
Temple Ter Heiwa

Title Sheet

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Abstract

The Temple for Hilma is a master thesis project, from Architectecture and Design, Aalborg university, 2017. Developed by Alexander Elgaard Sørensen, Casper Langberg Thaier, Dennis Ehrenreich Graves.
The project aims to develop a museum for the artist Hilma af Klint (1862-1944).

Hilma af Klint started painting abstract paintings in 1906. Four years before, MoMA decleared the beginning of abstract art (Peyton-Jones & Obrist, 2016), Due to the prejudices, pretty strong at the time, regarding women's inability to create, Hilma af Klint never showed her art in her life time. Through her testament, she stated that her paintings should only be revealed 20 years after her death.
In a time of massive change in society, Hima af Klint examined through her art and notes, subjects as the difference between men and women, war, religion and spirituality. With a scientific approach, she examined the different subjects through series of paintings. Throughout her life, she never stopped reflecting on her own art.

The project takes a point of departure from Hilma af Klint's work of dialogue between art and science. This research is carried out through the development of an integrated architectonical solution. Where the technical concerns are placed in response to phenomenological demands, applying the notion of ´creative engineering´. The ´temple for Hilma´ expresses the journey of Hilma af Klint's life and art, through the use of atmosphere and tectonics, setting the frame for her art. Enhancing the experience through architectonically leading the visitor via the senses.

ill. 1.1: Painting of Hilma af Klint, Childhood

Readers guide

The report is structured with four different segments, ‘Introduction & Methodology’, ‘Site Introduction’, ‘Presentation’ and ‘Design Process’, each representing individual areas of the project. These chapters are introduced with a short description of the content telling the reader of what to expect from the coming phase and the introduction page is also presented with a picture of Hilma af Klints painting giving an insight in her work.

First chapter of this report is ‘Introduction & Methodology’, which inform about the approach to architecture and engineering including our motivation for this project. Through analysis’ of history, case studies, atmosphere and tectonic a theoretical understanding of the subject is formed. Together with the ‘Site Introduction’ chapter, the first part of the report establishing the programme, that gives an overview of which parameters to influence the project. Centered on obtained knowledge through the programme, a presentation chapter follows, showing the design of the project.
`Design Process` follows up on the presentation, simplifying the process into phases, describing the core framework of the project. The report is completed with appendix, containing additional information pertinent to the project.

Table of contents

Introduction & Methodology

This chapter delves into our methodology, which is focused on the work towards the integration of the definition of "creative engineering " and its appliance in the field of architecture. The research and development of this thesis is based on the application of the integrated design process. Taking a point of departure, with a vision of creative engineering, a tectonic approach, with the notion of atmosphere combined with Hilma af Klint's life and art.The chapter provides the basic theoretical understanding for the design of a `Temple for Hilma`. The method is centered around understading Hilma af Klint, translating and analysing her art and journey with elements such as tectonics, light and senses in architecture. It concludes with the reflection about tools and expressions needed for the development, not of a modern museum, but of a dedicated temple.

ill. 1.2: Painting by Hilma af Klint - The Swan No 12

Introduction

The ´Temple for Hilma´ is a project that honors Hilma af Klint as an groundbreaking artist. The museum is designed to host her art, as a permanent exhibition, as well as other relevant artists that, during their life, reflected upon the topics to whom Hilma was particularly devoted, such as war, religion, genders and, more in general, the diversion in the world; topics which are as important today as they were at her time.
With her scientific approach, her paintings were able to blur the lines between art and science, proposing a seamless integration of scientific research and personal expression.
Seeking inspiration from her approach as well as from her art.

The site is located just outside Stockholm, more precisely on the island Lindingö, near the city of Hersby. Within walking distance, over the bridge to Lidingö, it is possible to reach the new, under development, area of Stockholm: New royal Seaport. The site, moreover directly faces the fjord, transforming, the place into an exposed and secluded area, at the same time.

ill. 1.3: Painting by Hilma af Klint - Selfportrait

Motivation

The artist Hilma af Klint seamlessly joined the two polarized fields of science and art into one, developping a new way of accessing the art of painting; a combination that both, in a contemporary artistic and architectural context, is infrequent. Very often, indeed, the engineer's role in architecture is reduced to the simple act of solving the technical problems of some already developed architecture. With the application of an integrated approach, the scientific tools of an engineer are introduced earlier into the process, resulting into the development of a more holistic design solution. The role of the technical aspects remains of providing information towards the architecture rather than a co-development of it, missing a level of creativity and innovation.

Similarly to Hilma af Klint, architects as Cecil Balmond and Santiago Calatrava are the forerunners for the real integration of the scientific elements into architecture. These personalities have been indeed able to combine architectural and engineering approach into one complex creative field. This has been possible thanks to the challenging of the technical concerns towards the ability of reinterpreting and developping the architecture. In this way, the technical concerns become defining features for the formulation of the concepts.

Such ´master builders´ demonstrated a level of creative engineering skills that goes beyond the simple integration of art and technique into an holistic solution, being able to push spatial and technical boundaries towards the symbiosis between the two.

- How do such designers achieve this goal?
- Is it possible to integrate this method as a natural part of every project, as an extension to the integrated design process, defined by Mary-Ann Knudstrup?

The application of `creative engineering` is often reserved to building whose technical performance and demands are crucial. When working on architecture of artistic value, often handled singlehandedly by the artistic architect, this level of creativity is nearly none existing.

- Is it possible to apply `creative engineering` on highly phenomenological aspects of architecture and on architecture whose technical demands, are phenomenological?

Hilma af Klint was a visionary painter, seeking to find spirituality by the use of a scientific approach towards her art. The story and memory of her, in the highly artistic space of a museum, provide an ideal point of departure for the development of a project that pursue an approach where the scientific and artistic elements of architecture are combined.

Vision

- How to create a museum for Hilma af Klint, able to portray her art, life and values?

Using her way of integrating art and science to create a building where the scientific and artistic parameters of architecture are used creatively, in a highly phenomenological demanding project.

Design Methodology

The design process takes a point of departure in Hilma Af Klint's life, art and design methodology. Hilma af Klint was not trying to create art for the sake of the art itself, but to use it as a tool to convey a new world view and to explore a new level of spirituality where all are equal, examining different subjects, as inequality between men and women, war and religion. By creating series of paintings, she explored these subjects using art as medium, while continuously reflecting on the analysis of her paintings, in a way in which each work was treated almost as a scientific data. This approach seamlessly mixes the methodologies of both art and science, generating a symbiosis between the two, creating paintings in series, exploring each subject and reflecting through her notes.

Hilma af Klint's approach, highlights a significant discussion around architecture, considered as a common practice leading to the separation of artistic and scientific elements into the two different professions of the architect and the engineer. Bryan Lawson describes in his book, "How Designers Think", the way in which both these professions can be defined as designers with different focuses and approaches to the problem (Lawson, 2005). The architect is moreover often considered to come from a humanistic background, while the engineer from a scientific one (Hansen & Knudstrup, 2005).

A method, based on the collaboration between engineering and architecture, is the integrated design process. The method seeks to combine the knowledge from the two fields, in order to solve the complex matter of designing a building, suggesting an holistic solution to the problem (Hansen & Knudstrup, 2005). Even though this method provides an overall structure for the process, it does not invoke a level of creative use of engineering. The result is a better informed solution, still lacking a level of ingenuity, constituting an holistic but not necessarily symbiotic result.

Many examples of how to reach this symbiosis are available. One of the most prominent ones being the architecture of Cecil Balmond. Balmond challenges the conventional unquestioned ideas of engineering, such as ever-repeating patterns, grids, straight columns and so on. Providing a structural solution which is not only statically satisfying but, artistically valuable. His solutions often see the use of already well-established

structural elements, though rethinking their structural and spatial relations.
Cecil Balmond is always looking for metaphors, but uses the tools of the engineer to achieve them, highlighting how his focus crosses both approaches. This is even more evident in his sketches, simple mathematical models where the vision is reaching a balance with the structural concerns.

By constantly questioning the technical solution on both a technical and phenomenological level, the ´Temple for Hilma´, will in a similar manner as Cecil Balmond, challenges the architectural solutions. Here, the engineering vision focuses on the support of the artistic drive, using a scientific approach to examine and understand how to reach these innovative solutions.

Portraying not only the art but messages of the art, the project takes advantages from a theoretical background based on atmosphere, tectonics and a understanding of Hilma af Klint's art. Getting a broad overview on the necessary tools to design a museum able to portray not only her art, but also her messages.

The scientific examination will be carried out using performance aided design (PAD). PAD seeks to integrate the more available tools, methodologies and interfaces for the execution of the performance analysis and the choice of the optimization strategies, into the design process. It aims to the expansion of the understanding and nurturing of the creativity of the designer, by letting the designer explore the ever-complex network of parameters of the performance design in an integrated manner (Parigi, 2015, p. 26). The collaboration of performance and artistic view, highlights the importance of reaching an optimized solution, not in the traditional performance focused sense, but rather searching for an optimal solution for the aimed artistic vision and atmosphere. By using a scientific approach to examine and explore the different elements involved in the phenomenological approach of the problem, each solution is documented, examined and evaluated, using the results to reach the desired effects. It is though important to note that the performance of the solutions will be ever more important. The performance of a column will not only be judged based on its ability to transfer loads, but also on its relation to the human scale, or the reverbarations ability to scale a room.

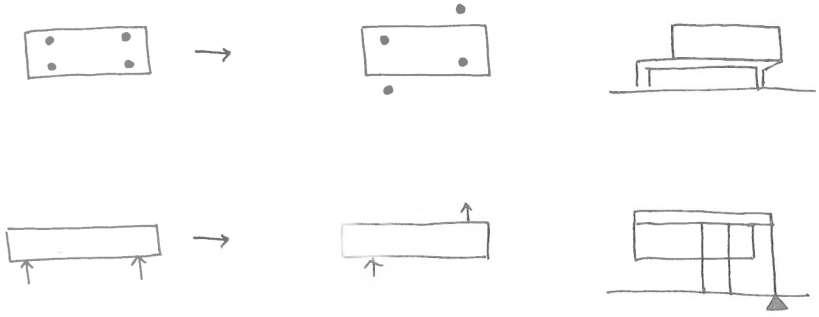
Creative Engineering

Engineering is increasingly starting to be incorporated earlier in the design process but, especially in some projects, it is able to enhance the architecture, characterizing the building with subtle solutions instead of only showing advanced structures.
An example of this is ´Villa in Bordeaux´ by OMA. The initial proposal for the building was a “flying box” coming out of the hill. The simple unquestioned solution would have been to place a series of discrete columns, but the solution was considered too “heavy” (Balmond, 2010). Instead, thanks to a series of iterations, the final solution opted for an offset cantilever. This choice, not only gives the effect that the building is flying, with nothing but a cable at the end, but emphasizes the dynamics and the tension, giving the feeling of a suspended building and highlighting the drama (Balmond, 2010). The result is a safe but seemingly risky `atectonic` construction. The surprising aspect is that all this, has been developed an achieved through the use of simple mathematical models and sketches construction.

Even though the elements used in the construction where nothing new, he managed to generate an innovative and unique architectonical solution, expressing both artistic and technological language. The process of Cecil Balmond show how the incorporation of artistic and scientific element can lead to a symbiosis where both elements elevate each other, instead of simply supporting.

The project for the ´Temple for Hilma´ will focus on how the dialogue between engineering and architecture can bring a level of symbiosis similar to the one present in the works of Cecil Balmond, even in a project where the necessity of creative engineering is not due to a high performance demand, but rather to a high phenomenological one. Cecil’s approach of questioning the unquestioned and develop projects with technical concerns and possibilities in mind, allows the technical design to be an idea generator that inspires and develops the projects instead of simply providing solutions.

ill. 1.4: Exterior picture of Villa Bordeaux



ill. 1.5: Tectonic principles of Villa Bordeaux

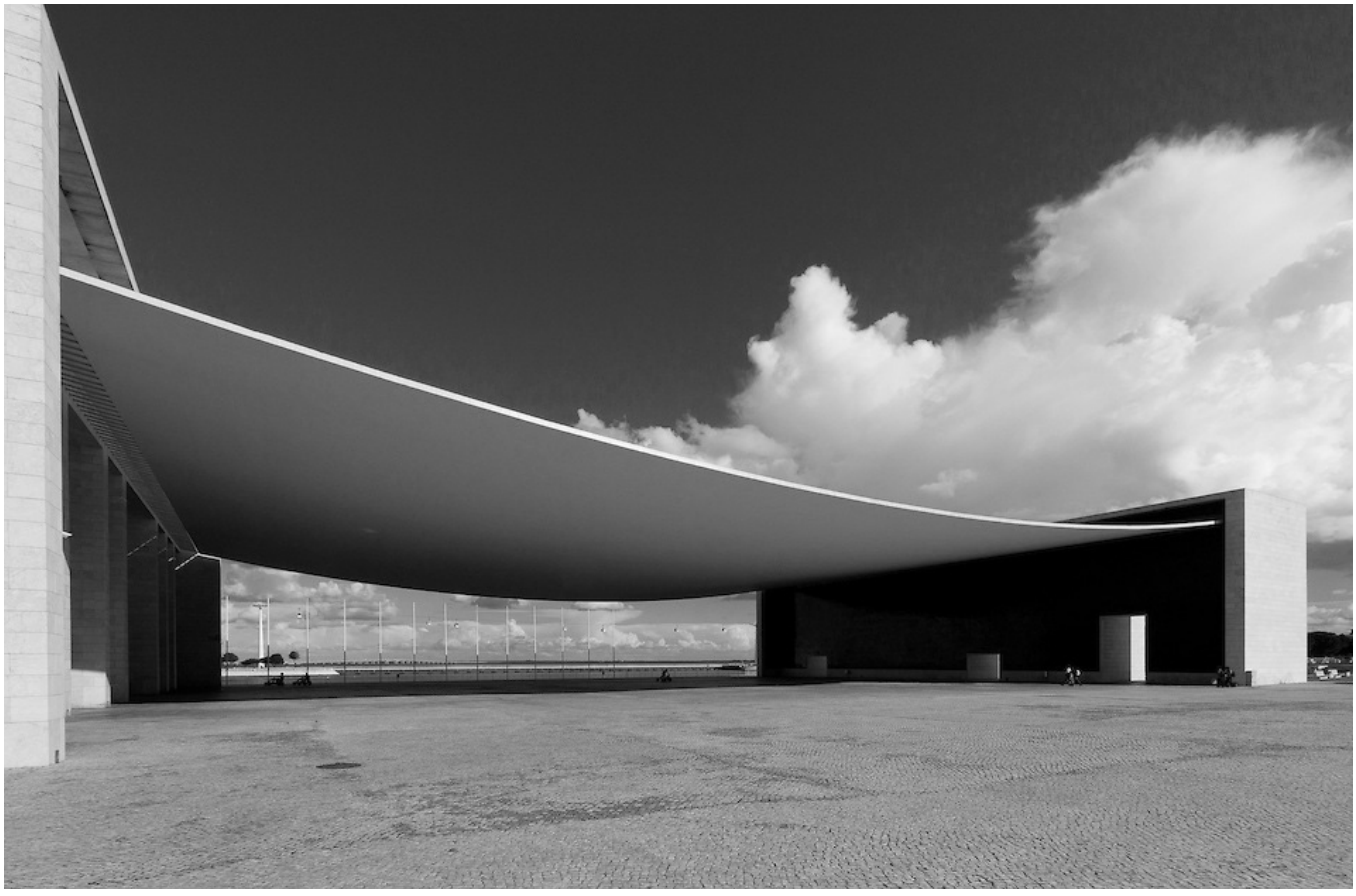
ill. 1.6: Exterior picture of Villa Bordeaux

Tectonic- Atectonc

When interpreting a tectonic expression through a museum milieu that determines a relation between structure and atmosphere, it is important to understand the influence of tectonic upon the visitor.
From an historical perspective, humankind has, from collapsed buildings, learned about forces and static, knowledge that have turned structure into an expression, developed by standing on earlier architects shoulders (Frampton,1995). As architecture is progressing, the knowledge of structure is progression beyond experience, as it is possible through performance aided design tools, to simulate the development of new untested solutions, beyond experience. This development generates solutions able to reverse the tectonic traditional hierarchy. The stereotomic can take the place of the tectonic, creating an expression of atectonic(Garritzman, 2017).

“Tectonic shall not be mistaken with art, the artistic dimension of tectonics is not figurative, the representation lies in the tactile skin and the structural composition” (Frampton, 1995). If the structure negates the load and support expression, the scenograpic appearance becomes a notion of atectonic, where material properties are not processed in a usual manner (Sekler, 1965). Such a composition is seen in “Lisbon Pavilion” by Álvaro Siza Vieira, using a thin layer of white concrete to perform as a wide spanned roof. It is crucial how, through the knowledge of engineering, it becomes possible to create a roof functioning under tension instead of compression. Underneath this massive slopping roof, the perception of the space may be fearful or the sense of being a dot in the space. This illustrates how the atectonic appears not as a negligence of the structure but as a relation between structure, space and senses.

Tectonic or atectonic lies not in the structure itself, but in the senses that are activated. This activation of senses defines the space for each individual human and create a unique experience for each person.
It is the task of the ´Temple for Hilma´ project, to form a space that has the poetics in the structure and the senses represented in the edifice. The essence of atectonic becomes valuable in a context where tectonic is considered.
The neglecting of the traditional use of material becomes poetic itself, and shows how a combination of science and art can create elevated architecture, progressing from traditions.



ill. 1.7: Pictures of Lisbon Pavilions roof structure

Hilma af Klint

Hilma af Klint - 1862-1944

Hilma af Klint comes from the first generation of women being accepted at the Art academy of Stockholm at the age of 20, where she studied portrait and landscape painting.(Westermann, 2014) In the late 1800 she took part in spiritual "séances" that led her to the interest towards theosophy (philosophy on the knowledge of life) and anthroposophy (spiritual inner development)(ibid). She moved away from the realistic art and became the pioneer of abstract paintings in 1906, when her first abstract painting saw the light(ibid). This was four years prior to MoMA's declaration of the beginning of abstract art, marked by a painting by Wassily Kandinsky (Peyton-Jones, Orbrist, Birnbaum & Higgie, 2016). Hilma never managed to expose any of her paintings during her lifetime, claiming in her testament that they should only have bene shown 20 years after her death.
She debuted in the exhibition "The Spiritual in Art – Abstract paintings" in 1990 – 1985, '86 and later exposed in 2013 at the "Moderna Museet" in Stockholm with about 230 works. (Westermann, 2014)
It is most likely that af Klint was inspired, in her compositions, from close family members and fast-evolving era. With the death of Hermina af Klint, Hilma's sister, in 1880, her interest for the spiritual world started and finally got seriously kicked off by the fact that this period saw the discovery of electromagnetic waves, by Hertz and the later invention of the x-ray images, by Röntgen in 1895 (Higgie, 2016). Shortly after, in 1896, af Klint and four other women formed a group called "The Five", in which they experimented and scientifically investigated the world of spirituality, working on trance-like experiments with automatic drawing and writing. With the séances, they were communicating with a higher entity of the spiritual world and, thanks to this, af Klint got guidance and inspiration for her art (Peyton-Jones, Orbrist, Birnbaum & Higgie, 2016).

Her abstract art never got communicated with the public during her life, and to get an income she used to still make portraits and landscape paintings on the sideline (Higgie, 2016). In af Klint's life she painted approximately 1200 works (Higgie, 2016).
Hilma af Klint painted her most popular abstract series of paintings between 1906 and 1915 with hybrid and symbolic forms which she used with a vivid palette of colors, compositions and symbols that she called "The Temple", counting a total of 193 works (Peyton-Jones, Orbrist, Birnbaum & Higgie, 2016). In this series, it is not possible to avoid to notice the simple spirals, symbolizing evolution, and the clear snail shells, symbolizing hermaphrodites, which possibly were inspiration from Charles Darwin's theory on the evolution of the species (Peyton-Jones, Orbrist, Birnbaum & Higgie, 2016). During this period, she made a series called "The Unseen", which was composed during the period in which her mom got sick and turned blind (Peyton-Jones, Orbrist, Birnbaum & Higgie, 2016).

Her spiritual method of performing her abstract art was also shared by her male colleagues: Wassily Kadinsky, Kasemir Malevich, Piet Mondrian and others, who had the goal of breaking the boundaries of the normal physical world, taking inspiration from theosophy. Instead of showing a visual impression they sought to show a more spiritual reality. (Peyton-Jones, Orbrist, Birnbaum & Higgie, 2016)
In 1908, the theosophist, Rudolf Steiner came to visit Hilma's studio, getting, at the same time, impressed and skeptical. He told her that her art would not have been understood for the next 50 years. The message was hard for her and it might have been one reason for the writing of the testament, dictating the 20 year wait for her release of the paintings.
Another highly notable remark is the contemporary

era, in which women were fighting for equality. This is best described through this quote from Otto Weninger's popular book from 1906 "Sex and Character": "The female is completely occupied and content with sexual matters, whilst the male, interested in much else, in war and sport, in social affairs and feasting, in philosophy and science, in business and politics, in religion and art" (Higgie 2016 p. 33). She later moved away from working as the séances/trance medium for her abstract art and made her paintings more symbolic (Birnbaum & Enderby, 2016).

The world is polarized and the way we perceive it is through opposites: day and night, woman and man and so on, but Hilma af klint sought to explore the invisible world beyond this, beyond our senses, beyond everything that is connected and related. (Westermann, 2013) This way of viewing the world highlights the way Hilma af Klint viewed spirituality. She believed that she could express, through her works, the conviction and belief in the spiritual dimension in life. She used the paintings as a tool to seek insight in a higher state behind the visible world, using an almost scientific approach of exploring spirituality through her paintings (Westermann, 2013). Her paintings are therefore, structured in series and developed in a systematic order. She worked on entire collections at once, instead of just a single painting, and her work should therefore be seen like a whole (Westermann, 2013). She worked swift, without changing anything, spending a lot of time after, to understand, analyze and read her own pencil strokes, ending up writing 1200 pages on the studies of spiritual life (Higgie, 2016). In her paintings, she expresses how her inner experiences and symbolism are chained together, to form the nonfigurative art that she never managed to show during her lifetime. Her main series of abstract paintings, "the Temple", was structured into 6 series around the investigation of different subjects within spirituality.

In the design of the museum, the different series are plotted into a timeline giving an overall view of them, see illustration 1.8 on the next page.
As the museum is dedicated to her, the architecture should reflect this narrative journey, in order to understand how she methodically explored the different subjects, displaying each painting as a coherent exhibition, tailored towards the specific series. The exhibition space should therefore be considered as a series of exhibition spaces, instead of a single one. As her entire work is a long coherent exploration of spirituality, the architecture should emphasize this research, by focusing on the materiality and the space and creating an atmosphere that manipulates the visitor and tells the story. "It is through bodies in space and through use, that narrative space and identity are activated" (MacLeod, Hanks, Hale,2012 p.1).

The museums narrative and atmosphere will take a point of departure in Hilma af Klint's life. Hilma af Klint lived in a period of great scientific discoveries, that changed the way people perceived the world. In conjunction with the new scientific discoveries, a wave of doubt but also curiosity, overwhelmed the world, and answers before set in stone now where questioned. Especially in the world of Hilma af Klint, where women were seen inferior to men, Hilma af Klint alone took up, proving and examining the subject.

Is it possible to encapture, this journey of rising against the dominating force, alone but with a goal, a hope ahead, fighting against these overwhelming forces, is the base of the atmosphere in the museum, using the architecture to invoke similar feelings, portraying not only her art but also her personality.

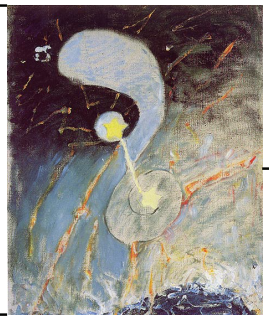
TIMELINE F

1882

At the age of 20, af Klint starts at Stockholm Kunstakademiet till 1887 where she creates landscape and portrait paintings. In 1880 Her sister dies, sets off her interest for Theosophy and spirituality, which the Russian occult and medium Helma Blavatsky founds in 1875. 1886 the electromagnetic waves are discovered by Hertz. 1890 af Klint and four other women forms a group and later names it The Five where they performe séances with automatic drawings and writings.

Primordial Chaos is a collection of 26 individual small canvas paintings which was ideas of forms that she could use as a library to take inspiration from. It's based on simple colours, snail shells, spirals, diversities, circles and flowers which can be seen in later works. Her Fascination by Darwin's theory of Evolution and the spiral, could be a sign of the snail being a hermaphroditic species which, through her eyes, was the ideal species.

1906

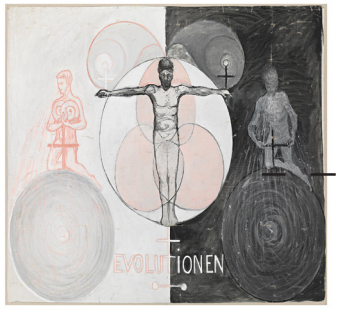


1907

The Ten Largest took inspiration from symbolic figures, from her trance seances, resembling symbolic figures of the sexes. Which could be an inspiration from the contemporary conflict and the women's fight for equality. Could also be an act against the misogyny philosopher Winninger's book Sex and Chracter which got very popular in this period.

Evolution is a series of 16 paintings and could be a self-inspiration from her own creative ongoing evolution and yet again the division of man and woman. It has a clear divisions with darkness and light and driven by symmetry. After she finished this collection, Steiner visits her studio.
A four-year break coursed by her mom losing sight. In 1912 Steiner founds Anthroposophy.

1908



ill. 1.8: Timeline of Hilma af Klints life and paintings

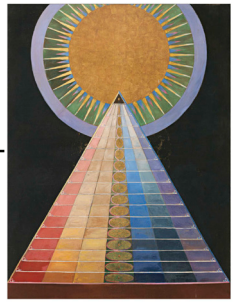
FOR SERIES

1914

A series of 24 works called The Swan incorporate a the swan as it is the strongest bird in the spiritual realm. Again we see the light and dark, female and male. Her inspiration later in the series show a clear colour-wheel from the fascinated Goethe's colour-wheel.
World War 1 breaks out.

The Dove is a series of 14 paintings. The dove symbolizes love and peace in Christianity which is probably an outcome of the ongoing war and an inspiration from Christianity, regarding the paintings. Though it is doubtful that she was a believer, more likely an agnostic. Symbolizing war, love, separation, darkness, light and the universe.

1915

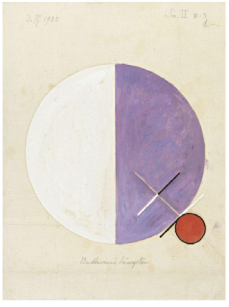


1915

Alter pieces consists of 3 paintings which display a form of sublimity, equality and the quality of being one.

After completing The Paintings for the Temple in 1915 she continued painting untill her death which enclude simple geometric forms in a spars colour palette which defines the dualities within the worlds religions. 1920 her mother passed away and she moves to Helsi ngborg. In 1921 marks the year of women gets the right to vote in Sweden.

1920-1944



All information in the diagram is based on `Painting the Unseen` (Peyton-Jones, Orbrist, Birnbaum & Higgie, 2016)

Atmosphere

Examinating how to incorporate the life, and feelings of Hilma af Klint within the architecture, the act of creating certain atmospheres are examined.

How can the museum activate senses of sight, hearing and touch. Creating an atmosphere that emphasize the despair but also the hope and curiosity of Hilma af Klint.
"A building can guide, direct, seduce, let go or grant freedom to the visitor. A building can catch the interest of the user, and the balance of guiding and letting go is central to form the experience of the building" (Zumthor, 2015 p. 43). The guidance and seduction that enhance the experience of curiosity, can be reached through the construction, by positioning walls intentionally where the space perception changes from closed to open. Also composition of light and darkness creates an interest and guides the visitor, through the manipulation of contrast-full-spaces.
Light creates a pleasant milieu while darkness is gesturing a gloomy atmosphere, symbolizing despair and hope.
"Light is essential when talking about perception of materials and surfaces. How the light drops, where the shadows are, how the materials reflect light and how the sun hits the surfaces" (Zumthor, 2015).
Material's tactility affects light reflectance, diffusion and absorption, and can alter the perception of the surface. Elements as thermal mass, and thermal transmittance, alters, in turn, the feeling of tactility. Through a selection of materials and an analysis on their belonging properties, both a sense of despair and hope can be achieved. Materials with low light reflectance, enrich the darkness and trigger a gloomy atmosphere, not only generating a dark space, but also depriving the sense of sight, which changes the focus onto other senses, even a change of focus to the peripheal vision, can change perception of a room. Peripheral vision unconsciously module our lived experiences, and medical evidence shows that peripheral vision has a higher priority in our bodies' perceptual and mental system (Pallasma, 2015). In the same way, an experience can be easier remembered mentally by introducing peripheral vision to the visitor.
Exemplification of the atmospheres despair, hope and curiosity can be reinforced through the sound of spaces. As the Stockholm public library, by Gunnar Asplund, creating a central room emphazing the life of the entire building.
"How does it sound when we speak and talk to each other?" (Zumthor, 2015,p. 31). It is interesting to experiment on how the sounds of speech are manipulated, how the reverberation time changes a space-appearance, how amplifying speech, amplifies the space and how a clear speech with high definition appears intimate compared to a low definition that can highlight the visitors connection to the rooms.
The surface tactility affect a long range of parameters, as reverberation time, definition and relation to the human scale. When the tactility is smooth, it becomes welcoming, as the hand is able to freely discover the surface. Rougher surfaces, instead, will reject the felling hand, inducing a level carefulness when touching the surface.

Another aspect of surfaces and tactility is the temperature of the building.
"The temperature of the materials affects the visitor's perception of a space, and the variation of the temperature from room to room can vary. The colligation of the varying temperatures, creates a stronger experience for the visitor" (Zumthor, 2015). The temperature of a surface can vary greatly, depending on its thermal properties and on its exposition to heat sources. By creating diversity in the experienced temperature, the visitor unconsciously strengthens the hope or despair, as warmer surfaces are experienced as welcoming and colder surfaces as rejecting.

"The human body is in constant interaction with the architecture, and intimacy is measured differently from human to human. Structure, scale, shape and thickness of a wall, relates to the human" (Zumthor, 2015 p. 51). Structure through an atectonic approach, offers a level of manipulation of the space, that affects these parameters, and highlights the important parameters to be considered when designing the construction. By considering the relation between structure and human, it is possible, via sight, to develop a construction that uses its own scale to dominate the room, making the visitor feel pushed down and creating drama, emphasizing the felling of despair.
"The poetic dimension of architecture is what we see, what we touch, what we hear, what we smell; it is activated through our senses" (Libeskind, 2017). "The relation and composition between these elements is the key to atmosphere. It is the combination, the contrasts and the choices of illumination, acoustics and material tactility, the completion of a sensory experiences that creates something that moves the visitor, trigger feelings that may scare us, may sadden us or something that seems impossible to the human eye. In that spectrum the visitor, experience something that is more than architecture; something that speaks to the mental body" (Pallasma, 2015).
"The feeling that we achieve in complete darkness triggers, in most of us, fear as it is a primal instinct in humans" (Petresin, 2015). "It is the unknown and danger that lures in the dark, and while it is light that we associate with safety" (Ryan, 2017). Shadows and darkness enhances objects that are in the light, and hiding the light source, makes the human focus on the illuminated object. The level of shadow, heavy shadows against light shadows, can be used to create depth in a space and give focus on an exhibit. This also has a side-effect with the perception of silence and admiration (Tanizaki, 2013). "How much darkness do we need? Even a space intended to be dark should have just enough light from some mysterious opening to tell us how dark it really is" (Kahn, 2017). "So where do we need the darkness? The darkness should be used on the narrative journey as the unknown deep mystery aspect" (Ryan, 2017). By manipulating light and darkness, an experience portraying hope through light and despair through darkness, is proposed. The contrast generates curiosity through both light and darknes, letting the fear of the unknown become a curiosity.

