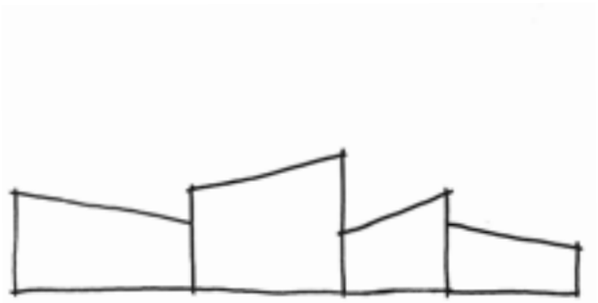
HERLEV CANCER CARING CENTRE



Master Thesis by

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ABSTRACT

English

Elaborating on the notion of Healing Architecture, this project comprises a cancer caring centre in Herlev. Situated in the Hospital Park, yet still in close relation to the Hospital, the centre exploits parameters of healing architecture and incorporates them through immense relation to the recreational character of the park, healing effects of daylight and sensible and tactile spatial qualities. The architectural profile of the centre resembles small wooden cabins in the woods that defy the conventional institutional character of other typologies associated with health care. The transition from hospital to nature is embedded in the design through the tectonics of the structural system to create a comfortable space for recovery to frame the wholesome relation between man and nature.

Dansk

Ved bearbejdning af begrebet Helende Arkitektur, består dette projekt af et kræftrådgivningscenter i Herlev. Beliggende i Hospitalsparken, men stadig i tæt relation til Herlev hospital, udnytter centret parametre for helende arkitektur og indarbejder dem gennem en relation til parkens rekreative karakter, helbredende virkninger af dagslys og taktile rumlige kvaliteter. Centrets arkitektoniske udtryk mimer små træhytter i skoven, der trodser den konventionelle og institutionelle karakter af typologier normalt forbundet med sundhedssektoren. Overgangen fra hospital til natur er indlejret i designet gennem det strukturelle systems tektonik til at skabe et behageligt rum til indramning og understregningen af relationen mellem menneske og natur.

Title: Herlev Cancer Caring Centre
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INTRO

One of the moments where life suddenly gets very serious is when you get cancer. No matter how the course of the illness evolves, it is inevitably the start of a new phase in one's life as well as for those close to you. Each year, nearly 33,000 Danes gets diagnosed with cancer (Cancer 2012). Therefore, it is important to have quality counselling facilities both for the patient and their relatives. Fighting and bringing down cancer diseases has been on the global agenda for a long time in terms of medicinal treatment, but the idea of architecture, specifically targeted to care for people with cancer, is a relatively new typology emerged from the United Kingdom. Lead by architectural theorist, Charles Jencks, and his late wife Maggie Jencks, the concept used in Maggie's centres have been carried out architecturally by prominent architects such as Rem Koolhaas, Zaha Hadid and Frank Gehry. This fact may partially take claim for the rising public interest.

On a national level, the Danish cancer organization, Kræftens Bekæmpelse and Realdania have to date completed six out of seven new cancer caring centres, called Livsrum. These are associated with the current larger hospitals and more will be added to the architectural portfolio once the new super hospitals will commence building process (Livsrum 2015). The programme and placement of these are intended to help as many cancer patients and their families as possible. This is where the architectural aspects play an essential and important role. Through the architectural vocabulary, Livsrum seek to create centres that invite you inside and give space for life. The recurrent themes are security, homely atmosphere, equity, openness and presence; a place where you can drop in at any time. This new breed of Danish cancer caring centers comprises natural meeting places for people affected by cancer with a variety of offers and activities developed in dialogue with the users. The activities and life in the open social space can positively influence the quality of the counselling. Some people find it easier to talk about serious things in a non-serious frame that allows joy, sorrow and despair at the same time.

Still, one centre – the one associated with Herlev Hospital – has yet to be initiated; the hospital and its oncology department need a cancer caring centre. It is estimated that the architectural competition starts during 2015, but the site and size has not yet been determined. This project takes its point of departure in designing a new cancer caring centre in Herlev and creating the physical structure for offering the practical, emotional and social support that people with cancer need. Ideally, it is about creating a place for support and presence and creating architecture that mediates the universal and the individual need. The type of project chosen, allows for thorough investigations to create a sensible architecture to strengthen both the function of the cancer centre and its users.

Ill. 02 - Map of cancer counsellings in Denmark

ACKNOWLEDGEMENTS

This project is partially based on information and insight retrieved on visits to the already existing cancer centres placed all over the country. Because of that, we would like to show our gratitude to all the executives and volunteers who opened up their doors to us to share their insight of the daily life at each of the newest centres. Their enthusiasm and hospitality are greatly appreciated.

We thank Claus Hoffmann from Søren Jensen Rådgivende Ingeniørfirma A/S who were kind to brief us about the processes concerning the architectural competitions, including knowledge of the functional neccessities of a cancer centre.

Finally, we would also like to thank associate professors, Claus Kristensen and Christian Frier, whom have showed great commitment to guide and further the development as supervisors of the project.

Ill. 03

MOTIVATION

The concern given to health care institutions and the planning of the health care sector, on a local as well as global level, has always been an intense point on societal agendas. Along with the increasing demand for sustainable aspects, the architectural trade will surely face challenges and the demands for architectural quality will increase as a result hereof.

The choice of subject, a cancer caring centre, derives from a genuine interest in healing architecture. This theme is as intriguing as it is challenging, and has the potential to illustrate the influence and importance of architecture. In this, we find an interaction between our physical surroundings and our general wellbeing and recovery – to create the basis of a good life is one of the most important trades in the field of architecture. Given our architectural standpoint, and the legacy that we carry from our educational background, we believe that the holistic approach and the interdisciplinary work between the architectural and engineering trades can provide the quality that is duly sought for.

By using healing architecture as an ideological approach, it is intended to clarify and demonstrate the architectural effects to create a space for recovery. Dealing with concepts of healing architecture naturally poses the resemblance between the architectural profession and the medical one. The medical profession conventionally practices a very physical treatment that is quite easy to take measure of, whereas the architectural profession renders results that are somewhat difficult to account for. Both occupations have the task and opportunity to aid those in need of a better future, which is a very relevant point in this matter. Both occupations project their experience and ability on what to come, to make a better world. This is where we see a clear role of the architect – and the kind of architects we want to be: architects who *care*. This ethic notion of caring is deemed to be applicable in all of the works of the architect; creating a comfortable place to live, a good place to study or an effective space to work. In all regards, architecture should reflect the skillfully cared for space, to frame and stage the good life. Upon this reflection, there is no better way of engaging the qualities of architecture, than that of which concerns our health and well-being, simply because it is the utmost important basis of the good life.

The project assumes a scale that should be dealt with by cross-disciplinary analysis and methodology; in other words, the character of the project invites us as students of architecture to explore the multifaceted palette of the trade with the focal points being spatial qualities, tectonics, details and daylight. Designing a building for the healthcare sector naturally focuses on the human being, which demands a special attention on the social aspects. This we see as an important factor in terms of creating a space for health and recovery. In a tectonic regard, it is then an interesting point to investigate how the structural principles and the basics of architecture can shape such place. The primitive idea of archetypical elements of walls, floor and ceiling were set to shelter from the weather to create a place to be. In the same way, persons with an ailment need the protective sheltering as well in order to recover. Needless to say, the objective is to clarify how a holistic tectonic approach can engage this particular quality.

We approach this problem with the hypothesis that health is not solely concerned with medicinal and technical treatment, but must be aided by the physical space in which we live. Architecture can gesture to us and through the physical framework, measurable and immeasurable, affect our emotions – and in the course of illness maybe even lighten our spirits, inspire hope?

Ill. 04 Herlev Hospital Ward Tower

METHODOLOGY

The process of this project follows the non-linear, constantly optimizing the different aspects, to ultimately ensure a final product with high quality. In terms of organizing the different phases of the project, ensuring validity and quality the Integrated Design Process as defined by Mary-Ann Knudstrup constitutes the fundamental approach.

As part of this design process, different aspects such as construction, function and aesthetics are considered into the design. The theory behind the method consists of five phases; Problem/idea, analysis, sketching, synthesis and presentation where these phases are processed in parallel and reviewed in relation to the previous phases to optimize the design to let the integrated design process emerge as a consequence hereof (Knudstrup 2004).

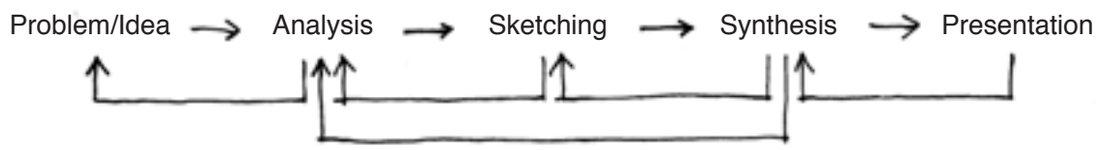
Phase 1: Problem/idea
The first phase is where the project is initiated and the problem or idea is defined in order to get a grasp of what kind of subject and theme the project subordinates to.

Phase 2: Analysis
In this phase the task will be studied in terms of the site through cartographical, hermeneutical and phenomenological investigations. The building functions, theories and various studies are carried out to further the understanding of the project realm. The architectural vision is consequently derived as a product of the knowledge collected.

Phase 3: Sketching
With the vision in mind this phase takes its point of departure in the two previous phases and many iterations are tested to see if they correspond to the analysis. All this creates the basis for a building concept, which is to be developed in the synthesis phase.

Phase 4: Synthesis
This phase facilitates and incorporates the many design parameters in a product to be further developed. The architectural design is specified through a synthesis of form, functionality, construction and climate; all of which is considered in terms of previously findings.

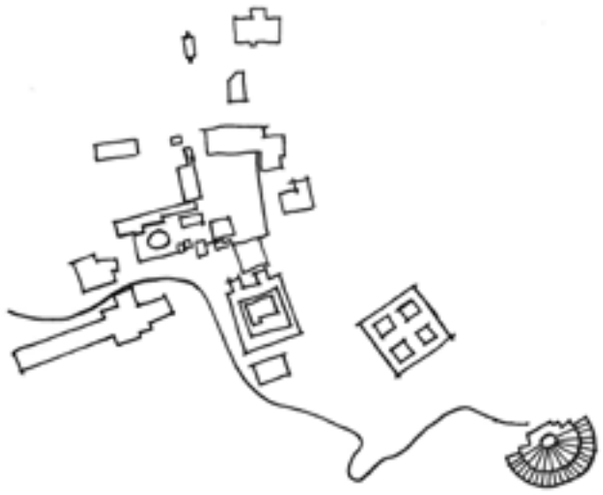
Phase 5: Presentation
During this phase, the building design is presented in various drawings and visualisations, supported by communicative text and diagrams. (Knudstrup 2004)



Ill. 05 - The Integrated Design Process

THEORETICAL BASIS

This chapter serves to illustrate the subject in a broader perspective to have an overview of what type of theme the project submits to. Relevant literature and cases have been selected as primary basis of knowledge, to ultimately inform the design process.



Ill. 06 - Epidaurus, Greece

Ill. 07 - Courtyard of Ospedale degli Innocenti, Brunelleschi

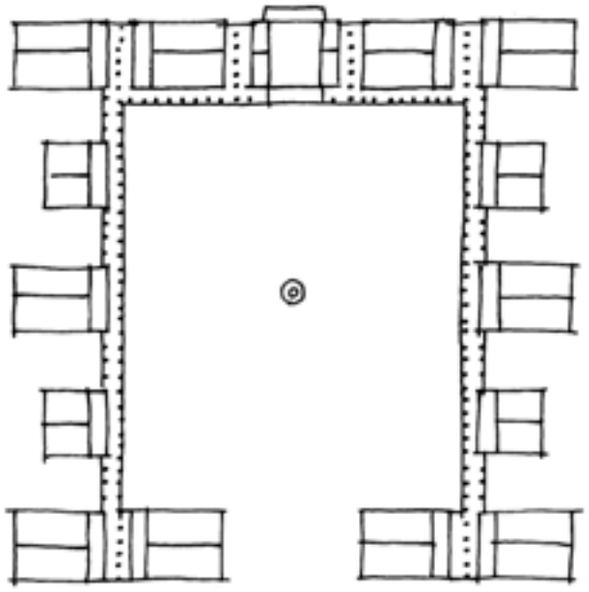
HEALTH CARE ARCHITECTURE

To understand the architectural values in present health care building environment, this paragraph aims to clarify the development of especially hospital architecture through time by pinpointed exemplifications. The health care sector, and hospitals generally familiarized with this term, changes its agenda in regards to the important tasks and issues of society of the given time. That architecture reflects this agenda is like other professional disciplines no different. The status of hospitals, however, remains to this day a symbolic monument and a solid reference point in the heart of cities.

One of the earliest examples of health care, Epidaurus in Greece, assumed a holistic approach to health encompassing health clinics, temples, sports facilities and theatres (Jencks 2015). The layout of different programmes in the city centre reflects a belief that the recuperation was not only medicinal as it was cultural, spiritual and topographical. It was regarded as the optimal solution when things were in balance, in medicine as well as in architecture. Even the great amphitheatre, situated in the middle of a dramatic landscape, was an indicator of your being in the world where comedies and tragedies were acted out – a place where you could take your pain to nature and see yourself within the larger landscape (Jencks 2015).

The renaissance period described the hospital as central to civic life. It had during this period transformed from a rather simple instrument for the poor and the pilgrims in need of rest, to a departmentalized and strictly medical institution (Jencks 2015). By this reform the city was able to use the hospital, at street level, to separate itself from disease, which overflowed Europe during the sixteenth century. The hospital layout assumed the cruciform plan, centred around a chapel, or courtyard, and with an arcaded façade to provide a buffer zone between the privacy of the hospital space and the public life. As an example hereof is the Ospedale degli Innocenti, Florence, which embeds these architectural features to create a place for recovering mentally and physically. It incorporated small courtyards so every room had daylight and fresh air. The rooms were large and with high ceiling so they felt comfortable to be in. However, hospitals of the time were often influenced by the church, thus more concerned with salvation of the soul than secondarily healing them (Jencks 2015).

During the Enlightenment the hospitals became rationalist projects; architecture powered by science and objectivity. The hospitals had to this point been monopolized by religion, but the revolution made way for rationalist ways and scientific thought (Jencks 2015). The general layout of the rationalist hospitals were carried out as freestanding pavilions arranged around a central plaza and connected via covered arcade walkways. This emphasized ventilation and enabled different diseases, to be tended to seperate wings. Royal Naval Hospital in Plymouth, England, resembles the idea of detached ward pavilions mainly to avoid infection as they were easy to ventilate. The hospital was arranged in a u-shaped plan and connected by an arcaded walkway to shelter employees



Ill. 08 - Detached Pavilions of Royal Naval Hospital, William Robinson

Ill. 09 - Paimio Sanatorium , Alvar Aalto

from bad weather as they walked from ward to ward. Although hospitals of the time were primarily detached from cities, the industrial revolution saw population rising in the city to eventually erasing the distance between them. Hospitals were infested by city filth and their presence made civic life aware of decay and death, which made way for rethinking the image of the hospital. The Enlightenment gave rise to the firm belief that the built environment was far more effective to public health than the medical profession (Jencks 2015)

The modernist paradigm gave rise to a hospital image, which included hygienic, cleanliness and well-being, with aesthetics comprising openness, bright natural light and the health associated with outdoor living. Along with the increasing complexity of technical devices and functional needs, the architecture of the modern era hospital diverted to a machine like architecture more than the monument it was experienced as before (Jencks 2015). One of the most well-reputed examples of the modernist hospitals is Alvar Aalto's Paimio Sanatorium from 1929. Aalto's thoughts on the aspects of healing are expressed in a branched floor plan on the sloping Finnish hillside to get in as much sunlight and views towards the large surroundings of pine forrest areas. The healing process is dealt with in the close contact to nature. With very little medical evidens to facilitate, it was very much Aalto's intuition of health boosted by contact to nature that was the driving of the design. The ideals of this way of thinking are still applicable in today's hospital design (DAC 2014).

Today, there is an increased demand for a holistically designed environment in the health care sector. The built environment is not only to meet functional, technical and hygienic requirements, but argues that the spatial surroundings of the patients play an equally important role in terms of healing processes. The way forward is to avoid the institutional character of the large complexes, as seen in conventional hospitals (Nickl-Weller 2013).

HEALING ARCHITECTURE

This paragraph serves to exemplify which parameters are important to incorporate into the process of creating a space for healing. The overview is based on the book 'Helende Arkitektur' made at Aalborg University and serves to state the different parameters in play. The book is a gathering of material of different researches and is methodologically refered to as evidentially based design. Though generally meant as a design tool for hospitals, the knowledge retrieved is thought applicable to other built environments holding health care as a central theme. The following extracted parameters are found suitable for the design process of the cancer caring center.

Light
Light has through recent centuries been known to have a positive effect on human beings both physically and mentally. Implementation of daylight at high intensity is important in the initial design strategies of the physical spaces to optimize the spatial and visual comfort. Spaces with small or poorly placed windows, or windows facing walls, are considered to have the same effect as one with no windows at all. The attributes of daylight and sunlight evidently reduces the level of experienced stress, is antidepressant and reduces the need for painkillers (Frandsen et al. 2009). Daylight also improves the orientation of the individuals, as it is a strong indicator of time and place. As a consequence hereof, the circadian rhythm is steadied.

Art
Studies show, that art, in the manner of visual, audial or tactile, can increase both pain threshold and have a calming effect. The physological effect of art additionally seem to provide a possitive stimulation of senses, as well as a mental distraction of the problems patients are facing. It is important, in achieving the optimal effect, to incorporate art in the early stages of architectural planning.

Sound
Just like art, incorporating acoustic considerations in the early stages is advantageous. Especially the reverberation time and sound level (decibel), or lack of noise, are important parameters to improve sense of privacy, reduce stress levels and even improve sleep. It is thus a question of the experienced sound quality, which may differ depending on the use of the room, whether it is for confidential talks or social participation (Frandsen et al. 2009).

Air
The air experienced concerns any given atmosphere. It can be sensed by temperature and by smell and affects our comfort and well-being. Wrong temperatures and unpleasant smells influence patients negatively while fresh air works de-stressing. Ventilation strategies, mechanical or natural, should be implemented early in design process.

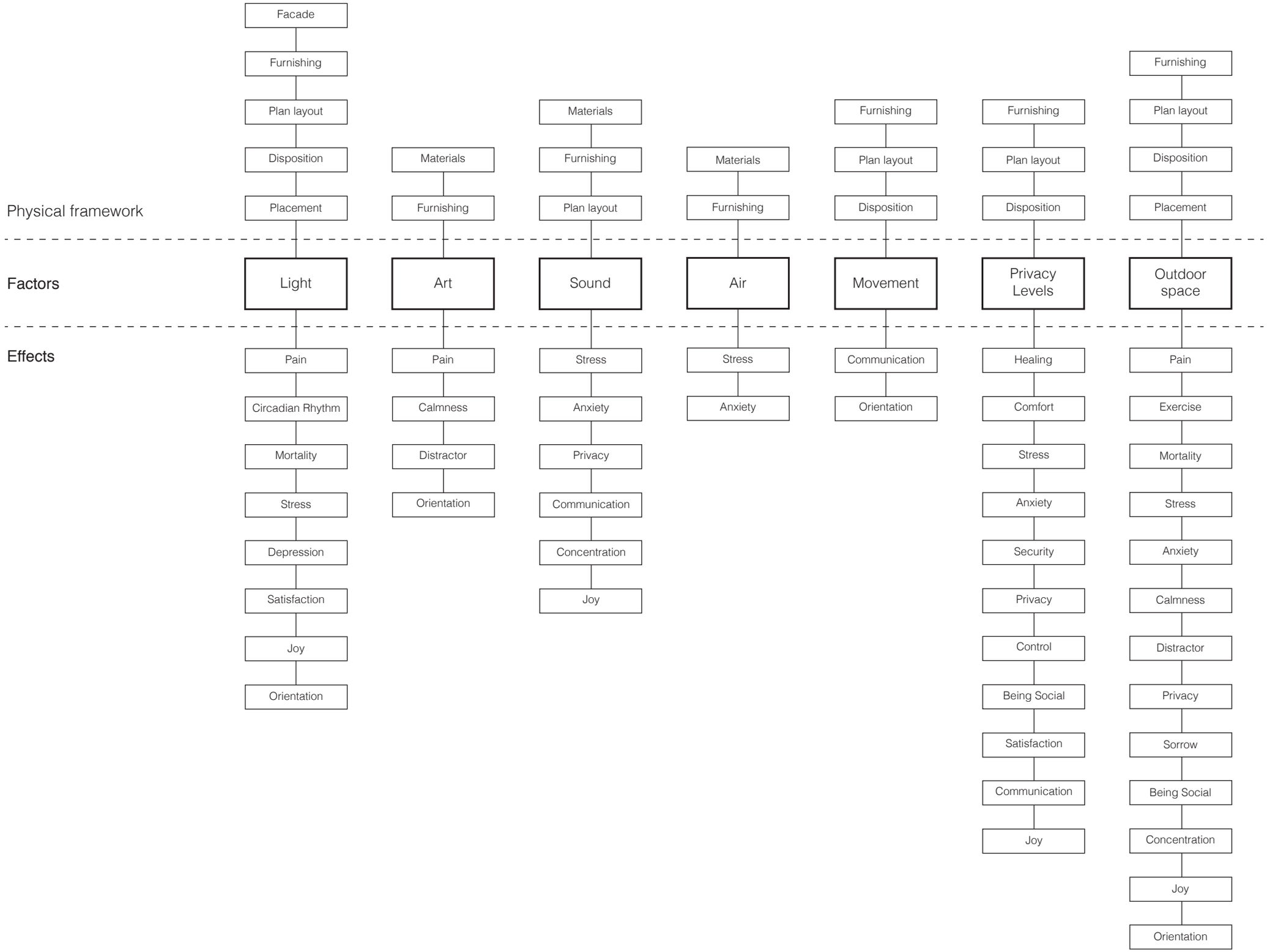
Movement
A clear building layout can help avoid stress among patients. Buildings that emphasize parallel or orthogonal lines are more likely to have a sensible and clear layout that simplifies movement. Clarity of spatial order ensures easy and efficient navigation for the user and prevents the necessity of using signs. The architectural concept can organize movement and differentiated experiences of the spatial qualities. It is important that all areas of the architecture, both indoor and outdoor areas, are experienced as a unified structure to retain clarity.

Privacy levels
Studies show the importance of designing a physical structure that emphasizes different levels of privacy and confidentiality. Patients tend to prefer private spaces when it comes to confidential conversation with staff, or simply, a place to be by yourself to collect your thoughts. This makes the patient participate more strenuously in the therapy.

The concept of socially oriented spaces considers human interaction between patients as well as interaction between staff and patients. Different types of encounters demands architecture to provide the basis for different physical environments. The placement of activities and functions can play an active part in i.e. raising the level of social activity. Thus, placing the kitchen as a central connection between more private features can benefit the social character and endorse informal meetings between users (Jencks 2015). The interaction between users going through similar tough phases has a healing effect in reducing the likes of anxiety, fear and nervousness.

Exterior spaces
Being able to stay in green vegetated areas or being visually connected to such space is evidently increasing the well being. Research shows that a view towards a green space with trees, bushes and flowers are highly preferred. Sub-complimenting these features we find other sorts of sensual stimuli such as smells, sun, shadow and even animal life. Similar to daylight qualities, configurations with small or poorly placed windows are considered to have the same effect as rooms with no windows. The most important aspects of a garden space are to serve as a social place, as well as a place to withdraw in privacy (Frandsen et al. 2009).

Evidently these parameters and healing spaces in general, concerns all of the human senses. The space for recovery offers a variety of stimuli for the eyes, the skin and the ears, which makes the concept difficult in terms of appealing to all types of people; sick and healthy, male and female, old and young. It remains an aspect that depends on our social background, previous experiences and spirit of character.



Ill. 10 - A diagrammatic overview of presented parameters showing the interrelation between the architectural framework and the physiological effects.

THE THIRD PLACE

Living with cancer often results in the feeling of being secluded from the informal social communities, such as at work or at the sportsclub. Regarding the architectural character of a cancer care centre, this paragraph seeks to determine what kind of atmosphere this particular typology should imply in order to benefit the users. The urban sociologist, Ray Oldenburg, elaborates on what makes a good social scenario for that which is not home and not work, hence *the third place*. These theories are compared to ideas behind British frontrunners of cancer caring centres to elaborate the understanding of the qualities associated with them.

Maggie's Cancer Caring Centres, originating from the United Kingdom, was invented by architect Charles Jencks and his cancer-stricken wife Maggie Jencks in 1996. Charles Jencks described the first centre as a new kind of institution, that is a hybrid between different conventional typologies. Maggie's Centres is located close to the hospital cancer sections and are clearly distinguishable from the hospital architecture with their own strong architectural identity. Though centres are mainly scattered over the UK, Maggie's are also located in Hong Kong and even more are internationally based centres are planned (Jencks 2015).

"Each centre is like a house that is not a home, an existentialist church that is non-demonational, a hospital that is a non-institution and a place of art that is a non-museum" (Jencks 2015; p.7).

As already suggested, Maggie's centres interpret the relaxing and casual mood of the home in their designs. It is important to make users feel safe and that nothing is expected of them. The third place, however, as introduced by Oldenburg, is not initially meant for recovering the physically ill or exhausted - to do that the home or the hospital is required. Although, in terms of regenerating the spirit and the social well-being, the third place has great potential (Oldenburg 1989). The third place, the place inbetween home and workplace, has in this regard an important role to play in terms of healing and is conventionally places like cafés, bookstores and other hangouts at the heart of communities. They tend to serve the people with an open-minded environment that offers social equality.

A characteristic concept adopted by Maggie's is the idea of "kitchenism" which defines the central role and location of the kitchen in the centres. The kitchen table, which is situated near the entrance, is used for informal meetings with patients so they interact more freely and feel more like at home (Jencks 2015). Also here is implied a relaxed and open-minded environment that invites for different people to take part in the small community. In the third place, the main activity is conversation between indivisuals, as suggested by Oldenburg (Oldenburg 1989). The activity in the kitchen promotes casual conversation which must be considered in architecture.

"The mixture of different functions make the centres very efficient in terms of treatment and counselling because they enhance the feeling of being socially united; patients and fundraisers, carers and those who drop in for tea, staff and doctors" (Jencks 2015; p.28).

The spaces must have the quality that individuals can come and go, where none are appointed to be the host. Consequently, the atmosphere enjoyed in a third place is *warmth*; warmth that emerges from the mutual concern and support that is present. It, as Oldenburg suggests, enhances the sense of being alive (Oldenburg 1989). As in the case of Maggie's centres it is the feeling of community, of belonging, that positively affects the individual.

As to the physical structure of a third place, they often assume low profile. They are not advanced structures but often plain and simple in their expression. This plainness itself carries a protective character often familiarized in the general home. The objective of the physical structure is not to impress but build for the pure reason of adressing the ones in need of place to enjoy good company (Oldenburg 1989). The architectural appearance of Maggie's, however tend to depict a more iconic character; an iconic yet sensible and friendly architecture.

The ideas behind the third place shares a lot of similarities with the atmosphere and architecture associated with Maggie's Cancer Caring Centres. This concept involves warmth in atmosphere, social activity, and sense of belonging to a community. The home-like and relaxed physical nature of the spaces are important in order to develop these qualities.

> *It is like a house which is not a home,*
> *a collective hospital which is not an institution,*
> *a church which is not religious,*
> *and an art gallery which is not a museum.*
>
> - Charles Jencks
> (Jencks 2015; p. 28)

Ill. 11 - Maggie's Cancer Caring Centre West London, RSH+P

Ill. 12 - Maggie's Cancer Caring Centre Dundee, Frank Gehry

Ill. 13- Maggie's Cancer Caring Centre Glasgow, OMA (Rem Koolhass)

NORDIC ARCHITECTURE

To fully understand the qualities of architectural identity, Nordic architecture in a regional context needs to be clarified. Nordic architecture has traditionally been acclaimed natural and authentic, and the tendency of contemporary Nordic architecture is still rooted firmly to the site-specific. The climate and topographical specificity of a place is what constitutes the Nordic way of architectural design and where one senses the authentic. The architectural theorist Christian Norberg-Schultz introduced a phenomenological discussion of the Nordic cultural domain in Nightlands published in 1997; he describes the Nordic through images of the northern region and its environment, the natural roots and given conditions, methodology and traditions.

Genus Loci

The place of the built retains an immense role of the Nordic architectural tradition. Architecture rooted in this particular region emerges from an intense reading of the local possibilities and a significant relation to the soil. This can be associated to the ancient expression of architecture that integrates well, “Genus Loci” which basically means “spirit of the place”, which comprises the atmosphere of a given site (Ibler 2014). It is important for the architecture that it becomes part of the great nature, so it will be part of the scenography you are fascinated by. That is to say, Nordic buildings do not stand as a foreign element in nature, but they open up to the surroundings and at the same time incorporate it (Norberg-Schultz 1997).

Tradition

One could argue that the Nordic has been isolated from the style of Southern European architecture because the Nordic region is physically isolated from the rest of Europe with exception of Denmark, which is connected to Germany. From the Norwegian stave churches, the construction and materials meant much in Nordic architecture and the user is a contributor rather than an observer (Norberg-Schultz 1997). Today in the globalized world, Nordic architecture is still produced with high awareness of quality and respect for the traditions. In addition to this, there is a tendency for the architect to reinvent and reuse the traditional and, consequently, create a new original architecture still firmly rooted in the Nordic tradition (Ibler 2014).

Light, shadow and environment

Light is a large part of the Nordic weather because of the dark winters and bright summers and is thus a significant element of Nordic architecture, where architects work actively and artistically with the Nordic light (Ibler 2014). The beautiful bright northern light can create a mood and as Louis Kahn describes it, the light defines an object’s visual character rather than creating it (Norberg-Schultz 1997). As already stated, weather plays a unique role as one of the main parameters of architecture. Basically, the architecture should primarily screen the weather, but even if there is bright sunlight or solid storm, the architecture should always be determined by the environments of the given place (Norberg-Schultz 1997). As implied here, the Nordic atmosphere can change instantly according to the weather, and consequently, the perception of space can change with it.

Materials and form

Nordic architecture is considered as natural and authentic, which unfolds in an honest construction carried out in natural materials. The materials themselves, ornamentation and the form are generally not ostentatious, in the sense that they blend into the surroundings. The construction can be enhanced by the surroundings to give the right atmosphere (Norberg-Schultz 1997). Examples of green roofs, and facades that age gracefully during the course of time, mediates a Nordic architecture to resemble how a given time and place can work strongly together while simultaneously communicating the construction rooted in tradition (Ibler 2014).

Ill. 14 - Summer House Inside Out, Reiulf Ramstad

Ill. 15 - Juvet Landskap Hotel, Jensen & Skodvin

Ill. 16 - Kindergarten in Sweden, Dorte Mandrup Arkitekter

> *The simplicity of design and content.*
> *The strong adaption to the surroundings.*
> *The social and functionally*
> *well-anchored architecture.*

- Marianne Ibler
(Ibler 2014; p. 6)

TECTONICS

Ill. 17 - Diagram of perception of tectonics

By definition, the concept of healing architecture is deeply rooted in the wellbeing of humans. Considering the analytical framework previously acquired, the architecture should assume a role that affects not only physical aspects but also mental, to create a space for recovery. The notion of tectonics suggests an approach to the architectural profession that is balancing a variety of disciplines to pursue the holistic. It is a mean of grasping architecture to gesture or affect us in immeasurable fashion.

"Construction is the art of making a meaningful whole out of many parts. Buildings are witnesses to the human ability to construct concrete things. I believe that the real core of all architectural work lies in the act of construction." (Zumpthor 2010; p.11)

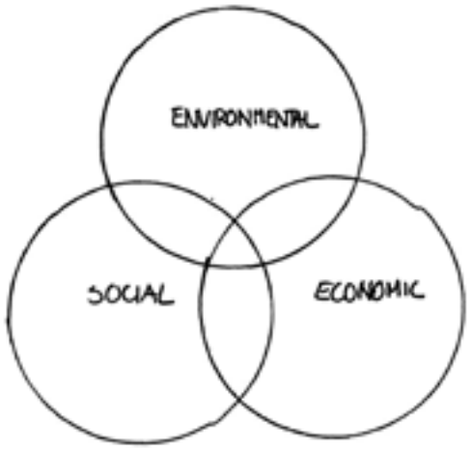
The word, tectonic, in its etymological meaning, derives from the Greek word tekton, meaning carpenter or craftsman; a notion of physicality. Only in the 5th century BC did the term assume a more generic understanding of making, which suggests a categorization of the term, as something aesthetic rather than technological (Frampton 1995). The role and notion of the tekton naturally associates with the master builder, or architecton, whose role it was to master the art of joining elements skillfully, as Adolf Heinrich Borbein would later come to suggest. The understanding of tectonics as the art of joining encompasses the term's initial specificity and concerns parts in its broadest sense non-determined by scale. Leon Battista Alberti suggests that architecture is the art of selecting the appropriate parts and skillfully joining them to the unity of which they belong (Frascari, 1984).

"Every touching experience of architecture is multi-sensory; qualities of space, matter and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton and muscle." (Pallasmaa 2012; p.45)

As implied, all senses are used for taking measure of space. Exploring the notion of tectonics there is a potential of being moved and touched by architecture beyond practicality and physicality. Structuring and joining parts in a functional and aesthetic manner lets architecture mediate a narrative. The principle and structural assemblage of parts to a whole can then bridge the gap between what is concrete and what is abstract. From a healing perspective, this narrative is important in order to gesture a place for well being, whether it mediates shelter, social openness or the homeliness as symbol of security.

The fore mentioned theoretical works of Alberti take departure in architecture's goal of achieving beauty. This is still applicable to every architectural product, but must, in any case be understood in its broadest sense. It is not merely visual beauty but a coming together of elements to form architectural beauty as a whole, both functionally, technically and aesthetically (Frascari 1984).

Concluding on this subject, tectonics is when the structure becomes an aesthetic element and the unification of these. It is when the construction mediates the poetic of the building and when the shape and the assembly of form elements turn into a whole. The artistic part must tell the structural part and vice versa. The expressive potentials in the structure must be used to tell the story of the building. Details as well can tell the story of the building and when the structural detail is an essential part of the architectural whole, tectonic quality is achieved.



Ill. 18 - The Rio Declaration's definition of sustainability.

Ill. 19 - Pyramid structure of sustainable strategies.

SUSTAINABILITY

Following the Rio Declaration's definition of sustainability from 1992, the theme can be divided into environmental, social and economic subcategories. When these three categories are represented and focus is equally handled, a holistic sustainable design occurs (Green Building Council Denmark 2014).

Environmental sustainability operates with energy efficiency, resource consumption, use of renewable resources and the ability to minimize the environmental and climatic influences. Economic sustainability deals with the buildings value optimization of operating costs. Social sustainability includes added value to the user of the building, such as well-being, better indoor thermal quality, increased flexibility, availability and security (Green Building Council Denmark 2014).

With these aspects applied in the phase of design, a building can be sustainable and moreover, it is possible to certify whether a building achieves to be sustainable. With the DGNB certification system it is possible to compare different buildings from their sustainable qualities. The building's rating is based on points earned in 40 criteria and 213 sub-criteria. Environmental, economic, social and technique are weighted 22.5% each, while the process is weighted by 10%. Buildings are certified by gold, silver or bronze (Green Building Council Denmark 2014).

Elaborating on the social qualities of a building, it comprises an efficient and productive working environment. This is mainly achieved by incorporating architectural qualities like a healthy indoor climate, a sense of security or privacy, integration of art and quality outdoor spaces. These architectural subthemes of social sustainability are very much coherent to the parameters of healing architecture as described previously. The social aspects also exceed the scale of the building to that of its connection to the city. It is thus a quality to implement the public life in terms of connectivity, identity and accessibility. Implementing these factors can help improve user satisfaction and make the building durable from a user's perspective.

In terms of general environmental sustainability, the different energy levels must comply with the 2015 standards, which requires that the energy consumption must not be higher than (41 + 1000/Area) kWh/m^2/year (for other buildings than housing, dormitories, hotels, etc.). In 2020, the energy consumption must be below 25 kWh/m^2/year and in 2025, energy consumption must be 0 kWh/m^2/year (Lehrskov 2012).

To achieve an energy consumption below the required, one must *reduce* with inetelligent building design, *optimize* with technical features and *produce* with renewable energy (Kongebro 2012). According to "Design med viden" published by Henning Larsen Architecture between 40 and 50 per cent of the energy consumption of a building is dictated by shape, positions of windows and construction (Kongebro 2012). Therefore, it is important to incorporate aspects of sustainability into the design from the beginning and include passive properties in the building layout.

First and foremost, orientation of the building and landscape context has to be considered. Are there objects that shades and how is the climate? The compression of the building and geometry also has great influence on the energy consumption, but is also one of architecture's most important means for giving the building character. Another important aspect is the facades and the orientation of windows, where parameters such as building envelope and sun protection must be considered. Daylight must be optimized both for the quality of it, but also enabling a reduction of artificial light (Lehrskov 2012). Emphasizing heavy materials in the interior can also bring down the consumption as bricks, concrete or tile, can store heat to function as thermal mass that can be integrated into the design together with strategies for natural ventilation (Lehrskov 2012).

CASE STUDY: LIVSRUM

When the architectural competition for Livsrum in Herlev is issued the competition program is supposed to be revised according to the experience of the existing cancer centres. During visits at the six cancer centres empiric data has been collected and different architectural qualities have been experienced phenomenologically. The following is a brief statement on the acquired observations.

