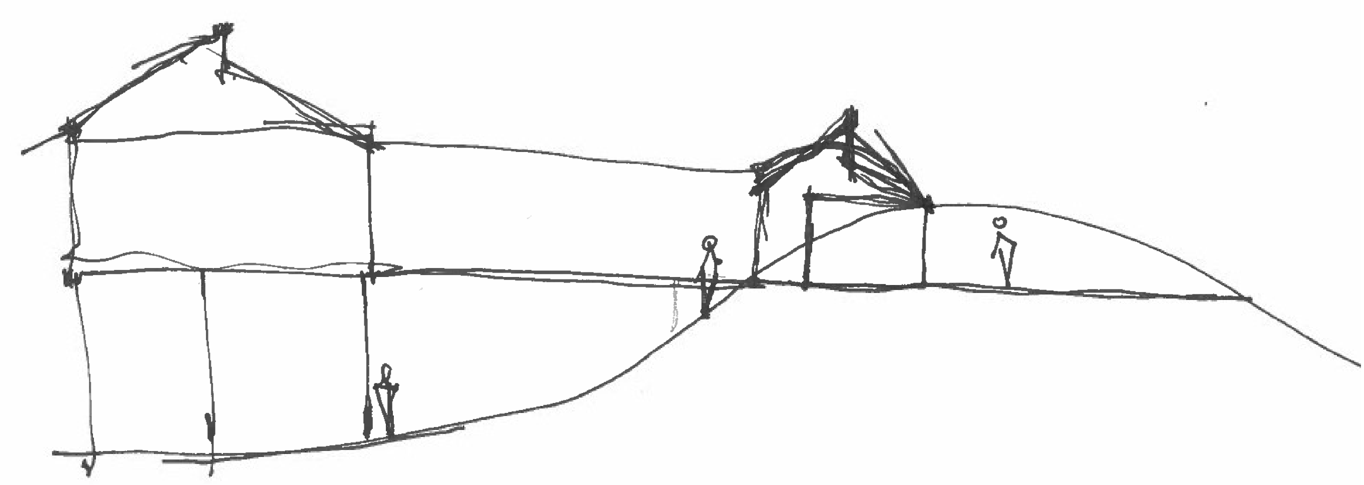
Technical

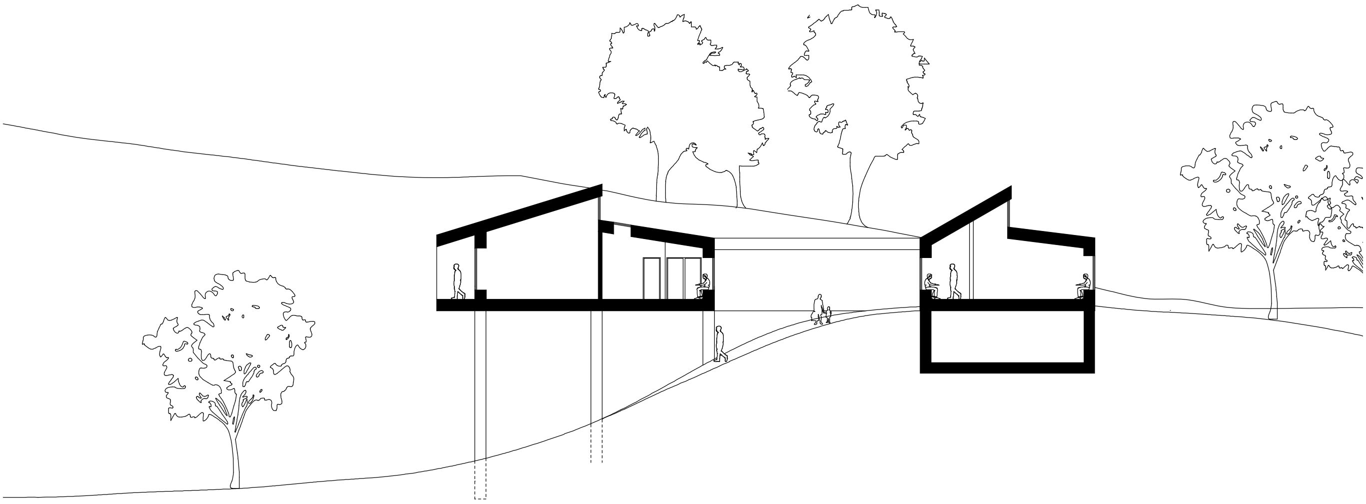


36. ill. Function placement is shown by colored boxes.

ACCESSIBILITY

One of the focus was on examining different perspectives given by the surroundings and how it may highlight the transition from the outside world to the children's hospice. The idea is to utilize the existing path from human's footprint and the small parking spot as an entrance to the site. The place where the building is located and its entry to the land are separated by an elevation difference of 6.5 meters. The diversity of individuals, their requirements, and how to incorporate them into a design are important considerations in making spaces that work for everyone. In addition to making it easier to traverse between different levels and heights, ramps are among the architectural features that increase a space's accessibility and provides users with disabilities equality and social inclusion, which relates to issues with their mobility and freedom to come and go. The entrance on the north side of the building is considered to allow users to drive right up to a drop-off area. The ramp has an inclination of max. 5% that make it easier to access for wheelchair users. The idea of the ramp is also implemented in the courtyard to give direct transition to the lake.





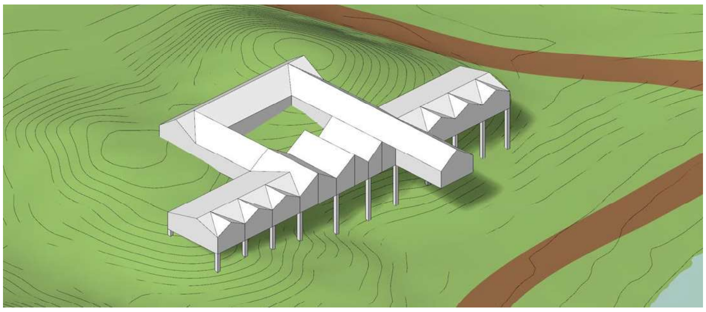
37. ill.   Providing a transition of the courtyard towards the lake.

ROOF CONCEPT DESIGN

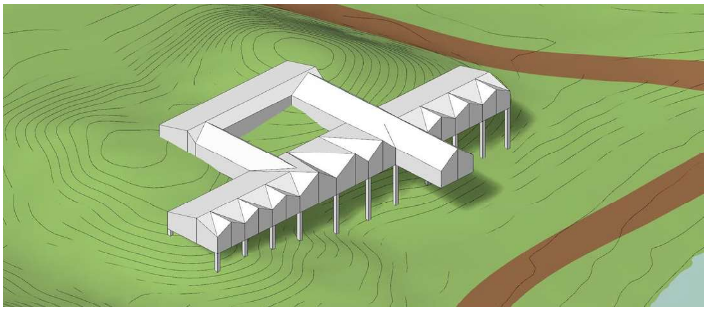
Following the choice of the courtyard concept a study on the roof design was made. The aim of this phase was to make the building integrated with the topography. This evolved into three different iterations of the roof.

GABLE

The idea of the gable roof design was to break the large volume into smaller units to give the building the expression of being composed by individual volumes becoming one large building. The façade should highlight the functions and the size of them.



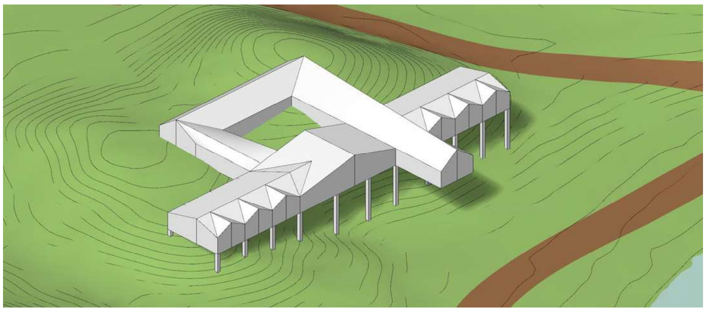
38. ill. Gable roof design 1



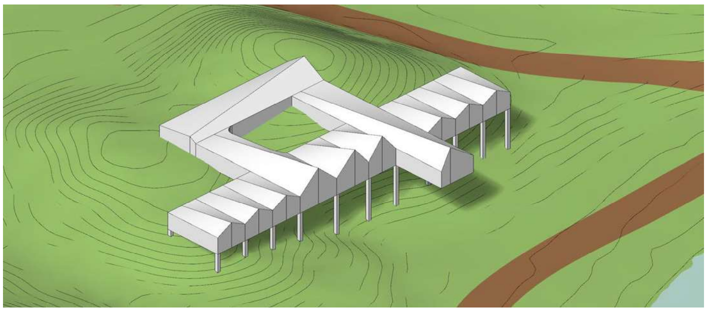
39. ill. Gable roof design 2

PARAMETRIC

The parametric design aimed at giving a more coherent roof design where gable and pitched roof were floating together into one roof design. During the process of this design there was a focus on keeping at least on surface orientated in a direction fitted for photovoltaics.



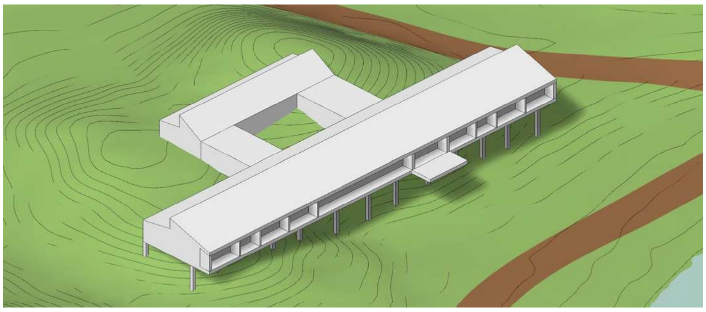
40. ill. Parametric roof design 1



41. ill. Parametric roof design 2

SKILLION & LEAN

The skillion and lean design focused on simplifying the design. And because of the apartment design at this stage was a deep rooms with a narrow façade the skillion and lean design would make it possible to implement a window in the vertical face of the skillion and lean roof design. Giving the apartment defuse light helping to light up the room deeper. This concept for the roof was also implemented into the treatment, shared functions, and parts of the staff function.



42. ill. Skillion and lean roof design

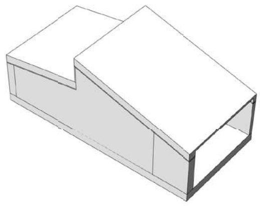
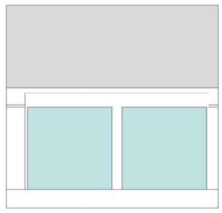
SUB-CONCLUSION

The gable roof design did not feel like it worked with the topography and the fact that the building is elevated as much as it is made it look complex. The small units the many edges and roof ridges did not give the simple and calm expression that was the aim. The idea of dividing the façade by the function did not give the expression that was aimed at. It did not make it easier to understand the size and functions from the façade. The parametric design did a sense of the building being more coherent. But the level of complexity was still an issue because the roof connection with interior was becoming more complex. The skillion and lean design gave a more simple and calm expression.

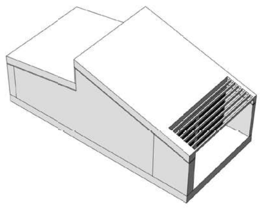
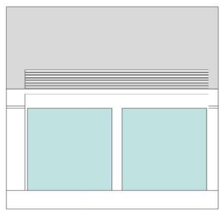
WINDOW PLACEMENT & SIZE

The design of the windows is an important element when creating a visual connection between interior and the surrounding context. Working with patient that could be forced to stay in the bed because of their illness or having to use a wheelchair. This is things that limit the eye level of the children. This meant the window design is based on giving the patients good visual connection to the context. One way of giving all users the same visual conditions was to add floor to ceiling windows in the façade facing South East to make the visual connection even stronger. A window is also added to the skillion and lean roof in the vertical part of the roof this window serves as a source for defuse light and natural ventilation. For the rest of the windows in the area where the patients has access to is the lower part of the window no more than 45 cm above the floor level to maintain visual contact with

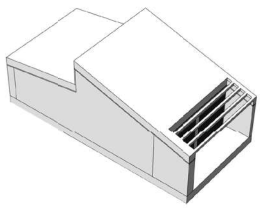
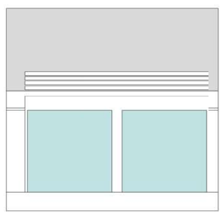
1. Iteration is showing that there are good light conditions close to the windows but the light does not reach deep into the room.

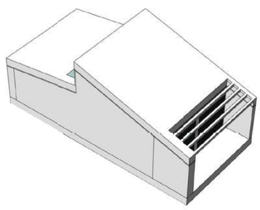
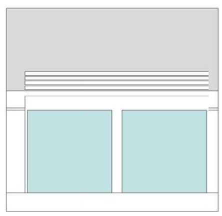
2. Iteration. Here louvers were added to get light deeper into the room.

3. Iteration. The distance between the louvers is increased.

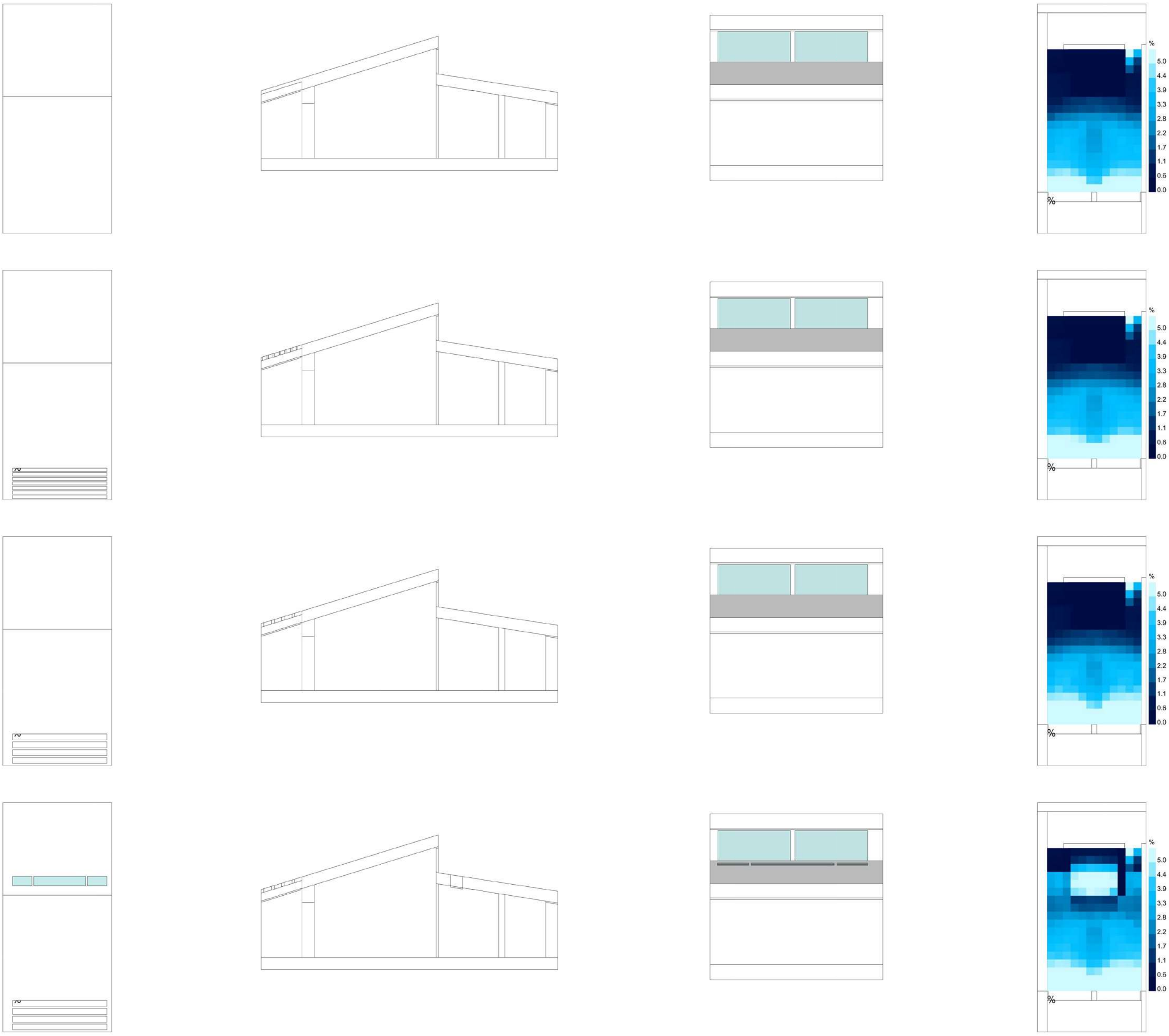



4. Iteration. Skylights were added to entrance and toilet.

the forest and to create seating spaces in these windows. For the rest of the building the principal idea for the windows was to create windows that would supply diffuse light. And create niches for social interaction. Some of the windows hight are restricted by the topography.

It was decided to focus on one of the apartments. To be able to evaluate the windows and the daylight condition a calculation of daylight factor was made using ladybug grasshopper tool. Here are the result of this study showing a couple of iteration everything above 3% was viewed as acceptable. All iterations have the same window size in the façade facing South East 3x3 meters and the window in the vertical section of the skillion and lean roof.

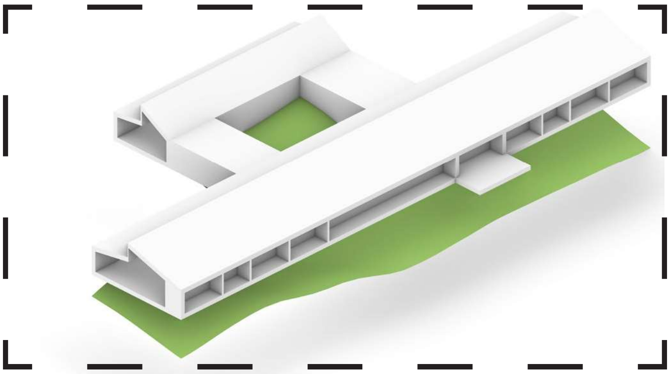
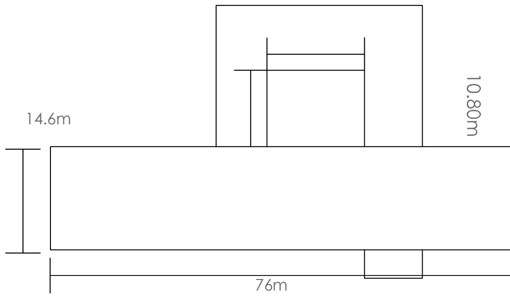
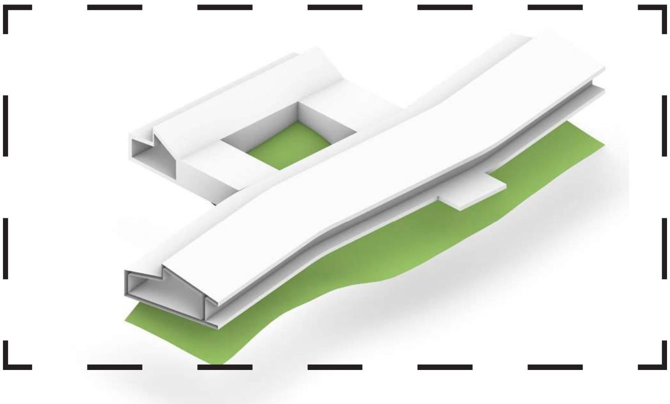
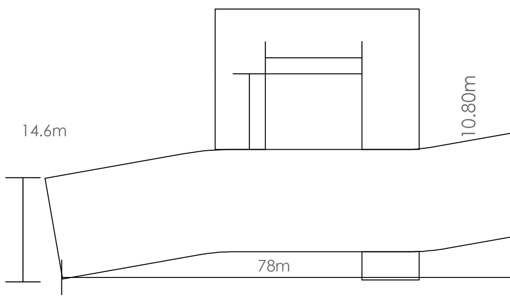
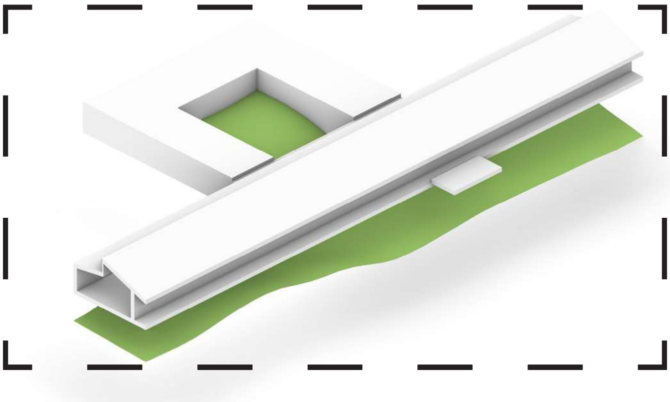
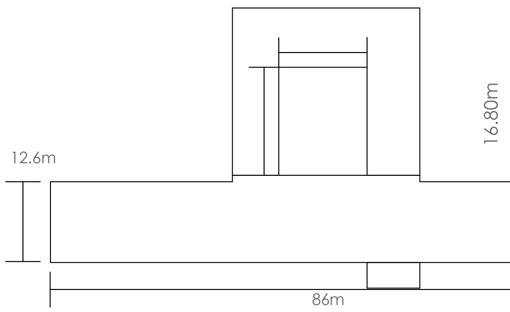
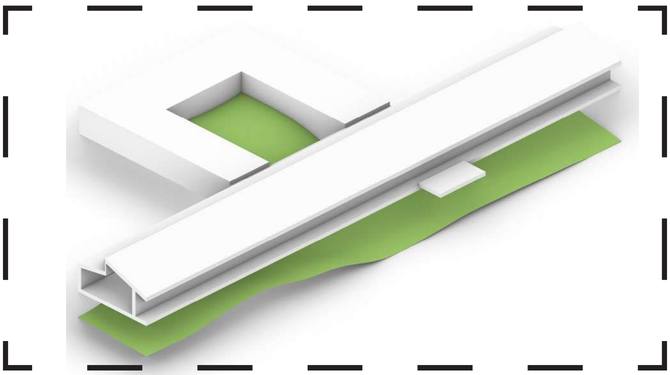
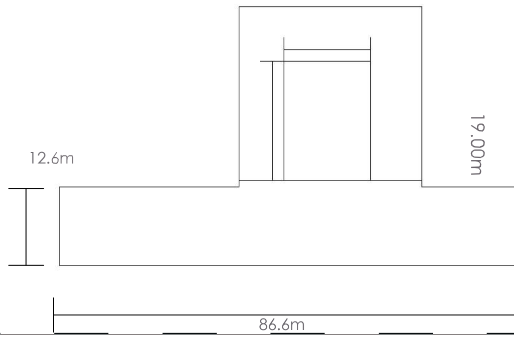


43. ill. The diagram indicated the windows placements for patient rooms.

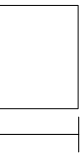
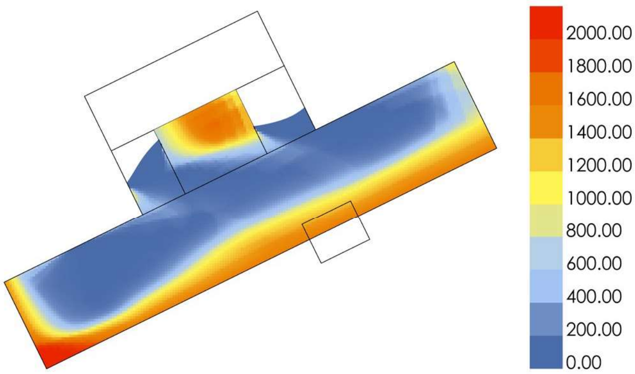
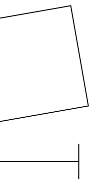
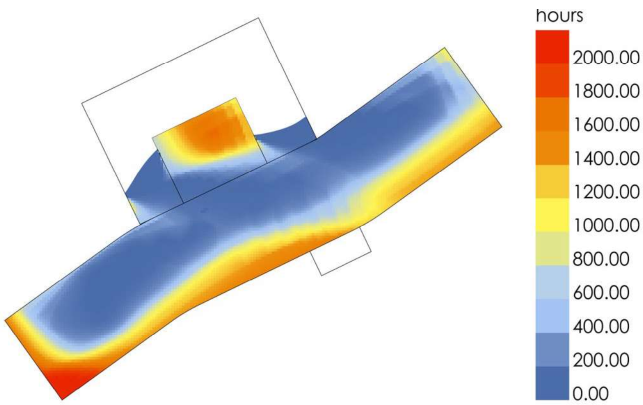
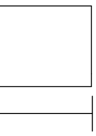
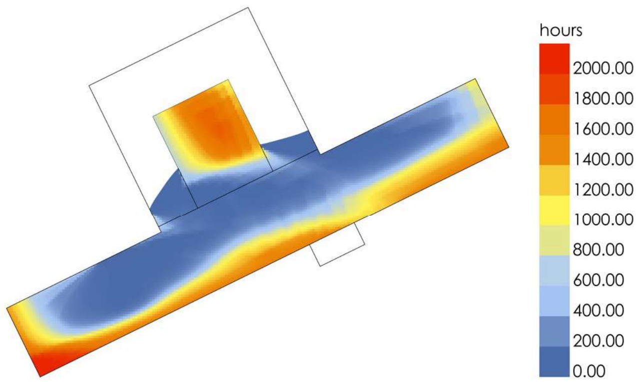
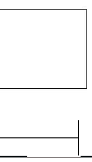
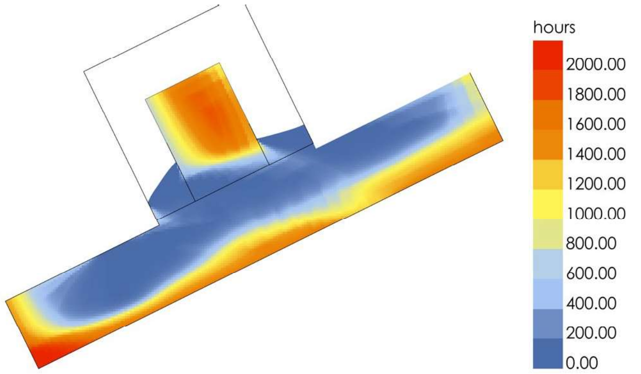
SUB-CONCLUSION

The overhang for the terrace is shading more than expected and the window in the vertical part of skillion and lean roof does not let light into the entrance area. The 2nd and 3rd iteration was trying to solve this problem with the louvers. From 1st to 2nd iteration there is a small increase. But the difference between 2nd and 3rd Iteration is too small to measure. To solve the problem the skylight is added in 4th iteration.

REITERATING SHAPE WITH FOCUS ON SUN HOURS IN THE COURTYARD

Concepts	Perspective	Plan
01		
02		Surface Area 
03		
04		

N

	Surface Area	Total Area	Volume	Compactness S.A/ V	Sun Hours
13.80m 	4280 sqm	1580 sqm	6677 m3	0,64	
13.80m 	4418 sqm	1600 sqm	6743 m3	0,65	
13.80m 	4660 sqm	1672 sqm	7304 m3	0,63	
13.80m 	4627 sqm	1667 sqm	7418 m3	0,62	

44. ill. Comparison of the courtyard iteration 1.

This phase of the design process is divided into sub-section. The parameters that are being evaluated on is the amount of sun hours hitting the topography in the courtyard and under the volume where it is not in contact with the ground. The focus for the sun hour analysis was to evaluate the amount of sun hours in the summer period from April to October.

During the midterm review the feedback led to a volume study where the goal was to integrate the building more to the site. The critic of the design was "is it possible to place the building in any other location and would it still work?" and another question raised was "is the courtyard even that useable, is there enough light and sun hours?". So, the first to iterations have the same courtyard size the only difference is the shape long volume.

CONCEPT 1 STRAIGHT LINE

The straight line is the design that was brought to the midterm review. This was used as the base line for the reiteration of the design.

CONCEPT 2 BENDING

This concept proposal is an attempt to make the building more integrated to the topography by bending the volume like the topography is pushing and pulling the volume.

SUB-CONCLUSION

The reason for CONCEPT 2 was an attempt to integrate the shape of the building more to the topography. Ended up feeling like it was a half-hearted integration. It was neither organic nor geometric. Not giving the impression of integration that was aimed at. This information was use in the next steps doing either fully geometric or organic shapes.

CHANGE OF COURTYARD SIZE

After the two first concept proposals the plan of the long volume containing apartments, treatment, kitchen and dining, changed. Increasing the length and making it narrower. As seen in the plan drawings beneath. The following two concepts are based on this change. The roof of the staff area also changed to a flat roof. The idea of this change was to divide the building into two volumes the staff and more loud functions in one volume and the apartment, treatment and gathering volume.

CONCEPT 3 MEDIUM

This CONCEPT focus on increasing the depth of the courtyard so it becomes larger it is increased from 10,8 meters to 16,8 meters. This increased the area of the courtyard. This increased the area which allowed for more light in the courtyard making it more useable.

CONCEPT 4 LARGE

The large courtyard concept proposal is increased by 2,2 meters to a length of 19 meters. This did as expected increase the area of which has a high number of sun hours. Looking at the other factors in comparison shows that the changes made increased the area of the building as well, but the compactness was not that effected by these changes (Hellwig 2022).

SUB-CONCLUSION

Comparing CONCEPT 1, 3, and 4 the area of the building is increased as the length of the courtyard is increased but the compactness is at the same time decreasing a very small amount. This means the courtyard size is not impacting the compactness leaving the chose of the size up to the quality of the space. It was decided that a higher number of sun hours in the courtyard was a quality that would make more of the courtyard usable for the users. Meaning concept 4 had the best conditions.

SHAPE OF APARTMENT, TREAMENT, & GATHERING

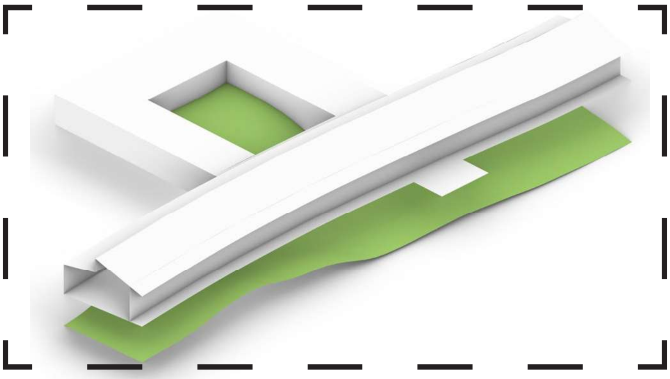
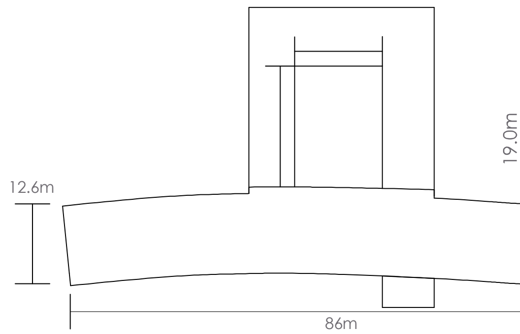
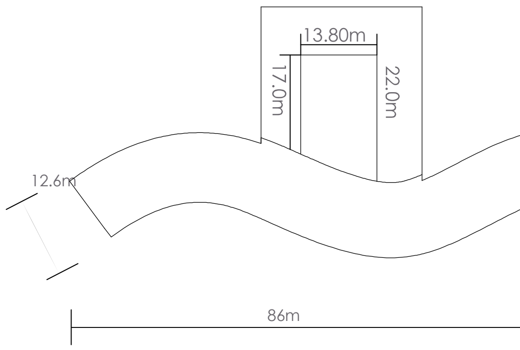
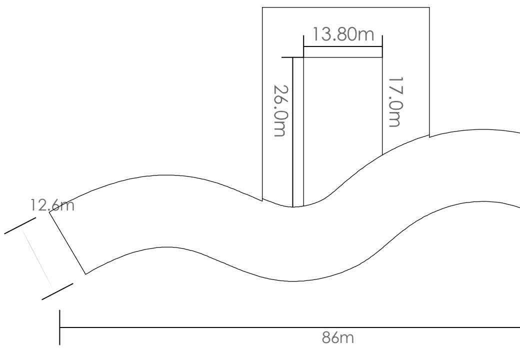
Based on the knowledge from comparing CONCEPT 1and 2 it should be either organic or geometric to strengthen the shape. Now the point of departure being CONCEPT 4 with the large courtyard and narrower apartment, treatment and gathering volume which is the point of departur of this part. The plan would be based on same principal as CONCEPT 4 the difference being a curved façade and interior. Iterating on shape the apartment, treatment and gathering volume the idea was to implement a more organic shape to enhance the relation between the building and the topography by either contrasting or following it.

CONCEPT 5 SLIGHTLY CURVED

This first curve proposal was the idea of only slightly curving the building to see how it would affect the concept. The idea was to follow the topography, but it would be subtle curve.

CONCEPT 6

The CONCEPT 6 is based on the idea of following the topography in an exaggerated way to enhance the relation between volume and topography.

Concepts	Perspective	Plan
05		
06		
07		

CONCEPT 7

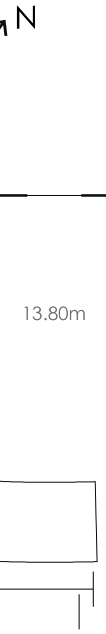
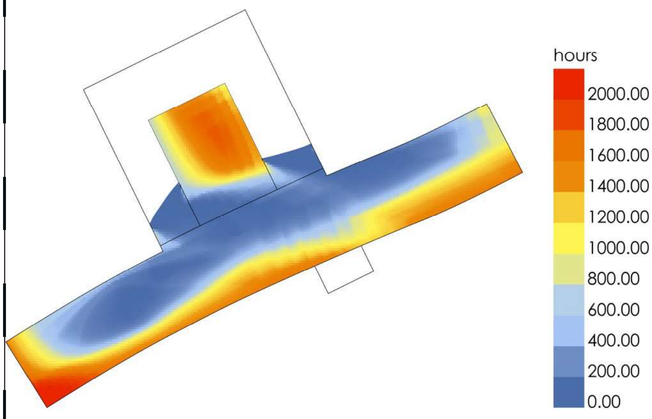
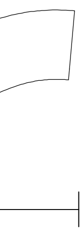
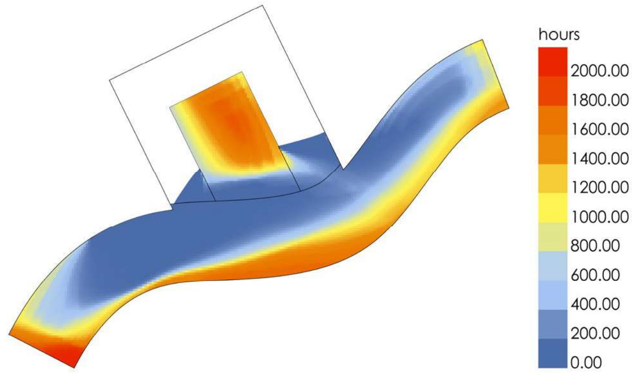
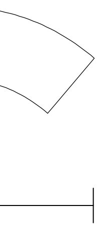
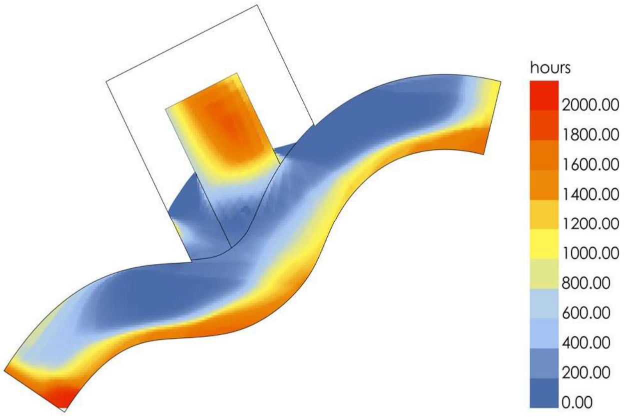
The CONCEPT 7 is like CONCEPT 6, but concept 7 is doing the opposite instead of following the topography it is pushing towards the topography contrasting the shape of the topography.

SUB-CONCLUSION

Looking at the courtyard the effect of curving the shape had a small impact on the sun hours. CONCEPT 7 being the worst of the three of them. CONCEPT 6 being a little better. While CONCEPT 5 is very close to the result from CONCEPT 4. Which eliminated CONCEPT 7.

When looking at CONCEPT 6 the privacy between the apartments would be lost as there would be a visual connection between them. Which was not wanted for the apartments.

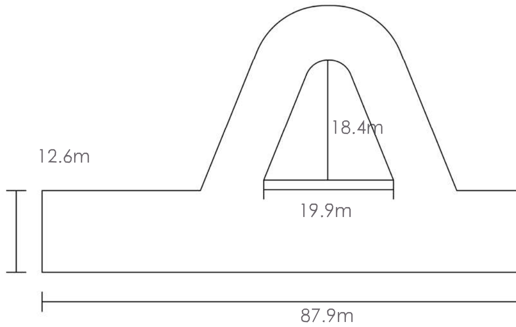
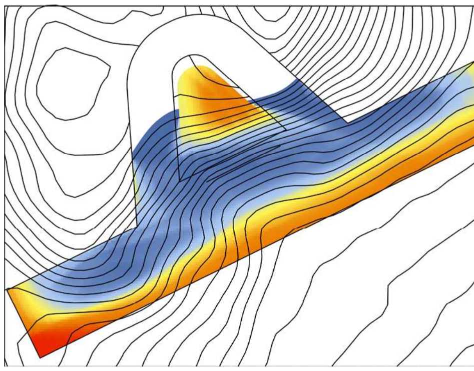
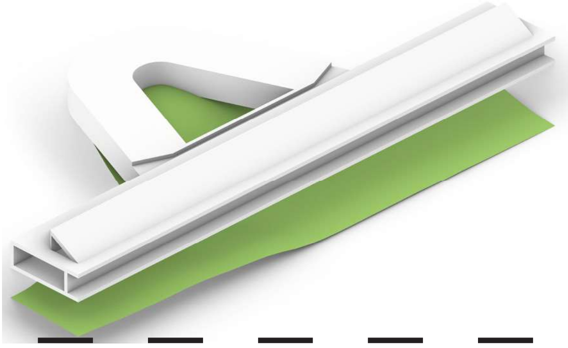
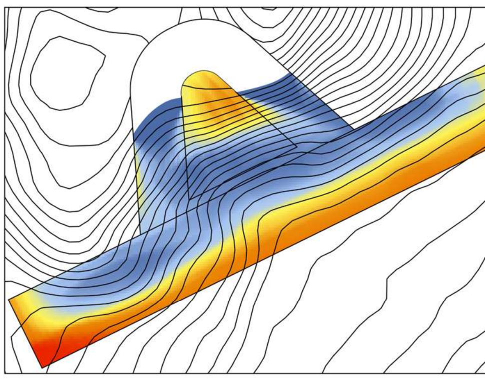
This mean there was two concepts in play being 4-5.

	Surface Area	Total Area	Volume	Compactness S.A/ V	Sun Hours
	4800 sqm	1726 sqm	7481 m3	0,64 m3	
	5036 sqm	1802 sqm	8063 m3	0,62	
	5160 sqm	1825 sqm	8277 m3	0,62	

45. ill. Comparison of the courtyard iteration 2.

MINIMALISTIC, MODERNISTIC SHAPE & TOPOGRAPHY

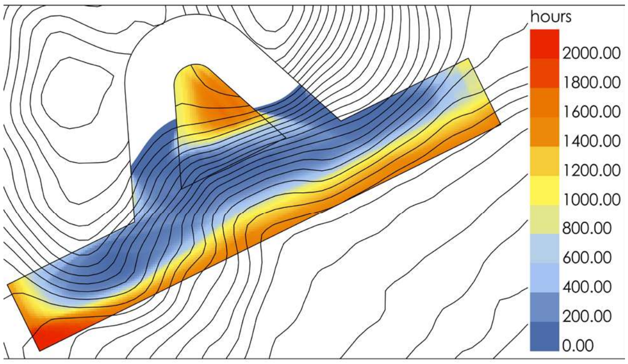
A question was arises “Is there a different way of integrating the building to the topography?”. This led to an investigation of a more minimalistic and modernistic approach. The concept is based on two different states of the building, the part that is touching the ground and the part that is elevated above the ground on columns. The part that is in contact with the ground is taking its shaped form the topography which gives the volume a natural organic shape. The other part of the building that is elevated from the ground is becoming a stricter geometric shape that is inspired by a modernistic approach with form follows function. This led to CONCEPT 8. As seen on the diagram the part of the

Concepts	Perspective	Plan
08		
		
		

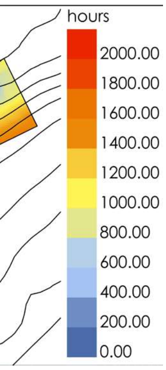
building that is in contact with the ground is bending because the topography is pushing the shape.

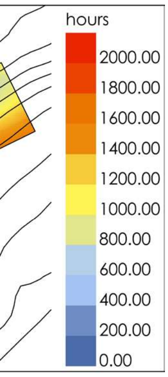
Another thing that was implemented was the idea of having flat roof on the entire building. Which is iterated more on in the in the part called FLAT ROOF DESIGN & INTEGRATION OF PHOTOVOLTAICS.

The iterations for CONCEPT 8 are focusing on how the courtyard is affected if the building is moved towards the lake. The reason for moving it closer to the lake is that less of the building is in contact with the topography. CONCEPT 8 is the base line then the second iteration is moved 2 meters and the third iteration is moved 5 meters from the base line.

Surface Area	Total Area	Volume	Compactness S.A/ V	Sun Hours
4930 sqm	1474 sqm	6725 m3	0,73m3	

46. ill. Comparison of the courtyard iteration 3.