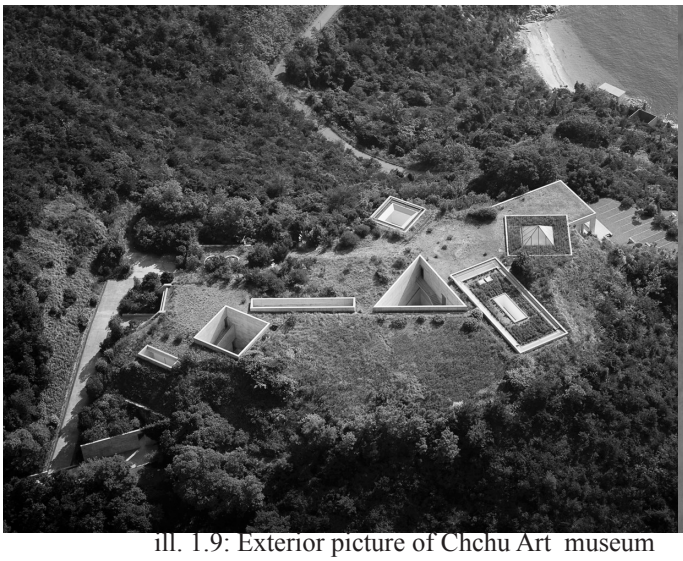
Case study - Chichu art museum

A museum able to invoke a similar experience as the `Temple for Hilma`, is the Chichu art museum. Creating a similar atmopshere of hope and despair. Chichu art museum is located on the island of Naroshima, an island in the Seto inland sea, Japan. The museum is underground, with different elements penetrating the surrounding nature, drawing in natural daylight. The museum is able to use the natural light to enlighten all exhibitions, even the underground ones. In the museum are exhibited three artists, with a room dedicated to each of them, portraying a single fixed exhibition. Beside the exhibited art, a number of structures are placed as a part of the museum's journey, resulting in nine areas in total. (Benesseartsite, 2017). The museum connects each of these rooms through a series of corridors, offering a journey and fusing the architecture and the experience.

When arriving at the museum, very little is visible, as the only part of the façade protruding from the ground is the entrance foyer. This creates a level of uncertainty, but also curiosity, as what to suspect is completely unknown. When entering the building, it is clear for the visitor that they are about to experience something new, both thanks to the darker exterior and to the radical temperature change provoked by the submerged concrete.

The hard surfaces of the concrete and the enclosed spaces of the corridors, amplify the sound through a rather high reverberation time, making every footstep heard and every conversations amplified. This amplification of the human presence, showcases the silence of the building, making the visitor aware of its own presence, pushing him minimizing the noise and reducing chatter to a whisper.

The museum guides people through a direct route with a constant clear direction about where to go next and with very limited options for exploration. The



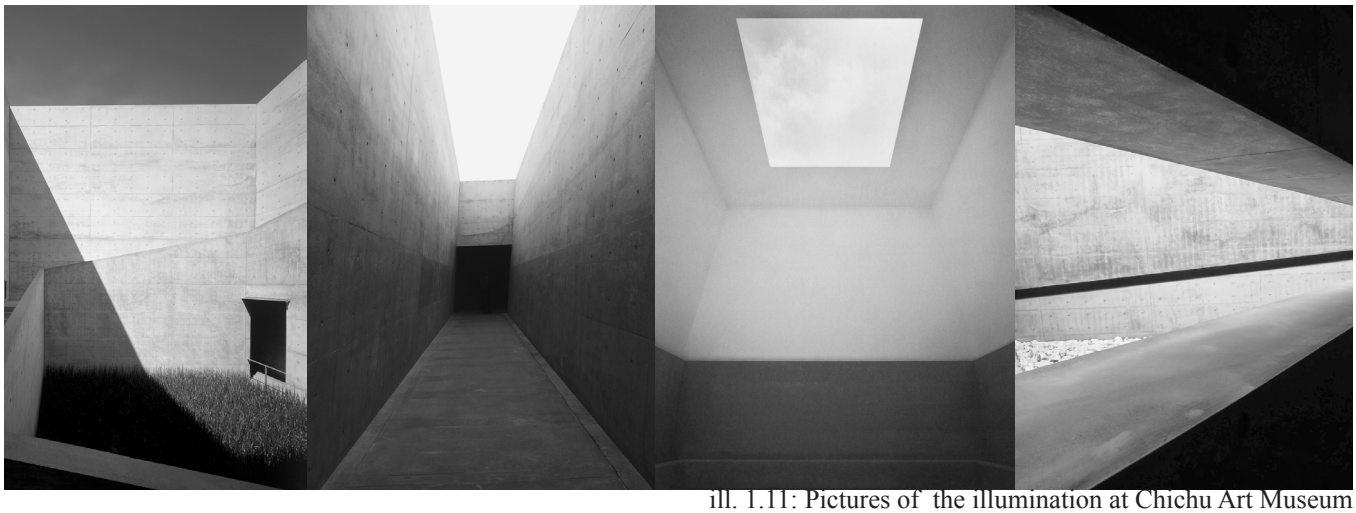
ill. 1.9: Exterior picture of Chchu Art museum

ill. 1.10: Corridor at Chichu Art museum

museum however still uses principles of misdirection, as the corridors connecting the exhibitions are, at times, very sparsely illuminated, creating tension and heightening the senses by minimizing the usage of sight. In other places, the light is used to guide people. Subtle hints of light guide them, letting the contrast of light and dark be a prominent part of the guidance. Even though the museum is a predetermined path, the experience becomes exploratory, engaging the senses instead of numbly going from exhibition to exhibition. Throughout the museum, a series of rooms connected to the outside via skylights, emphasizes the concept of being underground, while creating pockets of sensorial connections via sunlight and fresh air, avoiding the visitors to become dulled by walking underground for 1.5 hours. By creating contrast to the cave-like atmosphere, the experience of each room is heightened, avoiding the experience to become monotone.

The design of the outdoor spaces, in the shape of only skylights with no view to the surroundings, becoming a part of the experience, maintaining the atmosphere of being “trapped” underground. These rooms invokes a similar experience as the temple of Hilma, simulating a level of despair of being trapped, while highlighting the helplessness and the small scale of the human.

Chichu art museum is able through its simple use of the senses, to create an atmosphere. The sense of exploration, and curiosity, combined with the feelings of despair and helplessness of being trapped underground, create a journey through the museum, where the art and the architecture fuse together in one coherent journey. Where the art is highlighted by the architecture and where the atmosphere is able to create the right mood to experience the monumental art displayed in the museum.



ill. 1.11: Pictures of the illumination at Chichu Art Museum

Method resume

The project is working with the notion, defined as “creative engineering” in this report. Creating and utilizing technical demands of the building as part of the design process. Exploring how the scientific engineering can be utilized creatively, while artistic parts will be evaluated technically, and vice versa. Through the use of a tectonic design approach combined with how architecture are through its atmosphere able to invoke certain feelings within people, creating a timeline through Hilma af Klints life. Utilizing this approach to create a space portraying not only the art but also the time and journey of Hilma af Klint.

SITE

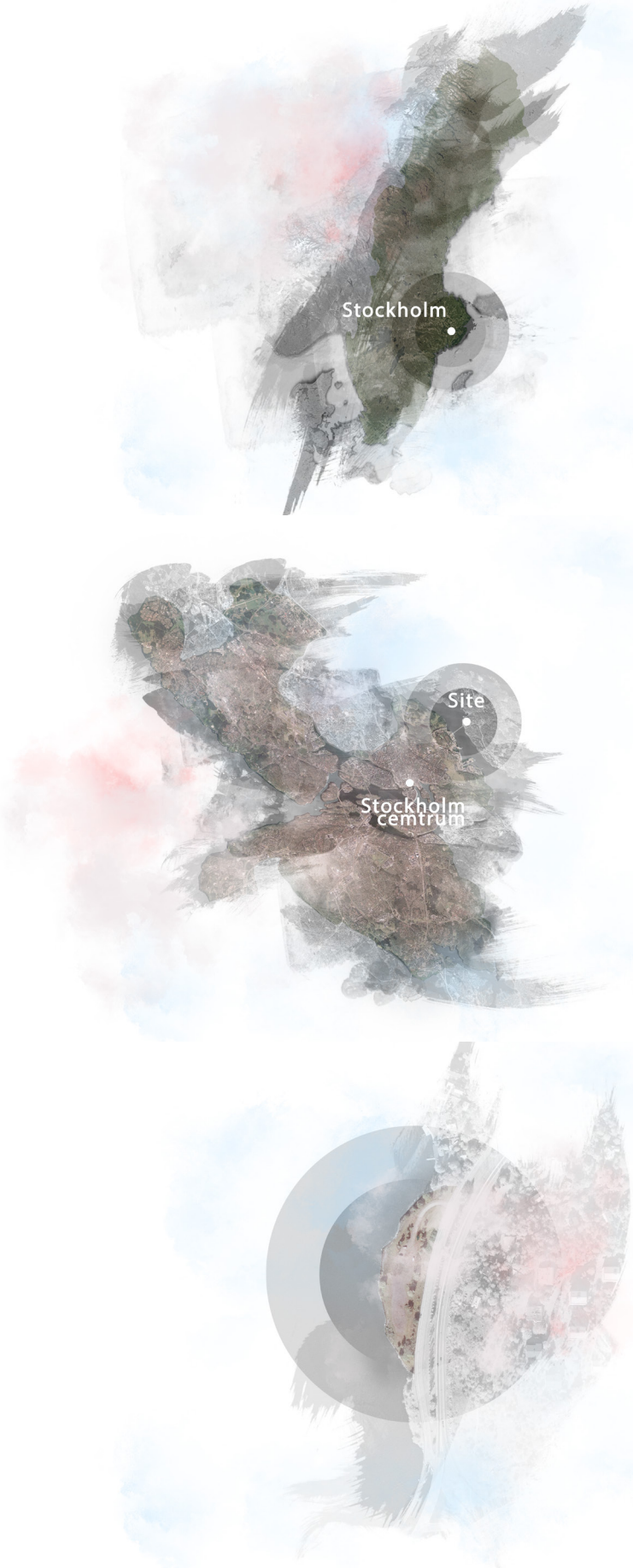
This Chapter focuses on the analysis of the project site, its surrounding context, accessibility and topology, providing a map of relevant parameters to be considered for the design of a museum.

ill. 2.1: Painting of Hilma af Klint The Swan No 17

Site introduction

The project site is located outside the Swedish capital, Stockholm. Stockholm currently counting 912.000 citizens (Statistik 2014). Its territory is distributed on 14 different islands near the Swedish east coast, and is centered around the fjord “Mälarens” with its outlet to “Østersøen”.

The 9000 square feet large site is located in the municipality of Stockholm. The site is separated from Stockholm by the fjord “Mälarens”, with a view towards Stockholm. The fjord defines the western side of the site in a slight curve. Easternmost, a road defines the opposite site boundary, defining a long and narrow area measuring ca. 200 meters on the longest edge and 47 meters on the widest, with a close relation to water and greeneries, shielding the site from a housing area, to the east. The road is the only connection to and from Stockholm.

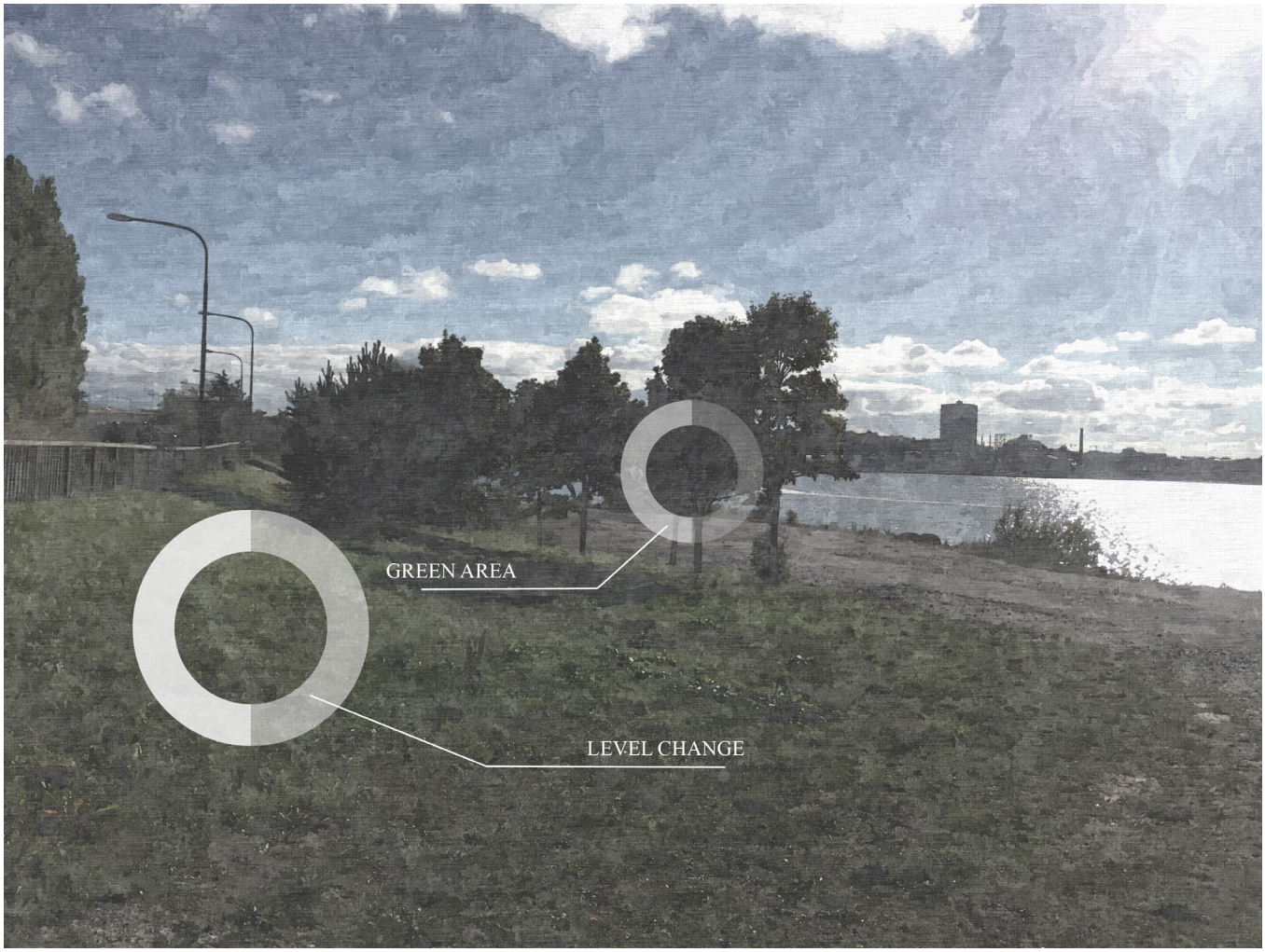


ill. 2.2: Site location Diagram

Approaching the site from the bridge, the site appears completely exposed. The bridge acts as a presentational route for the building, making the overall presentation from the bridge crucial, as it will act as landmark when arriving at Lidingö.

ill. 2.3: Site seen from nearby bridge

The site itself has a level change of 4 meters from the road. This forms a barrier, minimizing the disturbance from the traffic. However, as the road is secondary, the noise pollution is minimal The area in general is a natural landscape with cliffs and greeneries filling the whole area, except for a flattened part on the side, and the road. Even though the site has been leveled and changed to a dirt road, it still keeps a high degree of natural fauna, in the unleveled parts of the site.



ill. 2.4: Arrival to the site

The Site has an undisturbed view towards the city. The connection to the site, highlighting how visible the area is from the opposing shore. The lot is almost at the level of the fjord, creating a close connection to it.

ill. 2.5: View from the site to Stockholm

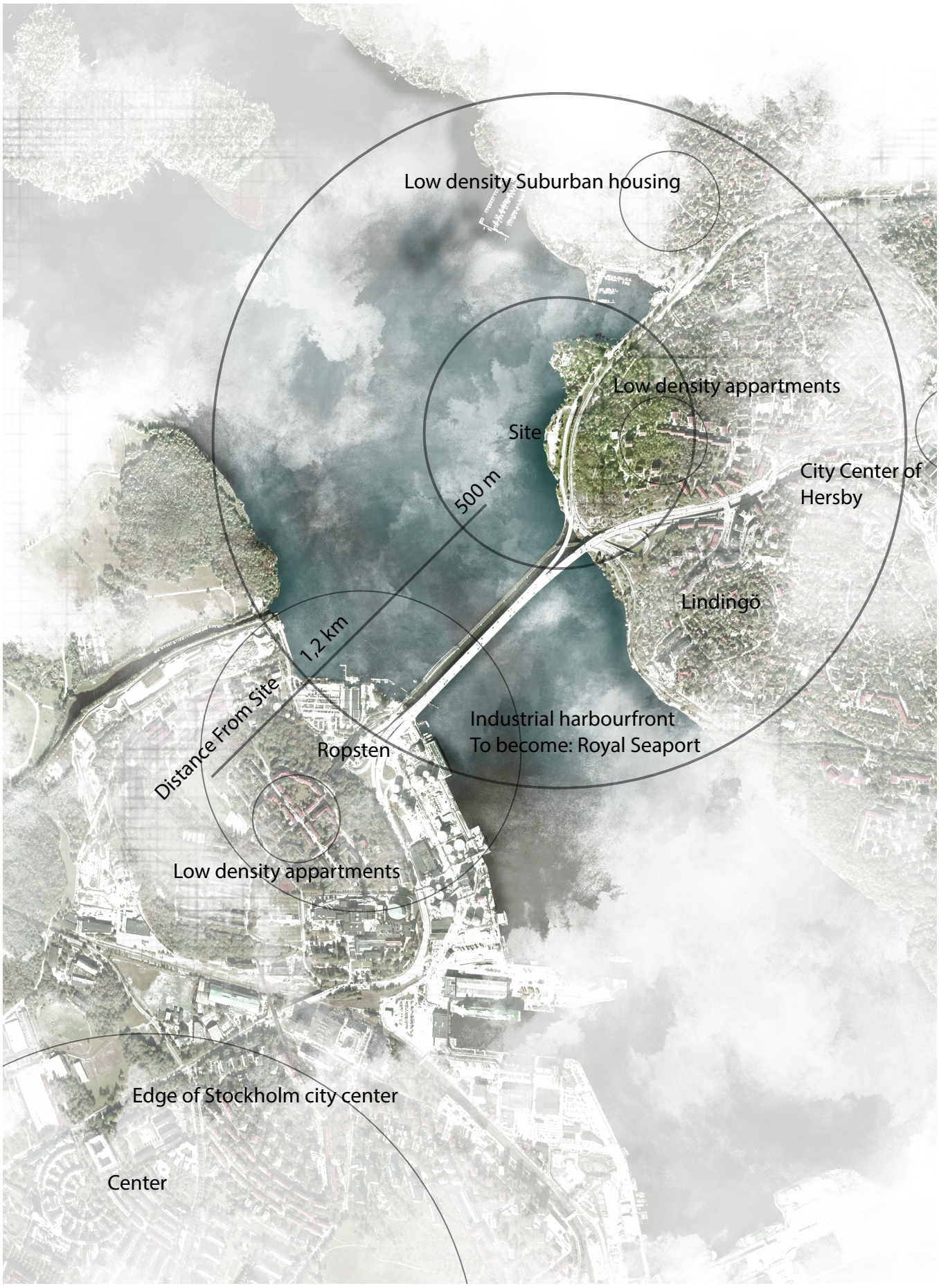
Looking in the opposite direction, a clear view along the fjord and a beautiful landscape appears. It is clear here, how flat the site is. In order to reintegrate the site into the surrounding environment, the landscape will be developed, removing the building site appearance of the current landscape.

ill. 2.6: Northwest view from the site

Context

The mapping of the different areas of the context, helps highlighting what and how the building should relate to the surrounding environment.

The areas in direct connection with the site are low-density apartments and suburban areas. The site is closer to the nearby town of Hersby than it is to Stockholm. Casual visitors stopping by would most likely be from these areas. The building, in connection with the already established museum Millesgården, have the potential to become a signature and a landmark for the area and for the whole island of Lidingö.
When analyzing the visibility of the building, the relation shifts completely. From Lidingö, the building would need a height of three stories in order to become visible, as the bedrock slopes lifts the surrounding area over the site. From the opposite shore, towards the center of Stockholm, the site is exposed for a large part of the shoreline.
Driving towards the island over the bridge, the building site exposes itself, almost becoming a presentational route towards the museum.
The opposite shoreline is right now an industrial area in the middle of a conversion that should transform it into the Stockholm Royal Seaport: an area with 12,000 new homes, 35,000 new workplaces, and a shoreline, completely open to the public (Ottoson, 2014). The area will be completed in 2030 (ibid). The museum will therefore, in the future, have a direct visual connection to the new area.



ill. 2.7: The context surounding the site

Availability

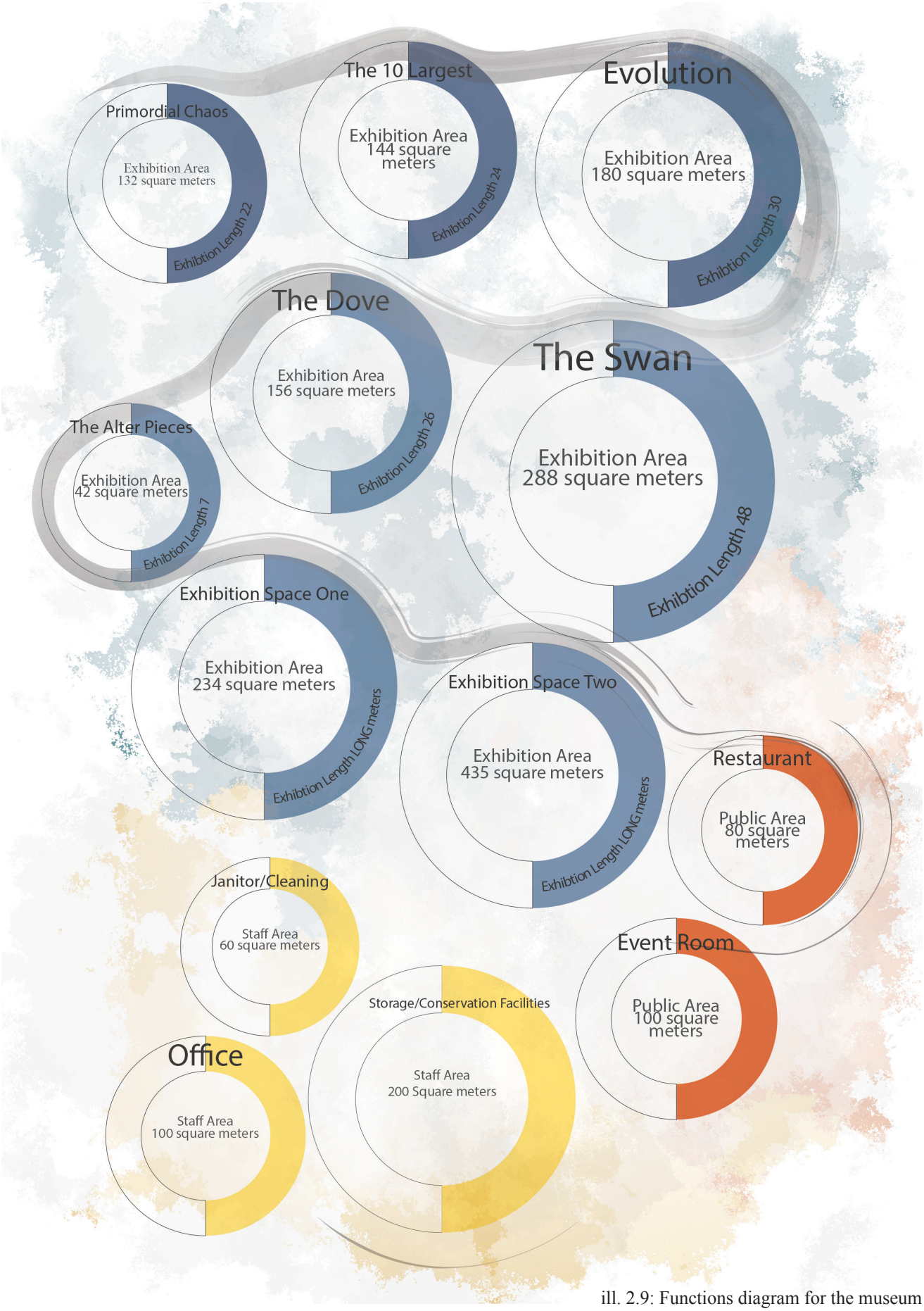
Considering the accessibility of the site, it is clear that from the central station of Stockholm, the trip to the museum is quite long, with around 20 to 30 min by car, bus and bicycle. This means that inhabitants and visitors from the center of Stockholm, would have to make a conscious decision about visiting the museum, and would have to have it pre-planned for the trip. The Building should therefore have a memorable image, while also providing enough content to make the trip worth it.
Looking at the closer context of Stockholm Royal Seaport, with a point of departure at Ropsten; the central transportation hub of the area, the trip is reduced to 5/8 minutes using transportation and 21 minutes walking, making the site much more accessible for the inhabitants. It would still need to be a planned trip to get there, but it opens up for the opportunity to integrate functions like a restaurant, which would give benefit to Lidingös inhabitants, as long as it would offer an experience exclusive enough to make the trip worth it.

Both the trip by bus and car is rather convoluted, as the visitor have to drive around and under the bridge, drive pass the museum and go back on a smaller road. On the other hand, this route screens the site, reducing the pollution noise and making it easier to establish outdoor areas undisturbed by traffic.
People cycling and walking have instead a direct route to the museum over the pedestrian bridge, besides the car bridge. As the trip over the bridge is rather spectacular and direct, many people living at the Royal Seaport would walk and bike rather than taking the car or bus.
The plan for Stockholm Royal Seaport will moreover provide a new infrastructure, including a new tramline, tubes, busses and faeries, making the overall transportation to the site easier. Another major change for the area, will be the introduction of a ferry port, which will house cruise ships from all over the world, making the site even more prominent.

ill. 2.8: The availability of the site

Function Analysis

The museum will have two levels of functions, public and private. The private functions will need to be implemented so that they get a logical connection with each other, but also hidden for the museum visitors. Making a clear separation between private and public. Operational functions as offices, meeting rooms, storage, and conservation facilities, are functions for the staff, while wardrobe, restrooms, foyer, ticketing/ information are basic functions for the visitors.
Some functions as toilet and cantina will overlap. A collected list of functions is seen in illustration XXX and is based around buildings of similar nature and size (mainly Kunsten and Utzon center).
The main exhibition space, is the essence and the heart of the museum and will be dedicated to the exposition of Hilma af Klint's "Temple series". The individual painted series instead, can be experienced in separated exhibition spaces. The result is a number of six exhibition spaces varying depending on the exhibition size. Based on a monographic approach, the main exhibition is focused on the detailing and customization of the exhibition spaces to the specific pieces, allowing for a tailored experience for the specific art. The secondary exhibition space will be used to exhibit both Hilma af Klints remaining art and notes, but also other artists, which have been relevant for Hilma af Klint's path. In this space, the museum is able to host temporary exhibition, and the space should therefore be multifunctional and flexible, as well as having space for both paintings and sculptures, primarily using artificial light for an optimal presentation. (Oddy, Lintrum & Thompson, 2013). Such space is more suitable to a MoMa approach, which appeals to a simpler and uniform space that can adapt to the different functions. To get a better understanding of the types of museum please see appendix XXX "Museum architecture".
The simplification can create a distinction to the monographic exhibition space and the task is to unify these spaces to a more common idiom, maintaining the functionality of the secondary space. A space to accommodate temporary functions as lectures, workshops and special events is also provided. As these functions are only relevant for special events, they will function as a library on a daily basis. To complete the program, natural stops, as restaurant and outdoor areas, are incorporated for the visitor. These function as breathing spaces throughout the journey.



ill. 2.9: Functions diagram for the museum

Site Resume

The site provides an interesting duality with the placement of the site. As the site is highly visible from the connecting bridge as well as the opposing shorefront. While still placed isolated without any direct connection any surrounding buildings, making the museum a place for designated journeys. The site is flattened, only showing signs of its former vegetation and nature, but with a close connecting to the fjord. The available transportation methods makes the occurrence of casual visitors limited, but with a possibility of public transportation to the site.

Presentation

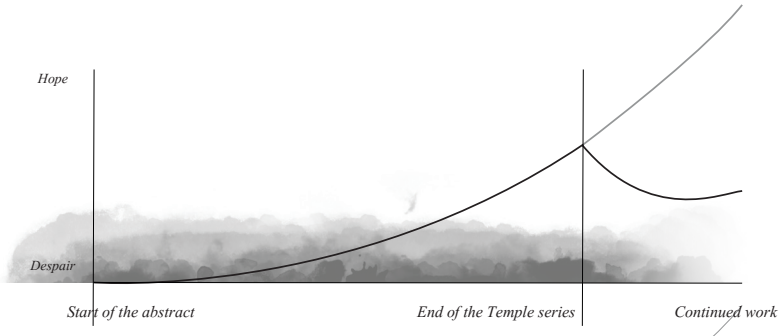
The presentation for the final project is explained and displayed through Renderings, floor plans, sections, elevations and various related diagrams. The presentation commences with a large scale on the site, then zooming into the detail. All drawings are attached in a drawing folder which shows the drawings in a larger scale.

ill. 3.1: Painting by Hilma af Klint- The Swan No 18.

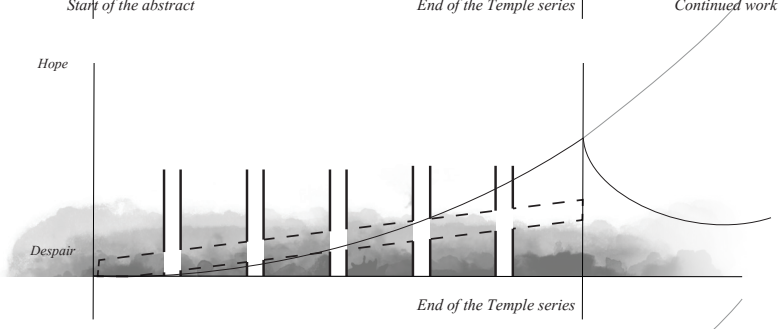
Concept

`The Temple for Hilma` is an interpretation of Hilma af Klint's life. Taking a point of departure from her life and from the "temple series", the journey starts with the beginning of her abstract period, when the `hope` was lowest. This period is surrounded by darkness and void, but as the art progresses, so does the hope. The "temple series" symbolizes certain subjects and even when the series finishes, the subjects are carried out in her subsequent works. The journey therefore continues, through Hilma's research about war and death, leading again towards the unknown and the despair. This journey is translated into the concept of the "Temple for Hilma".