Livsrum Næstved, Effekt
The centre is broken down into seven volumes with entrance in the middle of the building leading into the common space. There is circulation with long corridors around two courtyards that are used for outdoor activities, as there are no outdoor areas around the building, because of the adjacent roads. This context also means, that the rooms facing the roads have a lack of privacy. The offices are arranged around a common staff room which is visually connected through courtyards, thus the whole building can be overviewed.

Livsrum Roskilde, Adept
This centre is located in a residential neighbourhood and is broken down into three volumes to scale down the building. The entrance is located in the corner between two volumes, which leads directly into the common space where one is distributed out to the other functions that has different room heights. The administration is facing the road in two levels thus the arriving guests can be observed. Private functions are located away from the road towards the private outdoor spaces, which has the character of a villa garden.

Livsrum Odense, Wienberg Architects
The building is a faceted volume with an inviting entrance between two bulges of the volume. One enters the hall where the common space is located further inside the building. Both the exterior and interior consists mainly of concrete and wood implemented in horizontal bands. The common space distributes flow to the rest of the building using only few hallway square metres. The outdoor area towards south is closely connected to the common space providing a fluid transition between the two.

Ill. 20 - Livsrum Næstved, courtyard

Ill. 21 - Livsrum Næstved, staff area

Ill. 22 - Livsrum Roskilde, exterior

Ill. 23 - Livsrum Roskilde, common space

Ill. 24 - Livsrum Odense, entrance

Ill. 25 - Livsrum Odense, common space

Ill. 26 - Livsrum Vejle, lounge and view to nature

Ill. 27 - Livsrum Vejle, double high common space

Ill. 28 - Livsrum Herning, exterior

Ill. 29 - Livsrum Herning, mezzanine and common space

Ill. 30 - Livsrum Aalborg, exterior

Ill. 31 - Livsrum Aalborg, common space

Livsrum Vejle, Arcgency
Vejle Livsrum consist of four volumes arranged in a row, which works as a slab with the entrance in the middle. Here one have the option to go right or left. The flow is on a string that goes from one end to the other where the common space is like a cul de sac. The functions of the building are situated on several levels and there are voids between the single high spaces that create double high spaces. The building itself is located away from the road, so that private functions have privacy with views toward the sloping forrest. The outdoor areas are rather reduced, but this is compensated with a roof terrace with a view of Vejle.

Livsrum Herning, Claus Pryds
This centre stands out from the others because it is an extension and a renovation of an existing old villa. The centre consists of several small volumes all alligned in a slab formation, which has the entrance in the middle. The architect has worked with various levels with half and quarter floor shifts, which gives many different spaces, such as a balcony next to the double high kitchen area. The flow is vertical and provides a pathway up through the building. The private functions on ground floor are located towards a backyard and those on the first floor are privately raised from the road and the surroundings. There are many niches that can be used for informal conversations. The administration is also on different levels, but the split levels binds them together.

Livsrum Aalborg, Polyform
The building consists of five mono-pitched volumes of recycled brick with a roof structure that span the gap between them. The entrance is between two of these volumes. One enters a large common space, with many different functions. The heart is located further in the centre and from here, other functions can be reached. The building is located in a residential neighbourhood and the tile mimics the surrounding materiality. Roads encircle the centre, and as a consequence hereof, private functions are oriented towards the roads. However, the small windows ensure the desired privacy, they also reduce views.

SITE

The following chapter takes point of departure in exploring the characteristics and potentials of the site in Herlev. The methodology applied is a combination of gathering empiric data and phenomenological observations to get an understanding of the place in question.

SITE LOCATION

Herlev Hospital and Gentofte Hospital merged on January 1st 2015. The merged hospital is one of Region Hovedstaden's four acute hospitals serving 425,000 citizens in Ballerup, Gladsaxe, Herlev, Egedal, Rødovre, Fureso, Gentofte, Lyngby-Taarbæk and Rudersdal municipalities (Herlev Hospital 1 2015). Herlev Hospital, designed by Gehrdt Busch, Max Brüel and Jørgen Selchau in 1976 (Herlev Hospital 2 2015) is the last major hospital in Denmark, which has not yet been allocated a cancer caring centre.

The site is located inbetween Herlev Hospital, The Hospital Park and a residential neighbourhood. It is thus surrounded by vegetated areas, residential and urban context. The site is located relatively far from the oncology section, but still in close relation to the hospital itself. Following the architectural competition of the extension of Herlev Hospital, won by Henning Larsen Architects, Friis & Moltke and SLA, the hospital and the area related to it, is part of a restructuring of the city. This project takes its point of departure in the expansion of the hospital and the future development of the hospital area as accounted for in the local plan issued in 2012.

As aforementioned, the site for the competition project is yet not decided, therefore this site is chosen based on the idea of getting the beautiful and idyllic nature to interact with the architecture in continuation of the future master plans and current local plan. In relation to the connectedness to the hospital, this is assumed as a quality site because it is located closely, but still a hiding place from the large complex hospital.

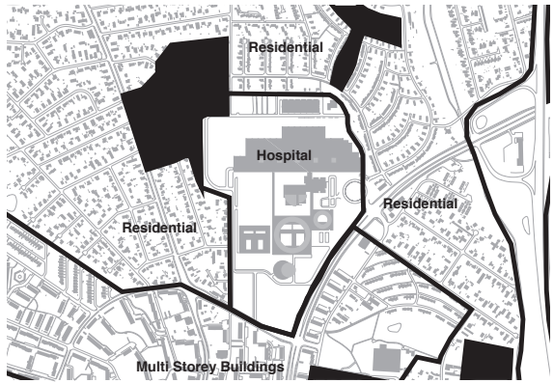
Ill. 32 - Visualisation of the extension of Herlev Hospital, Henning Larsen Architects, Friis & Moltke, SLA

Ill. 33 - Visualisation of the extension of Herlev Hospital, Henning Larsen Architects, Friis & Moltke, SLA

Ill. 34 - Site 1:2000

Ill. 35 - Herlev Hospital Park

CONTEXT ANALYSIS



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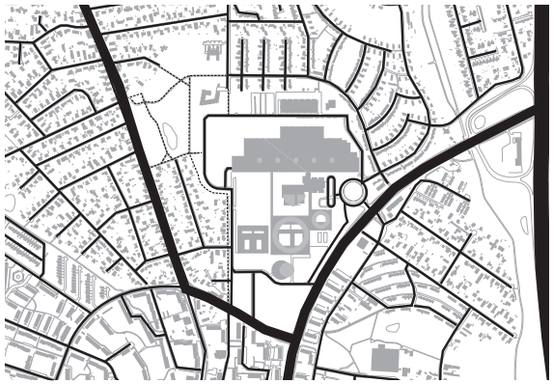

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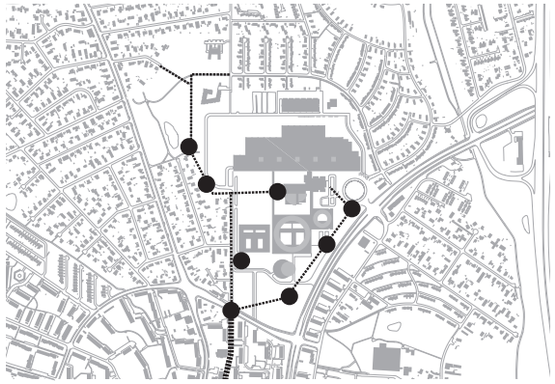

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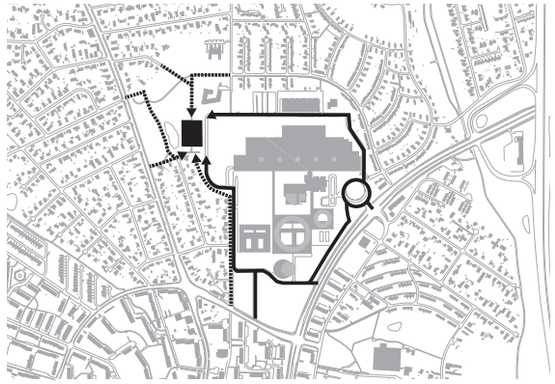


Ill. 39

Districts
Residential neighbourhoods characterize the area around Herlev Hospital to the west, north and east, while multi storey mixed-use buildings are located south of the hospital. Green recreational areas, including the Hospital Park, are situated close to the hospital. The villas to the west are mainly traditional brick houses, while those situated north and east of the site are similar in size, shape and material.

Infrastructure
Two main roads frames the hospital with high traffic intensity. In addition to this, there are smaller roads, which are only used by the residents themselves. The Hospital Park related to the site contains several walking and cycling paths.

Culture Axis
The retail area in the south and the hospital in the north are to be connected by the anticipated Culture Axis making the city centre easy accessible for bicycles and pedestrians. According to the local plan from 2012, the hospital must be an active part of Herlev and the axis must ensure that connection. The intention is to establish public experience points and active urban spaces along the axis (Local plan 2012). The axis branches out by “The Blue Path” which recreational character extends into the park and connects and activates small art installations herein.

Arrival
Arriving to the site by car one can use the various entrances to the hospital plot and either drive north or south of the main building at the road along the parking spaces. As a pedestrian one can also arrive through the hospital plot or from the west through the path system of the park.

LOCAL ARCHITECTURE

Herlev has several architectural characteristics. Inevitably, the hospital holds a significant position in the city. Its highly functional layout, the height of the ward tower of 120 metres and the extensive use of light concrete, glass and bronze coloured aluminium makes it an iconic building. As much as the exterior reflects the likes of function and massivity, the interior has a much more colourful and playful expression through coloured walls and art. The future extensions are to follow these materials on the base, whereas the circular structure on top are to have a more transparent appearance through glass and wood.

Situated just east of the hospital, the small houses of Herlev Husene determine a scale polar to that of the hospital. Herlev Husene is an area of mainly red houses from the late 1950's and is one of the first prefabricated projects of Denmark, which at a time of unemployment, need of housing and materials was an opportunity to overcome that. The approximately 300 red houses appear quite different from what is visually associated with concrete material housings (Kroppedal 2012).

Two institutions north of the site, Skovsgården and Juvelhuset, are facilitating care for people with mental and social disabilities. Both are done in brick, where Skovsgården is most noticeable, with its faceted façade panels and introvert shape to embrace the more private function of the building.

The area west of the Hospital Park holds a traditional Danish residential neighbourhood; mainly pitched roofs and brick constructions. The open-low layout emphasises a city structure with a variety of green garden spaces, private or public.

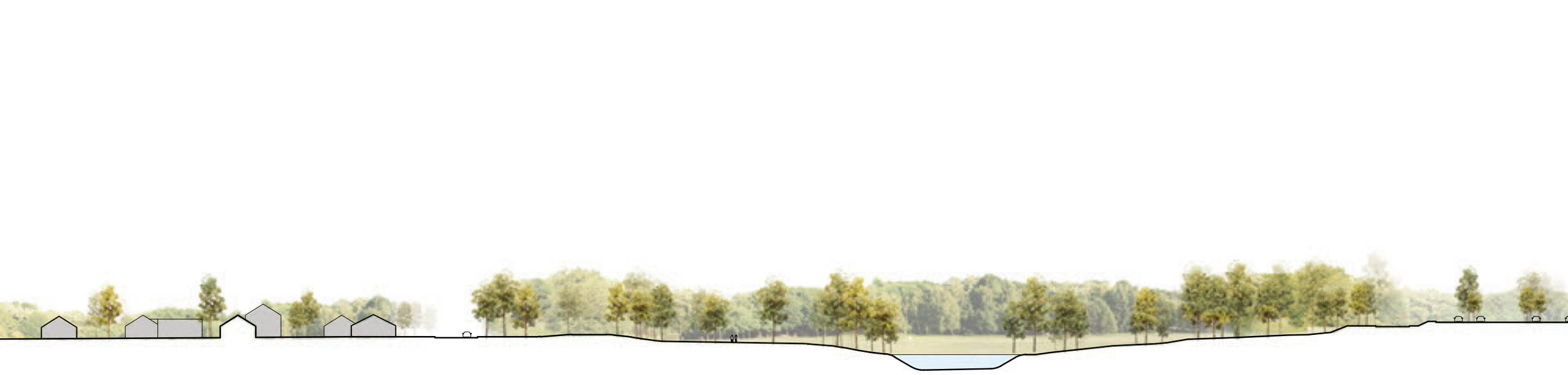
Ill. 40 - Herlev Hospital Park and Herlev Hospital in the background

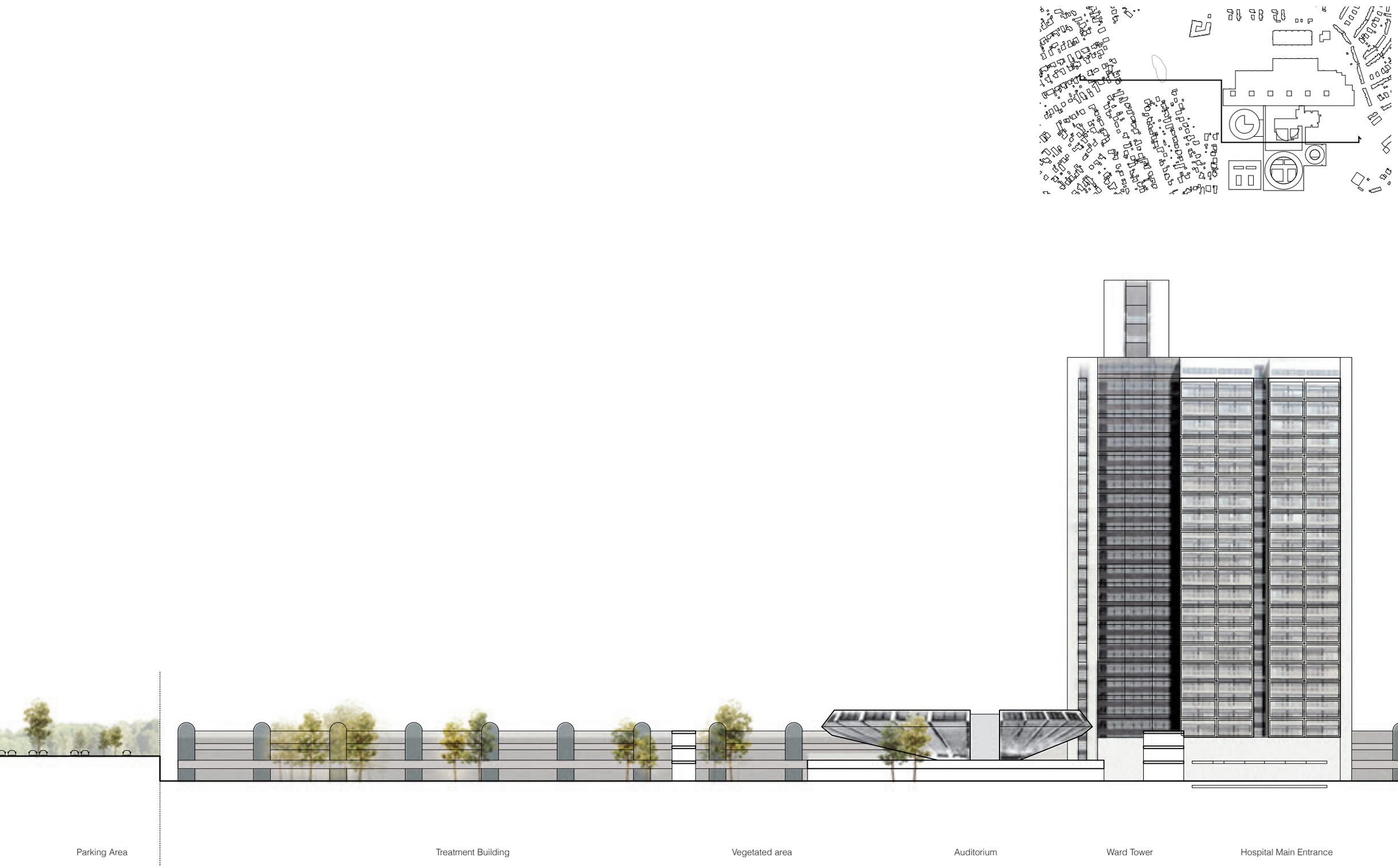
Ill. 41 - Herlev and Herlev Hospital 1:5000

URBAN SECTION

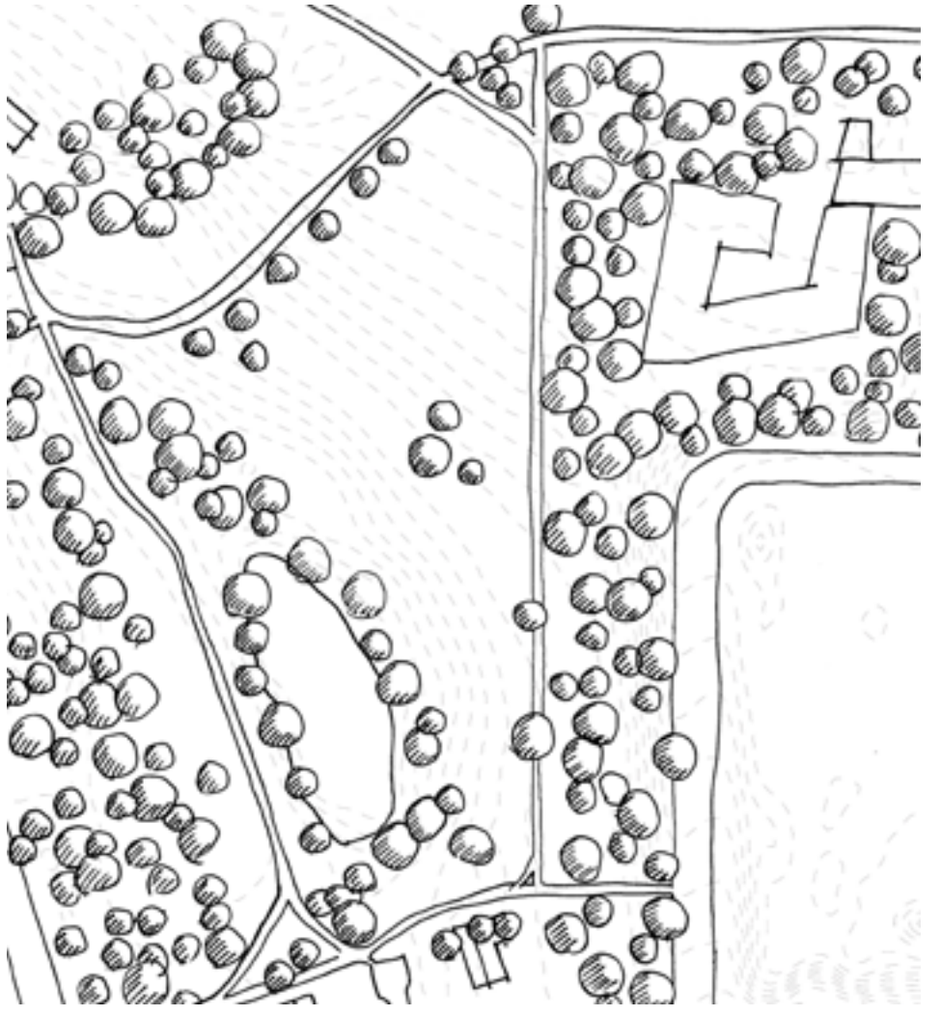
As already suggested, the site is wedged in between two polar scales. As much as it slopes and orients towards the recreational area of the park and the small-scale housings towards west, the large hospital complex backs the site towards west. The height and extent of the latter resembles a scale wise deviation in an otherwise discreet area. The area east of the site holds a parking area, and potentially a further extension of Herlev Hospital.

The green area and the parking space conforms a breathing space between the two scales and allows for more intimate space dislocated from the institutional character of the hospital and the privacy and individuality of the residential area.





Ill. 42 - Conceptual Section 1:1000



Ill. 43 - The Hospital Park

TOPOGRAPHY AND VEGETATION

It appears that the dense planting of trees is at the edge of the park. There are several large oak trees around the lake, which are scattered in the park, but the dense planting of trees at the edges, shielding the surrounding traffic. The centre of the park consists of various tall grasses and cultivated nature. The path system of the park goes around the lake, parallel to the edge of the park and leading to exits in four directions. These paths go on to Hjortespringvej and the hospital road. From this road the trees appear like a wall into the park with a portal around the path. Buildings are all located outside of the park with the exception of the institutions to the north. From the edge of the lake to the road between the park and hospital the landscape is sloping 8 meters of which the last 2,5 meters rises steeply to match the level of the road.

Ill. 44 - Herlev Hospital Park and lake

Ill. 45 - Herlev Hospital Park

SITE ATMOSPHERE

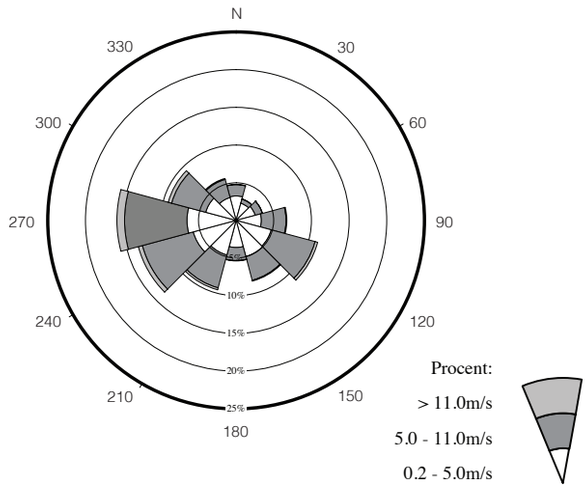
The Hospital Park takes on the urban landscape by providing a breathing space in the middle of the city. The nature and curvature of the park, gently slopes towards its own centre, where the lake quietly catches attention. The introvert shaping of the landscape and the dense composition of trees surrounding the area hinders noise and visually isolates the green space from the rest of the city. Even though the place rests in itself, the hospital tower as the only object, rises above the tree tops to indicate its landmark character and makes one aware of your being in the park.

One feel stung by peace by walking around inside the park and it acts as a refuge in the otherwise hectic context. It is a place where people from Herlev come walk their dog, playing with the kids or just sit alone on a bench. Patients or staff from the hospital who need a break from the hectic daily life in the hospital also frequently uses the park.

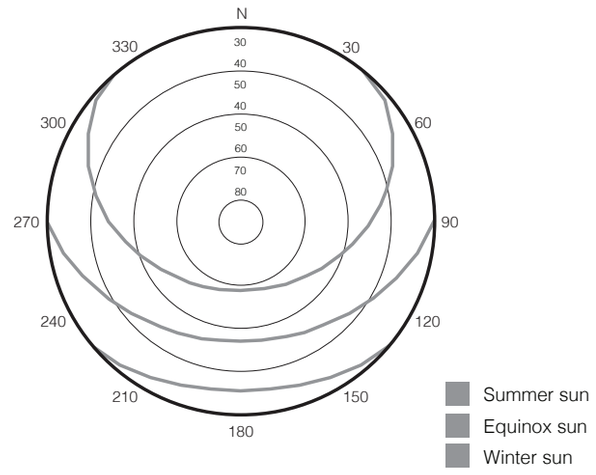
Ill. 46 - Herlev Hospital Park

CLIMATE

Based on data from DMI measured at Roskilde Airport the climate is analysed in the area. It appears that much of the wind comes from the west and the site is next to a relatively open area in the park with the lake and a few large trees to the west, thus the wind can be exploited in the design. The area, south of the site, is characterized of several trees that will shade the low winter sun. The site can utilize the morning and evening sun, as no large elements shade. These observations will be used during the design phase for the passive strategies.



Ill. 47 - Wind diagram



Ill. 48 - Sun diagram

SHADOW STUDIES

A digital sun study of the area is carried out to identify possible inconveniences of shadows on the site, since it is located close to Denmark's tallest building, the ward tower of 120 meters.

The shadows from the surrounding buildings at 8 am, 12 pm and 16 pm at equinox and at 8 am, 12 pm and 16 pm at summer solstice are analysed, with an interval of four hours. Furthermore, the shadows at winter solstice with an interval of two hours at 10 am, 12 pm and 14 pm are analysed, as the day is significantly shorter than the rest of the year.

These studies gives an understanding of the most extreme sun conditions a year in Denmark. It appears that the ward tower shades the site in the morning at equinox, but otherwise the shadows from surrounding buildings are considered not to be a problem on the site.

Equinox, 8 am

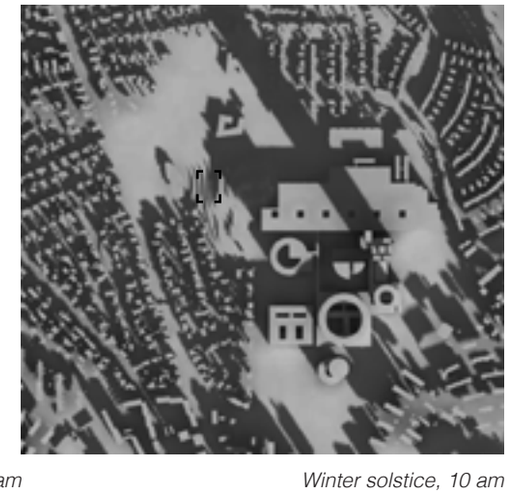
Equinox, 12 pm

Equinox, 16 pm

Summer solstice, 8 am

Summer solstice, 12 pm

Summer solstice, 16 pm



Winter solstice, 10 am

Winter solstice, 12 pm

Winter solstice, 14 pm

Ill. 49 - Shadow diagram

PROGRAM

This chapter is a presentation of the program to be incorporated into the design. It is based on the functional requirements proposed in the architectural competitions of the Danish cancer caring centres.

Ill. 50 - Herlev Hospital Park

AREA CHART

The area chart is based on the general competition program for the six existing Livsrum published and developed by Kræftens Bekæmpelse and Realdania.

The areas in this chart are seen as guidelines and are adjusted according to conversations with therapists and volunteers at the six centres in Denmark, regarding wishes and spatial needs. In general, all need more office space, conversation rooms and bigger group rooms. Furthermore, there is a need for a larger common room and exercise room and corresponding technical facilities. Inspired by Maggie's Cancer Caring Centres, a solemn reflection space is added, as an important part of the building to offer something spatially different.

The outdoor facilities are also based on the Livsrum programme, but therapy gardens and pavilions are more in focus in the concept of Maggie's, which is also evident in this area chart.

AREA CHART

Function	Quantity	Net m2/room	Net m2 total	Persons/room	Functional demands	Spatial potentials
Common area						
Entrance and windbreak	1	10	10	4 to 6	Placed close to parking Handicap accessible Robust and non-slippery floors	A window to the center The feeling of belonging
Common Space	1	70	70	15 to 20	The building's heart and pivotal point Dining area Flexible seating arrangement Small niches	Open, spacious and inviting A place for gathering and social encounters Homelike, but high ceiling
Kitchen	1	15	15	6 to 8	In connection with common space Kitchen hardware	Motivate to cook Inviting and social
Multipurpose / Lounge	1	30	30	6 to 8	Lounge furniture Shelves for books	Relaxed atmosphere A place for gathering and for privacy View to nature
Place for stay / Lounge	2	10	20	2 to 4	Lounge furniture One close to entrance	Relaxed atmosphere View to nature
Fireplace	1	25	25	6 to 8	In connection with common space	A place for privacy and reflection View to nature
Info	1	15	15	3 to 4	Computers and shelf for brochures	Exposed Formal atmosphere A place to share knowledge
Library	1	10	10	3 to 4	Shelves for books and brochures	Undisturbed A place to share knowledge
Children and youth space	1	20	20	4 to 6	Playroom with toys and books Placed away from private functions	Atmosphere in child's level
Flexible workstation	1	15	15	3 to 4	Multi-purpose Open	Undisturbed Light for work
Group room	2	20	40	10 to 20	Different furnishings Multi-purpose	Undisturbed Light for work
Conversation room	3	15	45	3 to 8	Different furnishings Soundproof walls	A place for privacy Relaxed atmosphere View to nature
Open conversation space	1	15	15	3 to 8	Different furnishings Open but undisturbed	A place for privacy Relaxed atmosphere
Reflective space	1	15	15	2 to 6	Fixed benches or chairs	Formal atmosphere Spiritual and mediativ peace Skylight Acoustically calm
Workshop	1	30	30	4 to 6	Flexible work tables Robust and non-slippery floors Place for small art exhibitions	Creative activity Light for work
Activity area						
Exercise room	1	70	70	10 to 12	Exercise machines and floor area Connection to outdoor areas	Atmosphere of stimulating optimism and energy High cieling Natural light
Wellness area	1	25	25	2 to 3	Reflexology and massage bench	Quiet place for privacy Relaxed atmosphere Meditative and acoustic calm
Examination room	1	20	20	2 to 3	Bench and desk	A place for privacy Hidden away

Function	Quantity	Net m2/room	Net m2 total	Persons/room	Functional demands	Spatial potentials
Staff area						
Offices	4	25	100	4 to 8	Administration, therapists, counselors Flexible workstation arrangement Team-based work	Light for work
Staff room w/tea kitchen	1	50	50	12 to 16	Dining area Informal meeting	Relaxed atmosphere
Copy room / Storage	1	10	10		Print and storage. Space for a table	
Wardrobe / changing rooms w/shower & toilets	1	20	20		Space for outerwear for approximately 20 people	
Additional spaces						
Wardrobe	1	10	10		Space for outerwear for approximately 60 people	
Storage	4	15	60		Different storage In connection with Exercise Room, Workshop and Common space	
Toilets	5	5	25		Gender specific One handicap toilet	
Changing rooms, bath & toilets	2	20	40		In conection with fitness area Gender specific	
Technical room	3	15	45		Ventilationsystem Servers	
Cleaning room	2	5	10		Cleaning trolley and storage	
Outdoor facilities						
Therapy gardens					Benches Different planting	Outdoor mediativ peace Sculptures in nature Peaceful
Terraces					Hard coating Terrace furniture In connection with common space	Outdoor relaxing area Exposed for sun
Herbal garden					Herbs, vegetables, berries etc.	Outdoor activity
Family area					Small outdoor play area	Atmosphere in child's level
Pavilions					Covered places Flexible seating arrangements	Relaxed and mediativ peace A place for privacy
Storage					In connection with herbal garden an terraces Various garden tools	
Total Net	46	605	860			

FUNCTIONS

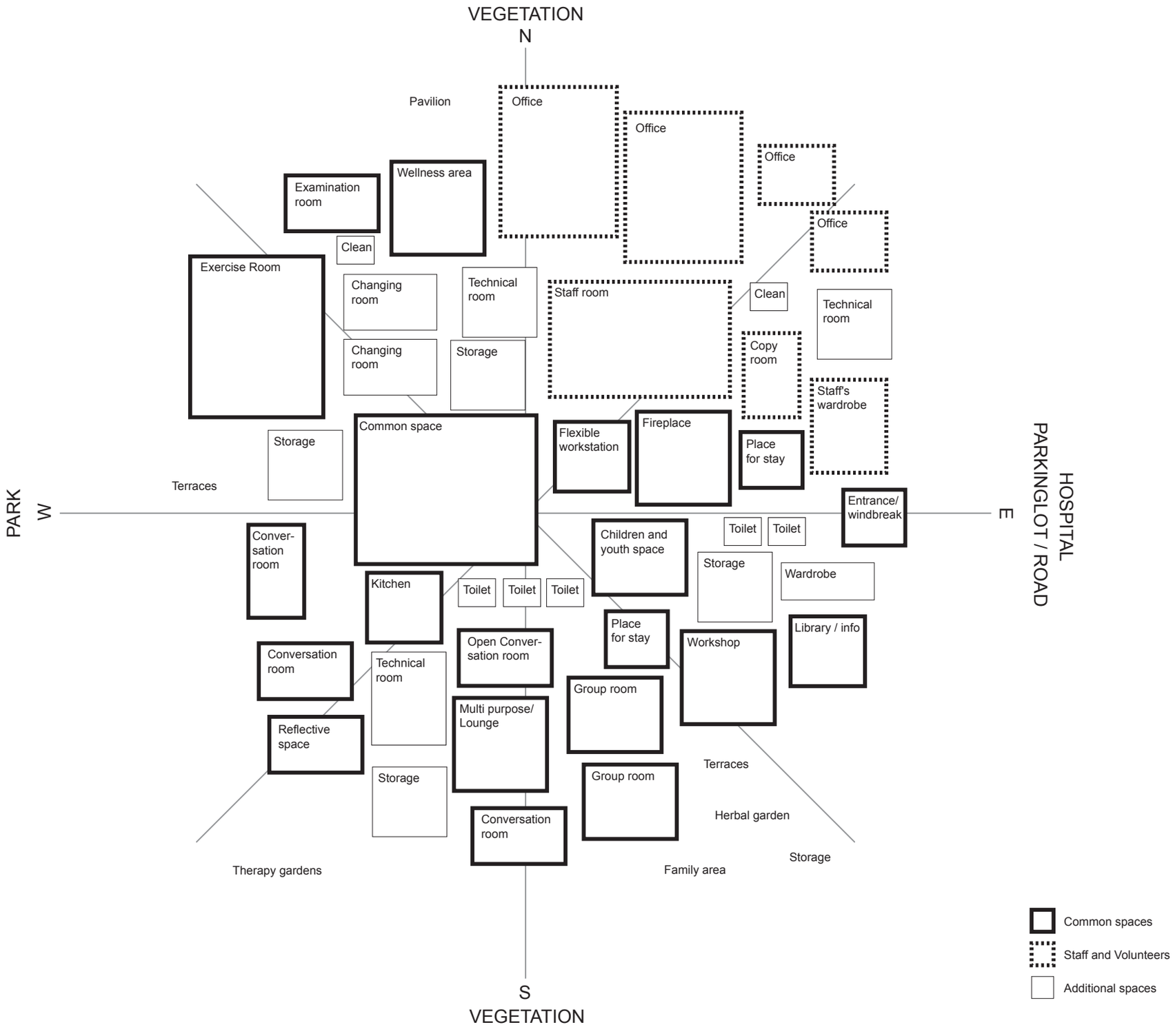
In order to understand the many different types of spaces, their sizes and their relation to each other, to the context and the climate, a function diagram is created.

The entrance area's optimal location is considered to be in the east, as the hospital and parking facilities are located in this direction; in connection to this, the wardrobe, lounge/place for stay and the info/library where the user can get an initial overview of the centre. Centrally located is the common space and kitchen to distribute users to the other functions of the centre. It is closely related with the south and west facing terrace and herbal garden which are sun exposed areas. Group rooms are distributed in the south-east, as they are mainly not used for private and sensitive conversations. Generally, the private and sensitive functions such as conversation rooms, exercise room and wellness area are located to the west, facing away from the road and taking advantage of the beautiful scenery in the park. These spaces are also associated with therapy gardens. The children and youth space are in close relation to the common space as well as the outdoor family area, which is located to the south to utilize the sun's heat and light as a pleasant place for stay. This location also prevents interference with sensitive talks in conversation rooms to the west. The reflective space sits quietly towards west as well, withdrawn from any possible disturbances found in the rest of the building. The workshops are located towards south in connection to the children and youth space with the good view to nature.

Found in the northwest corner is the exercise room to benefit from ventilation as well and oriented away from the direct solar exposure to prevent overheating. Connected to this are changing rooms, wellness area and an examination room.

Staff department including offices, staff room, wardrobe and copy room are towards north and northeast, to exploit the light from the north for work, but also to avoid overheating. The staff department should be isolated and can possibly face the road.

All the additional spaces are located in appropriate places according to the adjacent functions. The various storages are in close relation to exercise room, workshop, children's space and common space.



Ill. 51 - Function diagram: relation to each other, to context and to the climate.

VISION

The aim is to implement healing architecture through the synergy between context and architecture, and architecture and user. Consequently, the cohesion between centre and outdoor space through the likes of gardens and park must create a holistic image of a cancer caring centre communicating life and hope. By purposeful variation, the architecture should address a sensible place for happiness and hope, as well as sorrow and despair.

The qualities of the surrounding landscape must contribute to this correlation between inside and outside through integration of natural vistas that are essential. To continue Nordic traditions, it is important that the building is site-specific, focusing on natural materials and authentic constructions. The building must be open and inviting, but still embrace the user to create a sphere of intimacy with spatial potentials and well-defined logistics of functions.

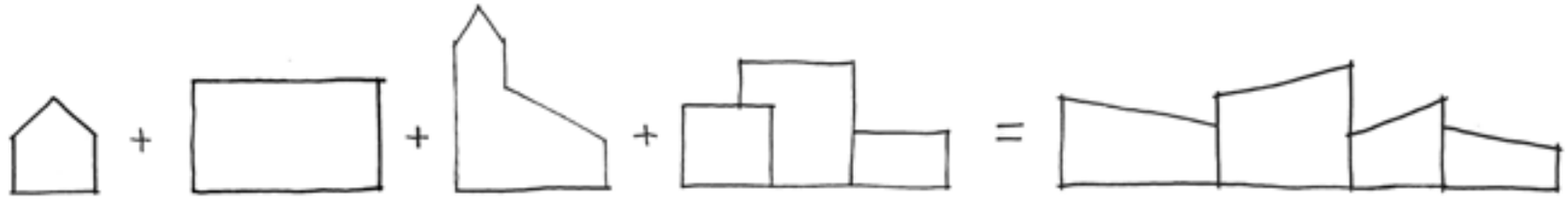
The centre must resemble tectonic quality in an overall expressive, yet sensible architecture that explores the optimal interrelation between functional layout, structural significance and poetry.

It is desired to design a building that addresses the various functions and explores the complex tensions between contradictions. A centre that has architectural familiarity of a house, yet not a home; one that allows spirituality without resembling religiousness; a specific place to recover that defies the institutional character. All of which must be confronted with technical aspects in an integrated design solution.

Ill. 52 - Herlev Hospital Park

PRESENTATION

The project is presented in an ensemble of technical drawings, axonometrics and visualisations supported by narrative text. All the spatial sequences of the project are exemplified and visualized through a step by step principle to further the overall understanding of the project.