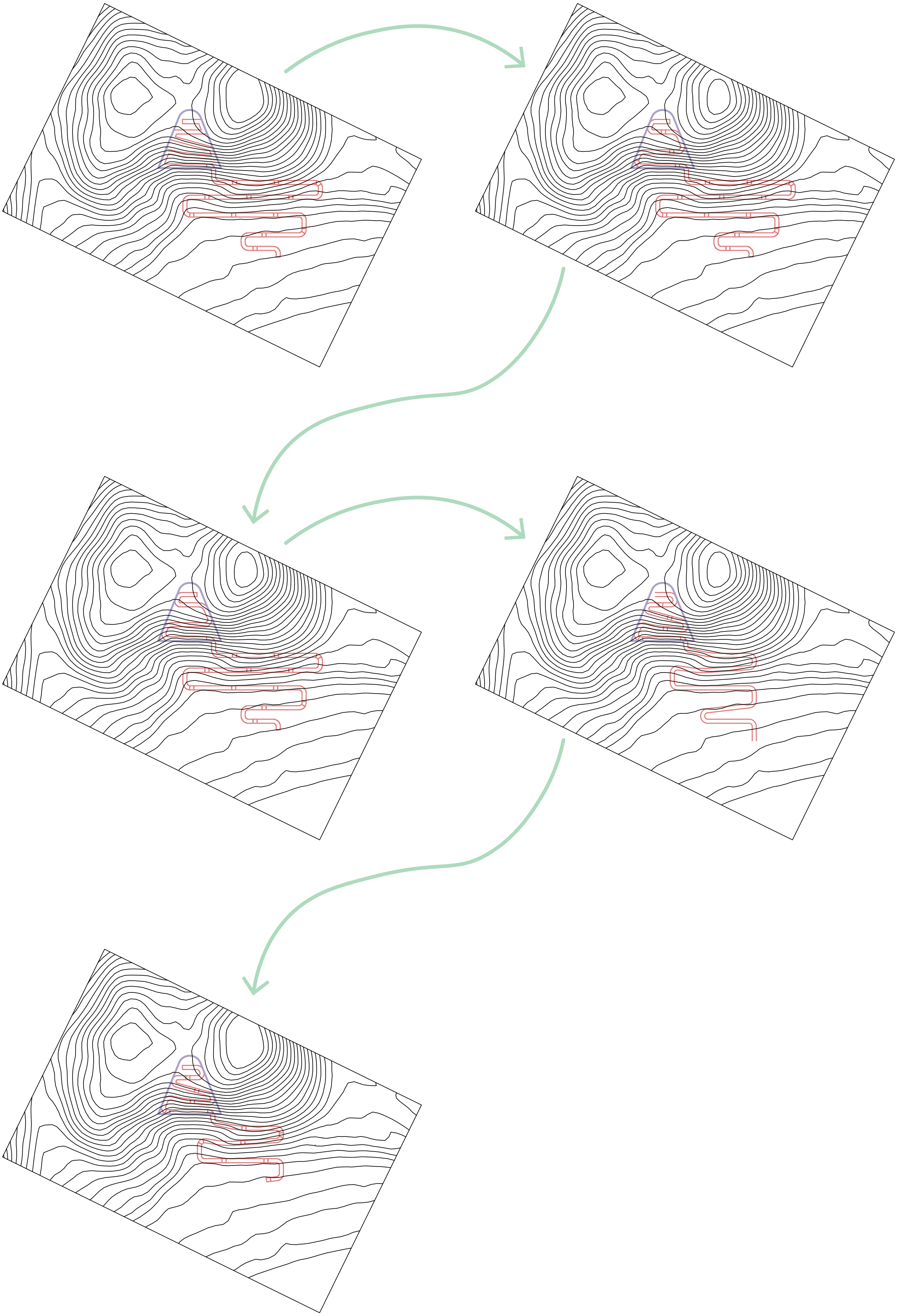


SUB-CONCLUSION

The building is interacting with the topography in a more respectful way when it curves like the topography, and it is not a straight geometric volume that is place in the topography. The iterations of moving the building towards the lake was made to test the effect and how this affected the courtyard. CONCEPT 8 being the base line has better sun condition than both the second and third iteration. Meaning there would not be any added quality to the courtyard by moving the building.

COURTYARD DESIGN

One of the courtyard's key criteria was that it was to be a contrast to the more haphazard and natural nature of the land and creating connectivity between exterior and interior spaces. Another crucial factor is to providing solid transition to the lake while attending to users requirements and their desire for lovely, comfortable spaces. The iterations gave rise to the notion that the path should provide users a variety of experiences while walking towards the lake, therefore the courtyard can be the focal point of the building, letting in natural light and warmth. The path in the courtyard towards the lake that is more sociable and flow-oriented as, putting different functions along the path, like sensory garden, amphitheatre and covered spaces.

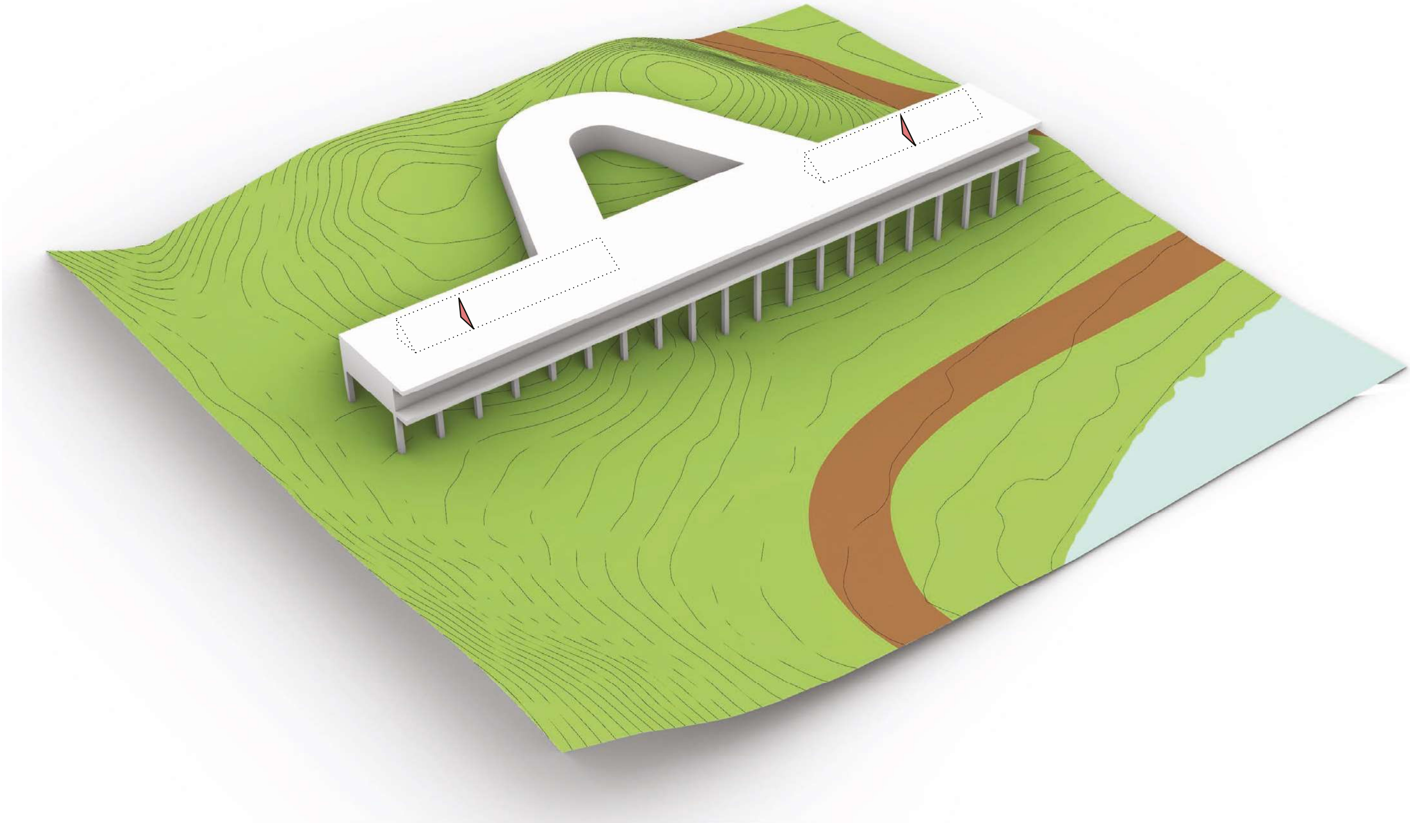


47. ill. The iteration of the ramp in the courtyard.

FLAT ROOF DESIGN & INTEGRATION OF PHOTOVOLTAICS

The change of roof design was based on the new concept of minimalism and modernism which led to simplifying the building. One of the elements introduced was the flat roof instead of the skillion and lean roof. The flat roof does pose a problem with photovoltaics and it would make it harder to get light into the apartments. To solve this problem a pitched surface on the roof was introduced to keep the window above ceiling level. This surface would also serve as a mounting surface for photovoltaics. Different iterations were made to find the right way to implement this slope surface. And new daylight factor calculations were made to evaluate the designs.

To figure out how many photovoltaics were needed



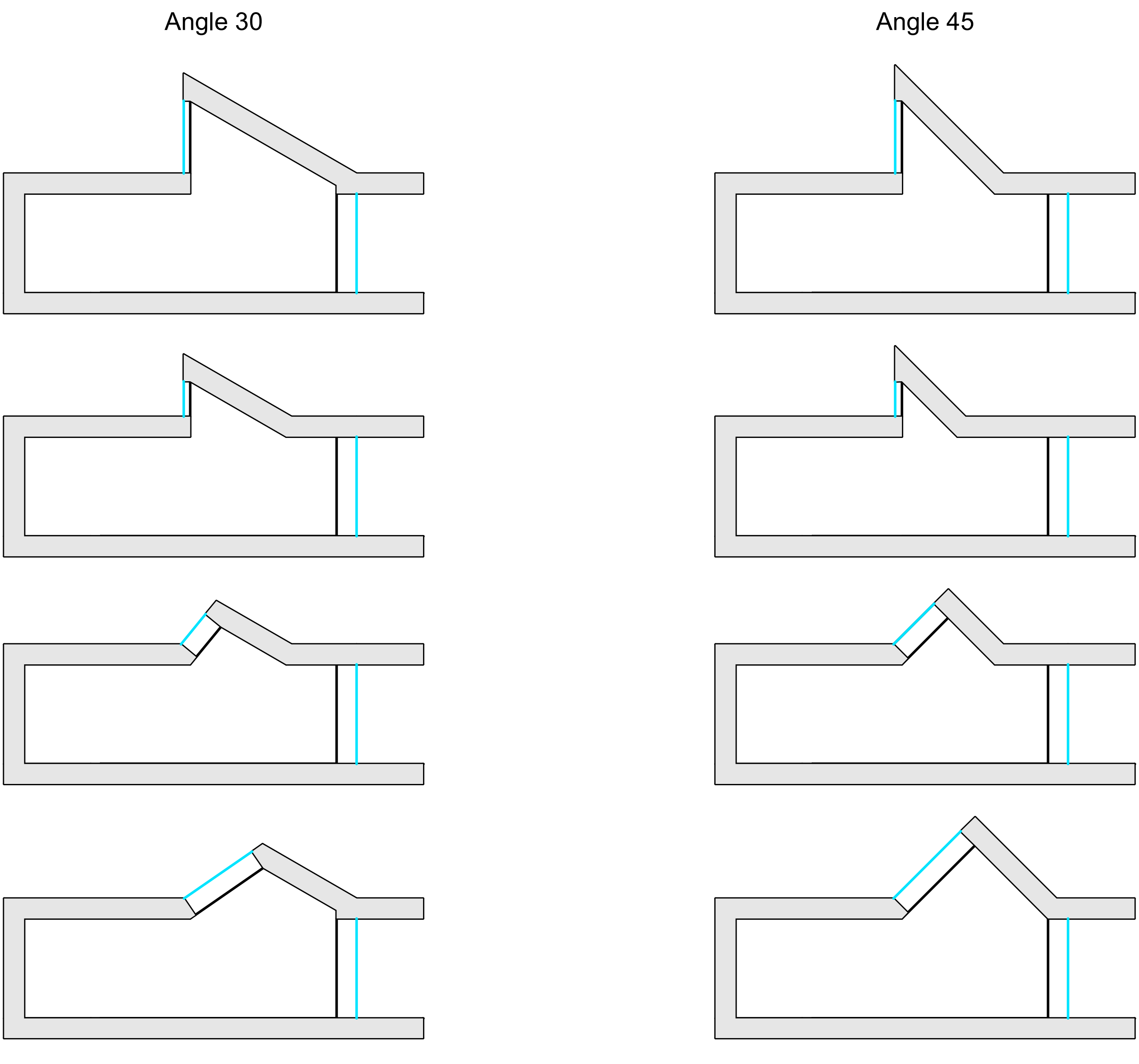
to cover the energy frame a calculation was made to estimate how much energy is be produced on a yearly basis. To estimate the energy demand, the area of the building is multiplied with the energy frame for BR2020 which is 25 kW/sqm. pr. year and the yearly energy consumption from the user is added.

$$25kW/m^2\ pr.year \cdot 1749m^2 = 43725kw$$

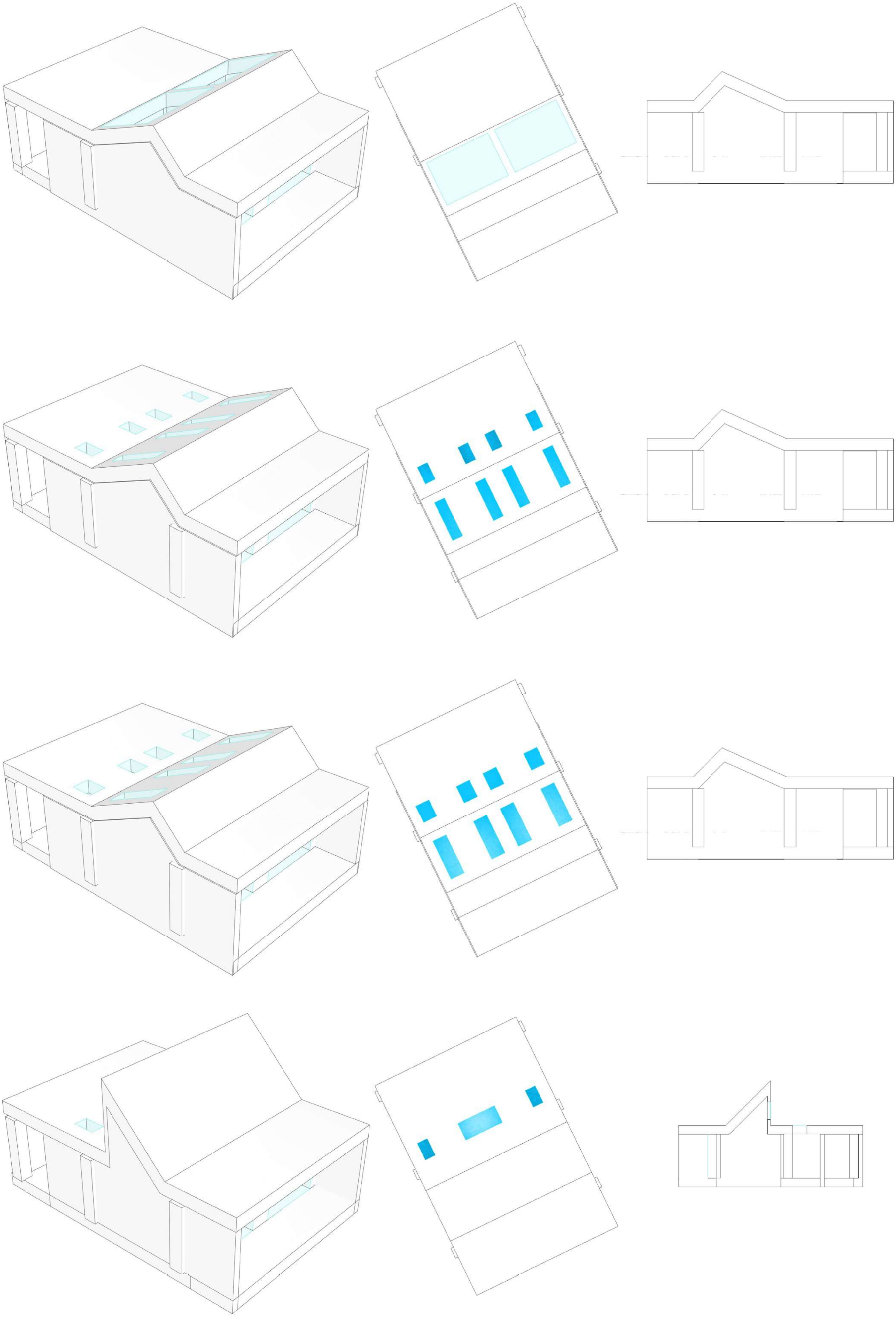
$$\frac{3{,}5W/m^2\ \cdot 1749m^2}{1000} \approx 27{,}13\ kW$$

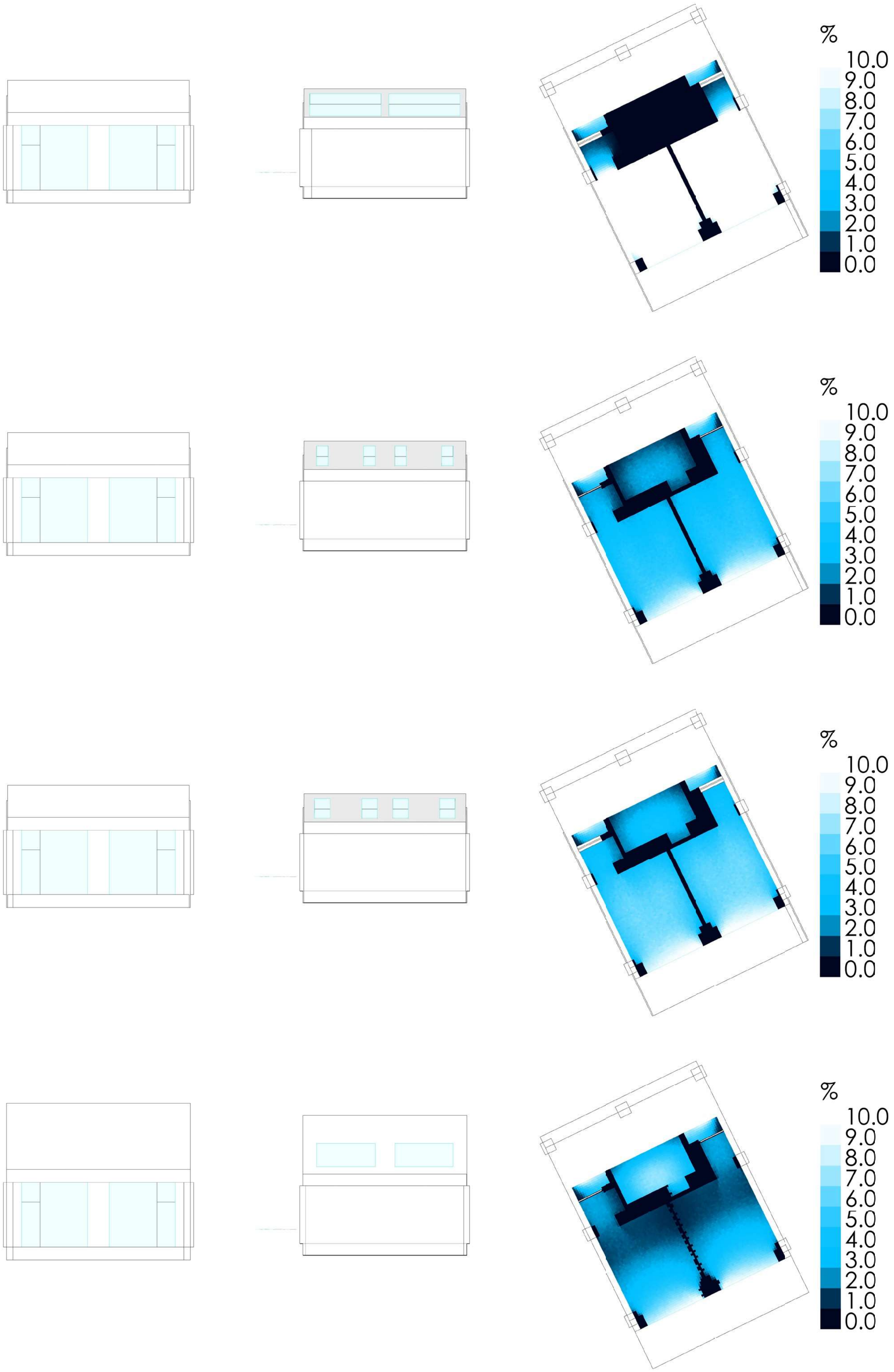
Making the total energy needed is

$$43725kw + 27{,}13\ kW = 43752{,}12kW$$



48. ill. The iteration of the roof.





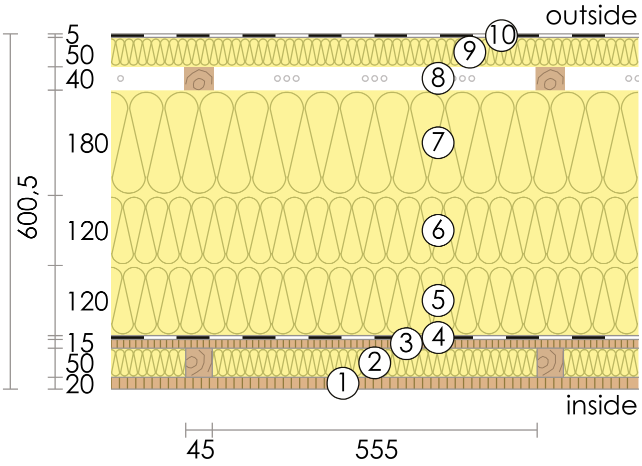
49. ill. The placement of the skylight.

ENVELOPE DESIGN

When designing the envelopes, the focus was on creating light weight envelopes for the roof, walls and floor with a very low U-value. As an inspiration the book called "komforhusnene" was used, as it includes a range of envelope descriptions with low U-values.

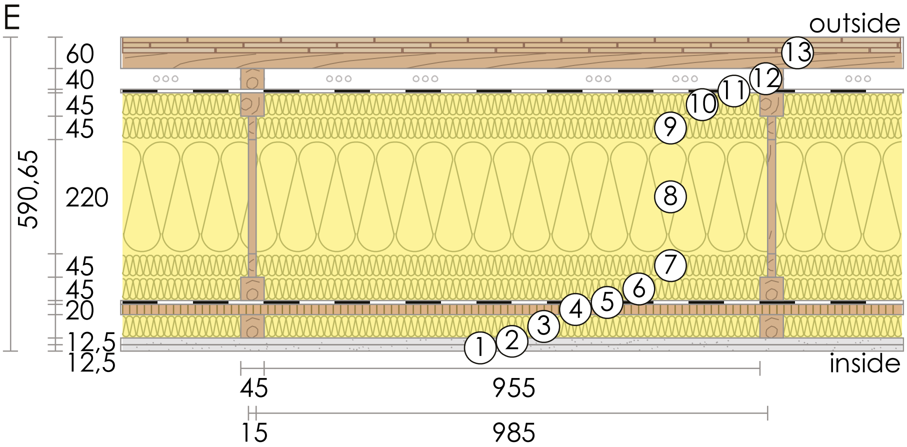
The roof is an extra light construction known as a warm roof.

ROOF ENVELOPE



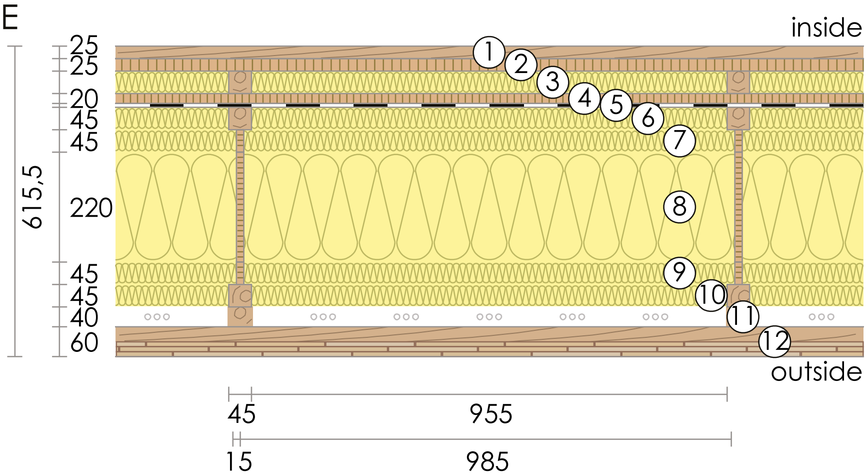
1. Plywood 500kg/m³ (20 mm)
2. Rigid insulation 0,036 (50 mm)
3. Plywood 500kg/m³ (15 mm)
4. Vapor barrier sd=100m
5. Rigid insulation 0,036 (120 mm)
6. Rigid insulation 0,036 (120 mm)
7. Rigid insulation 0,036 (180 mm)
8. Rear ventilated level (40 mm)
9. Rigid insulation 0,036 (50 mm)
10. Bitumen membranes

WALL ENVELOPE



1. Gypsum board (12,5 mm)
2. Gypsum board (12,5 mm)
3. Insulation 0,034 (45 mm)
4. Plywood 500kg/m³ (20 mm)
5. Vapor barrier sd=100m
6. Insulation 0,034 (45 mm)
7. Insulation 0,034 (45 mm)
8. Insulation 0,034 (220 mm)
9. Insulation 0,034 (45 mm)
10. Insulation 0,034 (45 mm)
11. Windpapier Ampack
12. Rear ventilated level (40 mm)
13. Wood Shingles (60 mm)

FLOOR ENVELOPE



1. Oak (25 mm)
2. OSB (25 mm)
3. Rockwool Murbatts (45 mm)
4. Plywood 300kg/m³ (20 mm)
5. Vapor barrier sd=100m
6. Rockwool Murbatts (45 mm)
7. Rockwool Murbatts (45 mm)
8. Rockwool Murbatts (220 mm)
9. Rockwool Murbatts (45 mm)
10. Rockwool Murbatts (45 mm)
11. Rear ventilated level (40 mm)
12. Wood Shingles (60 mm)

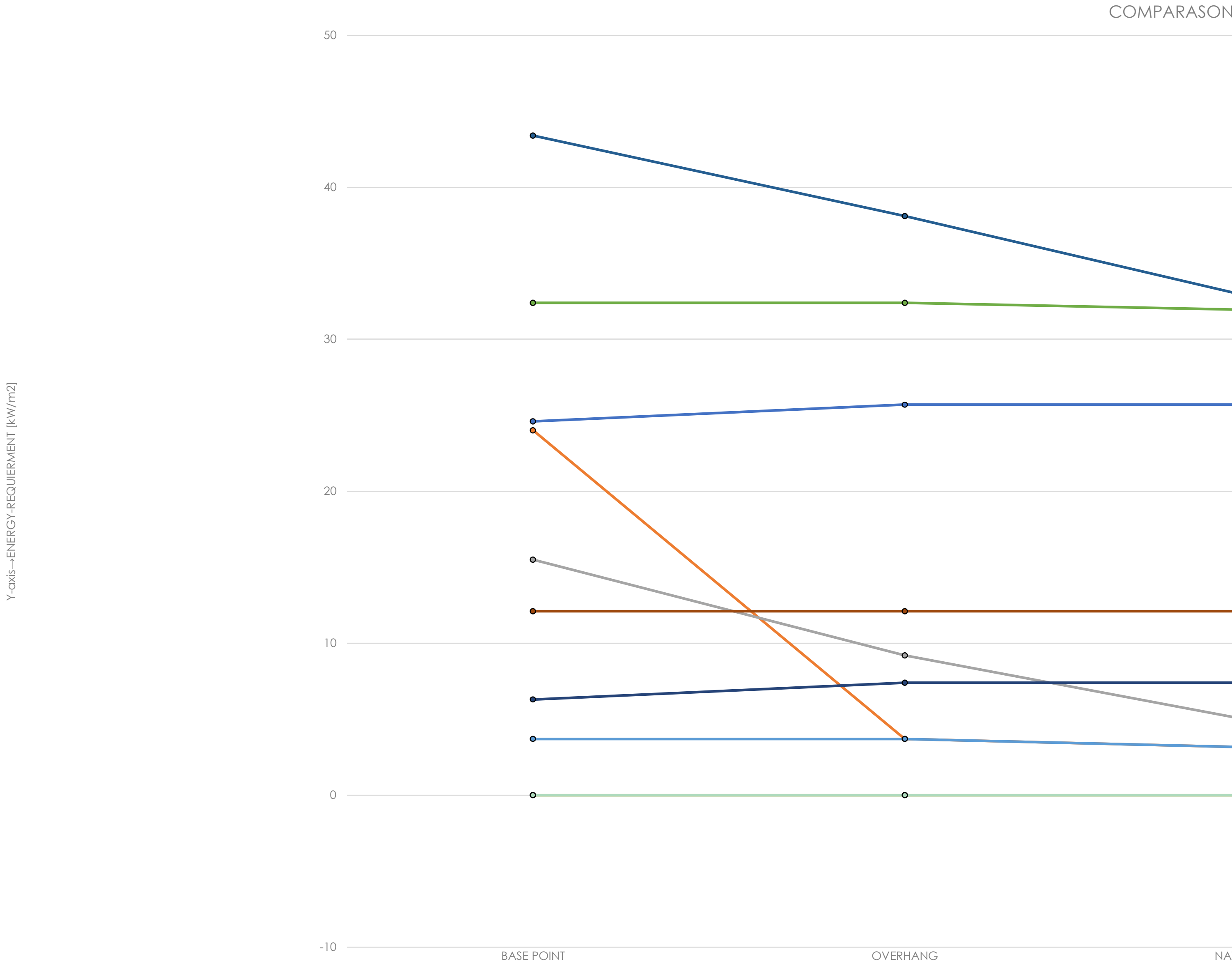
50. ill. Envelope roof, wall, and floor

Be18, Bsim & VENTILATION

Be18 is a tool that calculates the energy frame for a building as a monthly average calculation. The tool has been used to calculate the energy frame, during the process. In the start of the process, it was used as a tool to predict the energy frame. The first couple of iterations were based on the transmission loss and as the process evolved more and more details were added to get a more precis prediction. For full description see appendix 2

Bsim is on the other hand is a tool that calculates on an hourly basis. In this project it has been used to calculate the thermal comfort and the air quality. Because the Be18 calculation had issues with overheating there was an interest in looking at one of the apartments. This is one of the most critical rooms as some patient cannot leave their bed. The issue with the overheating was estimated to be caused by the large windows towards South East. To prevent this overheating passive strategies implemented to compensate for the overheating.

During this process it became clear that mechanical ventilation calculations were needed to supply



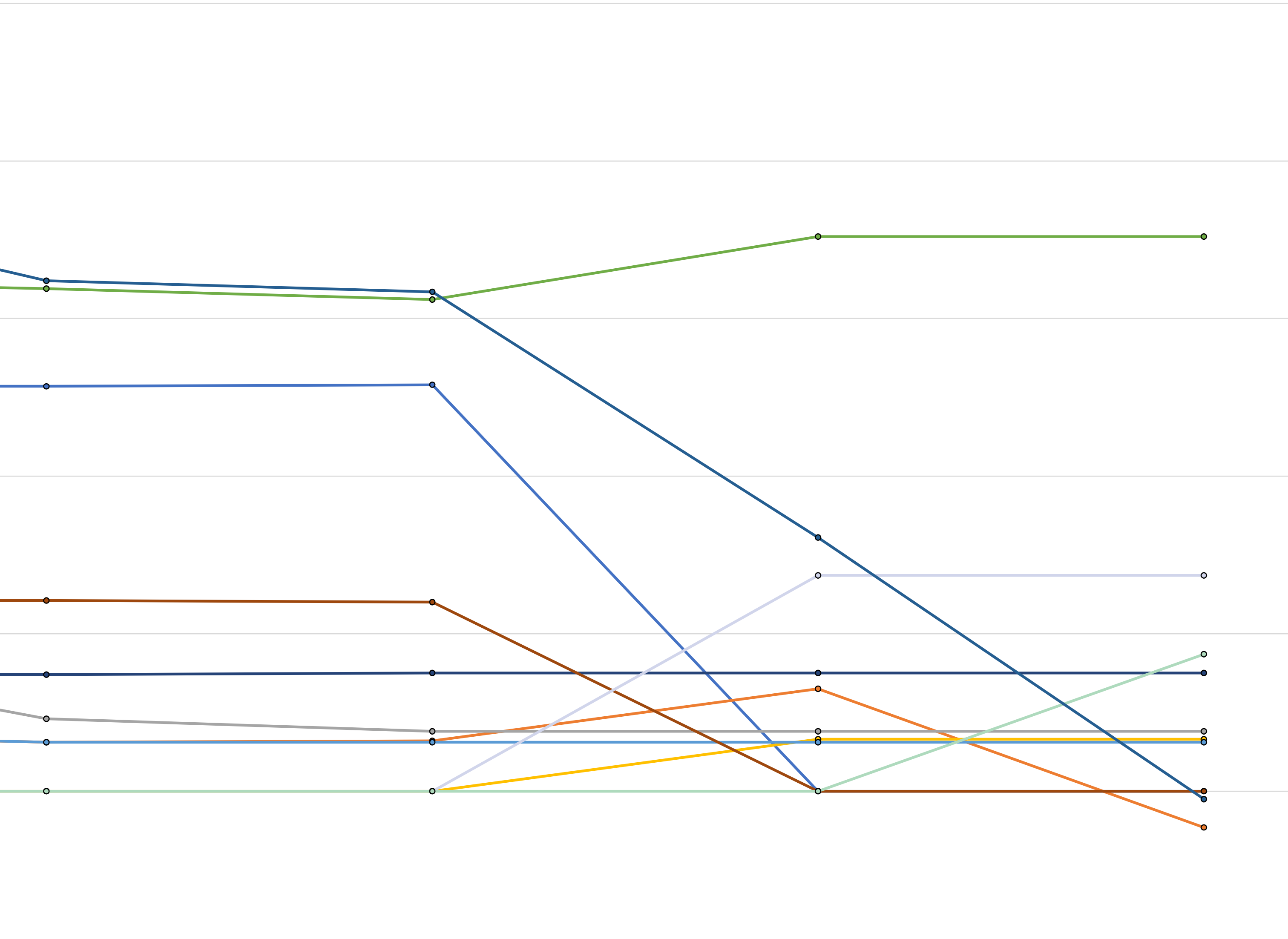
	BASE POINT	OVERHANG	NA
HEAT	24,6	25,7	
ELECTRICITY FOR OPERATION OF BUILDING	24	3,7	
EXESSIVE IN ROOM	15,5	9,2	
HEAT PUMP (Selected electricity)	0	0	
VENTILATORES (Selected electricity)	3,7	3,7	
TOTAL ELECTRICAL CONSUMPTION (Selected electricity)	32,4	32,4	
ROOM HEATING (Net requirement)	6,3	7,4	
ROOM HEATING (Heat loss from installations)	12,1	12,1	
HEAT PUMP (Output from special sources)	0	0	
PHOTOVOLTAICS (Output from special sources)	0	0	
TOTAL ENERGY REQURIMENT	43,4	38,1	

fresh air and to recover heat to prevent the building from having a very high heat loss from ventilation. See appendix 3

The natural ventilation was a passive strategy to prevent overheating. The calculations are based on thermal buoyancy, wind pressure and a combination of both. These calculations were made during the calculations in Be18 and Bsim. The reason being natural ventilation could be used to bring down the overheating of the building.

To show the progression during the process here is a simplified step by step to show the consequence of each action. It is illustrated with graphs underneath one illustrating the changing key numbers from Be18 and the other one showing the hours of overheating on the next page. As some of the actions happened simultaneously the steps will be further detailed in their own little section that has been named as follows: Base point, overhang, natural ventilation, shading, heat pump and photovoltaics.

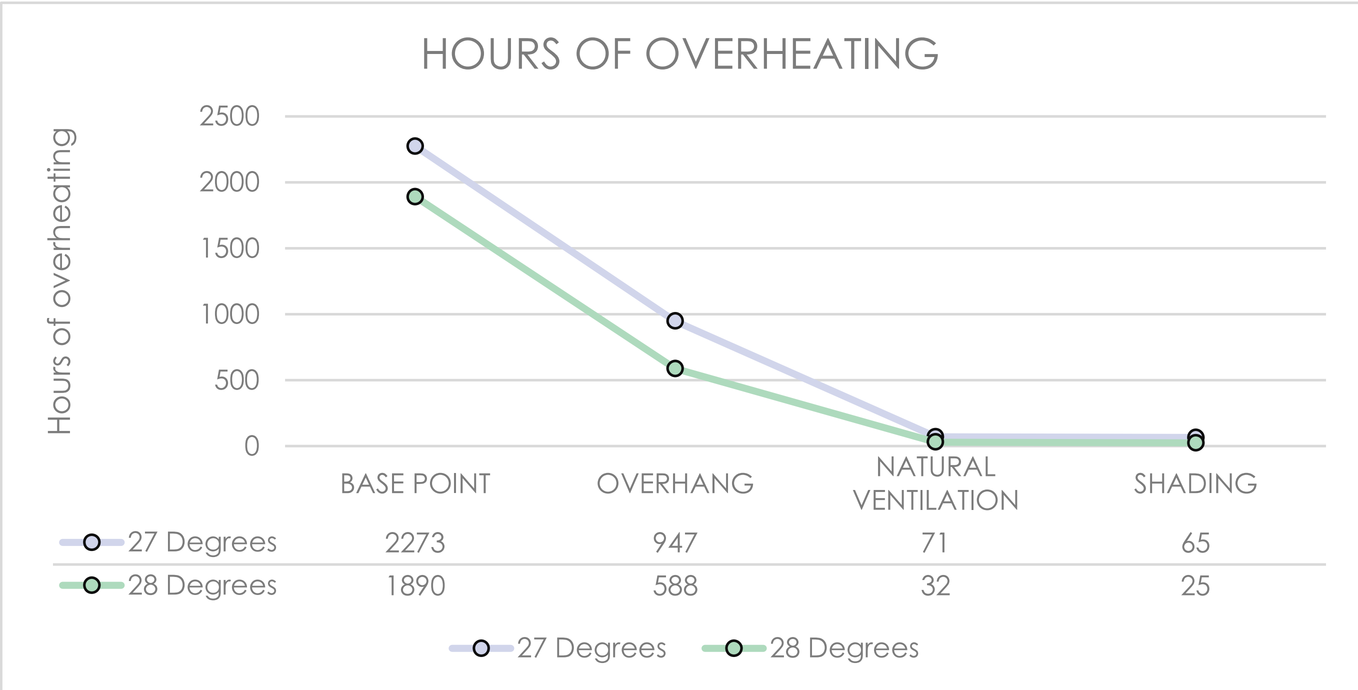
OF THE EFFECT OF EACH STEP



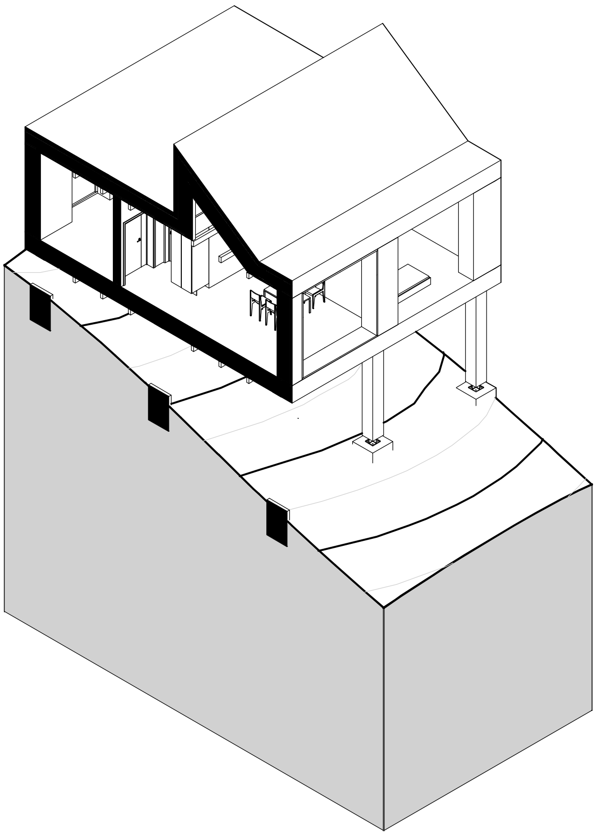
TURAL VENTILATION	SHADING	HEAT PUMP	PHOTOVOLTAICS
25,7	25,8	0	0
3,1	3,2	6,5	-2,3
4,6	3,8	3,8	3,8
0	0	3,3	3,3
3,1	3,1	3,1	3,1
31,9	31,2	35,2	35,2
7,4	7,5	7,5	7,5
12,1	12	0	0
0	0	13,7	13,7
0	0	0	8,7
32,4	31,7	16,1	-0,5

X-axis →STEPS

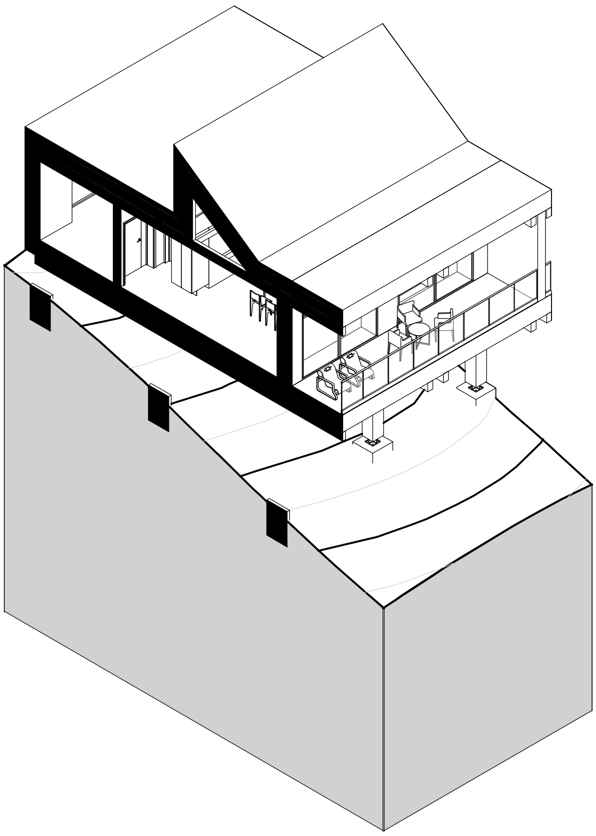
51. ill. Be18 6-Steps



52. ill. Bsim hour of over heating



The base point shows the energy frame before implementing strategies to lower the energy demand. And the same for the thermal comfort in Bsim. As seen on the graph from Be 18 and Bsim there is an excessive amount of overheating, which in Be18 translates into energy that would be needed to cool down the building. Giving a high energy frame.



The overhang was implemented as one of the first things with the terrasses. So, this is showing the effect that this design choice had on the energy frame in Be18 and the indoor thermal comfort in Bsim. As seen on the graph it decreases the amount of hour of overheating lowering the energy needed to cool down the building in Be18 but at the same time the demand for heating is creasing at the solar gain is lowered. In Bsim the overhang has a large effect on the overheating lowering it from 2273 hours above 27 degrees and 1890 hours above 28 degrees to 947 hours above 27 degrees and 588 hours above 28 degrees.

53. ill. Be18 and Bsim step 1-2

The natural ventilation was a principle that had been part of the design process since the design of the skillion and lean roof design but was first detailed later in the process as overheating became an issue. Here the natural ventilation calculations and diagrams of the threes scenarios.

The effect of the natural ventilation is that in Be18 it lowers the excessive in room which as mentioned before can be translated into energy needed to cool the building and the energy needed for running the ventilation system is also lowered, which lowers the total energy frame to 32,4 kW/sqm per year. In Bsim the natural ventilation is getting the thermal comfort close to the BR18 Danish building requirement requirements of maximum of 100 hour above 27 degrees and 25 hours above 28 degrees with 71 hours above 27 degrees and 32 hours above 28 degrees (Bygningsreglementet 2023b).