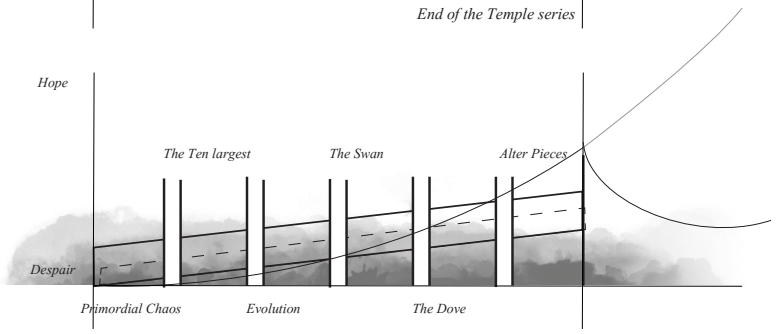
Interpretation of Hilma af Klints life



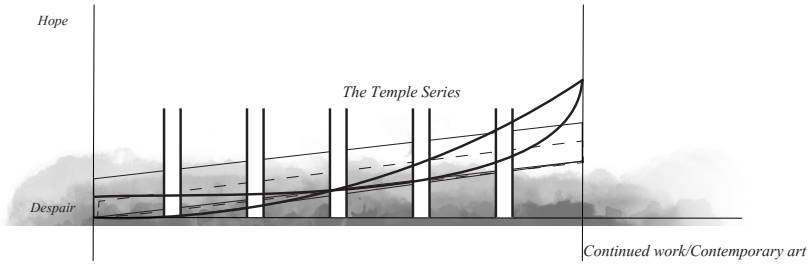
Corridors marks each exhibtion a each step, guiding the visitor through light in the darkness, but divided using a series of concrete plates. A Whole through all plates creates a view through the entire building.



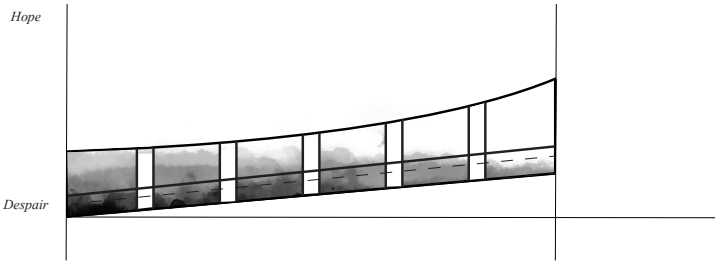
The galleries forms the bridge through the voids, out of the darkness



After the Temple series, the journey continues into new subjects, symbolised by turning around completing the journey back to the present.



The journey is encaptured within the architecture



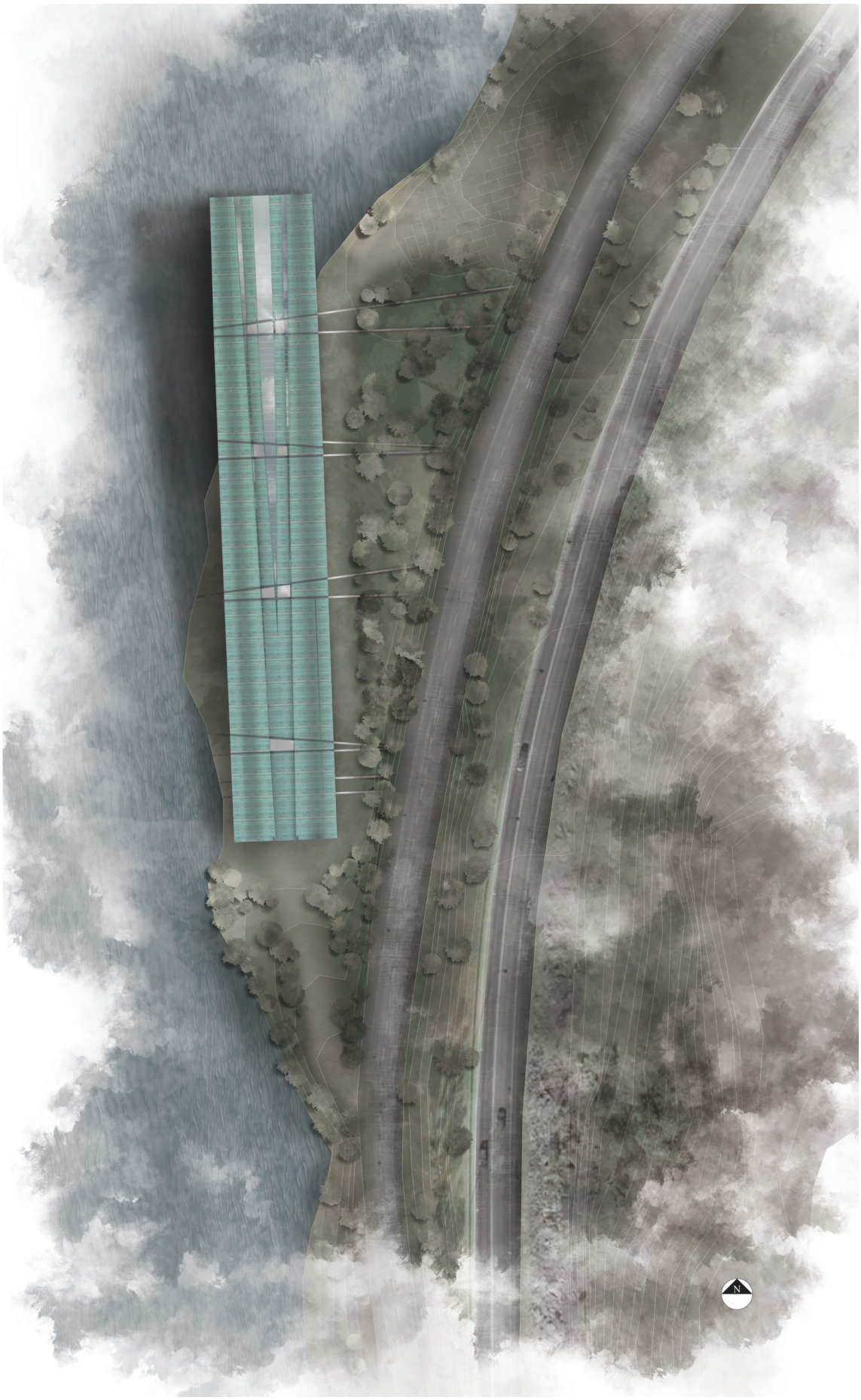
ill. 3.2: Concept diagram

The building observed from the bridge.
The building has a small inclination, while slowly rising upwards in height.
It is also possible to notice how the building is continuously opening up on the roof, as the journey leaves the darkness.
Arriving towards the building, the path over the bridge will act as a presentational route, letting the people observe and guess from the distance, while creating a landmark for the area.

ill. 3.3: Remdering showing the museum from the bridge

Masterplan

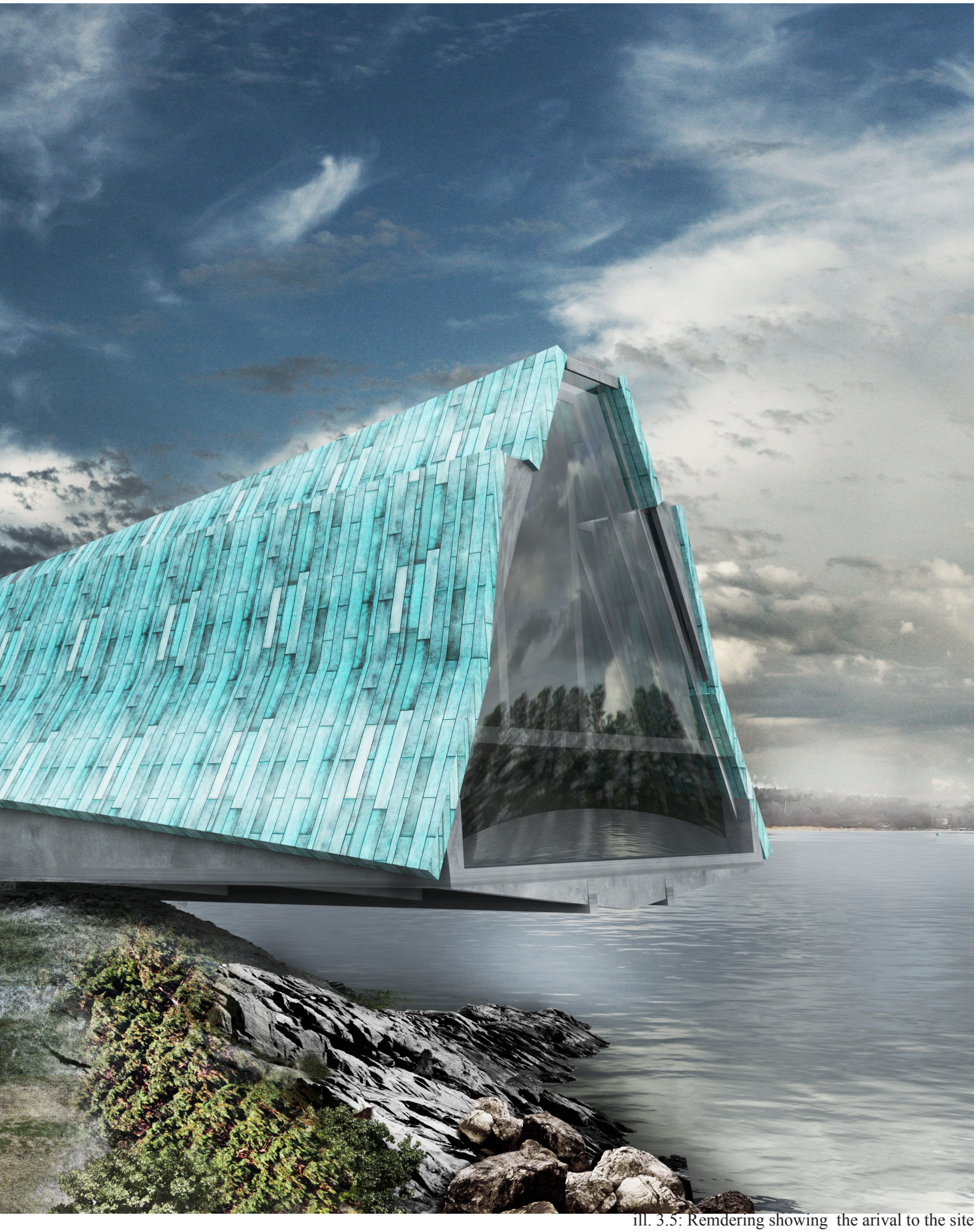
The building is stretching through the landscape as a l42m long and 20m wide straight building. It is following the inclination of the landscape, but as the site bends, the building continues as a cantilevered construction, hanging over the water. The simple straight volume, protruding the landscape, solidifies its monumentality, creating a view from the inside, up towards the fjord.
By approaching the museum by car, via the adjacent road from either Lidingô or Stockholm, the visitor will arrive at the parking lot, located at northeastern part of the site. A garden along the east side of the building will welcome the visitor. The garden is a metaphor of Hilma af Klint's early life, when botany and landscape paintings were her occupancy and her "façade". Garden walls are creating separations within the landscape, studied as an extension of the internal corridors of the building. This extension of walls from the building is drawn out into the garden just as half-meter high markings, creating gardening zones to be filled with trees and flowerbeds. To provide walkable and drivable space for visitor and service vehicles, these marking, slope down to ground surface along the building, offering a four meters wide path along the building.
If the visitors are arriving by feet or bicycle, the entrance to the site is located at the southeastern corner, in close relation to the bridge. From the edge, the site is sloping slowly down to the meeting point between the entrance of the museum and the visitor. The visitor, moving down from a five meters wide path, will experience a density change of the nature, as the amount of vegetation increases. By the entrance, the visitor will be surrounded by trees.



ill. 3.4: Masterplan

The building viewed from the parking lot.

Walking through the landscape, the visitor is passing along pleasant flowerbeds and greenery, while the building's monumental status and straight shape, stays in contrast with the peaceful nature, as a symbol of how, even before the abstract, the problems Hilma worked on with her art where already present. Walking along the building, it is possible to observe the building in the correct scale, establishing the monumentality of the building size compared to the human scale. The only places where the interior of the building is visible from this side, are the office, which is covered by the landscape. And the corridors, showing nothing but concrete surfaces. This creates a notion of uncertainty in the visitor.



ıll. 3.5: Remdering showing the arival to the site

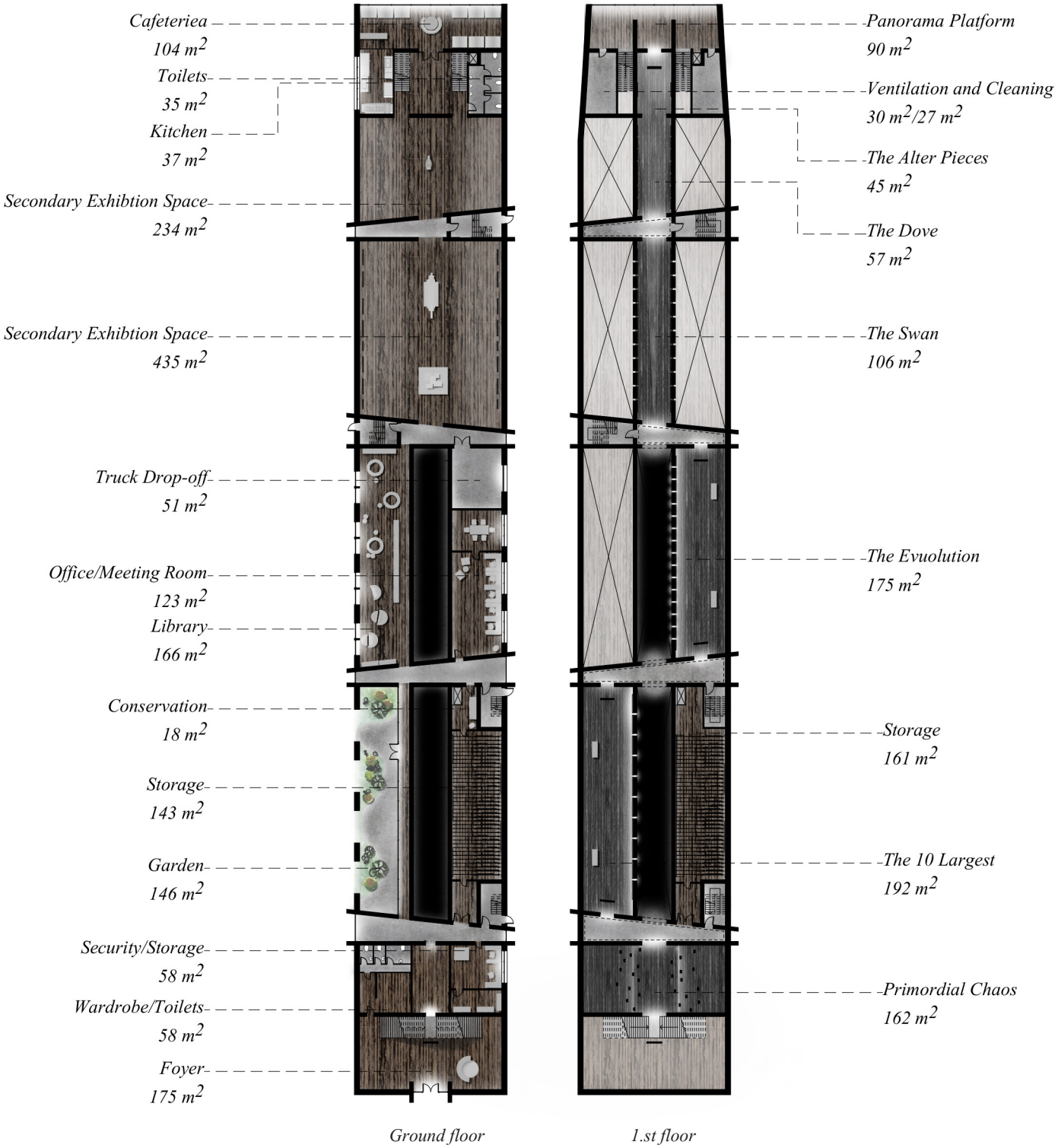
Plan

When entering the museum from the ground floor, the first view meeting the visitors is the double high foyer, with the staircase as a central element. When the ticket is bought at the reception to the right, the visitor can either place his jacket in the wardrobe located in the left corner at the foyer, or move up the staircase, to the first floor, and start the journey.

At the first floor, the main exhibition, Hilma af Klint's "Temple series" is presented chronologically, starting from "Primordial Chaos" and going through "The 10 Largest", "Evolution", "The Swan", "The Dove" and last "The Alter Pieces". The corridors in between the exhibition spaces, function as small breathing spaces for the visitor, marking the transitions between each exhibition. In between the first three exhibitions, two dark, void rooms are placed. After "The Alter Pieces", at the end of the building, the visitors sight is met by a framed view of the Swedish nature, with a view along the fjord, considered as the end of the "Temple series".

After the end of the temple series, people return down on the ground floor. The visitor can now take a break in the museum restaurant or continue into the two secondary exhibition spaces, reserved for contemporary art, representing existing society battles or other art of Hilma af Klint.
Final part of the journey is functioned with a library and a garden that symbolize the starting point of Hilma af Klint's paintings. The library can adapt to events as openings or workshops. The visitor's journey ends where it started, by walking out, underneath the staircase.

Functions for the staff, are located at the ground floor, separated from the visitor by the void spaces. Only the storage is located at both floors, in order to create easy access to both floors exhibitions. The conservation facilities are incorporated in the storage, for easy workflow. The storage is placed in close relation to the office space, providing easy access for the staff. The truck drop-off is located in relation to the secondary exhibition spaces, with temporary exhibitions.

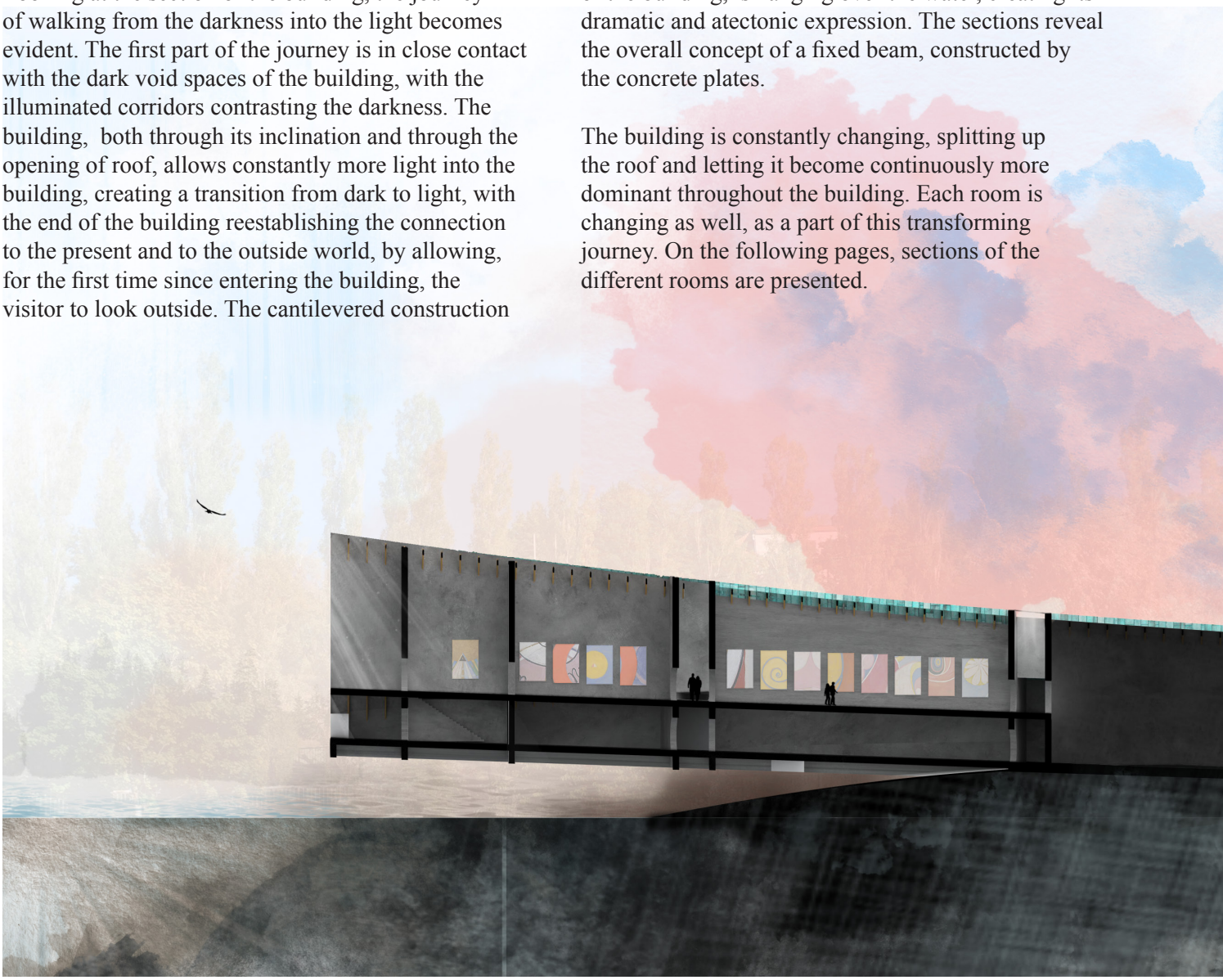


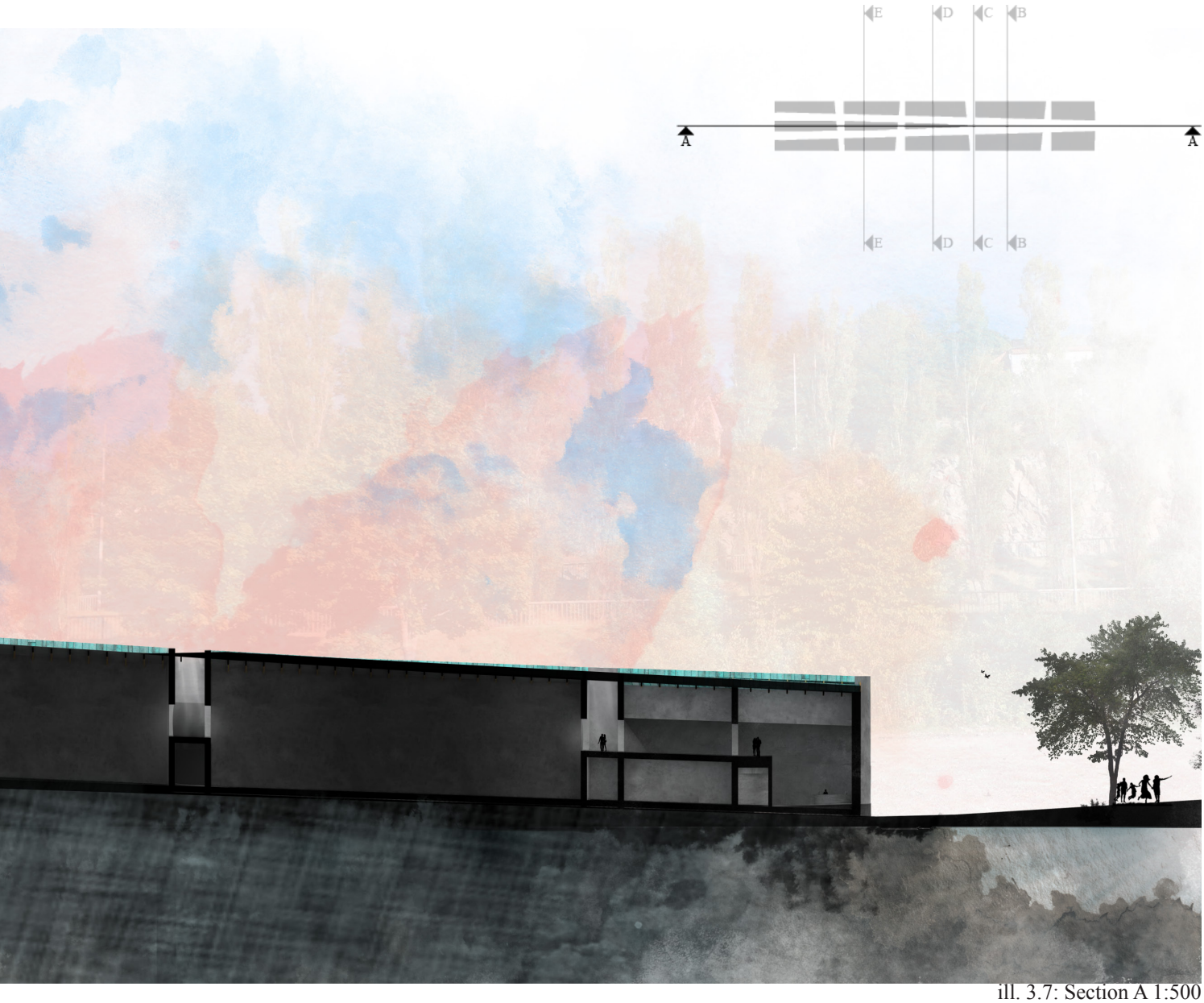
ill. 3.6: Floor plans of the museum

Sections

Looking at the section of the building, the journey of walking from the darkness into the light becomes evident. The first part of the journey is in close contact with the dark void spaces of the building, with the illuminated corridors contrasting the darkness. The building, both through its inclination and through the opening of roof, allows constantly more light into the building, creating a transition from dark to light, with the end of the building reestablishing the connection to the present and to the outside world, by allowing, for the first time since entering the building, the visitor to look outside. The cantilevered construction of the building, is hanging over the water, creating its dramatic and atectonic expression. The sections reveal the overall concept of a fixed beam, constructed by the concrete plates.

The building is constantly changing, splitting up the roof and letting it become continuously more dominant throughout the building. Each room is changing as well, as a part of this transforming journey. On the following pages, sections of the different rooms are presented.



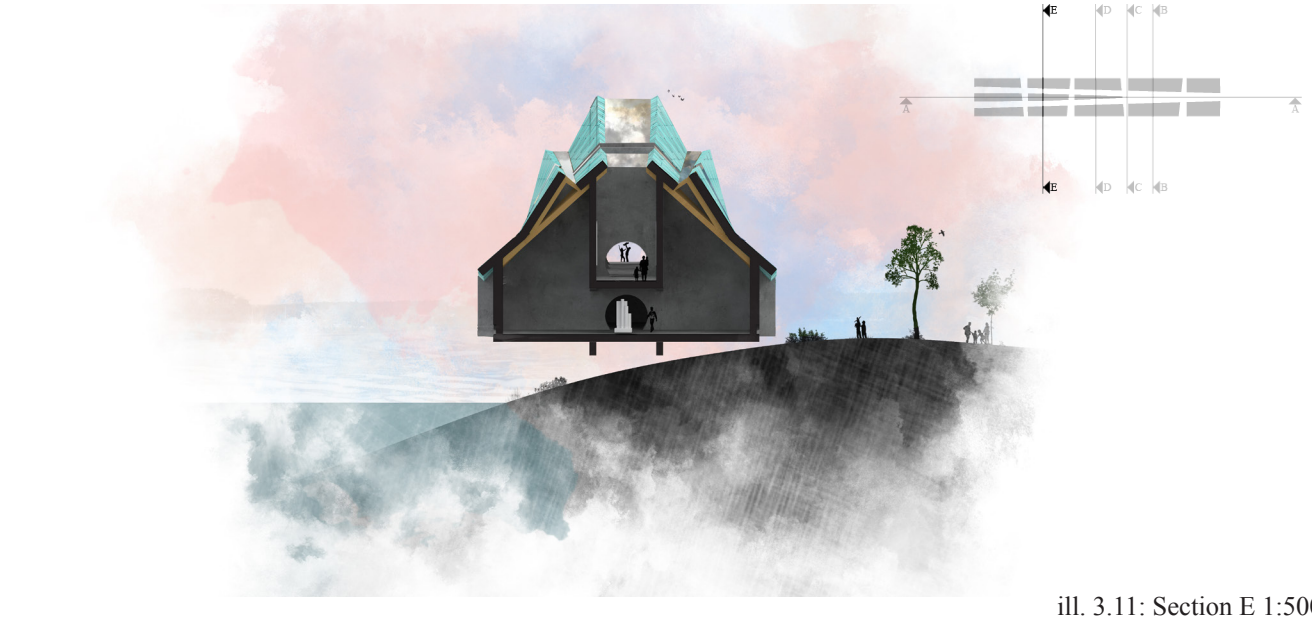


ill. 3.7: Section A 1:500

ill. 3.8: Section B 1:500

ill. 3.9: Section C 1:500

ill. 3.10: Section D 1:500

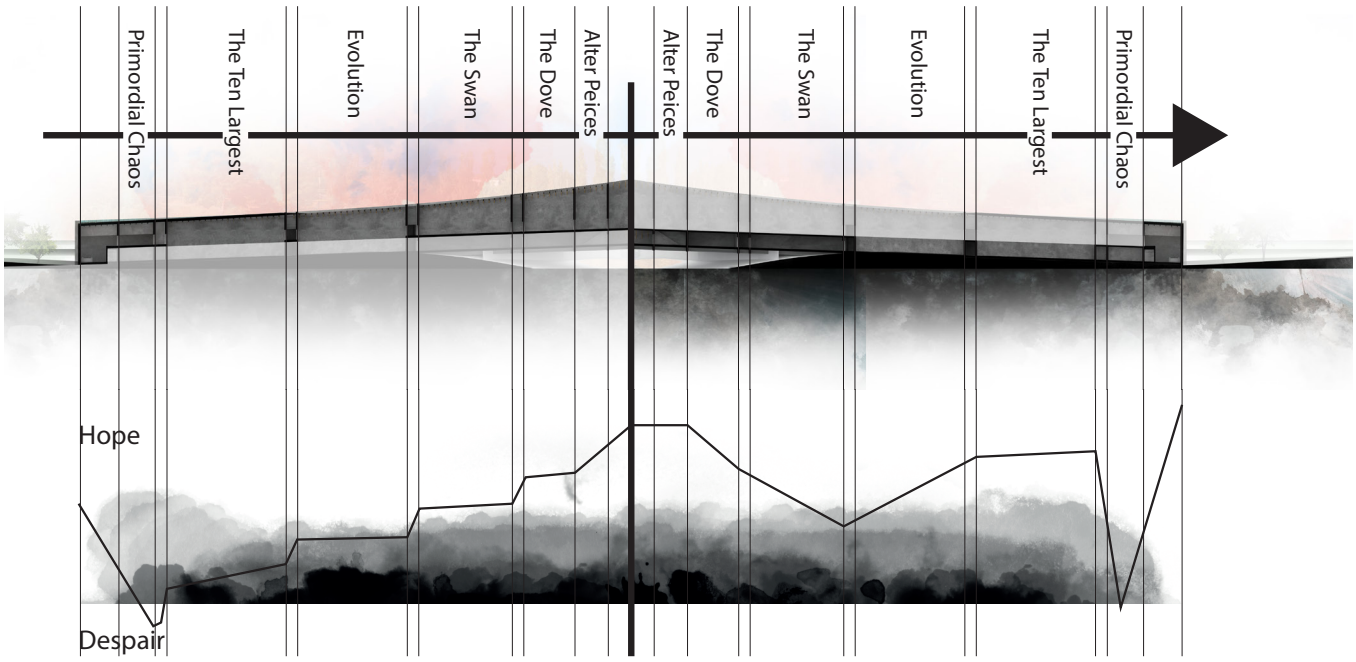


ill. 3.11: Section E 1:500

Journey

As an overall understanding of the building is established. The journey of the building is further detailed. The following pages will delve into the focus points of the building, in a chronological order, explaining how the visitor will experience the building.