> *It is like a house which is not a home,*
> *a collective hospital which is not an institution,*
> *a church which is not religious,*
> *and an art gallery which is not a museum.*
>
> *- Charles Jencks*
> *(Jencks 2015; p. 28)*

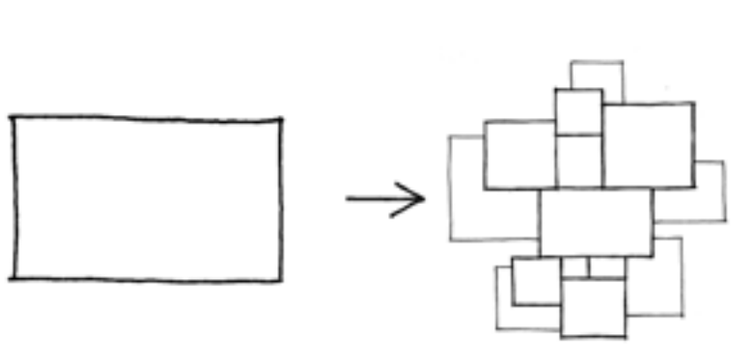
ARCHITECTURAL CONCEPT

As suggested by Charles Jencks, a cancer caring centre is about implementing different functions into one, thus not limiting the architecture to the idea of mono-functionality. The proposal for a new cancer caring centre in Herlev needs to reflect an architecture that combines these typologies to offer variation and to create a third place for users to go – a place that defies the institutional character.

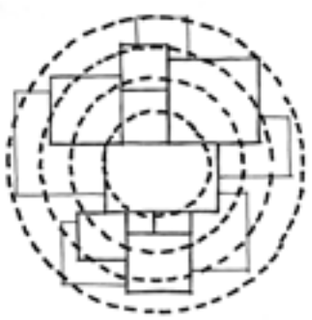
The proposed typology is broken down in several volumes varying in height and size to meet the functionality of the interior and the scale of the human on the outside. The dynamic expression on the exterior mimics the dynamics of the surrounding park landscape and the tilted roofs suggest a dialogue with the verticality of the trees. The pavilion structure appears in an all-wooden cladding as a cabin, which from a contextual perspective makes the building integrate respectfully to the site.

Taking up the idea of a cabin in the woods, the wooden pavilions appears inviting to mediate a refuge for persons who are in need of care. The simplicity of the design, the clean-cut shape and the large scattered openings brings identity and character to the project without compromising the inviting and friendly overall expression. Following the concepts of healing architecture the interior of the centre comprises intimacy, home like atmosphere and contact to nature through gathered openings that seek to blur the boundary between inside and out. The pavilion structure lets nature wrap around the building to emphasize the contact to nature, which is a very important part of healing processes. The wooden pavilions expand outwards with terrace decks to inscribe the structure into a circular layout to cement its own identity as a place for healing.

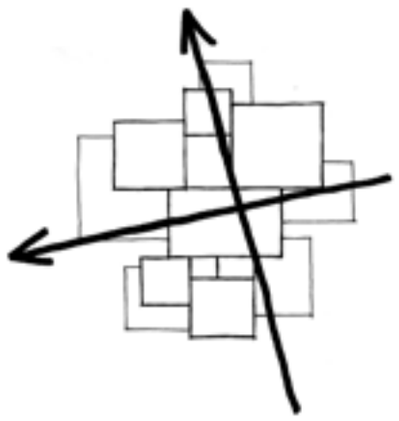
Given the physical context and the realm of the site, the architectural grasp is to underline the transition between the hospital on one side and nature on the other. The proposal for a new cancer caring centre incorporates this axial visibility and movement to gradually transit to the more calm and relaxing vegetated area of the hospital park. As part of this transition a countering axis resembles the sloping curvature of the landscape differentiating the two levels of hospital and nature, thus underlining the transition. The crossing of the two is set to be located in the main pavilion, accommodating the common space facilities to act as a heart and gathering point between nature, man and architecture.



Ill. 53 - Breaking down the volume



Ill. 54 - Volumes expanding outwards



Ill. 55 - Landscape axis (south to north) and visual axis (east to west)

Ill. 56 - The cancer caring centre seen from the park

MASTERPLAN

The cancer caring centre extends the visionary thoughts comprised in the extension of Herlev Hospital by Henning Larsen and Friis & Moltke as well as the visions detailed in the local plan by SLA Architects. The important recreational and cultural Blue Path connecting the inner city to the hospital is extended and connected to the Hospital Park. As opposed to the present straightness of the path system of the park, this is rearranged to go around the west of the caring centre to create a more organic flow. This proposal also activates the small lake creating small plateaus right next to it. In line with the vision of having art and sculptures centred around the Blue Path these are to be distributed around the park. Art is an important part of the program for the project so the recreational character and small art installations associated with the park are also beneficial to the users of the centre.

Parking is located east of the building on the hospital parking area. A small drop off spot/kiss 'n' ride area is placed close to the entrance of the building, which is marked by pavement creating a pedestrian crossing stretching out towards the parking area to create a safe environment for pedestrians. Arrival to the site is mainly by car around north or south of the hospital. Arrival can secondarily happen by walking through the park.

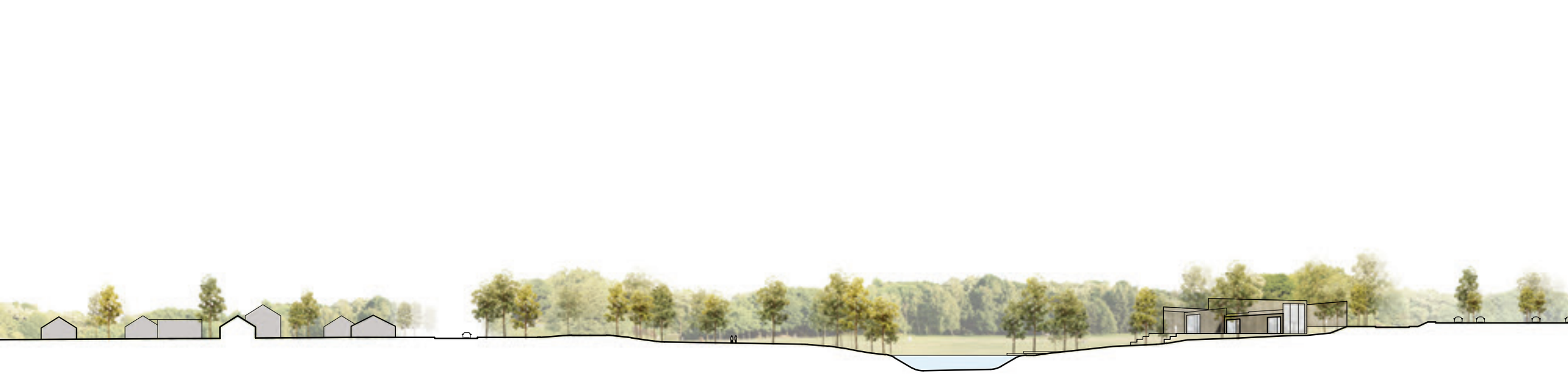
Herlev cancer caring centre is located right in the midst of villas, hospital and nature and mediates between them in size and expression. The architecture responds to the down sloping of the landscape in a site-specific Nordic design solution to utilize the potential rather than ignoring it.

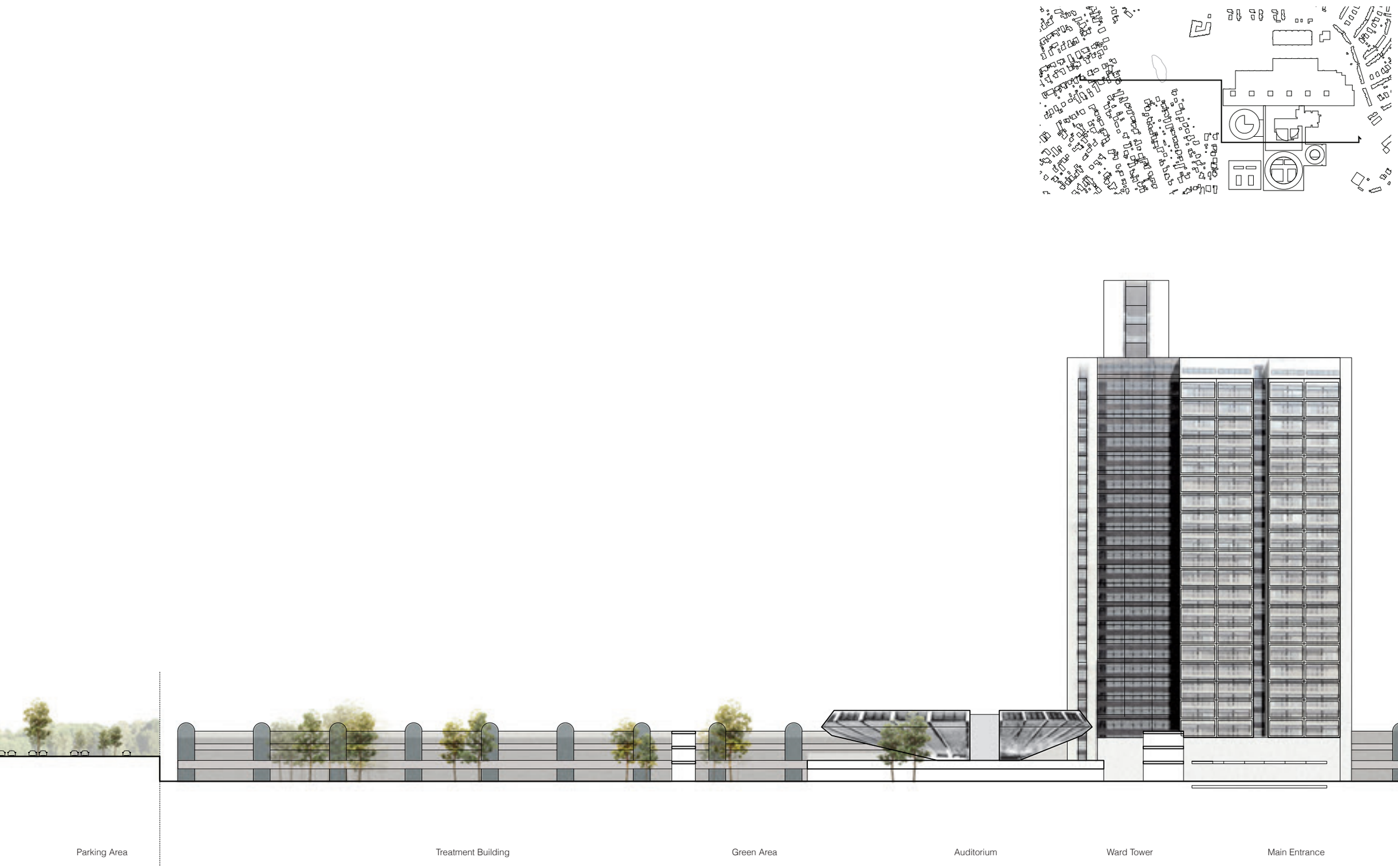
Ill. 57 - Aerial view of the cancer caring centre

Ill. 58 - Site plan 1:2000

URBAN SECTION

A section of the hospital area shows the building placement in the landscape between the polar scales of the hospital and the small villas on each side. The building adapts by scale wise relating to the villas whereas it defies the hospital in attitude and choice of materials. The wooden cladding makes a tangible architecture that relates to the human body and makes it blend in to the border of trees surrounding the park. The transition towards nature is underlined by the east to west directed axis and the terracing of the building makes it sit lightly on the sloping landscape.





Ill. 59 - Site section 1:1000

PLAN LAYOUT

Despite the breaking down of volumes the plan layout still appears unified and coherent to each different zone. The zoning in plan emphasizes a variety of life-giving spatial qualities both for social interaction and individual absorption. The zones of the layout are to provide optimal frames for users, visitors and employees.

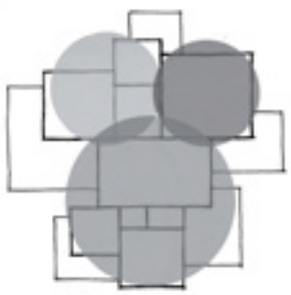
The entrance to the east is pushed back from the road to give a quiet yet visible entrance scenario, where the corner provided by the staggered volumes makes an embracing gesture. The rotation of the axis, and the direction from the hospital towards nature leads one through the entrance and directly into the common space that performs as the heart of the building. From this centrally placed social space, flow is distributed outwards to the different zones.

The building is divided programmatically in three different zones: the staff area, the activity area and the common area. The staff area is located in the north-east corner by the road to gain good light conditions and to prevent noise from the road to reach the functions that could benefit from a quieter environment. The administration is visually connected to the centre through the therapy garden and is highly connected to the entrance area to make it easier to welcome guests.

The common area holds the social gathering space in the middle including the kitchen as a central element and appears as an open floor plan to connect to the quiet and private function of conversation spaces towards south. These are located away from the potential noise and in close relation to nature. Spatial variation, ceiling heights and niches makes a differentiated spatial experience to accommodate private as well as social functions. One of the spatial features to exploit this is a mezzanine, which creates different zones of privacy and adds functional quality to the space in general.

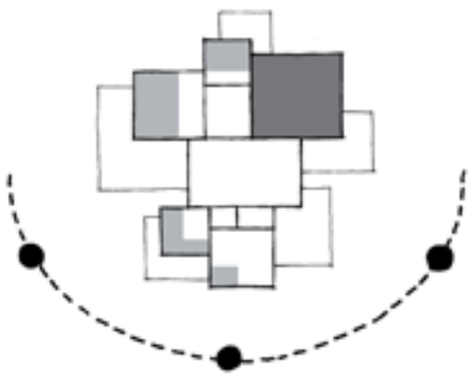
The activity area is placed towards north and west to avoid overheating of the spaces during the time it is used. The clarity of light coming from the north and the various views towards vegetated areas is a treasured quality.

The staggered pavilion structure encircles two courtyards different in size and character and renders different characteristic views to nature. The orientation of the pavilions and the opening up to both exterior and interior views gives a visual variation and a sensuous stimulation to benefit the experience. The courtyards make possible for flow around them and connects the different zones in terms of movement as well as visually. The large courtyard has a therapy garden that applies various sensuous qualities, whereas the small courtyard is more a visual break to let nature run through the building. In addition to these outdoor spaces, terrace decks forms private outdoor spaces on the outside of the building with different qualities though all closely connected to the idea of being close to nature. This distribution contributes to a centre that works in all 360 degrees, and in every time of day.

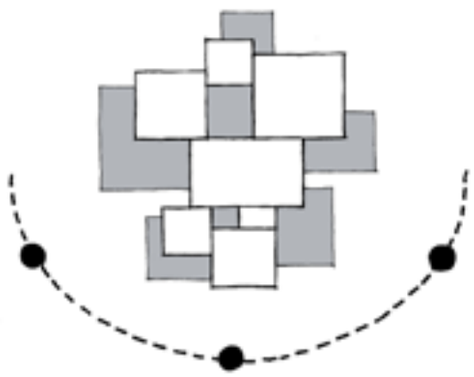


Ill. 60 - Zoning of the plan layout

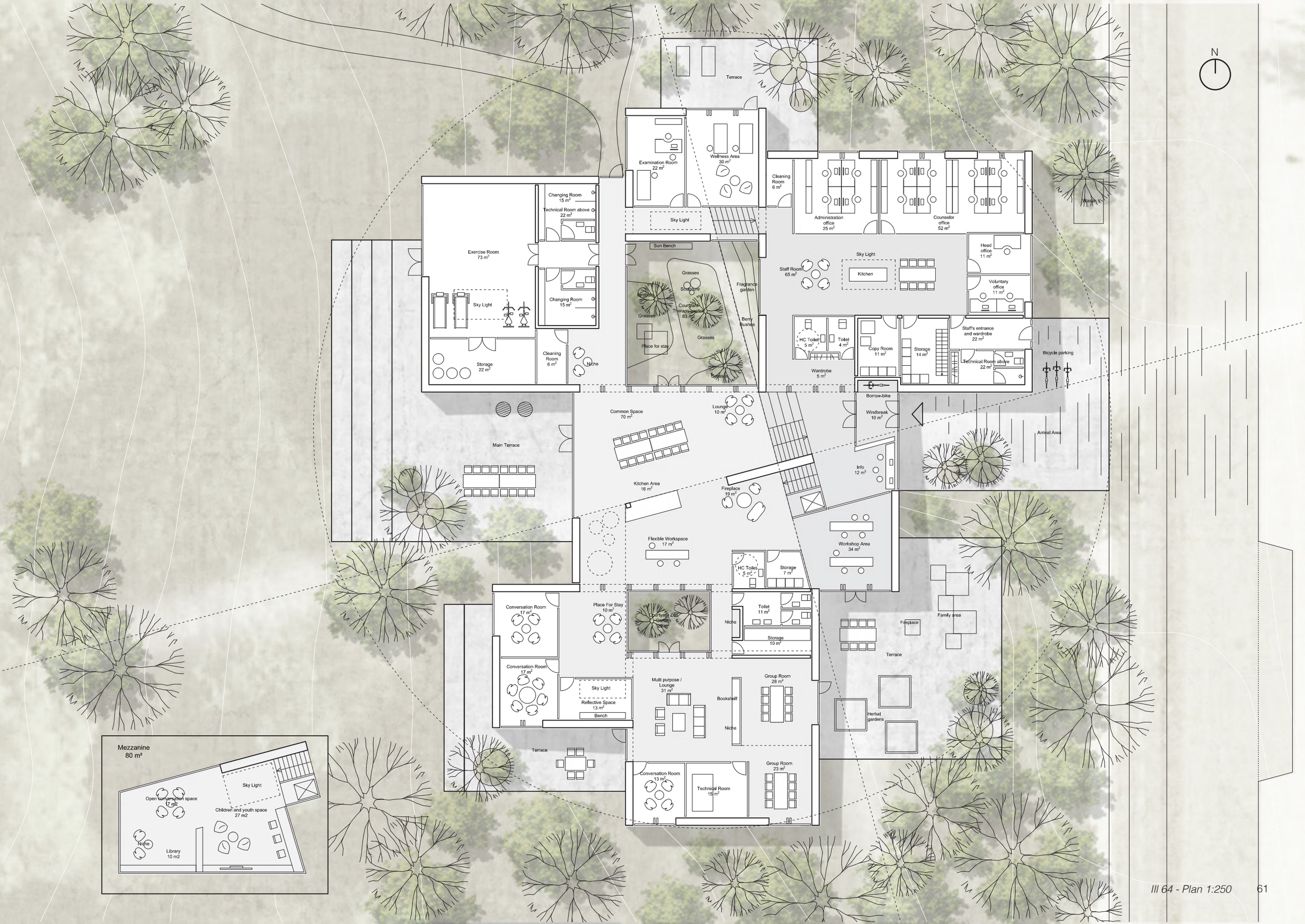
Ill. 61 - Distribution of flow from the center



Ill. 62 - Layout of private functions



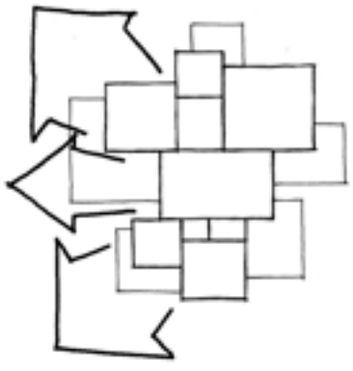
Ill. 63 - Outdoor spaces



Ill 64 - Plan 1:250

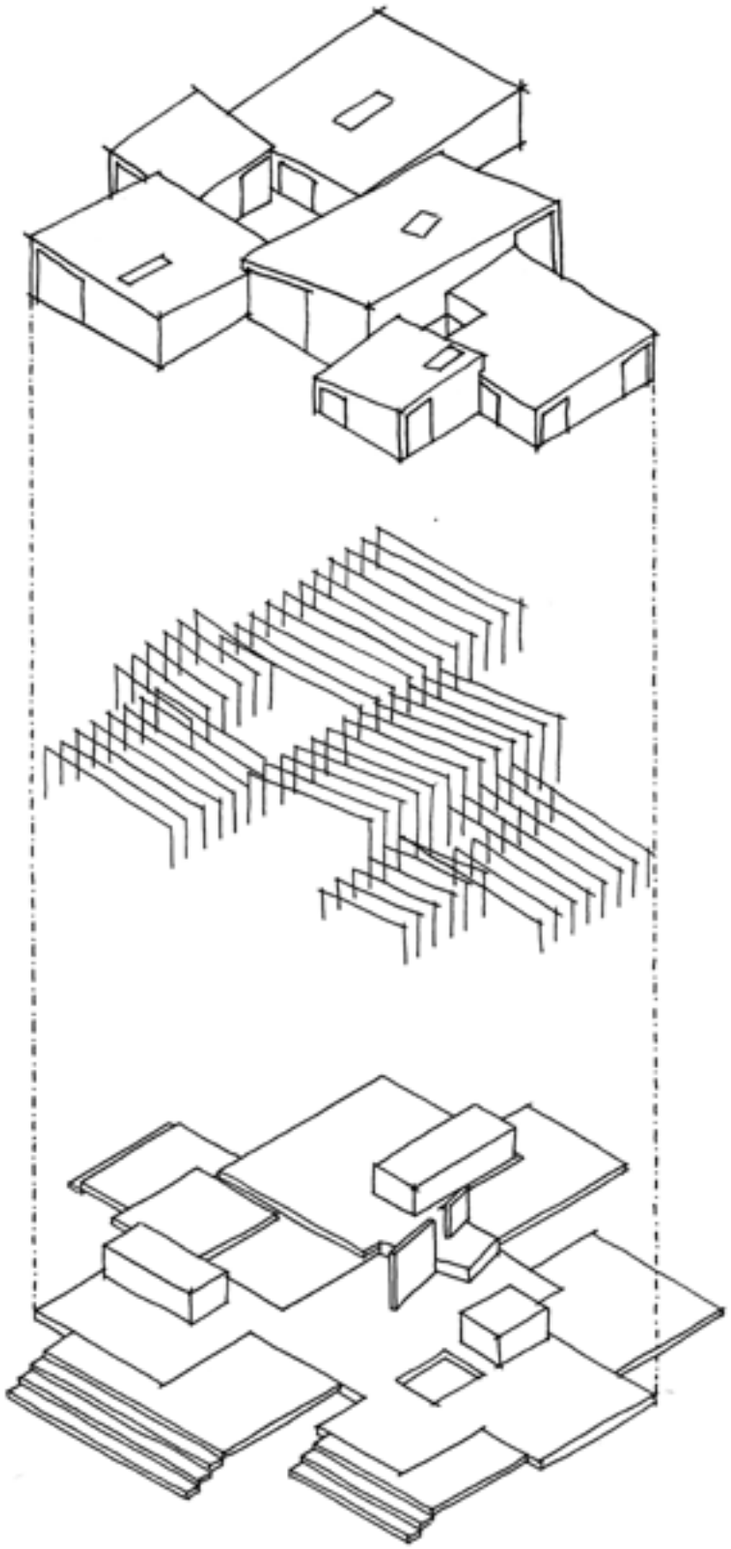
EXTERIOR

The building addresses nature in many levels. The pavilions are extruding outwards to secure views and connection to nature and still they have a respectful and inviting appearance in terms of the slim wooden panels on the façade. Floor to ceiling openings in the facade are gathered to have plenty of daylight inside, maximize view out and underline the simplicity of the shape. The extruded volumes levitate from the ground in the direction of the park to keep the privacy of the functions inside without compromising the view of the park landscape. Once one enters the building, nature is a central element to take one away from the formal and institutional character of the hospital. The ideology of the expression is to defy the complexity of the hospital. The staggered pavilions create different private areas around it to be used for different purposes.



Ill. 65 - Orientation towards the park

Ill. 66 - The cancer caring centre seen from the park

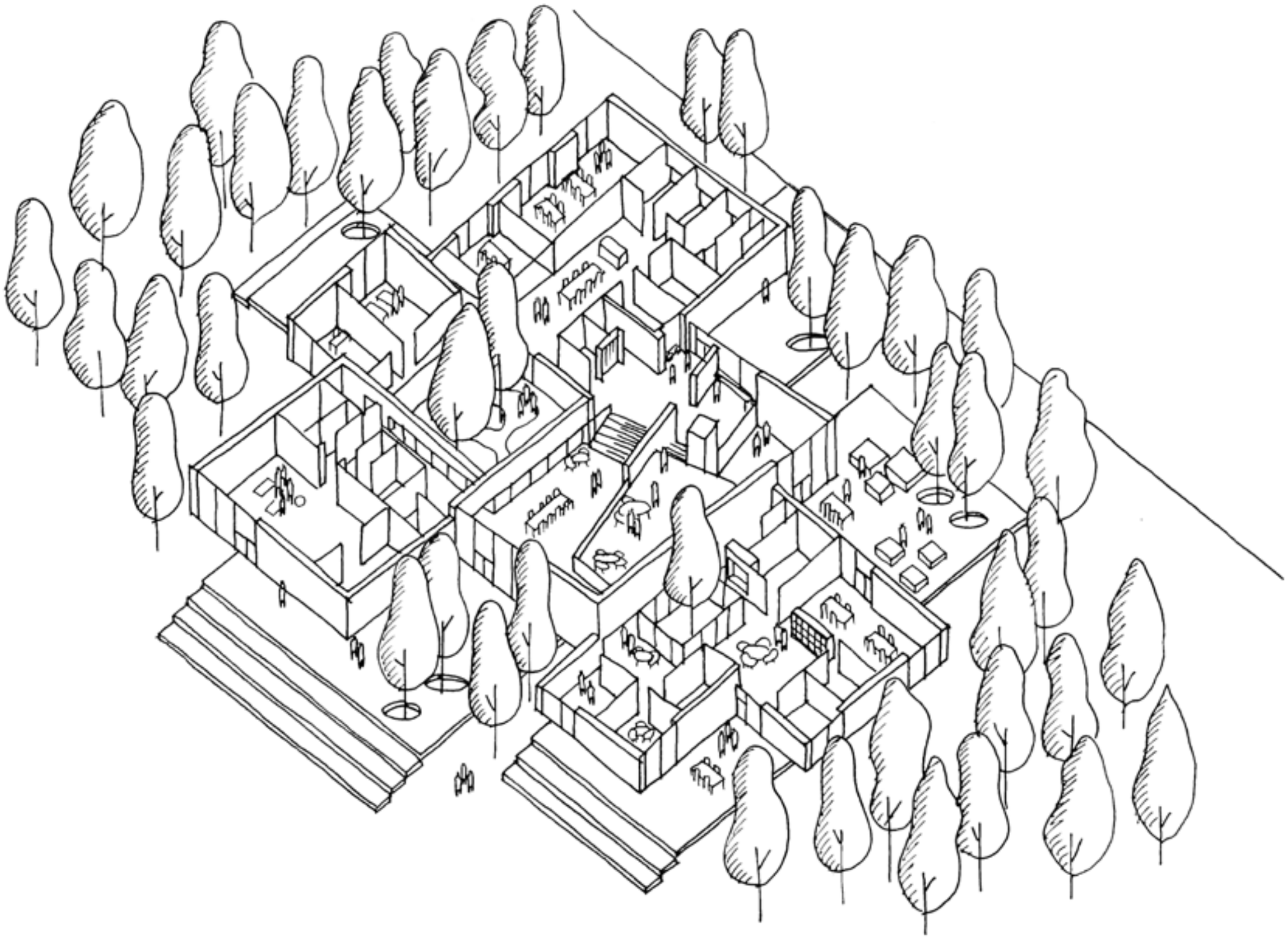


AXONOMETRIC DRAWINGS

The exploded axonometric drawing on the left shows the building's structure in three layers. At the top is the skin of wooden cladding, windows and insulation, in the middle the frame structure in glulam timber that supports the whole building and at the bottom is the concrete base with stabilizing cores and slabs.

The axonometric drawing on the right shows how the building is situated in the landscape and all the different spatial qualities in the building and around it.

Ill. 67 - An axonometric drawing of the construction principle

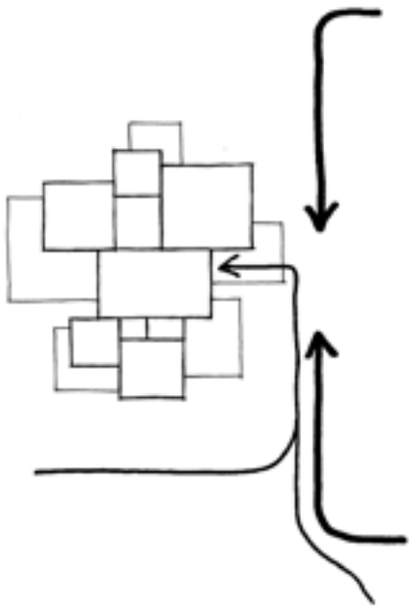


Ill. 68 - An axonometric drawing of the spatial qualities of the cancer caring centre

ARRIVAL

One arrives to the main entrance from the road. The arrival area is paved with concrete that continues to the interior and welcomes you inside. The large glass panels in the entrance ensure visibility through the building and towards the lake in the centre of the park. The administration pavilion stretches from the entrance and is tilted upwards to mark the arrival area, which ultimately creates an entrance on the corner. With trees next to the entrance stamped into the concrete, this brings out the idea of going behind the tree and into nature to deal with the personal struggle one might face. The humble character of the entrance also allows one to choose if you are not ready to enter and take part in the activities inside.

Employees of the centre have a private entrance towards the road, and the administration in general is less visible from the street to not make an institutional impression. From their entrance they have access to wardrobe facilities and the common staff area connecting the different offices around it. Both the layout and the facade properties supports flexibility to rearrange and reorganize the offices.



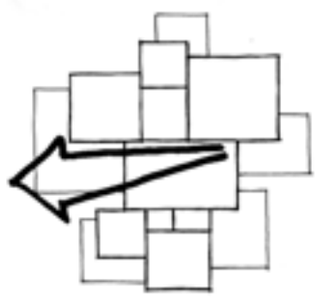
Ill. 69 - Arrival to the centre

Ill. 70 - Plan detail 1:200 - Entrance, arrival and staff area

Ill. 71 - View of the arrival area seen from the road

ENTRANCE

Once inside, the view to nature is there instantly and the irregular cone shape of the common space opens up and creates clarity. Visual connection to the kitchen is also instantly experienced and is important in order to make sure that visitors will be greeted and welcomed right when they drop in – it is important that they feel comfortable. These functions are placed half a storey down to emphasize the axis towards nature and the sloping of the landscape. To the left a stair leads up to the mezzanine to make a split in levels around a concrete wall that stands as a sculptural element, but also holds the potential of displaying art in a very central position of the house. The concrete element also functions as stabilizing to the characteristic glulam frame structure of the common space pavilion. The frames stands as an embracing element that follows one step by step as one go further. Next to the entrance is an info area with electronic devices for self-help on the relevant subjects. From here one has a view to both the arrival and the double high workshop space.

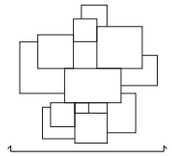


Ill. 72 - View to common space and nature

Ill. 73 - Section 1:200

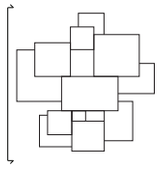
Ill. 74 - View of the common space from the entrance

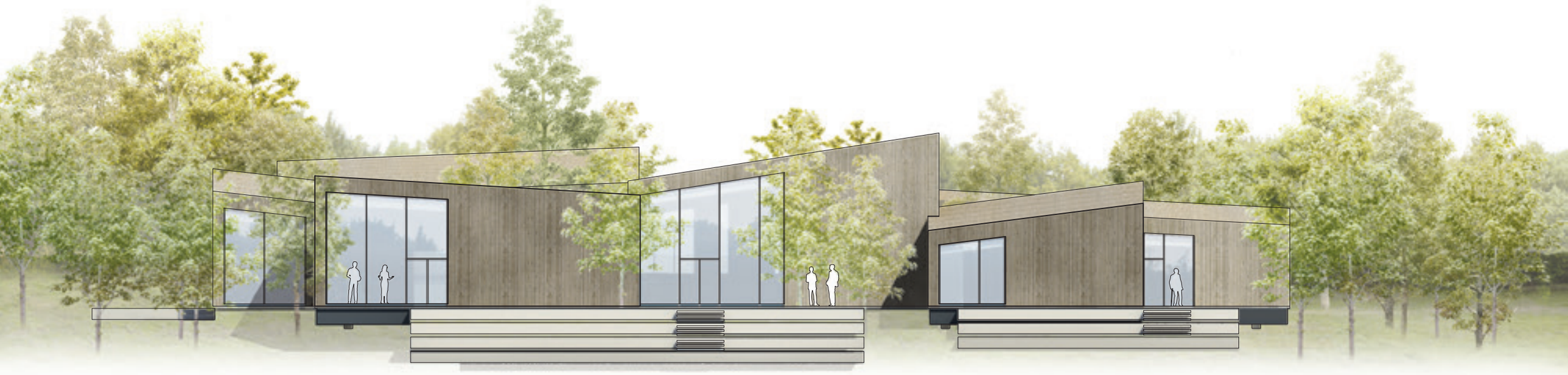
SOUTH FACADE



Ill. 75 - South Elevation 1:200

WEST FACADE





Ill. 76 - West Elevation 1:200

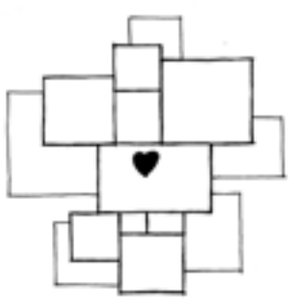
COMMON SPACE

The common space performs as the heart of the centre to physically tie the other pavilions together. It has its own special character with its strong visual connection to the park and the rest of the house. Several spatial qualities are housed in this space; the double high space, the mezzanine as a strong visual element, the flow around the sculptural concrete wall and the kitchen placed as a mediator between low and tall space.

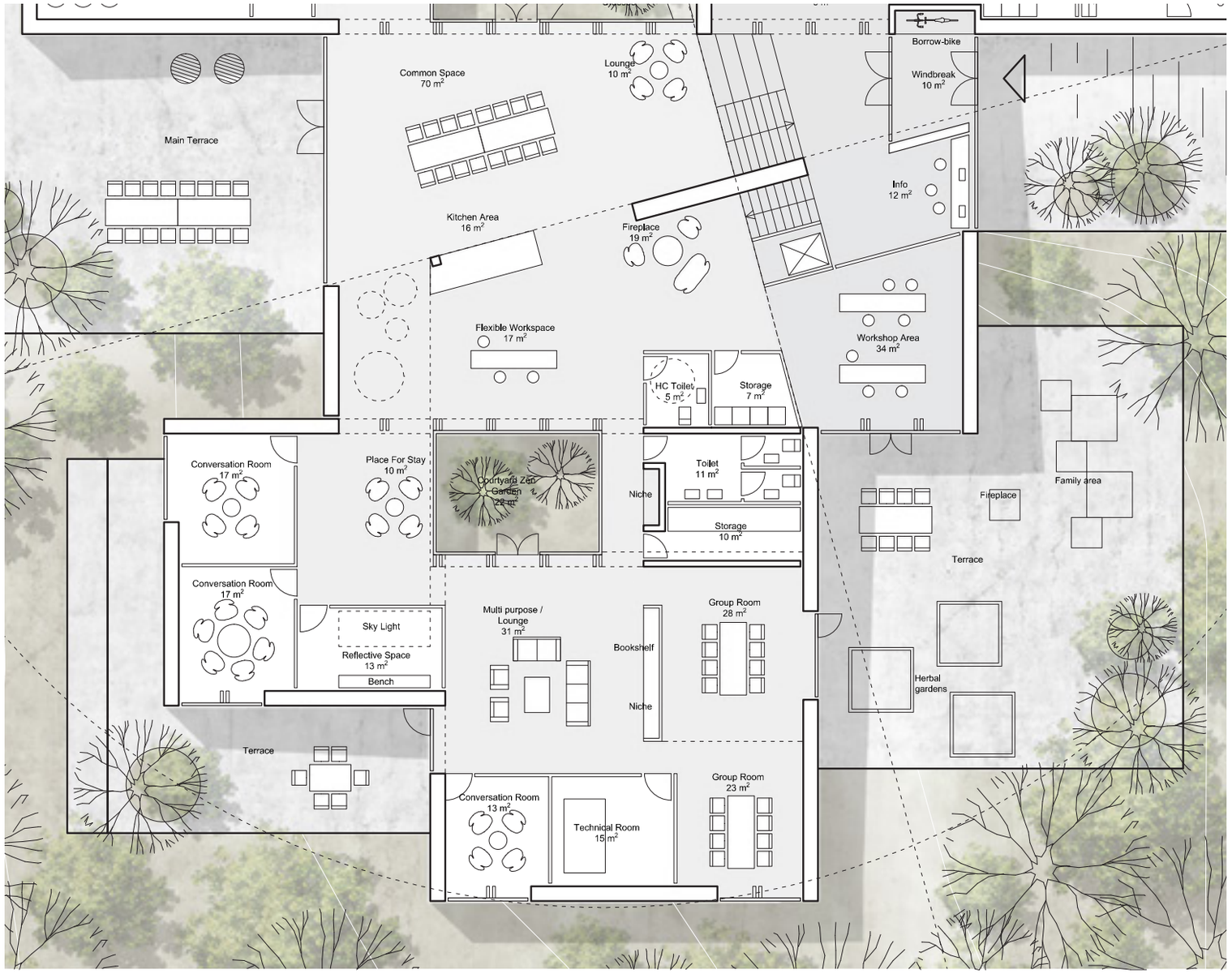
Inspired by the aspects of *kitchenism* as introduced by Charles Jencks, the kitchen holds a central position to enhance social activity in the midst of the space. The fireplace is pushed back into the lower part with the hearth integrated in the concrete wall to produce warmth. From here you have a good overview of the space. Behind it is the workshop area that opens up to a double high space and receives plenty of light from a large window opening. Following research, working creatively can have therapeutic effect. The workshop lets one access an outdoor space oriented south-east.