To be able to calculate the natural ventilation rate for wind driven ventilation you have to find the pressure coefficients in this case there has been calculated for three periods March to May, June to August and September to November. This is based on the wind roses in the program on page#. From the most comment wind directions in these periods. Then measuring the angle from the a perpendicular line to the façade to the wind direction. After determining the angle, it is used to find the wind pressure coefficients in the diagram. (Heiselberg 2022)

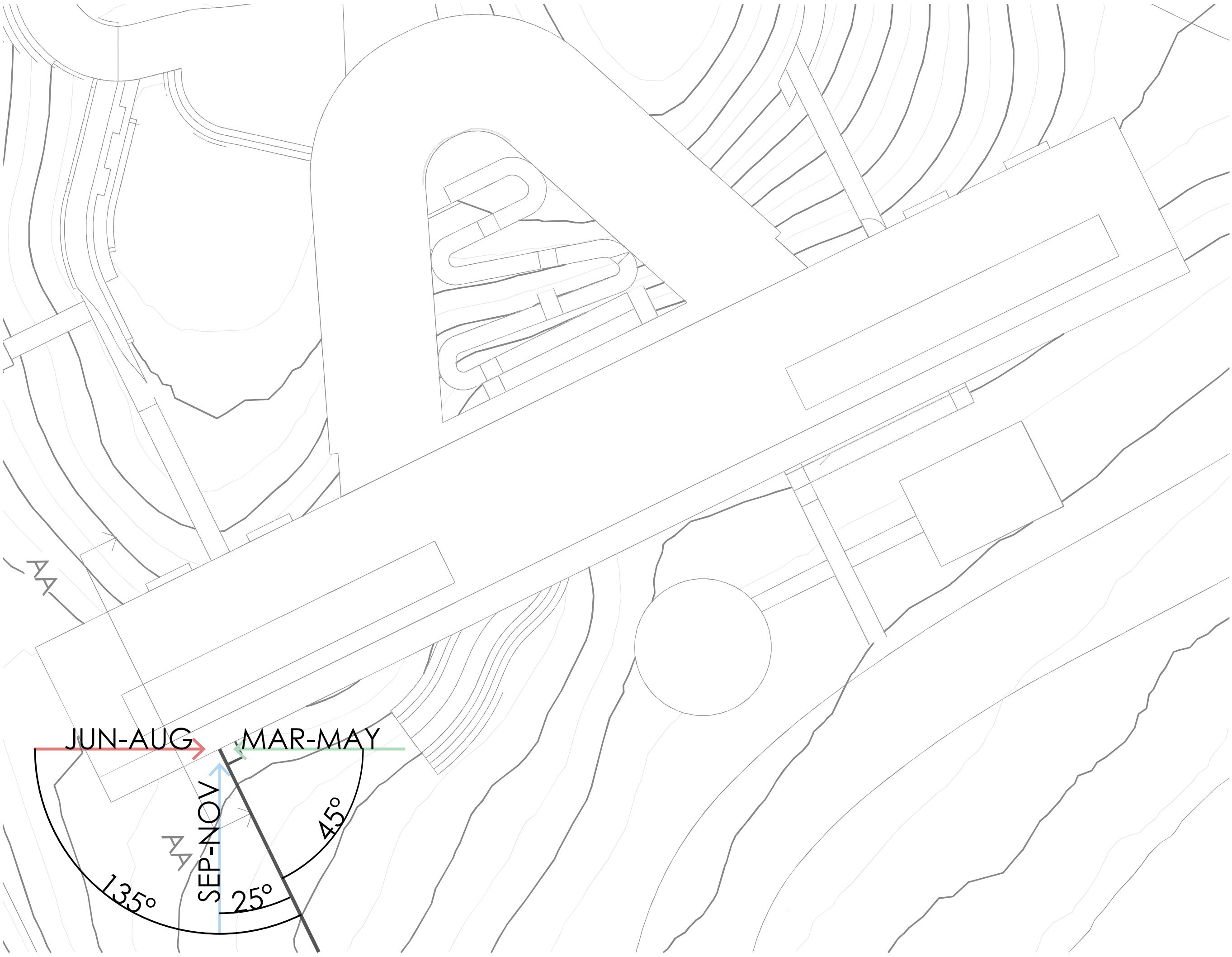
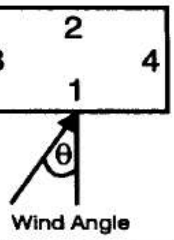


Table A2.5 Wind Pressure Coefficient Data

Low-rise buildings (up to 3 storeys)
Length to width ratio: 2:1
Shielding condition: Surrounded by obstructions equivalent to half the height of the building
Wind speed reference level: Building height



Location		Wind Angle 0°	45°	90°	135°	180°	225°	270°	315°
Face 1		0.25	0.06	-0.35	-0.6	-0.5	-0.6	-0.35	0.06
Face 2		-0.5	-0.6	-0.35	0.06	0.25	0.06	-0.35	-0.6
Face 3		-0.6	0.2	0.4	0.2	-0.6	-0.5	-0.3	-0.5
Face 4		-0.6	-0.5	-0.3	-0.5	-0.6	0.5	0.4	0.2
Roof (<10° pitch)	Front	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
	Rear	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Average		-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Roof (11-30° pitch)	Front	-0.6	-0.6	-0.55	-0.55	-0.45	-0.55	-0.55	-0.6
	Rear	-0.45	-0.55	-0.55	-0.6	-0.6	-0.6	-0.55	-0.55
Average		-0.5	-0.6	-0.55	-0.6	-0.5	-0.6	-0.55	-0.6

54. ill. Natural ventilation wind coefficients

The natural ventilation is divided into three thermal buoyancy, wind and combined. The thermal buoyancy is the same for all scenarios as the windows do not change. The wind direction change and thereby also the pressure coefficient giving different air change rates. On the next couple of pages the calculation is illustrated and a small section showing the rates of the three different natural ventilation factors.

Pressure Coefficient		**Windfactor**	0,57	**Pwind**	7,3 pa
Windward	0,06	**Vmeteo**	6 m/s	**Pmin**	0,0 pa
Leeward	-0,6	**Vref**	3,42 m/s	**Pmax**	0,4 pa
roof	0				

Location of neutral plan, Ho	8,3 m	**Buildingvol.**	m3		
Outdoor temperature	15,2 C	**Volume**	m3/section/floor		
Zone temperature	22 C				
Discharge coefficiei	0,09	**Internal pressure, Pi**	pa	-1,88	-1,881
Air density	1,25 kg/m3				

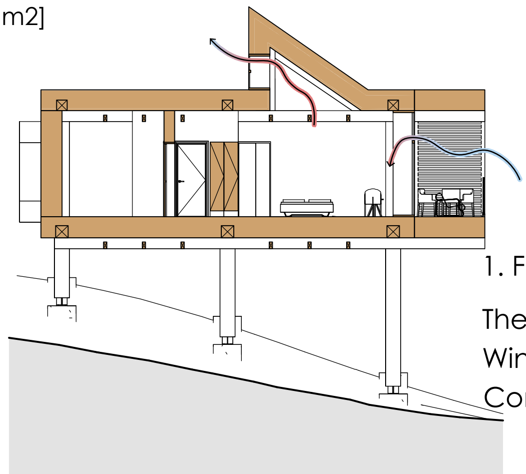
Floor	Area m2	Eff. Area m2	Height m	Thermal Buoyancy pa	AFR (thermal) m3/s	Pres Coefficient	Wind pressure pa	AFR (Wind) m3/s	Wind pressure pa	AFR total m3/s
1.	1,35	0,122	7,55	0,211	0,07	0,06	2,320	0,234	2,320	0,245
2.	1,3	0,117	9,1	-0,227	-0,07	-0,6	-2,505	-0,234	-2,505	-0,245
				Masse-balance	0,00		Masse-balance	0,00		0,000

MAXIMUM POSIABLE AIR RADES

	Area [m2]	Themal driven [l/s pr. m2]	Wind driven [l/s pr. m2]	Combined driven [l/s pr. m2]
Apartment	42,80	1,65	5,47	5,71

2. FLOOR

Thermal buoyancy -1,65 [l/s pr. m2]
Wind driven -5,47 [l/s pr. m2]
Combi -5,47 [l/s pr. m2]



1. FLOOR

Thermal buoyancy 1,65 [l/s pr. m2]
Wind driven 5,47 [l/s pr. m2]
Combi 5,47 [l/s pr. m2]

55. ill. Natural ventilation Mar-May

Pressure Coefficient		**Windfactor**	0,57		**Pwind**	7,3 pa
Windward	-0,6	**Vmeteo**	6 m/s		**Pmin**	0,0 pa
Leeward	0,06	**Vref**	3,42 m/s		**Pmax**	-4,4 pa
roof	0					

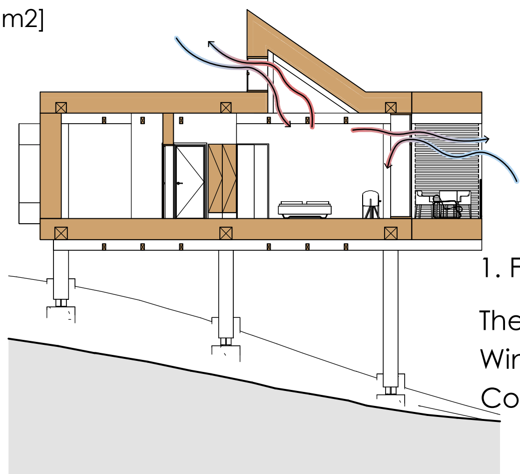
Location of neutral plan, Ho	8,3 m	**Buildingvol.**	m3		
Outdoor temperature	15,2 C	**Volume**	m3/section/floor		
Zone temperature	22 C				
Discharge coefficiei	0,09	**Internal pressure, Pi**	pa	-2,06	-2,065
Air density	1,25 kg/m3				

Floor	**Area [m2]**	**Eff. Area [m2]**	**Height [m]**	**Thermal Buoyancy [pa]**	**AFR (thermal) [m3/s]**	**Pres Coefficient**	**Wind pressure [pa]**	**AFR (Wind) [m3/s]**	**Wind pressure [pa]**	**AFR total [m3/s]**
1.	1,35	0,122	7,55	0,211	0,07	-0,6	-2,321	-0,234	-2,322	-0,223
2.	1,3	0,117	9,1	-0,227	-0,07	0,06	2,503	0,234	2,503	0,223
				Masse-balance	0,00		Masse-balance	0,00		0,000

MAXIMUM POSIABLE AIR RADES	**Area [m2]**	**Themal driven [l/s pr. m2]**	**Wind driven [l/s pr. m2]**	**Combined driven [l/s pr. m2]**
Apartment	42,80	1,65	5,47	5,22

2. FLOOR

Thermal buoyancy -1,65 [l/s pr. m2]
Wind driven 5,47 [l/s pr. m2]
Combi 5,22 [l/s pr. m2]



1. FLOOR

Thermal buoyancy 1,65 [l/s pr. m2]
Wind driven -5,47 [l/s pr. m2]
Combi -5,22 [l/s pr. m2]

56. ill. Natural ventilation Jun-Aug

Pressure Coefficient		**Windfactor**	0,57	**Pwind**	7,3 pa
Windward	0,06	**Vmeteo**	6 m/s	**Pmin**	0,0 pa
Leeward	-0,5	**Vref**	3,42 m/s	**Pmax**	0,4 pa
roof	0				

Location of neutral plan, Ho	8,3 m	**Buildingvol.**	m3		
Outdoor temperature	15,2 C	**Volume**	m3/section/floor		
Zone temperature	22 C				
Discharge coefficiei	0,09	**Internal pressure, Pi**	pa	-1,53	-1,531
Air density	1,25 kg/m3				

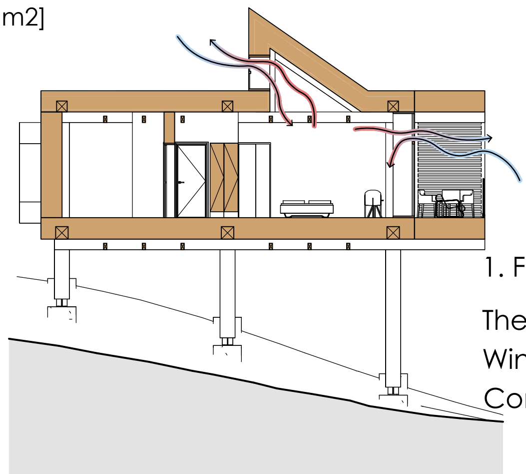
Floor	**Area m2**	**Eff. Area m2**	**Height m**	**Thermal Buoyancy pa**	**AFR (thermal) m3/s**	**Pres Coefficient**	**Wind pressure pa**	**AFR Wind) m3/s**	**Wind pressure pa**	**AFR total m3/s**
1.	1,35	0,122	7,55	0,211	0,07	0,06	1,970	0,216	1,970	0,227
2.	1,3	0,117	9,1	-0,227	-0,07	-0,5	-2,124	-0,216	-2,124	-0,227
				Masse-balance	0,00		Masse-balance	0,00		0,000

MAXIMUM POSIABLE AIR RADES

	Area [m2]	Themal driven [l/s pr. m2]	Wind driven [l/s pr. m2]	Combined driven [l/s pr. m2]
Apartment	42,80	1,65	5,04	5,30

2. FLOOR

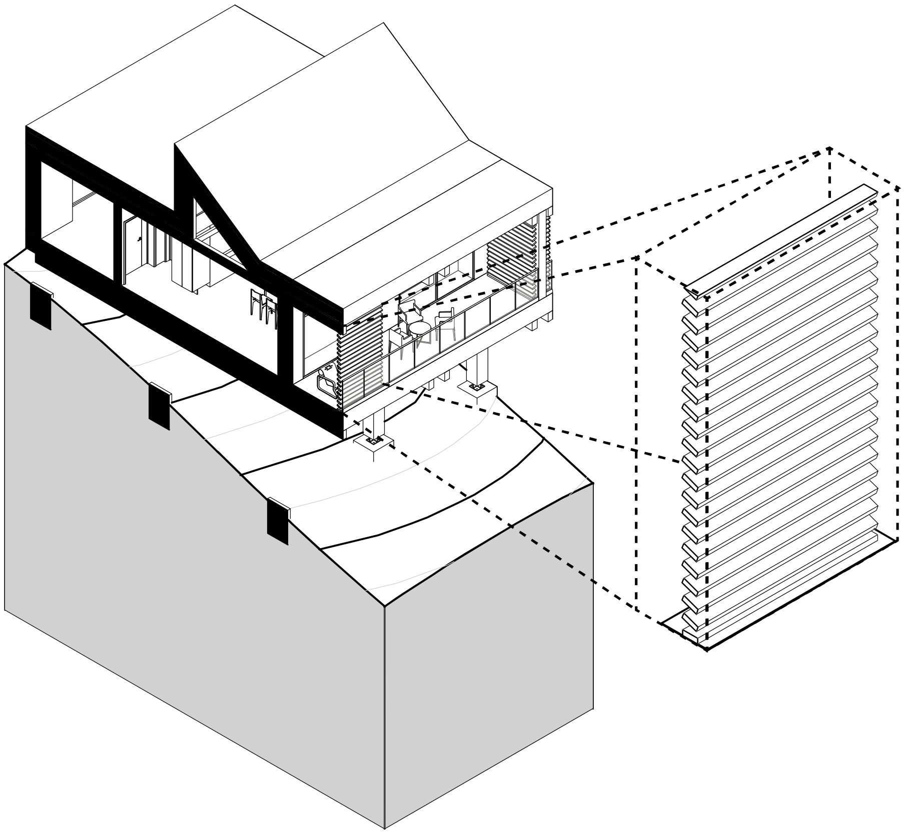
Thermal buoyancy -1,65 [l/s pr. m2]
Wind driven -5,04 [l/s pr. m2]
Combi -5,30 [l/s pr. m2]



1. FLOOR

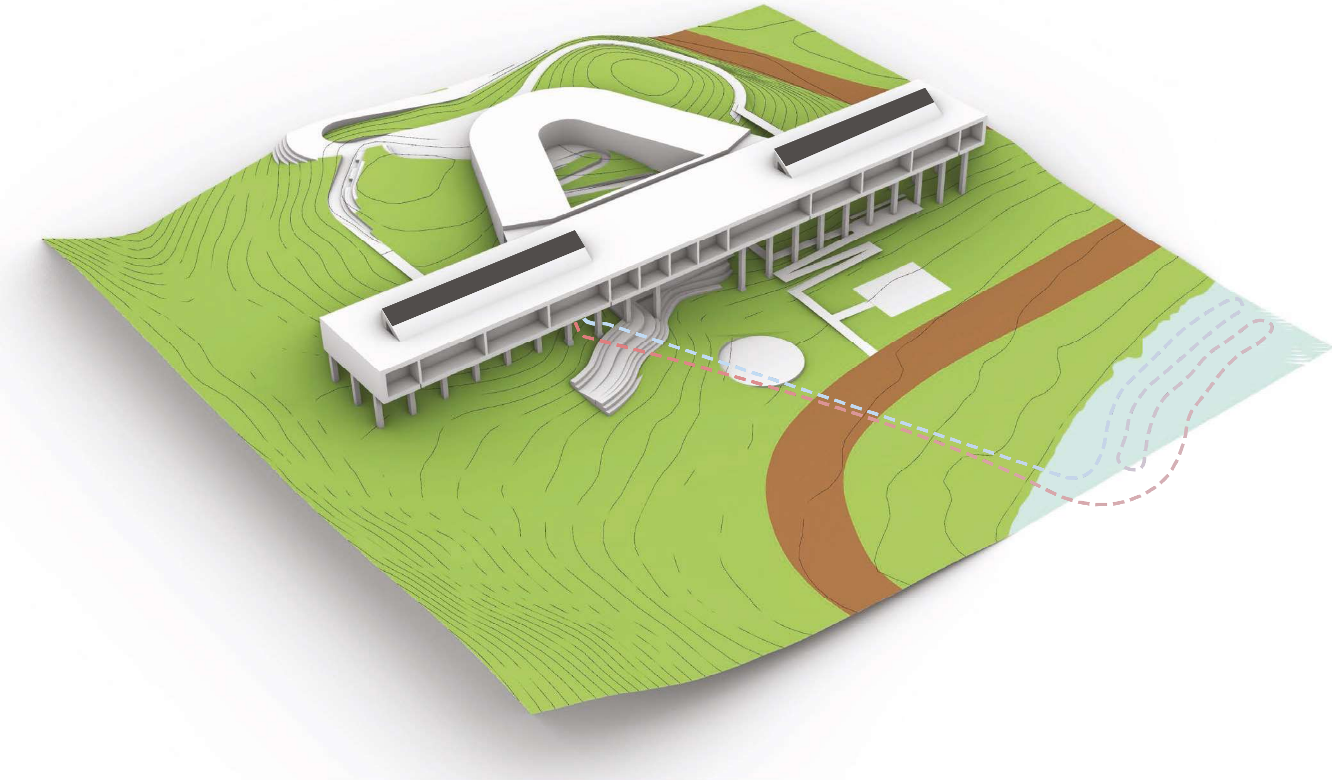
Thermal buoyancy 1,65 [l/s pr. m2]
Wind driven 5,04 [l/s pr. m2]
Combi 5,30 [l/s pr. m2]

57. ill. Natural ventilation Sep-Nov



The shading was added as the last measure to reach the allowed amount of overheating. In Be18 the effect it lowers the excessive in room from 4,6 to 3,8 kW and the total energy frame becomes 31,2 kW/sqm per year. In Bsim it makes it makes it possible to reach 65 hours above 27 degrees and 25 hours above 28 (Bygningsreglementet 2023b). The shading element are 150 millimeters wide and 50 millimetres thick which is angled by 20 degrees.

58. ill. Be18 and Bsim Shading 4



The heat pump is an active measure to lower the energy frame and in this case there is no plans for district heating in the area so a geothermal heat pump was decided as the most sufficient energy source. This only affects Be18 energy frame calculation. Where the addition of the heat pump lowers the energy frame to 16,1 kW/sqm. per year. The site allows for more than one way of designing the geothermal heat pump system. Making a horizontal grid of pips under the soil, digging a vertical piping system, and using the lake by laying out pips at the bottom of the lake. The horizontal piping grid would need a lot of trees cutting and excavating for it to be possible, the vertical piping system would be a expensive solution. Meaning the solution of adding the piping system to the lake is the most economical and environmentally friendly solution.

The photovoltaics is also an active measure that was added to reach net zero which is exceeded by a small overproduction of energy. The chosen panel is monocrystalline panel the specific producer haven not been determent. It was found that on average a photovoltaic panel has a peak power of 180 Wp/sqm, and an efficiency of 80 precent as 20 precent is lost in the conversion from AC to DC. (Viridian Solar) Ending on 95 sqm of photovoltaics produced enough energy to give a total energy frame of -0,4 kW/sqm per year.

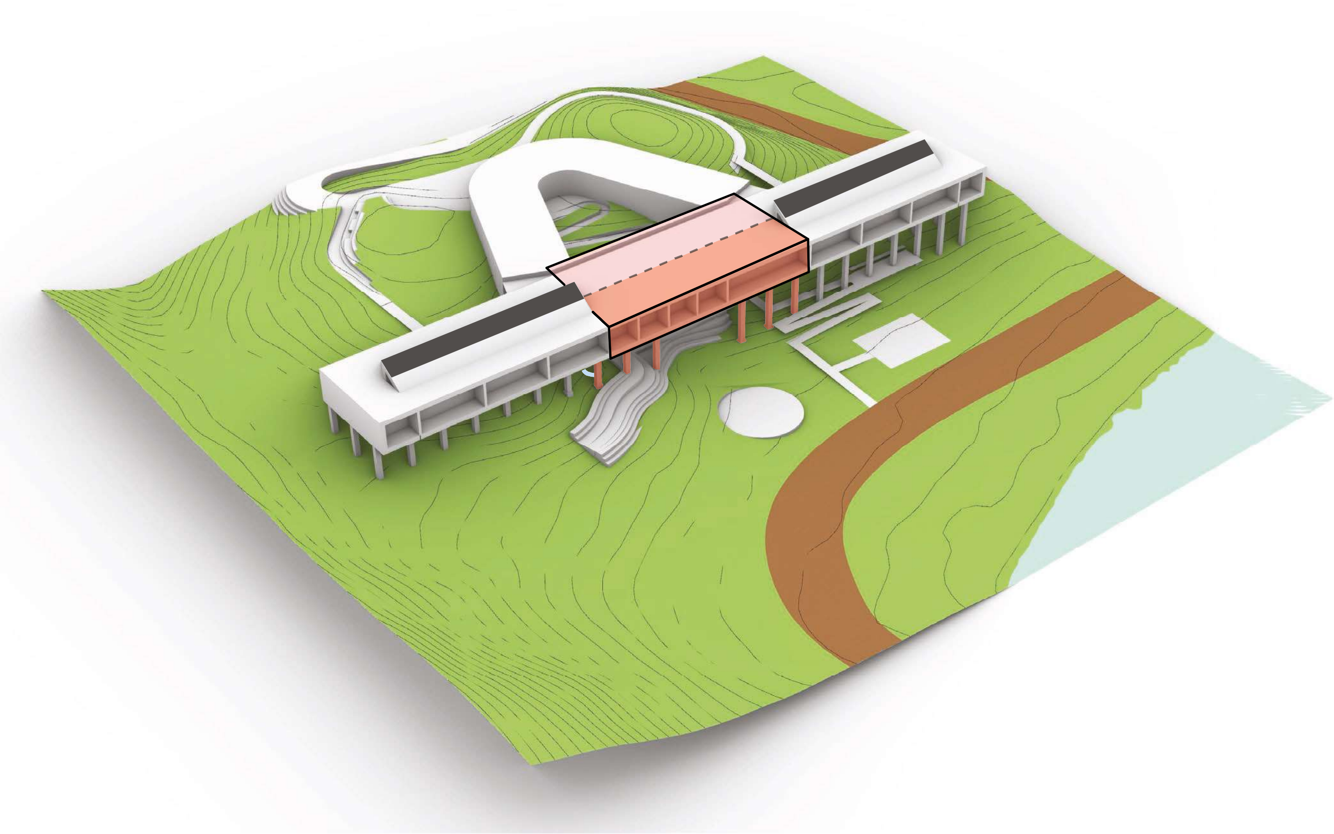
59. ill. Be18 and Bsim Shading step 5-6

CONSTRUCTION CALCULATION

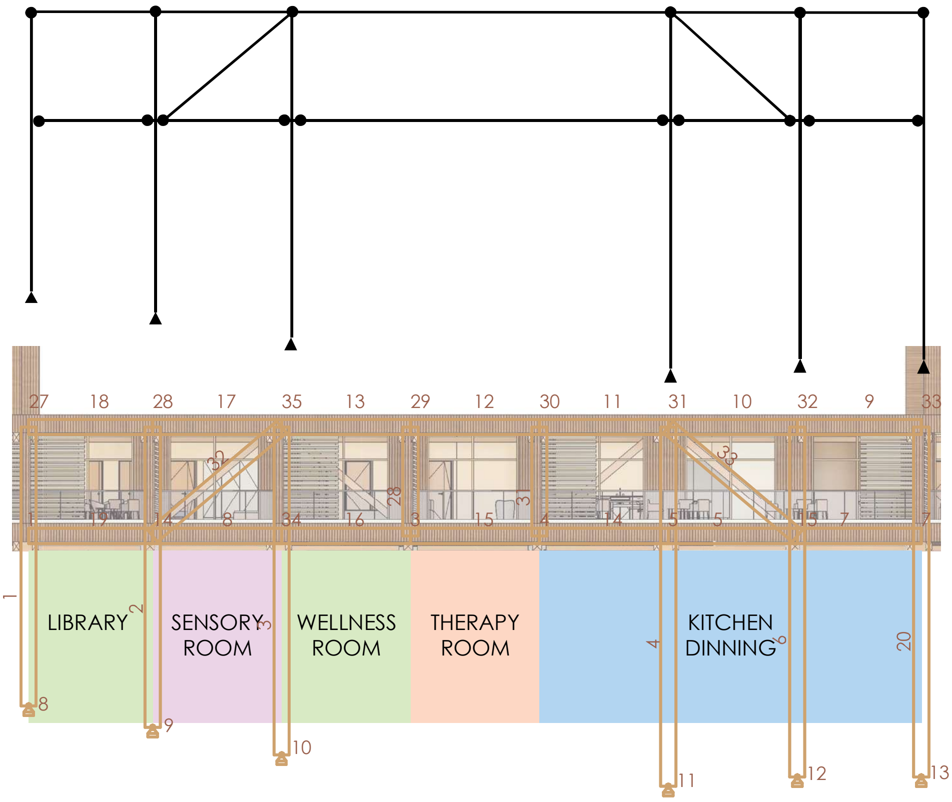
As some parts of the building is elevated on columns and the design has a large span between some of the columns it was found that construction calculations were needed for the most critical part of the construction. Here are the iterations made to find the right system and right dimensions to effectively utilize the material as efficiently as possible.

All structural calculations are made using Robot structural analysis using the timber design function which allows for structural analysis based on Eurocode 1. Testing for Ultimate Limit State and Service Limit State appendix 4-5 for the result of the timber design calculations

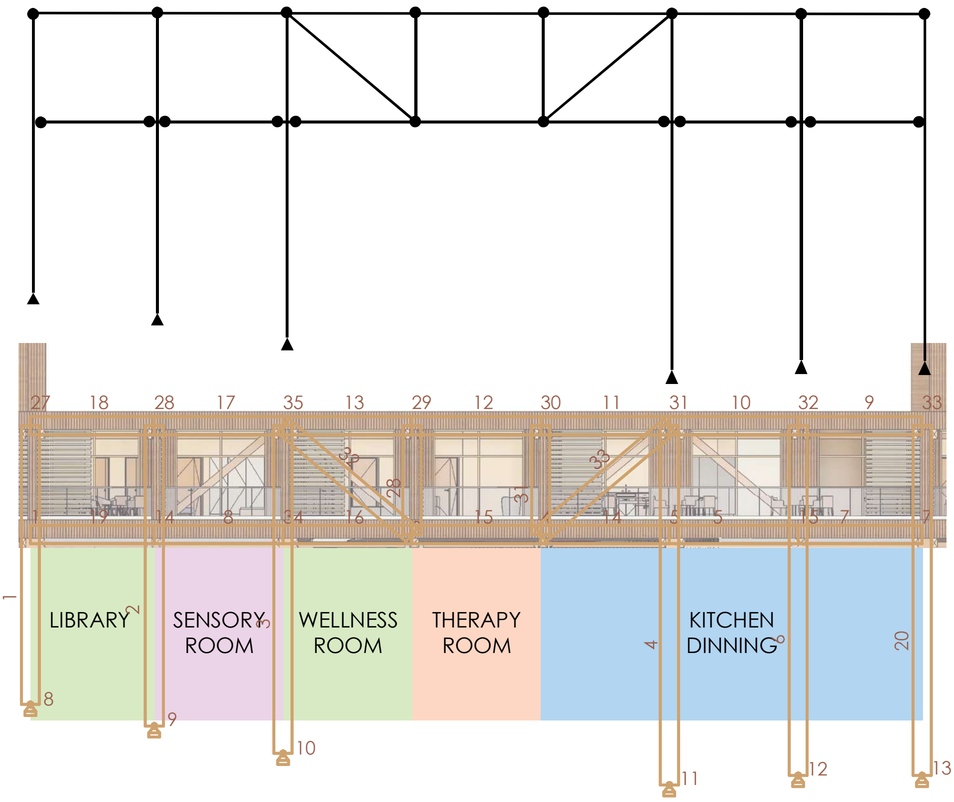
In the design iterations the focus was on not taking the access from the rooms that needs access to the terrace in the SOCIAL, DINNING & TREATMENT section of the building.



ITERATION 2

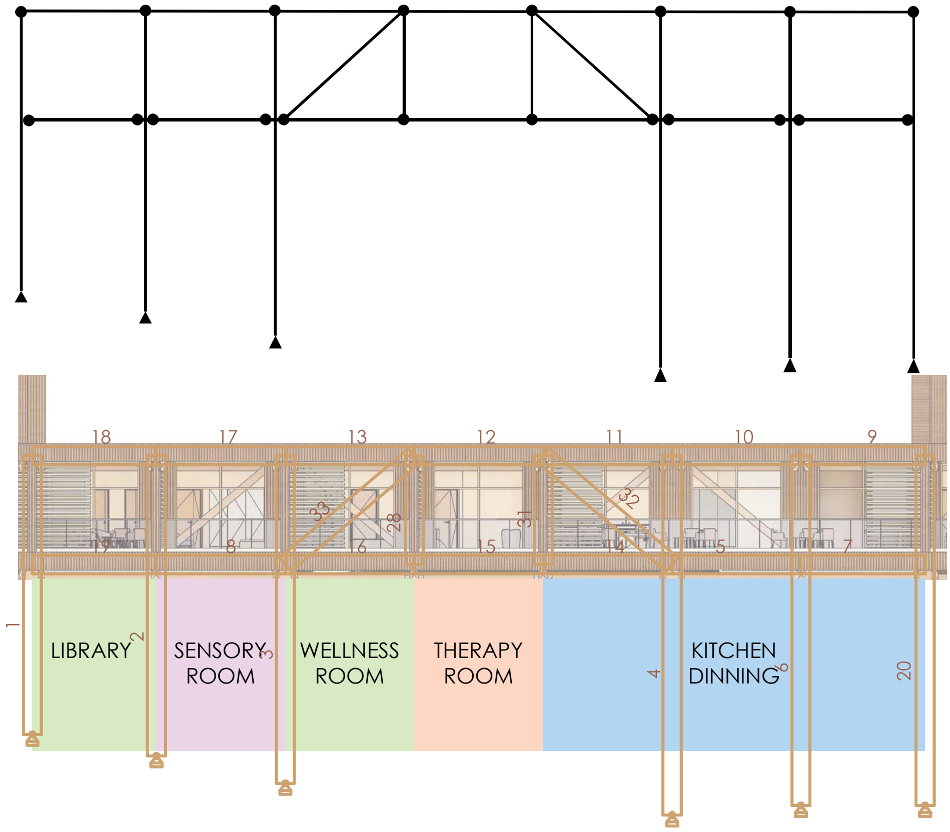


ITERATION 3



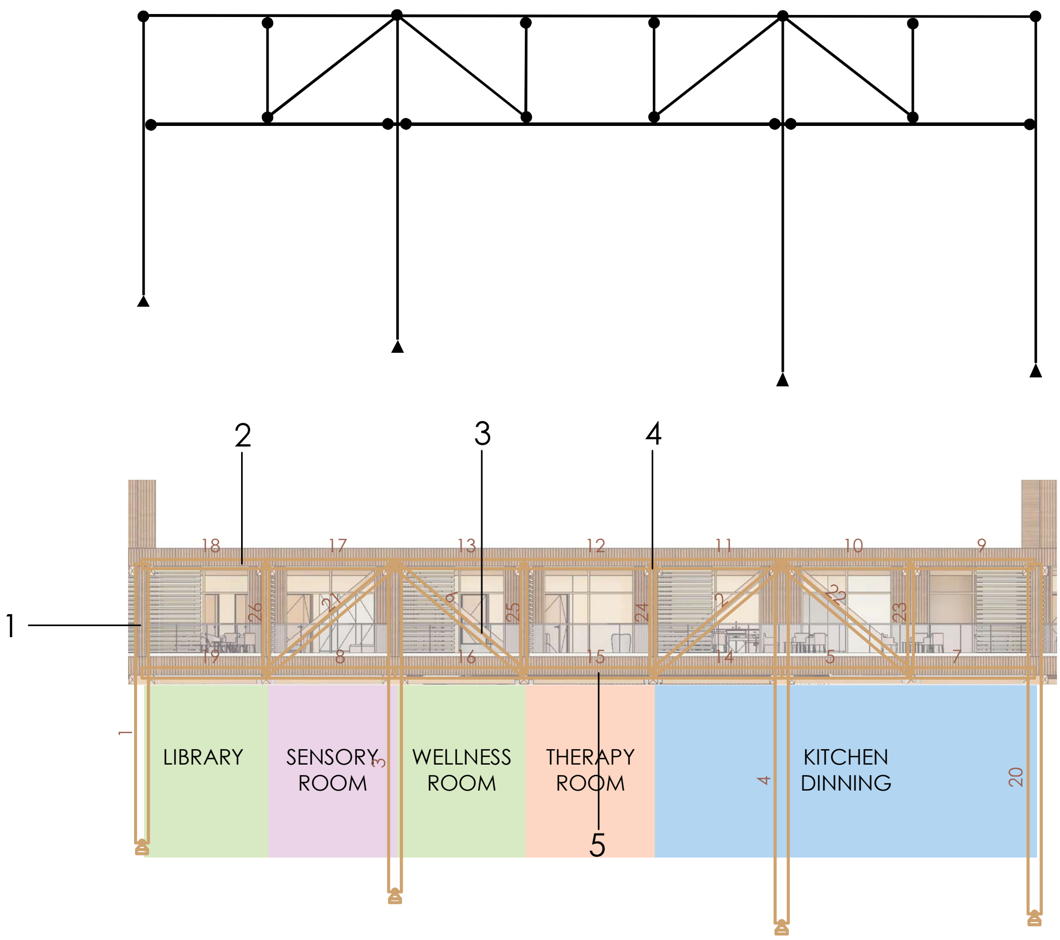
60. ill. Construction diagrams for iteration 2-3

ITERATION 4



61. ill. Construction iteration 4

ITERATION 5.9



1 Timber Column 425x425 mm

2 Timber Beam 200x300 mm

3 Timber Slanted Column 250x250 mm

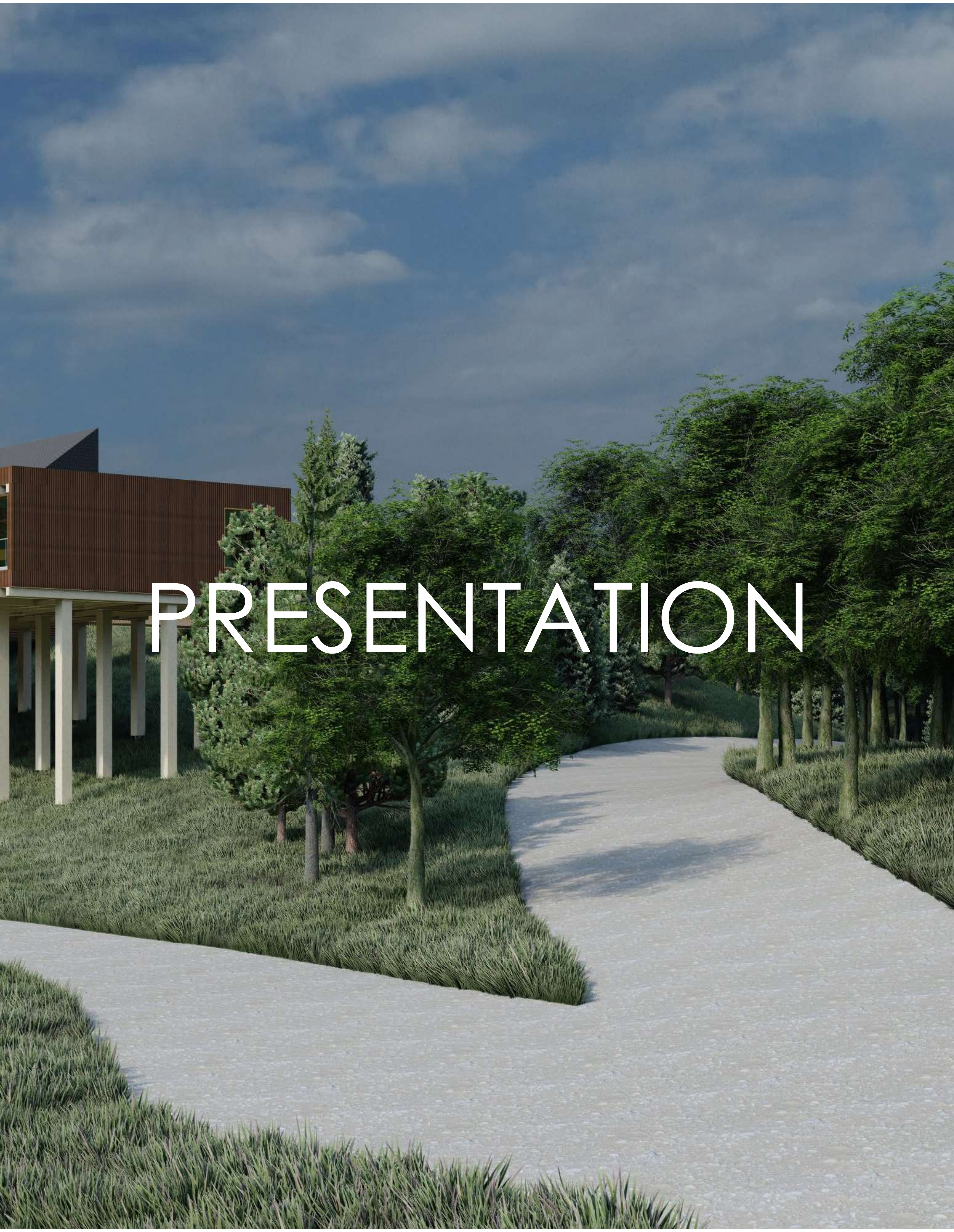
4 Timber Column 200x200 mm

5 Timber Beam 200x300 mm

SUB-CONCLUSION

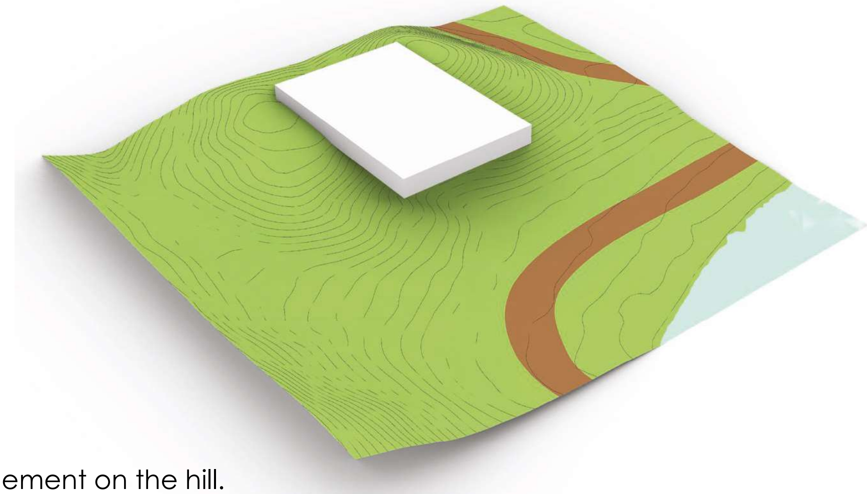
The structural analysis was used to verify the dimensions of the elements and the iteration were made to solve the structural issues by changing the number of element and their cross sections. Iteration 5.9 was the structure with the best utilization of the elements.

62. ill. Construction iteration 5

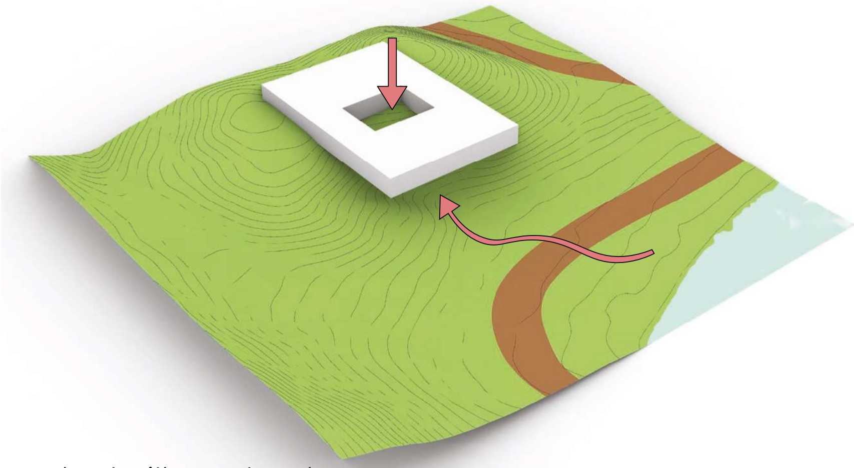


PRESENTATION

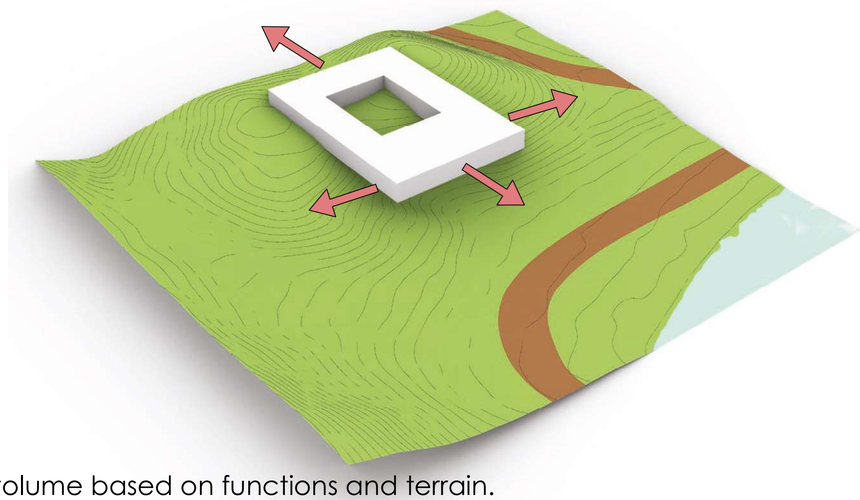
CONCEPT



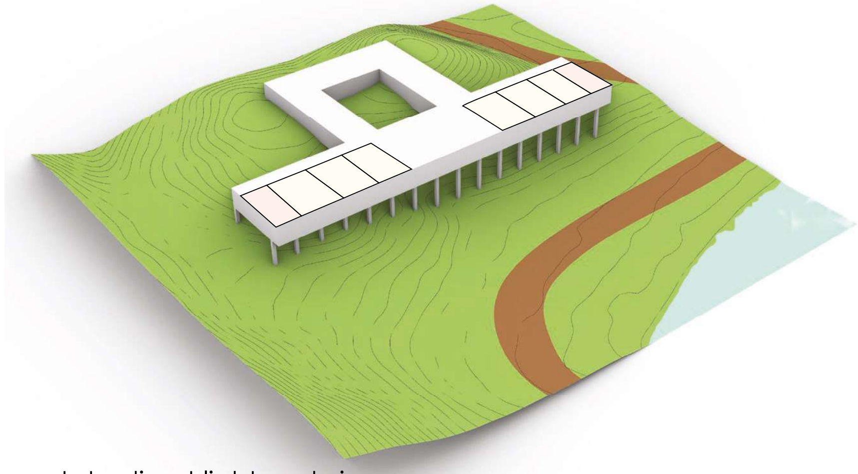
1 – The volume placement on the hill.