Returning to the timeline of Hilma af Klint, the journey of the building is not only defined by the interplay of light and darkness, but by a range of different parameters, constantly changing the perception of the space, and the atmosphere of the building. The building is therefore a constant shift between sensorial inputs, divided into four categories: reverberation time, definition, sight, and light versus darkness. When visiting the building, the different parameters will act as a mean to establish the atmosphere of the journey, influencing the way the building is portraying the art. A summarized curve is shown in ill. 3.12. Each parameter is plotted onto the building, defining each part of the journey through the museum. see the next page. ill, 3.13.



ill. 3.12: Journey through the museum summarized thorugh hope and despair

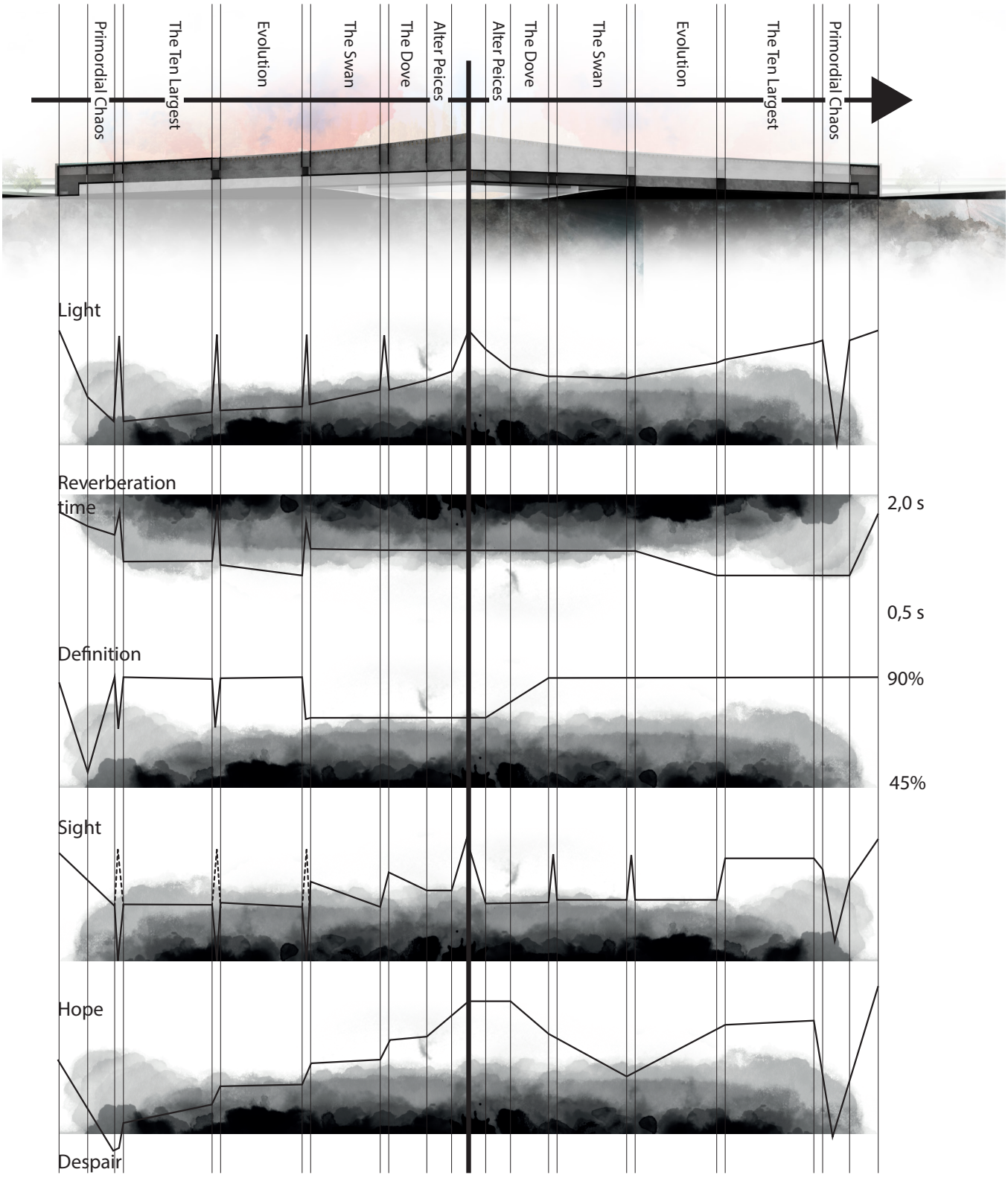
Entering the building, through the foyer the visitor enters a highly reverberant room, with a high light level, due to window slit, forming the entrance of the building. The high reverberation time, combined with the use of the monumental staircase induces an intimidating atmosphere. As the one-sided lighting of the room creates a gradient of light, initiating the transformation from hope to despair. The view to the outside is limited to a single framed view behind the visitor, strengthening the seclusion to the outside world. The Foyer acts as a transition from the present society back to the life of Hilma af Klint.

Entering the first exhibition space, primordial chaos, the reverberation time is 1.5 seconds, amplifying the space. However maintaining a relative high definition between adjacent visitors, abling commuincation through subdued speech, while the sound of other visitors are blurred through low definition of sources further away. Entering the corridors, a transition within the pace itself is presented, as when walking between the void spaces the reverberation is, at those points changed drastically. Emphasizing the ominous presence of the void.

A duality of the sight is created: As the whole creating a view through the entire length of the building, but also limits the sense of sight, as the visitor are able to stare directly into the void.

Throughout the journey, the curves all progress towards a hopeful atmosphere. Leaving the void, the exhibition is opening up through the splitting of the roof, allowing more light in. When finishing the temple series, the visitors enters the end of the building presenting a framed view along the fjord, the middle of the diagram, reintroducing the sight to the surroundings for the first time. Symbolizing the return to the present, while allowing for reflection. However, the journey continuous when the visitor turn around entering the second part of the exhibition. The use of light creates a similar atmosphere of when initially entering the exhibition symbolizing another decent into the despair, as contemporary subjects are displayed in the secondary exhibition, as a reflection of Hilma af Klints work. Both due to flexibility of the spaces and a wish for an overall continues more hopeful atmosphere, these rooms have an even daylight distribution, as well as the corridors introduces views to both fjord and garden. However elements as the height of the exhibition space and the protruding beam like, plate structure, hovering in the middle of room, maintains the overall suppressing atmosphere of the building. At the end, the building leads into areas for relaxation and study, with the library and outdoor area. Before finishing the journey, a last minor dark room is introduced as a reminder of the journey for Hilma as well as the forthcoming journey.

Reentering the foyer the window slice creating the entrance marks the end of the journey, similar as to the end of the temple series.



ill. 3.13: Journey through the museum explained by curves

Foyer

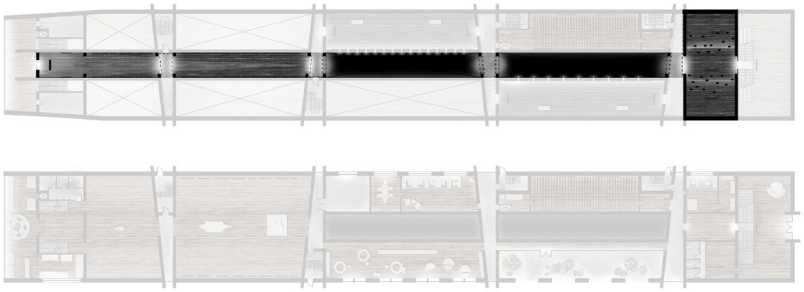
Entering the foyer, the beginning of the journey is revealed through a massive staircase leading up to the start of the journey. Both a symbol for Hilma's alter pieces, see appendix 3, that see the use of the pyramid with the circle on top, and a way to show the human scale in this massive construction. The scale of the room, initiates the feelings associated with the start of Hilmas journey and the domination of the prejudices against her and the women in general, underlined by the structural plates protruding the space from the rest of the building. The room is only enlighten through the window of the entrance, from floor to ceiling, which lets the light into the room, but due to the depth as well as the height of the entrance to the galleries, a transition from light to dark is generated. The journey is commenced when walking up the staircase into the void.

ill. 3.14: Render showing the foyer

Into the Void

Entering the first gallery, “Primordial chaos”, the building’s overall concept of the voids contrasting with the light is revealed. The holes cut through are inspired to her painting “the swan no. 18”, a work that initially inspired the whole concept, see appendix 3. The painting is translated into the series of plates of the construction and exhibition rooms.

Through all the barriers and the darkness, each corridor acts as a guiding light to the next step, with the ending goal straight ahead. Even though the ending goal is unknown, it acts as a guidance for the visitor, invoking curiosity. As people are lead onto the journey through the exhibitions and out of the darkness into the light.



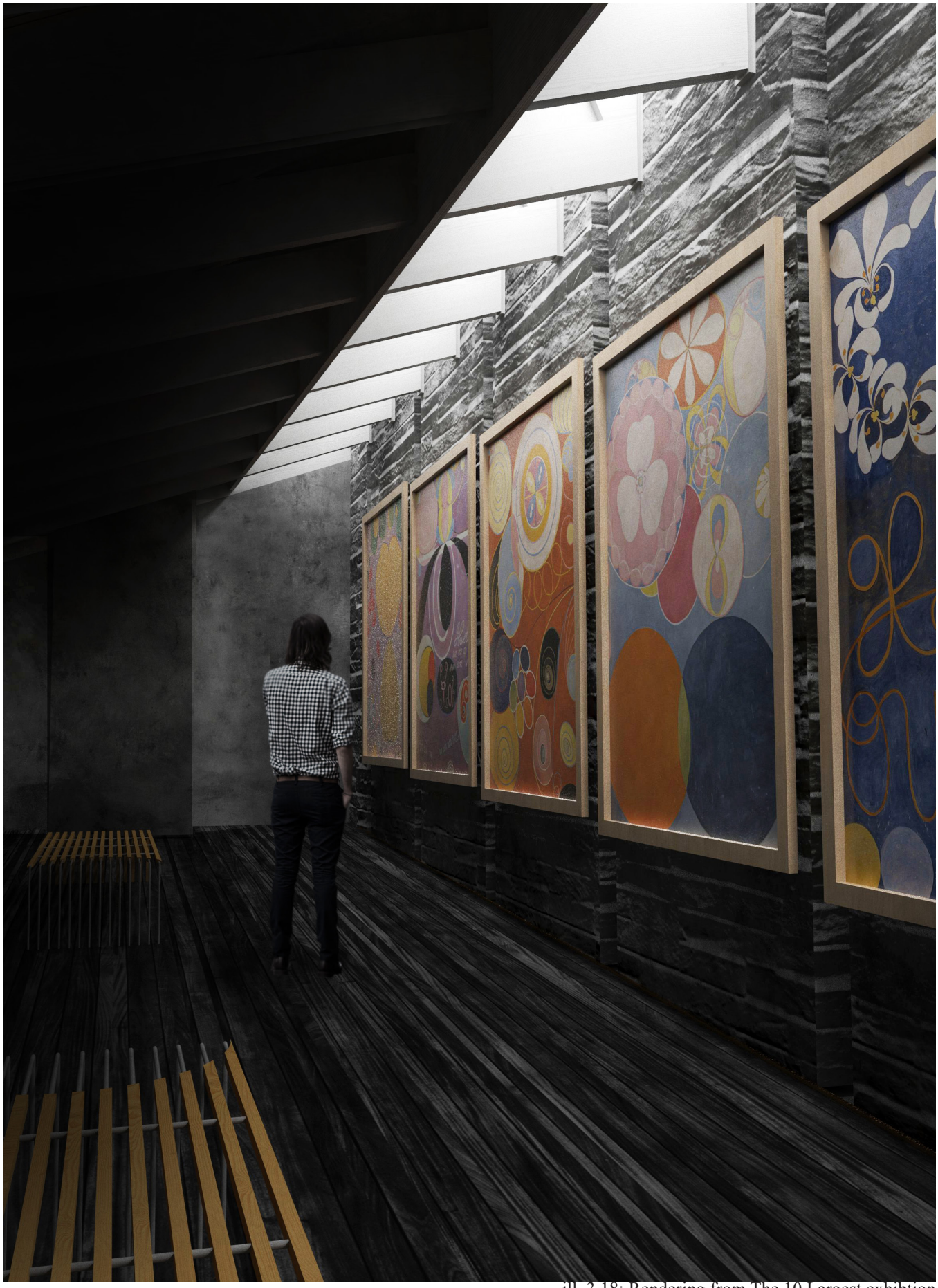
ill. 3.15: Location diagram showing the curiosity view

ill. 3.16: View through the museum

Breaking through the void

Each exhibition allows the visitor to break through the void, letting the people reach the new step of the temple series. Each exhibition spaces is a contrast between light and darkness, varying through the whole journey. The “Ten largest” and “Evolution” are in direct contact with the void spaces and the darkness, using it at as contrast to the natural light, by creating a separation between each painting, allowing the darkness to enter the space and highlighting the illuminated paintings. The paintings are illuminated, while the rest of the room has only dimly light, focusing the attention on the paintings, while still maintaining the notion of walking through the voids, emphasized through the dark wood flooring. The light on the paintings contrasts with the darkness of the void, which is visible between the paintings, as the darkness enters the exhibition space. By creating a direct connection to the void space adjacent to the exhibition space, the acoustic properties of the room also change. The reverberation time change to 1 second, modifying the overall perception of the room, as the void creates a visually and acoustically bigger room, maintaining the effect on the visitor, to be at the same time in the exhibition space and in the void.

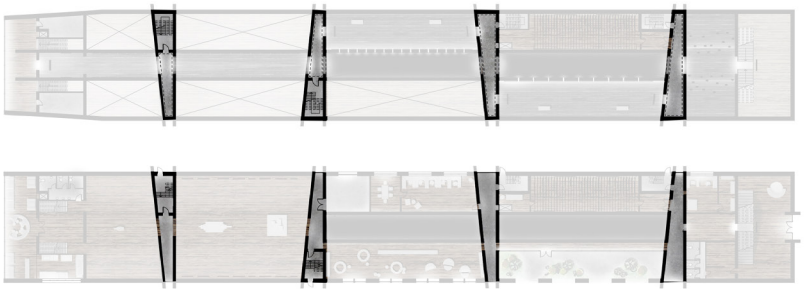
ill. 3.17: Location diagram of void connected exhibitions



ill. 3.18: Rendering from The 10 Largest exhibtion

The Corridors - A Place to Breath

Leaving the exhibition space, the end of it is marked by a corridor symbolizing each step of the journey. The corridor is narrow at the start, letting people come in contact with the surfaces of the walls, while creating a smaller intimate space. The reverberation time is also lowered to 0,7 seconds, in contrast with the prior exhibition space, that was 1 second. However, this intimacy is sharply contrasted when entering the middle of the path reconnecting the room to the void spaces, as the entire buildings length is exposed. This is emphasized by the reverberation time that changes to 1,5 seconds, within the same corridor.
Each of these corridors, marks a new step in the journey of Hilma. The corridors therefore change through the space, emphasizing the journey out of the darkness, while constantly enabling the visitor to look back and forth, so to see what is next and what they just left.



ill. 3.19: Location diagram of corridors

ill. 3.20: Render of corridor between exhibtion spaces

Walking in Light

Entering the last half of the “temple series”, the visitors start to move away from the void and darkness of the prior exhibitions, as the light starts to become the dominant factor and the building itself starts to open up. The room itself is starting to rise up, opening up to the world, while still maintaining a notion of the small scale of the human. At the end of the entire exhibition, the final series of the exhibition is presented, the “Alter pieces”. The “Alter pieces” marks the end of the “temple series”, leading out to the end of the building. The form of the museum has opened up to the fjord, leaving a spectacular view up along the water and returning the visitor to the present, allowing the visitor to reflect while admiring the view.

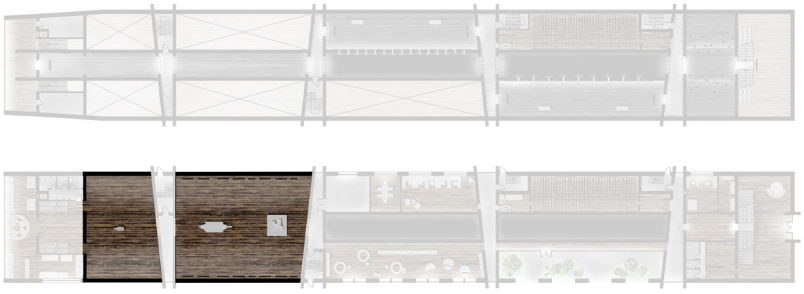
ill. 3.21: Location diagram of lighten exhibiton space

ıll. 3.22: Centered exhıbtıon space

Secondary Exhibtion Space

When the “temple series” ends, Hilma af Klint’s work does not. With a total of 1200 paintings and her 2400 pages of notebooks, the secondary exhibition can be used to show other aspects of Hilma af Klint. These spaces also allow for other exhibitions related to the subjects of Hilma af Klint’s art, which are still relevant in today’s society. This part of the journey will act as a way for the reflection on the relation between the problems of her life and the ones of the present society, letting the visitor understand how she fought, but also how nowadays peoples fight for similar opportunities, rights and answers.

Entering the space, the dominating structure is present and its massive beam-like atectonic structure penetrates the space, maintaining a similar atmosphere to the other exhibition space while allowing for a flexible space for various exhibitions. The structure also creates a space with limited daylight, allowing for a contrast between light and darkness and creating an ideal space for sculptures.



ill. 3.23: Location diagram of secondary exhibition spaces

ill. 3.24: Render of a secondary exhibtion space

Structure

Initially created together with the overall concept of the building, inspired by the swan no 17, see appendix 3, the structure is a series of plates intersecting each other, creating a coherent beam structure cantilevered over the fjord. The concrete structures is through its crossing plates, defining each step of the journey. The structure becomes a part of the metaphor of breaking through each barrier, into the void.

The long plates running the entire span of the building creates a coherent structure, forming the foundation of the concept, as a fixed beam. In ill. 3.26 the overall concept, of altering the beams structure, is shown. Changing the beam in order to maximize the spatial qualities while maintaining a strong coherent beam structure. The expression of the construction is through the use of an atectonic approach developed to impose a large-scale dominant structure, creating a scale difference between the visitor and the building. By cantilevering the building, the forces of the heavy concrete is exposed, highlighting the massive forces within the building, adding to the monumental and dominating expression of the building. The structure itself also transform along the building, letting the contrast between the stereotomic concrete structure, and the tectonic beams shift, letting the wooden beam structure become more dominant along the building.

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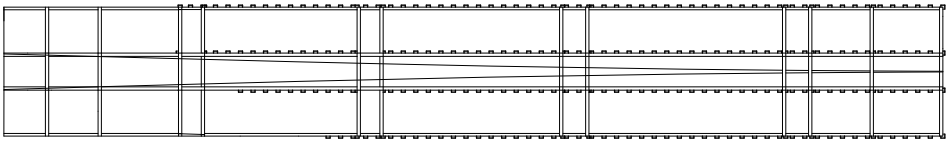
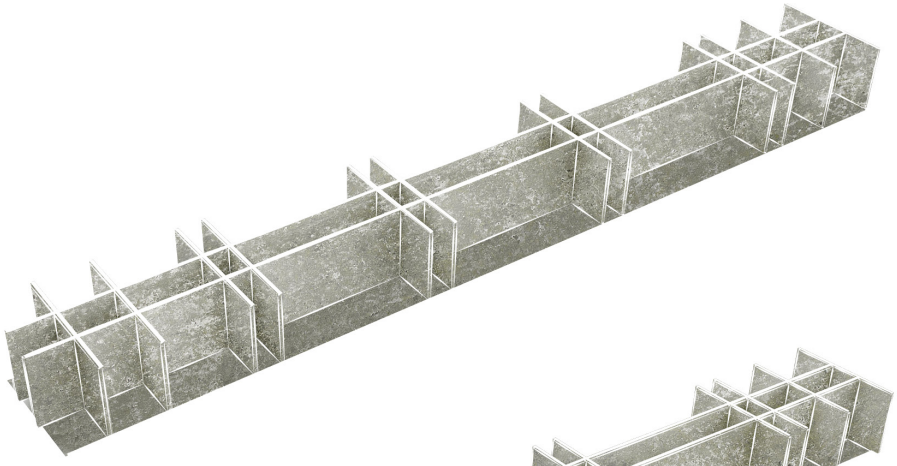
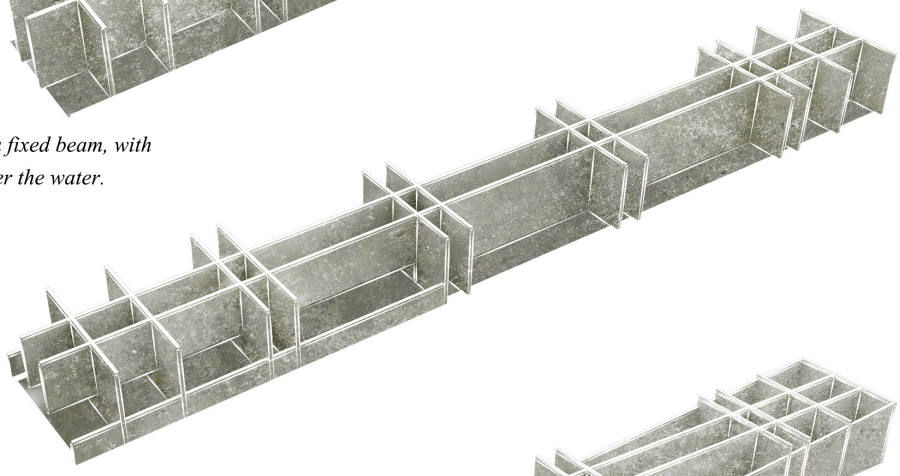


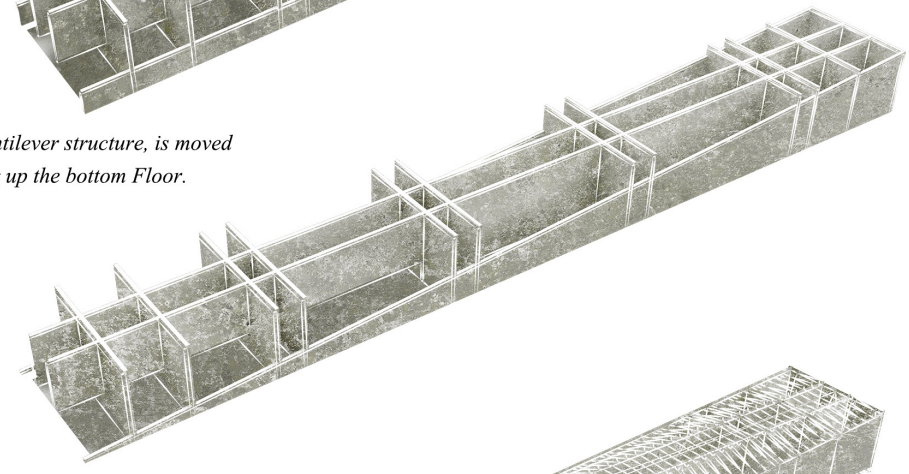
ill. 3.25: Plan of the supports



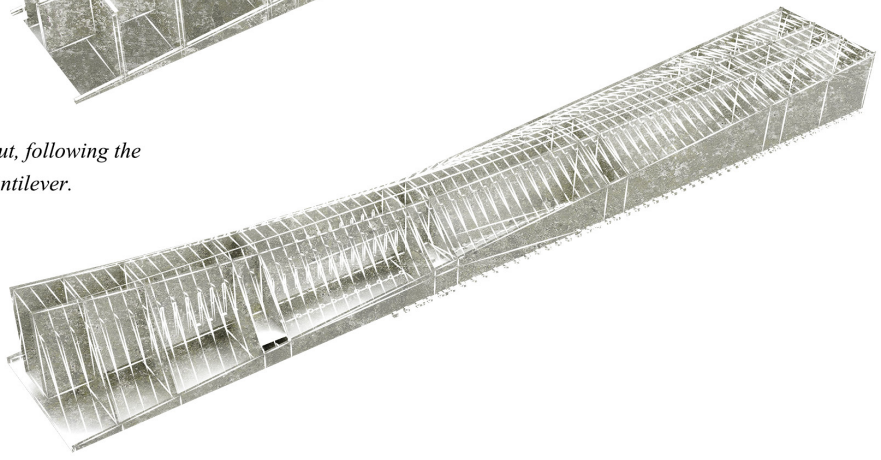
Structure itself acts as a fixed beam, with the end cantilevered over the water.



Bottom part of the cantilever structure, is moved to the facade, opening up the bottom Floor.



The Facade plates are cut, following the momentum within the cantilever.

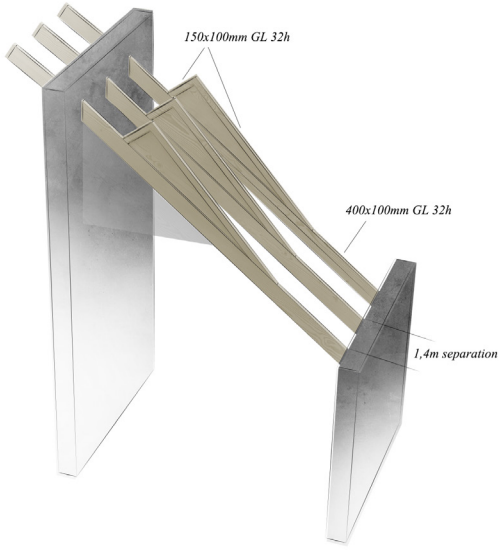


A simple beam structure is introduced to complete the shape.

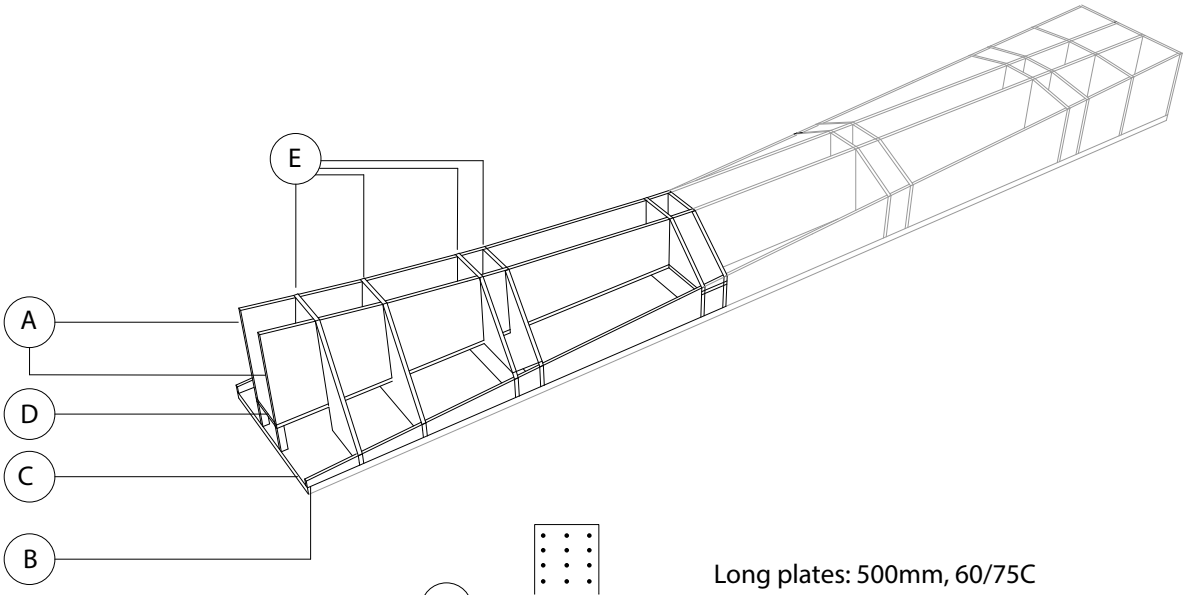
ill. 3.26: Diagram of different structural systems

Using robot structural analysis, the construction is simulated, verifying that the construction withholds, the result is seen in ill. 3.28.
As concrete is a composition material, a long range of solutions is available as the overall performance is determined between the amount of concrete and reinforcement, as well as the type of both concrete and reinforcement. Resulting in a solution of using rather high strength concrete in the cantilevered part of the building, allowing for the use of the same profile of the different elements of the construction, while withholding the tremendous forces of the cantilevered concrete.

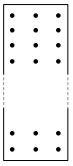
The simple beam structure is likewise developed in robot. The beam is simple beam connecting the center of the concrete structure with the edge plates. The roof however splits up, and the beam therefor have the attached triangular construction. In order to avoid large profiles in the skylight, the gap is filled with a wooden plate, strengthening the construction while forming the foundation for the skylight, creating the light shelfs blocking direct sunlight. The result is illustrated in ill. 3.27. Diagrams displaying more accurate results are located in appendix 6, while load calculations and distribution is located in appendix 7



ill. 3.27: Beam Section results

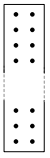


A



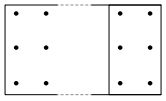
Long plates: 500mm, 60/75C
Critical Section:
Bar diameter= 36mm

B



Edge plates: 300mm, 60/75C
Critical Section:
Bar diameter= 36mm

C

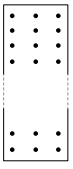


Floor plates:700mm, 80/95C
Critical Section:
Bar diameter= 36mm

D

Secondary Floor plates: 400mm, 70/85C
Critical Section:
Bar diameter= 36mm

E

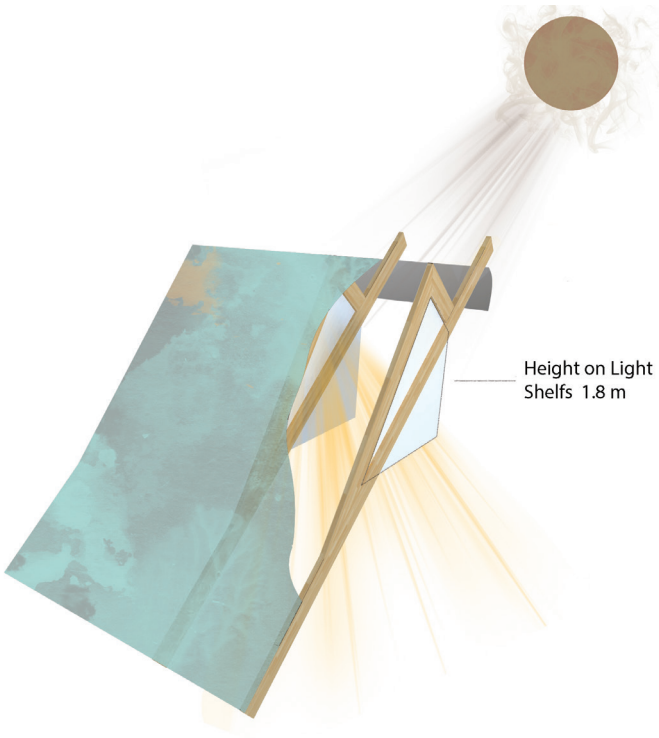


Cross plates: 500mm, 90/105C
Critical Section:
Bar diameter= 36mm

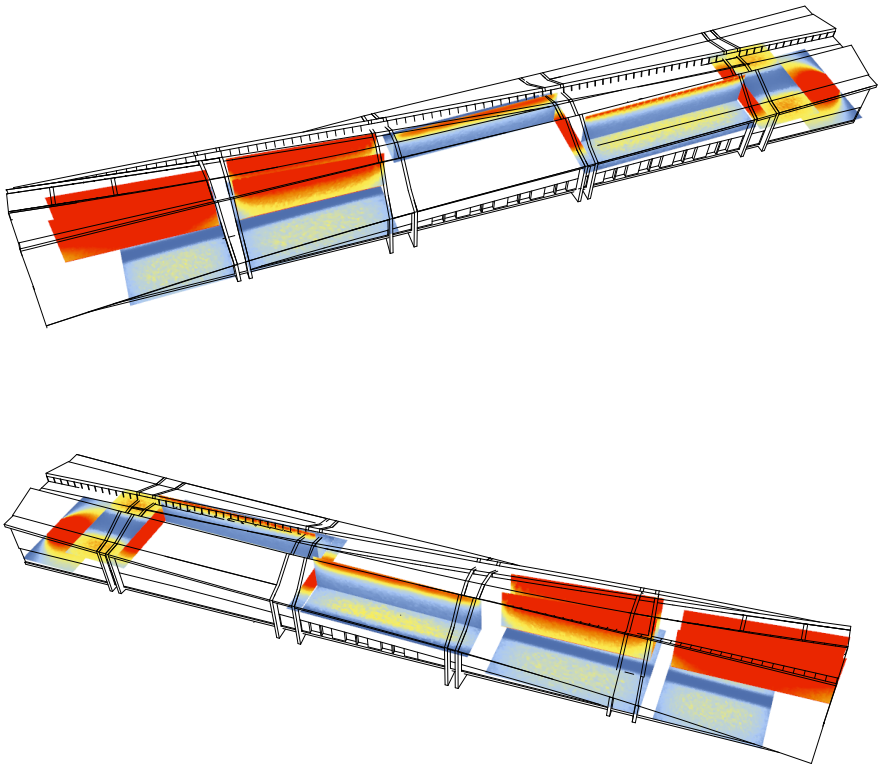
ill. 3.28: Diagram showing a structural overview

Daylight

When creating a museum, no sunlight is allowed to reach the paintings, in order to preserve them. A solution is therefor only viable when fulfilling this demand. By utilizing the fact that the sun hits the light in an angle and the diffuse daylight is coming perpendicular to the ground. The skylight illuminating the exhibitions, consist of a series of plates following the structural beams of the roof. With a height of 1.8 meters, the plates block all direct sunlight while still allowing for a satisfying daylight factor in the critical room of the secondary exhibition space. Along the journey of the building the skylight solutions demand is changing. The early exhibition areas would benefit from a lower daylight level while the later exhibitions would benefit from higher daylight levels. Emphasizing the transformation throughout the museum. The skylight solutions therefor transform along the building. Utilizing the angle of the window, to increase or reduce the daylight level, as is the case in Primordial Chaos, the Ten Largest and Evolution. Allowing for the same skylight to illuminate dimly light rooms of the early part of the journey and the secondary exhibitions in the later part of the jouney.