The common space is for social gathering but the different zones of the area also lets you withdraw to be by yourself. The mezzanine stretches into the room and makes you want to go explore what is under and behind it. Included in the common facilities are the conversation rooms, group rooms and a reflective space, which are placed and oriented towards the park in west and south directions; thus dislocated from places of social activities. These spaces are arranged around a spatial sequence that allows for small places to stay, lounge and niches, thus breaking with the thoughts of long narrow hallways like that of conventional institutions. The open space arrangement is enhanced by the small courtyard makes the atmosphere light and friendly.

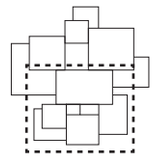
The choice of materials reflects the overall ambition to create a warm and tactile interior. Like often seen in the conventional wooden cabin, the walls and ceiling of the centre are cladded with timber to bring out a warm and embracing inside. The clean and simple appearance along with the smell of skilfully worked on timber makes a calm and intimate space. Contrasting the light colour of the timber, the darker tones of polished concrete constitute the flooring, to make a heavy base and make the ceiling lighter. The timber is treated to optimize acoustic properties that in addition to the lamellas, furnishing and beams help prevent unwanted acoustic phenomena. Clarity of speech is important as conversation is the main catalyst for social activity in the common space.



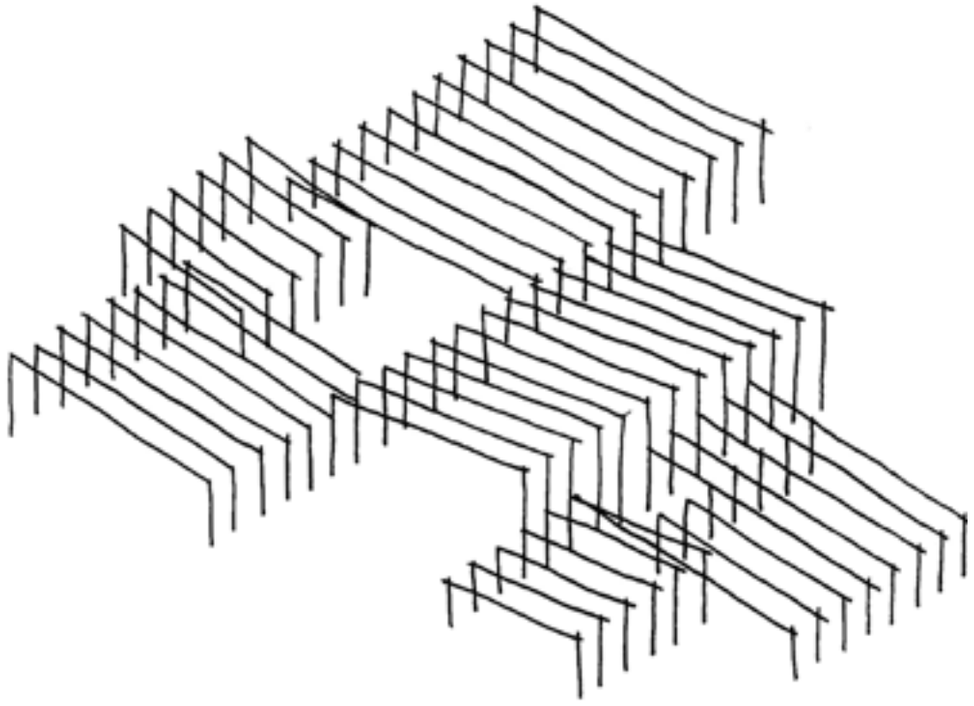
Ill. 77 - The heart of the centre



Ill. 78 - Plan Detail 1:200 - common area



Ill 79 - The common space with, kitchen, fireplace, mezzanine, workshop and view to courtyard



Ill. 80 - An axonometric drawing of the frame system

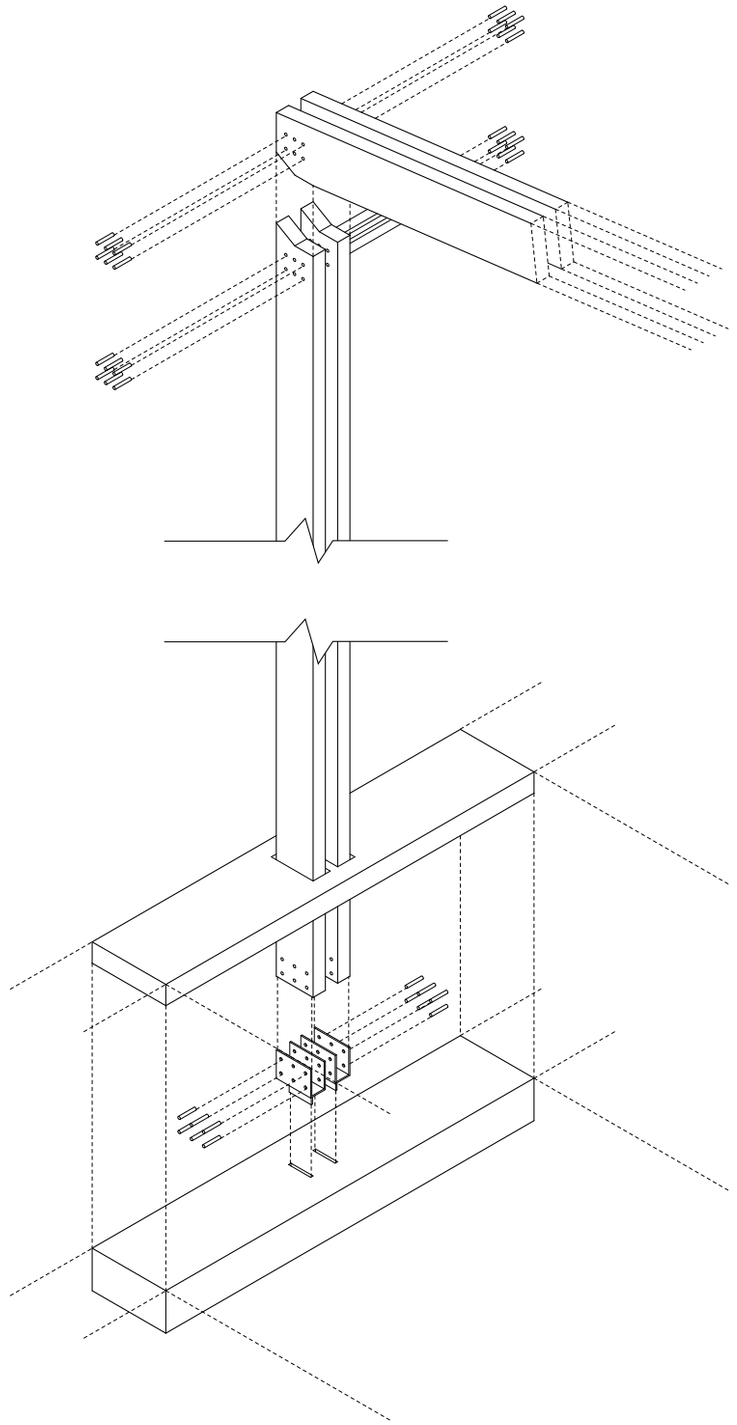
POETICS OF STRUCTURE

The general structural system of the centre comprises a structure that varies in size dependant on the use and span. The visual character of frames exploits the notion of embrace, to create a space of security but also a space that is visually light and attractive. The material of the frame structure is glulam and chosen because of its materiality rather than its strength. The wooden material offers a tactile and warm interior to emphasize a comfortable space to be in, and is easily associated with the wooden cabin or summer house as a third place for patients to go and exploit. According to theory about the third place, the physical structure is not advanced but often plain and simple in its expression.

The structure is broken down into a bifurcated beam/column system to make up for the heavier expression of an otherwise singular system. The gap between the elements and the distribution throughout the building still suggests a close relation and does hereby not blur the impression of the frame.

Half of the frames are exposed in the ceiling and partly hidden within the timber cladded walls where a little gap between column and wall arise. In places with larger window areas the columns are freed from the walls to join the concrete base that offers structural stability to the frames. Though partly hidden, the eye still connects the useable parts to get a visual impression of something wrapping around the space – still a light and tranquil space.

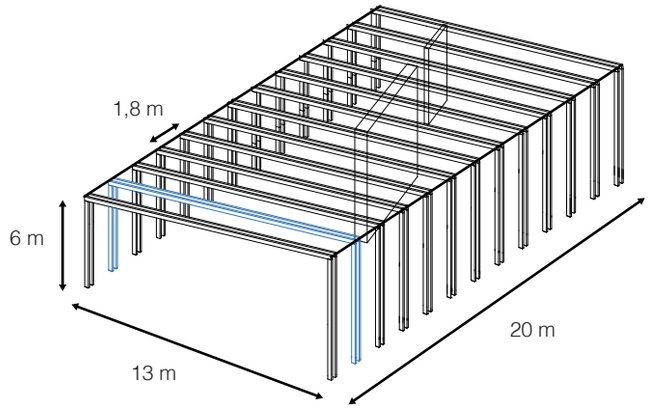
The details of the frames are also contributing to this architectural statement. The beams span beneath the ceiling to support the roof structure and gestures the protective feeling of being under treetops, which relates to the important factor of one being in nature. The small slip between column and ground brings lightness to the structure and highlights the frame as something of an element in it self. The building seems raised because of the cavity at the base of the columns where the fastening and the joint is solved below the deck, like stems of trees anchored in the ground by roots beneath the forrest floor. The columns symbolize the long slender trees in the area and to get an even slimmer expression the columns are, as mentioned, split in two.



Ill. 81 - An exploded axonometric drawing of column and beam joints

Ill 82 - The double columns, small courtyard and niche

CONSTRUCTION



Ill. 83 - Construction principle for common space

Ill. 84 - Simple supported column

In order to verify that the structure is durable, a calculation of a simple supported beam, and a simple supported column is made and it considers the longest span of the building which is found in the common space. This situation is relevant to investigate, when the beams found here will have to be dimensioned larger than the ones located in the other zones. The ceiling height is also the highest so this would be the most radical scenario in the building.

The dimensions of the beam and the column are calculated due to the height of 6 meters and the span of 13 meters. The common space volume is about 20 meters long. Since it is a large open space with a mezzanine, it is important that the beams can be designed to span all 13 meters as they cannot be supported midway. Therefore a simple and durable construction is advantageous. The 13 frames with the centre to centre distance of 1800 mm are stabilized in this volume by the diagonal concrete slab, as well as the roof and foundation.

A frame structure is fixed at the joint between the column and beam and will therefore be stronger than a simple supported beam. Calculations are carried out for a simple supported beam to simplify and take into account the worst case scenario, as a fixed frame calculation would give a better result.

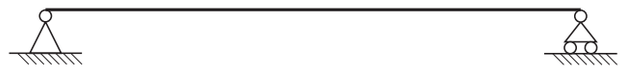
After various sketching calculations the dimensions of the double beams and columns are calculated to respectively 400 x 100 mm and 300 x 100 mm. The dimensioning of the column follows the beam width due to aesthetic considerations of relating the two in size and appearance. Due to the long span a different material than glulam such as steel would be more favourable, but the material chosen offers more tactility and quality to the concept of the cabins in the forest.

There are in the design process made initiating calculations to examine the necessary dimensions where the permanent load, wind load and snow load are taken into account. Dimensioning accounts for Ultimate Limit State and subsequently Serviceability Limit State for both beam and column. Cross sections can be seen on the illustration and calculations are found in Appendix. For more information about the process and studies made in structural software Karamba see the process chapter, page 114 to 117.

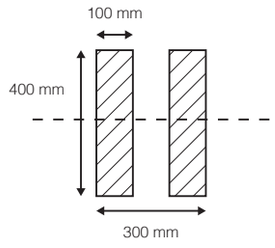
Double glulam beam (400 x 100 mm)
Ultimate Limit State:
Dominating permanent load:
5.62 MPa < 14.8 MPa
Dominating snow load:
11.55 MPa < 22.2 MPa
Dominating wind load:
-1.37 MPa < 19.0 MPa

Serviceability limit State:
The acceptable deflection:
32.5 mm
The instantaneous deflection:
30.04 mm
The long-term deflection:
48.06 mm < 32.5 mm

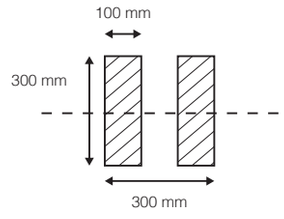
Double glulam column (300 x 100 mm)
Dominating permanent load:
0.15 MPa < 1.19 MPa
Dominating snow load:
0.32 MPa < 1.79 MPa
Dominating wind load:
-0.04MPa < 1.69 MPa



Ill. 85 - Simple supported beam

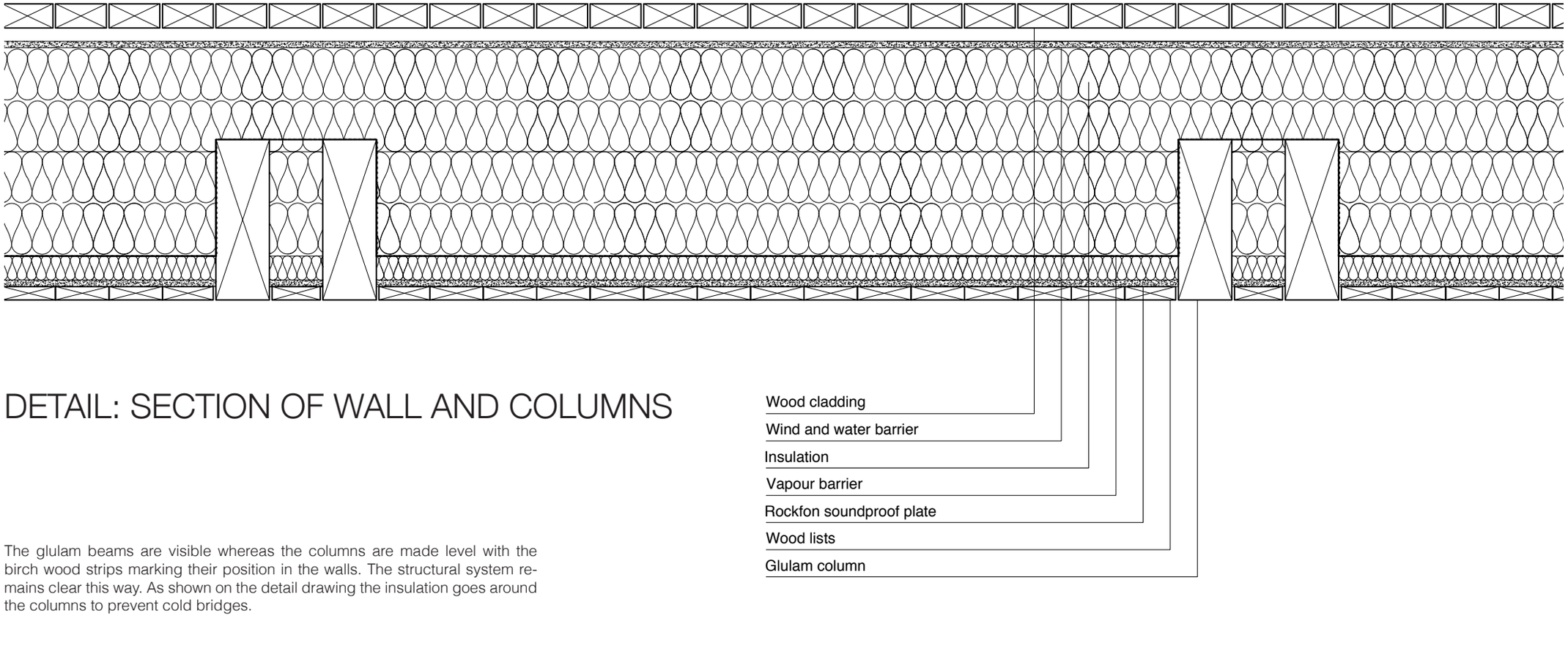


Ill. 86 - Cross section of beam



Ill. 87 - Cross section of column

DETAIL: SECTION OF WALL AND COLUMNS



The glulam beams are visible whereas the columns are made level with the birch wood strips marking their position in the walls. The structural system remains clear this way. As shown on the detail drawing the insulation goes around the columns to prevent cold bridges.

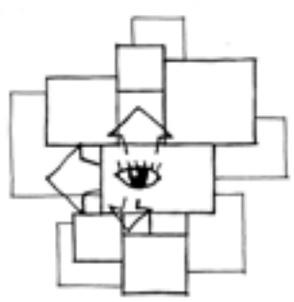
Ill. 88 - Detail plan section of the wall and columns 1:10

CONTACT TO NATURE

One of the principal aspects of healing architecture is contact to nature. The cancer caring centre in Herlev incorporates this particular aspect in different ways and makes the surrounding vegetation an active element in the experienced architecture.

The large floor-to-ceiling openings in the façade ensure that nature is always visible from the inside. Combined with the occasional terrace decks the floor of the inside is optically continued outside and thereby the difference between inside and outside is blurred. Towards west, the building is elevated slightly to frame nature, whereas in north and south direction it is level with the ground to make it easy accessible. This makes a varied experience of the surroundings that adds to the experience.

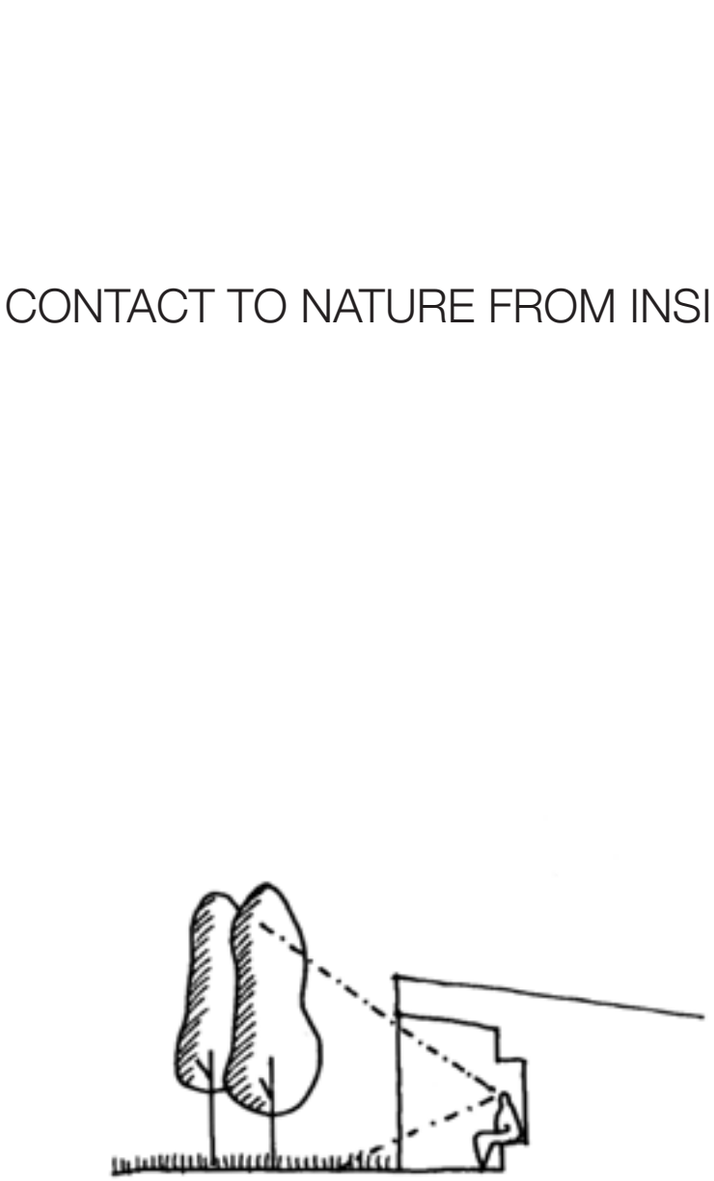
The pavilion structure has the qualities of breaking with the straight façade and thereby let vegetation embrace the structure. Another quality trade of the typology is the forming of small courtyards to have nature run through the building. In these the trees of the site can be preserved and add quality to the privatized outdoor spaces. The pavilion volumes are also allowed additional light to break down the depth of the building.



Ill. 89 - Visual connections from the common space

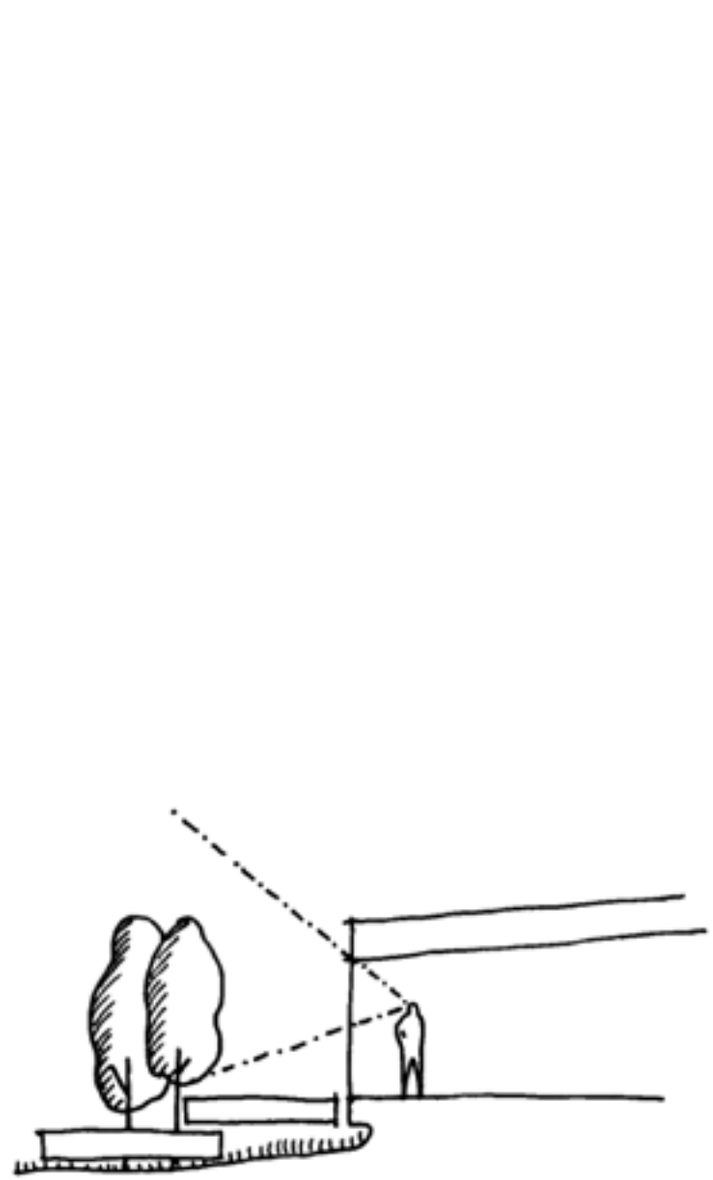
 Ill. 90 - Section 1:200

Ill. 91 - Common space with kitchen, mezzanine, sculptural lamp and view to park and the small courtyard

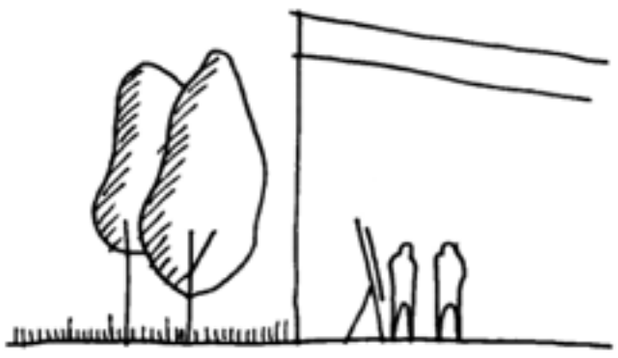


Ill. 92 - Seating niche with a clear view of nature

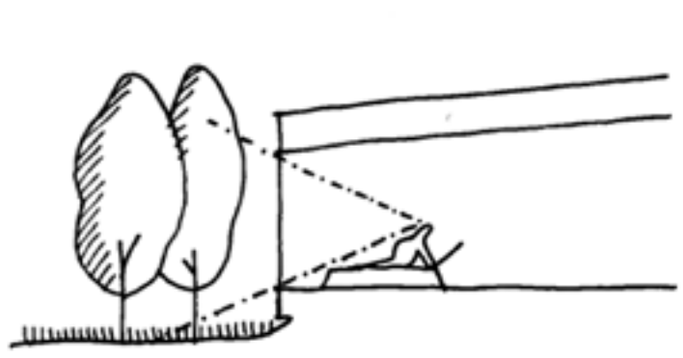
Ill. 93 - Level access to nature



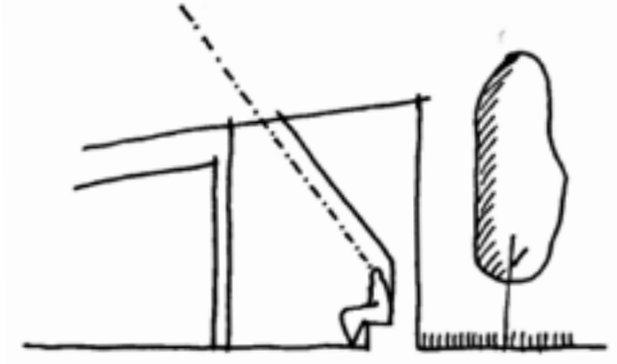
Ill. 94 - Raised building with terrace with views of nature



Ill. 95 - Double high workshop area with a clear view of nature

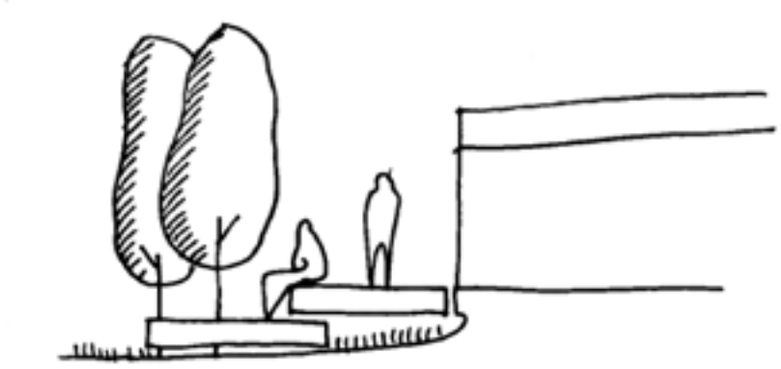


Ill. 96 - Raised building with views of nature

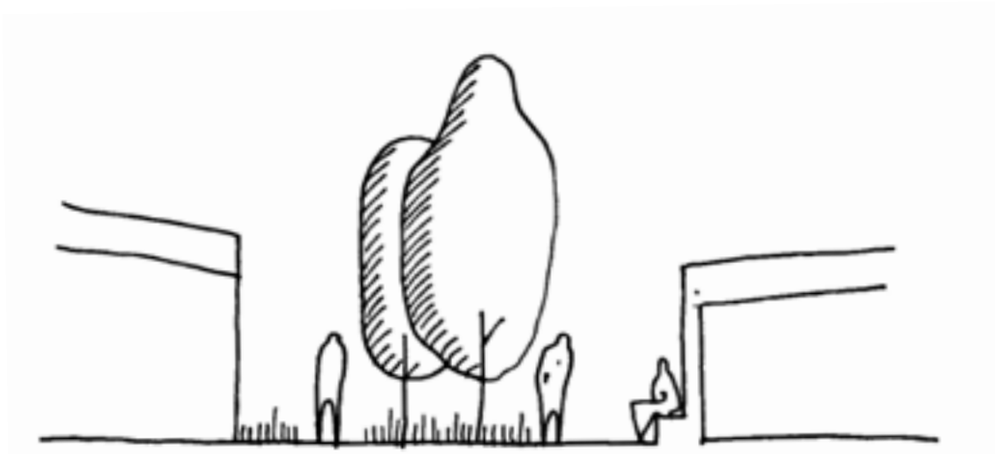


Ill. 97 - Reflective space with view towards the sky

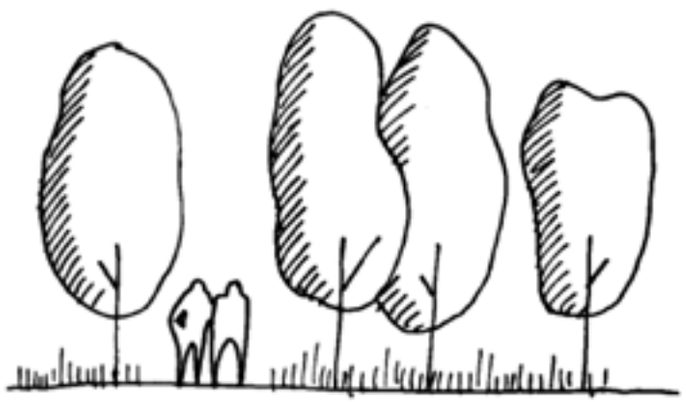
CONTACT TO NATURE FROM OUTSIDE



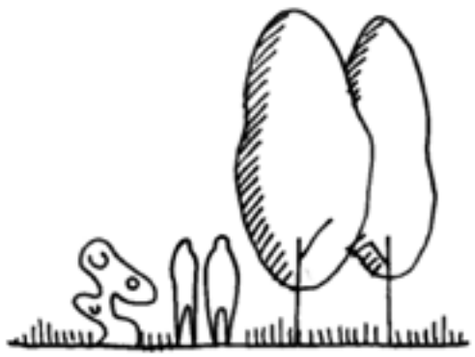
Ill. 98 - Raised building with terrace



Ill. 99 - Cultivated nature in courtyards with integrated bench



Ill. 100 - Preserved forrest



Ill. 101 - Cultivated nature with sculptures

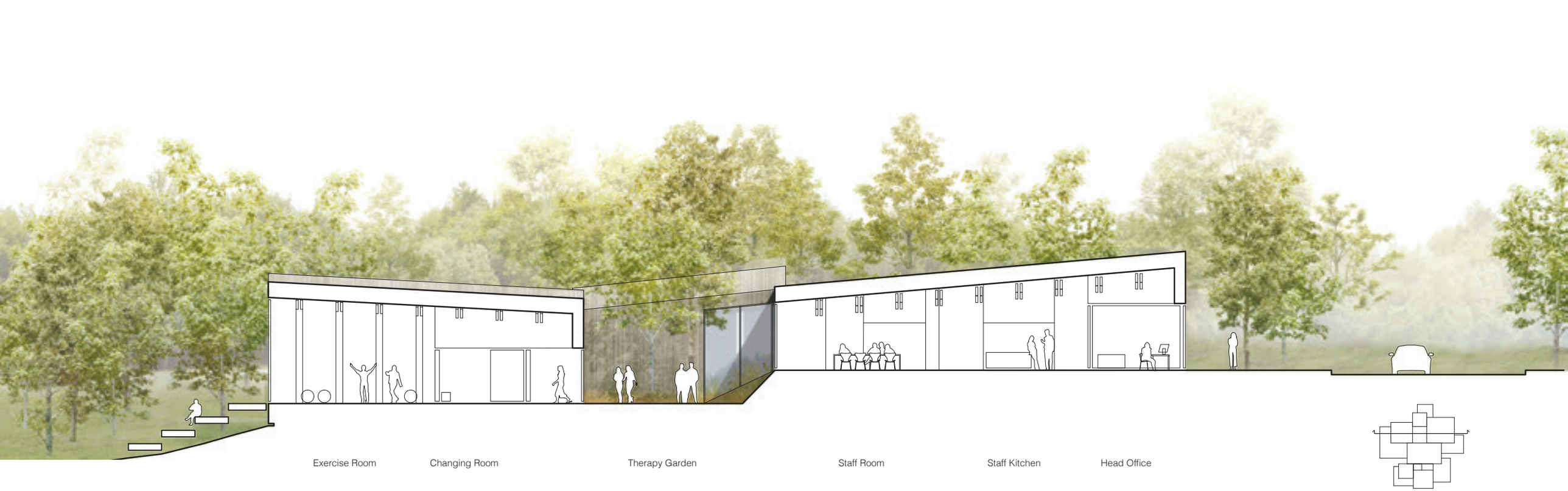
Ill. 102 - Cultivated nature with herbal garden and family area

COURTYARDS

The two courtyards follow the intention of purposeful variation, even though they share some quality trades like enhancing the quality of the walkways around them, connecting the different zones visually and letting light into the building centres.

The large courtyard is designed as a therapy garden to comprise a place for relaxation and spirituality. The outdoor space intentionally affects all senses through various colourful grasses, smells of flowers, birds twittering, berry bushes and sculptural elements. The grasses are all sorts that can grow in shade. The northern wall of the courtyard remains solid to have a nice place in the sun where your back is covered by solid wall for feeling safe and secure. The existing trees rising up above the roofs add to the quality by creating a play of light and shadow and serves as a reminder of seasons turning.

The small courtyard is less cultivated and more a simplistic resembling of existing nature framed as a small zen garden. It is a visual breathing space of the volumes surrounding it but can also be used for brief intimate conversations.



 Ill. 103 - Section 1:200

Ill. 104 - Courtyard as therapy garden with grasses, trees, sculpture and bench

OUTDOOR SPACES

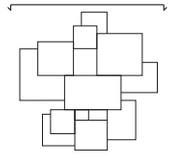
Besides the courtyards, outdoor spaces form and extend the vitality of the house to the outside of the building. The main west-facing terrace is raised from the ground to make it a private space. Here the evening sun can be utilized to have social gatherings, dinners and activity on the later evenings. The terrace facing east is due to the sloping of the landscape in a protected and private area surrounded by vegetation. Here the herbal gardens, fireplace and family area are placed to host activity. This terrace is accessed through either the group rooms or workshop space and is level with the floor plan.

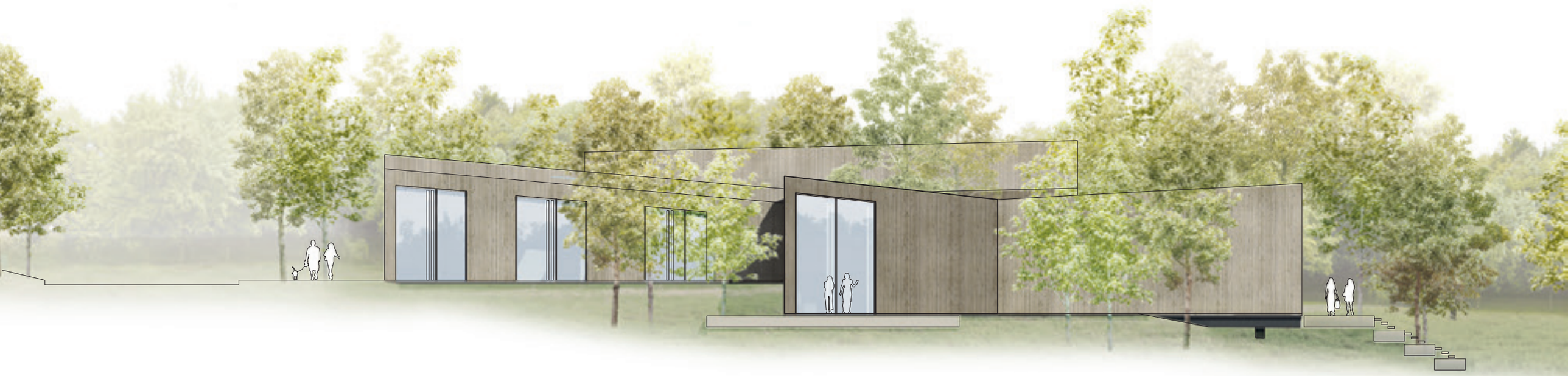
In general the terraces are to prolong the amount of time the outdoors spaces can be utilized by the users; different times of day calls for different use of terraces. As a general trade of character, all the terraces have openings cut in the deck to either let trees penetrate it or make space for small flower beds, hence the dialogue between nature and the built.

 Ill. 105 - Section 1:200

Ill. 106 - Outdoor space with family area, terrace and herbal garden with the double high workshop area in the background.