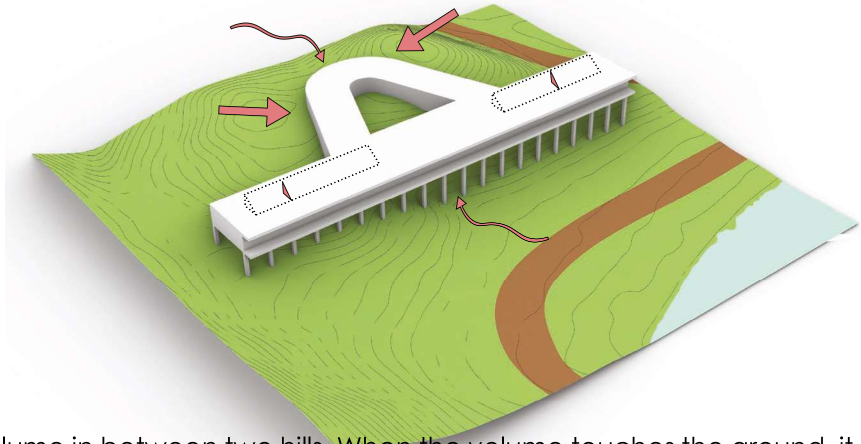
2 – Connection inside and out with courtyard.



3 – Evolution of the volume based on functions and terrain.



4 – Placement apartments to direct light and view.



5 – Integrating the volume in between two hills. When the volume touches the ground, it is following the topography with curved lines, and when elevating above the ground, it is sharp lines.

6 – Adapting the roof with a skylight and integrating architectural elements with the surroundings.

63. ill. Final concept

SITE PLAN 1:1000

The chosen spot is situated at Poulstrup Sø that offers a clear view of the lake because it is high above a hilly landscape and has a hilly topography. Most of the trees have been cut down on the chosen site. Tall tree alleyways around the area, giving it a lively and airy appearance.

64. ill. Site plan 1:1000

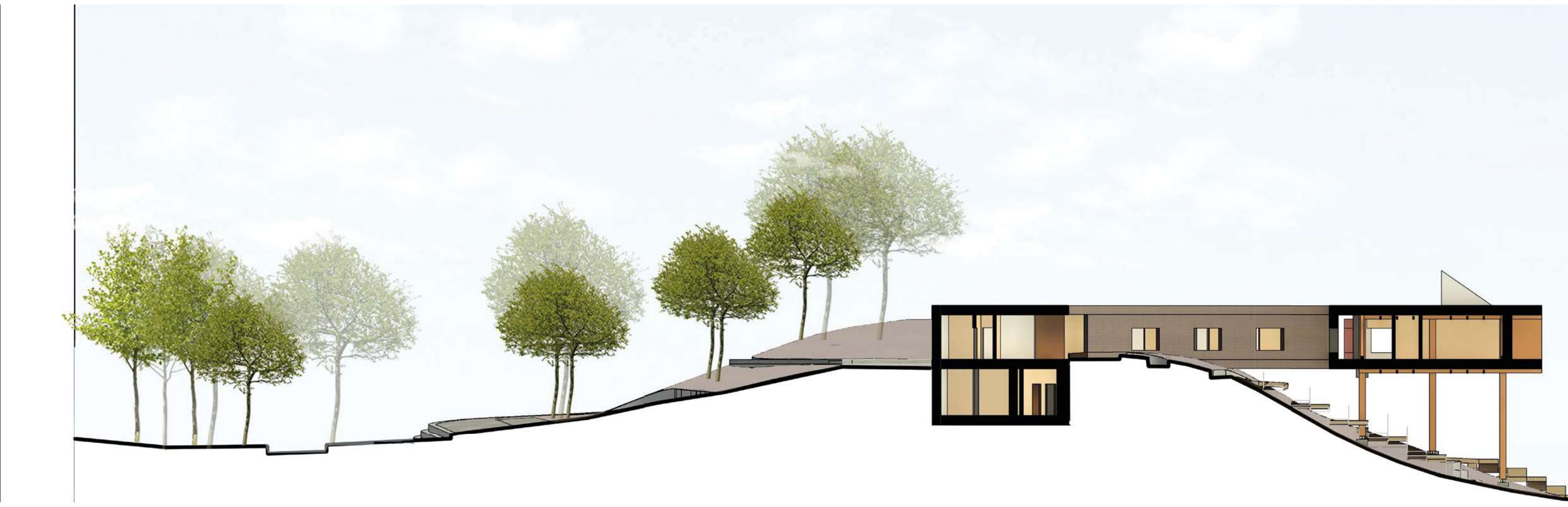
ARRIVAL

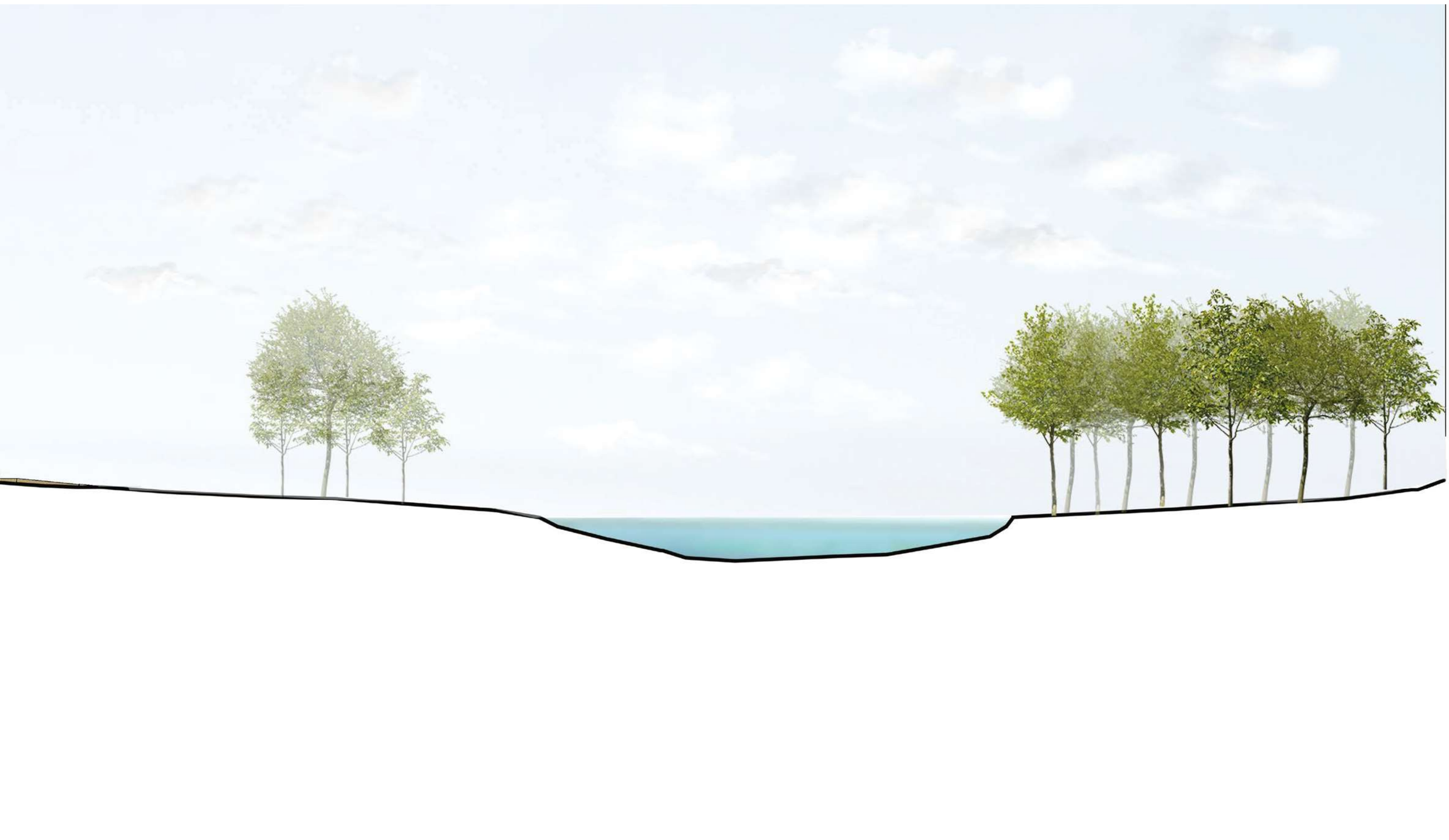
A contrast between nature and man-made structures greets users as soon as they arrive at the location. Placing the building at the top of the topography towards the lake and using a zigzag ramp to get there, fostering an atmosphere of adventurous curiosity, inviting visitors to explore the neighbourhood it has taken over and get to know the users. The entrance on the north side of the building is made to allow patients to drive right up to a drop-off area and using the existing walkway to connect with 4 m wide gravel ramp. It is crucial to take into account the variety of people, their needs, and how to involve them into a design in order to create spaces that function for everyone so that the ramp has been considered an inclination of max 5%. that the building can be accessed by users, even who

are frequently quite frail and confined to bed. The question of exactly what you are feeling on your trip from your car or bicycle or walking towards the building arose due to the parking areas location next to the ramp. The car-parking serves spaces for 12 cars and two disabled car parking spaces are included, enables relatives and staff to park for an extended period of time.

65. ill. Arrival

SITE SECTION 1.500



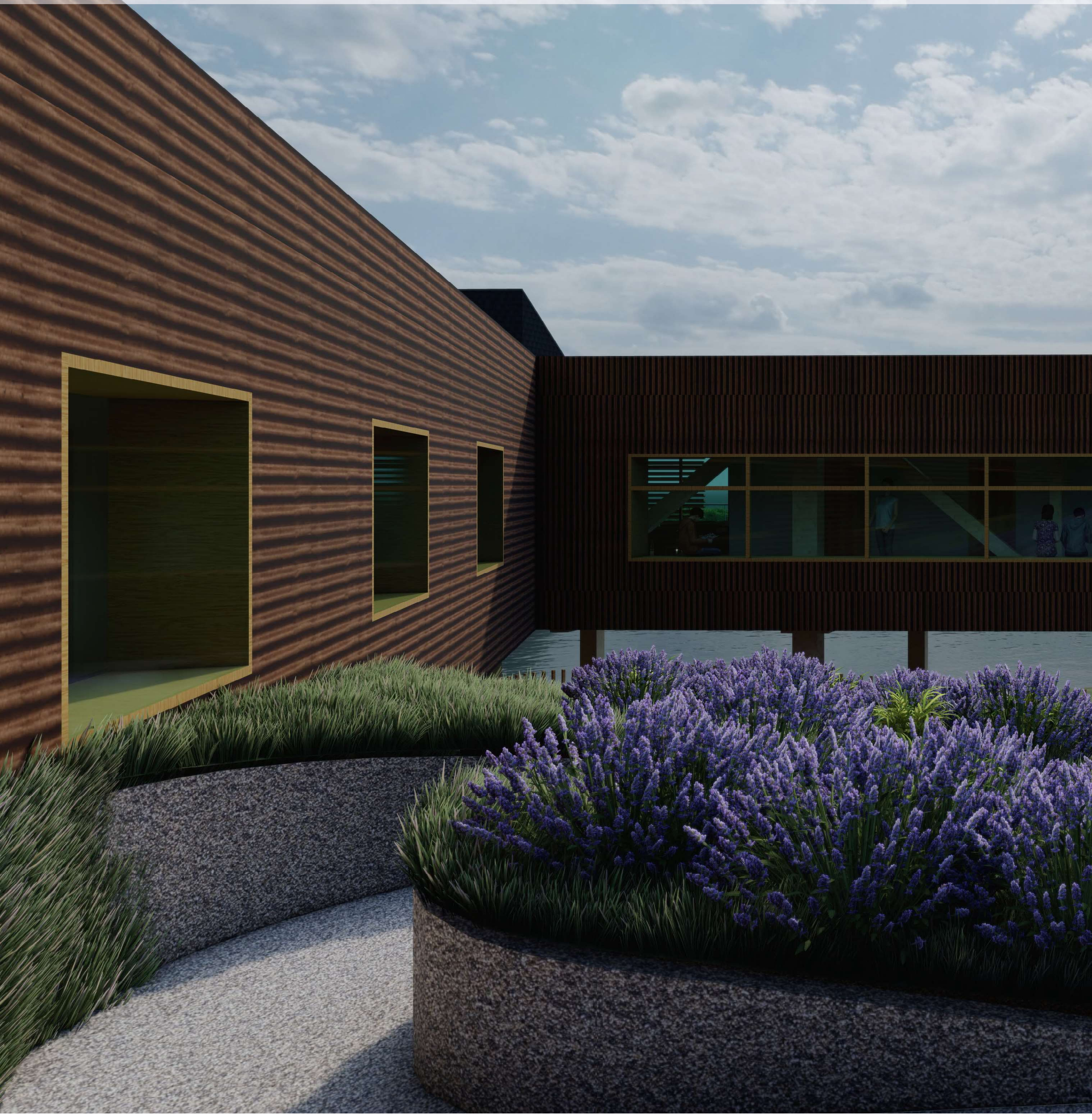


66. ill.   Site section 1:500

COURTYARD

An interior-exterior connection is made by the courtyard in the center of the building volume, which is a green oasis. While taking into consideration the needs of the users and their desire for pleasant, comfortable areas, it provides a direct transition to the lake. The transition is provided by a ramp. When the ramp touches the ground it has a curving lines just like the building curves when in contact with the ground and follow the landscape. The material is permeable concrete when touching the ground. When the ramp is elevated above the ground, Nordic pine that has been thermo-treated is used on the surface covering its outside. This is equal-sized horizontal and small grooves that provide serenity and promote calmness and makes the movement of wheelchairs easy. Since the road should enable patients a range of sensations as they proceed towards the lake, the courtyard can serve as the building's centrepiece by bringing in sunlight and warmth.

The path through the courtyard leading to the lake is more convivial and flow-oriented because it includes numerous features along the way, such as a sensory

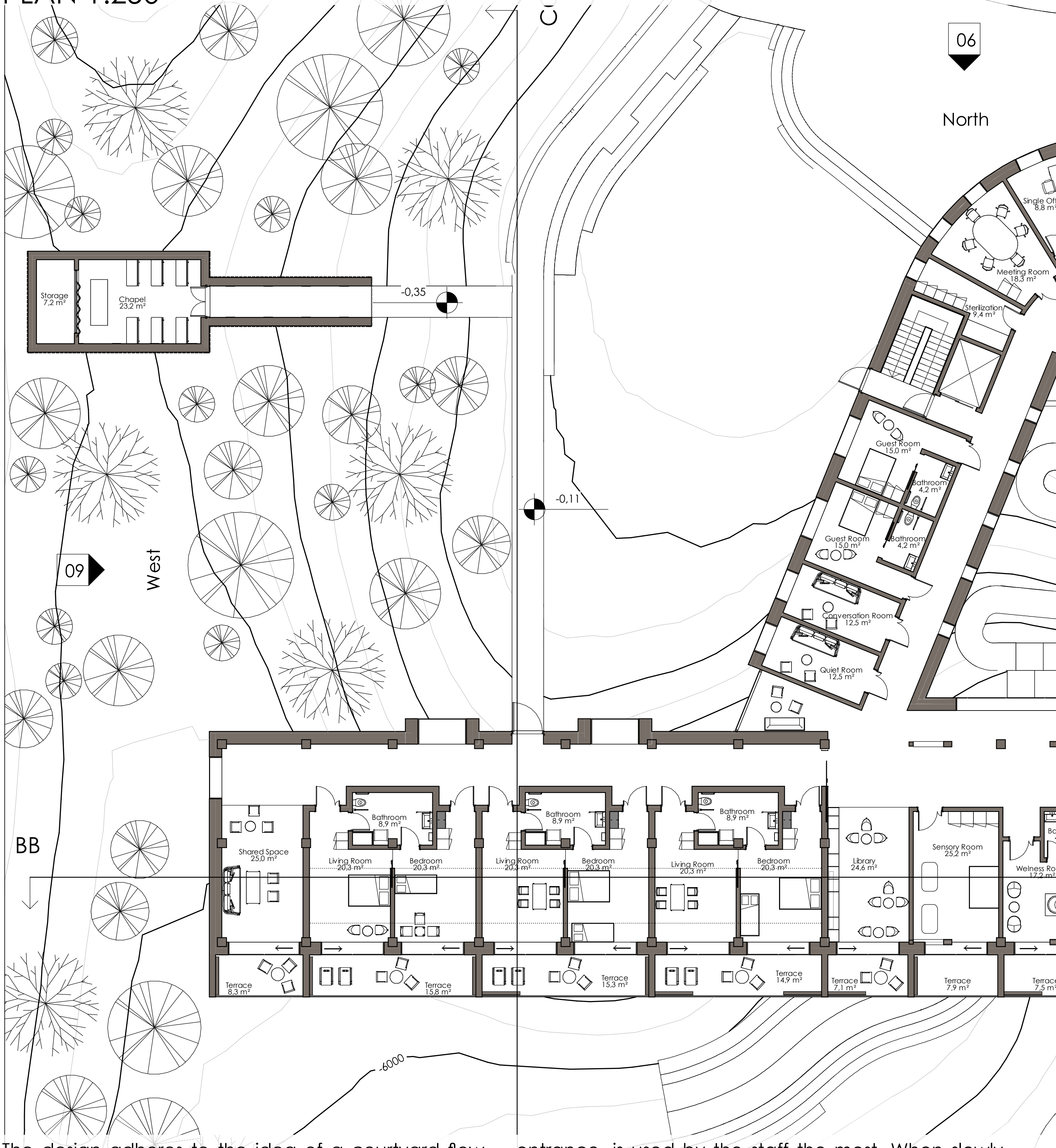


garden, an amphitheatre, and covered spaces. In the sensory garden, the raised flower beds are the garden's main attraction walking towards the lake; here, flowers and other plants arouse the senses with their colours, tactility, and scents. Patients' sensory perceptions are stimulated.

After moving a little closer to the lake, the amphitheatre and seating places in the semi-open area beneath the structure come together where they can enjoy with activities and maintain a view towards the lake. As you advance a little, a playground is placed in front of the building where play for children is encouraged. Making sure children have a save space to play in, one can observe the activity and the sounds from the outside from the courtyard and their terraces.

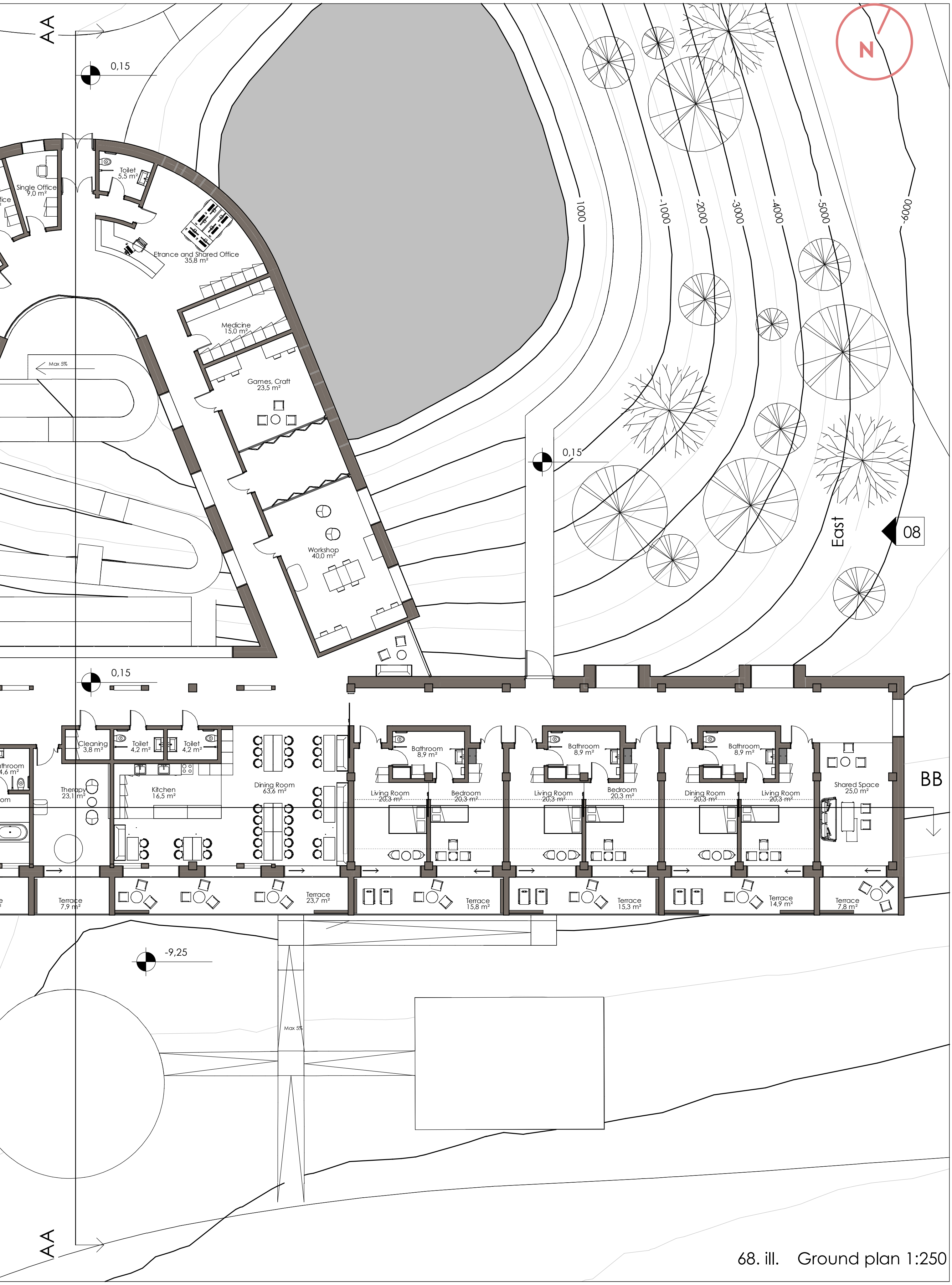
67. ill. Courtyard

PLAN 1:250



The design adheres to the idea of a courtyard flow, that presents different perspectives for patients, makes it easier to move around and gets away of the long hallways. The terrain, its dynamic mobility, the effect of the landscape on users and different views like towards lake or dense forest all played a significant part in where the functionals were placed. The building is totally flat, allowing the patients to move or be transferred throughout the entire building without the use of elevators.

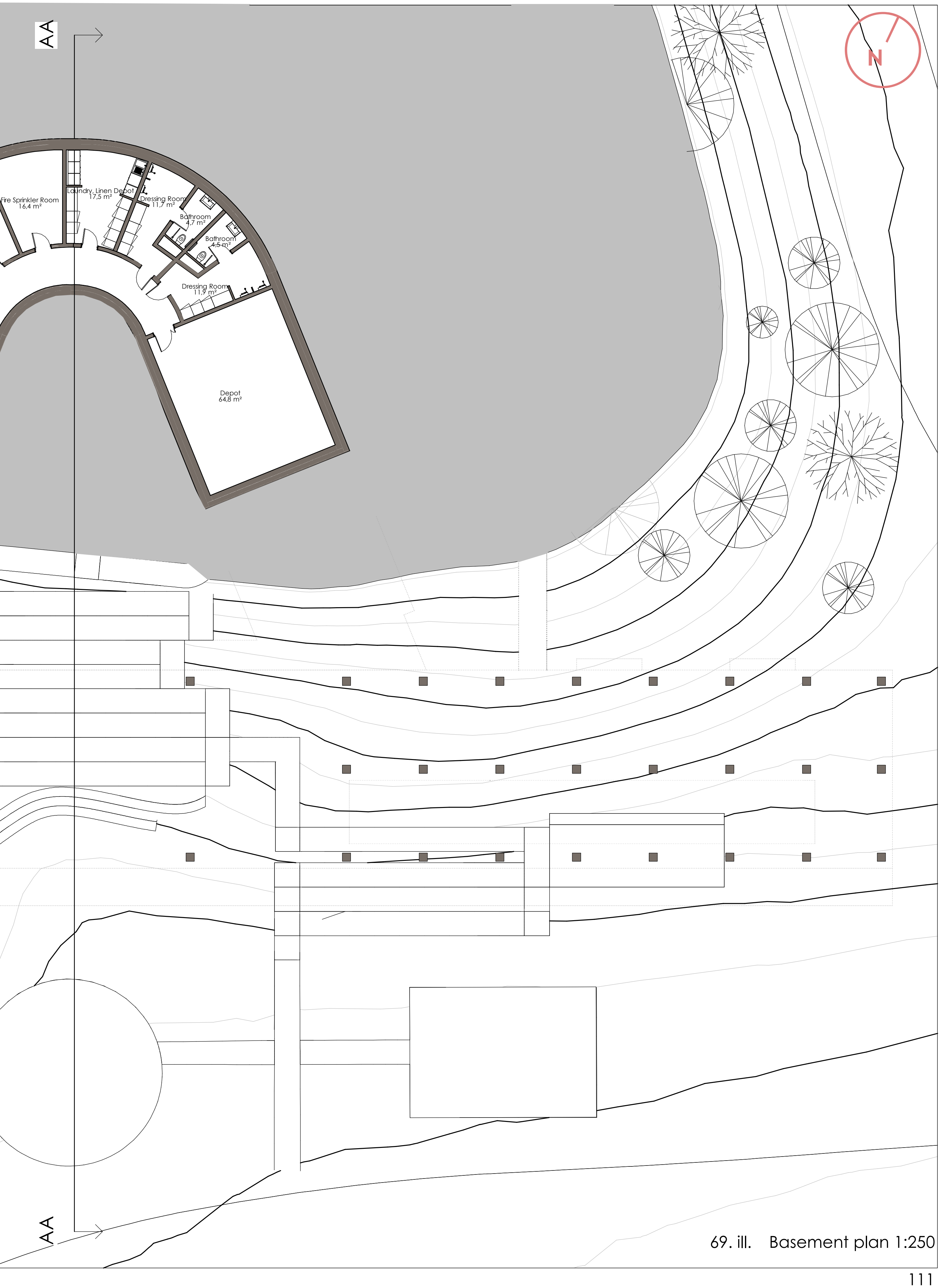
The building's northern part, which is closest to the entrance, is used by the staff the most. When slowly advancing toward the social area, which is the noisier area and where the workshops are located. When entering the private zone, getting further away from arrival the patient apartments are divided into two sections, with a shared space positioned next to it. The treatment area and kitchen/dining area are situated between two wings in the semi-private part. The patients' access and lake view being provided on an equal basis is the reason.



68. ill. Ground plan 1:250

BASEMENT PLAN 1:250

The basement was added for technical storage, and an elevator and a stairway were installed to access the basement on the north side. Occupants would have access to much-needed storage areas. The basement where the practical functions are placed.



69. ill. Basement plan 1:250

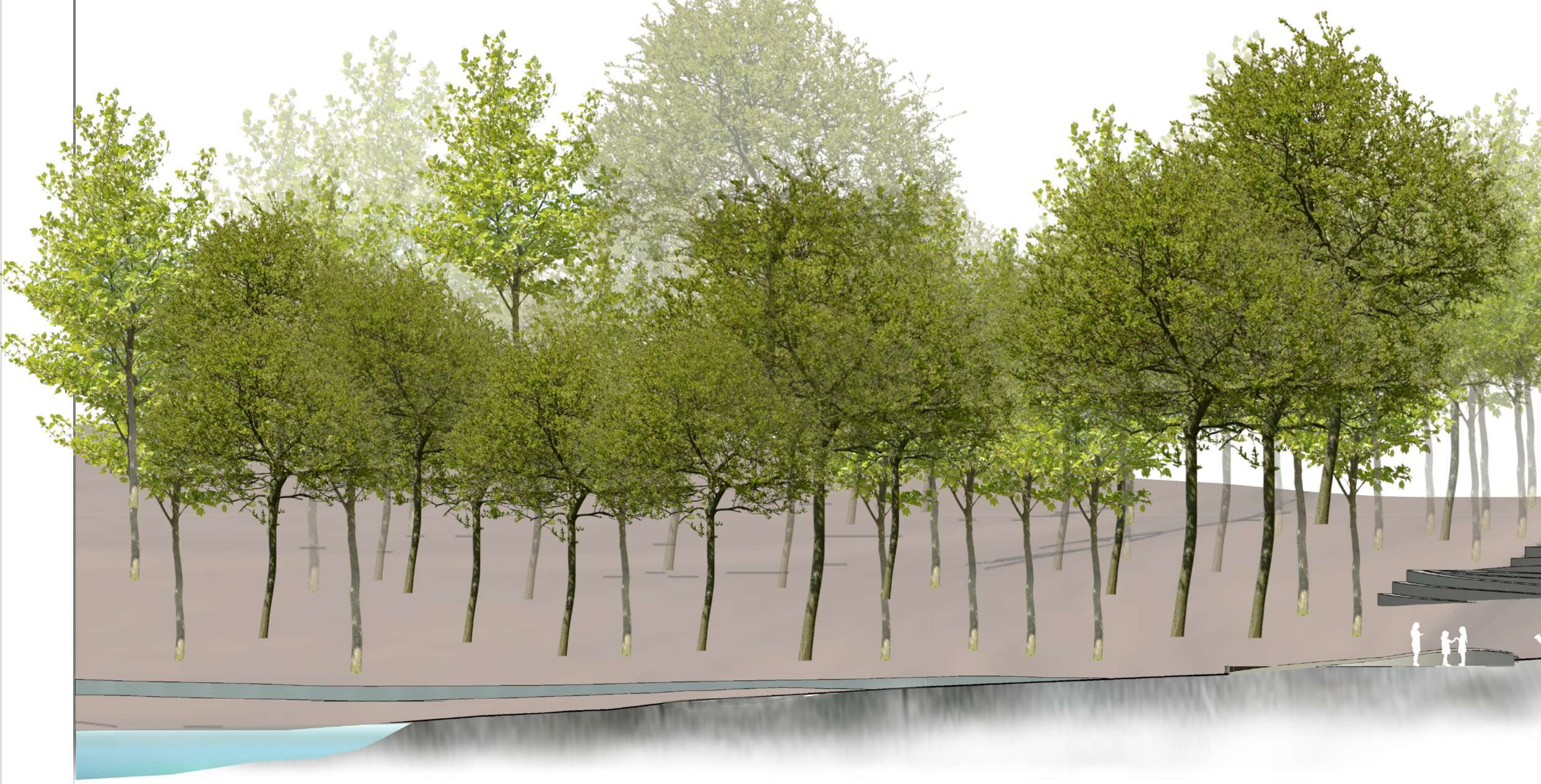
CHAPEL

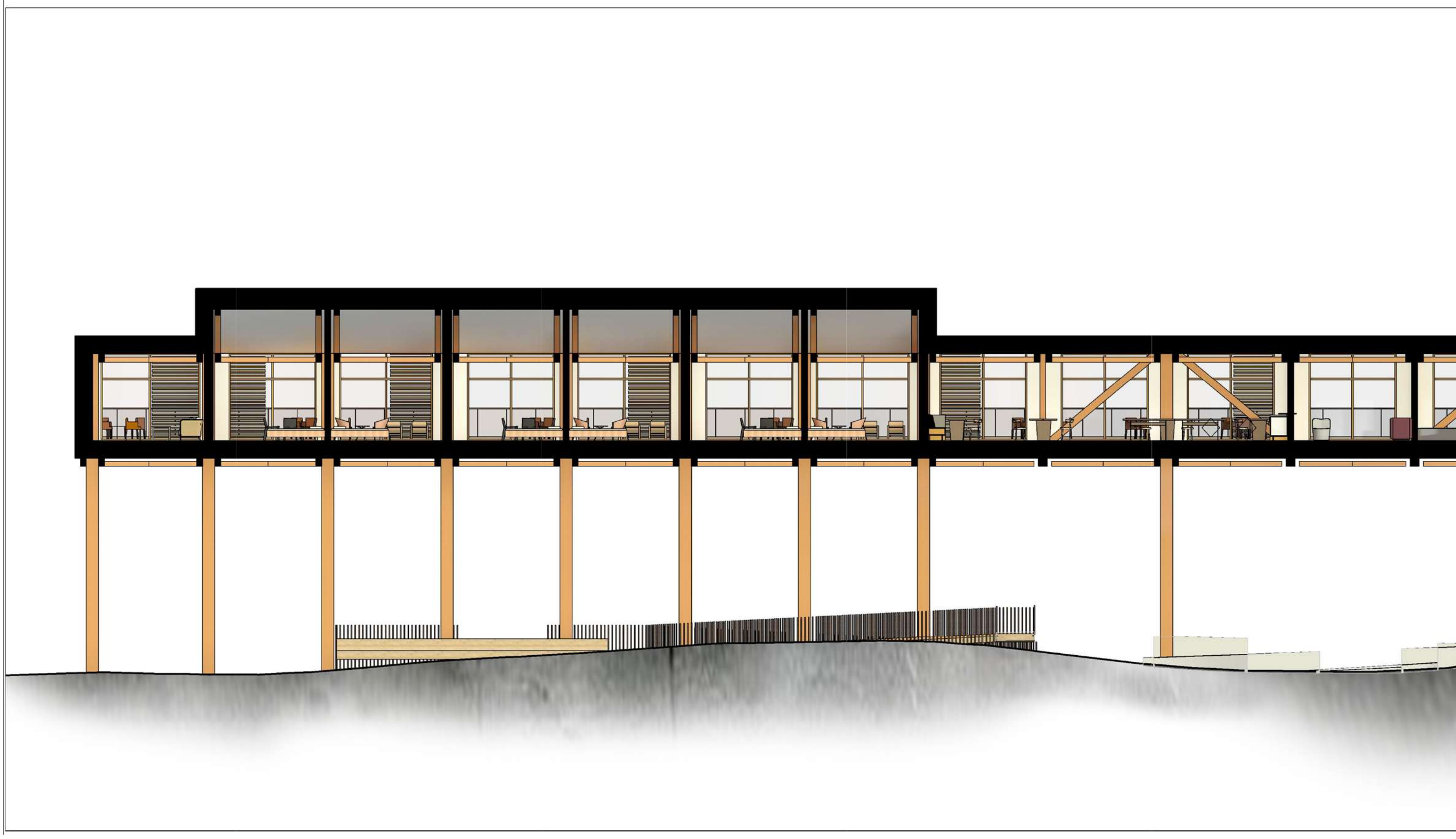
The chapel is located in western side of the building that right next to the towering trees in dense forest, brings to mind a natural boundary. As a result, a pathway connecting to the chapel, serving as a prelude to our entrance into the forest. The chapel is a place that is peaceful and detached from the everyday life. It is not a religion place, and it is a reflection of silence like a retreat. When entering to the chapel and are welcomed by a very small hallway, as moving further, the area becomes wider and opens up to the sky. In addition, the notion of the building is brought to the chapel that is elevated above the ground.

70. ill.   Chapel

SECTIONS

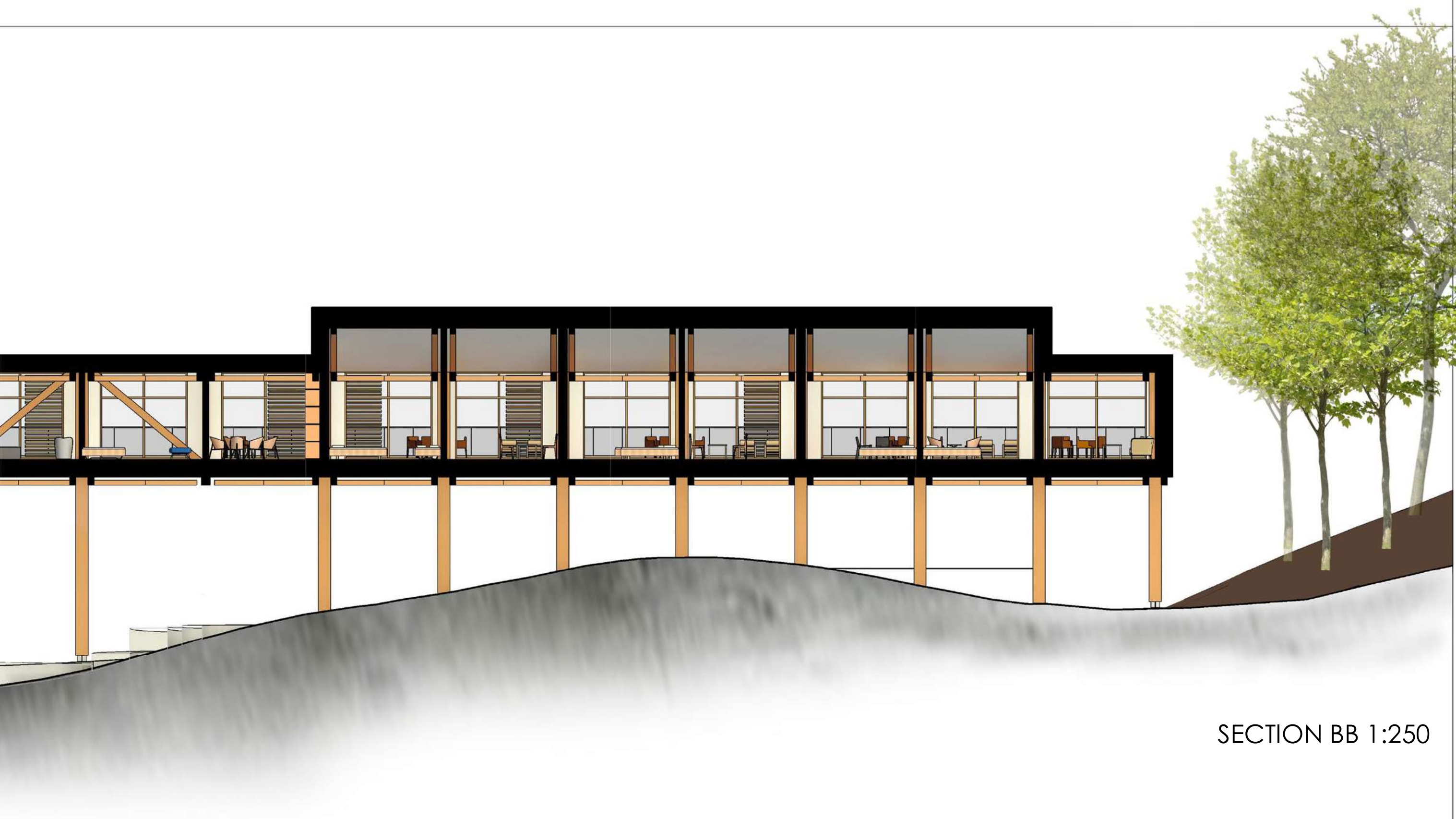
Children's Hospice is built on hilly landscape. The courtyard section AA illustrates that half of the volume is elevated on wooden columns which means treatment, social and apartments are above the ground while the other half is attached to the ground, where staff and some technical functions are placed. The section demonstrates that underneath of the structure gives a direct transition to the lake with a ramp.





Section BB illustrates the connection between apartments, treatment and social areas. The underneath of the structure is used as an amphi and sitting areas for the users where they can enjoy the view.