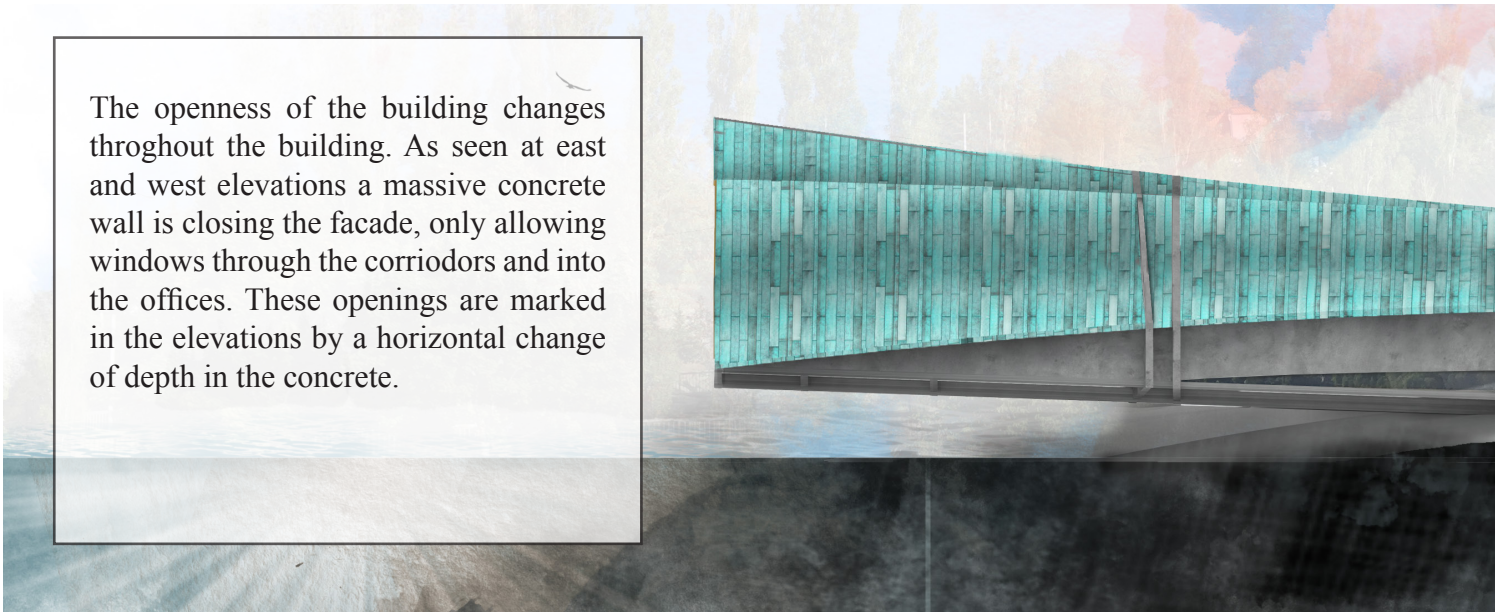
ill. 3.29: Daylight detail



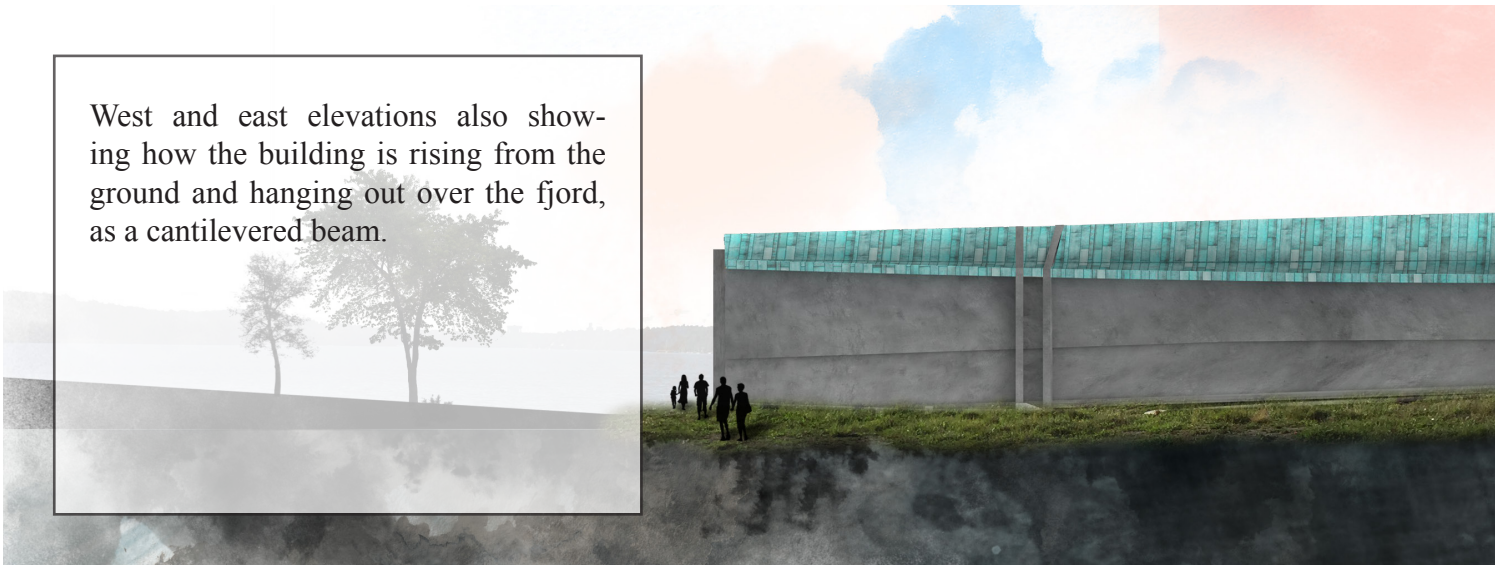
ill. 3.30: Daylight Plan

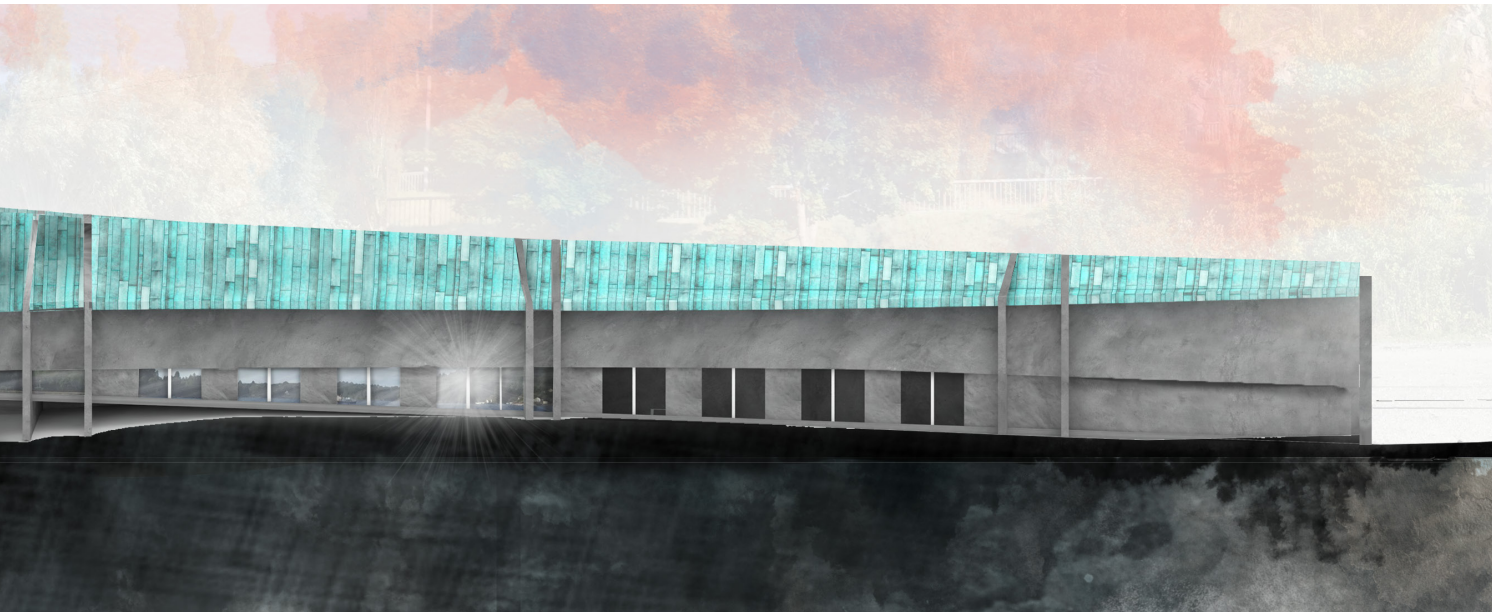
Elevations

The openness of the building changes throghout the building. As seen at east and west elevations a massive concrete wall is closing the facade, only allowing windows through the corriodors and into the offices. These openings are marked in the elevations by a horizontal change of depth in the concrete.

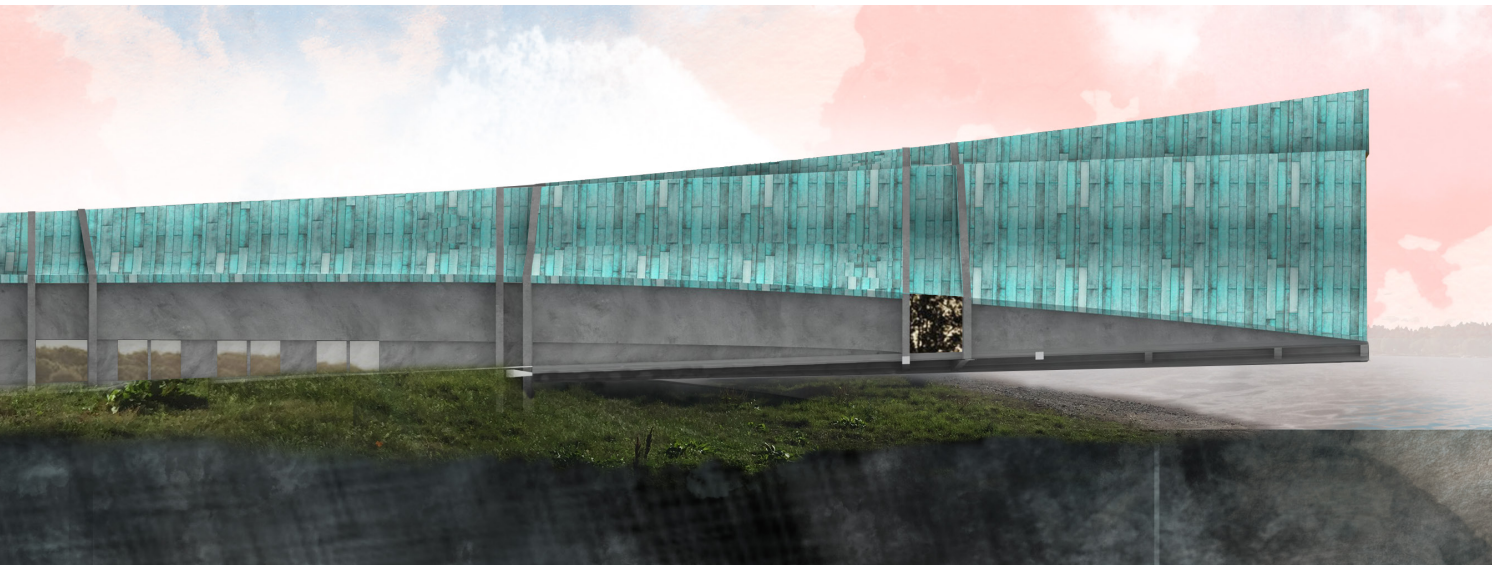


West and east elevations also showing how the building is rising from the ground and hanging out over the fjord, as a cantilevered beam.





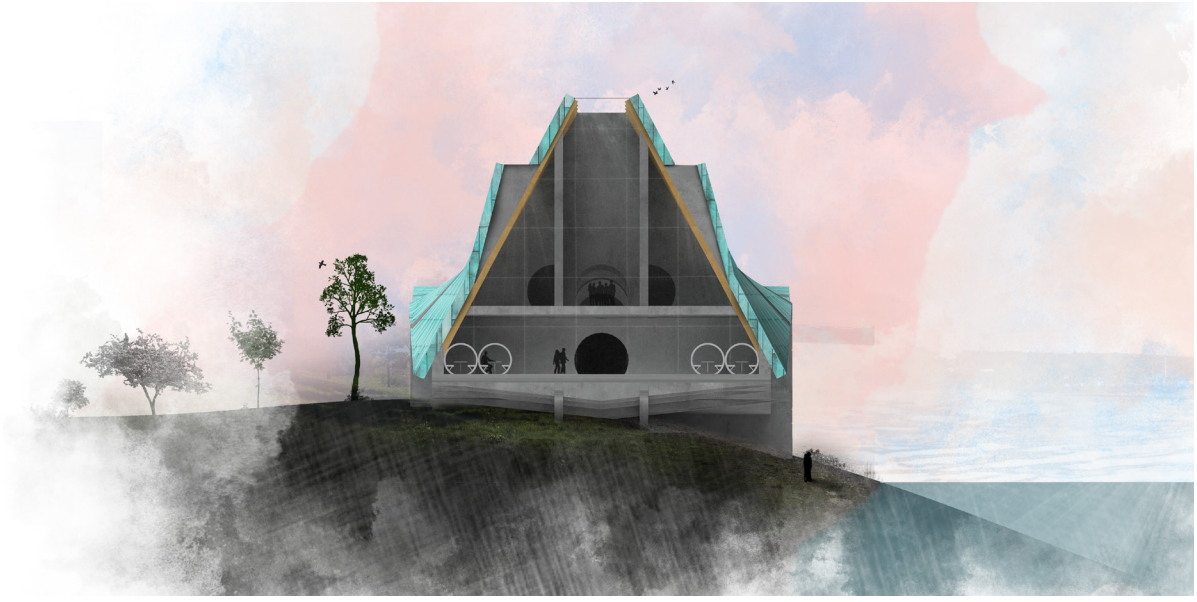
ill. 3.31: West elevation 1:500



ill. 3.32: East elevation 1:500

ill. 3.33: South elevation 1:500

From the south elevation the picture of a solid building fades, a centered glass wall is interrupting the concrete wall, but still with the concrete as the dominant surface material. This section of glass creates a clear direction to the entrance and revealing the inner to peak the interest of the visitor.



ill. 3.34: North elevation 1:500

The roof is designed to slightly rise towards the sky, simultaneously the roof construction is created to change from closed to the transparent. The south elevation shows same transparency and together with the roof an overwhelming light intake is created, a transformation that enhances the story and journey of Hilma af Klints life.

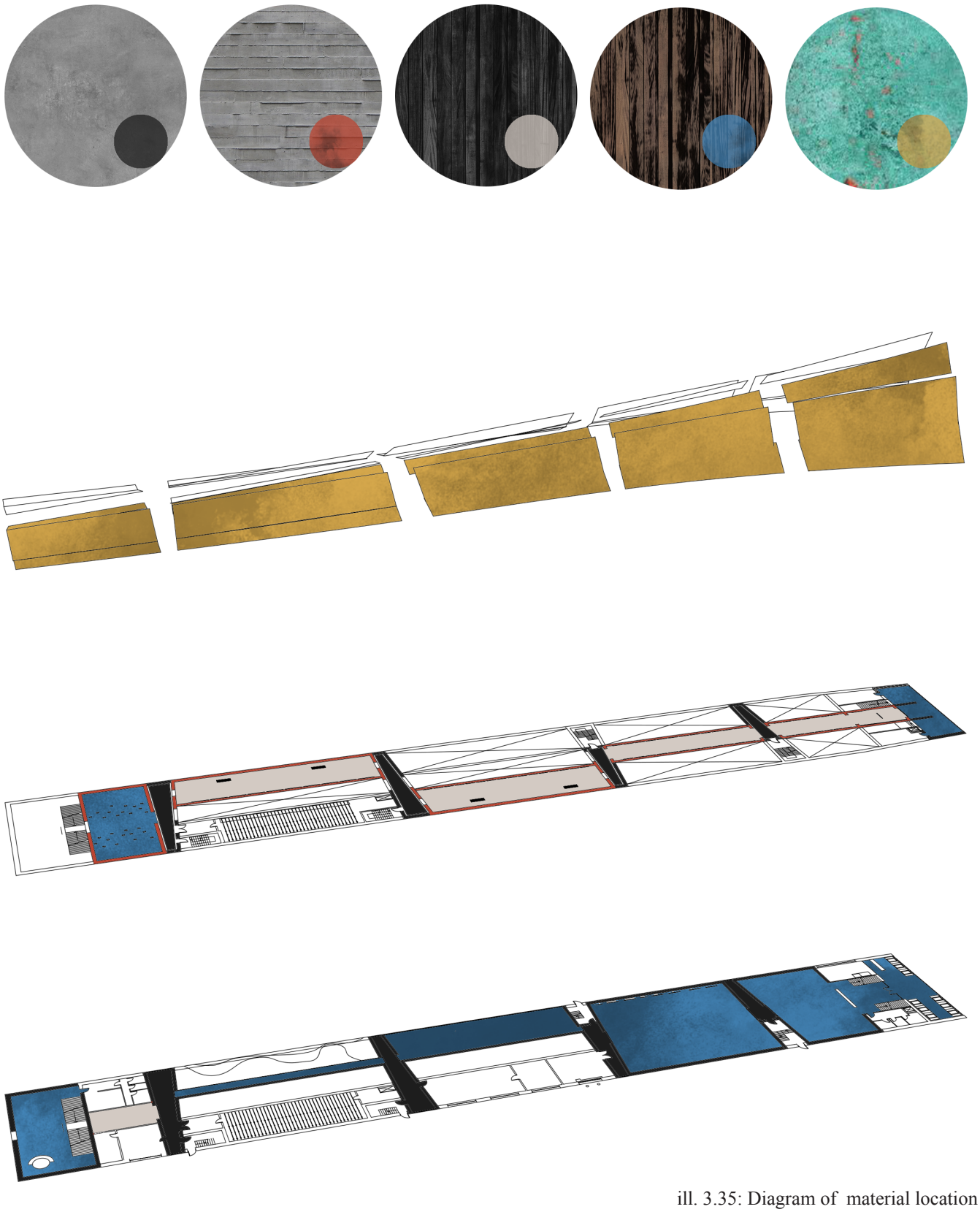
Materials

Based upon the journey with changing acoustical and illumination properties, requires adaptable materials. Copper, Concrete and wood are materials with the ability to change the tactility or the color of the surface, affecting the sound and illumination of the spaces..

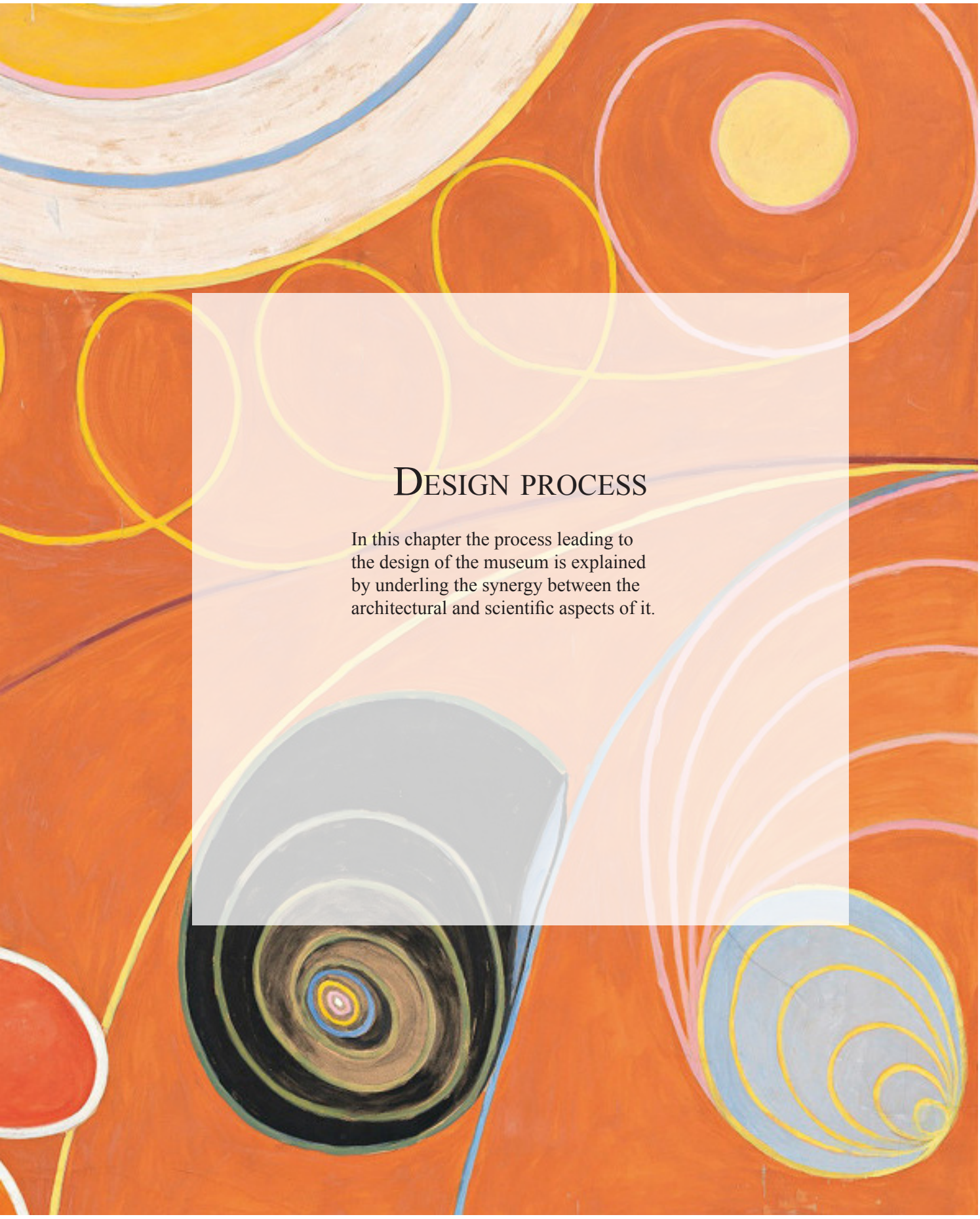
Concrete is an adaptable material that can be processed in countless ways; the tactility is transforming between a rough and smooth surface. The tactility of the concrete is not only affecting the perception of the surface, it's also influencing the illumination and acoustical properties. The concrete is positioned both as flooring and walls; the concrete floor, located in the corridors between each exhibition spaces, is processed with a smooth surface, creating a walk-able surface. The walls of the corridors are of smooth concrete, creating a space with high reflectance surfaces with high illumination properties. The long plates spanning the building is a rough concrete, allowing for the small light levels hitting it, still leave a visual clue in the darkness.

Wood, being the material for the floors, is selected with a chared top surface with the Shou Sugi Ban treatment, with some surfaces processed to almost black. Another with a variation from dark to light colors, creating both a distinction in the surfaces and a similarity in their tactile appearances. The dark wood is located in the main exhibition spaces, absorbing the incoming illumination, enhancing a gloomy atmosphere. The lighter wood enriches a more pleasant atmosphere, and is used at the more illuminated spaces, as the foyer or secondary exhibition space.

Copper is present as a decorative element through the museum. The copper highlight the change in material, highlighting when the barriers of the concrete construction is broken thorugh. Copper is selected as the roof material and can, in its shiny appearance, seem soft. Through the oxidizing period of 15 years, the light green/blue color complements softness in the building. With the slow transformation, it will take 15-20 years to fully be shown, a reference to the 20 years it took for Hilma to show her art, after her death.



ill. 3.35: Diagram of material location



Design process

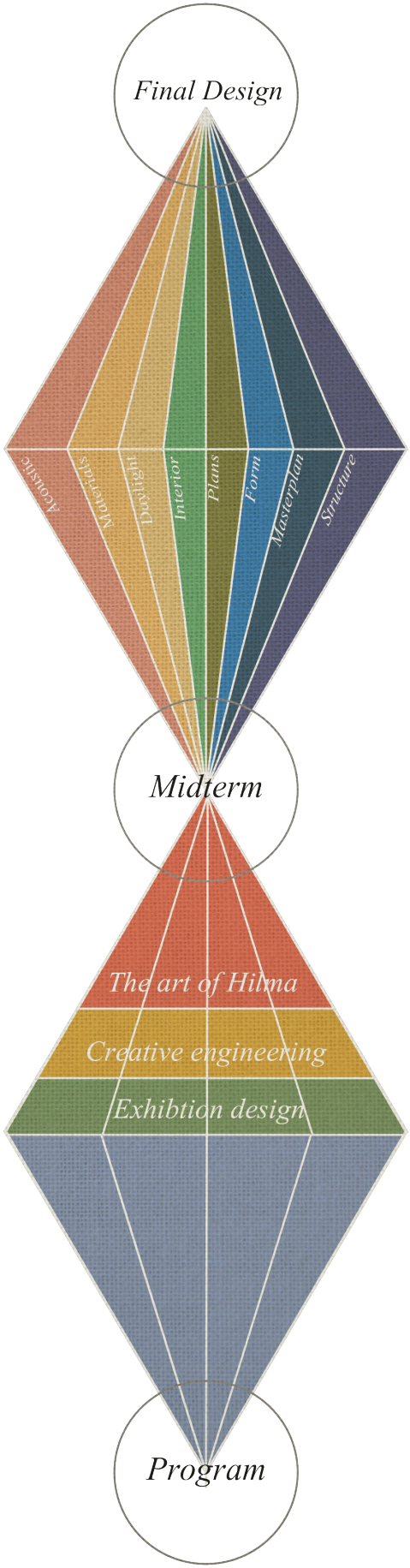
In this chapter the process leading to the design of the museum is explained by underling the synergy between the architectural and scientific aspects of it.

ill. 4.1: Painting by Hilma af Klint - The ten largest

Design process - Introduction

The design process of this project will be explained throughout the following chapter.
The process explanation is structured into two main sections to ease the understanding of the design.
A former section follows the chronological events, until the midterm presentation, event which gave the inputs to develop the final concept. The latter section explain design choices on a thematic base, meaning that it focuses on singular elements. Therefore, the order in which elements are explain does not relate to the chronological order of design, which, due to the definition itself of the integrated design process, strive for considering all elements contemporarily. The overall structure of the project is condensed into ill. XXX. The design process starts by following the initial program and widening the perspective of the given assignment. A following phase of narrowing, based on form analysis of galleries' structures lead to the definition of initial design parameters and structure.

The second section delved into how creative engineering can be utilized and what possibilities it can create for this particular project. Finally, the concept was developed by unifying the design criteria with the outcome of an attentive examination of her paintings. The midterm seminar proved a test of the overall concept that then was further expanded on through an ongoing process of iterations and examinations of the listed subjects. After a first concept configuration, a synthetic approach to develop the single elements was used. Anyways, the development of single elements always followed the main matrix governing the whole project, meaning that every choice had an influence on other design choices. A strong example of this is to be seen in acoustics and structural considerations, which became essential drivers for the design.