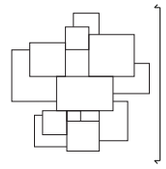
NORTH FACADE

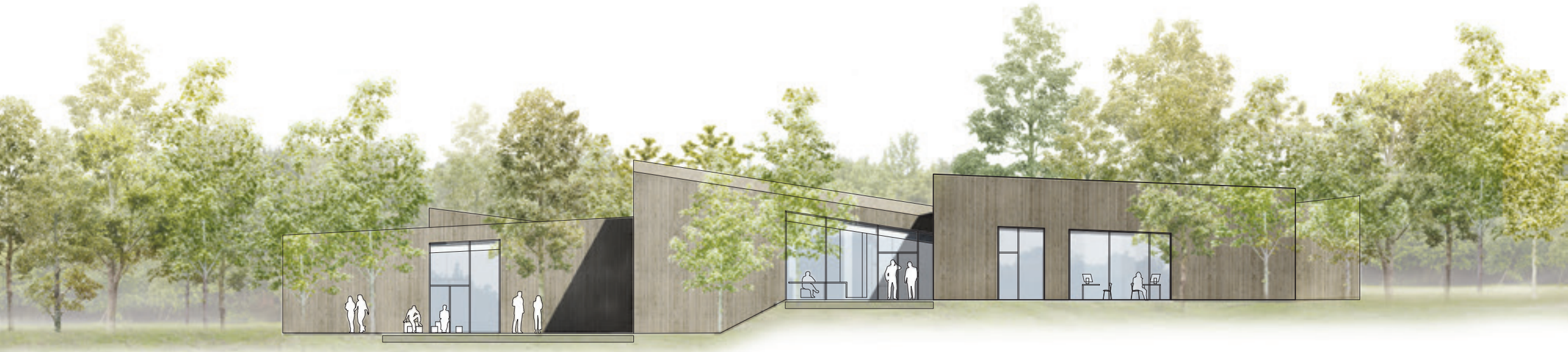




Ill. 107 - North Elevation 1:200

EAST FACADE



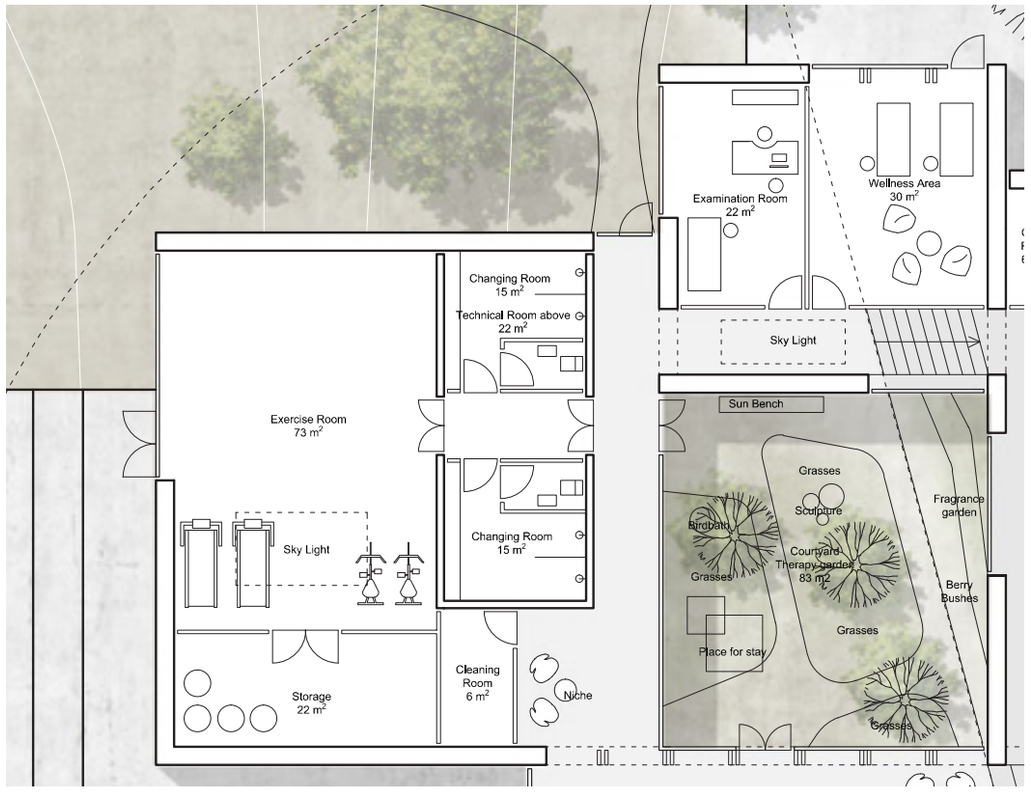


Ill. 108 - East Elevation 1:200

ACTIVITY AREA

The activity area is hosted in the two pavilions oriented towards northwest. Included is a double high exercise room where cancer patients rehabilitate and practice yoga and mindfulness as a part of their treatment programme. Connected to this are gender specific changing rooms. The exercise room is simple in its architectural expression and has a large window opening facing west towards the park. It is located towards the end of the space so that it has a part where you can withdraw to be totally unexposed. The space it self is elevated from the ground due to the natural downfall of the landscape and this is utilized to enhance privacy in the space. Hereby view out is maximized and view in from the outside is minimised.

As part of the collaboration with the hospital the examination room faces north, as do the wellness space. Here doctors can examine the patients, which calls for a private atmosphere, hence the placement towards north and the window opening that does not make space visible from other spaces in the building. Both the examination room and wellness benefits from the unspoiled forest landscape experienced through floor-to-ceiling windows.



Ill. 109 - Plan Detail 1:200 - activity area

Ill. 110 - Exercise room with view to nature

MATERIALS

The chosen materials are selected because of their appearance and tactility and to match with the overall ideas of the building. The materials of the inside reflect a warm interior with walls and ceiling cladded with light birch wood panels. The flooring material in the private functions, as opposed to that of the social spaces, is ash wood. The floor of the other spaces is robust polished concrete to make a contrast to the light wooden materials of ceiling and walls. The walls around technical spaces and wet areas are of concrete to both stabilize the glulam structure but also to add a refined interior with differentiated character.

The exterior sees both façade and roof cladded in treated dark larch wood in narrow strips varying in sizes on the different pavilions in line with the idea of purposeful variation. The wooden cladding wraps around the roof to create a clean cut pavilion that remains integrated in the forest – even as it is experienced from the hospital tower.

Ill. 111 - Birch wood

Ill. 112 - Glulam

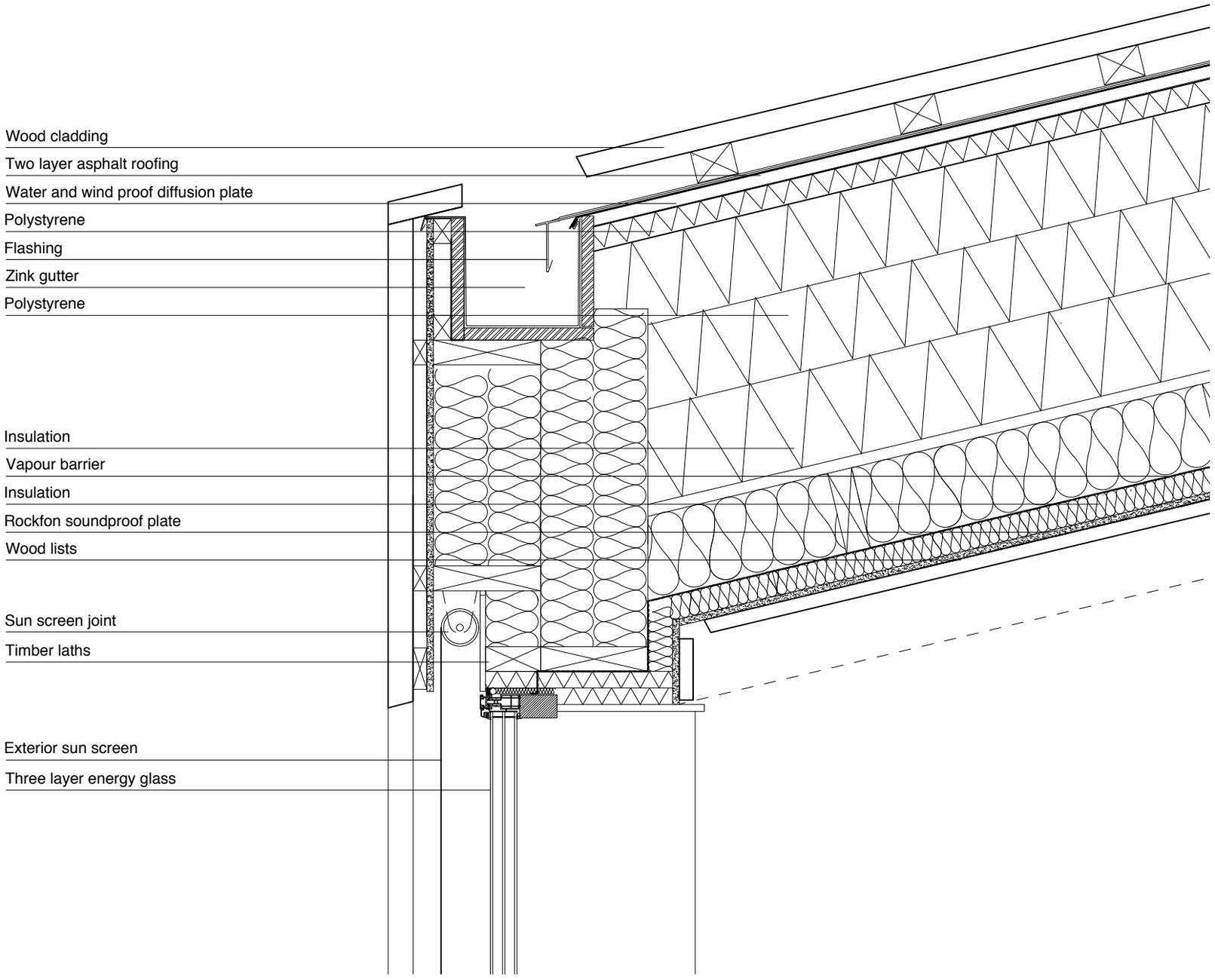
Ill. 113 - Polished concrete

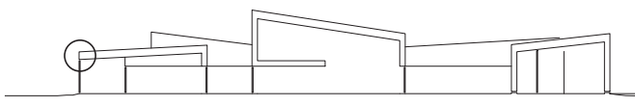
Ill. 114 - Larch wood

Ill. 115 - View through the entire building from lounge through courtyard to common space and large courtyard

DETAIL: GUTTER AND SUN SCREENS

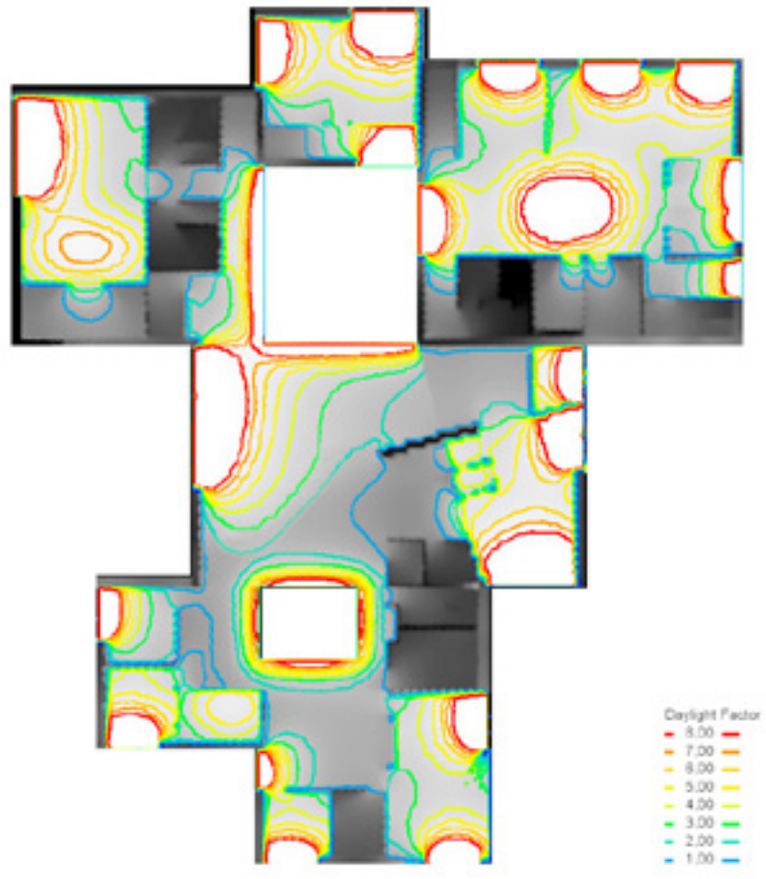
The detail and joining of elements need to be consistent with the idea of a sharply shaped pavilion structure. As means of doing so, the gutter is pushed back and integrated in the roof to not disrupt the strong shape. Due to the large windows openings exterior shading is installed in the facades, which means a small setback. This does not disturb the overall clarity of the shape and is beneficial in terms of avoiding overheating during warm summer periods.





Ill. 116 - Detail: Gutter and sun screen 1:10

Ill. 117 - Facade closeup from west



Ill. 118 - Daylight factor diagram

SUSTAINABLE FEATURES

The building is based on a range of environmentally sustainable passive strategies. The passive approach involves minimal cost of operation. Besides the environment and the economy the passive approach has also positive influence on the building's aesthetic, indoor climate, function and flexibility, which is essential for building sustainable in a longer perspective.

The northern location of the exercise room compared to overheating is among other things considered. The administration is also located to the north where the good light for work is. The other functions are located with focus on psychological well being, in terms of visibility and utilization of daylight.

Structures
First of all, the building is built with energy efficient structures, providing a low energy loss and no cold bridges. High density and well-insulated building envelope increases thermal comfort and reduces the energy consumption. The windows are triple layered energy glass, which has low energy loss as well.

U-values
Walls: 0.09 W/m^2 K
Ceiling: 0.07 W/m^2 K
Floor: 0.06 W/m^2 K
Three layer windows 0.8 W/m^2 K

Daylight
The large windows provide good daylight conditions and ensure light deep into the building, thereby reducing the need for artificial lighting. The daylight factor is visualized in the software Velux Daylight Visualizer 2, however, the analysis does not consider the surrounding trees.

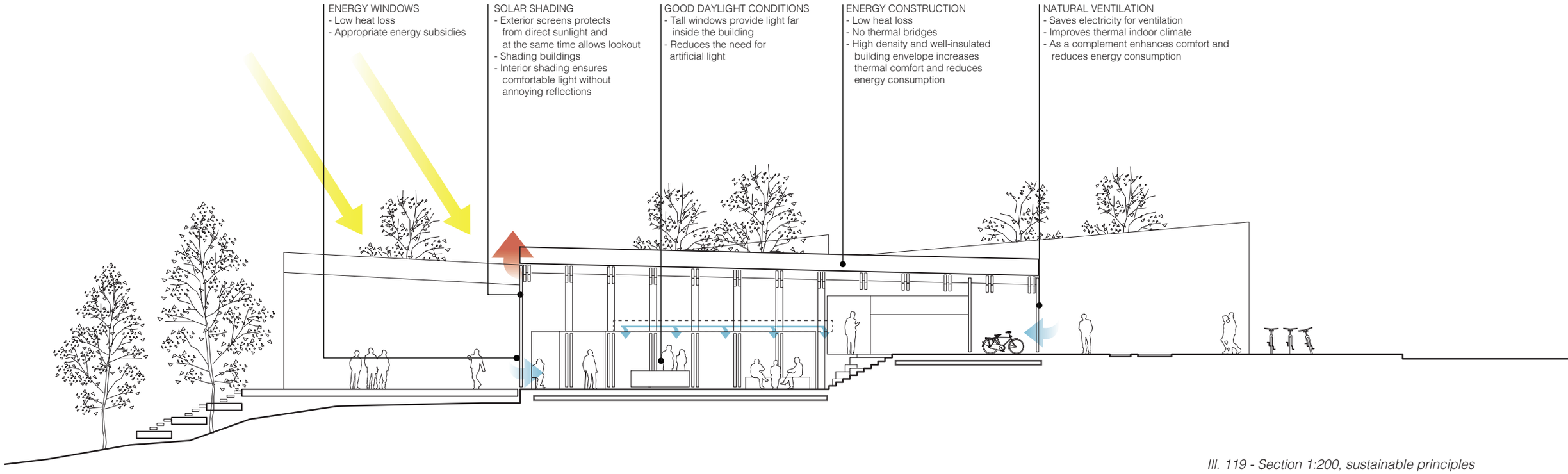
Daylight factors
Common space: 3.5% average
Staff room: 6.4% average
Office: 6.1% average
Group room: 4.4% average
Conversation room: 4.4% average
Exercise room: 6.0% average
Multipurpose Lounge: 2.5% average

Solar shading
The windows must have solar shading as external sunscreens, which shade direct sunlight and keeps the heat out. Interior shading ensures comfortable light without annoying reflections. Some parts of the building shade for the most vulnerable places at certain times of day and the surrounding trees cast shade as well, which reduces overheating.

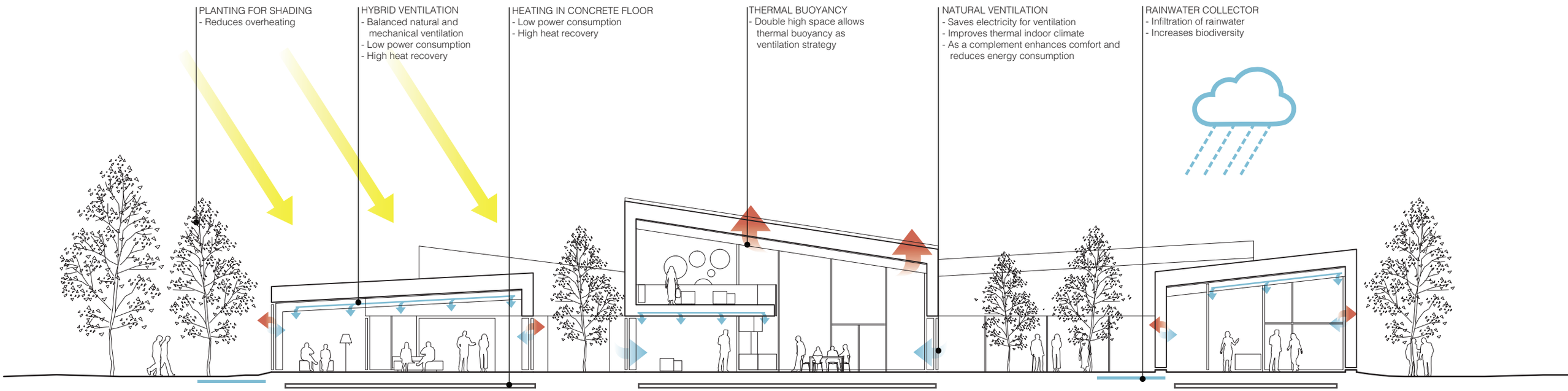
Around the building and in the courtyards there are rainwater collectors that will obtain all the water and lead it away from the building.

Ventilation and heating
In addition to this, there is implemented a hybrid ventilation strategy, which is balanced between natural and mechanical ventilation. This solution reduces the energy consumption when natural ventilation saves electricity for the mechanical ventilation and improves thermal indoor climate. In the large common space the height is used to create thermal buoyancy and lets the hot air come out in the top of the large window. The building floor uses floor heating that has high heat recovery.

Production
Production of the building is also sustainable because the intention is, among other things to use local materials and reuse and restructure the existing soil. There are maintained a large part of the existing trees, but these, which for good reasons cannot stay are gently being moved to a new location on the site. The intention is to let the smallest glulam frames be assembled before arriving at the site. The largest that are too large to be transported must be assembled on site.



Ill. 119 - Section 1:200, sustainable principles



Ill. 120 - Section 1:200, sustainable principles

Ill. 121 - Reflective space with art and sky light

REFLECTIVE SPACE

Inspired by American artist James Turrell, a space for spiritual contemplation that only have skylight and view up to the treetops is created. The idea is to create a different space where one can be oneself and philosophize in an enclosed space.

In deviation to the domestic aspect, this room is designed as a small art gallery where different arts can be exhibited and eventually be replaced. Depending on the season and time of day the artwork will be perceived in different ways because of the position of the shadows of the trees.

CONVERSATION ROOMS

Conversation rooms hosts the most sensitive and private conversations. These spaces have a calm atmosphere with a clearly defined space with warm wooden materials. Contributing to the calm intimate atmosphere is the good acoustic properties of the wooden panels that lower reverberation time. The conversation rooms are placed furthest from the road and oriented towards nature to include the calming effect of vegetation.

Ill. 122 - Conversation room with art, visible beams and columns and view to nature

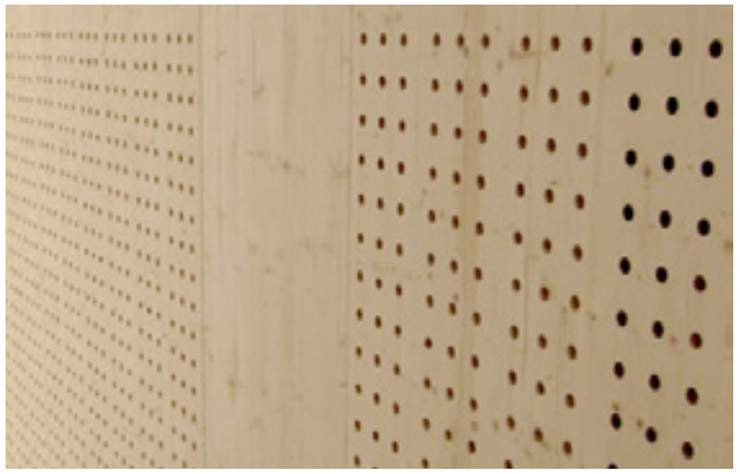
ACOUSTIC DETAILING

The good and intimate acoustic environment can be achieved by treating the wooden materials on the walls and ceiling as the beams and furnishings alone are not enough. To keep the clarity of the space, small perforation varying in size and position can be applied to optimize the acoustics. This is done to prevent high reverberation time. Calculations are done for a conversation room and based on surface areas and absorption coeffiencies for each material. The surface area of the walls are estimated to have perforation punchings corresponding to 25%. This area percentage has a absorbtion coeffiency of the Rockfon VertiQ material (Rockfon 2015), that is placed in behind the birch panel walls. The reverberation time is calculated by Sabine's equation:

$$T = 0.161 \cdot \frac{V}{(\alpha + (-S \cdot \ln(1-\alpha)))}$$

The reverberation time cannot exceed 0,4s (Bygningsreglementet.dk) for this type of room, which means that the the conditions are satisfactory.

Ill. 123 - Sound proof panels in wood, village hall in Holbæk, BBP Arkitekter



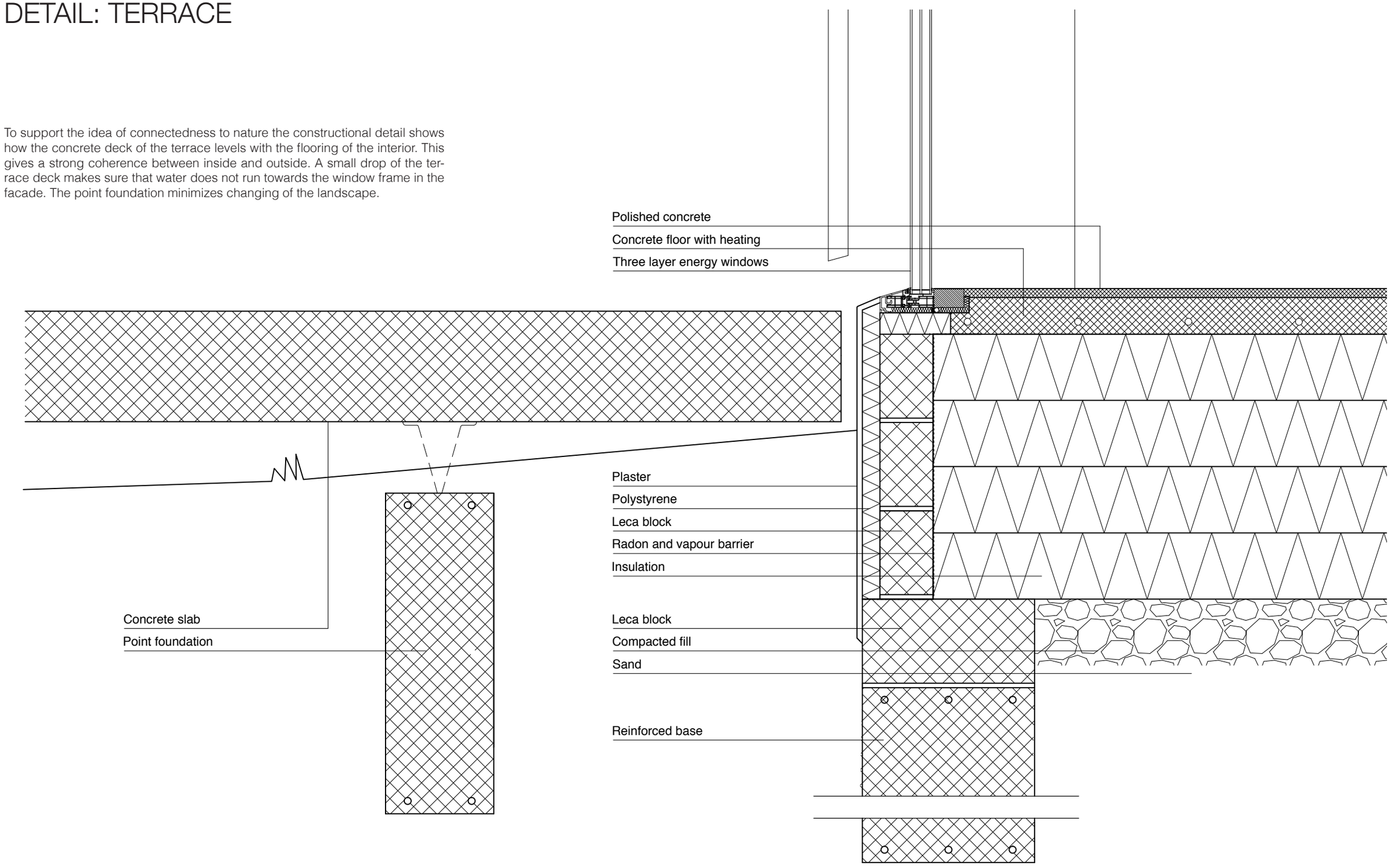
Ill. 124 - Sound proof panels in wood

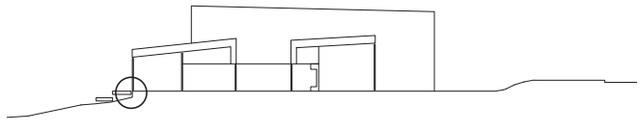
Reference of building part	Area (m^2) S	Material	125 Hz		250 Hz		500 Hz		1 kHz		2 kHz		4 kHz	
			α	- S*ln(1-a)	α	- S*ln(1-a)	α	- S*ln(1-a)	α	- S*ln(1-a)	α	- S*ln(1-a)	α	- S*ln(1-a)
Floor	19,80	Ash wood	0,25	5,70	0,11	2,31	0,10	2,09	0,07	1,44	0,06	1,23	0,07	1,44
Wall, perforation	7,73	Rockfon VertiQ	0,25	2,22	0,75	10,71	0,99	35,57	0,99	35,57	0,99	35,57	0,99	35,57
Wall, solid	23,18	Birch wood	0,14	3,50	0,10	2,44	0,06	1,43	0,08	1,93	0,10	2,44	0,10	2,44
Ceiling	20,10	Birch wood	0,14	3,03	0,10	2,12	0,06	1,24	0,08	1,68	0,10	2,12	0,10	2,12
Plasterwall	11,80	Plaster	0,15	1,92	0,10	1,24	0,08	0,98	0,06	0,73	0,06	0,73	0,06	0,73
Door	2,00	Birch wood	0,14	0,30	0,10	0,21	0,06	0,12	0,08	0,17	0,10	0,21	0,10	0,21
Window	8,80	Glass	0,35	3,79	0,25	2,53	0,18	1,75	0,12	1,12	0,07	0,64	0,04	0,36
SUM			1,42	20,46	1,51	21,56	1,53	43,19	1,48	42,64	1,48	42,94	1,46	42,87
Hz			125		250		500		1000		2000		4000	
Reverberation Time			0,32		0,40		0,21		0,21		0,21		0,21	

Ill. 125 - Reverberation time chart

DETAIL: TERRACE

To support the idea of connectedness to nature the constructional detail shows how the concrete deck of the terrace levels with the flooring of the interior. This gives a strong coherence between inside and outside. A small drop of the terrace deck makes sure that water does not run towards the window frame in the facade. The point foundation minimizes changing of the landscape.



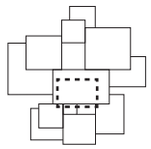


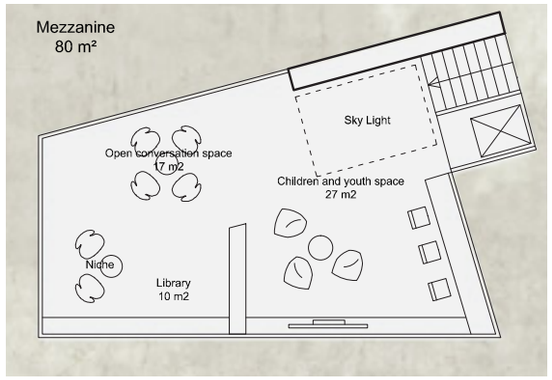
Ill. 126 - Detail: Terrace 1:10

MEZZANINE

The top level offers something different to the spatial portfolio. The lamella cladded mezzanine is visually strongly defined in the common space and gives the user an opportunity to go up under the ceiling to a cave-like atmosphere. This space has multiple functions such as space for children and youth, library and an open conversation room. The integrated furniture running along the back functions as shelves for the library books, stands for the TV and computers, and naturally divides the spaces to define the spaces. From the mezzanine one has a clear overview and a view to nature through the tall windows in both the common space and the workshop area.

The mezzanine offers the opportunity to quickly withdraw from the common space area or potentially when arriving from the street. The mezzanine is accessible by the staircase or by the disabled elevator that stops on every level.





Ill. 127 - Plan Detail 1:200 - mezzanine

Ill. 128 - The mezzanine with library, children and youth space and an open conversation space. View to the park and the big sculptural lamp.

PROCESS

Elaborating on the design, the process is set to clarify the shaping of the design. It contains various studies that have been examined and evaluated in terms of healing architecture, construction, sustainability and the overall architectural concepts.

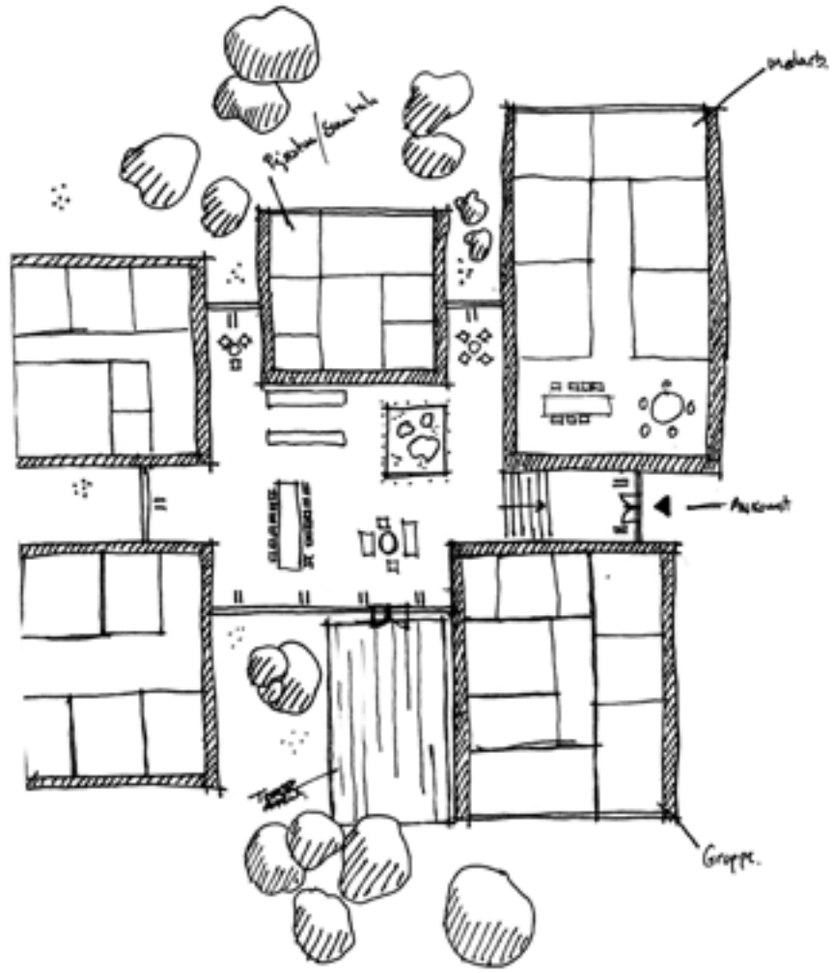
VOLUME STUDIES

The following shows the very first volume studies. The study is done to find out what 1.200 m2 obtain on the site and how it interacts with the context.

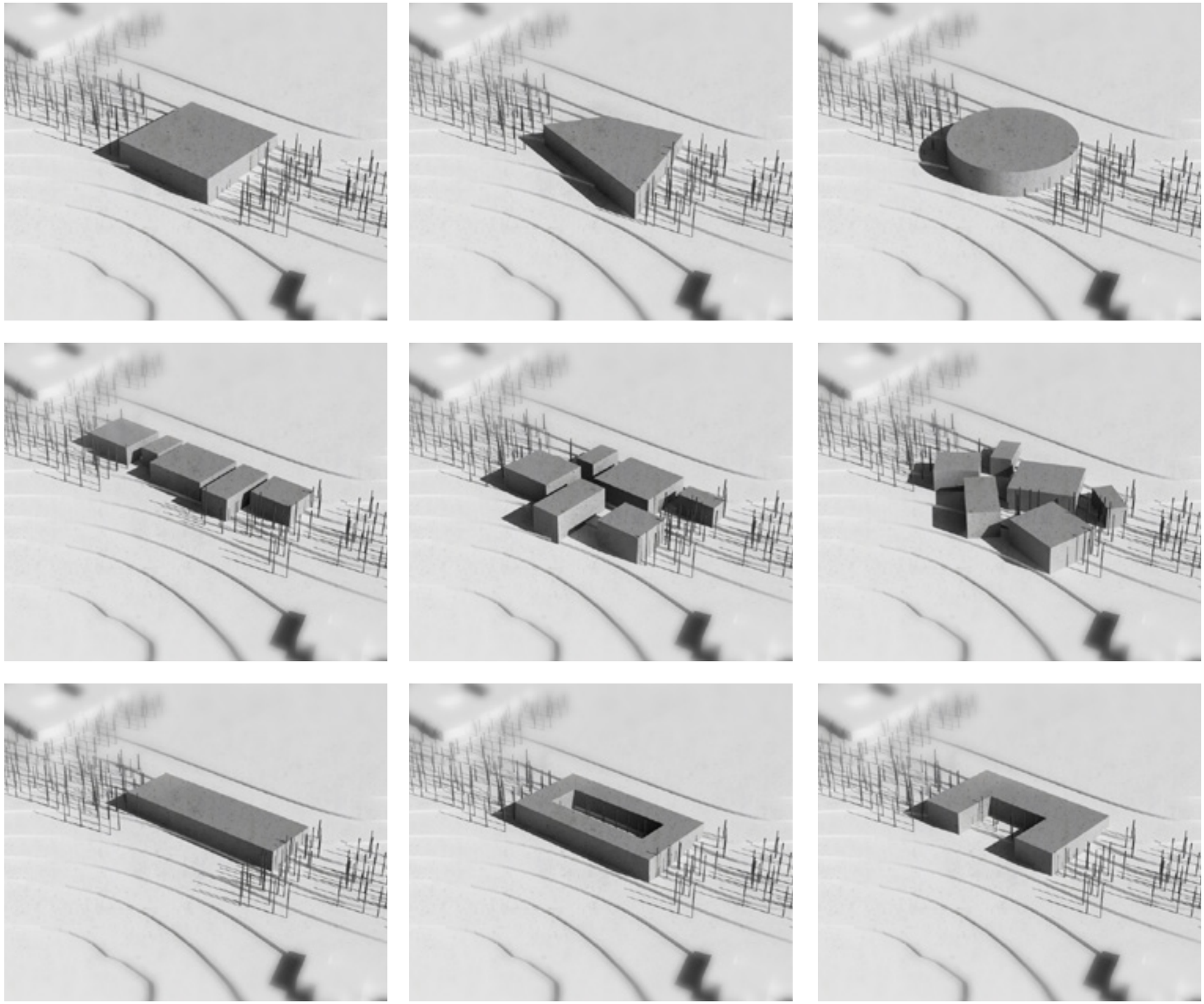
The three in top are three very compact volumes
The square, the polygon, the circle. All are very introverted in nature and do not let nature get into the architecture where outdoor spaces will be around the building. They are not welcoming and have no direction. They have long facades and the scale is large, and this gives a small façade surface area. One can say that it is a closed form, which cannot be extended and is not flexible. There is no possibility of light far into the building besides skylight.

The three in the middle are three fragmented volumes
Scattered in a row, scattered in a square, scattered and rotated. Here nature enters between the volumes, the scale is broken down and thus gives several but smaller facades. This also means more surface area, which means that there may be more light shed into the interior spaces. It is possible to have outdoor spaces between the volumes. The direction is dependent on the composition and thus flexible where the view can be controlled from volume to volume.

The three in bottom are three oblong volumes
The stick, the long block, the horseshoe. All have a clear direction, but only the horseshoe structure caters to the park. They have extensive facades and are less inviting but nature can come in and along the architecture. All have good opportunities to get enough light when the facade area is elongated. In the block and the horseshoe, the potential for private outdoor spaces are very essential.



Ill. 129 - Plan sketch



Ill. 130 - Volume studies

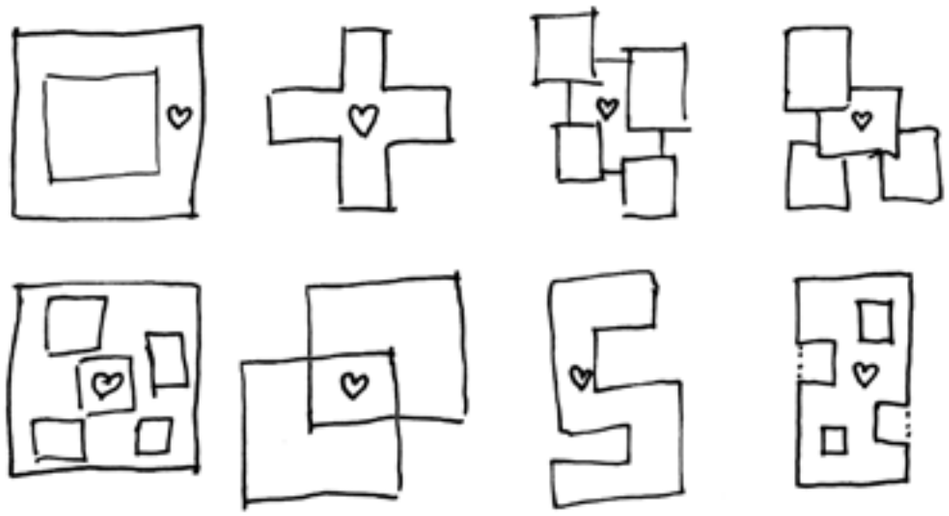
PLAN STUDIES

The following is an extract of the different plan proposals during the design process; studies showing different flows, potentials of light intake and locations of common space in the building. Common to all is that the functions are placed after the function diagram in which the private functions are located to the west (away from the road), the administration to the northeast because of the good daylight properties for working and the exercise room to the north to avoid overheating.