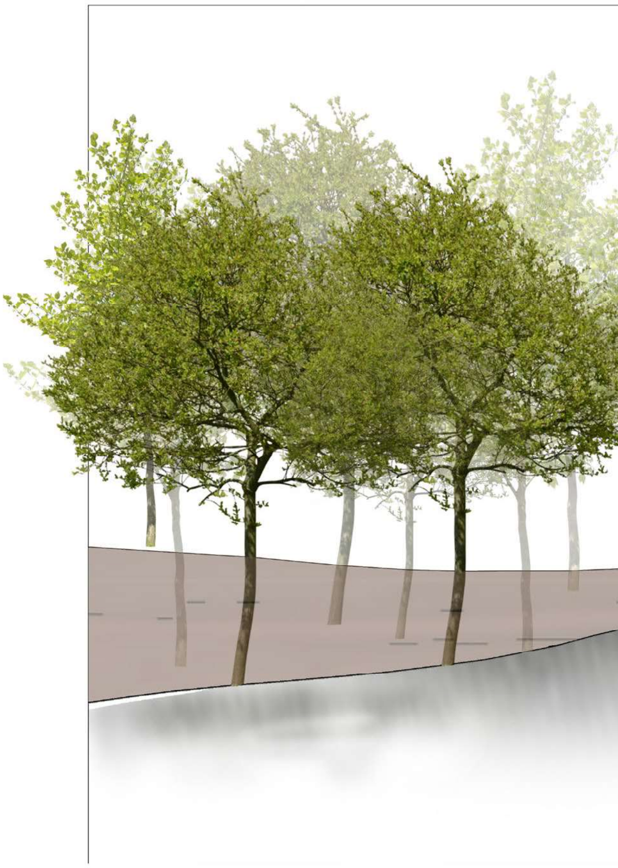
SECTION AA 1:250



SECTION BB 1:250

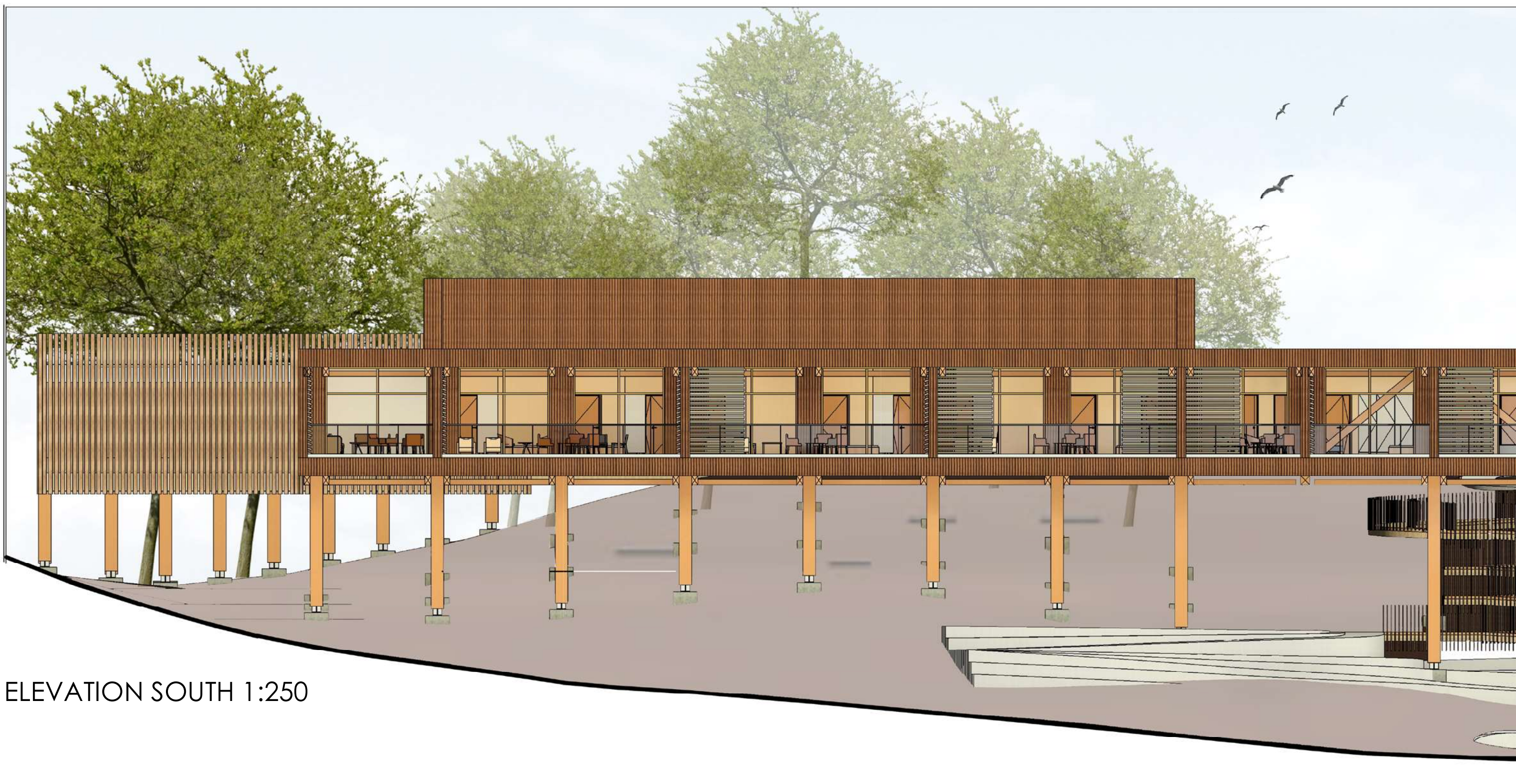
71. ill. Section AA & BB 1:250

Section CC shows the relation between the building and chapel. In addition, how the pitched roof has an impact on spatial quality in the apartments are.



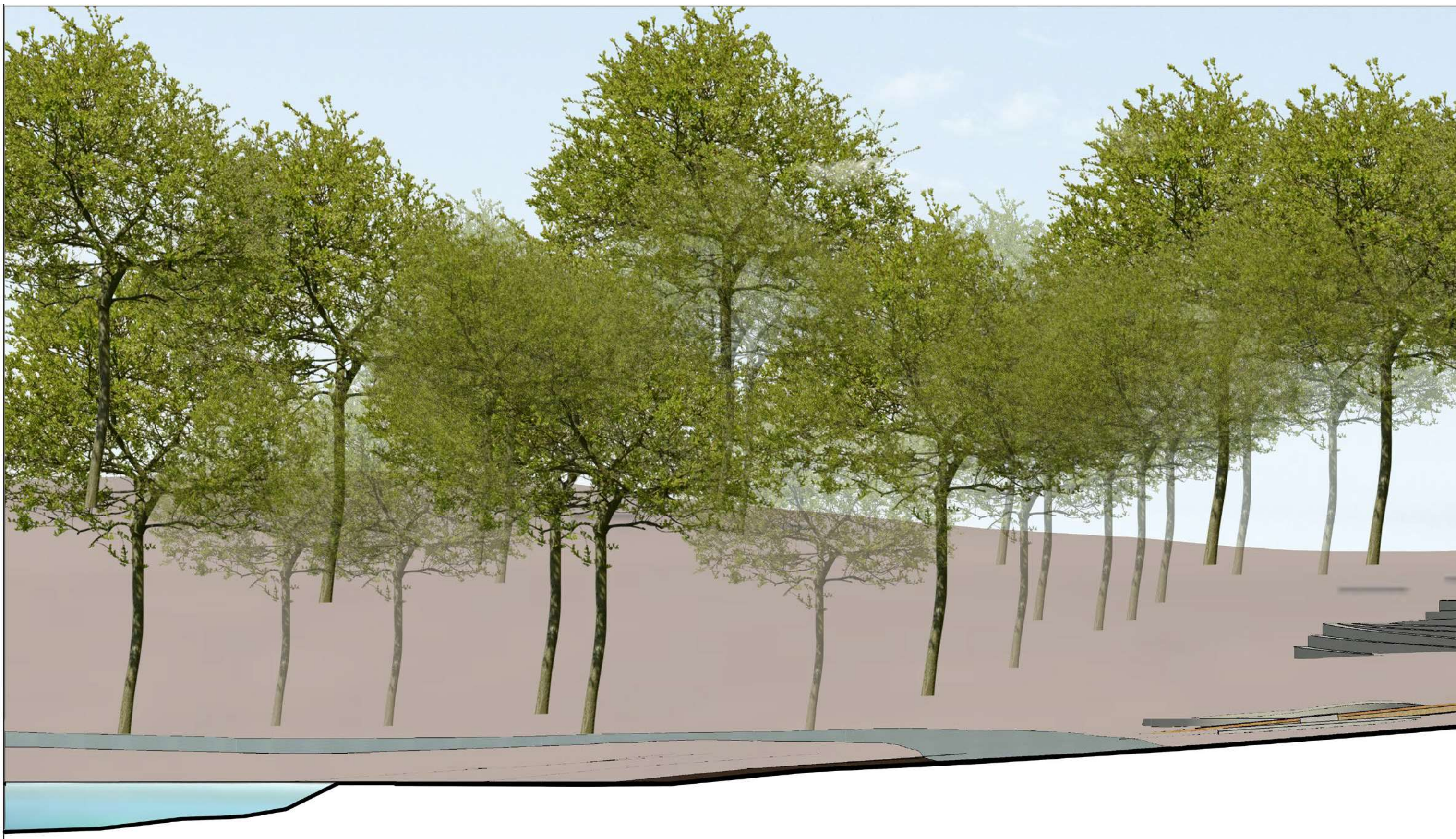
72. ill. Section AA & BB 1:250

ELEVATION NORTH 1:250



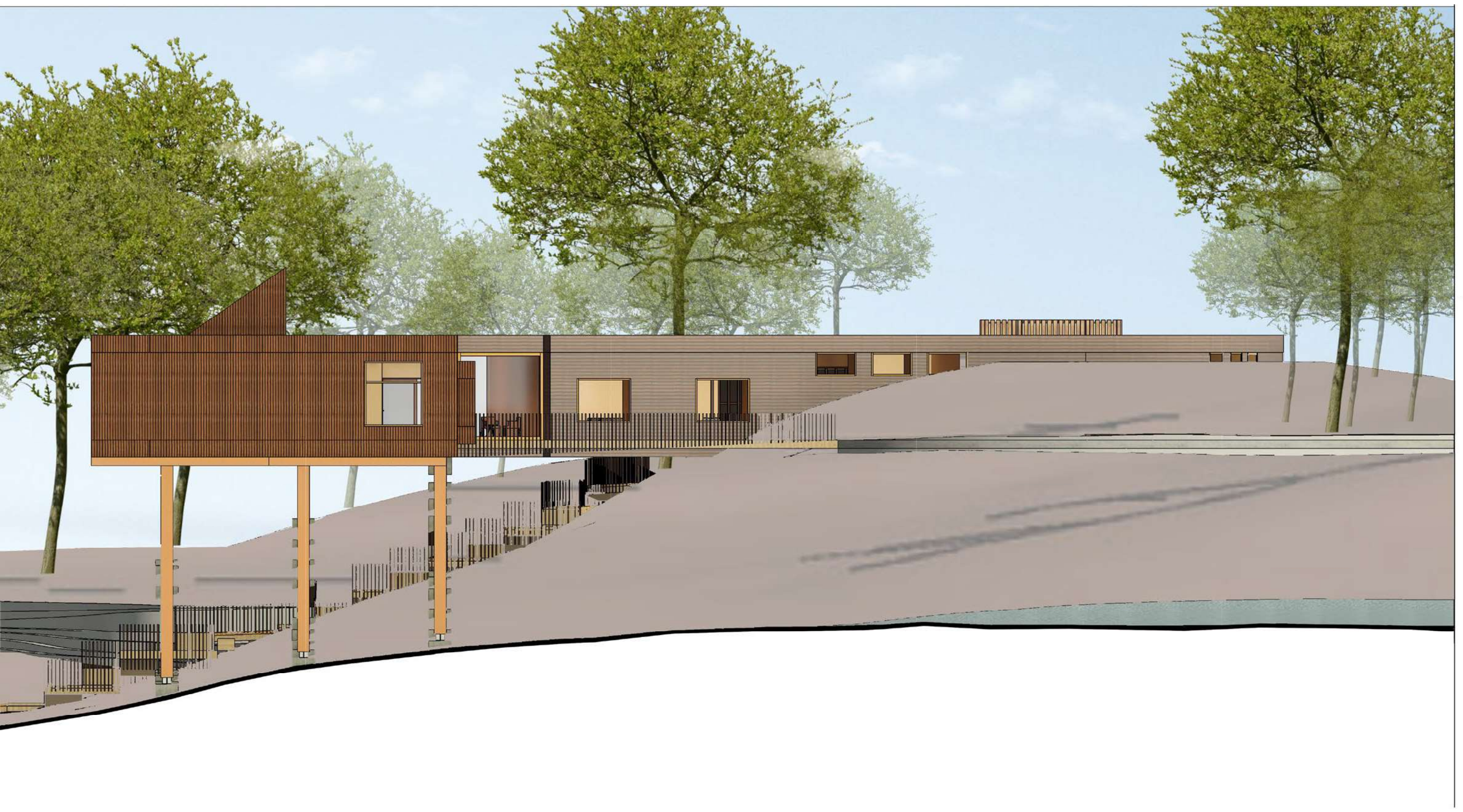
ELEVATION SOUTH 1:250

73. ill. Elevation North & South 1:250



75. ill. ELEVATION EAST 1:250

74. ill. ELEVATION WEST 1:250



76. ill. Elevation East & West 1:250

FIRE ESCAPE PLAN 1:250

Everyone must be able to leave the hospice in the case of a fire. According to fire rules, the distance from a building's interior to an exit must not be more than 30 meters. The width of the corridor must also be adjusted based on how many people utilize it. It must be at least 1.3 meters wide. Additionally. the width of the door must be at least 1,20 meters (Bolig og Planstyrelsen 2022). The distance to an escape route on the ground floor is no more than 28 meters. This is achieved according to the building's design.

77. ill. Fire escape plan

STAFF SOCIAL 1:200

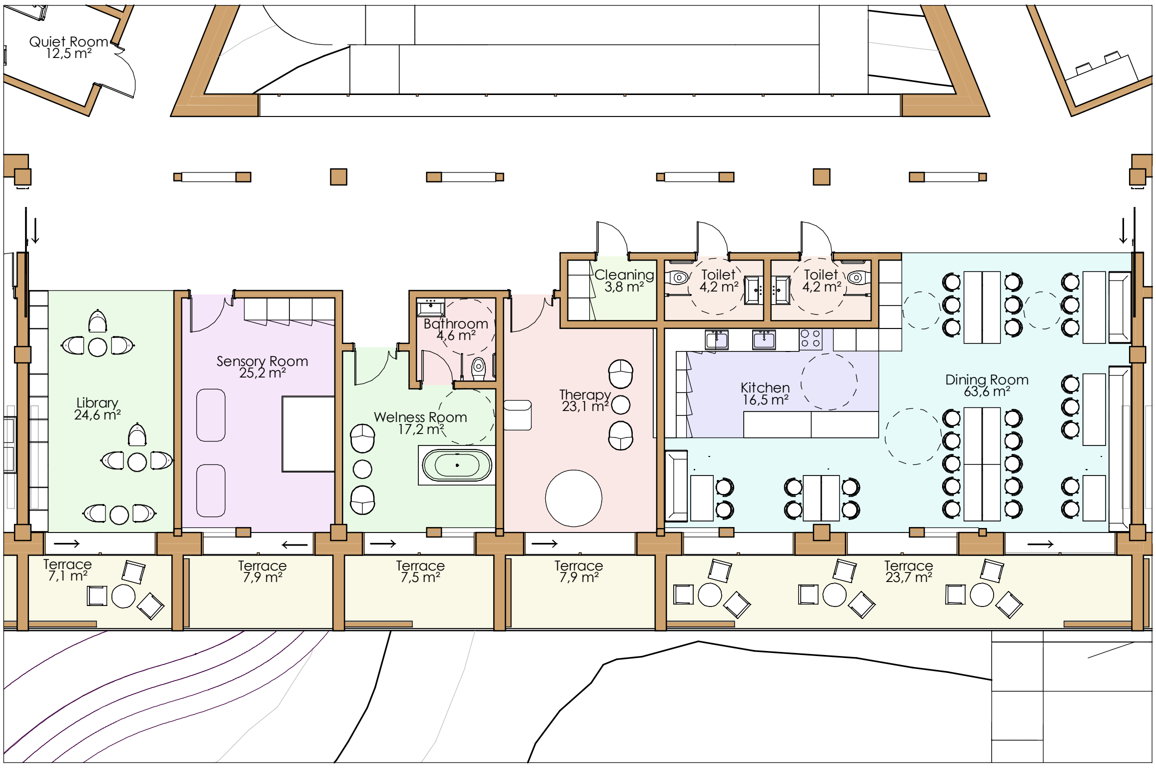
78. ill. STAFF SOCIAL 1:200

Staff and Social

- Bathroom
- Conversation Room
- Etrance and Shared Office
- Games, Craft
- Guest Room
- Medicine
- Meeting Room
- Quiet Room
- Single Office
- Sterilization
- Toilet
- Workshop

There is a clear view of and connection to the courtyard when entering the building. Offices and a meeting room are arranged in a row to the right and left of the welcoming reception. The flow naturally divides into three directions: a direct transition to the courtyard towards lake, a noisy zone with play areas and workshops on the east, and a quiet zone with visiting rooms, quite and conversation rooms on the west.

SOCIAL, DINNING & TREATMENT 1:200



79. ill. SOCIAL, DINNING & TREATMENT 1:200

Treatment and Kitchen

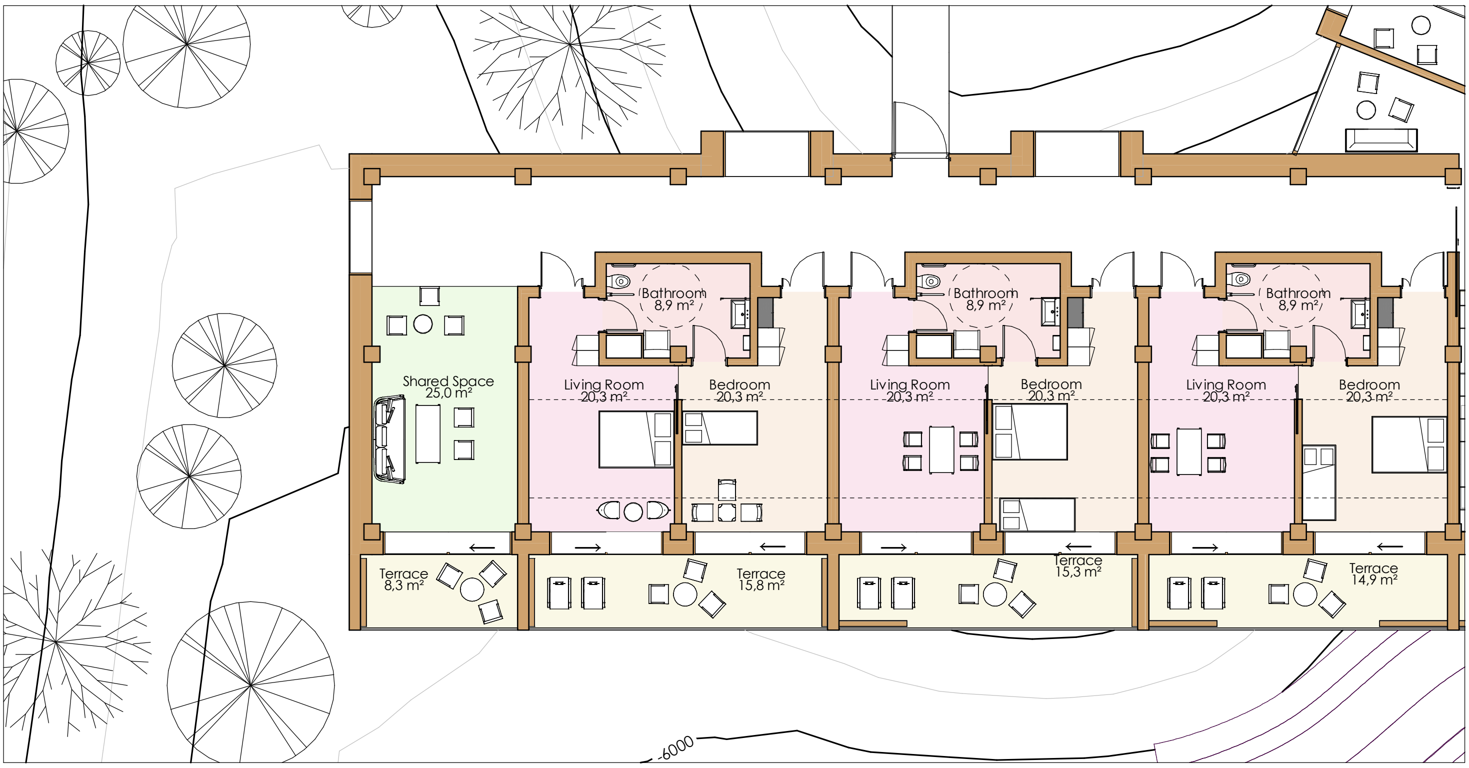
- Bathroom
- Cleaning
- Dining Room
- Kitchen
- Library
- Sensory Room
- Terrace
- Therapy
- Toilet
- Welness Room

These two hallways, which are a fluid space, provide a direct visual connection to the lake with a continuous flow at the kitchen and library areas towards south. The spaces create a sense of wonder when users walk along the corridor, and a visual connection is also provided to the dense of forest on the part facing east and west with sitting areas establishes spaces that are semi-private to promote casual interactions where you can relax or perhaps go to hide and cry. Opposite the treatment, on the part facing the courtyard, the structure of the building has become a part of the space. Play areas are created around the structure of the building to encourage more interaction between children and the environment, developing a child's playful nature.

80. ill. Kitchen

81. ill. Glass connection

APARTMENT & GATHERING 1:200



82. ill. APARTMENT & GATHERING 1:200

Apartments

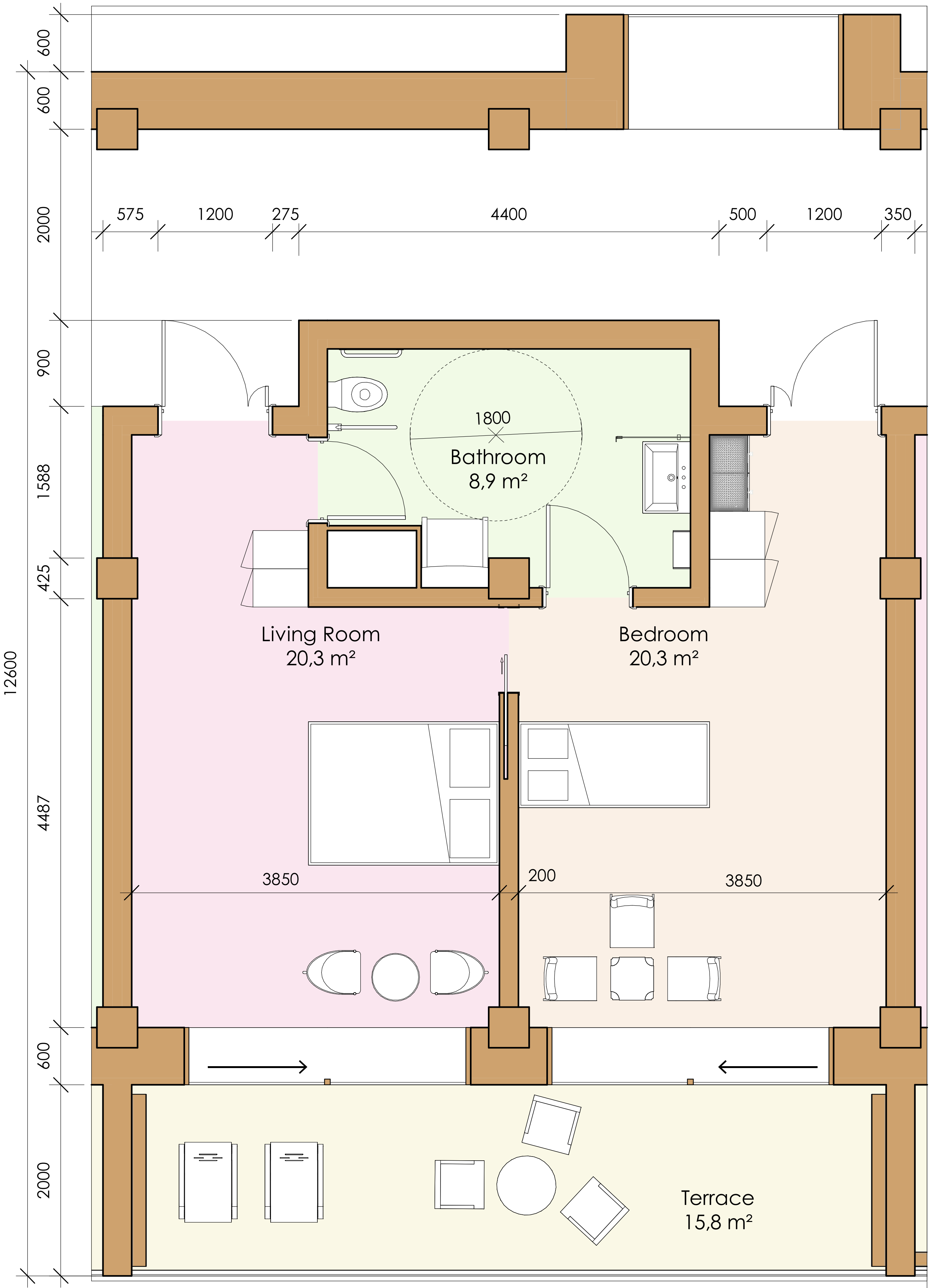
- Bathroom
- Bedroom
- Living Room
- Shared Space
- Terrace

There is an awe-inspiring scenery of the lake and the hilly landscape from the patient rooms that face south. The units were divided into two zones. Each zone has three apartments to avoid having to go far for social and treatment and to provide them with equal access. A visual connection to the deep forest on the east and west sides is also given to the patients in the private zone. Two 120cm-depth boxes were put in place on the north side of each zone facing the corridor. The patients sitting and lying on can be relaxed and at ease in this private and cozy section while enjoying a view of the forest. Fire escapes in this zone can be used to access the forest and the chapel from the bridges that is elevated above the ground. In addition, each wing has a shared space to make a lively and secure area for families and their children to gather and move. These spaces also encourage social interaction.

APARTMENT LAYOUT 1:50

“It is like an atmosphere of home facing the lake with a lovely view and soaking up the sunlight. They can set up a table on the terrace, watch their children play at the playground in front of the building that they may retreat temporarily while still keeping an eye on everyone else.”

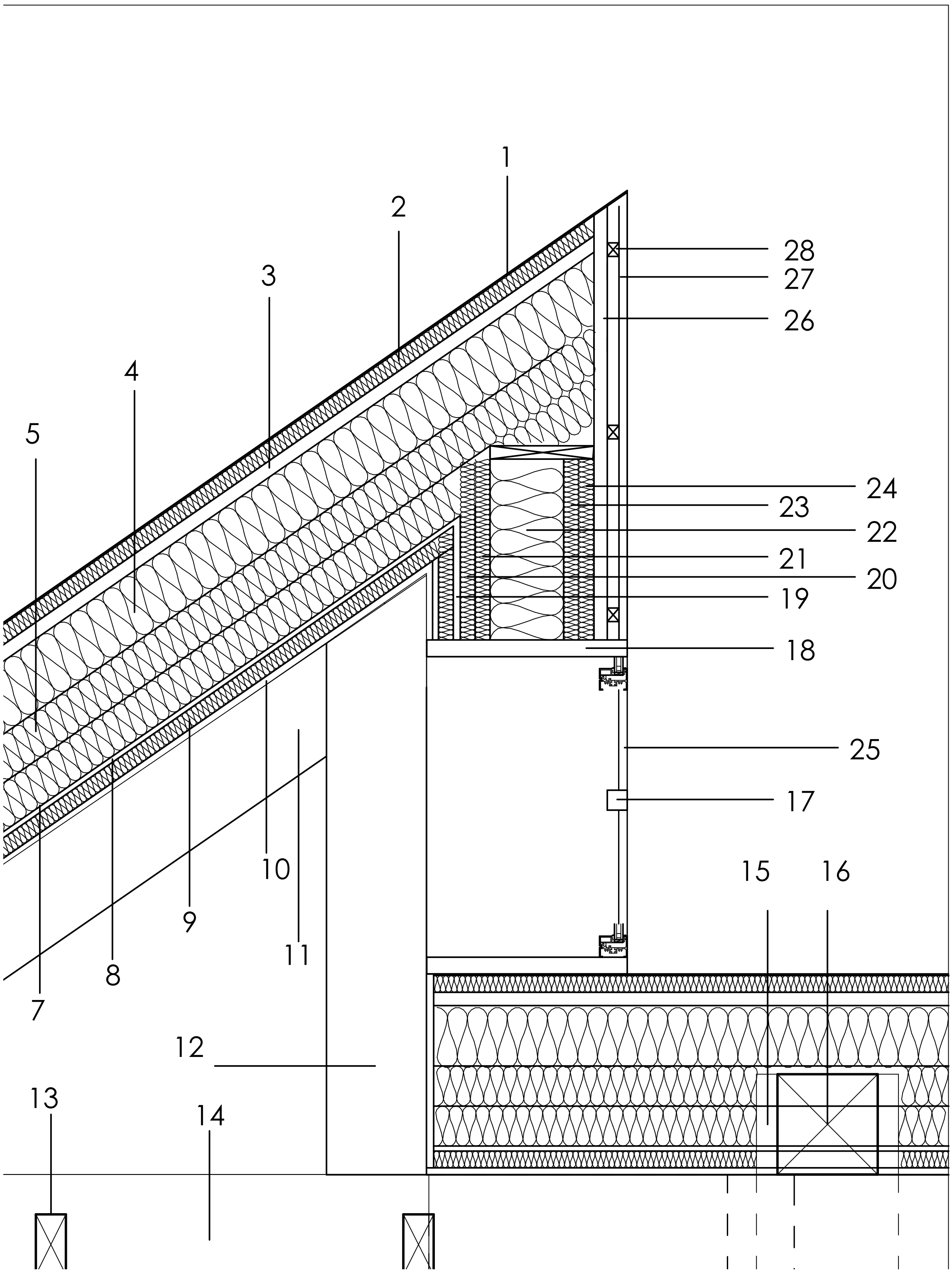
Patient unit is divided into two rooms. In a secure setting with space for both patients and staff, the rooms provide the foundation for family life so that a lift is placed in between to beams where can be able to take the patient directly into the bed. Diverse age groups should be catered to in the rooms so flexibility and spatial spaces are important that the rooms can be furnished according their needs. For instance, due to their vulnerability, young children often prefer to sleep near their families rather. Adults, on the other hand, favor sleeping alone. The rooms fits in these situations. Next to the patient room, a sliding door divides the family’s room from the room.The wooden structure with pitched roof in room is visible which makes the interiors cozy and welcoming atmosphere. The patients may watch the surroundings through a big glass facade, and a glass door opens to a terrace with a lake view.



83. ill. APARTMENT LAYOUT 1:50

84. ill. Apartment

85. ill. Hall way



86. ill. Detail roof connection with skylight 1:20

1 Bitumen Membrane 5mm

2 Rigid Insulation 50mm

3 Rear ventilation level 40 mm

4 Rigid Insulation 180 mm

5 Rigid Insulation 120 mm

6 Rigid Insulation 120 mm

7 Vapor Barrier

8 Plywood 15 mm

9 Insulation 50 mm

10 Plywood 20 mm

11 Timber Slanted Column 200x300 mn

12 Timber Column 200x300 mm

13 Timber Beam 90x180 mm

14 Timber Beam 200x300 mm

15 Timber Column 425x425 mm

16 Timber Beam 300x300 mm

17 Wooden frame 60x60 mm

18 Wooden Frame 50x600 mm

19 Plywood 20 mm

20 Insulation 45 mm

21 Insulation 45 mm

22 Insulation 220 mm

23 Insulation 45 mm

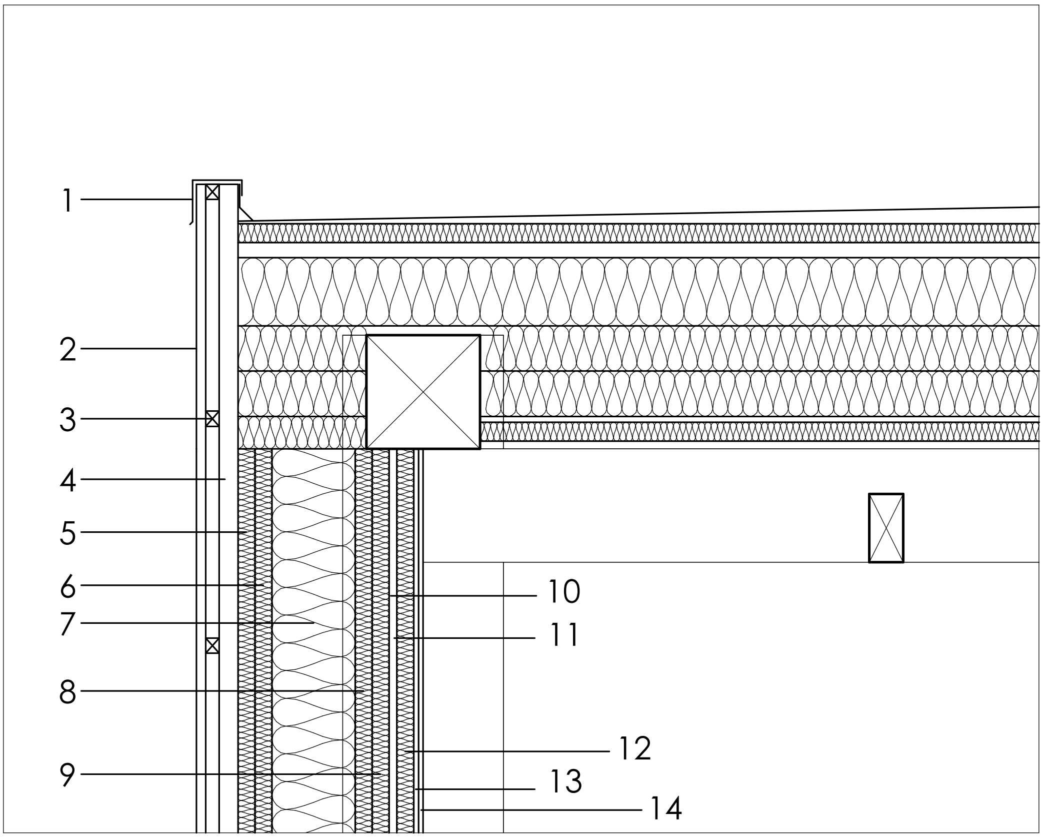
24 Insulation 45 mm

25 3 layers window

26 Rear Ventilated Level 40mm

27 Wooden lamellas 25 mm

28 Lath 35x40 mm



87. ill. Detail wall and roof 1:20

1 Zinc
2 Wooden lamellas 25 mm
3 Lath 35x40 mm
4 Rear ventilation level 50 mm
5 Insulation 45 mm
6 Insulation 45 mm
7 Insulation 220 mm
8 Insulation 45 mm
9 Insulation 45 mm
10 Vapor Barrier
11 Plywood 20 mm
12 Insulation 40 mm
13 Gypsum Board 12,5
14 Gypsum Board 12,5

CONSTRUCTION

The main structure is a wooden frame structure consisting of columns and breams these frames are set up in a grid system which is also part of the elements that is defining spaces. The grid system is also part of the wall structure both interior walls and exterior walls. As seen in the plan drawings. The section called SOCIAL, DINNING & TREATMENT is carried by a beam structure. For detailed calculations see appendix 4-5

88. ill. Construction Isometric

89. ill. Construction facade

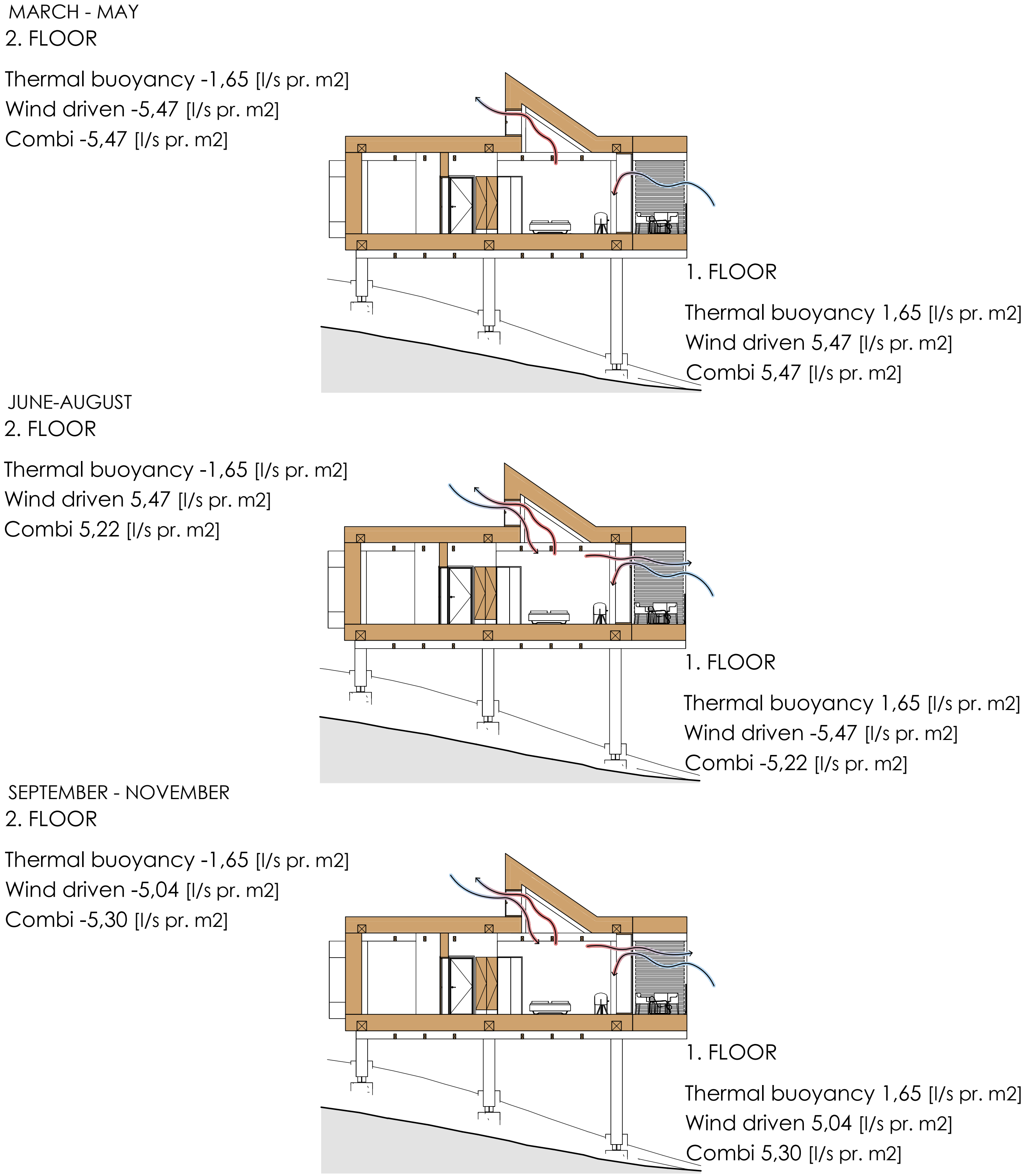
90. ill. Construction in shared space

INDOOR INVIRONMENT

For the indoor climate the focus has been on the thermal comfort and air quality. The air quality is covered by the mechanical ventilation and the natural ventilation.

For the thermal comfort there has been implemented different measures during the process but the result is that the overhang from the terraces, the shading shutters and the natural ventilation is making it possible to minimize the amount of hours of overheating in the apartment as these has been the main focus of the thermal comfort calculation. The reason being some of the patient not being able to leave their room because of the state of their illness.

If used correctly the it should be possible to have a maximum of 65 hours above 27 degrees and 25 hours above 28 and in case the user is not good at using the shutters the risk of overheating increases a small amount to 71 hours above 27 degrees and 32 hours above 28 degrees. Which will be worst case scenario. For further detailing look in the process under "Be18, Bsim & VENTILATION"



91. ill. Natural ventilation presentation

ENERGYFRAME

The energy frame of the building is a small overproduction of energy as the building has a energy frame of -0,4 kW/sqm. per year meaning there is an overproduction of a little less than 700 kW per year

The reason this was possible was the addition of the geothermal heat pump and the photovoltaics. The photovoltaics cover an area of 95 sqm of the sloped roof surface. While the geothermal heat pump has a piping system laid out in the leak. So, the building is a Net zero building.

CC
11
1
North
(LUX)
6000
11.1
2
West
BB
2000
1000
299
106
0
South
2
11
Results of Lighting Analysis
CC

92. ill. Daylight illuminace

CONCLUSION

This master's thesis presents a proposal for a children's hospice that is situated by Poulstrup Sø, in Aalborg, Denmark. The design is made utilizing an integrated design process, which combines an all-encompassing approach with evidence-based design. This concept uses Poulstrup Sø's inherent attributes to design a hospice where tie between utility and aesthetics that is entwined with space, nature, structure, construction, atmosphere, spaces for children, and other factors coexist in accordance with the principles of healing- and palliative architecture.

The natural features of the selected site have been used in the building design as they have a significant impact on the healing process. Integration of the design with its surroundings is an essential factor and is shaped by the context and places functions according to the existing elements of the site e.g., landscape, arrival, daylight, density of the forest. In order to provide patients with new viewpoints, make movement easier, and get them out of the long hallways, the children's hospice proposes the flow of a courtyard in nature.

Using the existing walkway to connected with a large gravel ramp, the entry on the north side of the building is designed to allow patients to drive directly up to a drop-off space and staff area is placed in this section. Utilizing the calm atmosphere and lake view, patient rooms and shared spaces are situated in a more private area. The courtyard in the center of the building volume is established to provide a transition for the patients towards the lake. It provides direct access to the lake with a ramp.

The patient rooms' ability to receive appropriate direct light and daylight was another crucial consideration. The light conditions in the patient rooms exceed 300 lux. There is a risk of glare as this occurs when there is too large contrast between light and shadow.

The timber structure was obviously designed inside the patient rooms with its natural and emotional influence through tactile, and visual interaction based on the research made. The wooden construction consists of beams positioned along the roof ridge and pillars in the apartments.

The goal of creating a building that fulfilled the energy frame requirements of BR2020 was exceeded as the building reached more than a net zero energy frame having a energy frame of -0,4 kW/sqm per year.

The indoor thermal comfort was as well proven to be reached with 65 hours above 27 degrees and 25 hours above 28.

REFLECTION

This reflection of this thesis examines and analyses the various decisions taken when designing the Poulstrup Sø Childrens Hospice and assesses the design process considering the Integrated Design Process and Evidence-Based Design methodology. The integrated design process has been the main driving force for the design process while the evidence-based design has been part of the problem, analysis, and sketching phase.

The goal was to use EBD in all decisions made during the design process. In a way it came naturally as it helped the development of concepts and the decision making during the design process.

It was a different approach of gathering data and organizing the information to then convert it into useful design parameters that could be used in the design of the Poulstrup Sø Childrens Hospice. Based on the evidence-based design the research had to be evaluated of its relevance. This proofed to be more difficult and time consuming the expected. How this researched knowledge could be incorporated into design parameters and finding ways of implementing these into the design to ensure the newest and most relevant knowledge available for healing and palliative architecture.

It was a challenge to figure out the need of all users especially the patient as the age group were spanning as wide as it is. Furthermore, the special needs that these patients have made it hard to design for such wide a user group at some patient might be new born and others on the edge of becoming an adult.

The design had to create a homely atmosphere as these users are extra vulnerable both patients and relatives in their own way. This means that the design had to avoid creating the traditional health care environment. The focus was also on creating different settings for different interactions between users. Creating a social environment that would still provide the privacy of a home.

The implementation energy tools need a high level of detail to give a precise image of the building. This meant the process of changes became time consuming as the design has a direct connection to how the building performs. This set some limitation to changes at the end of the process.

During the process light condition was a large focus point. At first the daylight factor was calculated. As the daylight factor is no longer the correct way of determining if the light condition is sufficient. It gave a wrong impression of the condition. This meant an illuminance analysis was made at the end of the process. This impacted the results from not thinking there was enough light to a situation where glare could be an issue.

If there had been more time, the topics of interest would have been acoustic, materiality, LCA and iterating more on the façade design.

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Illustration list

All illuststrations are made by the group except for ill. 93

APPENDIX

APPENDIX 1 - INTERVIEW

This interview was conducted by groups 09, 11, and 19 consisting of Simon Bak Albrechtsen, Emma Louise Jensen, Laura Obel Pinstrup, André Bjørnmose Dupont, and Nisanur Akkaya on 8 February 2023 with Lisbeth Refshauge Højer, which is department manager at Strandbakkehuset. The interview will be used in the same way by all groups and referred to as "Højer, 2023".

Lisbeth: Jeg hedder Lisbeth Højer og jeg er afdelingsleder her i Strandbakkehuset. Jeg er sygeplejerske og er leder for det personale der er i Strandbakkehuset. Vi er en del af en fællesorganisation med voksen hospice Djursland som ligger lige ved siden af. Vi har en fælles hospiceleder.