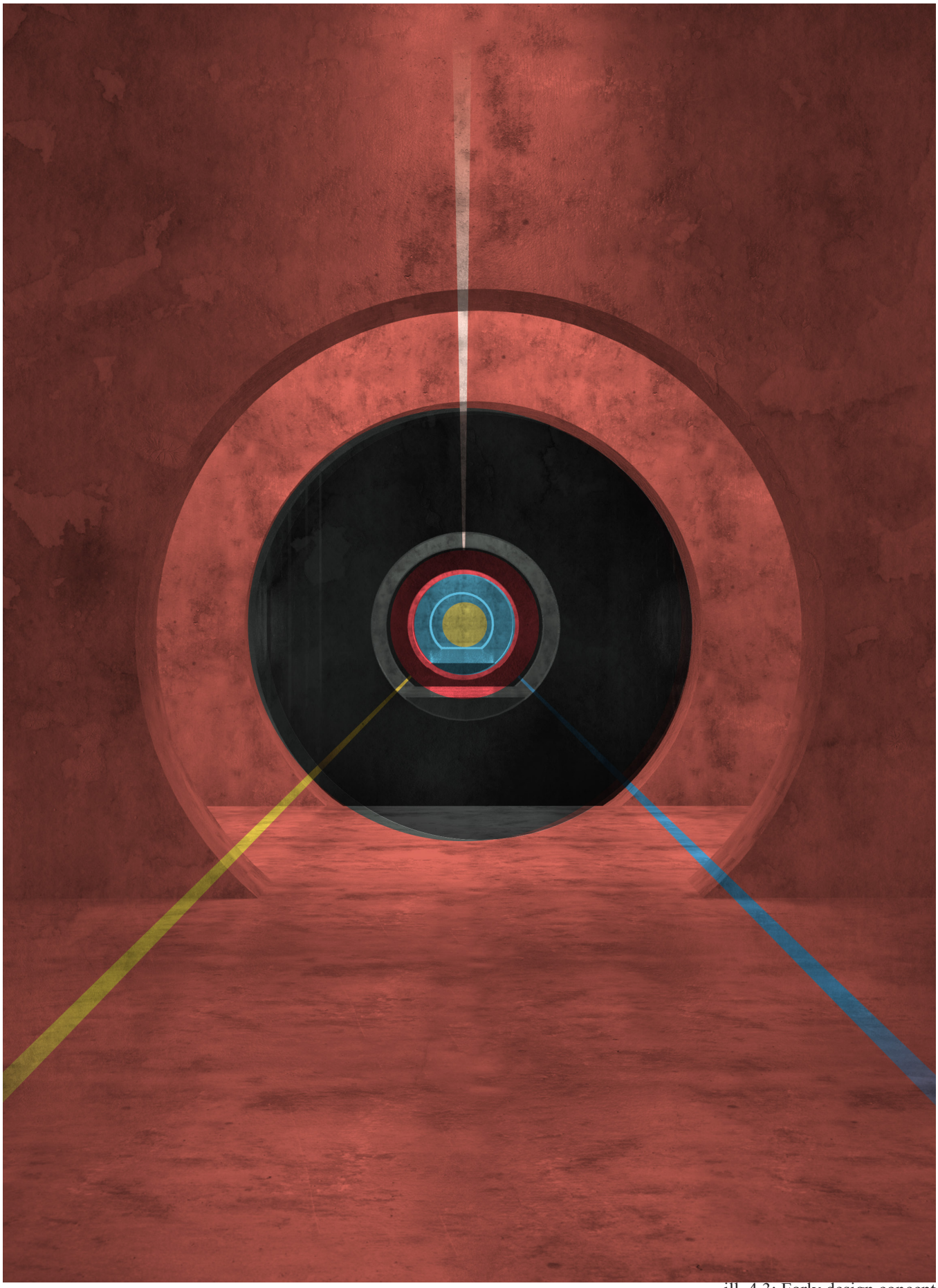


ill. 4.2: Process diagram

Concept development

The initial concept developed around the idea of creating a journey through Hilma af Klints life and art. The architecture should create an atmosphere which emphasize this journey, highlighting the experience of Hilma while accentuating the importance of her work.

The integration of artistic and scientific elements form the basis of this concept, using both tools and methods of each, to reach a design able to fulfill the requirements and, therefore creating a proper memorial of Hilma af Klint.



ill. 4.3: Early design concept

Gallery Organisation

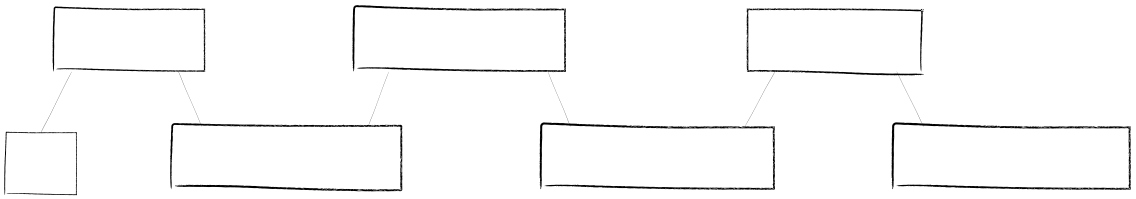
The “six galleries” initial main layout was thought in order to create independent experiences related to the timeline of Hilma af Klint’s work. This has been the key to the design of the journey, throughout the design process.

The layout development started with a study of form and organization, aiming at exploring different possibilities to express the timeline of Hilma af Klint journey in architectonic terms.
This opened the possibility to the use of three geometric ways of structuring the exhibition space: the spiral, the line, and the circle. These geometries served as inspiration for further concept development.

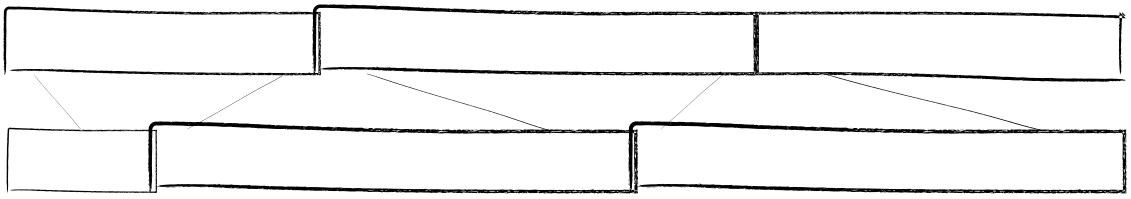
The first plan layout, see ill. 4.4, focuses on creating a sequence of separated exhibition spaces connected by corridors, therefore forcing a strong guidance through the exploration of spaces. A negative aspect of this solution was the abundance of distribution space.
Pushing the exhibition spaces together into two separated branches, see ill. 4.5, allowed the formation of a central axis, which naturally got the character of a distribution corridor, giving visitors the possibility to freely walk between the exhibition spaces. The more open floor plan weakened the idea of the timeline, the strength of the guidance and the curiosity of the experience.

The third illustration, ill 4.6 shows a spiral-based-layout, with each exhibition being placed into the spiral, using it to create the various-sized-galleries. The exhibition would focus toward the center foyer. This shape opens the possibility of different accesses, either independently either following the journey of the exhibition.

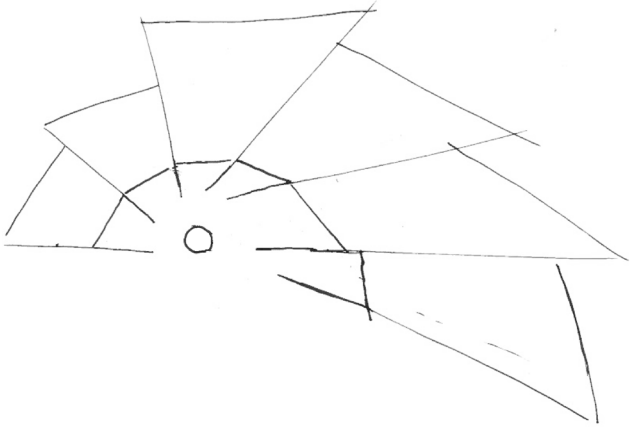
The forth illustration, illu 4.7 shows the circle layout, where people would enter through the circle by a ramp going across a void. From the ramp, becoming a main focal point, visitors would walk along the circular exhibition space. This would create an interesting visual experience, as the shape itself would block the view of the upcoming exhibition.



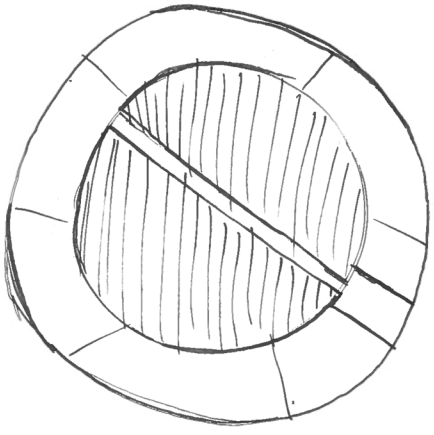
ill. 4.4: Sketches of serial layout



ill. 4.5: Sketches of serial layout connected



ill. 4.6: Sketches of spiral layout

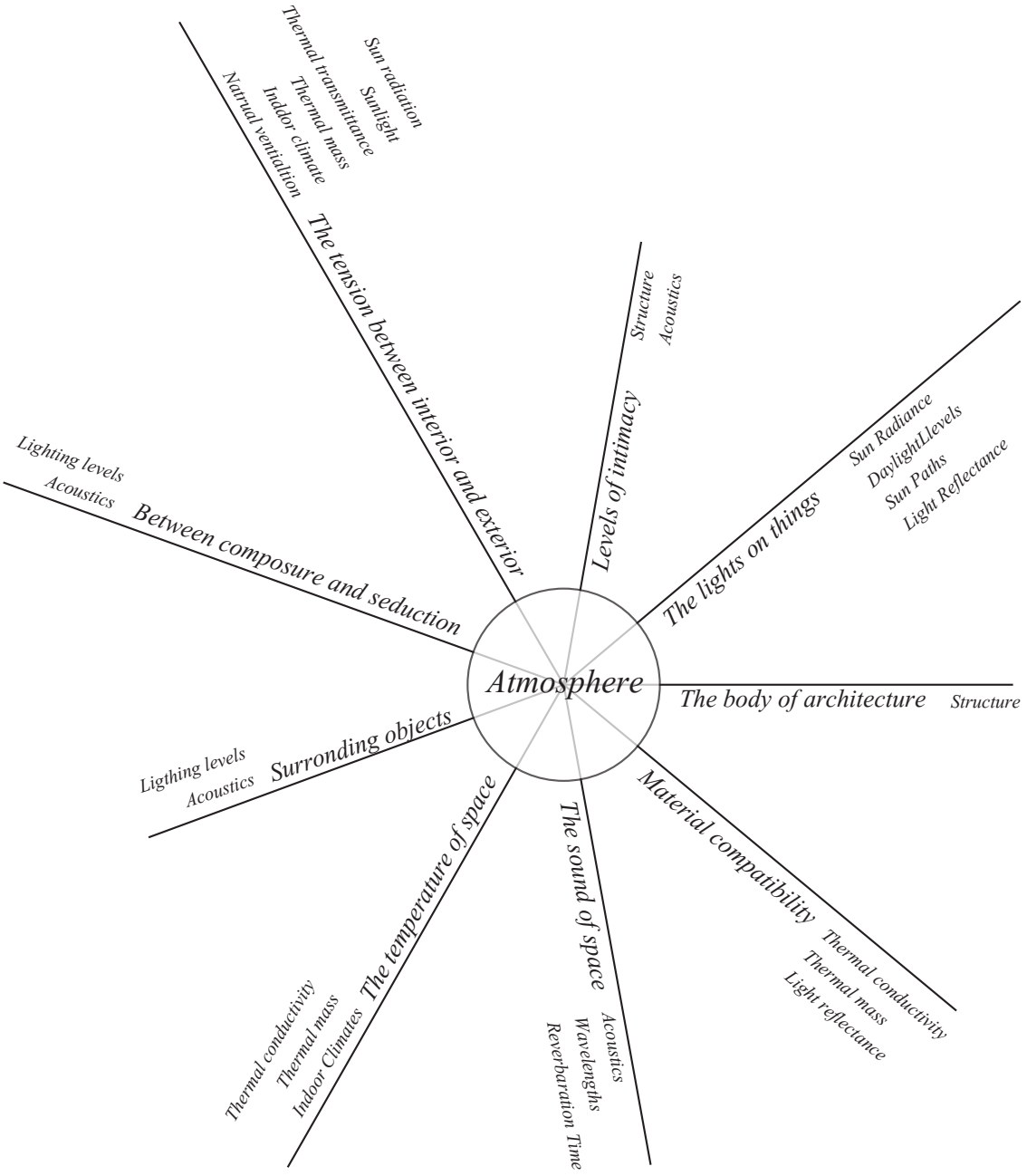


ill. 4.7: Sketches of circle layout gallery

Creative Engineering

To broaden the possibilities of integration between the artistic and technical matters, a certain level of creative engineering was embodied in the vision of the project from the very beginning.
A series of simple concepts were developed with the focus on how the technical concerns can enhance the museum experience. How structure, sound, and lighting can be utilized in this project, and inspire the architecture. This concerns were brought up very early in the design process, as mean of analysis and exploration, and to reach common understanding of the fusion of art and science desired in the project.

A simple diagram was developed linking the nine elements of creating atmosphere stated by Peter Zumthor
(Zumthor, 2015) with the technical descriptions of each parameter, as an exercise to rethink some of the classic architectural work into engineering, linking the scientific and artistic elements of creating atmosphere, ill. 4.8. The contemplation over these relations gave inputs for the creation of designs, details and concepts. Many of these sketches were developed with an explorative mindset toward the potential of the creative use of engineering.

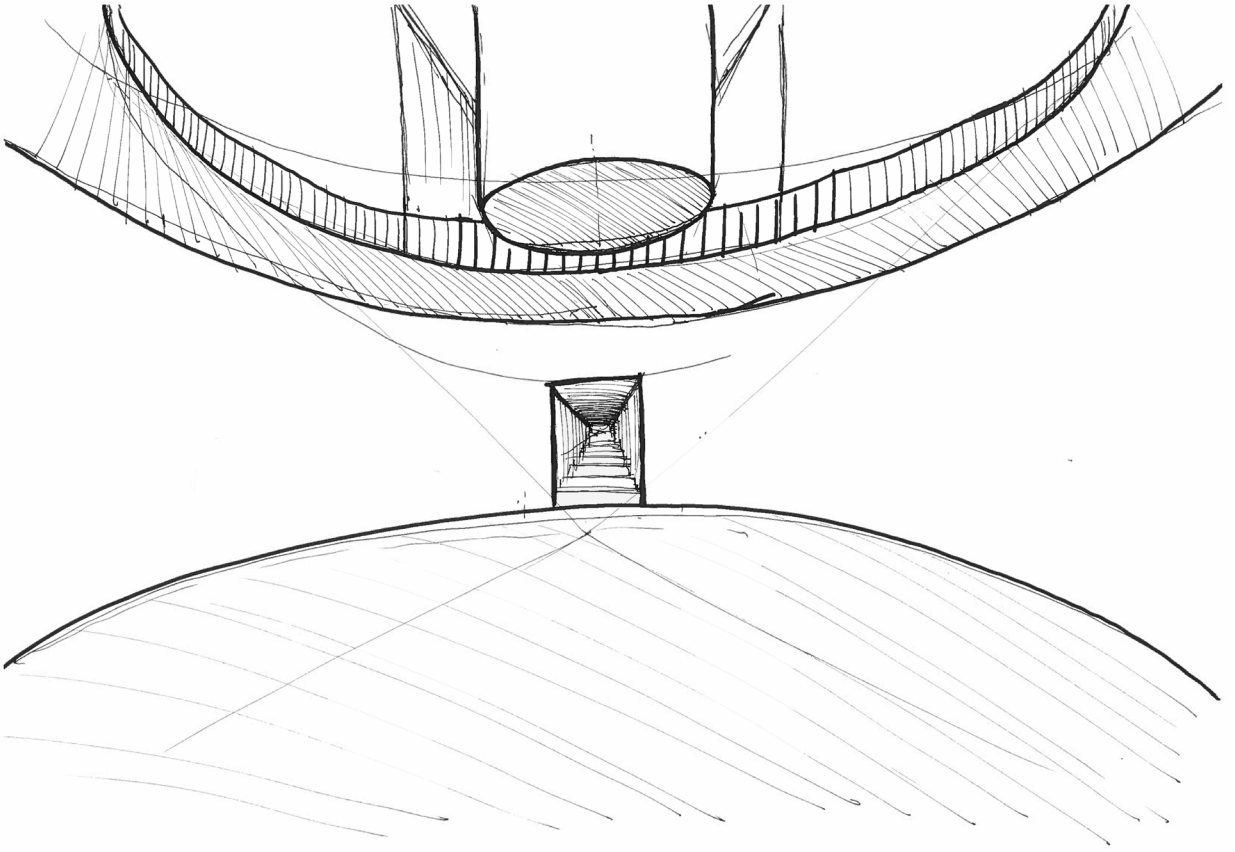


ill. 4.8: Diagram showing engineering aspects of atmosphere

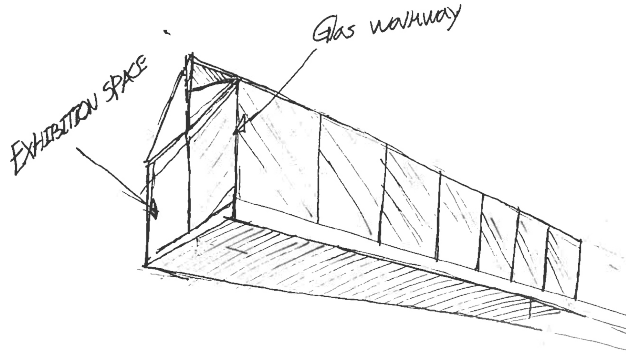
Some concepts were inspired by construction solutions with the focus of using the elements to create the desired atmosphere. The illustration 4.9 displays how exposing the tension of the forces in the building highlight the contrast between the human scale and the forces of nature, creating a dramatic effect, similar to the atectonic expression of the Lisbon pavilion. Some of the sketches lead to designs as ill. 4.9, where the idea of a cantilevered building, created a foyer where all the forces of the cantilevered exhibition area are exposed as a massive counterweight giving an extra dimension to the whole building.
Other solutions where more subtle, as, for example, the one of using solar gains as a way of transferring energy, as well as, differentiating surface temperatures, inspired by different materials thermal properties. Illustration 4.10 shows how the idea could be implemented.

Other revelations occurred by analyzing how sound would be transferred through different materials, beside air. Considerations about this opened up a series of concepts, as illustrates image 4.11 with the headline “A building you can listen to”. Creating a building with the possibility to hear the activities of certain rooms, or even creating pillars where visitors by ´placing their ears onto it´ can hear the entire building. Though, this was shifting the focus away from solving more essential demands of architecture, like avoiding undesired effect of footfall and overall impact of sound.

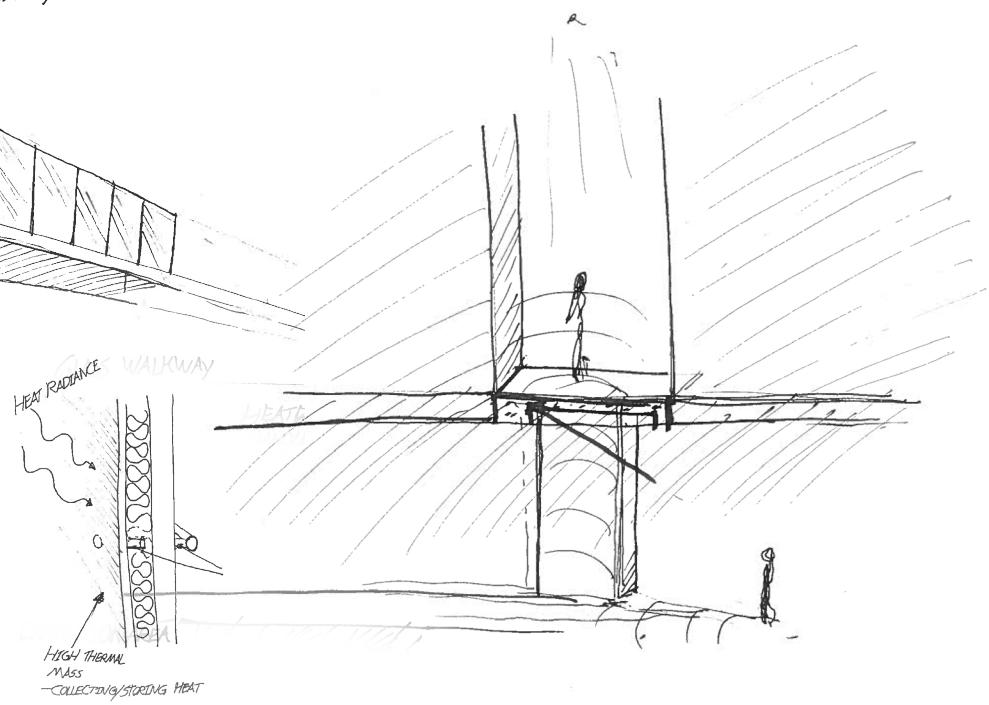
As this step was used as an early phase of exploration and analysis, many ideas needed further development, or, were unrelated to Hilma af Klint. The ideas and the general approach where, therefore, used as inspiration to develop other concepts, as the process focus shifted back to Hilma af Klint.



ill. 4.9: Sketches of creative engineering



ill. 4.10: Sketches of creative engineering



ill. 4.11: Sketches of creative engineering

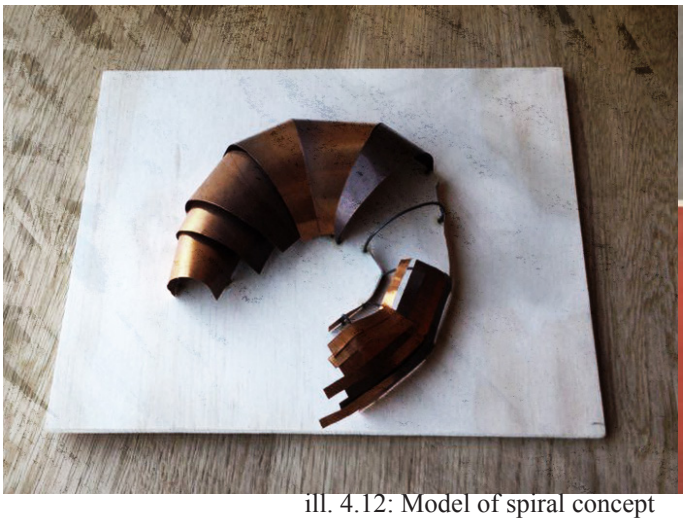
The art of Hilma

The initial studies of the exhibition design generated a series of layouts and gave an overall idea of possible arrangements, shapes and scale of the project, leading to the first design of the building. The project however did not capture the atmosphere of Hilma af Klint enough, and the displaying of art was generic and had a unnecessary resemblance of the mind-numbing white box museum. Therefore, the project was further developed, working towards the idea of empowering the art and capturing the essence of Hilma's life. It was clear from the initial studies about her, that the museum should have shown the essence of her life, and the journey she went through, by accentuating her temple series. Creating a building that embraced the journey of Hilma af Klint's life, as well as creating an atmosphere appropriate to her time and art. This resulted in a long range of proposals. Some of them were direct interpretation of her temple series, leading to a largely differentiating experience with a different experience in each room. Though, the developed ideas were too different and did not offer a coherent experience nor a coherent building design. Another aspect to consider was the necessity of creating our own interpretation of each gallery with little to go by in some galleries. So, the focus shifted to create a coherent display of her life in general and not just each individual piece of the temple series. The final inspiration for the concept of the building was found looking into her art. Prior, a lot of time was spent investigating her time period, life and art, to get an understanding of Hilma af Klint, but looking into her art for spatial inspiration yielded to the 3 final concepts. All representing different ways of interpreting her art.

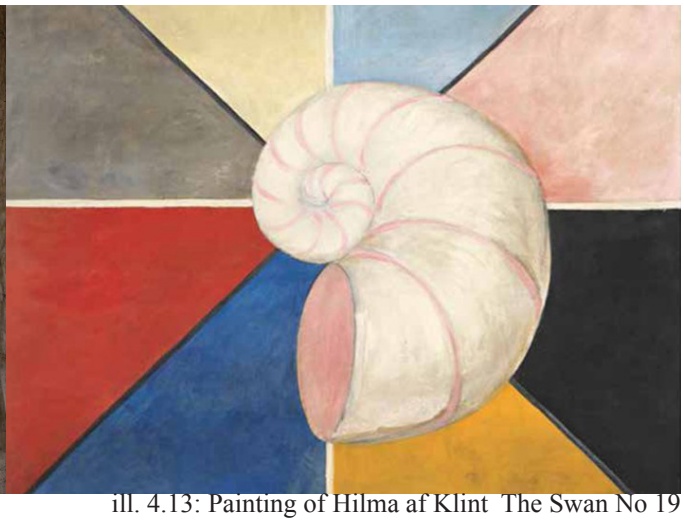
The first was inspired by an occurring element of her art, the spiral, ill. 4.12. The shape creates, a constantly changing view, with only a glimpse of what is around the corner, with a gallery in each shell. The concept also explored the façade and light intake.

The second, ill 4.14 is a fragmentation of one of her paintings. By deconstructing the elements of the more geometrically defined paintings, the building offered a varied range of rooms, with a strong reference to her paintings and Hilma herself. With the possibility to develop into a direct interpretation of her art, as an icon for the area.

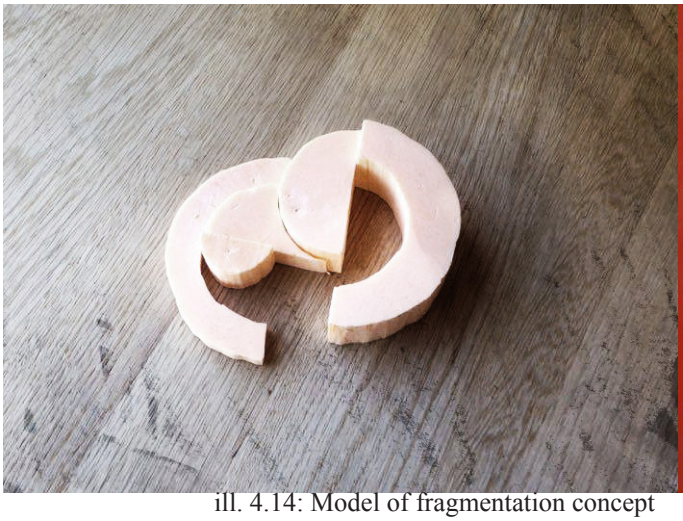
The last concept, ill. 4.16 was a spatial interpretation of her art, considering the depth and layers of her paintings. The building reinterprets it as a series of layers and a void with an undefined goal ahead, with the necessity of entering the void to reach the goal. Letting the interpretation become a metaphor for her journey while making references to her other art. The last concept was chosen due to its strong connection to both Hilma and the overall story of her art, after further development with the concept according to its possibilities with acoustics and structure.



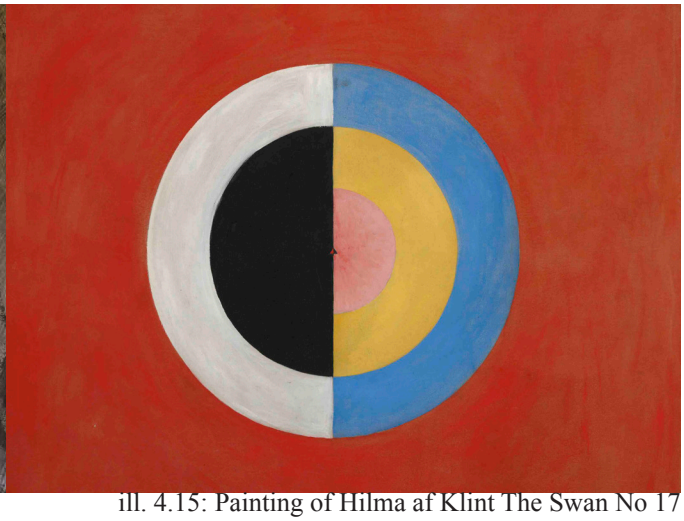
ill. 4.12: Model of spiral concept



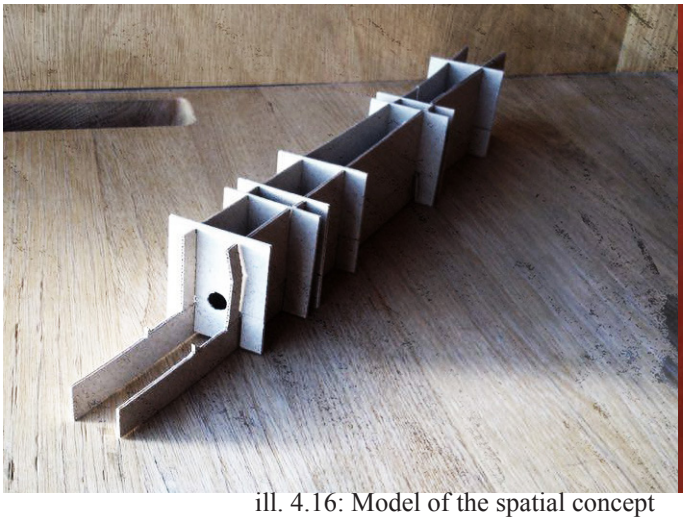
ill. 4.13: Painting of Hilma af Klint The Swan No 19



ill. 4.14: Model of fragmentation concept



ill. 4.15: Painting of Hilma af Klint The Swan No 17



ill. 4.16: Model of the spatial concept

ill. 4.17: Painting of Hilma af Klint The Swan No 18

Structural System

Inspired by the initial vision of a series of barriers, the structure was developed alongside the plan, and overall volume.

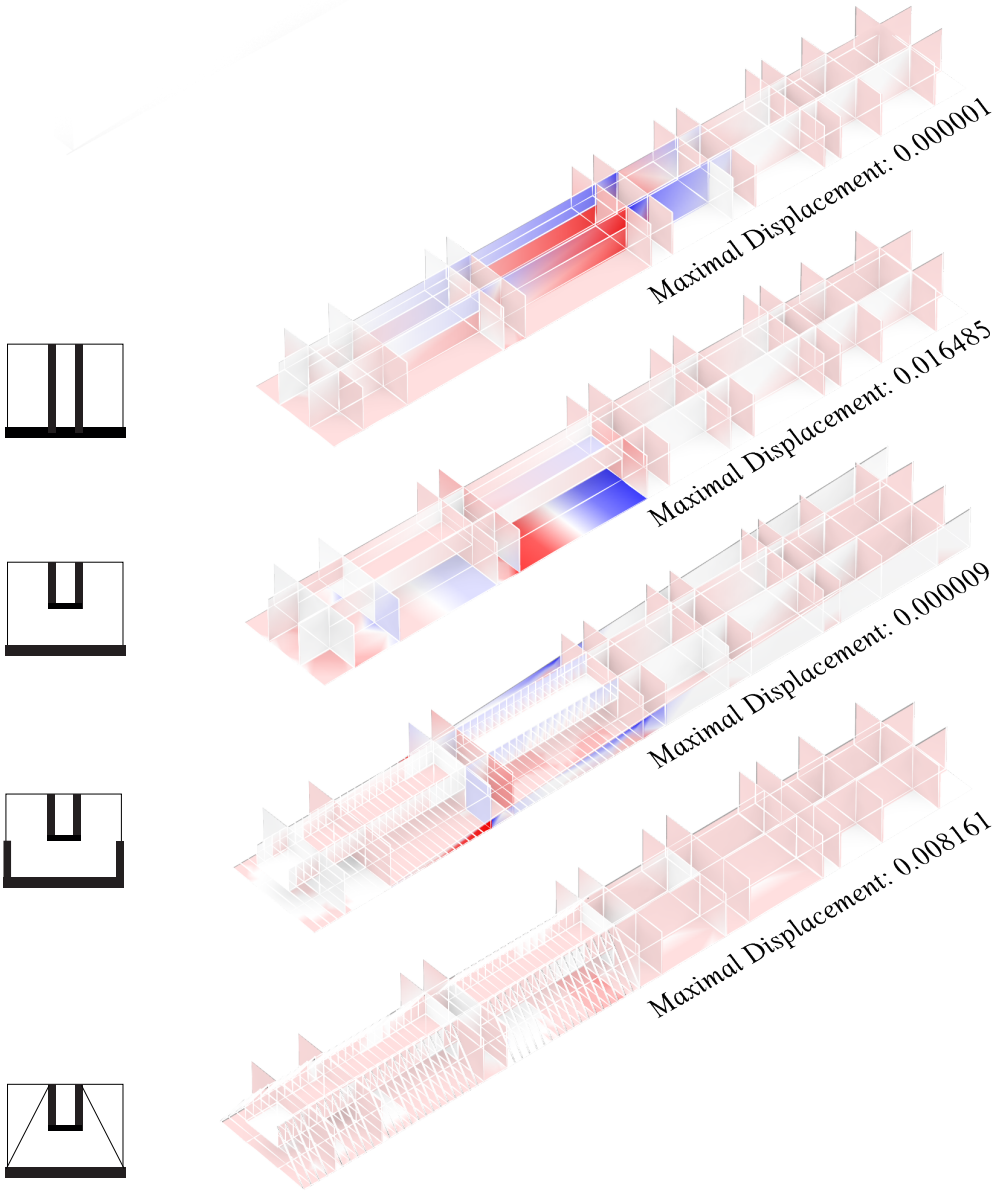
It was clear from the concept that the building should consist of a plate structure, even though some iterations where discussed and proposed. The aim was to have the defining plates of the building acting also as the bearing structure. The building length and the wish for an orientation along the fjord, to secure a good view, generated the idea of a cantilevered building over the water. By cantilevering the building, a general expression of an atectonic building with the stereotomic concrete flying over the edge was established. The concept of treating the structure as a restrained beam became stronger. The initial simulations with Karamba were focused on how to manipulate this beam and contemporarily were aiming at spatial and structural quality. In ill. 4.18 a simplification of the overall progress and exploration is documented

The initial concept is based on two plates acting as the main bearing structure, intersecting the middle plates, which aim at strengthen the structure against the horizontal moment of inertia. Together with the lower floor, the structure becomes a T-profile beam. Due to the room program and to a wish to display the atectonic concrete structure, the lower third section of the main plates where moved. By acting this way, due to its nature, the moment of inertia would fall by 3 times and be not directly readable from the karamba analysis, due to the complexity of structure. The cut away structure pieces were then moved to the façade using the crossing plates to connect the façade structure and the inner beam. This lead to regaining the inertia moment while engaging the crossing plates further.