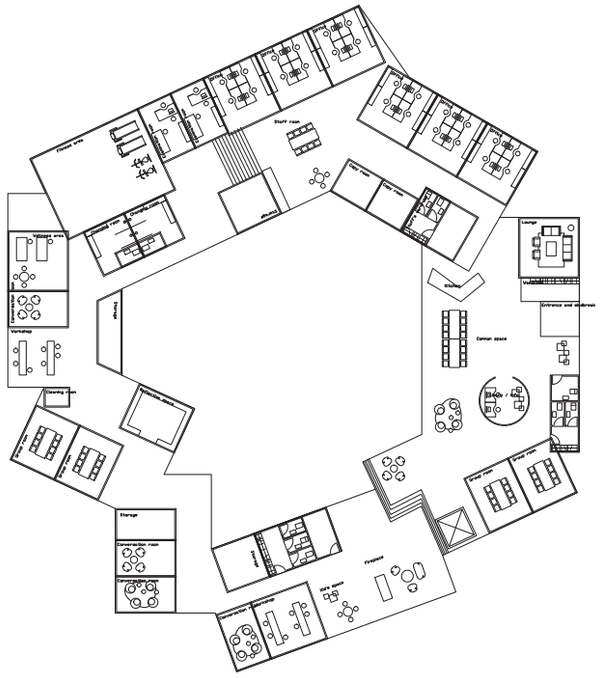
Two proposals have circular flow around a large inner courtyard where it is possible to assemble all the outdoor spaces. The interior functions are like pearls on a string, which adds much corridor area. One arrives directly into the common space and can either go right or left.

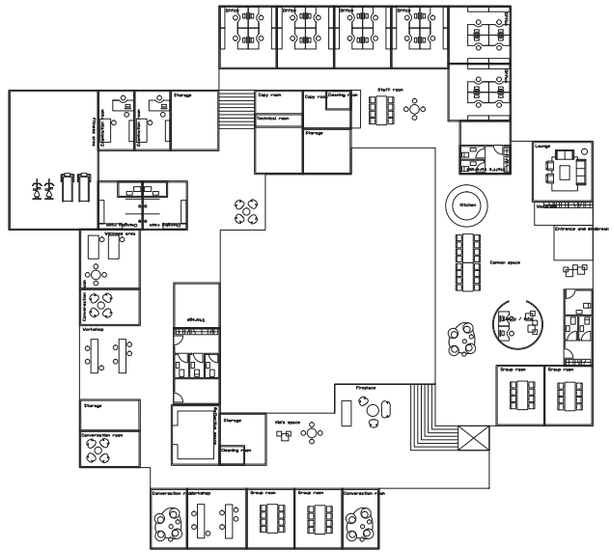
Another proposal have a star shape with direct arrival in the common space in the middle where one move out to other functions. There are dead ends in the wings where this is improved with a circular flow around a northern courtyard.

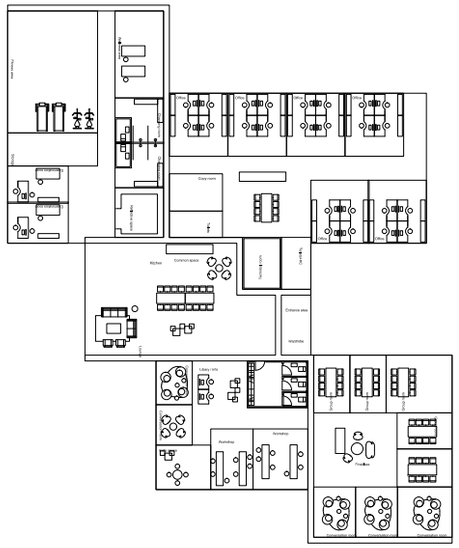
There are several proposals of a pavilion structure with common space as the centre and everything is located close to the heart of the house. Nature comes in between and into the volumes via small private courtyards with flow going around it. These structures have revealed good daylight potentials.

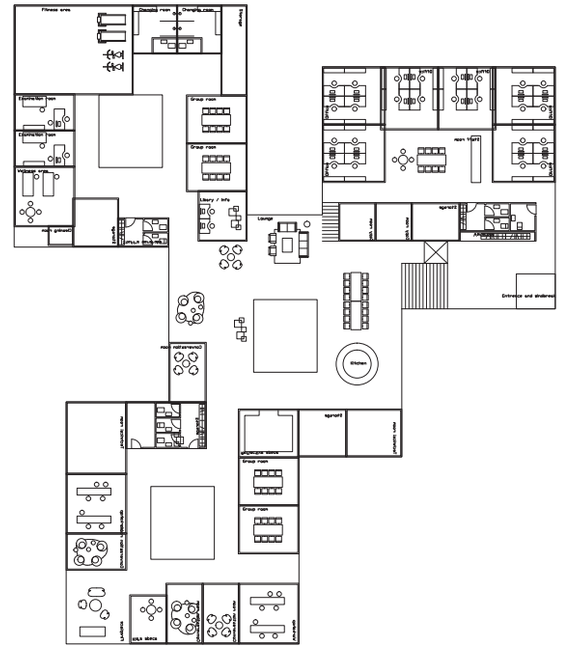


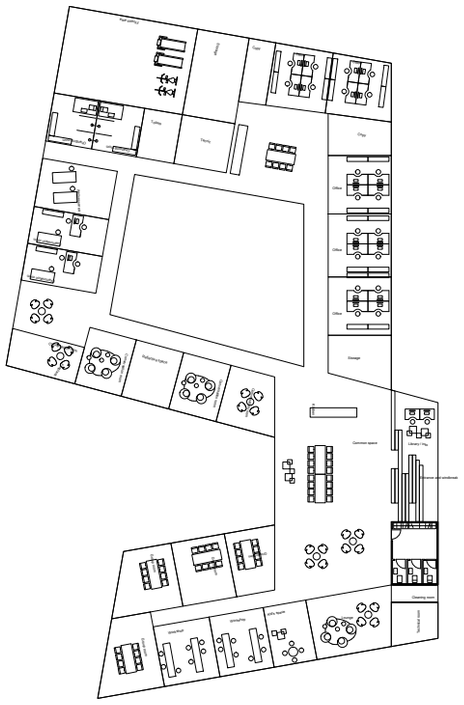
Ill. 131 - Concept diagrams

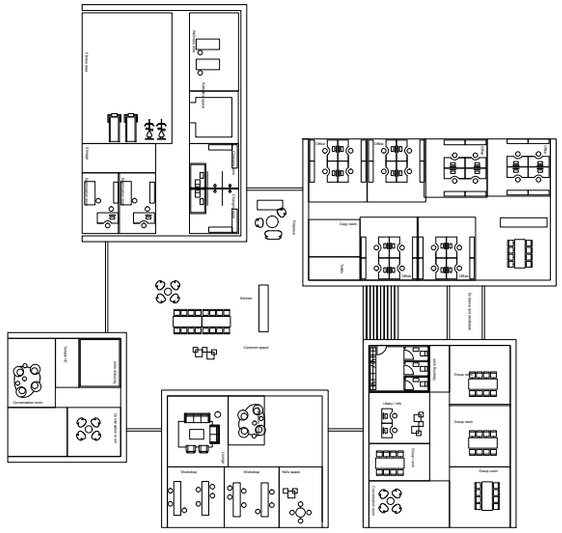


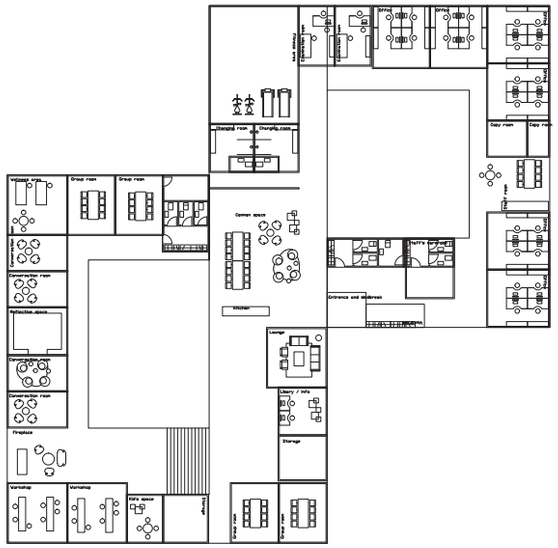








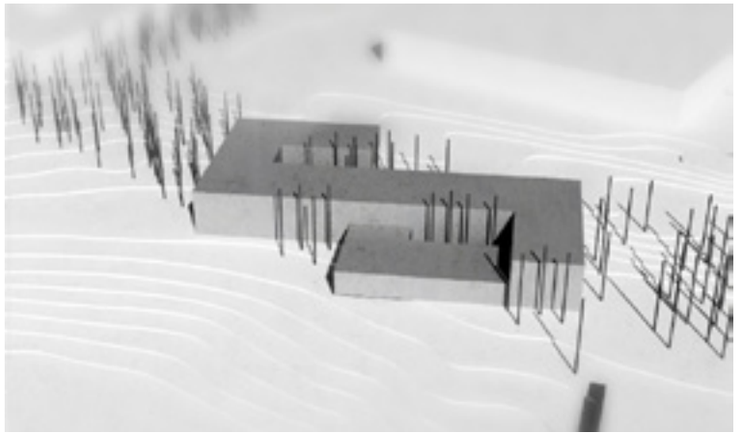


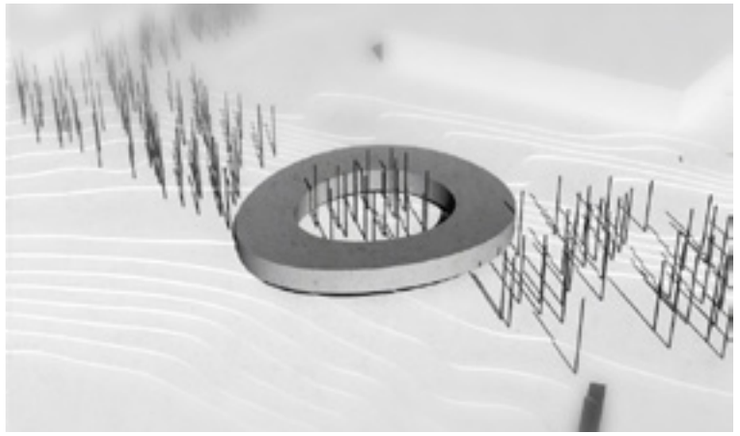


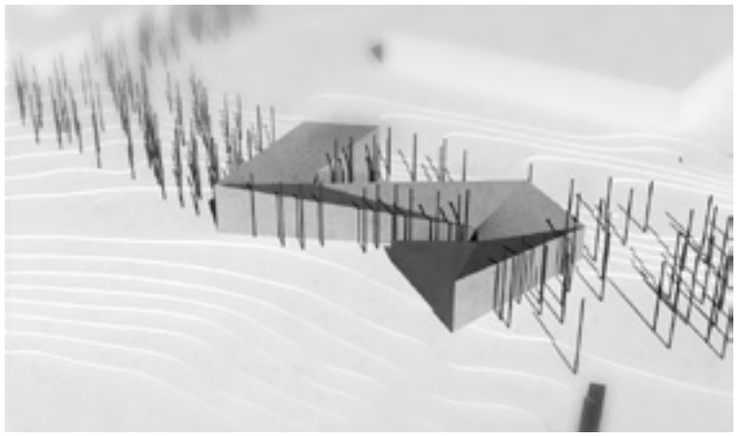
FORM STUDIES

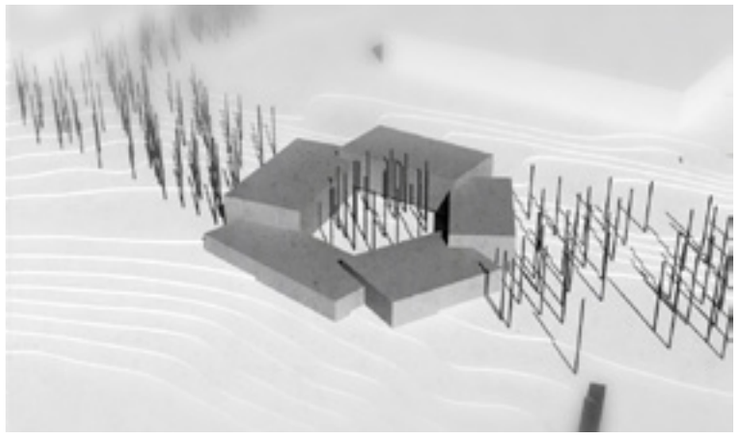
Considering the quote by Charles Jencks on the aesthetics of a cancer centre, these studies show several form iterations, that are discussed according to this proposition. To match the ambitions of designing a house that has the characteristics of a church, a hospital and an art gallery all at the same time, a wide range of model sketches of various forms and expressions has been carried out.

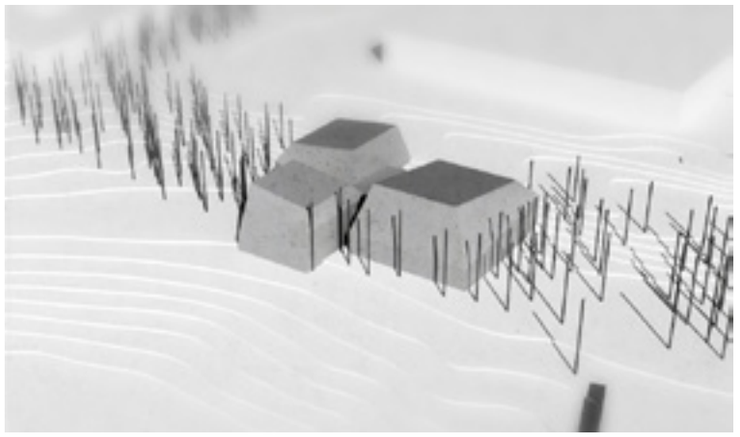
It is important that the architecture does not blend in to the surrounding villas with their traditional brick facades and pitched roofs. It must still be homelike, but attain more expressive aesthetics. The architecture must tell a story about the cabins in the woods and adapt to the context by being welcoming. The shape must be flexible in terms of allowing different spaces to have different heights. Common to all the sketches is that the architecture elaborates on sculptural and original characteristics.

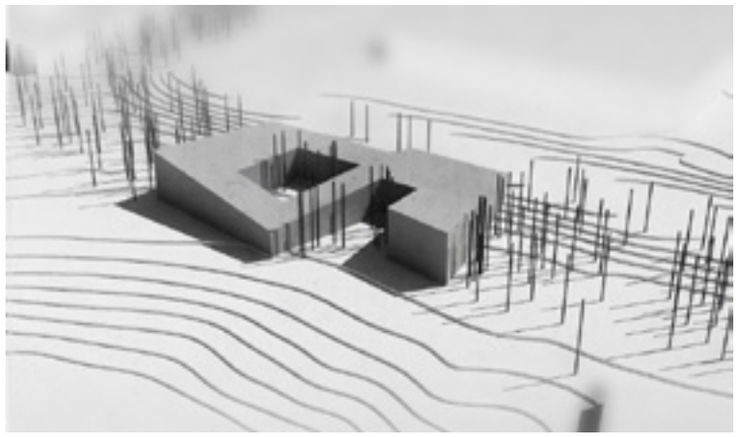


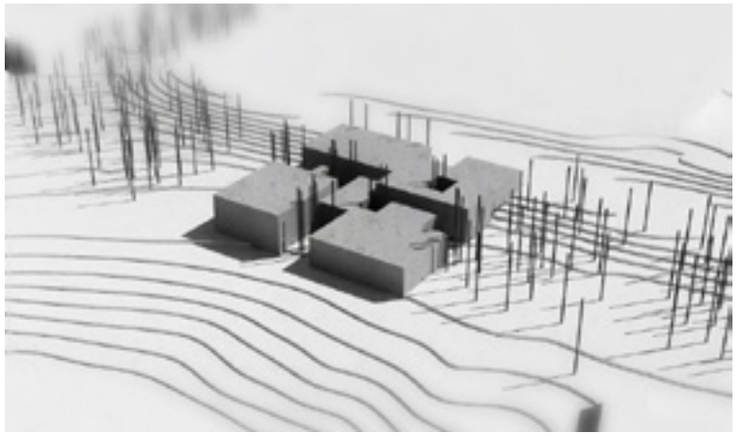
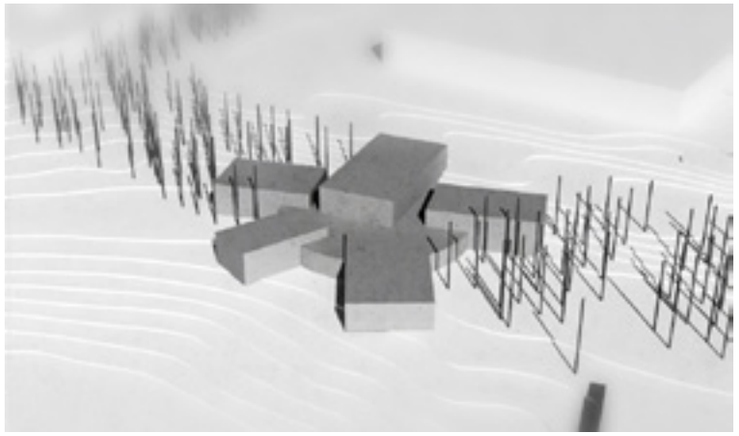
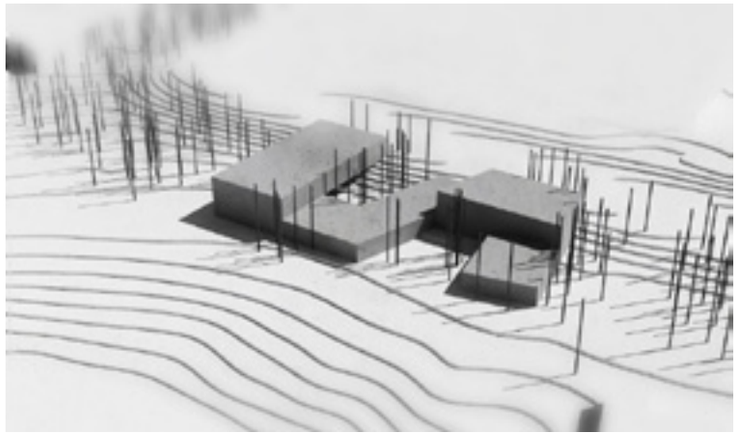
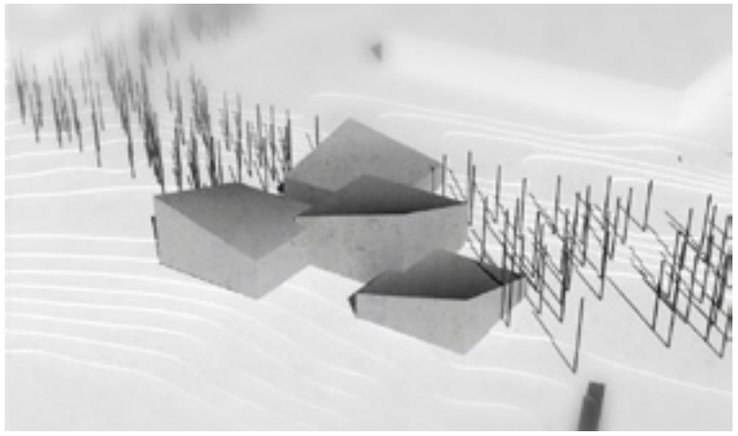
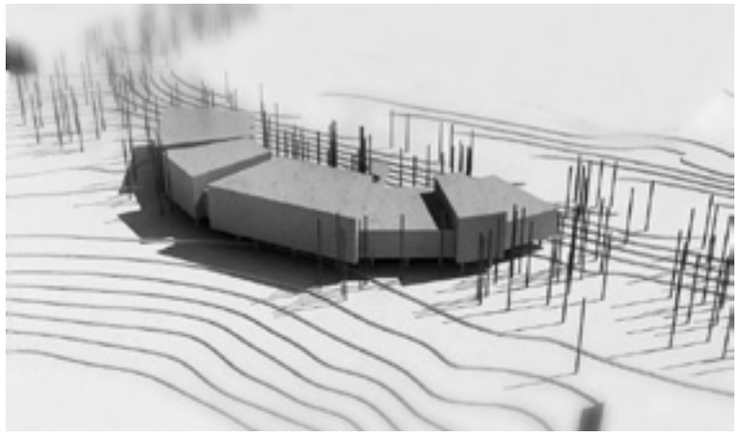
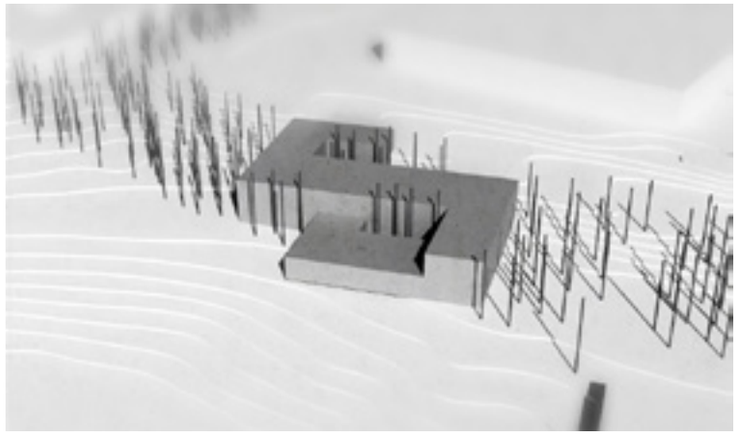
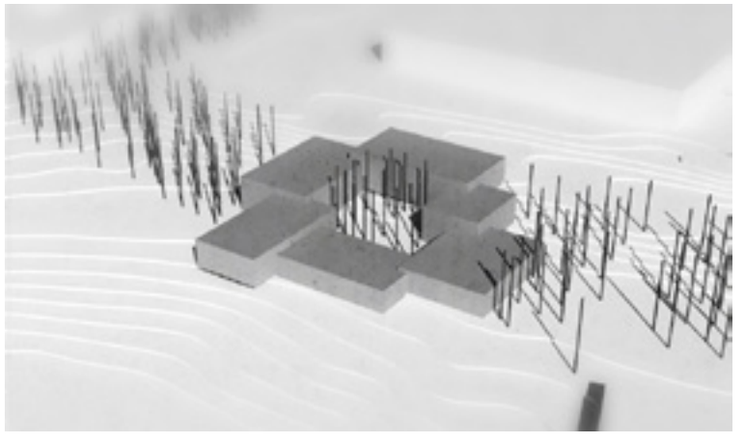
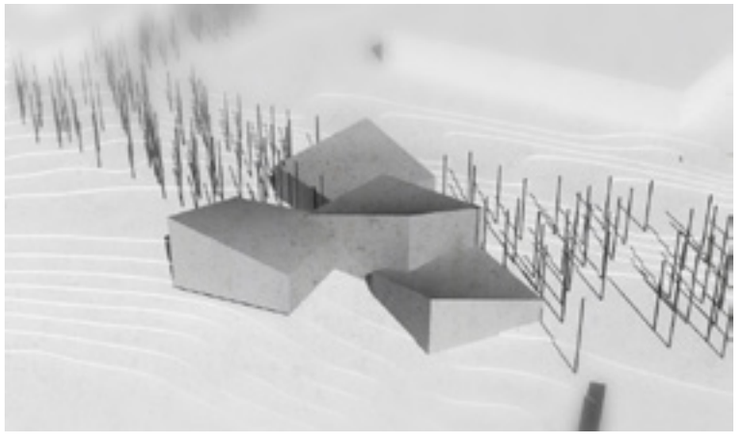










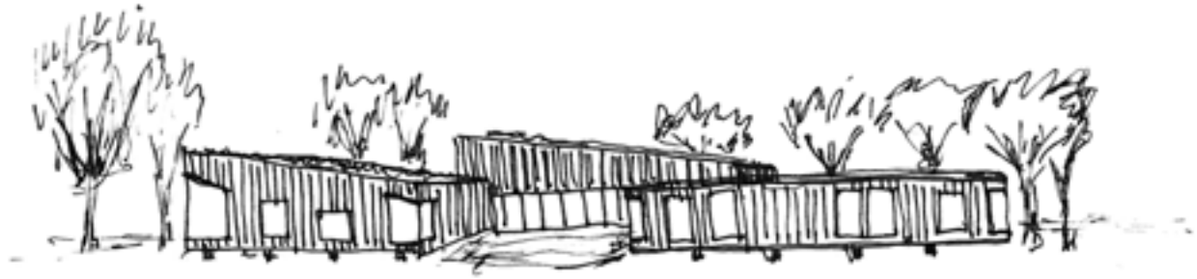

Ill. 133 - Form studies

FACADE STUDIES

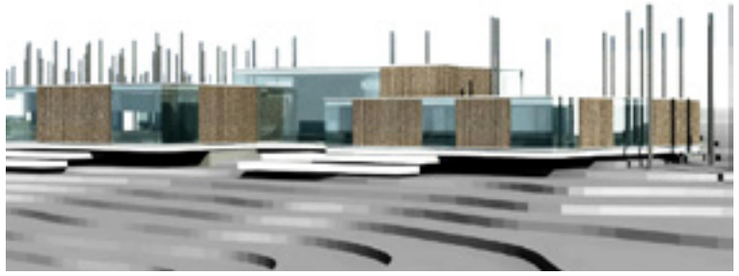
A narrowing in of the process occurs to further development of the facade and form and the link between them.

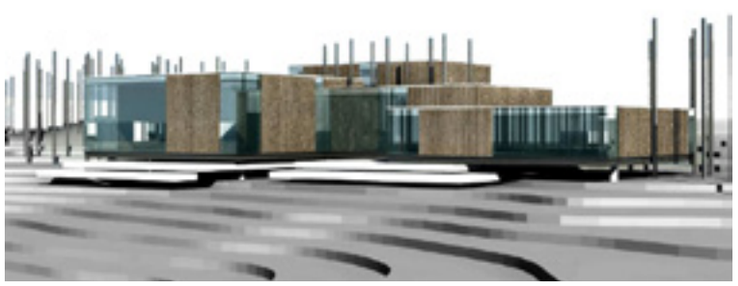
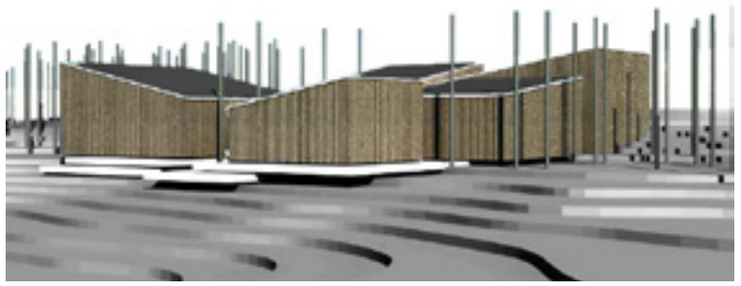
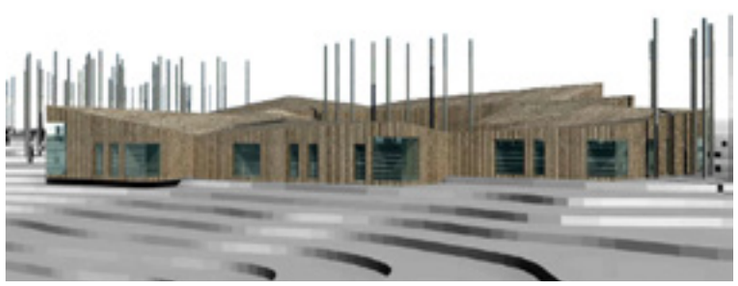
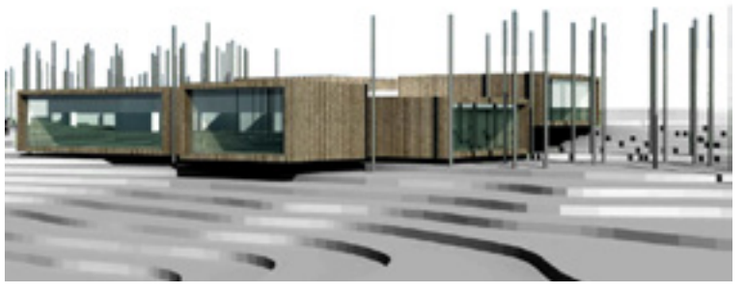
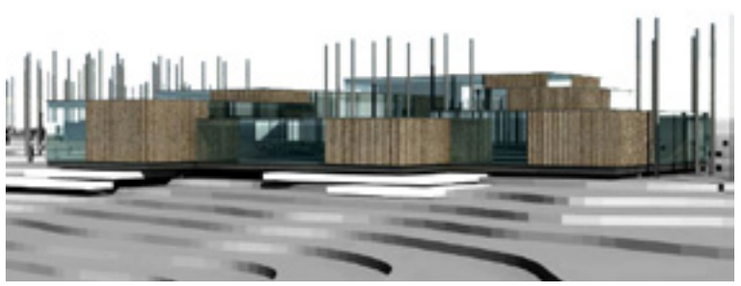
With the vision of creating a cabin atmosphere as well as the idea of Nordic architecture in mind, wooden materials are introduced. In addition, the quotation from Charles Jencks is still an important catalyst for the character. The shape and window location is still attempted to be different, sculptural and expressive.

The theory about healing architecture considers having large and few windows where they are needed, rather than having many small, which do not give the same view to nature and often result in a lower quality of daylight. The different ceiling heights, room depths and the different demands for daylight are factors taken into account, when designing the outer expression.

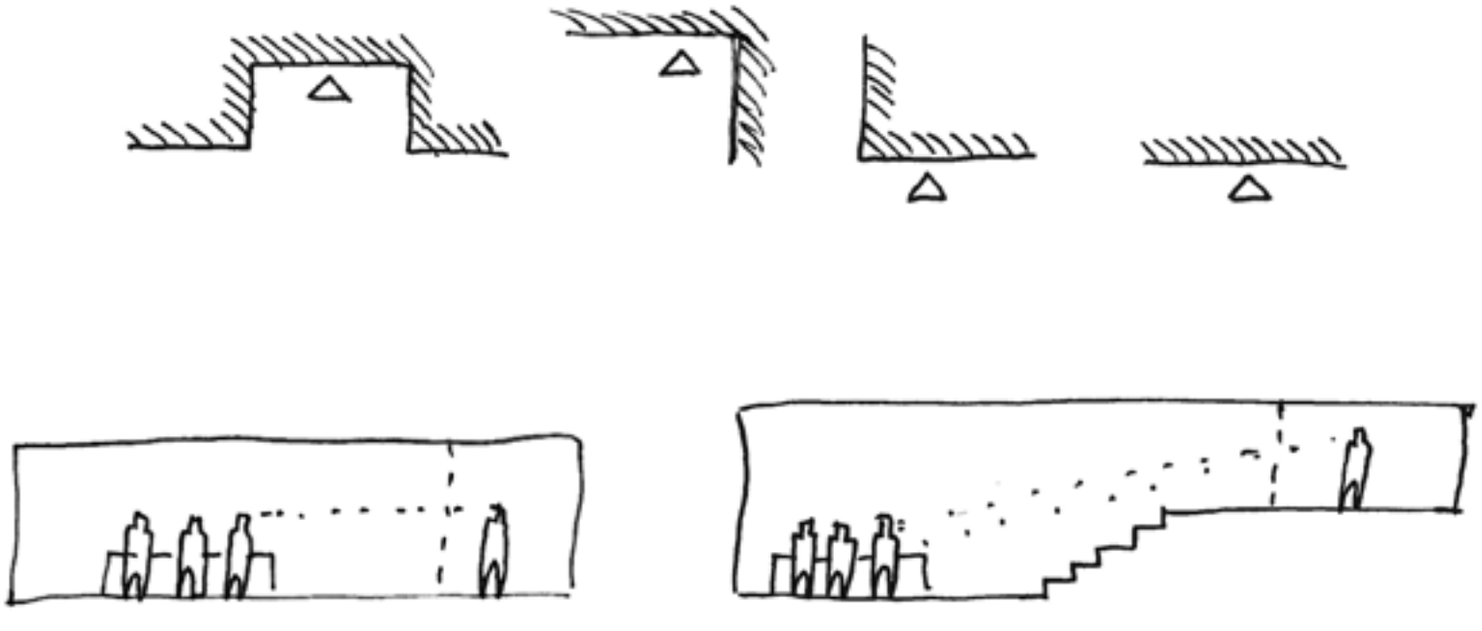


Ill. 134 - Facade sketches




Ill. 135 - Facade studies

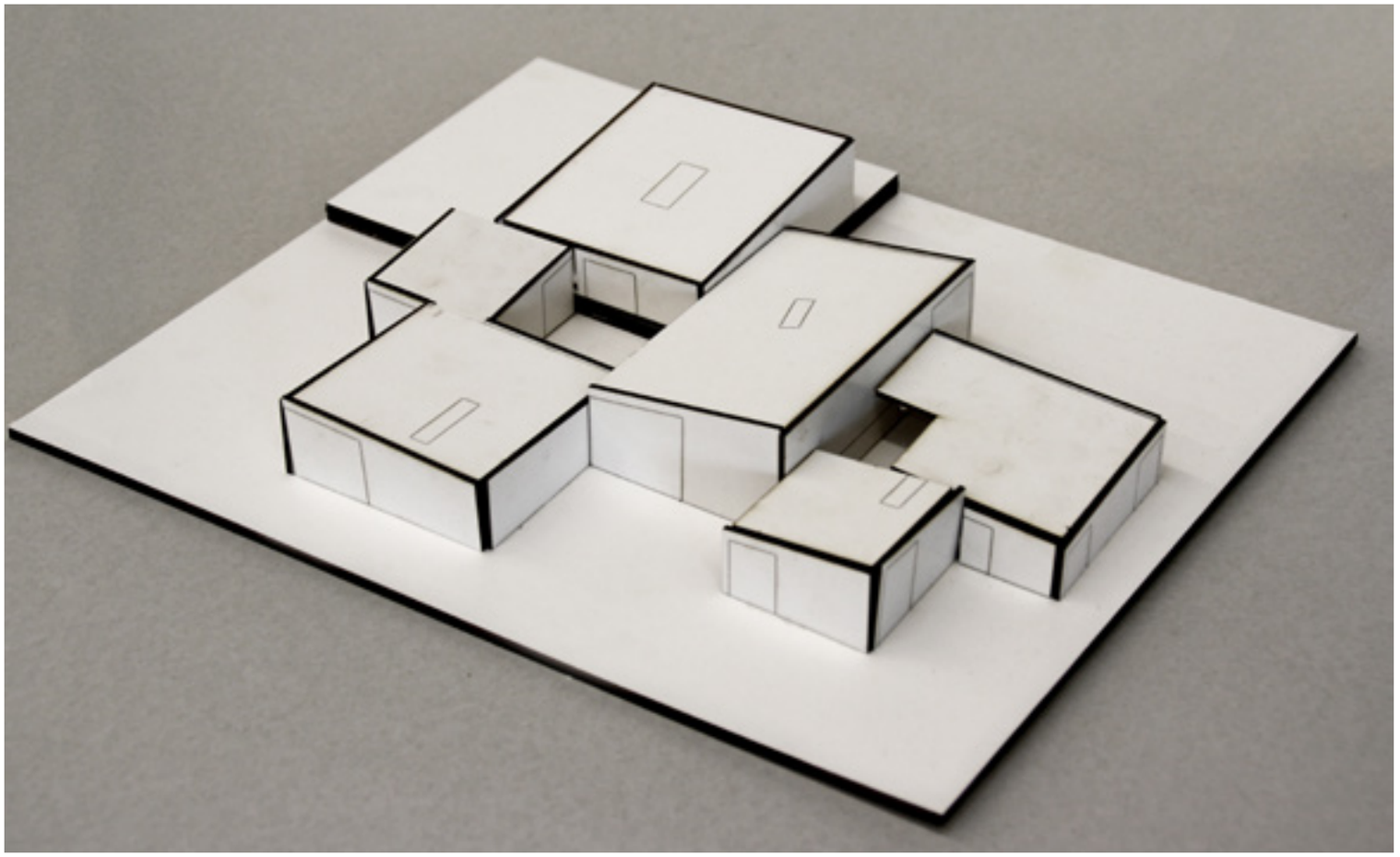


Ill. 136 - Sketches of entrance scenarios such as corner entrance, entrance between volumes and split in levels.

FINAL FORM

The following shows a processing of facade and form and the relation to the surroundings, which is important in Nordic architecture.

The proportions are tested for each volume relative to outer expression, but also for internal function. The windows are tested to create a simple expression, but also whether there will be enough light deep into the volumes. The position of the window have been tested to create clear volumes, but also to accommodate external sunscreens. The nuances in the wood are tested to find the perfect glow and significance plus the concrete terrace decks are tested to make them fit with the landscape. As opposed to approaching the entrance on a straight facade, other options of more embracing quality has been tested, including the entrance flanked by a building volume to access the centre in a corner.