Jeg har 13 sygeplejersker tilknyttet, jeg har en pædagog, en fysioterapeut, socialrådgiver, psykolog, præst og en musikterapeut også har vi forskellige samarbejdspartner som kommer i huset legehelte, hospitalsklovne og mange frivillige som har forskellige indsatser. Man kan sige at det er et hus der skal kunne bære mange aktiviteter.

André: Hvordan bruger i jeres fællesrum og hvilke får i lavet?

Lisbeth: Alrummet er et fælleskøkken, så vi har ikke tekøkkener i værelserne og det har vi fravalgt fordi vi gerne vil have at familierne skal mødes i alrummet. Og der er en helt særlig dynamik mellem familierne som vi kan mærke når vi kun for eksempel kun har én familie. Så mangler der et samspil. Så det er også helt klart en stor del af huset at de har hinanden. Så man kan sige at køkkenet skal bære eller rumme at flere familier kan lave mad der. De har deres eget køleskab og fryserplads og en skuffe til viktualier ting også er de ellers indrettet som et familiehus ordningskøkken, hvor de kan have deres ting og sager. Det varme mad får vi fra vores industrikøkken i hospice Djursland, og så laver familierne selv de andre måltider. Så man kan sige at vi har taget det ene måltid men egentlig har tanken fra starten været at de skulle selv lave alle måltider men vi fandt ud af at det var simpelthen for meget for dem. Så vi har prøvet at hjælpe lidt ved at lave et måltid. Og så sidder man og spiser i alrummet og det gør vi (personalet) også. En del af hospice filosofien er at man er sammen, personale, patient og pårørende. Så det skal rummet også kunne bære.

Vi drifter 4 pladser. Vi har 6 pladser men vi har kun 4 patienter, så vi har lidt ekstra plads. Og så kan vi mærke at huset er på arbejde, fordi det er ikke kun bare en patient og en bruger. Det er 2 forældre og flere søskende og der er liv og glade dage. Der er også nogen der hjælper med fordi vi måske har nogen patienter der er i respirator, så det skal kunne rumme meget også huset for de forskellige funktioner omkring barnet.

Emma: Nu hvor du siger at i som personale også sidder med familierne, så I har ikke et privat rum?

Lisbeth: Nej. Det nærmeste I kan komme, er det rum I sidder i (lille møderum). Egentlig var det her rum bygget som et terapirum, men vi fandt ret hurtigt ud af under Corona at vi havde brug for et sted hvor vi kunne sidde sammen og lukke døren. Som I kunne se tidligere, så har vi en åben kontor og det har vi for at vise denne tilgængelighed og nærværsfølelse vi gerne vil give familierne, så de kan føle sig tæt på os og komme til os. Men det har også en bagside fordi vi har også brug for at kunne gå ind og lukke døren og snakke sammen. Så det bruger vi det her rum til, men det er ikke her vi kommer for at holde pause væk fra patienterne. Så vi har ikke et personalerum og det har de heller ikke ved Hospice Djursland.

Ellers har vi fællesrum, som er hjerterummet. Det er det her rum huset er bygget rundt omkring. Man træder ind og man kan se niveauet i huset. Tanken med arkitekturen har været at bygningen skulle hænge sammen med hospice Djursland men på samme tid skille sig lidt ud. Man har valgt nogen af de samme materialer, men bygningen har sit eget udtryk og det er vi tilfreds med. På samme tid var grunden rigtig lille, så det var ikke nemt at bygge på, så det har også været en udfordring som vi synes de har løst rigtig godt. Og tanken om at man ikke går ned i kælderen og at alle bor i lige åbne rum.

Nisa: Og I har ikke nogen udfordringer med at bygningen er på to etager i forhold til børn?

Lisbeth: Nej. Jeg har godt nok nogen sygeplejersker, der har dårlige nerver over at børnene kan falde ned på trappen, men børn lærer at anvende disse rum. Jeg har helt ro i maven. Men selvfølgelig kan de falde og slå sig, men det kan de overalt. Der er gitter rundt, så der er sikkert.

Nisa: Der bliver ikke anbefalet at bygge hospicer i mere end en etage. Der er jo patienter der er sengelagt, så hvordan er transportering af dem?

Lisbeth: Der er en elevator. Det er et plan ved hospice Djursland og selvfølgelig er det en fordel at have det i et plan, men det var der ikke plads til her. Så det kommer an på situationen og hvad man har af muligheder. Og vi er egentligt rigtig glad for at det er samlet og det giver nogle andre muligheder, det her med at det er mere kompakt og der er ikke så meget gangarealer. Vi har kig til alle og det synes jeg egentlig at fungerer godt. Men selvfølgelig er det en udfordring, man skal med en elevator når man er i kørestol eller sengelagt, men det fungerer fint.

Emma: Er de fleste af jeres patienter i kørestol eller sengelagt, eller er der også nogen som kan bevæge rundt selv?

Lisbeth: Der er også nogen der kan bevæge sig rundt selv, det er lidt forskelligt. Vi har også babyer, så de kan være på barnevogn. Men dem der er sengeliggende, er på stuen, fordi de ikke magter det her med elevator.

Laura: Hvornår kommer man til et børne hospice?

Lisbeth: Det gør man når man har en livstruende sygdom, som man forventer barnet dør af det. Eller livsbegrænsende sygdom som er i en tilstand der er handicappet eller en kronisk lidelse, syndrom som du har et anderledes livsvilkår end andre. Så kan man komme her og gå igennem en restituerings periode. Og vi kan hjælpe med at give dem ny energi. For eksempel hvis der nu bliver et langt sygdomsophold på sygehusene og som måske ikke helt kan overskue. Så kan man blive henvist her til og få lindrende behandling, hvor forældrene vil kalde det for aflastning. Men altså vi arbejder med lindring så man kan sige at det skal have et eller andet lindrende perspektiv. Men det kan også være nogen som bare hænger i et tyndt tråd der hjemme og nogle forældre der er bare udslidte. Og de forældre der ikke kan overskue at have de raske børn sammen med de sygebørn og blive samlet som en familie. Ikke nødvendigvis i forbindelse med et dødsfald men kan også være fordi det er hårdt at være en familie med et sygt barn. Så det vil sige at vi har en fordeling på 80% og 20%, hvor de 20% er døende.

André: Så i har også børn der kommer hjem igen?

Lisbeth: Lige præcis.

Laura: Hvordan adskiller det sig for familier at opholde sig på hospice, kontra eksempelvis familiehuset Ronald Mcdonald huset i København?

Lisbeth: Vi skiller os rigtig meget. Familiehuse har ikke sundhedsansvarligt personale ansat. De kører på frivillige så de kan slet ikke sammenlignes. Men man kan sige rent arkitektonisk kan jeg forstå spørgsmålet, fordi der er nogen ting hvor vi minder om hinanden. Jeg er også med i et netværksgruppe med de folk der sidder der, for der er nogle ting i forhold til arbejde med frivillige og pårørende, familierne osv. Men har et tværfagligt team ansat, hvor vi laver et aktivt indsat og det gør man ikke på et familiehus. Der er det udelukkende frivillige, hvor her man er indlagt som en patient med familier. Vi har dokumentationspligt, så der hører vi under sygehusloven og det gør de ikke.

Simon: Får i flere henvisninger end der er plads til?

Lisbeth: Det har vi haft i starten af året, men Strandbakkehuset er rigtig nyt. Vi startede i december 2020. Vi er kun nummer 2 af sin slags i Danmark så vores samarbejdspartnere er ikke vandt til at bruge os. Som alting andet er al begyndelse svært, så de skal lære at bruge os. Det er en lang indkøringsperiode og der har corona bestemt ikke hjulpet. Så vi har ikke haft venteliste. Der har været et par uge hvor vi ikke kunne få nogen ind og skulle være på venteliste, men så kunne vi tage dem ind senere. Vi har lige haft fuldt hus, nu har vi så 3 familier.

André: Hvor lang tid er man indlagt?

Lisbeth: Mellem 2 uger og 5 måneder, så det er meget forskelligt. Vi har lindrende ophold hvor man typisk kommer fra hjemmet eller sygehuset og vil have et lindrende ophold og tage hjem igen. Det er typisk de der 2-3 uger. Men det giver heller ikke mening at være her i kortere tid. Meget af det vi laver er relations arbejde og man kan ikke nå at få dannet relationer på en uge og få gjort en indsats og sende dem hjem igen. Så dem der tænker på at komme her som et ferieophold giver ingen mening. Vi er her for at vi kan lave en indsats og fordi det er en hel familie der flytter ind, skal de bruge en hel uges tid på at falde på plads. Så begynder vi at lære hinanden at kende også kan vi lave indsatser. Så der går cirka 3 uger. Så det er typisk dem med et livsafsluttende forløb med lindrende indsats eller nogen som er mere usikker om hvordan deres situation er bliver her typisk længere. Så dem der kommer for at blive løftet kort, er dem der har kort ophold.

André: Vores opgavebeskrivelse ligger op til at vi skal designe en hospice børnehave, hvor man kan aflevere barnet i dagtimerne. Er der behov for det i et dansk kontekst eller har man brug for sovepladser?

Lisbeth: Jeg ved i voksen regi, der arbejder man med et dagtilbud, hvor man kan få en aflastning fra sygdommen eller lindrende behandling. Det skal ikke ses som et spa-hotel ophold, men som en pause fra hverdagens smerte og sygdom både for patienten og for de pårørende. Jeg ved dog, at det er svært at flytte patienter – det er hårdt at flytte dem. Det tager en del energi at vænne sig til nye steder og finde ro i en flytning, derfor gør man det heller ikke så ofte eller på daglig basis. Men jeg har svært ved at se funktionen i det og den ydelse det må give fremfor et hospice med overnattende mulighed.

Simon: Det er formentlig tiltænkt fra opgavebeskrivelsen at fungere ligesom en daginstitution for børn til at kunne være i dagtimerne og så komme hjem om aftenen eller besøge hospicet, når der var brug for det.

Lisbeth: Jeg har lidt svært ved at se at det fungerer for et børnehospice. Jeg tror ikke, ham der har lavet opgavebeskrivelsen har været fagligt engageret i faget. Man efterlader jo ikke sine alvorligt syge børn et sted i en institution, det har jeg svært ved at se for mig. Logistisk ville det ikke give mening. Der er en del logistik, ved jeg, der skal indtænkes for familierne, derfor virker det også atypisk, hvis man havde en daginstitution, hvor man satte sit syge barn af og hentede det igen senere på dagen.

Emma: Det er også en ret fleksibel beskrivelse, som man godt kan afvige fra eller ændre.

André: Kommer man til hospitalet og får behandling, mens man er her?

Lisbeth: Det kan man godt. Der er nogle, der går til løbende kontroller, fordi vi er jo ikke specialister i de lidelser, de kommer med, altså vi har ikke en overvægt af kræftpatienter for det første, vi har rigtig mange indenfor det neurologiske områder, altså hvor de er ramt med handicap for cerebral parese, en eller anden form for hjerneskade, som gør at de har nogle nedsatte funktioner. Så det er faktisk overvægten af vores patienter.

André: Er der mange hospitalsbesøg i løbet af en uges tid?

Lisbeth: Nej, for det kan de ikke holde til. Det svinger meget. Dem vi har nu, de er måske inde (på hospitalet) engang i måneden eller 1,5 måned og blive justeret. Det er så én, som har været her i længere tid. Han har været inde i januar og skal igen her om et par uger, og skal have reguleret det her med respirator. Så kan vi have nogle, som går til kontrol ved deres speciallæge, som så samarbejder med vores læge, vi har også en læge i huset 2 dage om ugen. Så man kan sige, vi er specialisterne på den lindrende indsats, og så er der de andre, som arbejder specifikt, det er igen afhængigt af om det er et barn, der skal leve videre, og der er nogle indsatser på behandlingen. Det kan også være justering af kramper, vi har rigtig mange børn med kramper. Der er mange, som har en neurologisk lidelse, som har en eller anden kram som påvirker dem, som også skal justeres løbende. Det er meget forskelligt fra forløb til forløb, vi har ikke nogen standardforløb her.

André: Hvad vil du mene, er de mest optimale rammer at placere et hospice i? Er det ude i naturen, isoleret og i ro, eller tættere på et hospital, eller et helt tredje eksempel?

Lisbeth: Jeg ville helt klart foretrække en beliggenhed ude, hvor der er natur omkring. Har I læst beskrivelsen af Det gode Hospice? Den beskriver også det med placeringen, og det betyder noget. Der findes jo forskellige hospicer i Danmark, og nogle ligger jo inde i byen, men typisk naturskønt med udsigt over sø, eller et eller andet, for det betyder bare noget. Også det her med at man kommer ind et sted og kan mærke, at nogle har gjort sig umage, hvor man kan sige, at vores pendant, Lukashuset, som ligger i Hellerup, det er jo et gammelt plejehjem, der er også en dejlig have og sådan, men det ligger ud til store veje og kun 4 minutter til Rigshospitalet. Så det bærer jo præg af det som det ligger i. Jeg kan kun sige, at dem som kommer her, er rigtig glade for at det er her, at de har skoven lige nedenfor, havet tæt på, om sommeren kan man godt lige nå til stranden og bade med søskende, altså det betyder noget. Men det er ikke det samme, som at det ikke kan fungere inde i en by. Jeg tror bare at rolige omgivelser, og det at man kan falde til ro. Det der er virkningsfuldt med vores hus, både den måde det er bygget på, og den stemning, vi skaber i det her hus, det er den ro, som familierne de mærker. Man kan sige, at nogen de beskriver det, som at de kommer lige fra en krigszone, når de kommer inde fra sygehuset af, og det er jo ikke særligt flatterende, men det er jo vilkårene på et sygehus, det skal køre på en anden måde, det skal være effektivt, hvor man kan sige, at der kan vi noget andet, og der er altså nogle familier, der virkelig får skulderne ned af at komme i et hus sådan her, og komme ind og mærke, at her er dejligt. Måske kunne i også have det sådan, når I kom ind af døren her.

Alle: Ja, her var roligt.

Lisbeth: Ja, man kan godt mærke, at det gør et eller andet ved os, den måde vi er til stede på, og det gør det også ved vores personale, vi skal også repræsentere det, så det er også vigtigt, at vi har det godt, hvor vi er. Jeg savner for eksempel overhovedet ikke portørerne, der fiser frem og tilbage på gangen, som de gjorde på mit gamle arbejde. Vi kan noget andet, også fordi vi skal løfte en anden opgave selvfølgelig. Så det betyder noget, at man er et sted, der er nemt til natur og man forener det i tilstedeværelsen i livet, det tror jeg har en kæmpe betydning.

Emma: Nu har vi også læst nogle historier fra familier, der har boet, ikke nødvendigvis lige her, men også i bl.a. Lukashuset og familiehusene. Det er ret vildt at læse, hvordan nogle børn faktisk selv har været glade for at komme på besøg igen efter et forløb. Det viser også, at selv for dem, har det været et behageligt sted at være.

Lisbeth: De fleste kommer glade tilbage (smiler). Vi samler også familierne engang om året, til noget vi kalder en Strandbakkedag, hvor vi inviterer til lidt festival, en hyggelig dag, sådan en børnefestival, hvor de kan komme og gense os, og hinanden, og huset, og bare lige mødes og kan gå rundt og mindes nogle ting. For nogle er det jo meget stærkt at komme tilbage, fordi det skaber nogle minder om nogen der ikke er her mere, og andre de har deres børn med stadigvæk, så det er meget forskelligt. Der skal jo også være et sted, hvor der er plads til den her berørthed, fordi den møder vi hvert eneste dag.

Laura: Hvor ofte er der behov for at besøge et hospital herfra?

Lisbeth: Det er meget forskelligt. Nogen gør det slet ikke, og andre er i sådan et forløb, hvor de skal tjekkes efter på forskellige ledder og kanter. Der er også nogen, der bliver så dårlige, at de skal indlægges, fordi de netop ikke er døende, men skal hjælpes. Altså når man har et handicap, i lungerne, luftvejene eller i hele taget at ens immunforsvar er nedsat, så får man også nemmere infektioner, og så er det nogen gange, at man skal ind og behandles og reguleres i et eller andet, fordi vi kan meget her, men vi har ikke læger hele tiden, så man kan sige, hvis der er en kritisk tilstand, og et barn som man i øvrigt skal genoplive, hvis der sker et eller andet, så skal det jo på sygehuset, såfremt at vi ikke kan håndtere det her. Vi har ikke et akut hold, vi kan ringe til, og så genopliver vi barnet. Der er det lidt ligesom på hjemlige vilkår. Huset her repræsenterer hjemligheden, og derfor har vi heller ikke alt det her akutsystem sat op.

Emma: Så I kan godt nogle gange have behov for, at der kommer en ambulance, der skal hastes på hospitalet.

Lisbeth: Ja. Og det vil jo være det samme, som hvis man blev hentet i eget hjem

Simon: Hvordan er forholdene så til det? Vi har nemlig været ved at kigge på et kort, så bruger de Ringvejen for at komme herud i forhold til transport? Vi har nemlig været ved at kigge på lokation, og de er ved at bygge det supersygehus i Aalborg, så for vores gruppe handlede det om, at vi ikke fik for lang afstand, men stadig fik de naturskønne omgivelser.

Lisbeth: Jeg vil sige, vi ligger jo en lille halv time fra AUH. Det tænker jeg, det er meget passende. Det er til at overskue og stadig lidt på afstand, og der er heller ikke længere herud, at vores samarbejdspartner også kan finde os.

Laura: Jeg tænkte lige på, siger man lejligheder eller værelser til børnene og deres familier?

Lisbeth: Ja, det går vi ikke så meget op i.

Laura: Hvad er der behov for, at der skal være tilknyttet de her værelser?

Lisbeth: Det skal jeg også nok vise jer, men der skal være en patient stue, der skal være stor nok til at der kan køres hospitalssenge ind og ud. Der er nødt til at være en hospitalsseng, så vi har et godt arbejdsmiljø, vi har en loftlift, vi har ilt og sug. Det skal der være på værelserne, men som I vil se, hvis I har været på sygehusene og set en patientstue, så har vi gjort alt for at gemme det ad vejen, så vi kan finde det frem, når vi skal, men det er diskret pakket væk.

Emma: Så når I har udstyret fremme, så står det også bare? Det er ikke fordi der er noget specielt designet til at gemme noget væk, mens det er i brug?

Lisbeth: Nej

Emma: Det er der måske heller ikke behov for?

Lisbeth: Nej, det synes jeg ikke, for det er klart, når vi har nogen, hvor vi for eksempel skal suge et barn, suge noget snot op i luftvejene, så skal det være tilgængeligt, så skal det stå fremme. Der har vi ikke noget specieludviklet, men som I vil se, så har vi nogen af de pæneste hospitalssenge på markedet, fordi vi har mulighed for det, og fordi vi går op I at det ser ordentligt ud. Man kan sige, der findes alle muligheder på markedet, så man kan sagtens vælge noget, der matcher vores stil i en eller anden udstrækning. Og det er ikke arkitekterne, der har valgt det, men det er os selv.

Simon: Men de har så nogen standardmål, vi kan finde?

Lisbeth: Ja, det tænker jeg. Men det er klart døre og sådan noget skal være designet til at kunne slås op, så man kan komme igennem med hospitalssengen og sådan noget. Badeværelserne skal være handicapvenlige.

Emma: De har eget badeværelse?

Lisbeth: Ja. Og her har vi valgt, at man så har en patientstue og en familiestue i tilknytning til hinanden, så man faktisk har et rum, hvor patienten er, hvor vi ligesom også har arbejdsrum, og så har familien en privat stue, og det er også i respekt for familiens integritet at de kan gå derind og lukke døren og have et privat rum, hvor vi kun går ind, hvis vi bliver inviteret, og det fungerer faktisk rigtig godt. Man kan altid bruge mere plads, men sådan er det. Det er også igen balancen, for vi har også nogen familier, som kun består af mor og barn, eller mor, far og barn, så er det også træls, hvis man har sådan en hel balsal, så der skal et eller andet sted findes en balance, hvor folk ikke bliver helt væk.

Emma: Alle de her værelser, de er ens?

Lisbeth: Ja, og så har vi også 2 gæsteværelser, som vi disponerer rundt til bedsteforældre eller store søskende eller hvis mor og far er skilt, så kan de få hver deres værelse, eller hvis det er en stor familie, som har brug for lidt mere plads, så vi har lidt ekstra at give af. Som jeg sagde, så fordi vi fik donationsmidler til det, så valgte man den gang og bygge 6 stuer, selvom vi kun har drift til 4. Så det vil sige, vi har egentlig 6 stuer, så der har vi også lidt en buffer.

Emma: Så I må gerne tage dem i brug, hvis nu det er en stor familie?

Lisbeth: Ja, vi disponerer bare selv over pladsen. Vi har jo nogle ekstra rum, selvom vi egentlig ikke har patienter til 6, og vi tager ikke 6 patienter ind.

Laura: Hvor mange overnattende er der krav på, I må have her?

Lisbeth: Det ved jeg faktisk ikke. Det ved jeg ikke, om der er noget maks på.

Laura: Det var mere i forhold til brand, om I skulle overholde noget der.

Lisbeth: Der er alle mulige regulativer omkring brand vi skal overholde, men jeg ved ikke lige, om der som sådan er et antal på.

Laura: Medbringer man selv madrasser i forhold til søskende?

Lisbeth: Der har vi i huset. Men altså for eksempel anbefaler jeg, at man tager en weekendseng med til små søskende, fordi det har vi ikke. Og det har også noget med hygiejne at gøre. De kan være svære at gøre ordentligt rene. Så er det bedre, at de tager deres eget med. Der er også noget i det med hjemligheden. Man må også gerne tage sit eget sengetøj med, igen der er nogen, som synes det er rarest at bare ligge i sit eget. Fordi selvom at vi selvfølgelig tilstræber at det ikke skal være en institution, så er der jo også nogle ting i forhold til hygiejne og sådan som vi skal overholde.

Laura: Vi læste at der er forskel fra andre hospicer, hvordan de håndterer hvis der sker et dødsfald, hvordan man så forlader bygningen, om det bliver mødt ud af hovedindgangen, eller om der er en baggang. Det er forskelligt, hvordan det håndteres.

Lisbeth: Vi har kun en indgang og udgang, så det giver helt sig selv, men uanset hvad så vil jeg aldrig sende døden ud af bagvejen. Hvis ikke vi kan se døden i øjnene, så ved jeg da ikke, hvor vi var henne. Så man kan jo sige, at vi repræsenterer jo nogen som er vant til at tale om døden og skal kunne være i det, og selvfølgelig skal det ud af fordøren. Og man kan sige, vi foreslår altid familien om de vil have en udsyngning eller et eller andet og så stiller vi et skilt på skranken: 'I dag tænder vi lys for lille et eller andet, eller store et eller andet' Og så er der et lys, og så kan de andre familier også spørge ind til det der, fordi vi har selvfølgelig tavshedspligt, men de får jo et bånd til hinanden, de familier vi har i huset. Men det her med at vise en respekt for at når der så kommer en kiste køre – altså vi har ikke mange dødsfald her, men når der så gør, så stopper man lige op, og viser sin respekt omkring det, men vi er ikke flere i det her hus end at vi deltager jo, os der er her, når det er. Og man kan sige på Hospice Djursland, hvor de nærmest har dødsfald dagligt, så når der kommer en kiste med følge, så stopper man bare lige op, man suser ikke bare lige forbi, man stiller sig lige i respekt, indtil det er kørt forbi, så det er også med at have en kultur, og det er det vi prøver at lære vores personale op til, at det er altså noget vi anerkender er der, og vi ser det sammen og er i det sammen.

Laura: Det er mere, at vi havde læst fra andre hospicer, at det er meget forskelligt indretningsmæssigt, hvordan man vil håndtere det.

Lisbeth: Men jeg tror der er nogle hospicer, der måske også har et kapel, og så kan man sige, så er det typisk der man stiller en kiste, men man kan sige, der bruger vi stuerne og så køler vi dem ned, vi har regulering på temperaturen, men vi har ikke oplevet at de har dem stående her længe, altså familien vil gerne videre, når først dødsfaldet er, altså når familien har været her, så vil de gerne videre umiddelbart.

Emma: Det var et interview, der var blevet lavet, hvor det var en sygeplejerske, der selv beskrev det som at kisten blev taget ud samme vej som skrald, altså det var en meget voldsom kontrast, hvor hun ville ønske, at de også kom ud af den indgang, man også kom ind ad.

Lisbeth: Ja, det kan jeg godt forstå, det er lige præcis, derfor jeg siger, at det skal ikke ud af bagvejen, vi anerkender fuldstændigt, at der er et menneske her, og det har vi respekt for, og det er ikke noget vi gemmer væk. Slet ikke her hos os. På et hospice skal vi jo kunne være i det også. Jeg kan fortælle jer, da hospice Djursland blev bygget i 2007, der var der klager fra naboerne over at de flagede på halv hele tiden, naboerne kunne simpelthen ikke bære det. Så der var vores Hospiceleder nødt til at gå i dialog med naboerne om at det er jo et vilkår. Vi skal alle sammen dø en dag. Men der var der simpelthen nogen som synes det var stødende, hvor man kan sige, at jeg synes, det er stødende man ikke kan få lov til at flage når man mister en. Hvordan vender vi den lige rundt. Altså man kan sige, selvfølgelig skal vi have lov til at flage på halv, men der er også de familier, som er her, som jo ikke har et barn, der er lige på vej til at dø, de synes jo også det er – altså det kan godt være konfronterende at møde sådan en flagstang, hvor flaget er på halv. Så jeg kan sagtens følge den der med, at når man ikke lige går i det hver dag, så den der 'hold da op, hvad er nu det' og når man er her hver dag, så vænner man sig også til det. Dem der byggede huset, alle håndværkerne, de skulle simpelthen også lige vænne sig til det. Der var en helt særlig stemning blandt dem også, fordi det var et særligt sted. Så det påvirker os jo, men det skal vi så bare tale om. Der skal vi ikke bare gemme det væk.

Emma: Jeg tror også tit, at det er det, folk har svært ved at tale om. Nu snakkede vi om i bilen, at bare vi fortæller, at vi skriver speciale om børnehospice, der er nogen der møder det med; 'puha et tungt emne' og så er der andre; 'waow, hvor spændende, interessant'. Det er meget forskelligt, hvordan reaktionen er.

Lisbeth: Jeg har heller ikke fået en passende grimasse endnu, selvom jeg har været i det her i snart 3 år, til hvordan jeg skal reagere på det blik jeg får, når de hører, hvor jeg arbejder. Altså folk de er sådan helt: Altså jeg er ikke ked af det, du behøver heller ikke være ked af det. Altså det her med, hvordan man egentligt responderer på, at det faktisk er et behov. At det er en nødvendighed at vi skal være her, fordi det faktisk er et behov. Altså vi har heldigvis mere liv her end vi har død. Og derfor er vores vision også Liv, Leg og Lindring. Fordi det er altså livet, vi går op i. Og så anerkender vi at døden kommer, når den kommer.

Vores Regionsformand sagde, det var meget modigt, vi havde Liv til at stå først i vores vision. Men det siger jo lidt om, hvor lidt han ved om det her felt. Men det er spændende, at I også får sådan en opgave her, synes jeg. Vi ønsker også kun at kaste lys på, at der findes sådan noget som det her, og at det kan bruges til forskellige formål.

Emma: Det er interessant at dykke ned i. Det er jo sådan en lidt afsides verden, man ikke hører så tit om.

Lisbeth: Man kan sige, det er jo selvfølgelig et specielt hus der her, fordi vi er det første nybyggede børnehospice i Danmark, men ellers så har de jo flere i Tyskland, England og sådan nogle steder.

Simon: Som også er dedikeret kun til børn?

Lisbeth: Ja, de har også et i Stockholm, men jeg tror mange ligger i relation til voksenhospice, så hvordan de lige integrerer det er lidt forskelligt.

André: Ved du egentlig, hvordan det generelt er på de danske hospice? Er der også børn på dem, som ikke er designeret børnehospice?

Lisbeth: Altså det håber jeg ikke. Men man kan sige, Lukashuset er 7 år nu, det er 5 år ældre end os, så man kan sige, at før det så har der ikke været en mulighed for at sende børn på andet end et voksenhospice. Jeg tror så oftest, at man ikke har sendt børn på Hospice, så tror jeg måske, at der har været mange unge, som er blevet indlagt på et voksenhospice, og jeg har også hørt om, at der har været nogen børn, der har været på voksenhospice, også efter vi er kommet til, og det stikker ondt i mit hjerte, fordi jeg synes vi tilbyder noget, som de ikke kan tilbyde. Og den mulighed vi har om at støtte op om hele familien, det fokus har de simpelthen ikke på et voksenhospice, det kan de ikke have. Og mine sygeplejersker de er jo dedikeret til at passe børn og det er bare noget andet. Børn er ikke små voksne, og det er derfor vi har brug for børnehospice. Det er også derfor der er børneomdelinger, ellers gav det jo heller ikke mening. Jeg ved også, der er noget der hedder logistik for en familie, og når man bor i Hjørring, så er der bare super langt til Djursland, og af en eller anden grund, så er der meget længere fra Hjørring til Djursland, end omvendt, altså der er et eller andet med jer nordjyder, nu ved jeg ikke om I alle er derfra, jeg er selv gift med en vendelbo. Men der er lidt angstbestemt, for vi har haft rigtig mange fra Fyn, og der er jo også langt ned, så der er noget med, at det er farligt at krydse Limfjorden. Tænk, hvis ikke man kommer tilbage. Det er i hvert fald meget interessant at betragte i min stol, at vi faktisk ikke har haft nogle børn fra Nordjylland. Vi har haft en enkelt, som var her meget, meget kort. Så det har vi dog haft, men det var en lidt speciel situation også. Jeg forstår godt, at det er en logistisk udfordring for familier, for nogen gange så er det også kun den ene forældre, der har kørt fri til at passe barnet. Så der er selvfølgelig noget logistik i det. Men jeg synes man negligerer lidt, at vi faktisk løfter en særlig opgave, som man ikke på samme måde kan tilbyde på et voksenhospice, eller som et dagteam.

Emma: Hvordan i forhold til at I ligger i forbindelse til et voksen hospice, har i nogle fordele ved det eller ville i godt kunne ligge separat?

Lisbeth: Vi har en stor drift fordel. Det er et meget lille sted at drive rent økonomisk. Så det er helt klart en stordrifts fordel. Vi kan også gøre nogle ting i fællesskab, vi har også nogle funktioner, der går på tværs, vores musikterapeuter, vores psykolog går på tværs. Og det kan man sagtens, for det giver mening. Det vil være et meget, meget lille sted at drive selv. Vi har fælles hospiceleder, fælles pedel, fælles køkken, fælles rengøringservice, så der er nogle ting der.

Laura: Hvordan i forhold til aldersforskellen på børn, er der nogle forskellige behov, faciliteter eller aktiviteter?

Lisbeth: Jamen det er der, og vi prøver ligesom at vores hus, ikke bare ligner en børnehave, når man kommer ind, samtidig skal der være plads til børn, så vi gør meget ud af at finde legesager frem til børn i den aldersgruppe, vi nu har indlagt og så pakker vi det lidt væk, altså vi behøver ikke at have kravlegård fremme, hvis vi kun har børn over 6 år. Så det der med hele tiden at tilpasse det, det kræver en masse opbevaringsplads, så en stor kælder er der behov for, og det er jo ikke det mest interessante vel og det er dyrt at bygge, men opbevaringsplads det er altid lige super, for det kræver mange hjælpemidler.

Laura: Nu når det er et nybyggeri henvendt til et børnehospice, og du har været her i 3 år, er der så noget der kunne være gjort anderledes, eller ikke fungere nær så godt som, der måske var tiltænkt?

Lisbeth: Altså jeg ville nok retænke det åbne kontor, og det er lige så meget at vi arbejder med et projekt, eller har gjort, de første 2 år vi har været i gang, med et projekt der hedder 'Omsorg i Balance', hvor det her med at man også skal kunne trække sig og få ro som medarbejder for egentlig også at kunne gå ud og give noget til familierne. Altså tanken om at man er tilgængelig og man er nærværen, den er jo fin, men man har simpelthen også bare brug for at kunne trække sig. Så den vil jeg nok gøre på en anden måde i dag.

André: Vil det så være, at man skulle lave et lukket, lukket kontor, eller egentlig bare give faciliteten til at kunne trække sig tilbage foruden man har det åbne kontor?

Lisbeth: Jamen det kunne være en blanding. Man kan jo også lave meget med glasvægge, men det er jo fuldstændig åbent og selvom der er de her trælameller i loftet og lyden egentlig er god, så er der bare meget lydt. Nu var der roligt, da I kom, men når vi har 3-4 søskende, der hopper og danser rundt og spiller bold, så sidder man bare og tænker (angiver irritation/frustration). Og man skal koncentrere sig, og man kan så sige, nu har vi lavet en ekstra arbejdsplads heroppe (i mødelokalet) for at man ligesom kan trække sig væk, men det gør de ikke, personalet. Det er lidt ligesom derhjemme, alle samles i køkkenet, og man vil være der. Så det vil jeg i hvert fald tænke ind.

Emma: Så man kan forestille sig, hvis I havde en glasvæg dernede, hvor man kan se i er der og tilgængelige på den front, men i er stadig lukkede og i et lydtæt rum.

Lisbeth: Ja, hvis man kunne lukke i hvert fald, når man har brug for det. Altså nu vi har hospitalsklovnene på besøg, så er der altså også virkelig gang i den, så der har vi også måtte anvise en eller anden adfærd, der var lidt mere hensigtsmæssig i forhold til at vi vil kunne få arbejdsro. Fordi det er godt givet ud til at man faktisk også har energi til at være nærværende, når man så skal være det. Men jeg synes ikke som sådan, at vi savner et personalerum, så går vi jo herop (i mødelokalet). Så har vi også indrettet et af gæsteværelserne til at man kan sidde og hvile, når man har 12 timers vagter, så der skal være sådan nogle rum, så man kan trække sig lidt i. Men vi bruger vores rum meget fleksibelt. Og fordi det er sådan et lille sted, så kan man sagtens bruge rummene til flere forskellige ting, så det vil jeg også anbefale at I tænker med at man kan bruge det fleksibelt, netop fordi der også er forskellige grupper og behov løbende.

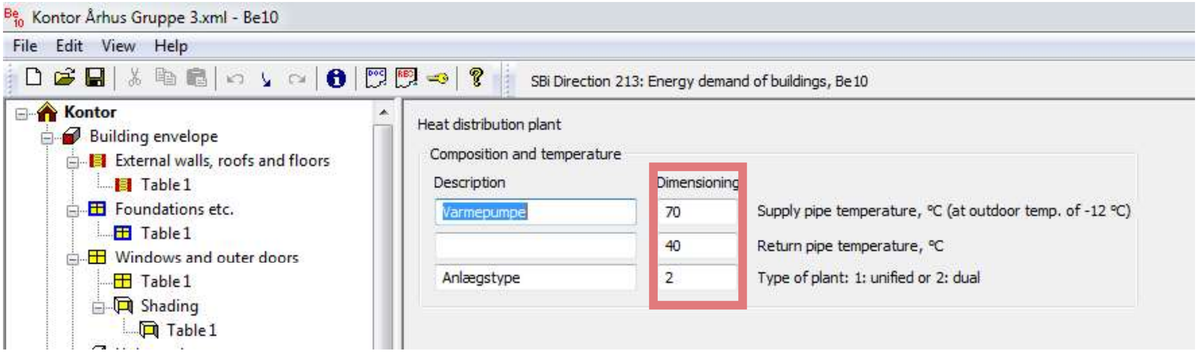
Emma: Er det kun jer sygeplejerske, der er her i døgndrift?

Lisbeth: Ja det er det. Der er 2 sygeplejersker på vagt hele tiden.

The size of the hot water tank and the heat loss or gain from water pipes is defined based on material supplied during the course "A&D (MSc01 ARC) Advanced Integrated Design II: Green Building Strategies with Focus on Energy and Emission Assessment 2021 (Hellwig 2021)

Systems Data

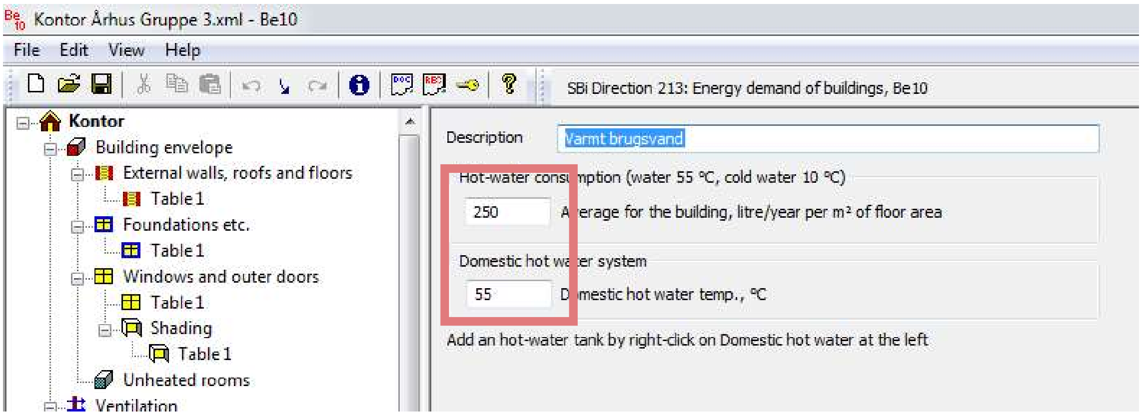
1. Heat distribution plant



Heating pipes
These are the pipes outside of heated space. Approximate length: 2*building length.
Loss =0.45 W/m
b=0.7

You do not need to define pumps in that section

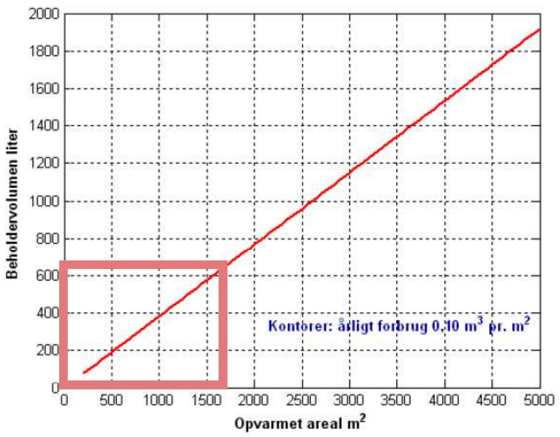
2. Domestic hot water



In the assignment you want to add a hot-water tank. Right click in the tree menu on "domestic hot water". A menu will appear and you press "Add new tank"

Hot-water tank, size

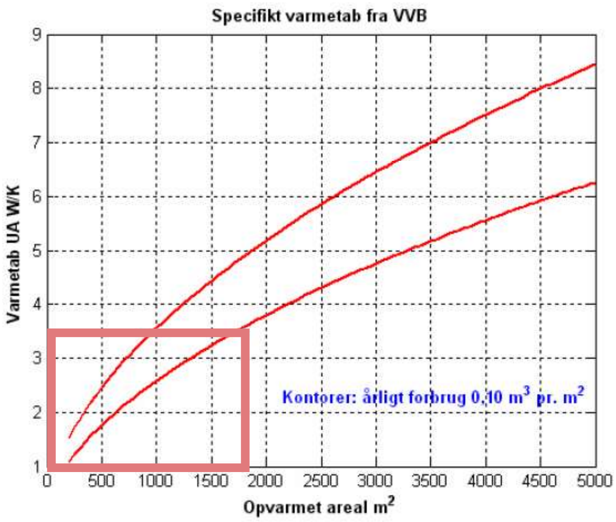
93. ill. System data for Be18



700 liter Hot water tank

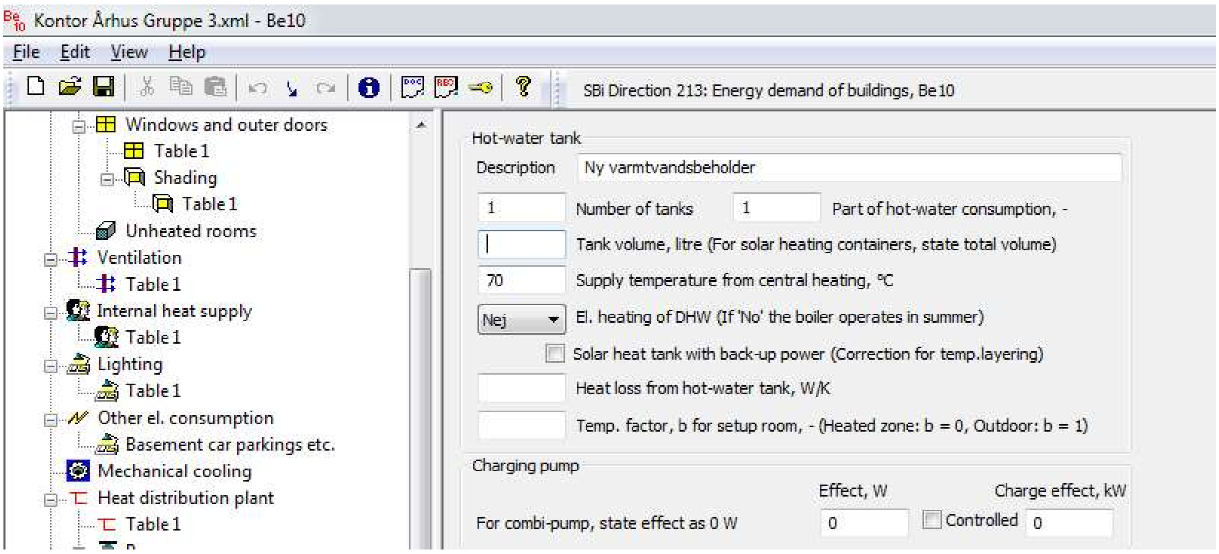
x-axes: Heated floor area, m2
y-axes: size of hot-water tank, in liters

Heat loss from hot-water tank



3,5 W/K Heat loss from water tank

x-axes: Heated floor area, m2
y-axes: Heat loss, W/K
This is the data for an isolated hot-water tank, thus for an old system reasonable values will be at the upper curve, at least.



Heat loss from connector pipe to hot water tank

Pipe length= apx. 40 m
Loss =0.45 W/m
b=0

Circulation pump for domestic hot water

Number=2
Effect= 80W

Domestic hot water discharge pipes:

Loss =0.45 W/m
Here you must include length of all pipes for domestic hot water (distribution pipes and circulation pipes), including the pipes within the heated space.
Aproximate length of pipes within the heated space can be calculated as :
L=n*2*(e-1)*h
n- number of entry-pipes (upward going distribution pipe)
e – number of floors
h- height of 1 floor

Aproximate length of pipes outside the heated space can be calculated as : 2*length of the building

b=0.7 (within heated space)
b=0 (within unheated space)

The base line is illustrating the data that was entered to get a detail level acceptable for the process and energy frame calculations.