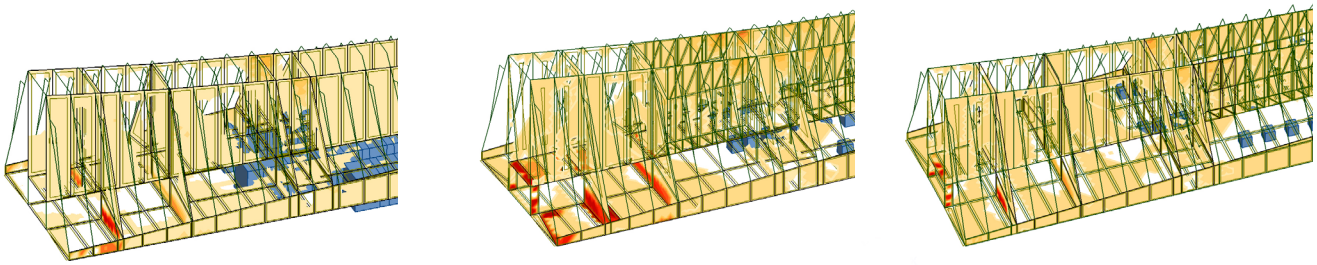
Other variations were examined in order to get a better understanding of the possibilities of the construction.

These preliminary studies gave an initial tool to simulate the structural behavior and possibilities, while discussing the spatial potential of construction. When the development of the construction concept was complete, the process shifted towards full realistic simulations. As it was clear what would be optimal and suboptimal, the question was if the construction would hold while using the suboptimal solution.

For example the creation of the visual and acoustic connection between the center exhibtion area and secondary exhibtion area, where different levels of punctuation were applied on the form or slits between the paintings. The result was a solution which let half of the main beam be puntuated, as the other half is crucial to minimize the high torsional effect. ill. 4.19.



ill. 4.18: Structural analysis of displacement

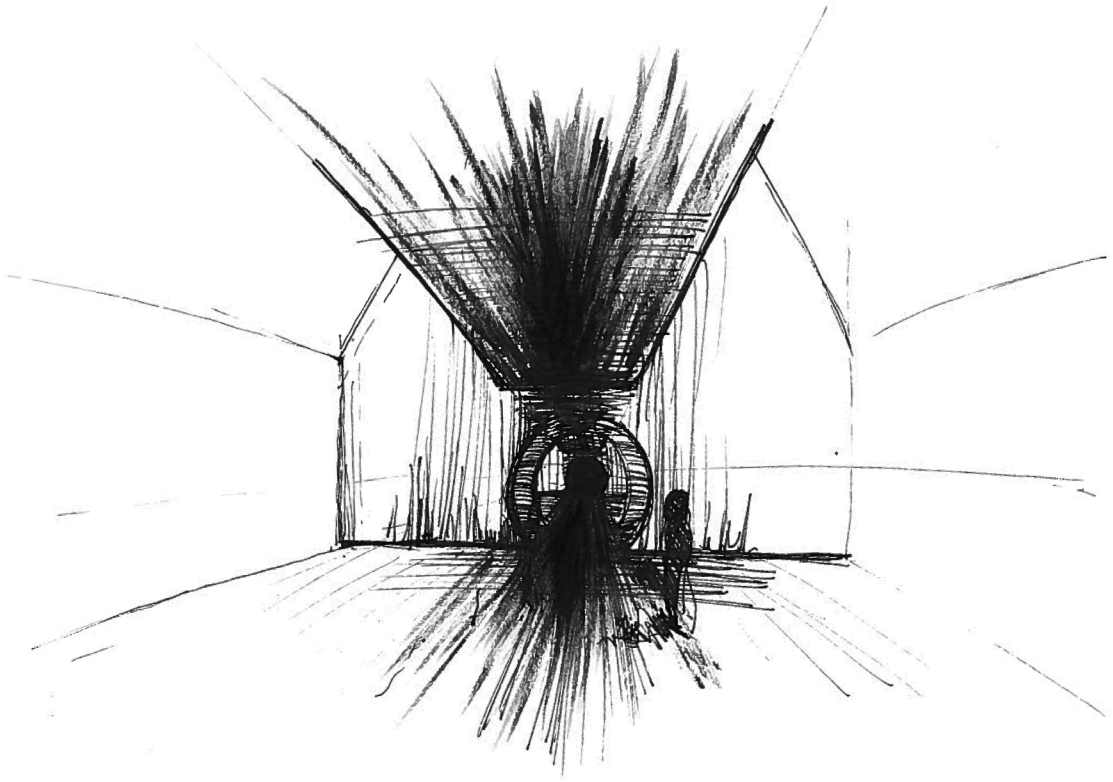


No punctuation of primary center beam | Punctuation through entire primary center beam | Punctuation on first halve of primary center beam

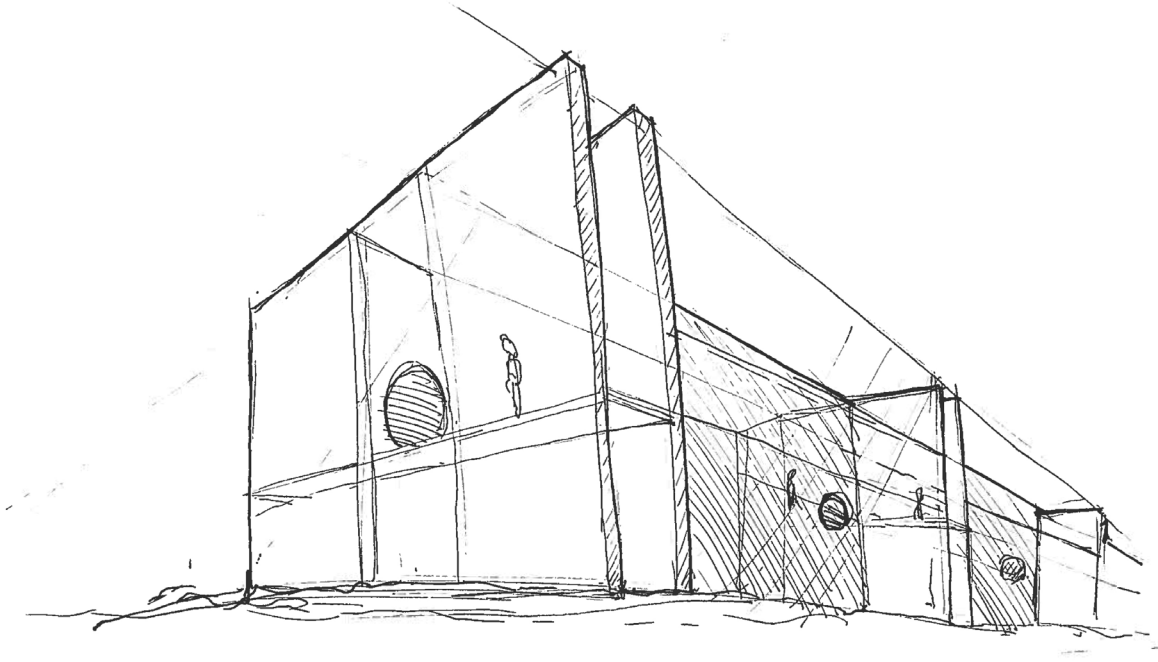
ill. 4.19: Structural elements analysis of punctuation

Even though the structure is suboptimal, it fulfills the spatial vision inside and outside. It enhance the monumentality of the building by displaying the massive forces, and creating a beam far larger than the human scale.

The solution was documented not only structurally, but also spatially through sketches and 3D modelling. The first sketch is from the initial design of the plan, exploring the possibilities of introducing the structure as a monumental beam running through the exhibition, ill. 4.20. The second sketch, ill. 4.21 is an early vision of how the structure becomes the spaces itself, and how people would navigate through the structure. The structure would, further on, be shaped into the final form with a series of iterations between structural, acoustics and spatial qualities. A simple wooden beam structure was introduced to transfer roof load to the main plate construction, while streghening the overall `fixed beam` structure.



ill. 4.20: Sketch showing a conceptual atmosphere

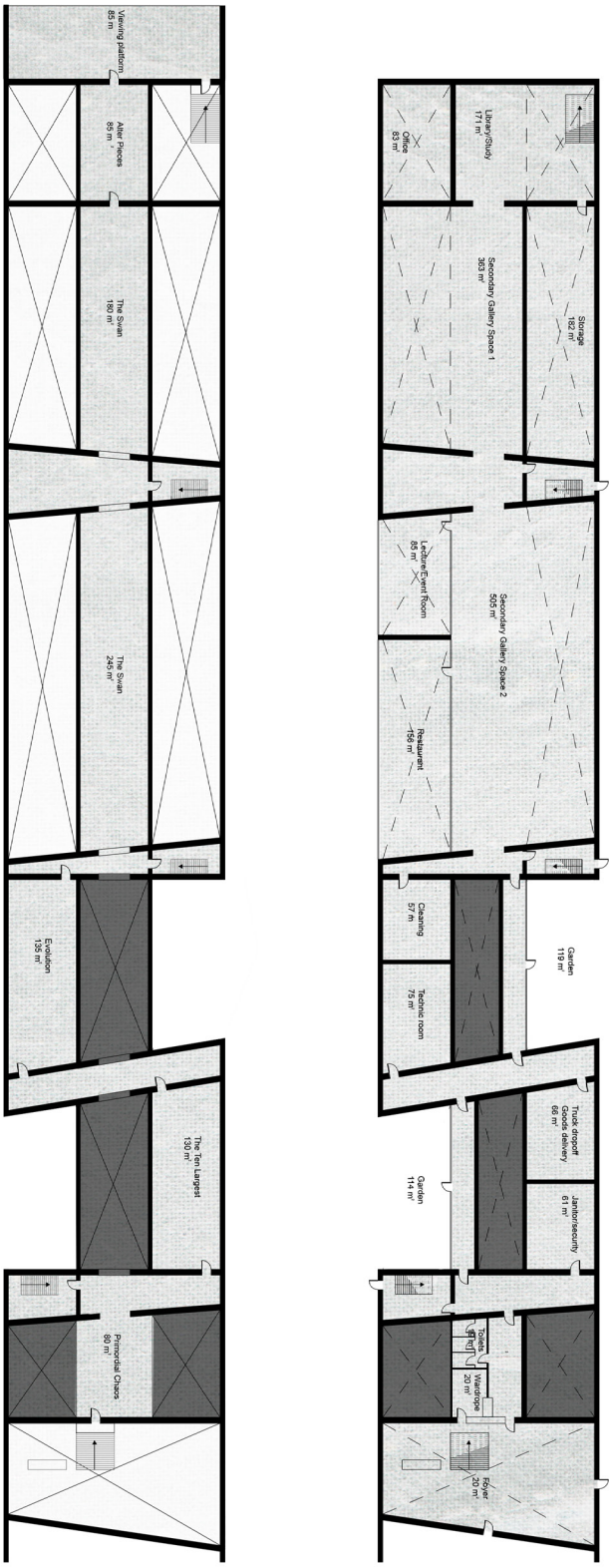


ill. 4.21: Sketch showing space creation through structure

Midterm

The midterm presentation marked the final concept development. The overall concept was introduced and explained as a defragmentation of the painting that inspired the project.
The concept is a timeline of Hilma's art, with each period of the alter pieces becoming their own exhibition space, laid out in the long shape with a series of void rooms, creating a contrast of light and dark, visible through the round holes, portrayed in ill. 4.22. The building had a temporary layout, fitting all functions within the shape. The overall idea was proven strong but the organization of spaces was found confusing and arizing expectations which were not met. Other details as the floor plan creating a mezy layout with large gaps in the shape of the building.

ill. 4.22: Early render of interior view



ill. 4.23: Floor plans at midtterm

Plan Development

Throughout the project, the floor plan have been the essential tool to accomplish the wanted journey, narrative and atmospheres for the visitor, at the same time creating a functional and well-operative museum for the staff.
By having the centralized axis, splitting a large area of the building into two sections, it creates advantages and disadvantages. The long slender building forms a demanding loop, a node where the journey and atmosphere collide with the functionality. In this situation, which is present at both ends of the museum, they shall unify in a turning point with each other. Another aspect of the floor plan process was to keep the staff functions as invisible to the visitor as possible, to both strengthen the journey atmosphere and to avoid confusion. This was done by hiding doors that are not accessible to the visitor.
The two integrated voids, with a location in the beginning, identify the same advantages as the axis, these voids naturally creates an isolated staff area and an open area for the visitor. The challenge for the area in front of the voids have been to avoid the feeling of an ended journey that just let the visitor out, by having functions that creates an open and hopeful atmosphere.

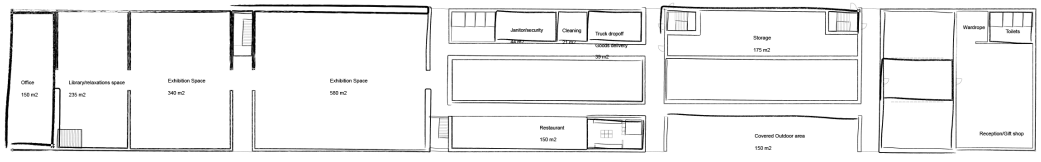
As seen at ill. 4.24. the restaurant and garden were located in front of the voids, with a possibility to walk through the voids, giving the visitor control of the journey, which was not in connection with the general approach of controlling the sensed experiences. By closing the voids, a more controlled environment was created for the visitor, but with a non-existing spatial experience at the restaurant. The narrow space between the void and restaurant became an area that let the visitor out, which was not enjoyable for both the visitors in the restaurant and visitors who were walking through. The substitution of the restaurant and the library created a more open environment and together with the garden the two functions create a place that all visitors can enjoy throughout the day. The journey of the museum starts and ends in almost the same point that only diverts by a vertical line between the two openings, challenging the staircase design. Seen at ill. 4.25. this solution suggested a stair case that was extended from the wall, creating an exit not fulfilling the experience from the journey to the foyer. The key to solve that point was through staircase design, that both should be integrated with the foyer design and function as navigation for the visitor, as seen on ill. 4.26 and 4.27

In the other end of the museum, the development of the staircase represented also a challenge, where the staircase should be a central element, easy accessible, be a part of the journey and at the same time not disturbing the area right beneath. The importance at ground floor was to have useful spaces, a staircase not interrupting the environment of the restaurant and maintaining the view to the fjord. The navigation to the right solution was through a combination of staircase width, -length and -orientation, through iterations of a variety of designs, a unity between the experience and functionality was found.

ill. 4.24: developing sketches of floor plan

ill. 4.25: developing sketches of floor plan

ill. 4.26: developing sketches of floor plan

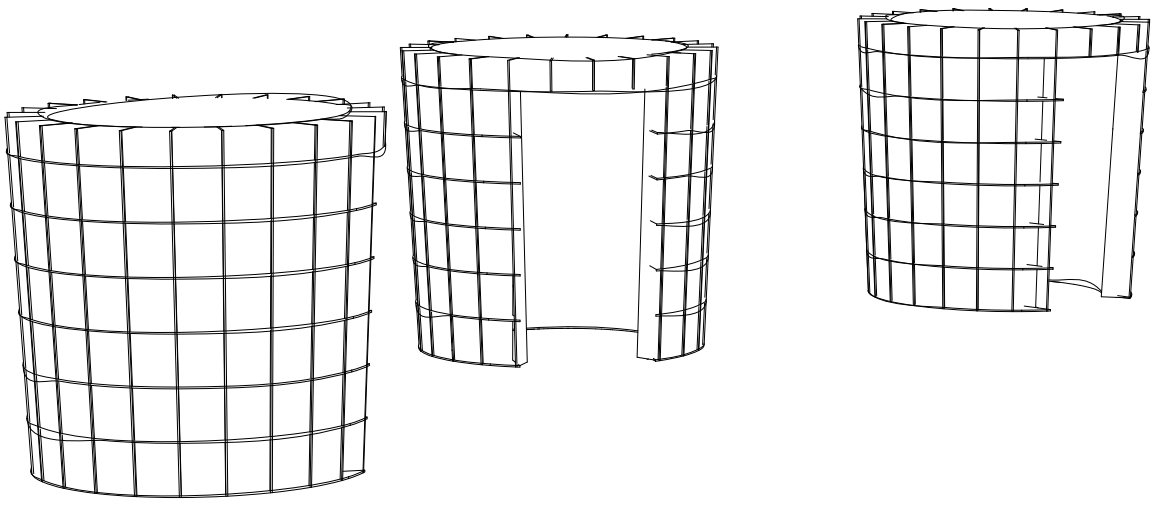


ill. 4.27: developing sketches of floor plan

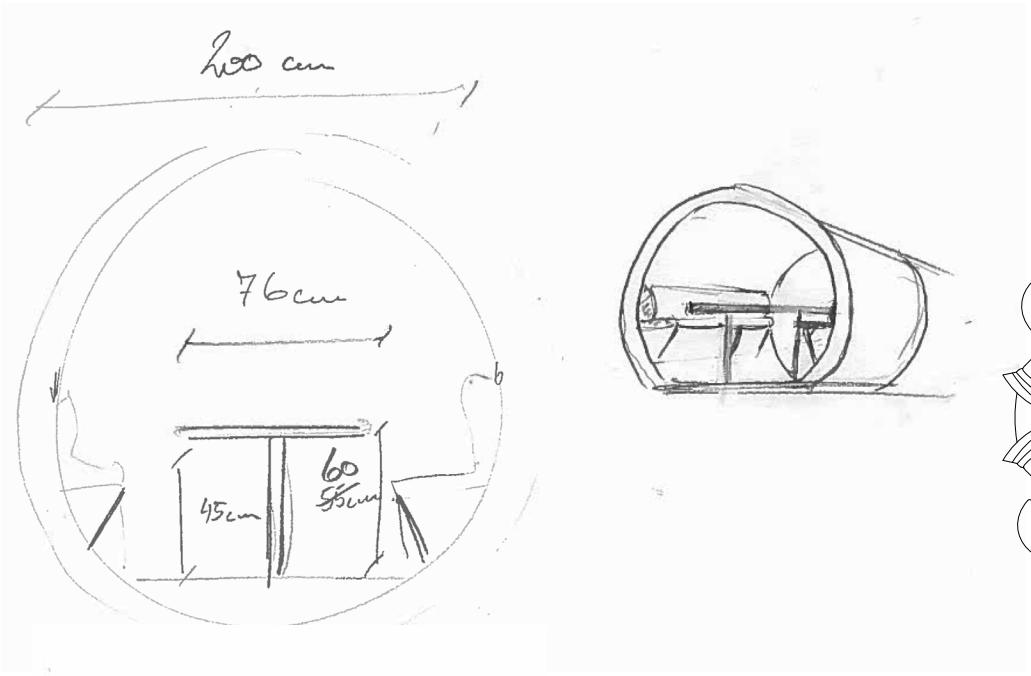
Interior

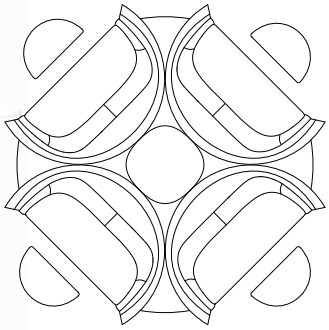
Through the whole design process, ideas have sprung into mind that would enhance a specific atmosphere with integrated furniture. The essential part of designing useful furniture is putting it where it will be needed. It was important to the whole narrative journey characterizing the building where the furniture would have been placed. Would the furniture be stuck to the building or be moveable? Furniture that enrich the atmosphere and the visitors experience will have a sense of the artist, Hilma af Klint, and be integrated in such a way that it emphasizes the journey.

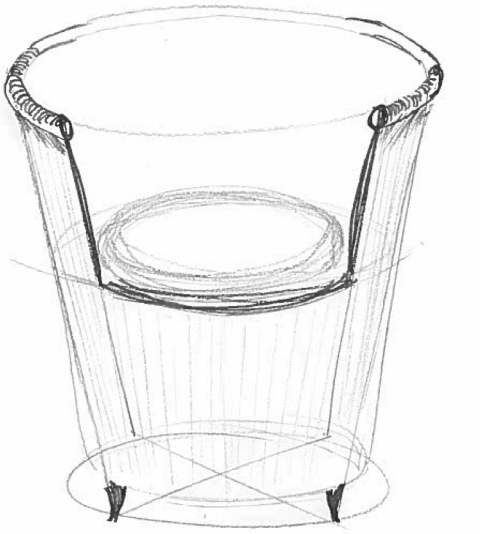
The corridors along the journey was considered to be placed as benches in the corridors, in between the galleries, but that would create a longer stay to some extend and leaving the galleries of resting areas, where it actually would be appropriate for the experience of Hilma af Klint's works.
The cafeteria started as a mere reflection of a standard furnished cafeteria, with square tables put into a grid division that would be able to hold as many guests as possible. It was later furnished with booths that would create a better atmosphere for the guests. Creating intimate space of their own in a bigger space. Where the back of the chairs was getting higher, that would enhance the intimacy and the booths that would have a direction, which then could be connected to the view.
The library design was focused on showing the introduction to a room for entertainment and relaxation with the view to the fjord, as an ideal area to place furniture for the view, with the purpose to create small niches that defines the space, as small individual rooms, for contemplation and discussion.

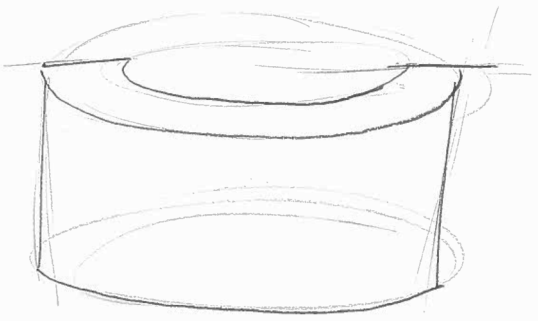


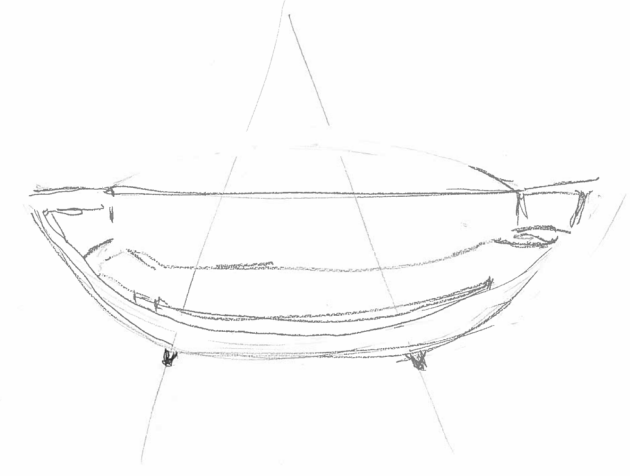
ill. 4.28: Development sketches of library bookcase

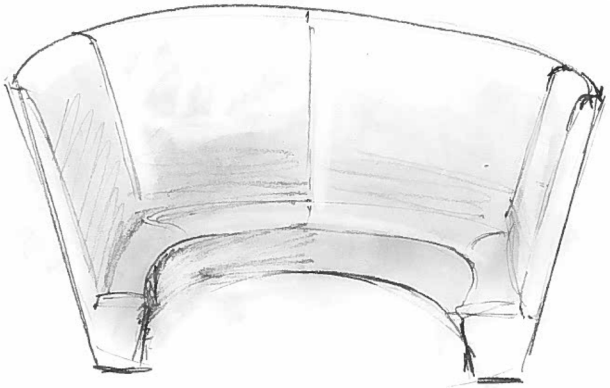












ill. 4.29: Interior design sketches

Light

The natural lighting solutions in a museum offer an extra parameter of complexity. Due to the preservation of the paintings, no direct sunlight is allowed to reach the paintings. Each solution toward the light intake should therefore first be designed to obstruct any direct sunlight, before it is able to be evaluated on its ability to create the wanted daylight factor.
The process started out with a basic study of orientation, in order to get an overview of the consequences of certain orientations. The analysis consisted of a box, 5x5x5 meters with an oriented light intake and a light shelf blocking all direct light. First part consisted of dimensioning the light shelf. Each box was tested with sunrays for each hour for the entire year, and with an accuracy of 3cm. See ill. 4.31
The North-facing box had no need for a light shelf as the light intake itself blocked all direct sunlight while the South, West and East facing light intakes needed an equally long light shelf. The light shelf proved to have a big effect on the daylight factor reducing it from around 3% to a below 1%, ill. 4.30. It is important to note that this analysis does not dictate northern facing lights as superior as the project is not striving solely towards highly illuminated areas but rather the contrast between light and dark. The analysis gave the needed background information to allow for an informed decision making when creating the overall building design and orientation.

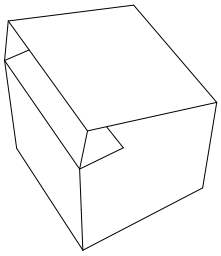
Other solutions were examined with similar simulations. By analyzing other lighting effects and reconstructing them using the same analysis types as before, effects as the top light between the exhibition spaces where analyzed figuring out the nature of the concentrated light pillar. Parameters as depth of frame, distance from floor, and height of the room, help guide the design solutions. See ill 4.32, in order to get an understanding of the relation between each parameter.