Ill. 137 - Physical model

Ill. 138 - Facade and form

CONSTRUCTION STUDIES

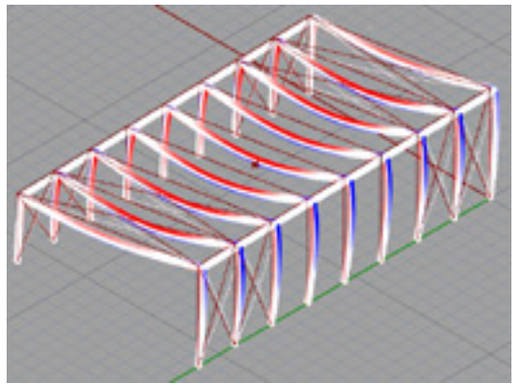
During the design process the construction is tested. A simple structure can change with a few initiatives. There are evaluated on the carrying capacity but also on aesthetics and expression at the same time to pursue a tectonic approach of a structure that works in severeal aspects.

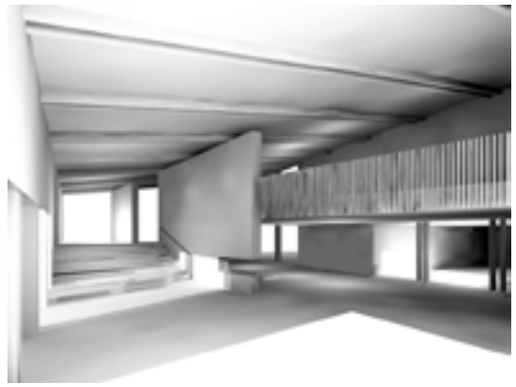
Therefore, the structural system is built in the plugin for Rhino, Grasshopper, so it can be designed parametrically where dimensions of the overall shape can be changed, but also the dimensions of each column and beam as well as the number of frames and the c/c distance. This parametric model can be transferred to the program Karamba that can show the deflection and maximum displacement with the introduction of the right permanent loads, wind load and snow load and material values. In this way, the effect of smaller, bigger, fewer or more beams and columns can be seen instantly and shows how the structure acts under stresses of different loads. The loads applied considers both vertical and horizontal loads.

Therefore, there is made several iterations of different frame configurations for making the carrying capacity match the desired expression of the light, embracing and securing. In the six iterations there are tested on, c/c distance, number of frames, the dimensions of the beams and columns, one versus two frame systems and the reaction thereof.

Iteration 1

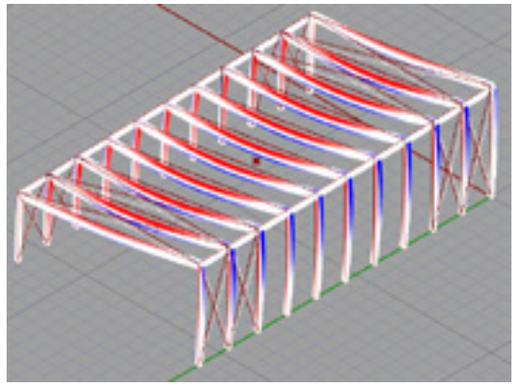
- Number of frames: 9
- C/C distance: 2700 mm
- Beam dimensions (H x W): 40mmx10mm (x2)
- Maximum displacement: 46.9 mm





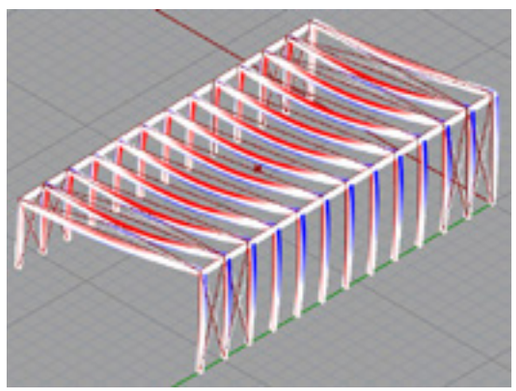
Iteration 2

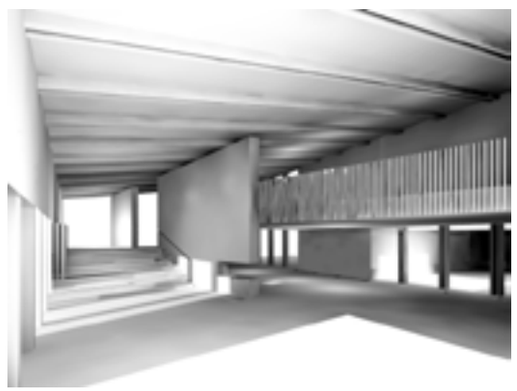
- Number of frames: 11
- C/C distance: 2200 mm
- Beam dimensions (H x W): 50mmx10mm (x2)
- Maximum displacement: 26.5 mm



Iteration 3

- Number of frames: 13
- C/C distance: 1800 mm
- Beam dimensions (H x W): 40mmx10mm (x2)
- Maximum displacement: 31.4 mm

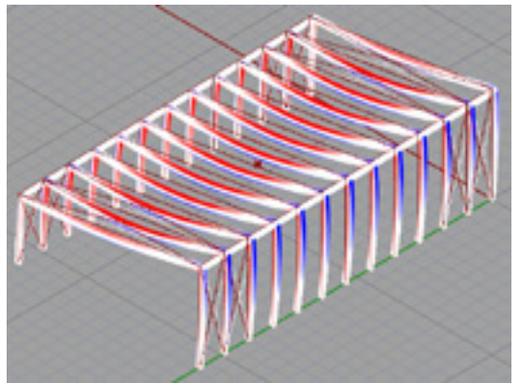


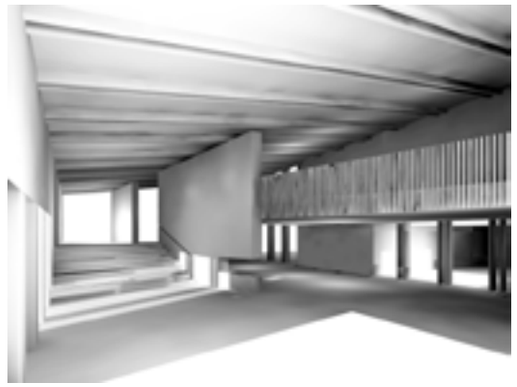


III. 139 - Structure studies

Iteration 4

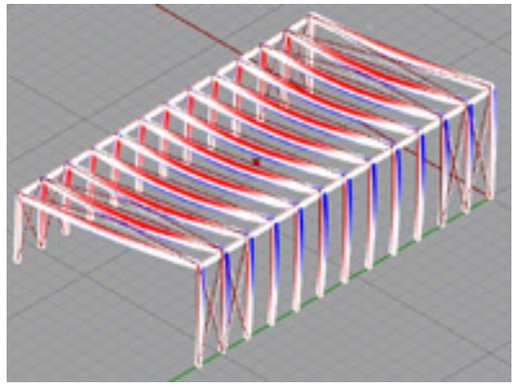
- Number of frames: 13
- C/C distance: 1800 mm
- Beam dimensions (H x W): 40mmx10mm (x2)
- Maximum displacement: 28.2 mm

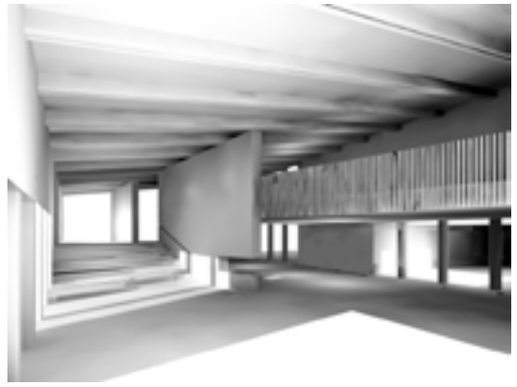




Iteration 5

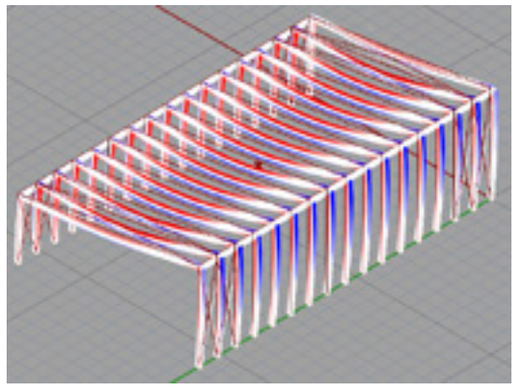
- Number of frames: 13
- C/C distance: 1800 mm
- Beam dimensions (H x W): 46mmx10mm (x2)
- Maximum displacement: 25.3 mm

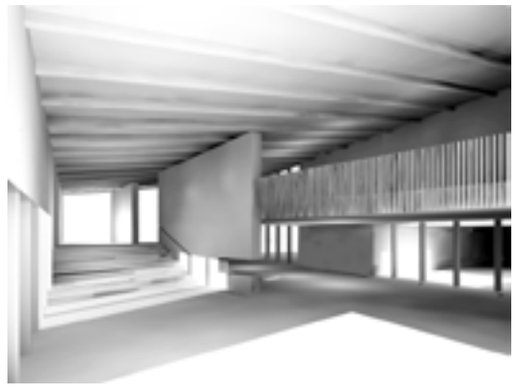




Iteration 6

- Number of frames: 17
- C/C distance: 1300 mm
- Beam dimensions (H x W): 40mmx5mm (x2)
- Maximum displacement: 29.4 mm





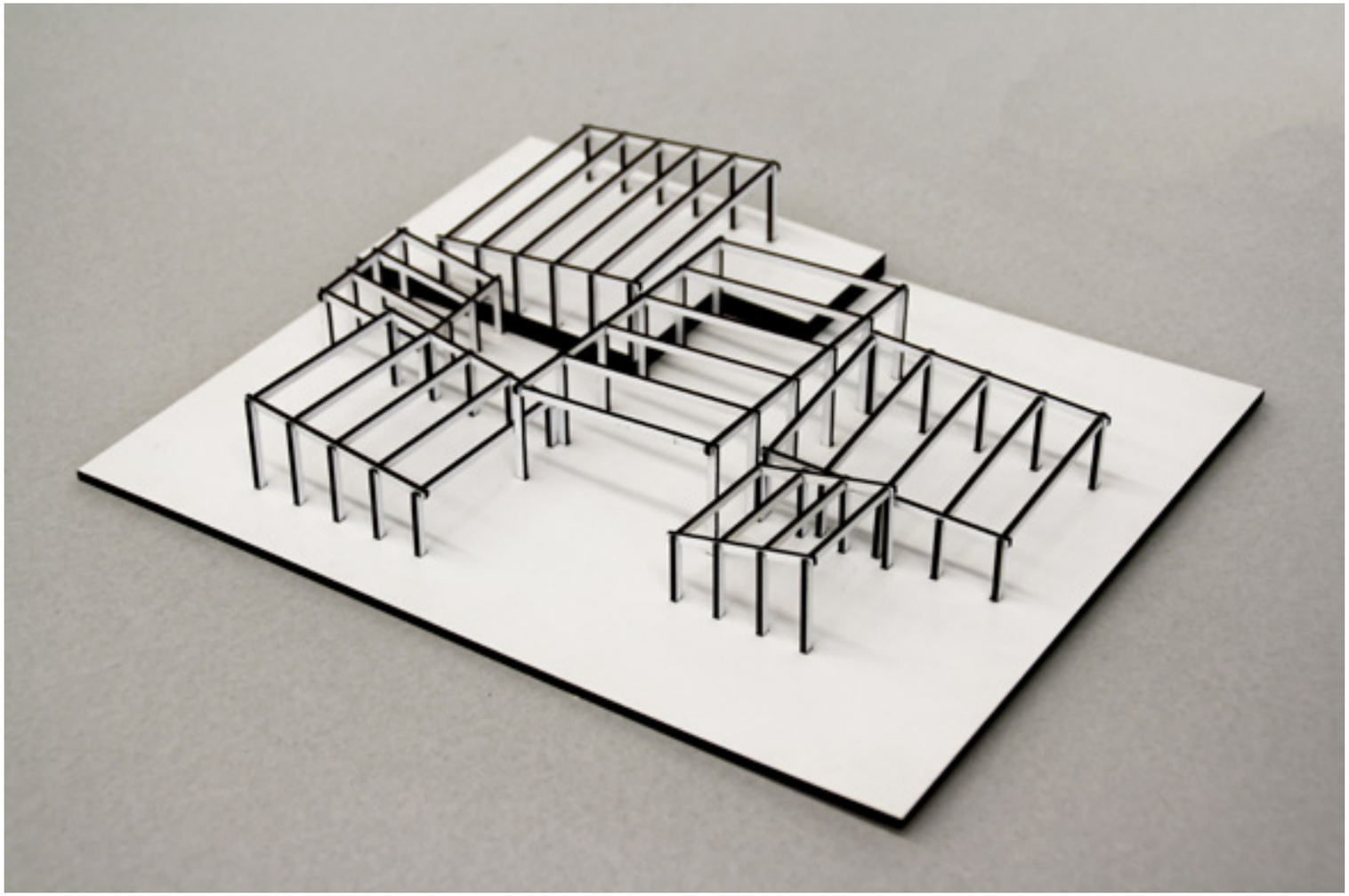
Ill. 140 - Structure studies

DETAILING THE JOINT

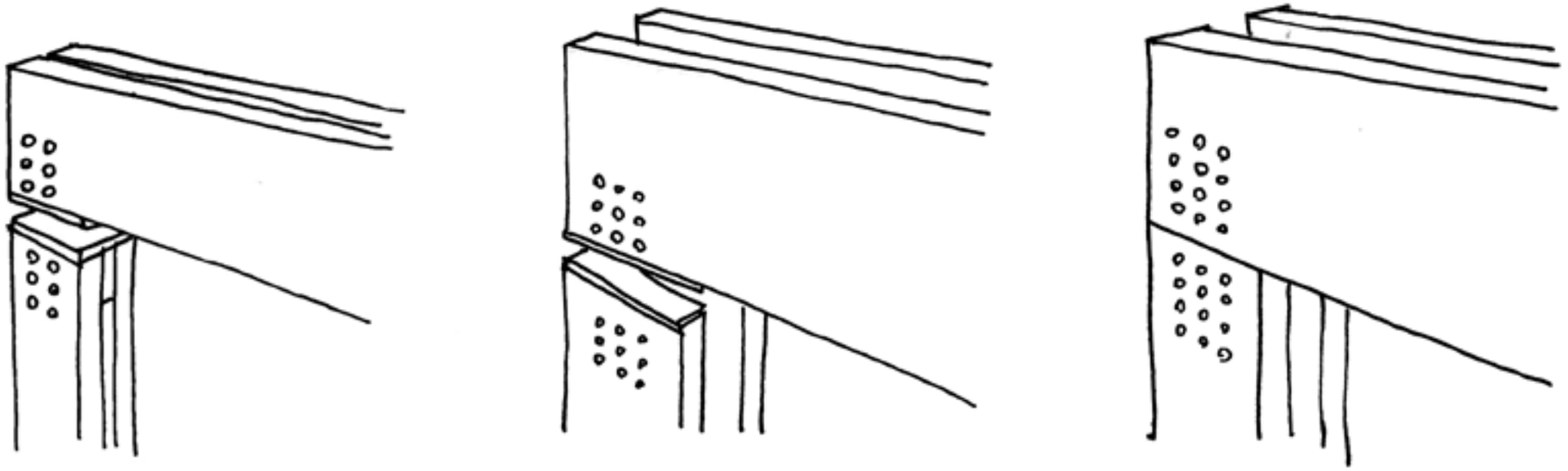
As previously mentioned, the construction reflects something embracing because being sheltered beneath the trees is reckoned a safe feeling. The column reflects the tree in the forest and their roots below ground where the joint in this case is under the concrete floor with a small gap between the concrete floor and the column.

The entire column is not visible some places in the building in the fact that it aligns the inner wall. However, the tectonic detailing of the wall makes the column present itself to complete the image of a unified construction. The joint between column and beam is a simple bolt joint that in some parts of the building are visible, whereas other places one senses the joint in the same way as one sense the frame structure.

There are in the design process made various proposals to the joint of the glulam, visualised here.



Ill. 141 - Physical model of the structure



Ill. 142 - Detail sketches of the joint

EPILOGUE

The chapter rounds off the project in a reflecive text and a conclusion to the overall project design.

CONCLUSION

The proposal for Herlev Cancer Caring Centre is located in the Hospital Park in close proximity to Herlev Hospital. This allows for easy accessibility while still being withdrawn from the institutional centre to utilize the green areas of the park. The architecture takes up the concept of small wooden cabins creating a refuge for recovery and health whilst mediating between nature, user and context. The clean-cut pavilions make a significant original landmark in the area without compromising an open and embracing quality. The mono-pitched roofs and simple wooden facades integrate well in nature to constitute a building that represents a balance between the conventional and familiar architecture of the home and the more expressive, according to the quote by Charles Jencks.

In continuation of the Nordic traditions the building exploits the landscape to naturally make a split in levels to underline an axis from hospital to nature, all of which to make a transition from the institutional character of the Hospital towards the recreational qualities of the park. The significance and importance of the vegetated area is reflected in the pavilions and terrace decks expanding outwards to emphasize different views. The layout of the plan comprises openness and clarity in a design that facilitates both social and private environments. By purposeful variation, the architecture addresses a sensible and warm place for happiness and hope, as well as sorrow and despair.

The common space stands as the heart of the building, containing a differentiated spatial experience to stimulate the individual. The kitchens central location herein creates a socially active space for informal interaction, which is in play instantly by entering the building. The more private functions are oriented peripherally to engage nature and ensure privacy. They are arranged around a free flowing space that allows for niches and places to stay to make a comfortable non-institutional space. All spaces benefits from the wholesome effects of daylight through the gathered large window openings of which comply with the simplistic appearance and detailing of the building.

As the appearance of the exterior is inviting, the structural system is embracing inside. The ideation of embrace resembles the protective nature of the treetops to add value to the concept of the cancer caring centre. Inspired by tree stems the architectural detailing sees the glulam frames bifurcating to create a refined expression. The slenderness of the columns make a light and uplifting appearance before it is rooted and fastened beneath the floor; all of which to underline the position of being in nature.

The architecture introduces principles from the concept of healing architecture in different ways to suggest purposeful variation. The breaking down of volumes lets nature wrap around the building to always make a visual appearance inside. The pavillon structure makes courtyard spaces that further the idea of green elements running through the building. These are used for therapeutic purposes by creating a cultivated haven of different sensuous stimuli and to make space for spirituality and relaxation. To enhance the variation of recreational impressions, the terrace decks extrudes from the building to extend the interior space beyond the floor to ceiling windows. This blurs the boundary between inside and outside. To support the idea of the place as a refuge in nature, the materiality emphasizes wooden materials that wraps around the spaces to create a comfortable and warm interior. The tactility and scent of the wooden materials are a valued quality that adds to an intimate atmosphere. Art is incorporated in different areas to affect the individuals positively to comply with studies of healing architecture.

The cancer caring centre corresponds to the local context by integrating the vision regarding the new cultural axis and the extension of the existing hospital. The flow of the park is converted into a more organic and recreational character to connect art objects scattered throughout the park. The cancer caring centre will have benefit of this planned cultural regeneration of the park to constitute the site specific and strong local anchorage of the design.

REFLECTION

When it all comes down to this, one might ask the obvious question: Is this relevant? Is the physiological treatment not enough for those who fall victims of dreadful diseases?

The physical nature of hospitals are arguably not at all close being as humane and invigorating as one could hope for. Or maybe demand. We believe that architecture is an important part of the physiological treatment, because it takes into account the psychological affects, which is something that is quite difficult to measure. That something starts with a dialogue. The domestic atmosphere of a cancer caring centre, as one parameter, might answer just that.

This project encircles domestic aspects, simply to create a comfortable place to be in. That informs the project and resulted in considerations of down scaling the building volume, which does not resemble the large machine like institution. The project emphasizes tactile and warm materials that appeal to the human well being, as opposed to cold and unnatural materials. Contact to nature works distressing and is implemented through large and clear views, whereas small windows and long narrow hallways would have a stressing effect.

There are many cases where the disease goes hand in hand with being depressed and this is also a scourge that must be fought. The cancer caring centre is a sanctuary and a refuge where one as a cancer patient can come by and focus on all the implications of the disease, both sociologically and physiologically. The different theories based on healing architecture are scientifically proven, but architecture might still have to catch up with these factors to really utilize them. We all know it from our own experience when we are in a place where it is nice to be. Conversely, we all also know the feeling of being in the endless hospital corridors with that rare smell, the white spaces and hard sterile surfaces. Would we all rather not be somewhere where it smells homelike and where we can look at peaceful nature? Arguably the characteristics of a home are essential in the healthcare sector, but often difficult to implement due to the scale and complexity of institutions. In principle, the architecture can help ameliorate life in this aspect and may become really relevant in order to create a better health care environment.

We as architects have to deal with how the building relates to the larger context. Can the building be used for a long time into the future and who should use it? The architecture must ensure that the building meets the needs of today but also the needs of tomorrow. We need to consider whether the building offers so much value for users and therefor, it is important to create architecture that is relevant and robust and which could contribute to the social sustainability. In health care, good architecture will always be relevant because it concerns the human well being and not exclusively the medical condition.

The architectural competition for Herlev cancer centre is underway and the future site will most likely not be situated in the Hospital Park, but this location could help to create even better conditions for the concept of Livsrum, simply because of its position in a vegetated area. The concepts of Livsrum concerns a conceptual model that, say, hospitals do not match and this model might not only work in this specific category. Thus, it is likely to think that it can be applied to other institutions that care for other diseases. The architecture does not have to have fancy shapes but subtly apply principles of healing architecture and a humane environment. The architecture itself is not the goal; it is the means – the means of achieving the goal of a good life.

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ILLUSTRATIONS

Unless mentioned otherwise, it is the authors's own illustrations

Ill. 02: Own illustration based on http://www.cancer.dk/hjaelp-viden/raadgivning/radgivninger/
Ill. 05: Own illustration based on illustration in “Arkitektur som Integreret Design” by Knudstrup, M. A.
Ill. 18: Own illustration based on illustration in “Mini-guide til DGNB”, p. 4
Ill. 19: Own illustration based on illustration in “Design med viden”, p. 16
Ill. 11: http://www.bustler.net/images/news2/maggies_17310778592.jpg
Ill. 12: http://www.designboom.com/wp-content/uploads/2014/03/maggies-centres-exhibtion-designboom-05
Ill. 13: http://ad009cdnb.archdaily.net.s3.amazonaws.com/wp-content/uploads/2012/11/1352483126-maggies-12630911100-1000x1000.jpg
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Ill. 16: http://www.dortemandrup.dk/raa-day-care-center-helsingborg-sweden-2013
Ill. 27: http://www.protecvinduer.dk/files/billeder/Nyheder/Livsrum/Livsrum%20Odense_artikel1.jpg
Ill. 32: http://www.sla.dk/files/3114/1233/6557/Large_HerlevH_have01.jpg
Ill. 33: http://www.godtsygehusbyggeri.dk/Byggeprojekterne/~/media/Hospitals/NHE/NHE4.ashx
Ill. 47: Own illustration based on http://www.dmi.dk/fileadmin/user_upload/Rapporter/TR/1999/tr99-13.pdf
Ill. 48: Own illustration based on https://kunsten2010.files.wordpress.com/2010/10/vind-og-solrose.jpg
Ill. 123: http://www.bbp.dk/projekt/kultur/holbaek-foreningshus
Ill. 124: http://i01.i.aliimg.com/img/pb/702/342/886/886342702_748.jpg

APPENDIX

The appendix covers aspects such as structural calculations, a collection of detail drawings and technical strategies included in the project.

AREA CHART

Function	Quantity	Net m2 total
Common area		
Entrance and windbreak	1	10
Common Space	1	70
Kitchen	1	16
Multipurpose / Lounge	1	31
Place for stay / Lounge	2	20
Fireplace	1	19
Info	1	12
Library	1	10
Children and youth space	1	27
Flexible workstation	1	17
Group room	2	51
Conversation room	3	47
Open conversation space	1	17
Reflective space	1	13
Workshop	1	34
Activity area		
Exercise room	1	73
Wellness area	1	30
Examination room	1	22
Staff area		
Offices	4	99
Staff room w/tea kitchen	1	65
Copy room / Storage	1	11
Wardrobe / changing rooms w/shower & toilets	1	22
Additional spaces		
Wardrobe	1	5
Storage	4	53
Toilets	5	25
Changing rooms, bath & toilets	2	30
Technical room	3	59
Cleaning room	2	12
Total Net	46	900
Total Gross		1240

CONSTRUCTION

Overall thoughts and facts about the construction can be seen in the presentation on page 74-77.

The following shows a calculation of a simple supported beam, and a simple supported column wherein the span is the furthest without midway support of the concrete slabs, and the height is the highest in the building as seen in the diagram. The estimation of this is relevant because the dimension of the building volumes here is the most radical. Therefore it provides the largest dimensions of beams and columns. In the calculation, permanent, snow and wind load are taken into account.

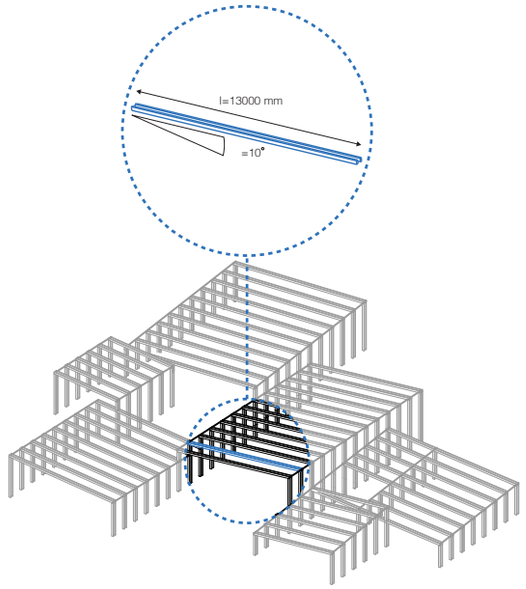
There is to simplify the calculation calculated on the beam and column separately and assumed that the outcome may be worse than if it was a frame structure calculation which joints are fixed.

In the design process the 3D software Karamba is used to sketch the dimensioning of the elements while simultaneously evaluating on the aesthetics of the different iterations. Karamba can in real time calculate and show the maximum displacement and behaviour of the structure. To verify that the structure is durable the following calculations are created.

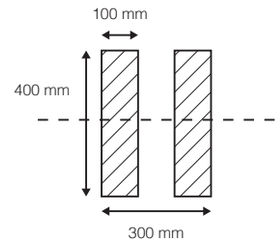
al Properties of GL32h

's Module	13700,00 MPa
Modulus	850,00 MPa
y	510,00 kg/m^3
	32,00 MPa
	19,70 MPa
	2,34 MPa
	2,03 MPa

BEAM

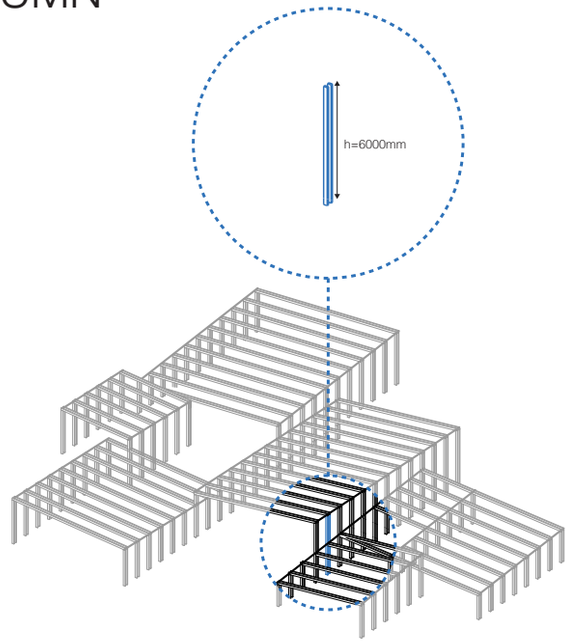


Calculated beam

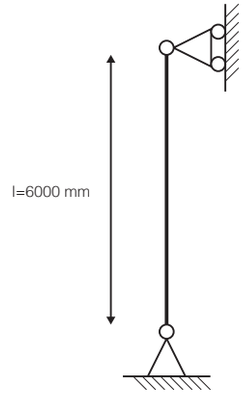


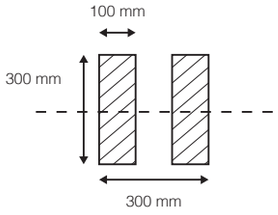
Static model and cross section of simple supported beam

COLUMN

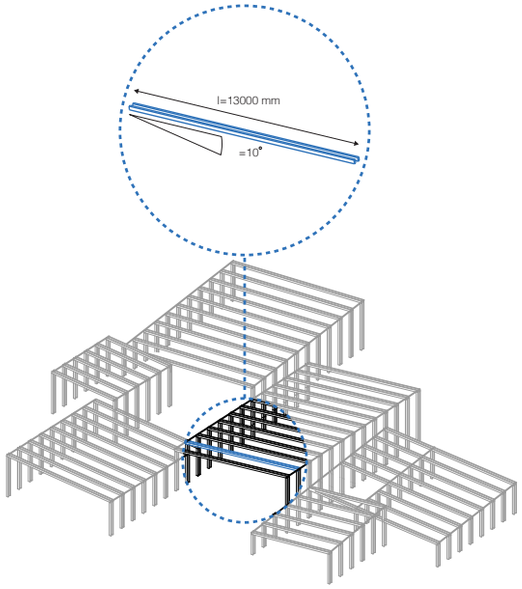


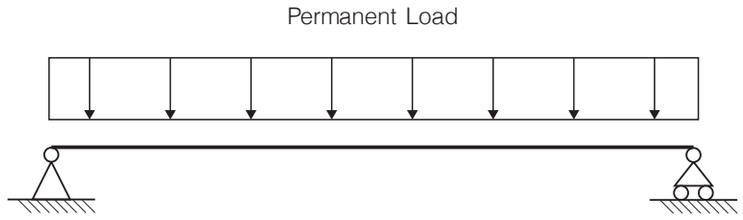
Calculated column

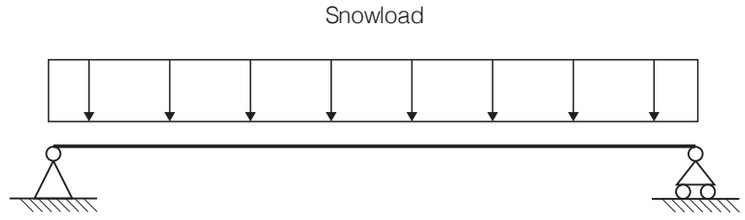




Static model and cross section of simple supported column







LOAD CALCULATIONS

Permantent Load

The beam members of the structure need to carry its own weight along with the roof structure above. The characteristic value for the permanent load is calculated on the basis of the weight of the construction.

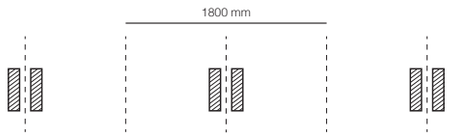
Wooden Panels:	$4.6\frac{kg}{m^2}$
Insulation:	$20.0\frac{kg}{m^2}$
Lathing:	$5.9\frac{kg}{m^2}$
Installations:	$14.0\frac{kg}{m^2}$

The permanent roof construction load is then, P:

$$P_{roof} = \left(4.6\frac{kg}{m^2} + 20.0\frac{kg}{m^2} + 5.9\frac{kg}{m^2} + 14.0\frac{kg}{m^2}\right) \cdot 0.982\frac{N}{kg} = 0.43\frac{kN}{m^2}$$

This is calculated with the length from centre to centre

$$0.43 \cdot 1.8\text{m} = 0.78\frac{kN}{m}$$



The load is divided in two because of the two beams

$$\frac{0.78\frac{kN}{m}}{2} = 0.39\frac{kN}{m}$$

The self weight of each beam is determined by:

$$P_{beam} = (\rho \cdot h \cdot b \cdot g)$$

$$P_{beam} = 510\frac{kg}{m^3} \cdot 0.4\text{m} \cdot 0.1\text{m} \cdot 0.982\frac{N}{kg} = 0.20\frac{kN}{m}$$

The accumulated permanent load

$$P_{total} = P_{roof} + P_{beam} = 0.59\frac{kN}{m}$$

Snow Load

The snow load comprises the short-term variable load evenly distributed on each of the structural beam members and calculated as a downward line load force. The flatness of the roof structure raises the effect of the calculated snow load.

$$S = \mu_i \cdot c_e \cdot c_t \cdot S_k$$

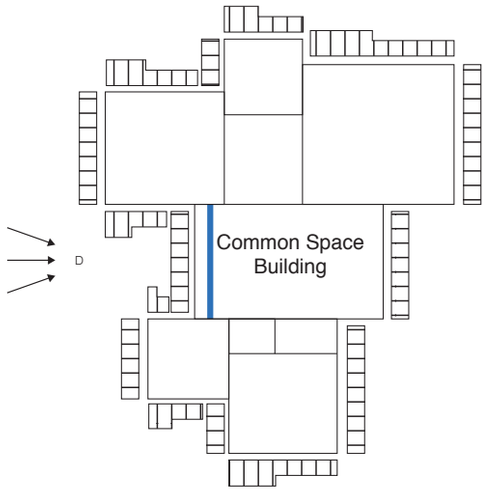
$$S = 0.80 \cdot 0.80 \cdot 1 \cdot 1\frac{kN}{m^2} = 0.64\frac{kN}{m^2}$$ (Teknisk Ståbi 2013, s146)

μ_i = form factor = 0.8
C_e= exposure factor = 0,8
C_t = thermal factor = 1
S_k = characteristic terrain factor = 1 kN/m²

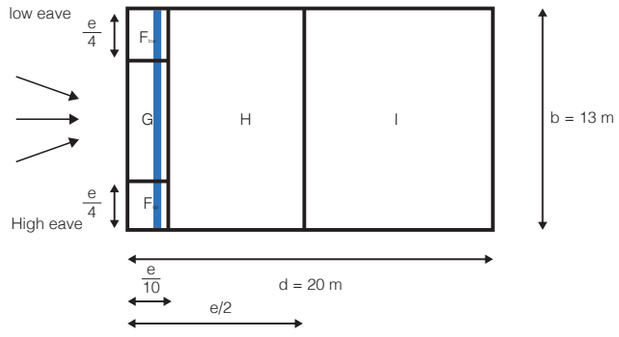
For each beam

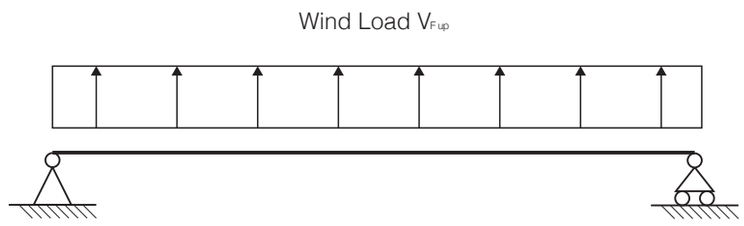
$$\frac{0.64\frac{kN}{m} \cdot 1.8\text{m}}{2} = 0.58\frac{kN}{m}$$

Wind diagram of building (plan)



Common space building geometry (roof plan)





Wind Load

Wind loads are variable loads calculated on the common space building volume and applied in Karamba to see the immediate effects. Firstly, the topography factor is calculated as terrain category III, as the building is *situated in a suburban environment characterized by regular vegetation and buildings*. (Teknisk Ståbi 2013, p. 146):

$$K_r = 0.19 \cdot \left(\frac{z_0}{z_{0.2}}\right) = 0.19 \cdot \left(\frac{0.4\text{m}}{0.3\text{m}}\right)^{0.07} = 0.19$$

K_r= Topography factor
z_0 = length of roughness = 0.4 (Vindenergibegreber/drømstørre.dk)
z_{02} = length of roughness category III = 0.3

The peak factor is defined:

$$q_p = \left(1 + \frac{7}{\ln\frac{z}{z_0}}\right) \cdot 0.5\rho\left(V_b \cdot K_r \cdot \ln\left(\frac{z}{z_0}\right)\right)^2$$

$$q_p = \left(1 + \frac{7}{\ln\frac{6m}{0.4m}}\right) \cdot 0.5 \cdot 1.25\frac{kg}{m^3} \cdot \left(24\frac{m}{s} \cdot 0.19 \cdot \ln\left(\frac{6m}{0.4m}\right)\right)^2 = 0.25\frac{kN}{m^2}$$

ρ = density of air
V_b= Basic air velocity

See table 6.2(8), DS410.

The formfactor C_p is calculated on the basis of the shape of the structure. The "factor" e is set to 2h = 12 and thus e < d these wind zones are applied, as shown on the illustration above.

$$A = \frac{e}{5} = \frac{12\text{m}}{5} = 2.4\text{m}$$

$$B = \frac{4}{5}e = \frac{4}{5} \cdot 12\text{m} = 9.6\text{m}$$

$$C = d - e = 20\text{m} - 12\text{m} = 8\text{m}$$

These lengths are applied when calculating the different areas of zones of wind pressure on the building.

$$A = -1.2$$
$$B = -0.8$$
$$C = -0.5$$
$$D \cdot \rho = 0.8 \cdot 0.85 = +0.68$$
$$E \cdot \rho = -0.5 \cdot 0.85 = -0.425$$

(Teknisk Ståbi 2013, p.148)

Where the correlation factor is 0,85 as h/d<1, and the resulting force is (D-E).