Courtyard	
The building	
Building type	Other
Rotation	26,0 deg
Area of heated floor	1748,3 m²
Area heated basement	290,7 m²
Area existing / other usage	0,0 m²
Heated gross area incl. basement	1893,6 m²
Heat capacity	80,0 Wh/K m²
Normal usage time	168 hours/week
Usage time, start at - end at, time	0 - 24
Calculation rules	
Calculation rules	BR: Actual conditions
Suplement to energy frame	0,0 kWh/m² år
Heat supply and cooling	
Basic heat supply	District heating
Electric panels	No
Wood stoves, gas radiators etc.	No
Solar heating plant	No
Heat pumps	No
Solar cells	No
Wind mills	No
Mechanical cooling	No

Room temperatures, set points	
Heating	20,0 °C
Wanted	23,0 °C
Natural ventilation	24,0 °C
Mechanical cooling	25,0 °C
Heating store	15,0 °C
Dimensioning temperatures	
Room temp.	20,0 °C
Outdoor temp.	-12,0 °C
Room temp. store	15,0 °C

External walls, roofs and floors					
Building component	Area (m²)	U (W/m²K)	b	Dim.Inside (C)	Dim.Outside (C)
	0,0	0,00	1,000		
Basement	290,7	0,07	0,700		
Basement Walls	368,3	0,07	0,700		
Floor not in contact with ground	1167,0	0,08	1,000		
Floor in contact with the ground	0,0	0,00	1,000		
Roof Staff /Workshop area	538,4	0,08	1,000		
Courtyard wall	174,2	0,08	1,000		
Staff/Workshop/Guest room Wall	238,0	0,08	1,000		
	0,0	0,00	1,000		
	0,0	0,00	1,000		
	0,0	0,00	1,000		
	0,0	0,00	1,000		
Roof Aparmtent, Treatment, Gathering	843,9	0,08	1,000		
Wall South East	208,5	0,08	1,000		
Wall South West	39,7	0,08	1,000		
Wall North West	39,7	0,08	1,000		
North West	167,9	0,08	1,000		
WindowBox x 4	49,5	0,08	1,000		
Ialt	4125,8	-	-	-	-

Foundations etc.					
Building component	l (m)	Loss (W/mK)	b	Dim.Inside (C)	Dim.Outside (C)
Ground Floor outer line	233,6	0,40	1,000		
Courtyard lineloss	63,5	0,40	1,000		
Basement	77,3	0,40	1,000		10
Windows Apartment	72,0	0,06	1,000		
Skylight	43,2	0,06	1,000		
Rest of the doors and windows	298,0	0,06	1,000		
Ialt	787,6	-	-	-	-

Windows and outer doors													
Building component	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside (C)	Dim.Outside (C)	Ext
Apartment Left	6	180	90,0	6,0	0,70	1,000	0,90	0,47		1,00			1
Apartment Right	6	180	90,0	6,0	0,70	1,000	0,90	0,47		1,00			1

Windows and outer doors													
End of coridore South East	1	90	90,0	4,8	0,70	1,000	0,90	0,61		1,00			0
End of coridore North West	1	270	90,0	4,8	0,70	1,000	0,90	0,61		1,00			0
Library	1	180	90,0	6,0	0,70	1,000	0,90	0,47		1,00			1
Wellness and Sensory	2	180	90,0	6,0	0,70	1,000	0,90	0,47		1,00			1
Kitchen Left	1	180	90,0	6,0	0,70	1,000	0,90	0,47		1,00			1
Kitchen mid	1	180	90,0	6,0	0,70	1,000	0,90	0,47		1,00			1
Kitchen Right	1	180	90,0	6,0	0,70	1,000	0,90	0,47		1,00			0
Skylight	12	0	90,0	1,0	0,70	1,000	0,90	0,61		1,00			0
	0		0,0	0,0	0,00	0,000	0,00	0,00		1,00			0
Glass Roof	1		0,0	0,0	1,10	1,000	0,75	0,53		1,00			0
Glass Wall Left	1	270	90,0	10,4	0,70	1,000	0,90	0,61		1,00			0
Glass Wall Right	1	90	90,0	10,4	0,70	1,000	0,90	0,61		1,00			0
Courtyard indside east	3	337,94	90,0	3,0	0,70	1,000	0,90	0,63	Courtyard inside east	1,00			0
courtyard inside west	5	22,06	90,0	1,5	0,70	1,000	0,90	0,63	courtyard inside west	1,00			0
Courtyard inside north	1	180	90,0	27,0	0,70	1,000	0,60	0,63	courtyard north	1,00			0
Courtyard inside south	1	0	90,0	28,1	0,70	1,000	0,75	0,63	courtyard north	1,00			0
Ialt	45	-	-	222,0	-	-	-	-	-	-	-	-	

Shading					
Description	Horizon (°)	Eaves (°)	Left (°)	Right (°)	Window opening (%)
Apartment Right	0	53	18	45	10
Apartment Left	0	53	45	18	10
Library	0	53	46	46	10
Wellness and Sensory	0	53	45	45	10
Kithcen Left	0	53	46	11	10
Kitchen Mid	0	53	18	18	10
Kitchen Right	0	53	12	45	10
Courtyard inside east	10	0	0	0	10

Shading					
courtyard inside west	15	0	0	0	10
courtyard north	15	0	0	0	10

Summer comfort	
Floor area	240,0 m²
Ventilation, winther	0,3 l/s m²
Ventilation, summer, 9-16	3,5 l/s m²
Ventilation, summer, 17-24	3,5 l/s m²
Ventilation, summer, 0-8	0,6 l/s m²

Ventilation

Zone	Area (m²)	Fo, -	qm (l/s m²), Winter	n vgv (-)	ti (°C)	El-HC	qn (l/s m²), Winter	qi,n (l/s m²), Winter	SEL (kJ/m³)	qm,s (l/s m²), Summer	qn,s (l/s m²), Summer	qm,n (l/s m²), Night	qn,n (l/s m²), Night
Apartment 1	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom 1	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 2	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom 2	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 3	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom 3	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 4	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom 4	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 5	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom 5	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 6	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom 6	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Shared space Gathering	24,6	0,30	5,07	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Shared space Gathering	24,6	0,30	5,07	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Visitor	19,2	0,30	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom	0,0	0,30	3,38	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Visitor	19,2	0,30	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom	0,0	0,30	3,38	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Game, play, craft	40,0	0,30	4,00	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Workshop	40,0	0,30	4,00	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Kitchen dinning	78,8	0,30	6,08	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Library	24,0	0,30	5,94	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Toilet	0,0	0,00	2,11	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Therapy room	22,7	0,30	1,88	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Wellness room	21,7	0,30	2,17	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00

Ventilation												
Sensory room	24,9	0,30	1,80	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Quiet room	12,5	0,30	2,60	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Conversation Room	12,5	0,30	2,60	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Toilet	0,0	0,00	3,17	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
	0,0	0,00	0,00	0,00	0,0	No	0,00	0,00	0,0	0,00	0,00	0,00	0,00
	0,0	0,00	0,00	0,00	0,0	No	0,00	0,00	0,0	0,00	0,00	0,00	0,00
Individual Offices	9,0	0,50	2,11	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Individual Offices	9,0	0,50	2,11	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Shared Office	40,0	0,40	2,00	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Meeting Room	18,3	0,30	6,46	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,60	0,00
Medecin Room	15,0	0,20	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Dressing Room	15,0	0,30	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Toilet	4,2	0,00	3,38	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00

Internal heat supply				
Zone	Area (m²)	Persons (W/m²)	App. (W/m²)	App,night (W/m²)
Appartments	622	1,5	3,5	0,0
Kitchen	100	1,5	3,5	0,0
Staff officespace +300m2 Basement	523	1,5	3,5	0,0
Treatment	528	1,5	3,5	0,0

Lighting											
Zone	Area (m²)	General (W/m²)	General (W/m²)	Lighting (lux)	DF (%)	Control (U, M, A, K)	Fo (-)	Work (W/m²)	Other (W/m²)	Stand-by (W/m²)	Night (W/m²)
	0,0	3,0	10,0	200	0,00	A	1,00	2,0	0,0	0,0	0,0

Other el. consumption	
Outdoor lighting	0,0 W
Spec. apparatus, during service	0,0 W
Spec. apparatus, always	0,0 W

Basement car parkings etc.											
Zone	Area (m²)	General (W/m²)	General (W/m²)	Lighting (lux)	DF (%)	Control (U, M, A, K)	Fo (-)	Work (W/m²)	Other (W/m²)	Stand-by (W/m²)	Night (W/m²)

Mechanical cooling	
Description	Mekanisk køling
Share of floor area	0
El-demand	0,00 kWh-el/kWh-cool
Heat-demand	0,00 kWh-heat/kWh-cool
Load factor	1,2

Mechanical cooling	
Heat capacity phase shift (cooling)	0 Wh/m²
Increase factor	1,50
Documentation	

Heat distribution plant					
Composition and temperature					
Supply pipe temperature	70,0 °C				
Return pipe temperature	40,0 °C		Anlægstype		
Type of plant	2-string				
Pumps					
Pump type	Description	Number	Pnom	Fp	
Heating pipes					
Pipe lengths in supply and return	l (m)	Loss (W/mK)	b	Outdoor comp (J/N)	Unused summer (J/N)
	80,0	0,70	1,000	N	N

Domestic hot water			
Description	Varmt brugsvand		
Hot-water consumption, average for the building	250,0 litre/year per m² of floor area		
Domestic hot water temp.	55,0 °C		
Hot-water tank			
Description	Ny varmtvandsbeholder		
Number of hot-water containers	8,0		
Tank volume	700,0 liter		
Supply temperature from central heating	65,0 °C		
El. heating of DHW	No		
Solar heat tank with heating coil	No		
Heat loss from hot-water tank	3,5 W/K		
Temp. factor for setup room	0,0		
Charging pump			
Effect	0,0 W		
Controled	No		
Charge effect	5,0 kW		
Heat loss from connector pipe to DHW tank			
Length	Loss	b	Description
0,0 m	0,0 W/K	1,00	

Heat loss from connector pipe to DHW tank			
0,0 m	0,0 W/K	1,00	
0,0 m	0,0 W/K	1,00	
0,0 m	0,0 W/K	1,00	

Cirkulating pump for DHW	
Description	PumpCirc
Number	0,0
Effect	0,0 W
Number	0,0
Effect	0,0 W
Reduction factor	0,00 [-]
El. tracing of discharge water pipe	No

Domestic hot water discharge pipes			
Pipe lengths in supply and return	l (m)	Loss (W/mK)	b

Water heaters	
Electric water heater	
Description	Elvandvarmer
Share of DHW in separate el. water heaters	0,0
Heat loss from hot-water tank	0,0 W/K
Temp. factor for setup room	0,00
Gas water heater	

District heat exchanger	
Temp. factor for setup room	1,00
Automatics, stand-by	5,0 W

Other room heating	
Direct el for room heating	
Description	Supplerende direkte rumopvarmning
Share of floor area	0,0
Wood stoves, gas radiators etc.	
Description	
Share of floor area	0,0
Efficiency	0,4
Air flow requirement	0,1 m³/s

Solar heating plant		
Description	New solar heating plant	
Type	Domestic hot water	
Solar collector		
Area 0,0 m²	Start 0,8	-
Coefficient of heat loss a1 3,5 W/m²K	Coefficient of heat loss a2 0,0 W/m²K	Anglefactor 0,9
Orientation S	Slope 0,0 °	-
Horizon 10,0 °	Left 0,0 °	Right 0,0 °
Solar collector pipe		
Length 0,0 m	Heat loss 0,00 W/mK	Circuit 0,8
Electricity		
Pump in solar collector circuit 50,0 W	Automatics, stand-by 5,0 W	

Heat pumps		
Description	Ny varmepumpe	
Type	Combined	
Share of heating requirement	1,0	
El. driven heat pump		
-	Room heating	DHW
Nominal effect	145,0 kW	145,0 kW
Nominal COP	4,50	4,50
Rel. COP at 50% load	0,90	0,00
Test temperatures		
-	Room heating	DHW
Cold side	0,0 °C	0,0 °C

Test temperatures		
Warm side	43,0 °C	43,0 °C
Type		
-	Room heating	DHW
Cold side	Earth hose	Earth hose
Warm side	Room air	-
Additional		
-	Room heating	DHW
Special auxiliary tool	0,0 W	0,0 W
Automatics, stand-by	40,0 W	40,0 W
Heat pumps connected with ventilation		
-	Room heating	DHW
Temp. Efficiency for HRV before heat pump	0,00	0,00
Dim. air supply temperature	0,0 °C	-
Air flow requirement	0,00 m³/s	0,00 m³/s

Solar cells		
Description	Nyt solcelle anlæg	
Solar cells		
Area 95,0 m²	Orientation 180	Slope 45,0 °
Horizon 0,0 °	Left 0,0 °	Right 0,0 °
Additional		
Peak power 0,180 kW/m²	Efficiency 0,80	

The second step is the addition of the terrasses that also provides side fins and overhang.

Windows and outer doors

End of coridore South East	1	90	90,0	4,8	0,70	1,000	0,90	0,61		1,00			0
End of coridore North West	1	270	90,0	4,8	0,70	1,000	0,90	0,61		1,00			0
Library	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Library	1,00			1
Wellness and Sensory	2	180	90,0	6,0	0,70	1,000	0,90	0,47	Wellness and Sensory	1,00			1
Kitchen Left	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Kithcen Left	1,00			1
Kitchen mid	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Kitchen Mid	1,00			1
Kitchen Right	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Kitchen Right	1,00			0
Skylight	12	0	90,0	1,0	0,70	1,000	0,90	0,61		1,00			0
	0		0,0	0,0	0,00	0,000	0,00	0,00		1,00			0
Glass Roof	1		0,0	0,0	1,10	1,000	0,75	0,53		1,00			0
Glass Wall Left	1	270	90,0	10,4	0,70	1,000	0,90	0,61		1,00			0
Glass Wall Right	1	90	90,0	10,4	0,70	1,000	0,90	0,61		1,00			0
Courtyard indside east	3	337,94	90,0	3,0	0,70	1,000	0,90	0,63	Courtyard inside east	1,00			0
courtyard inside west	5	22,06	90,0	1,5	0,70	1,000	0,90	0,63	courtyard inside west	1,00			0
Courtyard inside north	1	180	90,0	27,0	0,70	1,000	0,60	0,63	courtyard north	1,00			0
Courtyard inside south	1	0	90,0	28,1	0,70	1,000	0,75	0,63	courtyard north	1,00			0
Ialt	45	-	-	222,0	-	-	-	-	-	-	-	-	

Shading

Description	Horizon (°)	Eaves (°)	Left (°)	Right (°)	Window opening (%)
Apartment Right	0	53	18	45	10
Apartment Left	0	53	45	18	10
Library	0	53	46	46	10
Wellness and Sensory	0	53	45	45	10
Kithcen Left	0	53	46	11	10
Kitchen Mid	0	53	18	18	10
Kitchen Right	0	53	12	45	10
Courtyard inside east	10	0	0	0	10

The natural ventilation is not added as the maximum air flow rate. But it is added to decrease the over-heating.

Summer comfort	
Floor area	240,0 m²
Ventilation, winther	0,3 l/s m²
Ventilation, summer, 9-16	3,5 l/s m²
Ventilation, summer, 17-24	3,5 l/s m²
Ventilation, summer, 0-8	0,6 l/s m²

Ventilation													
Zone	Area (m²)	Fo, -	qm (l/s m²), Winter	n vgv (-)	ti (°C)	El-HC	qn (l/s m²), Winter	qi,n (l/s m²), Winter	SEL (kJ/m³)	qm,s (l/s m²), Summer	qn,s (l/s m²), Summer	qm,n (l/s m²), Night	qn,n (l/s m²), Night
Apartment 1	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	3,50	0,00	0,00
Bathroom 1	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 2	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	3,50	0,00	0,00
Bathroom 2	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 3	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	3,50	0,00	0,00
Bathroom 3	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 4	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	3,50	0,00	0,00
Bathroom 4	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 5	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	3,50	0,00	0,00
Bathroom 5	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Apartment 6	48,6	0,60	1,39	0,85	18,0	No	0,00	0,00	1,0	0,00	3,50	0,00	0,00
Bathroom 6	0,0	1,00	5,76	0,85	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Shared space Gathering	24,6	0,30	5,07	0,90	18,0	No	0,00	0,00	1,0	0,00	2,50	0,30	0,00
Shared space Gathering	24,6	0,30	5,07	0,90	18,0	No	0,00	0,00	1,0	0,00	2,50	0,30	0,00
Visitor	19,2	0,30	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom	0,0	0,30	3,38	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Visitor	19,2	0,30	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Bathroom	0,0	0,30	3,38	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Game, play, craft	40,0	0,30	4,00	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Workshop	40,0	0,30	4,00	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,30	0,00
Kitchen dinning	78,8	0,30	6,08	0,90	18,0	No	0,00	0,00	1,0	0,00	2,50	0,30	0,00
Library	24,0	0,30	5,94	0,90	18,0	No	0,00	0,00	1,0	0,00	2,50	0,30	0,00

Ventilation													
	0,0	0,00	0,00	0,00	0,0	No	0,00	0,00	0,0	0,00	0,00	0,00	0,00
	0,0	0,00	0,00	0,00	0,0	No	0,00	0,00	0,0	0,00	0,00	0,00	0,00
Individual Offices	9,0	0,50	2,11	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Individual Offices	9,0	0,50	2,11	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Shared Office	40,0	0,40	2,00	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Meeting Room	18,3	0,30	6,46	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,60	0,00
Medecin Room	15,0	0,20	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Dressing Room	15,0	0,30	2,33	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00
Toilet	4,2	0,00	3,38	0,90	18,0	No	0,00	0,00	1,0	0,00	0,00	0,00	0,00

The shutters are added as well to minimize the overheating.

Windows and outer doors													
Building component	Number	Orient	Inclination	Area (m²)	U (W/m²K)	b	Ff (-)	g (-)	Shading	Fc (-)	Dim.Inside (C)	Dim.Outside (C)	Ext
Apartment Left	6	180	90,0	6,0	0,70	1,000	0,90	0,47	Apartment Left	-0,40			1
Apartment Right	6	180	90,0	6,0	0,70	1,000	0,90	0,47	Apartment Right	-0,40			1
End of coridore South East	1	90	90,0	4,8	0,70	1,000	0,90	0,61		1,00			0
End of coridore North West	1	270	90,0	4,8	0,70	1,000	0,90	0,61		1,00			0
Library	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Library	-0,40			1
Wellness and Sensory	2	180	90,0	6,0	0,70	1,000	0,90	0,47	Wellness and Sensory	-0,40			1
Kitchen Left	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Kithcen Left	-0,40			1
Kitchen mid	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Kitchen Mid	-0,40			1
Kitchen Right	1	180	90,0	6,0	0,70	1,000	0,90	0,47	Kitchen Right	-0,40			0
Skylight	12	0	90,0	1,0	0,70	1,000	0,90	0,61		1,00			0
	0		0,0	0,0	0,00	0,000	0,00	0,00		1,00			0
Glass Roof	1		0,0	0,0	1,10	1,000	0,75	0,53		1,00			0
Glass Wall Left	1	270	90,0	10,4	0,70	1,000	0,90	0,61		1,00			0
Glass Wall Right	1	90	90,0	10,4	0,70	1,000	0,90	0,61		1,00			0
Courtyard indside east	3	337,94	90,0	3,0	0,70	1,000	0,90	0,63	Courtyard inside east	1,00			0
courtyard inside west	5	22,06	90,0	1,5	0,70	1,000	0,90	0,63	courtyard inside west	1,00			0
Courtyard inside north	1	180	90,0	27,0	0,70	1,000	0,60	0,63	courtyard north	-0,50			0
Courtyard inside south	1	0	90,0	28,1	0,70	1,000	0,75	0,63	courtyard north	1,00			0
Ialt	45	-	-	222,0	-	-	-	-	-	-	-	-	

The data for the Heat pump is based on and the data is supplied by from lecture material as follows. Water to Water – 4,3 COP (Marszal-Pomianowska 2021)

Courtyard	
The building	
Building type	Other
Rotation	26,0 deg
Area of heated floor	1748,3 m²
Area heated basement	290,7 m²
Area existing / other usage	0,0 m²
Heated gross area incl. basement	1893,6 m²
Heat capacity	80,0 Wh/K m²
Normal usage time	168 hours/week
Usage time, start at - end at, time	0 - 24
Calculation rules	
Calculation rules	BR: Actual conditions
Suplement to energy frame	0,0 kWh/m² år
Heat supply and cooling	
Basic heat supply	Electricity
Heat distribution plant	No
Electric panels	No
Wood stoves, gas radiators etc.	No
Solar heating plant	No
Heat pumps	Yes
Solar cells	No
Wind mills	No
Mechanical cooling	No

Room temperatures, set points	
Heating	20,0 °C
Wanted	23,0 °C
Natural ventilation	24,0 °C
Mechanical cooling	25,0 °C
Heating store	15,0 °C
Dimensioning temperatures	
Room temp.	20,0 °C
Outdoor temp.	-12,0 °C
Room temp. store	15,0 °C

Heat pumps		
Description	Ny varmepumpe	
Type	Combined	
Share of heating requirement	1,0	
El. driven heat pump		
-	Room heating	DHW
Nominal effect	145,0 kW	145,0 kW
Nominal COP	4,50	4,50
Rel. COP at 50% load	0,90	0,00
Test temperatures		
-	Room heating	DHW
Cold side	0,0 °C	0,0 °C
Warm side	43,0 °C	43,0 °C
Type		
-	Room heating	DHW
Cold side	Earth hose	Earth hose
Warm side	Room air	-
Additional		
-	Room heating	DHW
Special auxiliary tool	0,0 W	0,0 W
Automatics, stand-by	40,0 W	40,0 W

The photovoltaics are added and the peak power is set to 180 W per sqm. and the efficiency is set to 80 (Viridian Solar)

Courtyard	
The building	
Building type	Other
Rotation	26,0 deg
Area of heated floor	1748,3 m²
Area heated basement	290,7 m²
Area existing / other usage	0,0 m²
Heated gross area incl. basement	1893,6 m²
Heat capacity	80,0 Wh/K m²
Normal usage time	168 hours/week
Usage time, start at - end at, time	0 - 24
Calculation rules	
Calculation rules	BR: Actual conditions
Suplement to energy frame	0,0 kWh/m² år
Heat supply and cooling	
Basic heat supply	Electricity
Heat distribution plant	No
Electric panels	No
Wood stoves, gas radiators etc.	No
Solar heating plant	No
Heat pumps	Yes
Solar cells	Yes
Wind mills	No
Mechanical cooling	No

Room temperatures, set points	
Heating	20,0 °C
Wanted	23,0 °C
Natural ventilation	24,0 °C
Mechanical cooling	25,0 °C
Heating store	15,0 °C
Dimensioning temperatures	
Room temp.	20,0 °C
Outdoor temp.	-12,0 °C
Room temp. store	15,0 °C

Solar cells		
Description	Nyt solcelle anlæg	
Solar cells		
Area 95,0 m²	Orientation 180	Slope 36,0 °
Horizon 0,0 °	Left 2,0 °	Right 3,0 °
Additional		
Peak power 0,180 kW/m²	Efficiency 0,80	

APPENDIX 3 - MECHNICAL VENTIALTION CALCULATION

The calculation for the mechanical ventilation is split into four different types of dimensioning of the air flow rate

Lokaler	Bygningsklasse					Personbelastning
		Antal	Højde	Gulvareal	Volumen	Antal pers.
			m	[m2]	[m3]	[børn/voksne]
Residential						
Apartments	**B <= 20%**	6	3	40,4	121,2	4
Bathroom	**B <= 20%**	6	3	8,2	23	1
Shared Space	**B <= 20%**	2	3	24,6	73,8	10
Visitor Room	**B <= 20%**	2	3	15	45	2
Bathroom	**B <= 20%**	2	3	4,2	12,6	1
Social Room						
Games, Play, Craft	**B <= 20%**	1	3	40	120	12
Kitchen	**B <= 20%**	1	3	78,8	236,4	40
Workshop	**B <= 20%**	1	3	40	120	12
Library	**B <= 20%**	1	3	24,3	72,9	12
Toilet	**B <= 20%**	2	3	9	27	1
Treatment						
Therapy room	**B <= 20%**	1	3	22,7	68,1	2
Wellness room	**B <= 20%**	1	3	17,1	51,3	2
Sensory room	**B <= 20%**	1	3	24,9	74,7	2
Quiet room	**B <= 20%**	1	3	12,5	37,5	2
Conversation room	**B <= 20%**	1	3	12,5	37,5	2
Toilet	**B <= 20%**	1	3	4,6	13,8	1
Staff					0	
Individual Office Space	**B <= 20%**	2	3	9	27	1
Shared Office Area	**B <= 20%**	1	3	40	120	4
Meeting Room	**B <= 20%**	1	3	18,3	54,9	10
Medicine Room	**B <= 20%**	1	3	15	45	2
Dressing Room	**B <= 20%**	2	3	15	45	2
Toilet	**B <= 20%**	1	3	4,2	12,6	1

Lokaler	BR18 - Minimumskrav			
	Dimensioneringsgrundlag		Indblæsning/Udsugning	
	[l/s pr. m2]	[l/s]	[l/s]	[h^-1]
Residential				
Apartments	0,35	14,14	**14,14**	**0,42**
Bathroom	0,35	2,87	**2,87**	**0,45**
Shared Space	0,35	8,61	**8,61**	**0,42**
Visitor Room	0,35	5,25	**5,25**	**0,42**
Bathroom	0,35	1,47	**1,47**	**0,42**
Social Room				
Games, Play, Craft	0,35	14	**14**	**0,42**
Kitchen	0,35	27,58	**27,58**	**0,42**
Workshop	0,35	14	**14**	**0,42**
Library	0,35	8,505	**8,505**	**0,42**
Toilet	0,35	3,15	**3,15**	**0,42**
Treatment				
Therapy room	0,35	7,945	**7,945**	**0,42**
Wellness room	0,35	5,985	**5,985**	**0,42**
Sensory room	0,35	8,715	**8,715**	**0,42**
Quiet room	0,35	4,375	**4,375**	**0,42**
Conversation room	0,35	4,375	**4,375**	**0,42**
Toilet	0,35	1,61	**1,61**	**0,42**
Staff				
Individual Office Space	0,35	3,15	**3,15**	**0,42**
Shared Office Area	0,35	14	**14**	**0,42**
Meeting Room	0,35	6,405	**6,405**	**0,42**
Medicine Room	0,35	5,25	**5,25**	**0,42**
Dressing Room	0,35	5,25	**5,25**	**0,42**
Toilet	0,35	1,47	**1,47**	**0,42**

Lokaler	DS447				
	Dimensioneringsgrundlag			Indblæsning/Udsugning	
	[l/s pr. pers]	[l/s pr. m2]	[l/s]	[l/s]	[h^-1]
Residential					
Apartments	10	1	80,4	**80,4**	**2,39**
Bathroom	10	1	18,2	**18,2**	**2,85**
Shared Space	10	1	124,6	**124,6**	**6,08**
Visitor Room	10	1	35	**35**	**2,8**
Bathroom	10	1	14,2	**14,2**	**4,057142857**
Social Room					
Games, Play, Craft	10	1	160	**160**	**4,80**
Kitchen	10	1	478,8	**478,8**	**7,291370558**
Workshop	10	1	160	**160**	**4,8**
Library	10	1	144,3	**144,3**	**7,125925926**
Toilet	10	1	19	**19**	**2,533333333**
Treatment					
Therapy room	10	1	42,7	**42,7**	**2,257268722**
Wellness room	10	1	37,1	**37,1**	**2,60**
Sensory room	10	1	44,9	**44,9**	**2,16**
Quiet room	10	1	32,5	**32,5**	**3,12**
Conversation room	10	1	32,5	**32,5**	**3,12**
Toilet	10	1	14,6	**14,6**	**3,808695652**
Staff	10	1			
Individual Office Space	10	1	19	**19**	**2,53**
Shared Office Area	10	1	80	**80**	**2,40**
Meeting Room	10	1	118,3	**118,3**	**7,76**
Medicine Room	10	1	35	**35**	**2,80**
Dressing Room	10	1	35	**35**	**2,80**
Toilet	10	1	14,2	**14,2**	**4,06**

Lokaler	Oplevet lufkvalitet						
	Koncentration af forurening	Udeforurening	Sensorisk belastning		Samlede forurening	Indblæsning/Udsugning	
	c [Decipol]	ci [Decipol]	Olf pr. pers	[Olf pr. m2]	q [Olf]	[l/s]	[h^-1]
Residential							
Apartments	1,4	0,09	1,2	0,4	20,96	**160,00**	**4,75**
Bathroom	1,4	0,09	1,2	0,4	4,48	**34,20**	**5,35**
Shared Space	1,4	0,09	1,2	0,4	21,84	**166,72**	**8,13**
Visitor Room	1,4	0,09	1,2	0,4	8,4	**64,12**	**5,13**
Bathroom	1,4	0,09	1,2	0,4	2,88	**21,98**	**6,28**
Social Room							
Games, Play, Craft	1,4	0,09	1,2	0,4	30,4	**232,06**	**6,96**
Kitchen	1,4	0,09	2	0,4	111,52	**851,30**	**12,96**
Workshop	1,4	0,09	1,2	0,4	30,4	**232,06**	**6,96**
Library	1,4	0,09	1,2	0,4	24,12	**184,12**	**9,09**
Toilet	1,4	0,09	1,2	0,4	4,8	**36,64**	**4,89**
Treatment							
Therapy room	1,4	0,09	1,2	0,4	11,48	**87,63**	**4,63**
Wellness room	1,4	0,09	2	0,4	10,84	**82,75**	**5,81**
Sensory room	1,4	0,09	1,2	0,4	12,36	**94,35**	**4,55**
Quiet room	1,4	0,09	1,2	0,4	7,4	**56,49**	**5,42**
Conversation room	1,4	0,09	1,2	0,4	7,4	**56,49**	**5,42**
Toilet	1,4	0,09	3	0,4	4,84	**36,95**	**9,64**
Staff							
Individual Office Space	1,4	0,09	3	0,4	6,6	**50,38**	**6,72**
Shared Office Area	1,4	0,09	3	0,4	28	**213,74**	**6,41**
Meeting Room	1,4	0,09	1,3	0,4	20,32	**155,11**	**10,17**
Medicine Room	1,4	0,09	1,6	0,4	9,2	**70,23**	**5,62**
Dressing Room	1,4	0,09	1,6	0,4	9,2	**70,23**	**5,62**
Toilet	1,4	0,09	1,6	0,4	3,28	**25,04**	**7,15**

Lokaler	CO2								
	Maksimale CO2 indhold i luften	Koncentration af forurening	Udeluftkoncentration CO2	Koncentration af forurening i udeluft	Aktivitetsniveau	Tilført forurening pr. pers		Indblæsning/Udsugning	
	[ppm]	c [m3/m3]	[ppm]	ci [m3/m3]	[Met]	q [l/h]	q [l/s]	VL [l/s]	[h^-1]
Residential									
Apartments	1000	0,001	400	0,0004	1,2	81,6	0,02	**37,77777778**	**1,12**
Bathroom	1000	0,001	400	0,0004	1,2	20,4	0,01	**9,44**	**1,47826087**
Shared Space	1000	0,001	400	0,0004	1,2	204	0,06	**94,44**	**4,61**
Visitor Room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**1,51**
Bathroom	1000	0,001	400	0,0004	1,2	20,4	0,01	**9,44**	**2,70**
Social Room									
Games, Play, Craft	1000	0,001	400	0,0004	1,2	244,8	0,07	**113,33**	**3,40**
Kitchen	1000	0,001	400	0,0004	1,2	816	0,23	**377,78**	**5,75**
Workshop	1000	0,001	400	0,0004	1,2	244,8	0,07	**113,33**	**3,40**
Library	1000	0,001	400	0,0004	1,2	244,8	0,07	**113,33**	**5,60**
Toilet	1000	0,001	400	0,0004	1,2	20,4	0,01	**9,44**	**1,26**
Treatment									
Therapy room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**1,00**
Wellness room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**1,33**
Sensory room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**0,91**
Quiet room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**1,81**
Conversation room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**1,81**
Toilet	1000	0,001	400	0,0004	1,2	20,4	0,006	**9,44**	**2,46**
Staff									
Individual Office Space	1000	0,001	400	0,0004	1,2	20,4	0,01	**9,44**	**1,26**
Shared Office Area	1000	0,001	400	0,0004	1,2	81,6	0,02	**37,78**	**1,13**
Meeting Room	1000	0,001	400	0,0004	1,2	204	0,06	**94,44**	**6,19**
Medicine Room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**1,51**
Dressing Room	1000	0,001	400	0,0004	1,2	40,8	0,01	**18,89**	**1,51**
Toilet	1000	0,001	400	0,0004	1,2	20,4	0,01	**9,44**	**2,70**

[l/s]	[m3/s]	[l/s pr. m2]	Min air supply [l/s pr. m2		flow [l/s pr. m2]	[m3/h]	[h-1]
80,40	0,08	1,99	0,30	40,40	1,99	289,44	2,388118812
18,20	0,02	2,22	0,30	8,20	2,22	65,52	2,848695652
124,60	0,12	5,07	0,30	24,60	5,07	448,56	6,07804878
35,00	0,04	2,33	0,30	15,00	2,33	126,00	2,8
14,20	0,01	3,38	0,30	4,20	3,38	51,12	4,057142857
160,00	0,16	4,00	0,30	40,00	4,00	576,00	4,8
478,80	0,48	6,08	0,30	78,80	6,08	1723,68	7,291370558
160,00	0,16	4,00	1,30	40,00	4,00	576,00	4,8
144,30	0,14	5,94	0,30	24,30	5,94	519,48	7,125925926
19,00	0,02	2,11	0,30	9,00	2,11	68,40	2,533333333
42,70	0,04	1,88	0,30	22,70	1,88	153,72	2,257268722
37,10	0,04	2,17	0,30	17,10	2,17	133,56	2,603508772
44,90	0,04	1,80	0,30	24,90	1,80	161,64	2,163855422
32,50	0,03	2,60	0,30	12,50	2,60	117,00	3,12
32,50	0,03	2,60	0,30	12,50	2,60	117,00	3,12
14,60	0,01	3,17	0,30	4,60	3,17	52,56	3,808695652
	0,00			0,00			
19,00	0,02	2,11	0,30	9,00	2,11	68,40	2,533333333
80,00	0,08	2,00	0,30	40,00	2,00	288,00	2,4
118,30	0,12	6,46	0,30	18,30	6,46	425,88	7,757377049
35,00	0,04	2,33	0,30	15,00	2,33	126,00	2,8
35,00	0,04	2,33	0,30	15,00	2,33	126,00	2,8
14,20	0,01	3,38	0,30	4,20	3,38	51,12	4,057142857

Zone	[m3/h]	Area
Aparment	354,96	48,60
Shared space	448,56	24,60
Visitor room	177,12	19,20
Game Workshop Office	1869,12	169,20
Treatment, kitchen, library	2881,44	181,6
Quite, conversation room	234,00	25,00
Meeting/ 2x Individual office	562,68	36,30

APPENDIX 4 - LOADS

DEAD LOAD

Dead load from envelopes

There is a couple of factors that needs to be determined when doing construction calculation.

Consequence class: CC2 (The consequences in case of failure involve medium risk of loss of human life. the economic, social, and environmental consequences are significant) KFi=1,0 (Jensen, Olsen a)

The service Class of the construction is determined by the conditions can be divided into two

SNOW

The snow load determined using Teknisk Ståbi (Jensen, Olsen c)

WIND

The wind load is determined by us of a table: 0,65kN/sqm. In this case the wind load is only affecting the gable which is also divided into two load distribution areas. And then divided with of each load distribution areas width. (Jensen, Olsen d)

IMPOSED LOAD

The imposed load is determined by Eurocode 1. In a residential building the imposed load is 2,5 kN/sqm. (Jensen, Olsen b)

LOAD COMBINATIONS

ULS – ULTIMATE LIMET STATE

SLS – SERVIVE LIMET STATE

Towards Lake Roof Beam

	Area	Thickness	Density	Mass	
Roof	246,74	0,59	72	10481,52	kg
Total load				10481,52	kg
Neton				102718,8	N
Kilo Newton				102,7188	kN
				14,07108	kN/m

Mass Towards Lake Floor Beam

	Area	Thickness	Density	Mass	
Exterior wall	69,66	0,59	89	3657,847	kg
Interior Wall	90	0,3	81	2187	kg
Glazing	72	0,12	20	1440	kg
Floor	179,14	0,59	86	9089,564	kg
				16374,41	kg
				160469,2	N
				160,4692	kN
				21,98208	kN/m

Towards courtyard Roof Beam

	Area	Thickness	Density	Mass	
Roof	200,33	0,59	72	8510,018	kg
Glazed Roof	32,89		20	657,8	kg
	233,22				
				9167,818	kg
				89844,62	N
				89,84462	kN
				13,02096	kN/m

Towards courtyard Floor Beam

	Area	Thickness	Density	Mass	
Exterior wall	70	0,59	89	3675,7	kg
Interior Wall	93,598	0,3	81	2274,431	kg
Glazing + Glass roof	21		20	420	kg
Floor	233,22	0,59	86	11833,58	kg
				18203,71	kg
				178396,4	N
				178,3964	kN
				25,85455	kN/m

Snow load is given by:
$s = \mu_i C_e C_t s_k$
μ_i is the formfactor, in this case 0,8
C_e is the exposure factor calculated by:
$C_e = C_{top} C_s$
Where:
C_{top} is the factor for the topography 0,8 for windy, 1,0 for normal, and 1,2 for sheltered topography. As the project site is situated in a forest the sheltered topography is chosen giving the factor 1,2
C_s is the factor for the size of the roof which gradually increases from 1,0 to 1,2. As the roof is a quiet large flat surface 1,2 is used
$C_e = 1{,}2 \cdot 1{,}2 = 1{,}44$
C_t is the thermal factor which for a well-insulated roof is 1,0
s_k is the characteristic terrain value which in Denmark is 1,0 kN/m^2

$$s = 0{,}8 \cdot 1{,}44 \cdot 1{,}0 \cdot 1{,}0 kN/m^2 = 1{,}152 kN/m^2$$

Load distribution area	Width [m]	Length [m]	Snow load per sqm.	Snow load as a uniform load [kN/m]	Snow laod total [kN]
Stadic system towards lake	7,3	33,8	1,152	8,41	284,24448
Static system towards courtyard	6,90	33,8	1,152	7,95	268,66944

Load distribution area	Width [m]	Length [m]	Wind load per sqm.	Wind load as a Uniform load [kN/m]	Wind load total [kN]
Stadic system towards lake	7,3	4,2	0,65	4,75	19,929
Static system towards court	6,90	4,2	0,65	4,49	18,837

Load distribution area	Width [m]	Length [m]	Imposed load per sqm.	Imposed load as a uniform load [kN/m]	Imposed laod total [kN]
Stadic system towards lake	7,3	33,8	2,5	18,25	616,85
Static system towards courtyard	6,90	33,8	2,5	17,25	583,05

LOAD COMBINATIONS

ULS – ULTIMATE LIMET STATE

Load combination	Permanent load	Patialcoeficient	Leading variable load	Combinations factor 1	Accompanying variable load 1
Dominant load SNOW 1	DL1+DL2+DL3	1,0*K(FI)	SNOW 1	1,5*K(FI)	WIND
Dominant load SNOW 2	DL1+DL2+DL3	1,0*K(FI)	SNOW 2	1,5*K(FI)	IMPOSED
Dominant load WIND 1	DL1+DL2+DL3	1,0*K(FI)	WIND 1	1,5*K(FI)	SNOW
Dominant load WIND 2	DL1+DL2+DL3	1,0*K(FI)	WIND 2	1,5*K(FI)	IMPOSED
Dominant load IMPOSED 1	DL1+DL2+DL3	1,0*K(FI)	IMPOSED 1	1,5*K(FI)	SNOW
Dominant load IMPOSED 2	DL1+DL2+DL3	1,0*K(FI)	IMPOSED 2	1,5*K(FI)	WIND

SLS – SERVICE LIMET STATE

	Permanent load	Patialcoeficient	Leading variable load		Accompanying variable load 1
SNOW 1	DL1+DL2+DL3		SNOW 1		WIND
SNOW 2	DL1+DL2+DL3		SNOW 2		IMPOSED
WIND 1	DL1+DL2+DL3		WIND 1		SNOW
WIND 2	DL1+DL2+DL3		WIND 2		IMPOSED
IMPOSED 1	DL1+DL2+DL3		IMPOSED 1		SNOW
IMPOSED 2	DL1+DL2+DL3		IMPOSED 2		WIND

Accompanyingvariable Combinations factor 2	Accompanying variable load 2	Accompanying variable combinations factor 3
0,3	IMPOSED	0,6
0,6	WIND	0,2
0	IMPOSED	0,6
0,6	SNOW	0
0,3	WIND	0,2
0,3	SNOW	0,2

Accompanyingvariable Combinations factor 2	Accompanying variable load 2	Accompanying variable combinations factor 3
0,3	IMPOSED	0,6
0,6	WIND	0,2
0	IMPOSED	0,6
0,6	SNOW	0
0,3	WIND	0,2
0,3	SNOW	0,2

APPENDIX 5 - TIMBER DESIGN RESULTS

Result based on robot structural analysis timber design in every design proposal has a schedule showing all element in each design, the cross section of each element and its utilization. The elements of interest for each design has been picked out with a black highlight and the detail calculation is under for each of the picked elements.