The area and their respective loads can then be calculated. The calculations only concern the west/east wind direction, as this is where the wind pressure is highest. The area of the west oriented gable D and east oriented E respectively:

$$G_D = 84\text{m}^2 \cdot 0.25\frac{\text{kN}}{\text{m}^2} \cdot 0.68 = 14.28\text{kN}$$

$$G_E = 63\text{m}^2 \cdot 0.25\frac{\text{kN}}{\text{m}^2} \cdot -0.425 = -6.69\text{kN}$$

$$G_{\text{roof A}} = 33.6\text{m}^2 \cdot 0.25\frac{\text{kN}}{\text{m}^2} \cdot -1.2 = -10.08\text{kN}$$

$$G_{\text{roof B}} = 134.4\text{m}^2 \cdot 0.25\frac{\text{kN}}{\text{m}^2} \cdot -0.8 = -26.88\text{kN}$$

$$G_{\text{roof C}} = 112\text{m}^2 \cdot 0.25\frac{\text{kN}}{\text{m}^2} \cdot -0.5 = -31.92\text{kN}$$

$$G_{D+E} = 14.28\text{kN} + (-6.69\text{kN}) = 7.59\text{kN}$$

$$V_{\text{roofA}} = \frac{0.25\frac{\text{kN}}{\text{m}^2} \cdot (-1.2) \cdot 1.8\text{m}}{2} = -0.27\frac{\text{kN}}{\text{m}}$$

$$V_{\text{roofB}} = \frac{0.25\frac{\text{kN}}{\text{m}^2} \cdot (-0.8) \cdot 1.8\text{m}}{2} = -0.18\frac{\text{kN}}{\text{m}}$$

$$V_{\text{roofC}} = \frac{0.25\frac{\text{kN}}{\text{m}^2} \cdot (-0.5) \cdot 1.8\text{m}}{2} = -0.1125\frac{\text{kN}}{\text{m}}$$

Because of the dual beams the wind load value is divided by two.

LIMIT STATES CALCULATIONS

Limit states consist of both the serviceability limit state, and the ultimate limit state. The first mentioned deals with the edge between acceptable and unacceptable conditions under normal everyday use and is determined by maximum allowed static deformations. The ultimate limit state encompasses a collapse of the structure, total or partly.

These load calculations are displayed for further calculating the Ultimate Limit State
.
P = the permanent load,
S = the snow load
V = the wind load.
K_{fi} = the safety factor relating to the CC2, set to 1.
(Teknisk Ståbi 2013, p. 143)

Load Combinations For Ultimate Limit State

Hereby is:

Dominating Permanent load

$$1.2 \cdot K_{fi} \cdot P$$

$$= 1.2 \cdot 1 \cdot 0.59 \frac{kN}{m} = 0.71 \frac{kN}{m}$$

Dominating Snow load

$$1 \cdot K_{Fl} \cdot P + 1.5 \cdot K_{Fl} \cdot S + 1.5 \cdot 0.3 \cdot K_{Fl} \cdot V$$

$$= 1 \cdot 1 \cdot 0.59 \frac{kN}{m} + 1.5 \cdot 1 \cdot 0.58 \frac{kN}{m} + 1.5 \cdot 0.3 \cdot 1 \cdot 0.27 \frac{kN}{m} = 1.69 \frac{kN}{m}$$

Dominating Wind load

$$1 \cdot K_{Fl} \cdot P + 1.5 \cdot K_{Fl} \cdot V$$

$$= 1 \cdot 1 \cdot 0.59 \frac{kN}{m} + 1.5 \cdot 1 \cdot 0.27 \frac{kN}{m} = 0.99 \frac{kN}{m}$$

Ultimate Limit State

Regarding the Ultimate Limit State, it is sought to determine that the calculated strength of the construction does not exceed the value of strength for the material by (Teknisk Styrkelære 2007, p. 59)

$$\frac{M}{W} < f_{m,d}$$

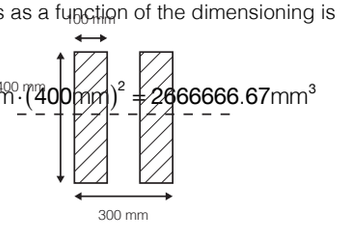
fm,d = calculated strength value
M = the maximum design moment
W = the cross section modulus of the beam

For a simple supported beam, with an equally distributed load, the following is applicable:

$$M_{max} = \frac{1}{8} \cdot q \cdot L^2$$

The cross section modulus as a function of the dimensioning is then:

$$W_x = \frac{1}{6} \cdot b \cdot h^2 = \frac{1}{6} \cdot 100mm \cdot (400mm)^2 = 2666666.67mm^3$$



The different load combinations are applied to find the calculated (regningsmæssige laster) loads, which are to determine the highest amount of load on the structure by which the dimensioning is determined.

Dominating Permanent Load

$$M_{max} = \frac{1}{8} \cdot 0.71 \frac{kN}{m} \cdot (13m)^2 = 14.99 \frac{kN}{m}$$

Dominating Snow Load

$$M_{max} = \frac{1}{8} \cdot 1.69 \frac{kN}{m} \cdot (13m)^2 = 35.70 \frac{kN}{m}$$

Dominating Wind Load

$$M_{max} = \frac{1}{8} \cdot 0.99 \frac{kN}{m} \cdot (13m)^2 = 20.91 \frac{kN}{m}$$

Depending on the character of the load (in this case wind, snow or permanent load) the glulam material has its own specific calculated strength value for each case. In ultimate limit state these specific values should not be lower than the strength value calculated for the beams found in this project. The calculated strength factor is found by applying a conversion factor to the characteristic strength value for GL32h :

Permanent load:

$$f_{m,d} = f_{m,k} \cdot k_d = 32MPa \cdot 0.462 = 14.8MPa$$

Snow load:

$$f_{m,d} = f_{m,k} \cdot k_d = 32MPa \cdot 0.692 \Rightarrow 22.2MPa$$

Wind load:

$$f_{m,d} = f_{m,k} \cdot k_d = 32MPa \cdot 0.846 = 27.1MPa$$

Finally it is calculated that for

Dominating permanent load

$$\frac{14.99 \frac{kN}{m} \cdot 10^6}{2666666.67 mm^3} = 5.62MPa < 14.8MPa$$

Dominating snow load

$$\frac{35.70 \frac{kN}{m} \cdot 10^6}{2666666.67 mm^3} = 13.39MPa < 22.2MPa$$

Dominating wind load

$$\frac{20.91 \frac{kN}{m} \cdot 10^6}{2666666.67 mm^3} = 7.84MPa < 27.1MPa$$

The strength conditions of the beam are hereby satisfactory for all load combinations.

Serviceability Limit State

The structure examined is determined as belonging to the Middle Consequence Class (CC2), where possible failures hold medium risk of loss of human lives. The deflection is to be defined to see whether or not it is acceptable. The permissible deflection depends on the character of the load, and is set to:

$$U_{inst,P} = \frac{l}{400} = \frac{13000mm}{400} = 32.5mm$$

$$U_{inst,S} = \frac{l}{400} = \frac{13000mm}{400} = 32.5mm$$

$$U_{inst,V} = \frac{l}{250} = \frac{13000mm}{250} = 52mm$$

The permanent load, along with the variable loads of wind and snow are applied in calculating the deflection of the beam.

First the moment of inertia is found:

$$I_x = \frac{1}{12} \cdot b \cdot h^3 = \frac{1}{12} \cdot 100mm \cdot (400mm)^3 = 5.33 \cdot 10^8 mm^4$$

The instantaneous deflection of the beam is then:

Permanent load deflection:

$$U_{P,inst} = \frac{5}{384} \cdot \frac{q \cdot l^4}{E \cdot I} = \frac{5}{384} \cdot \frac{0.59\frac{kN}{m} \cdot (13000mm)^4}{13700MPa \cdot 5.33 \cdot 10^8 mm^4} = 30.04mm$$

Snow load deflection:

$$U_{S,inst} = \frac{5}{384} \cdot \frac{q \cdot l^4}{E \cdot I} = \frac{5}{384} \cdot \frac{0.58\frac{kN}{m} \cdot (13000mm)^4}{13700MPa \cdot 5.33 \cdot 10^8 mm^4} = 29.53mm$$

Wind load deflection:

$$U_{V,inst} = \frac{5}{384} \cdot \frac{q \cdot l^4}{E \cdot I} = \frac{5}{384} \cdot \frac{0.27\frac{kN}{m} \cdot (13000mm)^4}{13700MPa \cdot 5.33 \cdot 10^8 mm^4} = 13.75mm$$

All the instantaneous deflections do not exceed the permissible deflection previously described, and is therefore satisfactory.

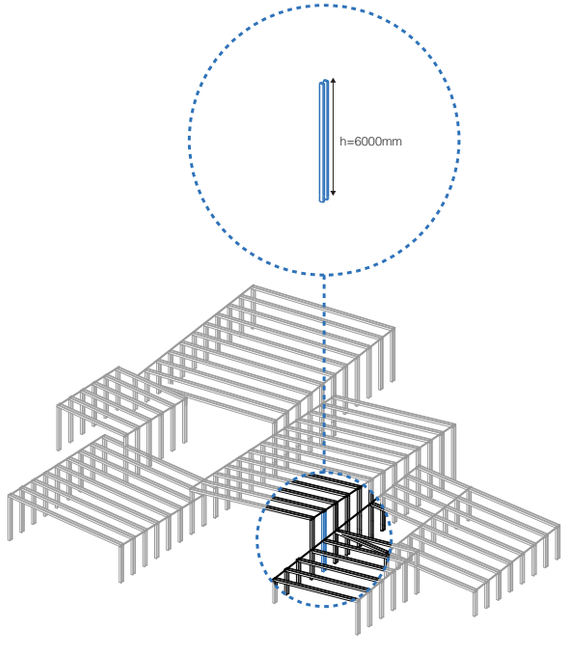
In terms of the permanent load, long-term effects have to be taken into account. For this, it is applicable that:

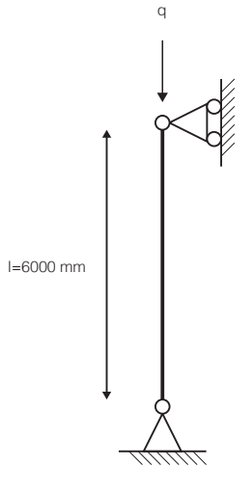
$$U_{P,fin} < \frac{l}{400} = 32.5mm$$

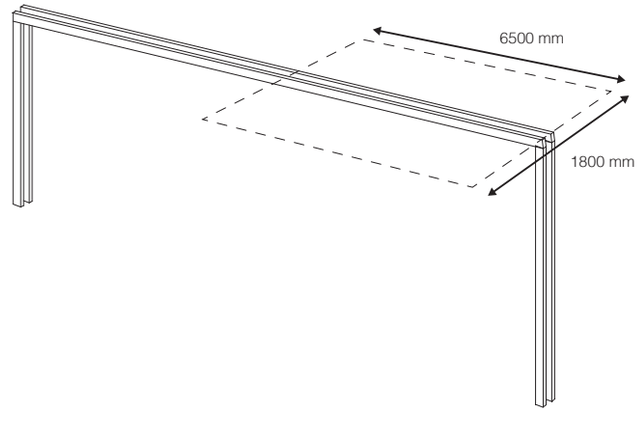
The deflection of long-term effects are defined:

$$U_{P,fin} = (1 + \psi_2 \cdot k_{def}) \cdot U_{P,inst} = (1 + 1 \cdot 0.6) \cdot 30.04mm = 48.06mm$$

ψ_2 = Partial coefficient for permanent load = 1
k_{def} = Modification factor, application class 1 = 1







DIMENSIONING OF A COLUMN

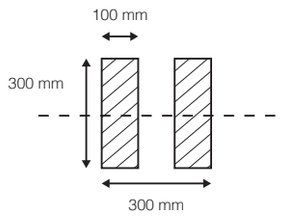
Like the beams previously calculated, the columns of the frame structure are also examined. They appear like the beams bifurcated and in glulam material. In order to secure a light expression and a connection towards outdoor spaces, they need to be as slim as possible. These calculations takes its point in departure in Middle Consequence Class 2 (CC2) and the material is glulam GH32h.

First the relative slimness factor of the column is calculated:

$$\lambda_{rel} = \frac{k_{rel} \cdot l_s}{b}$$

k_{rel} =factor to determine k_{rel} (Teknisk Ståbi 2013, p. 313)
l_s = length of the column
b = width of the column in section

$$\lambda_{rel} = \frac{0.056 \cdot 6000\text{mm}}{100\text{mm}} = 3.36$$



The column is examined in the strength condition equation:

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

F = Calculated Load [N]
A = Area of the section
k_c = Column Factor = 0.089 (Teknisk Ståbi 2013, p. 313)
k_d = Conversion Factor = 0.462 (Teknisk Ståbi 2013, p. 305)
$f_{c,0,k}$ = Characteristic strength number = 29MPa (Teknisk Ståbi 2013 (p. 304)

The calculated load is multiplied by the length of the span the column needs to carry which is half of the building width. The load is the previously calculated loads with load combinations.

Permanent Load Dominating:

$$\sigma_{c,0,d} = \frac{\left(0.71\frac{\text{kN}}{\text{m}} \cdot 6.5\text{m}\right) \cdot 10^3}{100\text{mm} \cdot 300\text{mm}} \leq 0.089 \cdot 0.462 \cdot 29\text{MPa}$$

$$0.15\text{MPa} \leq 1.19\text{MPa}$$

Snow Load Dominating:

$$\sigma_{c,0,d} = \frac{\left(1.69\frac{\text{kN}}{\text{m}} \cdot 6.5\text{m}\right) \cdot 10^3}{100\text{mm} \cdot 300\text{mm}} \leq 0.089 \cdot 0.692 \cdot 29\text{MPa}$$

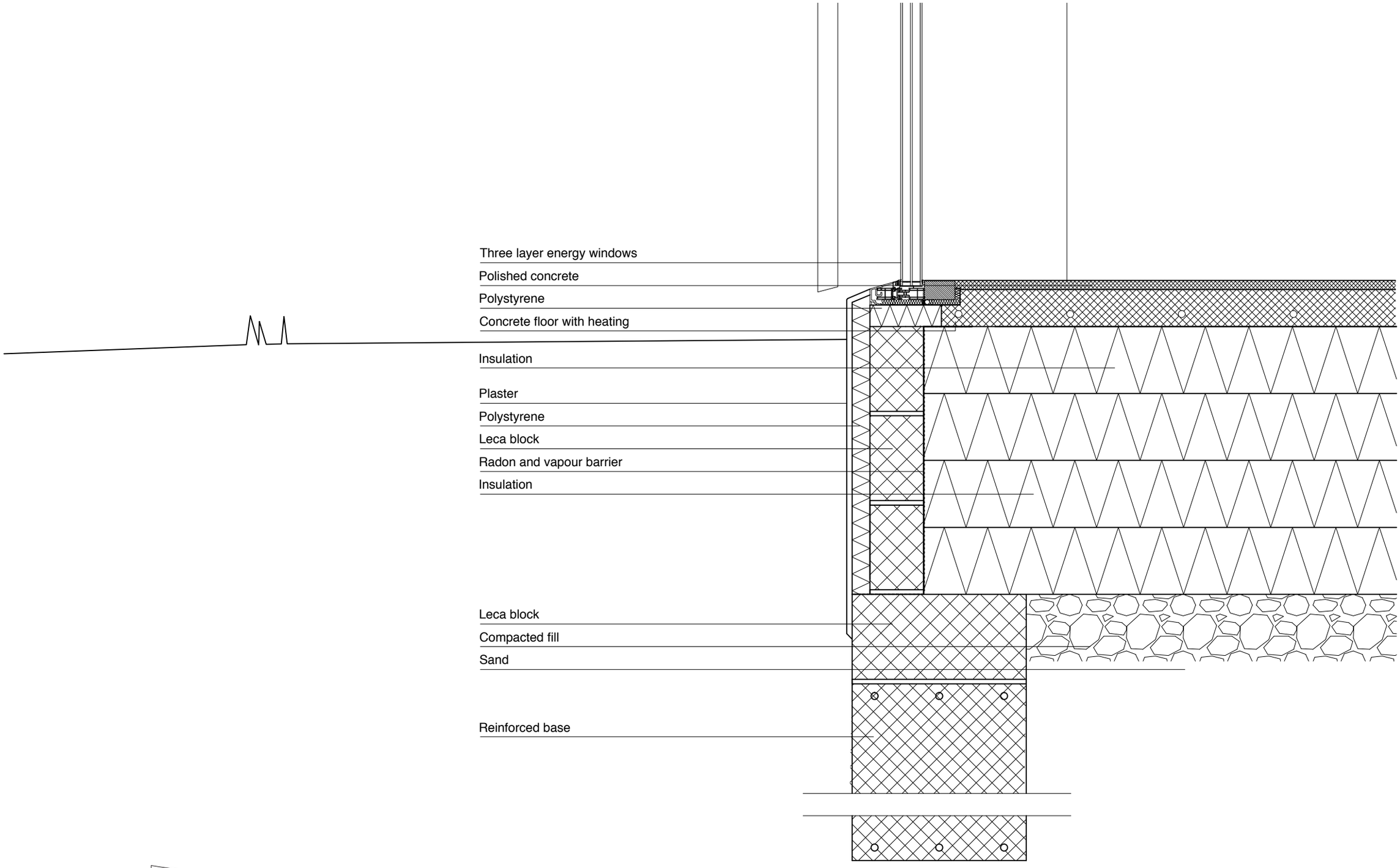
$$0.37\text{MPa} \leq 1.79\text{MPa}$$

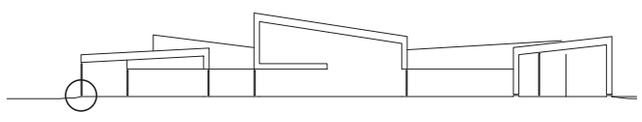
Wind Load Dominating:

$$\sigma_{c,0,d} = \frac{\left(0.99\frac{\text{kN}}{\text{m}} \cdot 6.5\text{m}\right) \cdot 10^3}{100\text{mm} \cdot 300\text{mm}} \leq 0.089 \cdot 0.846 \cdot 29\text{MPa}$$

$$0.21\text{MPa} \leq 2.18\text{MPa}$$

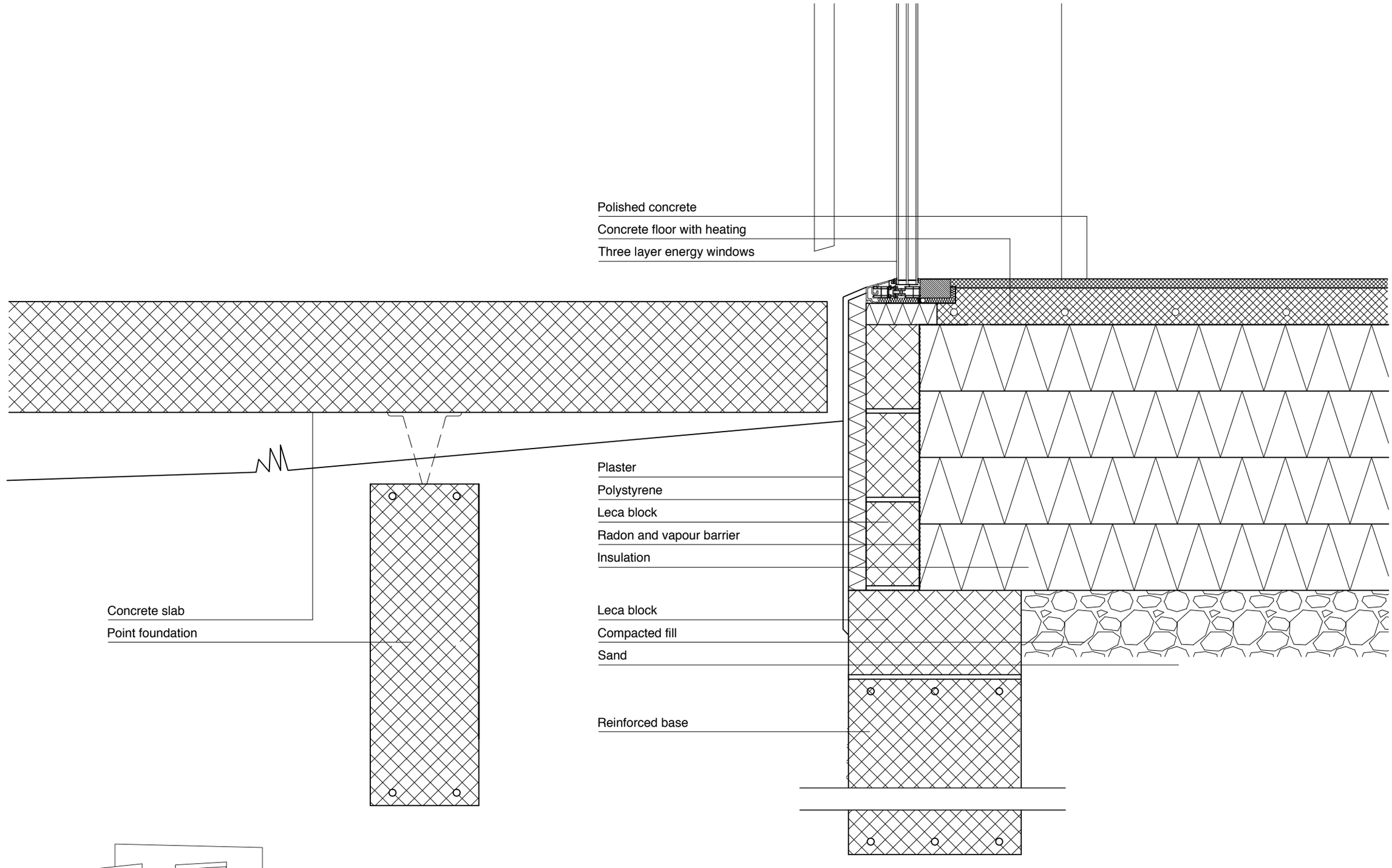
DETAIL: LEVEL ACCESS TO NATURE

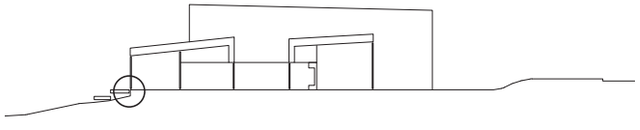




DETAIL: LEVEL ACCESS TO TERRACE

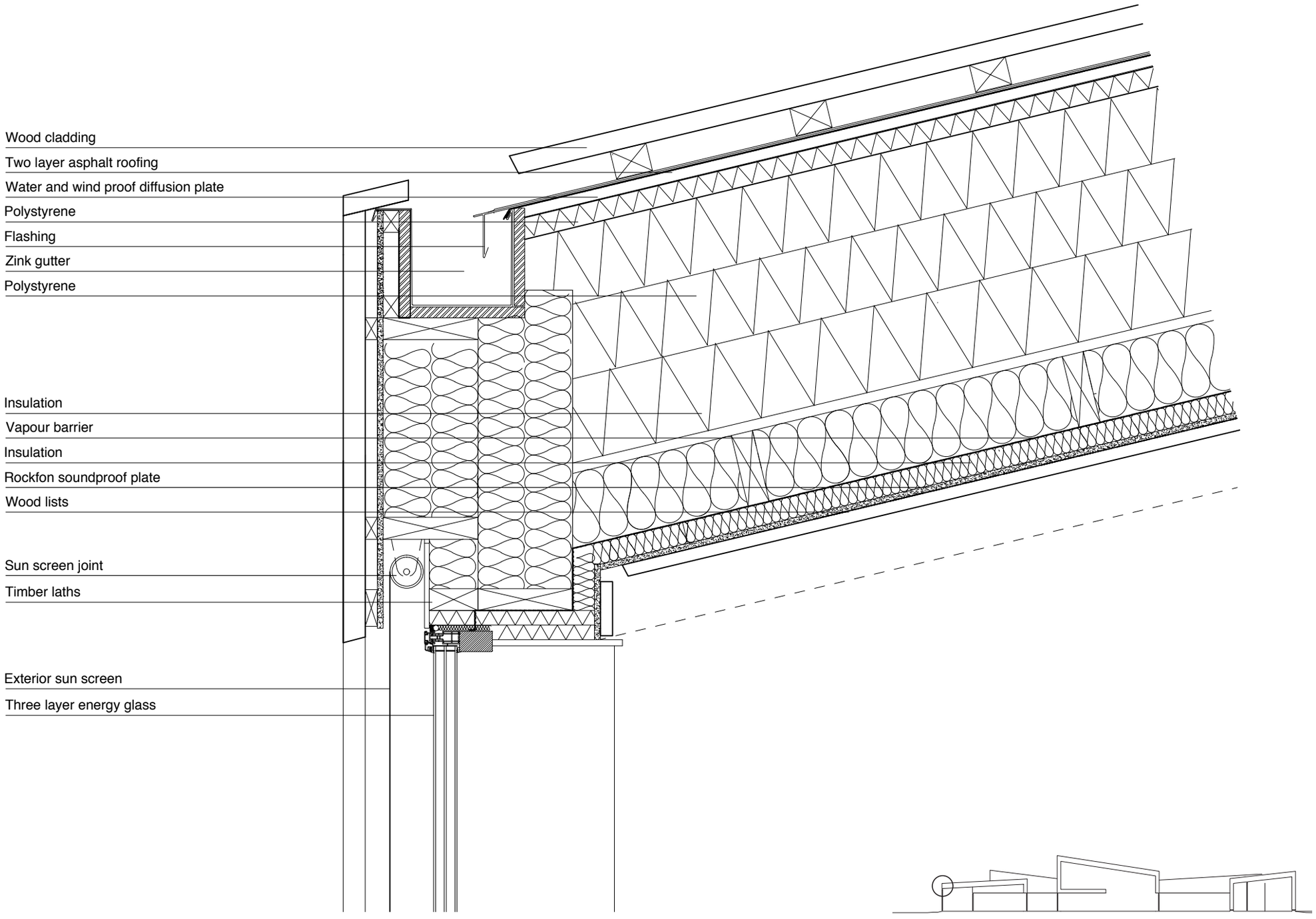
Section 1:10





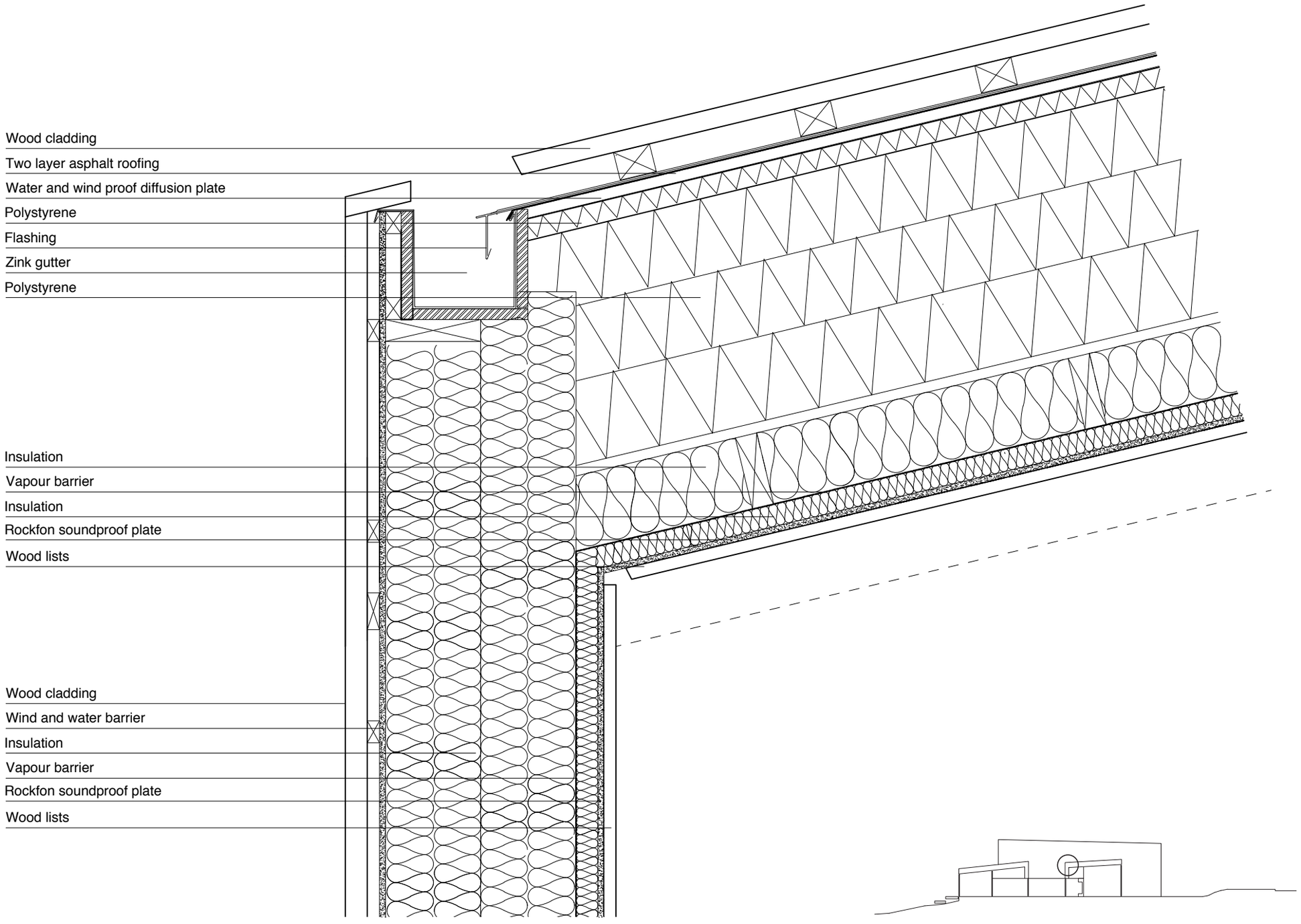
DETAIL: GUTTER AND SUN SCREENS

Section 1:10



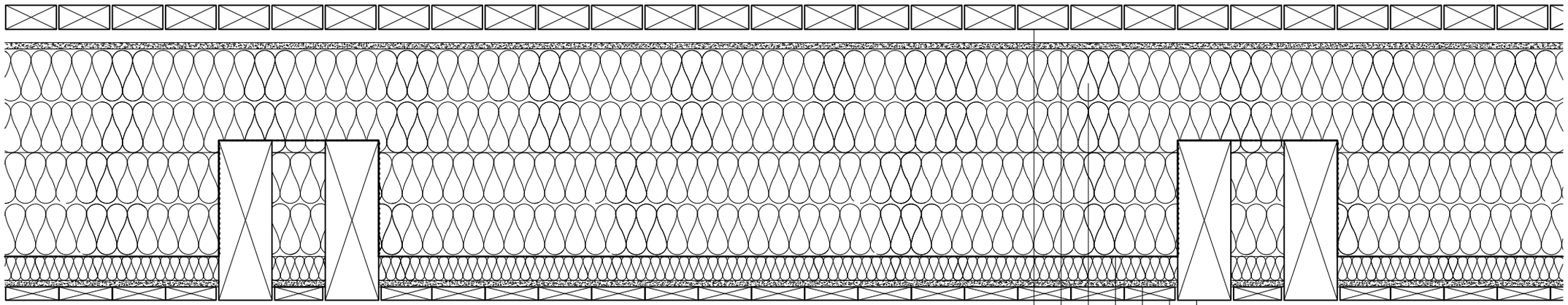
DETAIL: ROOF AND WALL

Section 1:10



DETAIL: WALL AND COLUMNS

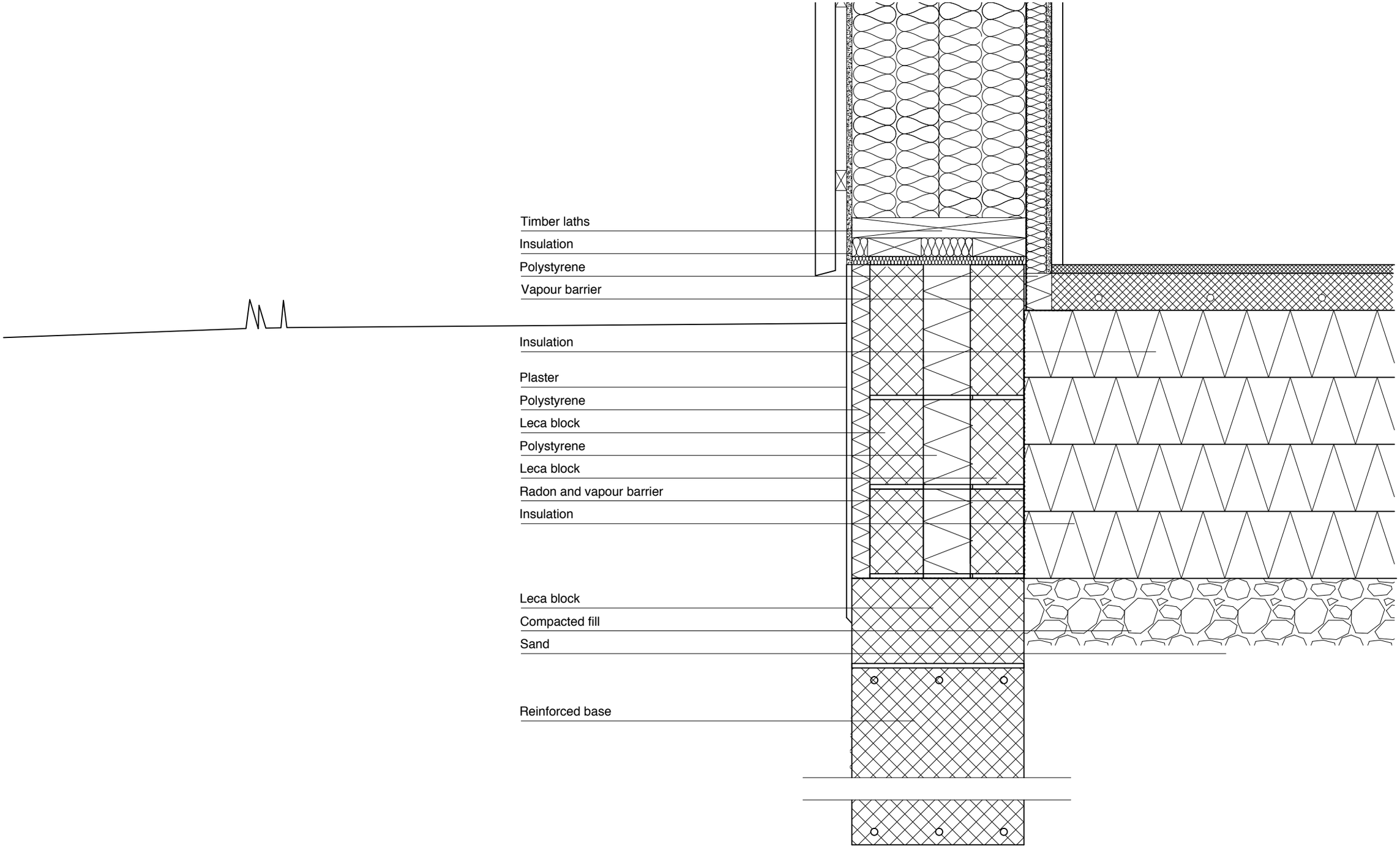
Plan section 1:10

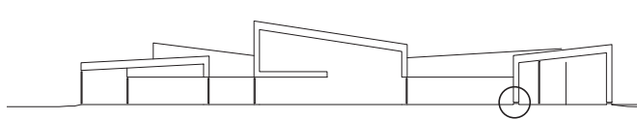


Wood cladding
Wind and water barrier
Insulation
Vapour barrier
Rockfon soundproof plate
Wood lists
Glulam column

DETAIL: BASE

Section 1:10





FIRE ESCAPE PLAN

Emergency route min 130mm

Access to emergency exit

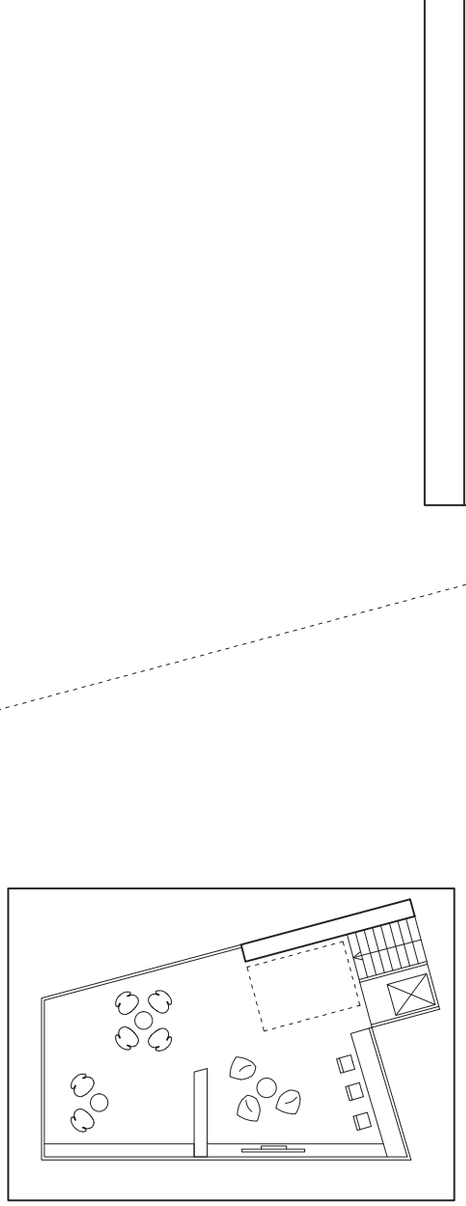
Emergency exit

Hose reel

Fire cell

Fire section with fire ventilation

VENTILATION



Supply Air

Exhaust

Technical room