APPENDIX 5.1 - ITERATION 2

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24c 600x60	GL24c	53.23	53.23	1.28	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	GL24c 600x60	GL24c	57.33	57.33	0.54	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	GL24c 600x60	GL24c	62.58	62.58	0.29	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	GL24c 600x60	GL24c	68.59	68.59	0.76	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.55	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.28	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.52	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
28 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.04	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
31 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.07	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
32 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.12	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
33 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.22	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 1 Timber Column 1_1 **POINT:** 15 **COORDINATE:** x = 0.61 L = 5.62 m

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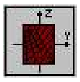
LOADS:
Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c
gM = 1.25 f m,0,k = 24.00 MPa f t,0,k = 17.00 MPa f c,0,k = 21.50 MPa
f v,k = 3.50 MPa f t,90,k = 0.50 MPa f c,90,k = 2.50 MPa E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa G moyen = 650.00 MPa Service class: 1 Beta c = 0.10



SECTION PARAMETERS: GL24c 600x600
ht=600 mm
bf=600 mm Ay=240000 mm2 Az=240000 mm2 Ax=360000 mm2
tw=300 mm Iy=10800000000 mm4 Iz=10800000000 mm4 Ix=18219568173 mm4
tf=300 mm Wy=36000000 mm3 Wz=36000000 mm3

STRESSES
Sig_c,0,d = N/Ax = 106.37/360000 = 0.30 MPa
Sig_m,y,d = MY/Wy= 781.34/36000000 = 21.70 MPa

Tau z,d = 1.5*119.01/360000 = 0.50 MPa

ALLOWABLE STRESSES
f c,0,d = 15.48 MPa
f m,y,d = 17.28 MPa
f v,d = 2.52 MPa

Factors and additional parameters
kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 9.22 m	Lambda Y = 53.23	LZ = 9.22 m	Lambda Z = 53.23
Lambda_rel Y = 0.82	ky = 0.87	Lambda_rel Z = 0.82	kz = 0.87
LFY = 9.22 m	kcy = 0.88	LFZ = 9.22 m	kcz = 0.88

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.30/(0.88*15.48) + 21.70/17.28 = 1.28 > 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.50/0.67)/2.52 = 0.29 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 46 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 31 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section incorrect !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 4 Timber Column 1_4 **POINT:** 15 **COORDINATE:** x = 0.70 L = 8.28 m

---

LOADS:

Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: **GL24c 600x600**

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES

Sig_c,0,d = N/Ax = 439.29/360000 = 1.22 MPa

Sig_m,y,d = MY/Wy= 406.31/36000000 = 11.29 MPa

Tau z,d = 1.5*-49.07/360000 = -0.20 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 17.28 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 11.88 m	Lambda Y = 68.59	LZ = 11.88 m	Lambda Z = 68.59
Lambda_rel Y = 1.06	ky = 1.10	Lambda_rel Z = 1.06	kz = 1.10
LFY = 11.88 m	kcy = 0.72	LFZ = 11.88 m	kcz = 0.72

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 1.22/(0.72*15.48) + 11.29/17.28 = 0.76 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.20/0.67)/2.52 = 0.12 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 59 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 40 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

APPENDIX 5.2 - ITERATION 2.2

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24c 600x60	GL24c	53.23	53.23	1.28	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	GL24c 600x60	GL24c	57.33	57.33	0.54	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	GL24c 600x60	GL24c	62.58	62.58	0.29	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	GL24c 600x60	GL24c	68.59	68.59	0.76	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.55	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.28	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.52	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
28 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.04	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
31 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.07	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
32 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.12	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
33 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.22	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

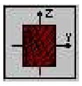
CODE GROUP:
MEMBER: 14 Timber Column 1_14 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

---

LOADS:
Governing Load Case: 15 ULS_IMPOSED1 (1+2+3)*1.00+(4+5)*0.30+6*1.50

MATERIAL GL24c

gM = 1.25 f m,0,k = 24.00 MPa f t,0,k = 17.00 MPa f c,0,k = 21.50 MPa
f v,k = 3.50 MPa f t,90,k = 0.50 MPa f c,90,k = 2.50 MPa E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa G moyen = 650.00 MPa Service class: 1 Beta c = 0.10



SECTION PARAMETERS: **GL24c 500x500**

ht=500 mm
bf=500 mm Ay=166667 mm2 Az=166667 mm2 Ax=250000 mm2
tw=250 mm Iy=5208333333 mm4 Iz=5208333333 mm4 Ix=8786442985 mm4
tf=250 mm Wy=20833333 mm3 Wz=20833333 mm3

STRESSES
Sig_t,0,d = N/Ax = -49.46/250000 = -0.20 MPa
Sig_m,y,d = MY/Wy= -912.28/20833333 = -43.79 MPa

Tau z,d = 1.5*107.07/250000 = 0.64 MPa

ALLOWABLE STRESSES
f t,0,d = 12.47 MPa
f m,y,d = 17.60 MPa
f v,d = 2.52 MPa

Factors and additional parameters
kh = 1.02 kh_y = 1.02 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

VERIFICATION FORMULAS:

Sig_t,0,d/f t,0,d + Sig_m,y,d/f m,y,d = 0.20/12.47 + 43.79/17.60 = 2.50 > 1.00 (6.17)

(Tau z,d/kcr)/f v,d = (0.64/0.67)/2.52 = 0.38 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section incorrect !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 15 Timber Column 1_15 **POINT:** 8 **COORDINATE:** x = 0.50 L = 2.13 m

---

LOADS:

Governing Load Case: 15 ULS_IMPOSED1 (1+2+3)*1.00+(4+5)*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 500x500

ht=500 mm			
bf=500 mm	Ay=166667 mm2	Az=166667 mm2	Ax=250000 mm2
tw=250 mm	Iy=5208333333 mm4	Iz=5208333333 mm4	Ix=8786442985 mm4
tf=250 mm	Wy=20833333 mm3	Wz=20833333 mm3	

STRESSES

Sig_t,0,d = N/Ax = -49.46/250000 = -0.20 MPa

Sig_m,y,d = MY/Wy= -1026.31/20833333 = -49.26 MPa

ALLOWABLE STRESSES

f t,0,d = 12.47 MPa

f m,y,d = 17.60 MPa

Factors and additional parameters

kh = 1.02 kh_y = 1.02 kmod = 0.90 Ksys = 1.00

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

VERIFICATION FORMULAS:

Sig_t,0,d/f t,0,d + Sig_m,y,d/f m,y,d = 0.20/12.47 + 49.26/17.60 = 2.82 > 1.00 (6.17)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section incorrect !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 16 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

LOADS:

Governing Load Case: 15 ULS_IMPOSED1 (1+2+3)*1.00+(4+5)*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 500x500

ht=500 mm			
bf=500 mm	Ay=166667 mm2	Az=166667 mm2	Ax=250000 mm2
tw=250 mm	Iy=5208333333 mm4	Iz=5208333333 mm4	Ix=8786442985 mm4
tf=250 mm	Wy=20833333 mm3	Wz=20833333 mm3	

STRESSES

Sig_t,0,d = N/Ax = -49.46/250000 = -0.20 MPa

Sig_m,y,d = MY/Wy= -912.28/20833333 = -43.79 MPa

Tau z,d = 1.5*-107.07/250000 = -0.64 MPa

ALLOWABLE STRESSES

f t,0,d = 12.47 MPa

f m,y,d = 17.60 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.02 kh_y = 1.02 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

VERIFICATION FORMULAS:

Sig_t,0,d/f t,0,d + Sig_m,y,d/f m,y,d = 0.20/12.47 + 43.79/17.60 = 2.50 > 1.00 (6.17)

(Tau z,d/kcr)/f v,d = (0.64/0.67)/2.52 = 0.38 < 1.00 (6.13)

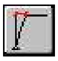
LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3



Displacements (GLOBAL SYSTEM):

Section incorrect !!!

APPENDIX 5.3 - ITERATION 2.3

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24c 500x50	GL24c	63.88	63.88	0.21	14 ULS_WIND1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
2 Timber Column	GL24c 500x50	GL24c	68.80	68.80	0.28	14 ULS_WIND1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
3 Timber Column	GL24c 500x50	GL24c	75.10	75.10	0.31	14 ULS_WIND1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
4 Timber Column	GL24c 500x50	GL24c	82.31	82.31	0.28	14 ULS_WIND1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
5 Timber Column	GL24c 500x50	GL24c	29.51	29.51	0.38	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
6 Timber Column	GL24c 500x50	GL24c	80.16	80.16	0.28	14 ULS_WIND1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
7 Timber Column	GL24c 500x50	GL24c	28.41	28.41	0.37	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
8 Timber Column	GL24c 500x50	GL24c	29.51	29.51	0.38	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
9 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
10 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
11 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.83	11 ULS_SNOW1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
12 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.93	11 ULS_SNOW1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
13 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.83	11 ULS_SNOW1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
14 Timber Column	GL24c 500x50	GL24c	29.51	29.51	2.51	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
15 Timber Column	GL24c 500x50	GL24c	29.51	29.51	2.82	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
16	GL24c 500x50	GL24c	29.51	29.51	2.51	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
17 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
18 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
19 Timber Column	GL24c 500x50	GL24c	28.41	28.41	0.37	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	
20 Timber Column	GL24c 500x50	GL24c	80.16	80.16	0.17	14 ULS_WIND1	0.00	(1+0.6)*1 + (0.3+0*0.	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

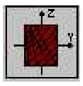
CODE GROUP:
MEMBER: 11 Timber Column 1_11 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

---

LOADS:
Governing Load Case: 11 ULS_SNOW1 (1+2+3)*1.00+4*1.50+5*0.30+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10



SECTION PARAMETERS: **GL24c 600x600**

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES
Sig_c,0,d = N/Ax = 189.91/360000 = 0.53 MPa
Sig_m,y,d = MY/Wy= 508.20/36000000 = 14.12 MPa

Tau z,d = 1.5*59.65/360000 = 0.25 MPa

ALLOWABLE STRESSES
f c,0,d = 15.48 MPa
f m,y,d = 17.28 MPa
f v,d = 2.52 MPa

Factors and additional parameters
kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 24.60	LZ = 4.26 m	Lambda Z = 24.60
Lambda_rel Y = 0.38	ky = 0.58	Lambda_rel Z = 0.38	kz = 0.58
LFY = 4.26 m	kcy = 0.99	LFZ = 4.26 m	kcz = 0.99

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.53/(0.99*15.48) + 14.12/17.28 = 0.85 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.25/0.67)/2.52 = 0.15 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 12 Timber Column 1_12 **POINT:** 8 **COORDINATE:** x = 0.50 L = 2.13 m

---

LOADS:

Governing Load Case: 11 ULS_SNOW1 (1+2+3)*1.00+4*1.50+5*0.30+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 600x600

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_c,0,d = N/Ax = 189.91/360000 = 0.53 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 571.72/36000000 = 15.88 MPa	f m,y,d = 17.28 MPa

---

Factors and additional parameters

kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:

LY = 4.26 m	Lambda Y = 24.60
Lambda_rel Y = 0.38	ky = 0.58
LFY = 4.26 m	kcy = 0.99

About Z axis:

LZ = 4.26 m	Lambda Z = 24.60
Lambda_rel Z = 0.38	kz = 0.58
LFZ = 4.26 m	kcz = 0.99

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.53/(0.99*15.48) + 15.88/17.28 = 0.95 < 1.00 (6.23)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 13 Timber Column 1_13 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

---

LOADS:

Governing Load Case: 11 ULS_SNOW1 (1+2+3)*1.00+4*1.50+5*0.30+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: **GL24c 600x600**

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES

Sig_c,0,d = N/Ax = 189.91/360000 = 0.53 MPa

Sig_m,y,d = MY/Wy= 508.20/36000000 = 14.12 MPa

Tau z,d = 1.5*-59.65/360000 = -0.25 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 17.28 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:

LY = 4.26 m   Lambda Y = 24.60
Lambda_rel Y = 0.38   ky = 0.58
LFY = 4.26 m   kcy = 0.99

About Z axis:

LZ = 4.26 m   Lambda Z = 24.60
Lambda_rel Z = 0.38   kz = 0.58
LFZ = 4.26 m   kcz = 0.99

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.53/(0.99*15.48) + 14.12/17.28 = 0.85 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.25/0.67)/2.52 = 0.15 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm   Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3   u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm   Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

APPENDIX 5.4 - ITERATION 3

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24c 600x60	GL24c	53.23	53.23	1.28	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	GL24c 600x60	GL24c	57.33	57.33	0.54	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	GL24c 600x60	GL24c	62.58	62.58	0.29	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	GL24c 600x60	GL24c	68.59	68.59	0.76	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.55	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.28	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.52	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
28 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.04	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
31 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.07	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
32 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.12	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
33 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.22	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 1 Timber Column 1_1 **POINT:** 15 **COORDINATE:** x = 0.61 L = 5.62 m

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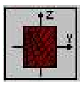
LOADS:
Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10



SECTION PARAMETERS: **GL24c 600x600**

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES **ALLOWABLE STRESSES**

Sig_c,0,d = N/Ax = 106.37/360000 = 0.30 MPa f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 781.34/36000000 = 21.70 MPa f m,y,d = 17.28 MPa
f v,d = 2.52 MPa

Tau z,d = 1.5*119.01/360000 = 0.50 MPa

Factors and additional parameters

kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 9.22 m	Lambda Y = 53.23	LZ = 9.22 m	Lambda Z = 53.23
Lambda_rel Y = 0.82	ky = 0.87	Lambda_rel Z = 0.82	kz = 0.87
LFY = 9.22 m	kcy = 0.88	LFZ = 9.22 m	kcz = 0.88

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.30/(0.88*15.48) + 21.70/17.28 = 1.28 > 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.50/0.67)/2.52 = 0.29 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 46 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 31 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section incorrect !!!

APPENDIX 5.5 - ITERATION 3.2

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24c 600x60	GL24c	53.23	53.23	0.12	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	GL24c 600x60	GL24c	57.33	57.33	0.15	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	GL24c 600x60	GL24c	62.58	62.58	0.17	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	GL24c 600x60	GL24c	68.59	68.59	0.20	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.13	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.31	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	GL24c 600x60	GL24c	24.60	24.60	0.30	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.11	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
28 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.02	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
31 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.02	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
32 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.12	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
33 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.12	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

APPENDIX 5.6 - ITERATION 3.3

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24c 600x60	GL24c	53.23	53.23	0.12	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	GL24c 600x60	GL24c	57.33	57.33	0.15	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	GL24c 600x60	GL24c	62.58	62.58	0.17	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	GL24c 600x60	GL24c	68.59	68.59	0.20	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.13	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.31	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	GL24c 600x60	GL24c	24.60	24.60	0.30	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.11	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
28 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.02	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
31 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.02	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
32 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.12	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
33 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.12	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	OK GL24c 600x60	GL24c	53.23	53.23	0.13	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	OK GL24c 600x60	GL24c	57.33	57.33	0.15	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	OK GL24c 600x60	GL24c	62.58	62.58	0.17	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	OK GL24c 600x60	GL24c	68.59	68.59	0.19	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	OK GL24c 500x50	GL24c	29.51	29.51	0.38	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	OK GL24c 600x60	GL24c	66.80	66.80	0.13	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	OK GL24c 500x50	GL24c	28.41	28.41	0.37	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	OK GL24c 500x50	GL24c	29.51	29.51	0.38	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	OK GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	OK GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	OK GL24c 600x60	GL24c	24.60	24.60	0.85	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	OK GL24c 600x60	GL24c	24.60	24.60	0.95	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	OK GL24c 600x60	GL24c	24.60	24.60	0.85	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	OK GL24c 500x50	GL24c	29.51	29.51	0.46	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	OK GL24c 500x50	GL24c	29.51	29.51	0.40	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	OK GL24c 500x50	GL24c	29.51	29.51	0.44	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	OK GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	OK GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	OK GL24c 500x50	GL24c	28.41	28.41	0.37	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	OK GL24c 600x60	GL24c	66.80	66.80	0.10	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
32 Timber Column	OK GL24c 600x60	GL24c	32.20	32.20	0.09	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
33 Timber Column	OK GL24c 600x60	GL24c	32.20	32.20	0.09	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 11 Timber Column 1_11 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

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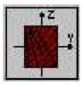
LOADS:
Governing Load Case: 11 ULS_SNOW1 (1+2+3)*1.00+4*1.50+5*0.30+6*0.60

MATERIAL GL24c

gM = 1.25 f m,0,k = 24.00 MPa f t,0,k = 17.00 MPa f c,0,k = 21.50 MPa
f v,k = 3.50 MPa f t,90,k = 0.50 MPa f c,90,k = 2.50 MPa E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa G moyen = 650.00 MPa Service class: 1 Beta c = 0.10



SECTION PARAMETERS: **GL24c 600x600**

ht=600 mm
bf=600 mm Ay=240000 mm2 Az=240000 mm2 Ax=360000 mm2
tw=300 mm Iy=10800000000 mm4 Iz=10800000000 mm4 Ix=18219568173 mm4
tf=300 mm Wy=36000000 mm3 Wz=36000000 mm3

STRESSES
Sig_c,0,d = N/Ax = 189.91/360000 = 0.53 MPa
Sig_m,y,d = MY/Wy= 508.20/36000000 = 14.12 MPa

Tau z,d = 1.5*59.65/360000 = 0.25 MPa

ALLOWABLE STRESSES
f c,0,d = 15.48 MPa
f m,y,d = 17.28 MPa
f v,d = 2.52 MPa

Factors and additional parameters
kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 24.60	LZ = 4.26 m	Lambda Z = 24.60
Lambda_rel Y = 0.38	ky = 0.58	Lambda_rel Z = 0.38	kz = 0.58
LFY = 4.26 m	kcy = 0.99	LFZ = 4.26 m	kcz = 0.99

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.53/(0.99*15.48) + 14.12/17.28 = 0.85 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.25/0.67)/2.52 = 0.15 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 12 Timber Column 1_12 **POINT:** 8 **COORDINATE:** x = 0.50 L = 2.13 m

---

LOADS:
Governing Load Case: 11 ULS_SNOW1 (1+2+3)*1.00+4*1.50+5*0.30+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 600x600

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES	ALLOWABLE STRESSES
Sig_c,0,d = N/Ax = 189.91/360000 = 0.53 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 571.72/36000000 = 15.88 MPa	f m,y,d = 17.28 MPa

---

Factors and additional parameters

kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:

LY = 4.26 m Lambda Y = 24.60
Lambda_rel Y = 0.38 ky = 0.58
LFY = 4.26 m kcy = 0.99

About Z axis:

LZ = 4.26 m Lambda Z = 24.60
Lambda_rel Z = 0.38 kz = 0.58
LFZ = 4.26 m kcz = 0.99

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.53/(0.99*15.48) + 15.88/17.28 = 0.95 < 1.00 (6.23)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified
Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified
Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 13 Timber Column 1_13 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

---

LOADS:
Governing Load Case: 11 ULS_SNOW1 (1+2+3)*1.00+4*1.50+5*0.30+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: **GL24c 600x600**

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES
Sig_c,0,d = N/Ax = 189.91/360000 = 0.53 MPa
Sig_m,y,d = MY/Wy= 508.20/36000000 = 14.12 MPa

Tau z,d = 1.5*-59.65/360000 = -0.25 MPa

ALLOWABLE STRESSES
f c,0,d = 15.48 MPa
f m,y,d = 17.28 MPa
f v,d = 2.52 MPa

Factors and additional parameters
kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 24.60	LZ = 4.26 m	Lambda Z = 24.60
Lambda_rel Y = 0.38	ky = 0.58	Lambda_rel Z = 0.38	kz = 0.58
LFY = 4.26 m	kcy = 0.99	LFZ = 4.26 m	kcz = 0.99

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.53/(0.99*15.48) + 14.12/17.28 = 0.85 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.25/0.67)/2.52 = 0.15 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24c 600x60	GL24c	53.23	53.23	1.28	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	GL24c 600x60	GL24c	57.33	57.33	0.54	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	GL24c 600x60	GL24c	62.58	62.58	0.29	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	GL24c 600x60	GL24c	68.59	68.59	0.75	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.55	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.27	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.17	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.28	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.28	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	GL24c 600x60	GL24c	24.60	24.60	0.28	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	GL24c 600x60	GL24c	24.60	24.60	0.15	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.14	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	GL24c 600x60	GL24c	23.67	23.67	0.26	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	GL24c 600x60	GL24c	66.80	66.80	0.52	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
28 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.05	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
31 Timber Column	GL24c 600x60	GL24c	20.78	20.78	0.05	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
32 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.09	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
33 Timber Column	GL24c 600x60	GL24c	32.20	32.20	0.09	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 1 Timber Column 1_1 **POINT:** 15 **COORDINATE:** x = 0.61 L = 5.62 m

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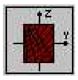
LOADS:
Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10



SECTION PARAMETERS: **GL24c 600x600**

ht=600 mm			
bf=600 mm	Ay=240000 mm2	Az=240000 mm2	Ax=360000 mm2
tw=300 mm	Iy=10800000000 mm4	Iz=10800000000 mm4	Ix=18219568173 mm4
tf=300 mm	Wy=36000000 mm3	Wz=36000000 mm3	

STRESSES
Sig_c,0,d = N/Ax = 106.37/360000 = 0.30 MPa
Sig_m,y,d = MY/Wy= 783.39/36000000 = 21.76 MPa

Tau z,d = 1.5*119.37/360000 = 0.50 MPa

ALLOWABLE STRESSES
f c,0,d = 15.48 MPa
f m,y,d = 17.28 MPa
f v,d = 2.52 MPa

Factors and additional parameters
kh = 1.00 kh_y = 1.00 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 9.22 m	Lambda Y = 53.23	LZ = 9.22 m	Lambda Z = 53.23
Lambda_rel Y = 0.82	ky = 0.87	Lambda_rel Z = 0.82	kz = 0.87
LFY = 9.22 m	kcy = 0.88	LFZ = 9.22 m	kcz = 0.88

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.30/(0.88*15.48) + 21.76/17.28 = 1.28 > 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.50/0.67)/2.52 = 0.29 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 46 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 31 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section incorrect !!!

APPENDIX 5.10 - ITERATION 5.8

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	OK GL24C 425x42	GL24c	75.15	75.15	0.52	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	OK GL24c 250x25	GL24c	77.28	77.28	0.60	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	OK GL24C 425x42	GL24c	88.35	88.35	0.81	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	OK GL24C 425x42	GL24c	96.83	96.83	0.84	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	OK GL24c 350x35	GL24c	42.16	42.16	0.91	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	OK GL24c 250x25	GL24c	77.28	77.28	0.59	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	OK GL24c 350x35	GL24c	40.58	40.58	0.88	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	OK GL24c 350x35	GL24c	42.16	42.16	0.91	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	OK GL24c 300x30	GL24c	47.34	47.34	0.68	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	OK GL24c 300x30	GL24c	49.19	49.19	0.71	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	OK GL24c 300x30	GL24c	49.19	49.19	0.67	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	OK GL24c 300x30	GL24c	49.19	49.19	0.58	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	OK GL24c 300x30	GL24c	49.19	49.19	0.68	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	OK GL24c 350x35	GL24c	42.16	42.16	0.92	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	OK GL24c 350x35	GL24c	42.16	42.16	0.78	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	OK GL24c 350x35	GL24c	42.16	42.16	0.91	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	OK GL24c 300x30	GL24c	49.19	49.19	0.67	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	OK GL24c 300x30	GL24c	47.34	47.34	0.65	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	OK GL24c 350x35	GL24c	40.58	40.58	0.89	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	OK GL24C 425x42	GL24c	94.31	94.31	0.34	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
21 Timber Column	OK GL24c 250x25	GL24c	77.28	77.28	0.63	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
22 Timber Column	OK GL24c 250x25	GL24c	77.28	77.28	0.59	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
23 Timber Column	OK GL24c 200x20	GL22c	62.35	62.35	0.22	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
24 Timber Column	OK GL24c 200x20	GL22c	62.35	62.35	0.27	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
25 Timber Column	OK GL24c 200x20	GL22c	62.35	62.35	0.28	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
26 Timber Column	OK GL24c 200x20	GL22c	62.35	62.35	0.29	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

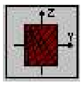
CODE GROUP:
MEMBER: 3 Timber Column 1_3 **POINT:** 15 **COORDINATE:** x = 0.67 L = 7.24 m

---

LOADS:
Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c

gM = 1.25 f m,0,k = 24.00 MPa f t,0,k = 17.00 MPa f c,0,k = 21.50 MPa
f v,k = 3.50 MPa f t,90,k = 0.50 MPa f c,90,k = 2.50 MPa E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa G moyen = 650.00 MPa Service class: 1 Beta c = 0.10



SECTION PARAMETERS: **GL24C 425x425**

ht=425 mm
bf=425 mm Ay=120417 mm2 Az=120417 mm2 Ax=180625 mm2
tw=213 mm Iy=2718782552 mm4 Iz=2718782552 mm4 Ix=4586578153 mm4
tf=213 mm Wy=12794271 mm3 Wz=12794271 mm3

STRESSES

Sig_c,0,d = N/Ax = 617.69/180625 = 3.42 MPa
Sig_m,y,d = MY/Wy= 81.34/12794271 = 6.36 MPa

Tau z,d = 1.5*11.24/180625 = 0.09 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa
f m,y,d = 17.89 MPa
f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.04 kh_y = 1.04 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 10.84 m	Lambda Y = 88.35	LZ = 10.84 m	Lambda Z = 88.35
Lambda_rel Y = 1.37	ky = 1.49	Lambda_rel Z = 1.37	kz = 1.49
LFY = 10.84 m	kcy = 0.48	LFZ = 10.84 m	kcz = 0.48

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.42/(0.48*15.48) + 6.36/17.89 = 0.81 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.09/0.67)/2.52 = 0.06 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 54 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 36 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 4 Timber Column 1_4 **POINT:** 15 **COORDINATE:** x = 0.70 L = 8.28 m

---

LOADS:

Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24C 425x425

ht=425 mm			
bf=425 mm	Ay=120417 mm2	Az=120417 mm2	Ax=180625 mm2
tw=213 mm	Iy=2718782552 mm4	Iz=2718782552 mm4	Ix=4586578153 mm4
tf=213 mm	Wy=12794271 mm3	Wz=12794271 mm3	

STRESSES

Sig_c,0,d = N/Ax = 641.07/180625 = 3.55 MPa

Sig_m,y,d = MY/Wy= 64.22/12794271 = 5.02 MPa

Tau z,d = 1.5*7.76/180625 = 0.06 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 17.89 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.04 kh_y = 1.04 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 11.88 m	Lambda Y = 96.83	LZ = 11.88 m	Lambda Z = 96.83
Lambda_rel Y = 1.50	ky = 1.68	Lambda_rel Z = 1.50	kz = 1.68
LFY = 11.88 m	kcy = 0.41	LFZ = 11.88 m	kcz = 0.41

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.55/(0.41*15.48) + 5.02/17.89 = 0.84 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.06/0.67)/2.52 = 0.04 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 59 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 40 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 5 Timber Column 1_5 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

---

LOADS:

Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: **GL24c 350x350**

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES

Sig_c,0,d = N/Ax = 363.05/122500 = 2.96 MPa

Sig_m,y,d = MY/Wy= 79.66/7145833 = 11.15 MPa

Tau z,d = 1.5*-124.80/122500 = -1.53 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 18.24 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 2.96/(0.94*15.48) + 11.15/18.24 = 0.81 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.53/0.67)/2.52 = 0.91 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 7 Timber Column 1_7 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

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LOADS:
Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_c,0,d = N/Ax = 1.45/122500 = 0.01 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 79.66/7145833 = 11.15 MPa	f m,y,d = 18.24 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*121.55/122500 = 1.49 MPa	

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.10 m	Lambda Y = 40.58	LZ = 4.10 m	Lambda Z = 40.58
Lambda_rel Y = 0.63	ky = 0.71	Lambda_rel Z = 0.63	kz = 0.71
LFY = 4.10 m	kcy = 0.95	LFZ = 4.10 m	kcz = 0.95

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.01/(0.95*15.48) + 11.15/18.24 = 0.61 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.49/0.67)/2.52 = 0.88 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 8 Timber Column 1_8 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

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LOADS:

Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES	ALLOWABLE STRESSES
Sig_c,0,d = N/Ax = 380.21/122500 = 3.10 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 82.33/7145833 = 11.52 MPa	f m,y,d = 18.24 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*-125.43/122500 = -1.54 MPa	

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.10/(0.94*15.48) + 11.52/18.24 = 0.84 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.54/0.67)/2.52 = 0.91 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 14 Timber Column 1_14 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

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LOADS:

Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES

Sig_c,0,d = N/Ax = 378.95/122500 = 3.09 MPa

Sig_m,y,d = MY/Wy= 86.26/7145833 = 12.07 MPa

Tau z,d = 1.5*-126.35/122500 = -1.55 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 18.24 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.09/(0.94*15.48) + 12.07/18.24 = 0.87 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.55/0.67)/2.52 = 0.92 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 16 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

LOADS:

Governing Load Case: 15 ULS_IMPOSED1 (1+2+3)*1.00+(4+5)*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES

Sig_c,0,d = N/Ax = 377.70/122500 = 3.08 MPa

Sig_m,y,d = MY/Wy= 81.71/7145833 = 11.43 MPa

Tau z,d = 1.5*125.28/122500 = 1.53 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 18.24 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.08/(0.94*15.48) + 11.43/18.24 = 0.84 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.53/0.67)/2.52 = 0.91 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 19 Timber Column 1_19 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

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LOADS:

Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_t,0,d = N/Ax = -5.60/122500 = -0.05 MPa	f t,0,d = 12.92 MPa
Sig_m,y,d = MY/Wy= -82.33/7145833 = -11.52 MPa	f m,y,d = 18.24 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*122.20/122500 = 1.50 MPa	

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

VERIFICATION FORMULAS:

Sig_t,0,d/f t,0,d + Sig_m,y,d/f m,y,d = 0.05/12.92 + 11.52/18.24 = 0.64 < 1.00 (6.17)

(Tau z,d/kcr)/f v,d = (1.50/0.67)/2.52 = 0.89 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

APPENDIX 5.11 - ITERATION 5.9

Member	Section	Material	Lay	Laz	Ratio	Case	Ratio(uy)	Case (uy)	Ratio(vy)	Case (vy)
1 Timber Column	GL24C 425x42	GL24c	75.15	75.15	0.52	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
2 Timber Column	GL24c 250x25	GL24c	77.28	77.28	0.60	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
3 Timber Column	GL24C 425x42	GL24c	88.35	88.35	0.81	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
4 Timber Column	GL24C 425x42	GL24c	96.83	96.83	0.84	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
5 Timber Column	GL24c 350x35	GL24c	42.16	42.16	0.91	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
6 Timber Column	GL24c 250x25	GL24c	77.28	77.28	0.59	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
7 Timber Column	GL24c 350x35	GL24c	40.58	40.58	0.88	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
8 Timber Column	GL24c 350x35	GL24c	42.16	42.16	0.91	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
9 Timber Column	GL24c 300x30	GL24c	47.34	47.34	0.68	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
10 Timber Column	GL24c 300x30	GL24c	49.19	49.19	0.71	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
11 Timber Column	GL24c 300x30	GL24c	49.19	49.19	0.67	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
12 Timber Column	GL24c 300x30	GL24c	49.19	49.19	0.58	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
13 Timber Column	GL24c 300x30	GL24c	49.19	49.19	0.68	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
14 Timber Column	GL24c 350x35	GL24c	42.16	42.16	0.92	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
15 Timber Column	GL24c 350x35	GL24c	42.16	42.16	0.78	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
16	GL24c 350x35	GL24c	42.16	42.16	0.91	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
17 Timber Column	GL24c 300x30	GL24c	49.19	49.19	0.67	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
18 Timber Column	GL24c 300x30	GL24c	47.34	47.34	0.65	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
19 Timber Column	GL24c 350x35	GL24c	40.58	40.58	0.89	16 ULS_IMPOSED2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
20 Timber Column	GL24C 425x42	GL24c	94.31	94.31	0.34	14 ULS_WIND1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
21 Timber Column	GL24c 250x25	GL24c	77.28	77.28	0.63	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
22 Timber Column	GL24c 250x25	GL24c	77.28	77.28	0.59	15 ULS_IMPOSED1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
23 Timber Column	GL24c 200x20	GL22c	62.35	62.35	0.22	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
24 Timber Column	GL24c 200x20	GL22c	62.35	62.35	0.27	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
25 Timber Column	GL24c 200x20	GL22c	62.35	62.35	0.28	12 ULS_SNOW2	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	
26 Timber Column	GL24c 200x20	GL22c	62.35	62.35	0.29	11 ULS_SNOW1	0.00	(1+0.6)*1 + (1+0*0.6)	0.00	

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

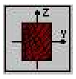
CODE GROUP:
MEMBER: 3 Timber Column 1_3 **POINT:** 15 **COORDINATE:** x = 0.67 L = 7.24 m

---

LOADS:
Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c

gM = 1.25 f m,0,k = 24.00 MPa f t,0,k = 17.00 MPa f c,0,k = 21.50 MPa
f v,k = 3.50 MPa f t,90,k = 0.50 MPa f c,90,k = 2.50 MPa E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa G moyen = 650.00 MPa Service class: 1 Beta c = 0.10



SECTION PARAMETERS: GL24C 425x425

ht=425 mm
bf=425 mm Ay=120417 mm2 Az=120417 mm2 Ax=180625 mm2
tw=213 mm Iy=2718782552 mm4 Iz=2718782552 mm4 Ix=4586578153 mm4
tf=213 mm Wy=12794271 mm3 Wz=12794271 mm3

STRESSES
Sig_c,0,d = N/Ax = 617.69/180625 = 3.42 MPa
Sig_m,y,d = MY/Wy= 81.34/12794271 = 6.36 MPa

Tau z,d = 1.5*11.24/180625 = 0.09 MPa

ALLOWABLE STRESSES
f c,0,d = 15.48 MPa
f m,y,d = 17.89 MPa
f v,d = 2.52 MPa

Factors and additional parameters
kh = 1.04 kh_y = 1.04 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 10.84 m	Lambda Y = 88.35	LZ = 10.84 m	Lambda Z = 88.35
Lambda_rel Y = 1.37	ky = 1.49	Lambda_rel Z = 1.37	kz = 1.49
LFY = 10.84 m	kcy = 0.48	LFZ = 10.84 m	kcz = 0.48

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.42/(0.48*15.48) + 6.36/17.89 = 0.81 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.09/0.67)/2.52 = 0.06 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 54 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 36 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 4 Timber Column 1_4 **POINT:** 15 **COORDINATE:** x = 0.70 L = 8.28 m

---

LOADS:

Governing Load Case: 14 ULS_WIND1 (1+2+3)*1.00+5*1.50+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24C 425x425

ht=425 mm			
bf=425 mm	Ay=120417 mm2	Az=120417 mm2	Ax=180625 mm2
tw=213 mm	Iy=2718782552 mm4	Iz=2718782552 mm4	Ix=4586578153 mm4
tf=213 mm	Wy=12794271 mm3	Wz=12794271 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_c,0,d = N/Ax = 641.07/180625 = 3.55 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 64.22/12794271 = 5.02 MPa	f m,y,d = 17.89 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*7.76/180625 = 0.06 MPa	

Factors and additional parameters

kh = 1.04 kh_y = 1.04 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:

LY = 11.88 m
Lambda_rel Y = 1.50
LFY = 11.88 m

Lambda Y = 96.83
ky = 1.68
kcy = 0.41

About Z axis:

LZ = 11.88 m
Lambda_rel Z = 1.50
LFZ = 11.88 m

Lambda Z = 96.83
kz = 1.68
kcz = 0.41

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.55/(0.41*15.48) + 5.02/17.89 = 0.84 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (0.06/0.67)/2.52 = 0.04 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 59 mm Verified
Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 40 mm Verified
Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 5 Timber Column 1_5 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

---

LOADS:
Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES

Sig_c,0,d = N/Ax = 363.05/122500 = 2.96 MPa
Sig_m,y,d = MY/Wy= 79.66/7145833 = 11.15 MPa

Tau z,d = 1.5*-124.80/122500 = -1.53 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa
f m,y,d = 18.24 MPa
f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 2.96/(0.94*15.48) + 11.15/18.24 = 0.81 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.53/0.67)/2.52 = 0.91 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 6 Timber Column 1_6 **POINT:** 8 **COORDINATE:** x = 0.50 L = 2.79 m

---

LOADS:

Governing Load Case: 15 ULS_IMPOSED1 (1+2+3)*1.00+(4+5)*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 250x250

ht=250 mm			
bf=250 mm	Ay=41667 mm2	Az=41667 mm2	Ax=62500 mm2
tw=125 mm	Iy=325520833 mm4	Iz=325520833 mm4	Ix=549152687 mm4
tf=125 mm	Wy=2604167 mm3	Wz=2604167 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_t,0,d = N/Ax = -479.32/62500 = -7.67 MPa	f t,0,d = 13.36 MPa
Sig_m,y,d = MY/Wy= -0.66/2604167 = -0.26 MPa	f m,y,d = 18.86 MPa

---

Factors and additional parameters

kh = 1.09 kh_y = 1.09 kmod = 0.90 Ksys = 1.00

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

VERIFICATION FORMULAS:

Sig_t,0,d/f t,0,d + Sig_m,y,d/f m,y,d = 7.67/13.36 + 0.26/18.86 = 0.59 < 1.00 (6.17)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 28 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 19 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 7 Timber Column 1_7 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

LOADS:
Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_c,0,d = N/Ax = 1.45/122500 = 0.01 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 79.66/7145833 = 11.15 MPa	f m,y,d = 18.24 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*121.55/122500 = 1.49 MPa	

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

LY = 4.10 m	Lambda Y = 40.58	LZ = 4.10 m	Lambda Z = 40.58
Lambda_rel Y = 0.63	ky = 0.71	Lambda_rel Z = 0.63	kz = 0.71
LFY = 4.10 m	kcy = 0.95	LFZ = 4.10 m	kcz = 0.95

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.01/(0.95*15.48) + 11.15/18.24 = 0.61 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.49/0.67)/2.52 = 0.88 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 8 Timber Column 1_8 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

---

LOADS:

Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_c,0,d = N/Ax = 380.21/122500 = 3.10 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 82.33/7145833 = 11.52 MPa	f m,y,d = 18.24 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*-125.43/122500 = -1.54 MPa	

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.10/(0.94*15.48) + 11.52/18.24 = 0.84 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.54/0.67)/2.52 = 0.91 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 10 Timber Column 1_10 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

---

LOADS:

Governing Load Case: 11 ULS_SNOW1 (1+2+3)*1.00+4*1.50+5*0.30+6*0.60

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 300x300

ht=300 mm			
bf=300 mm	Ay=60000 mm2	Az=60000 mm2	Ax=90000 mm2
tw=150 mm	Iy=675000000 mm4	Iz=675000000 mm4	Ix=1138723011 mm4
tf=150 mm	Wy=4500000 mm3	Wz=4500000 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_t,0,d = N/Ax = -1.24/90000 = -0.01 MPa	f t,0,d = 13.12 MPa
Sig_m,y,d = MY/Wy= -59.35/4500000 = -13.19 MPa	f m,y,d = 18.52 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*-71.52/90000 = -1.19 MPa	

Factors and additional parameters

kh = 1.07 kh_y = 1.07 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis: About Z axis:

VERIFICATION FORMULAS:

Sig_t,0,d/f t,0,d + Sig_m,y,d/f m,y,d = 0.01/13.12 + 13.19/18.52 = 0.71 < 1.00 (6.17)

(Tau z,d/kcr)/f v,d = (1.19/0.67)/2.52 = 0.71 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 14 Timber Column 1_14 **POINT:** 15 **COORDINATE:** x = 1.00 L = 4.26 m

---

LOADS:

Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_c,0,d = N/Ax = 378.95/122500 = 3.09 MPa	f c,0,d = 15.48 MPa
Sig_m,y,d = MY/Wy= 86.26/7145833 = 12.07 MPa	f m,y,d = 18.24 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*-126.35/122500 = -1.55 MPa	

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.09/(0.94*15.48) + 12.07/18.24 = 0.87 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.55/0.67)/2.52 = 0.92 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 15 Timber Column 1_15 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

---

LOADS:

Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: **GL24c 350x350**

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES

Sig_c,0,d = N/Ax = 11.79/122500 = 0.10 MPa

Sig_m,y,d = MY/Wy= 86.26/7145833 = 12.07 MPa

Tau z,d = 1.5*107.21/122500 = 1.31 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 18.24 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:

Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 0.10/(0.94*15.48) + 12.07/18.24 = 0.67 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.31/0.67)/2.52 = 0.78 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*

ANALYSIS TYPE: Member Verification

CODE GROUP:

MEMBER: 16 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

LOADS:

Governing Load Case: 15 ULS_IMPOSED1 (1+2+3)*1.00+(4+5)*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: GL24c 350x350

ht=350 mm

bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES

Sig_c,0,d = N/Ax = 377.70/122500 = 3.08 MPa

Sig_m,y,d = MY/Wy= 81.71/7145833 = 11.43 MPa

Tau z,d = 1.5*125.28/122500 = 1.53 MPa

ALLOWABLE STRESSES

f c,0,d = 15.48 MPa

f m,y,d = 18.24 MPa

f v,d = 2.52 MPa

Factors and additional parameters

kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:

About Y axis:		About Z axis:	
LY = 4.26 m	Lambda Y = 42.16	LZ = 4.26 m	Lambda Z = 42.16
Lambda_rel Y = 0.65	ky = 0.73	Lambda_rel Z = 0.65	kz = 0.73
LFY = 4.26 m	kcy = 0.94	LFZ = 4.26 m	kcz = 0.94

VERIFICATION FORMULAS:
Sig_c,0,d/(kc,y*f c,0,d) + Sig_m,y,d/f m,y,d = 3.08/(0.94*15.48) + 11.43/18.24 = 0.84 < 1.00 (6.23)

(Tau z,d/kcr)/f v,d = (1.53/0.67)/2.52 = 0.91 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):
u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified
Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified
Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *EN 1995-1:2004/A2:2014*
ANALYSIS TYPE: Member Verification

CODE GROUP:
MEMBER: 19 Timber Column 1_19 **POINT:** **COORDINATE:** x = 0.00 L = 0.00 m

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LOADS:
Governing Load Case: 16 ULS_IMPOSED2 (1+2+3)*1.00+4*0.20+5*0.30+6*1.50

MATERIAL GL24c

gM = 1.25	f m,0,k = 24.00 MPa	f t,0,k = 17.00 MPa	f c,0,k = 21.50 MPa
f v,k = 3.50 MPa	f t,90,k = 0.50 MPa	f c,90,k = 2.50 MPa	E 0,moyen = 11000.00 MPa
E 0,05 = 9100.00 MPa	G moyen = 650.00 MPa	Service class: 1	Beta c = 0.10

SECTION PARAMETERS: **GL24c 350x350**

ht=350 mm			
bf=350 mm	Ay=81667 mm2	Az=81667 mm2	Ax=122500 mm2
tw=175 mm	Iy=1250520833 mm4	Iz=1250520833 mm4	Ix=2109624961 mm4
tf=175 mm	Wy=7145833 mm3	Wz=7145833 mm3	

STRESSES	**ALLOWABLE STRESSES**
Sig_t,0,d = N/Ax = -5.60/122500 = -0.05 MPa	f t,0,d = 12.92 MPa
Sig_m,y,d = MY/Wy= -82.33/7145833 = -11.52 MPa	f m,y,d = 18.24 MPa
	f v,d = 2.52 MPa
Tau z,d = 1.5*122.20/122500 = 1.50 MPa	

Factors and additional parameters
kh = 1.06 kh_y = 1.06 kmod = 0.90 Ksys = 1.00 kcr = 0.67

LATERAL BUCKLING PARAMETERS:

BUCKLING PARAMETERS:
About Y axis: About Z axis:

VERIFICATION FORMULAS:
Sig_t,0,d/f t,0,d + Sig_m,y,d/f m,y,d = 0.05/12.92 + 11.52/18.24 = 0.64 < 1.00 (6.17)

(Tau z,d/kcr)/f v,d = (1.50/0.67)/2.52 = 0.89 < 1.00 (6.13)

LIMIT DISPLACEMENTS

Deflections (LOCAL SYSTEM):

u fin,y = 0 mm < u fin,max,y = L/200.00 = 21 mm Verified

Governing load case: (1+0.6)*1 + (1+0*0.6)*5 + (0.6+0.5*0.6)*6 + (1+0.6)*2 + (1+0.6)*3 u inst,y = 0 mm < u inst,max,y = L/300.00 = 14 mm Verified

Governing load case: 1*1 + 1*5 + 0.6*6 + 1*2 + 1*3

Displacements (GLOBAL SYSTEM):

Section OK !!!