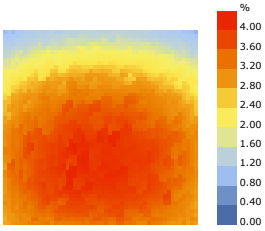
NORTH:

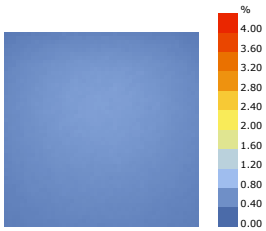
Lightshelf: 0m

SOUTH / WEST / EAST:

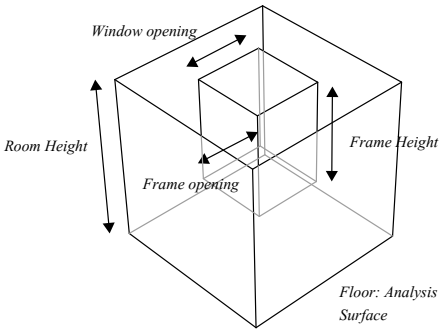
Lightshelf:1,5m



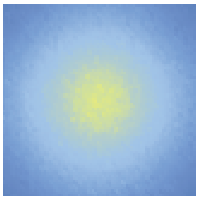




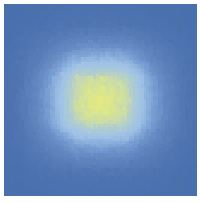
ill. 4.30: Illumination analysis with different orientation



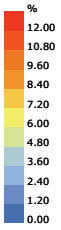
ill. 4.31: Box used for daylight simulation

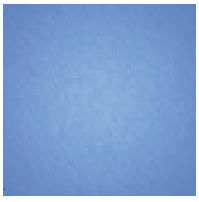


Room Height. 5m
Frame Height: 0m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7

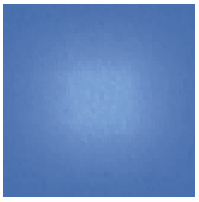


Room Height. 5m
Frame Height: 2m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7

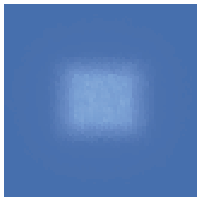




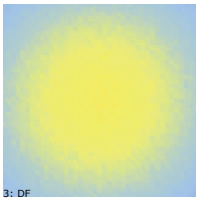
Room Height. 8m
Frame Height: 0m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7



Room Height. 8m
Frame Height: 2m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7

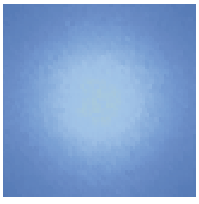


Room Height. 8m
Frame Height: 5m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7

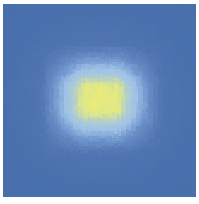


3: DF

Room Height. 8m
Frame Height: 0m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7



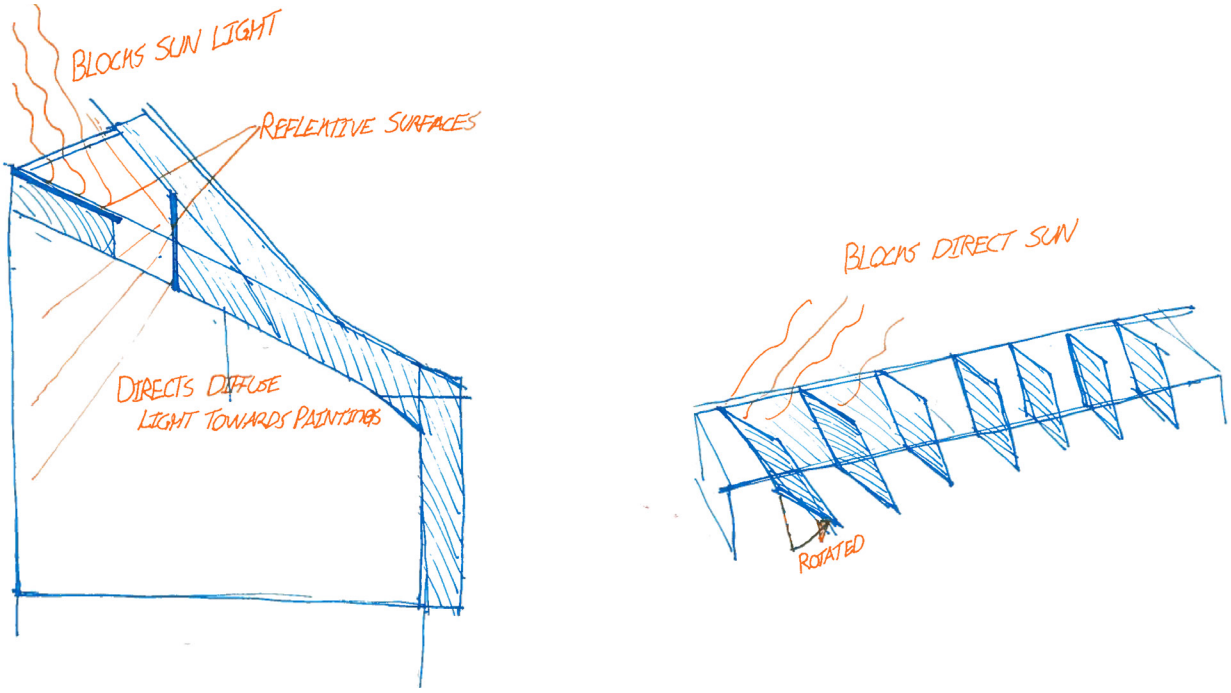
Room Height. 8m
Frame Height: 2m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7



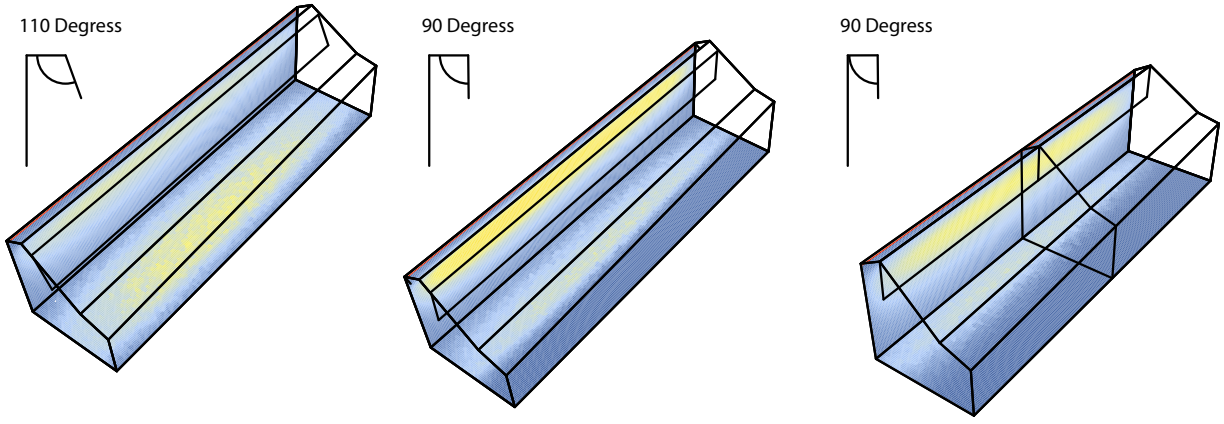
Room Height. 8m
Frame Height: 5m
Window opening: 1,8x2,1
Frame Opening: 1,8x2,1
Surface Reflectenca: 0,7

ill. 4.32: Illumination analysis with different openings

After the completion of the rough plan layout, the final solution for the light intake was designed. The plan itself offers a range of different scenarios where the height from ceiling to floor varies from 6 to around 12 meters, and with the temple exhibition areas having fixed exhibitions and therefore oriented light, while the secondary would need an even daylight level, to allow for a flexible exhibition space, due to the ceiling height and nature of lighting in the secondary exhibition spaces. The light intake was designed as a flat skylight with a series of plates blocking direct sunlight. This idea was created in coherence with the acoustic design, suggesting a highly absorbing surface would be beneficial, and a lamella solution would therefore allow for an elegant integration of both solutions, that is also in coherence with the simple beam structure of the roof. See Ill 4.33
As the exhibition spaces acts as a bridge through the void, a controlled daylight level was needed, the pictures themselves should be illuminated while letting the rest of the room remain dark. Therefore, a solution was developed to direct the sunlight towards the paintings using the light shelf, blocking the direct sunlight in the room and directing the diffuse illumination toward the paintings rather than the room, allowing for the wanted darker atmosphere. This allowed to both highlight the paintings, both the contrast of light and darkness. A series of solutions were then examined to allow for a final placement and orientation that would allow the wanted light distribution of the gallery. See ill. 4.34. All tests were done in close dialogue with the acoustic analysis, as each solution would dictate different ranges of materials, allowing acoustics, daylight and esthetic values all to inform each other to obtain the desired phenomenological performance.



ill. 4.33: Sketches combining structure and daylight

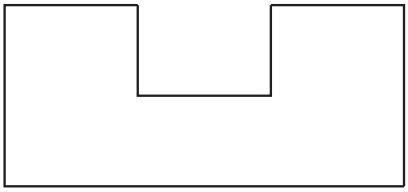


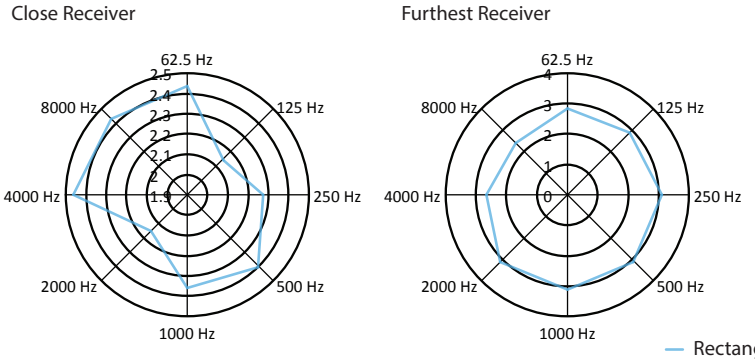
ill. 4.34: Analysis of angled light panels

Acoustics

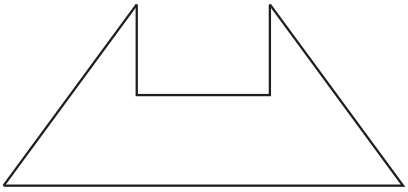
The phenomenological experience of the acoustic properties was a focus from the early sketching process, as explained under creative engineering, even though many of these ideas were never implemented as the possibilities were a constant parameter able to enhance and developed the proposals of the project. From the initial concept model created during the early concept development, developing the ideas of the voids within the building, the acoustic possibilities with the void was examined. One of the main drivers for choosing and proceeding forward with the project was the possibility to manipulate the acoustic properties of each room using varying room relations to create a varied and vivid sensorial experience, letting the acoustic properties guide many aspects of the design.
The process started out with simple examinations of how this void manipulated the reverberation and definition of the sound and how room relation in different manners would be changed with different relations, being it placed in the middle, with small gaps and even in complete connections with it. All these studies helped to inform the overall plan layout securing that acoustic possibilities created a coherent and enhanced journey through the museum.

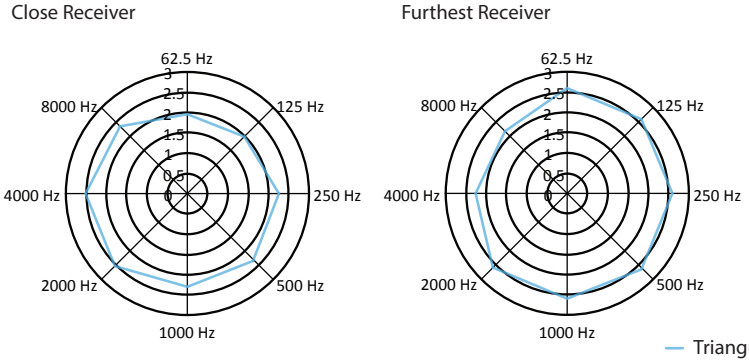
The initial acoustic form investigations, were a rectangular shape, a triangular shape and a round shape forming a convex. A study not just to identify the acoustic properties, but also an integrated parameter to influence on both the overall shape of the building and affecting how illumination reaches the exhibition spaces. The acoustic analysis is done through Pachyderm and the comparison between the different shapes is made possible by having the same volume.
One source and two receivers, first receiver close to the source and one far from the source, were used to test how sound would be perceived from different scenarios. To create the right experience in some of the rooms it was essential that the acoustic properties were different from receiver to another, where the source should be understandable to the close receiver and second receiver could both have a lower definition and higher reverberation time to imitate a more sacred feeling. While in other rooms, a lower reverberation time would be beneficial.
The results show that the circular shape and triangular shape is creating lower reverberation time for the closest receiver, with averagely 2.1 and 2.2 seconds, see ill. see 4.36 and 4.37. For the furthest away receiver the reverberation time is significantly higher for the rectangular shape with 2.9 seconds, while the circular shape is averagely performing with 2.6 seconds and the triangular shape with 2.5, see ill. 4.35.
The definition for the triangular and the rectangular shape performing close to 55 percent, see appendix 4.36. The circular shape has a definition at 60 percent, which is possible with its convex shape. The triangular shape has the acoustical properties that fit well into the acoustical and atmospheric experiences to be created, these shapes, however, were quite similar and the variation is within the margin of error.
See appendix 8 for results for more results of the analysis.



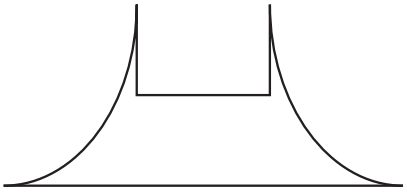


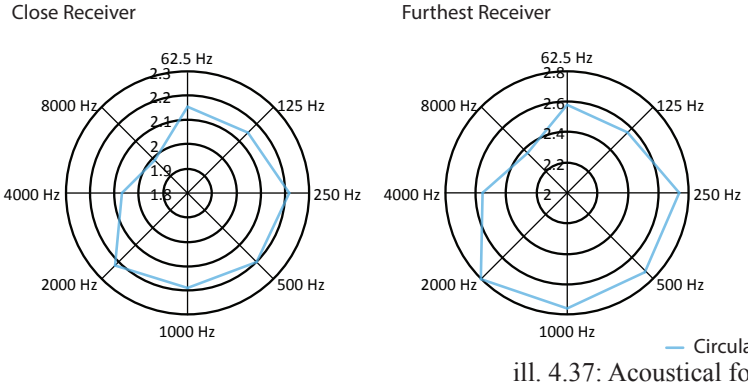
ill. 4.35: Acoustical form analysis





ill. 4.36: Acoustical form analysis





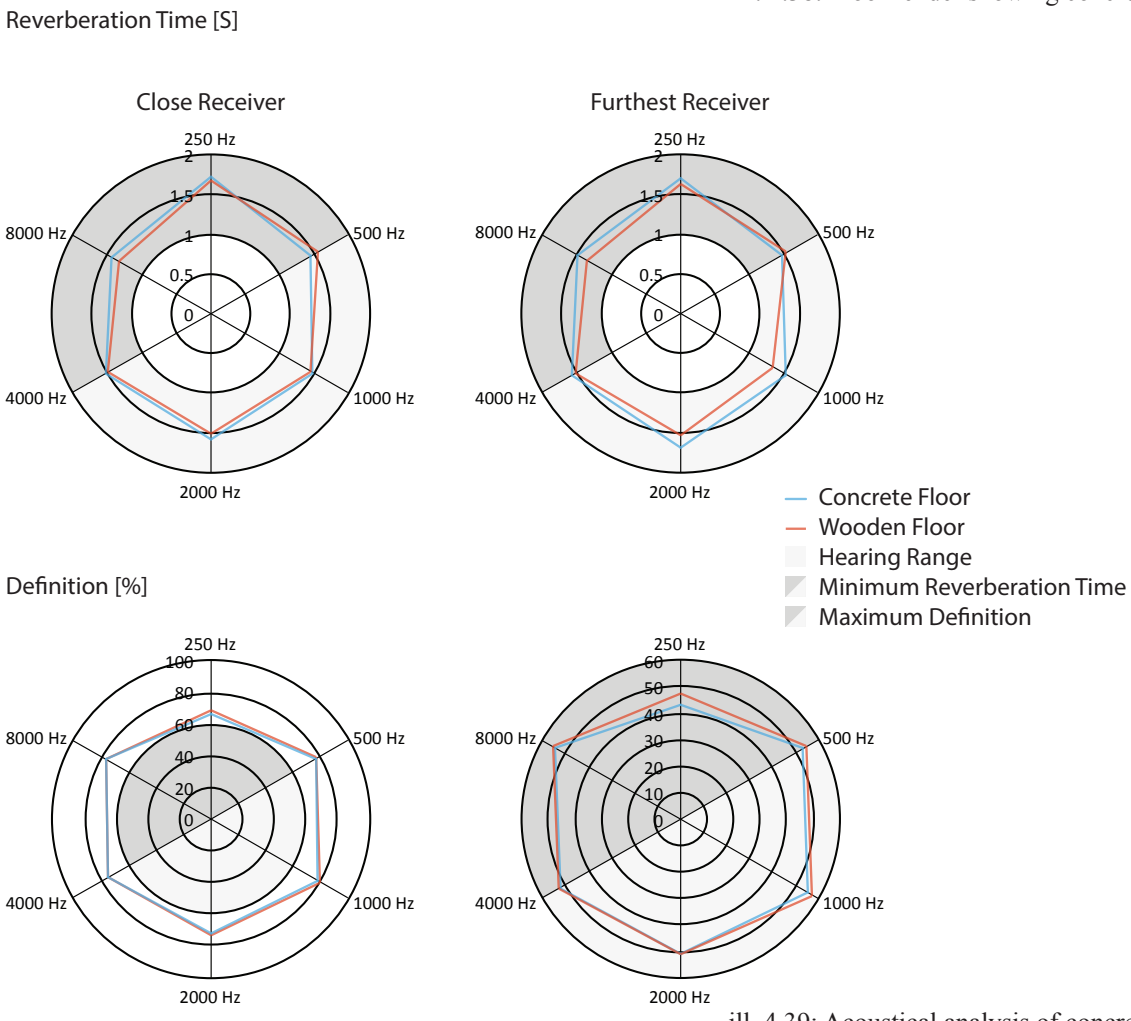
ill. 4.37: Acoustical form analysis

Throughout the acoustical analyses, all parameters were tested at all relevant spaces, but is exemplified in the design process; to give a better overview to how the parameters affects the acoustics. As each part of the building went through series of iterations, many overlapping, as material change etc, a specific part the acoustic solution is highlighted for each room, while discussing the overall design of the room.
Primordial Chaos is the first exhibition space. As the nature of this exhibition was to start the journey of Hilma af Klint, an effect of amplifying the room volume, and presence of the visitor, an effect of high reverberation time and low definition was sought. One of the tests done was comparing the effect of having a concrete floor versus wooden planks as flooring.

Results showing that high similarity in the tactility of the materials create a minimal distinction from each other; with a necessity for walkable surfaces it did not allow for extreme roughness. Letting the material choice of flooring be determined by esthetical, light properties rather than the acoustic solution, especially in this room due to massive volume.

As seen on ill. 4.39., Primordial Chaos has a reverberation time close to 1.5 seconds that enriches the spatial feeling of the space. Nevertheless, the definition at the receiver close to the source show values above 70 percentages, giving the possibility for understanding speech for small groups walking together, see ill. 3.9 aiding to the cathedral like atmosphere of being small entity in a colossal world.

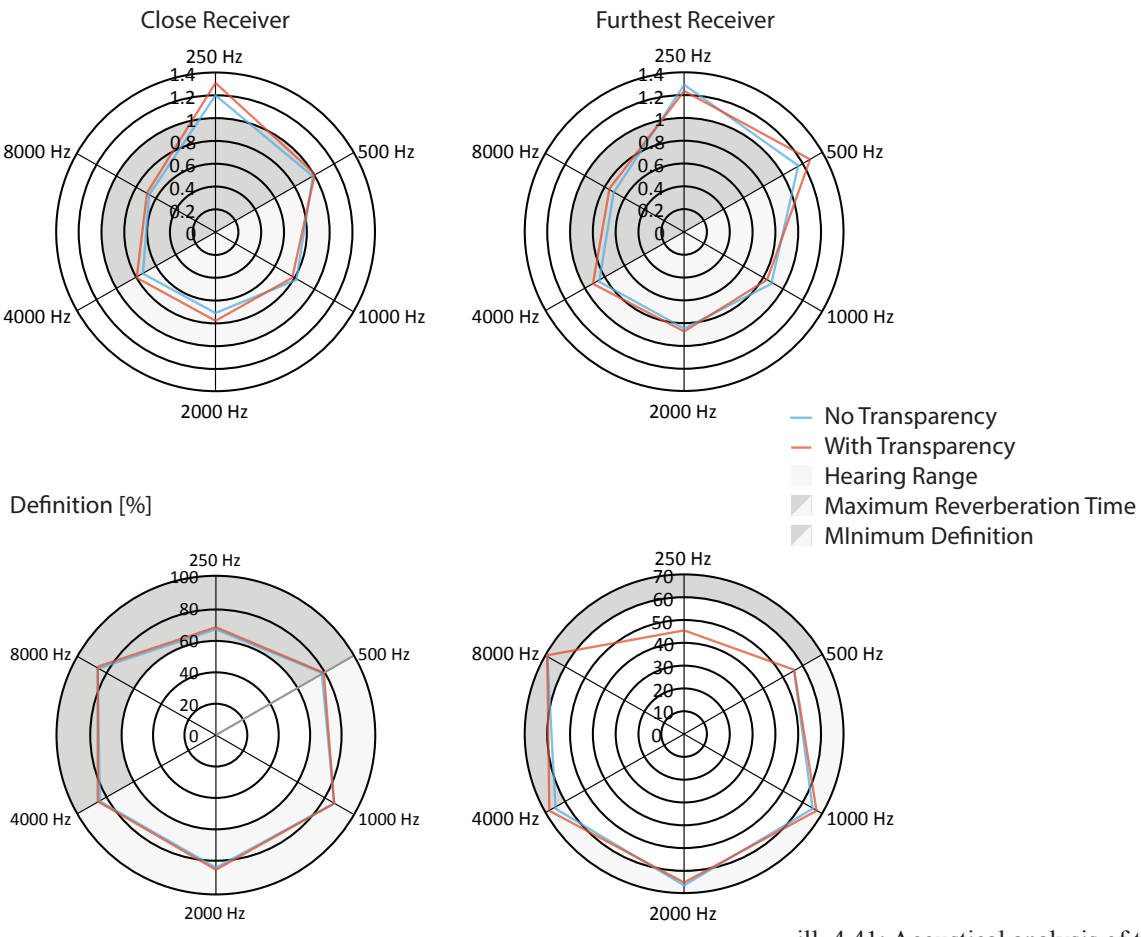
ill. 4.38: Floor render showing concrete and wood



ill. 4.39: Acoustical analysis of concrete and wood

The second exhibition space is acoustically interesting for the positioning next to one of the two voids. This gives the opportunity to create an acoustical and sensory relation between the exhibition and the void, whereas having small glances into the void, creating a new dimension between the darkness and the illumination, can form a sensory experience, on multiple levels.
Through the acoustical solution, the experience is to be developed further, by adding cuts to the wall separating the exhibition space and the void, creating small gaps that allows the darkness of the void entering the exhibition space. The comparison of this test is based on a solid concrete wall not interacting with the void and a concrete wall with half a meter gap between each painting allowing views into the void, see ill. 4.40..
The result shows that a perforated wall slightly increased the reverberation time and lowered the definition, see ill. 4.41, creating the possibility for both control and manipulation of sound, through openings into the void.

ill. 4.40: Wall render with and without transparency

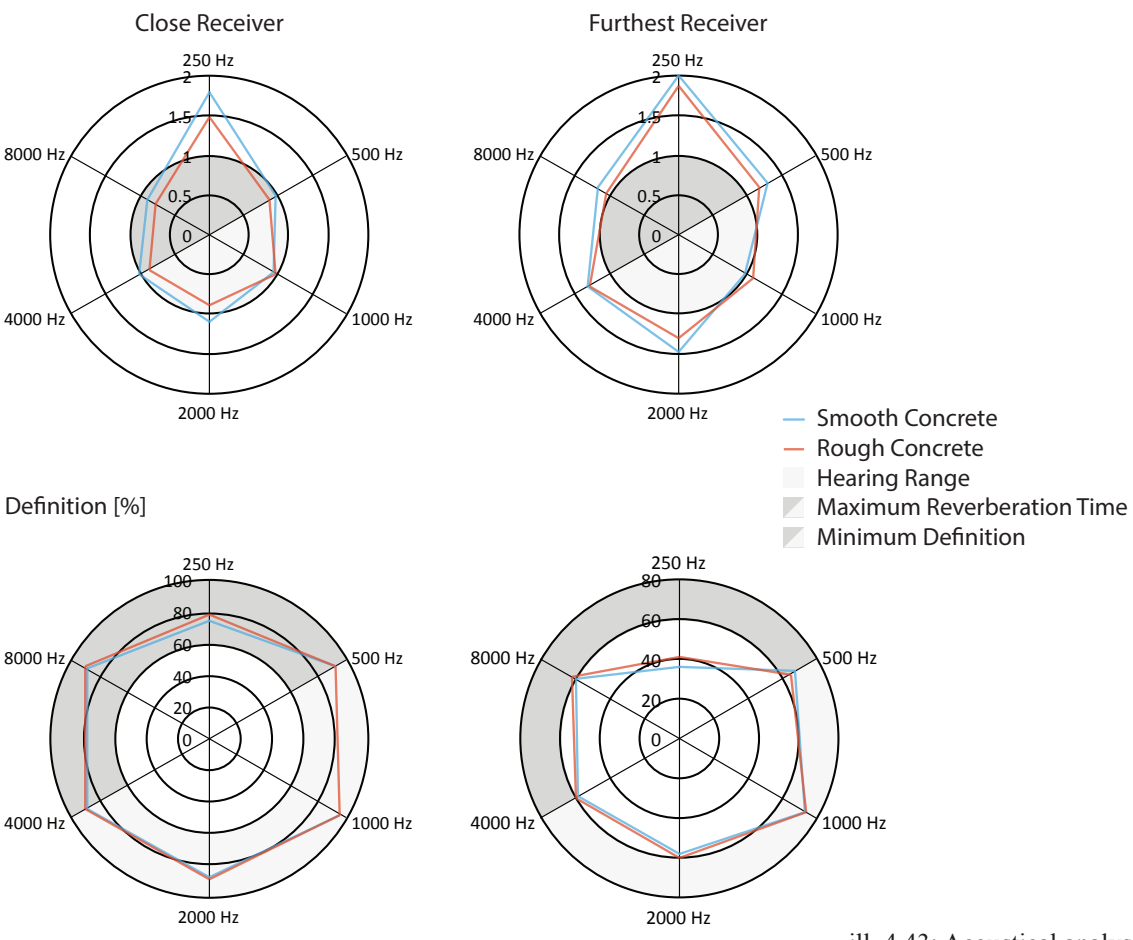


ill. 4.41: Acoustical analysis of transparency

The corridors are repeatedly located between all the exhibition spaces and function as breathing space between the art paintings. They offer an interesting possibility for creating a space that acts both as a break but also as connection to the void spaces, letting the distribution spaces themselves become a varied journey. The narrow space create the sudden transition of the massive voids, but also a space where the visitor is in close relation to the wall surfaces and can touch and feel the tactility of the materials.

By having the possibility of touch in mind, the tactility of the material was tested, as seen at ill. 4.42., a rough concrete surface and a more smooth concrete were tested. By increasing the roughness of the surface resulting in a larger surface area of the wall showed that the reverberation time decreased to averagely 1.2 seconds, with an improvement of 0.2 seconds, see ill. x.x. The definition showed the same picture and had a averagely improvement of 1.6 percentage, see ill 4.43., giving the possibility of creating a contrast full space, with low reverberation time, high definition and a rough tactility.

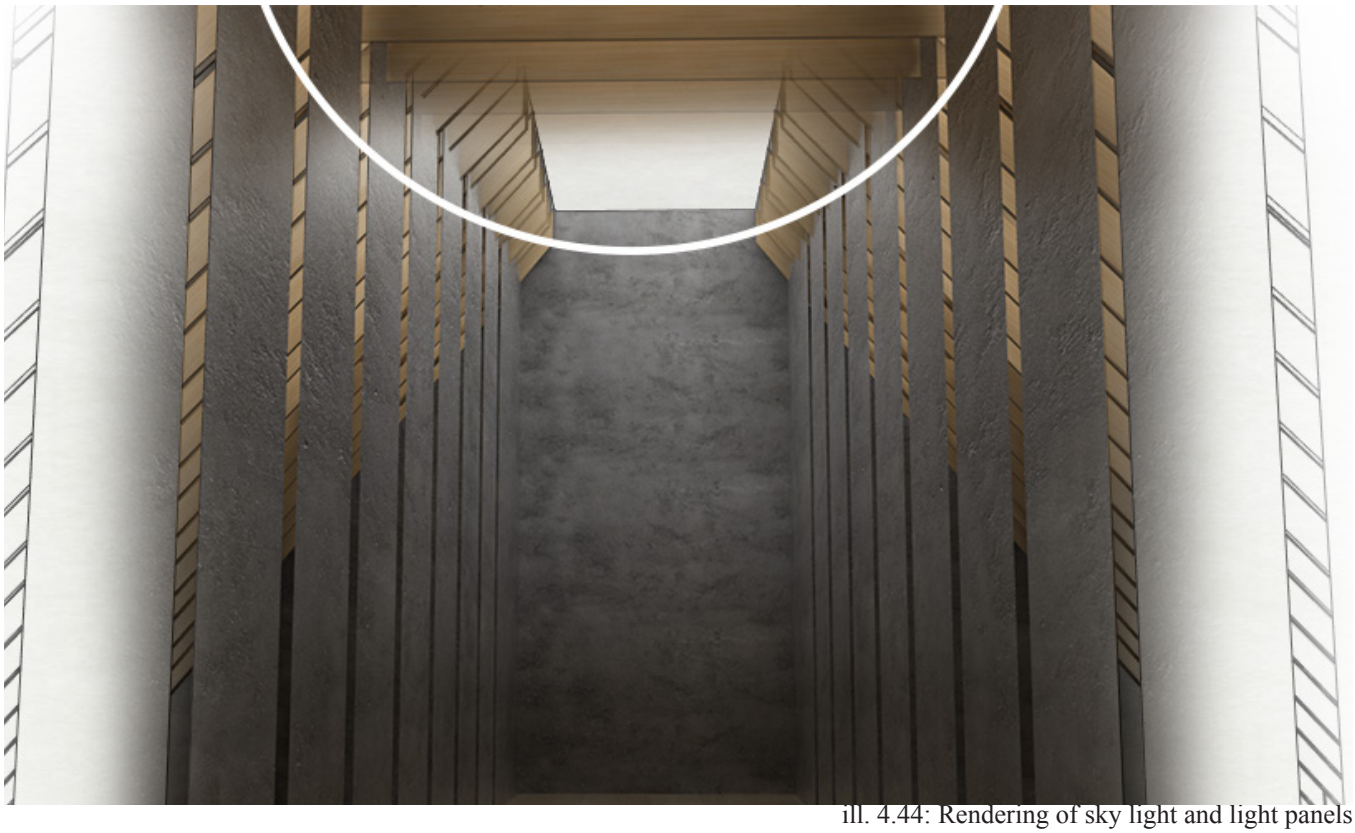
ill. 4.42: Render with change of tactility



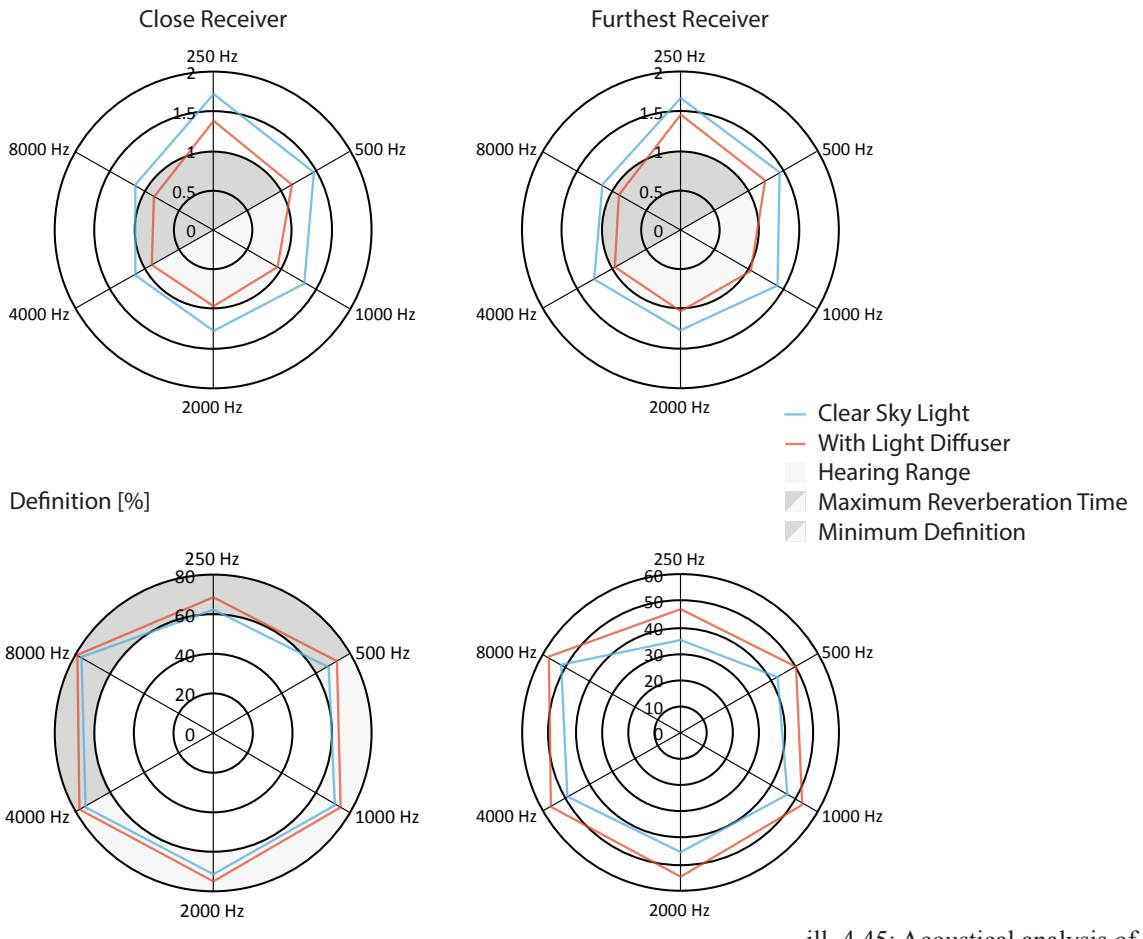
ill. 4.43: Acoustical analysis of tactility

The centered exhibition spaces, the Swan and the Dove, offered a significantly different scenario, as the roof is significantly higher as well the construction and, therefore, light intake of the building is different because the splitting roof. Even though the exhibition no longer is in direct connection to the void, the room still had the possibility to relate to the room below, the secondary exhibition space. In a likewise manner with the void, the connection of the two rooms could be manipulated.

Until this point, the darkness has been the dominating element throughout the exhibition spaces. Now the building opens up to the sky, with the illumination overcoming the darkness, creating a hopeful and well lighten atmosphere. The skylight in these exhibitions becomes a prominent surface, and the skylight solution, becoming an important part of the process, is, therefore, tested. Through the tests of a clear skylight and with light diffuser panels, see ill. 4.45., tells that the incorporation of the panels increases the definition with proximately 2 percentages and in the same time averagely lowered the reverberation time with 0.35 seconds, see ill. 4.45., emphasizing that the journey is moving away from the darkness and the void.



ill. 4.44: Rendering of sky light and light panels

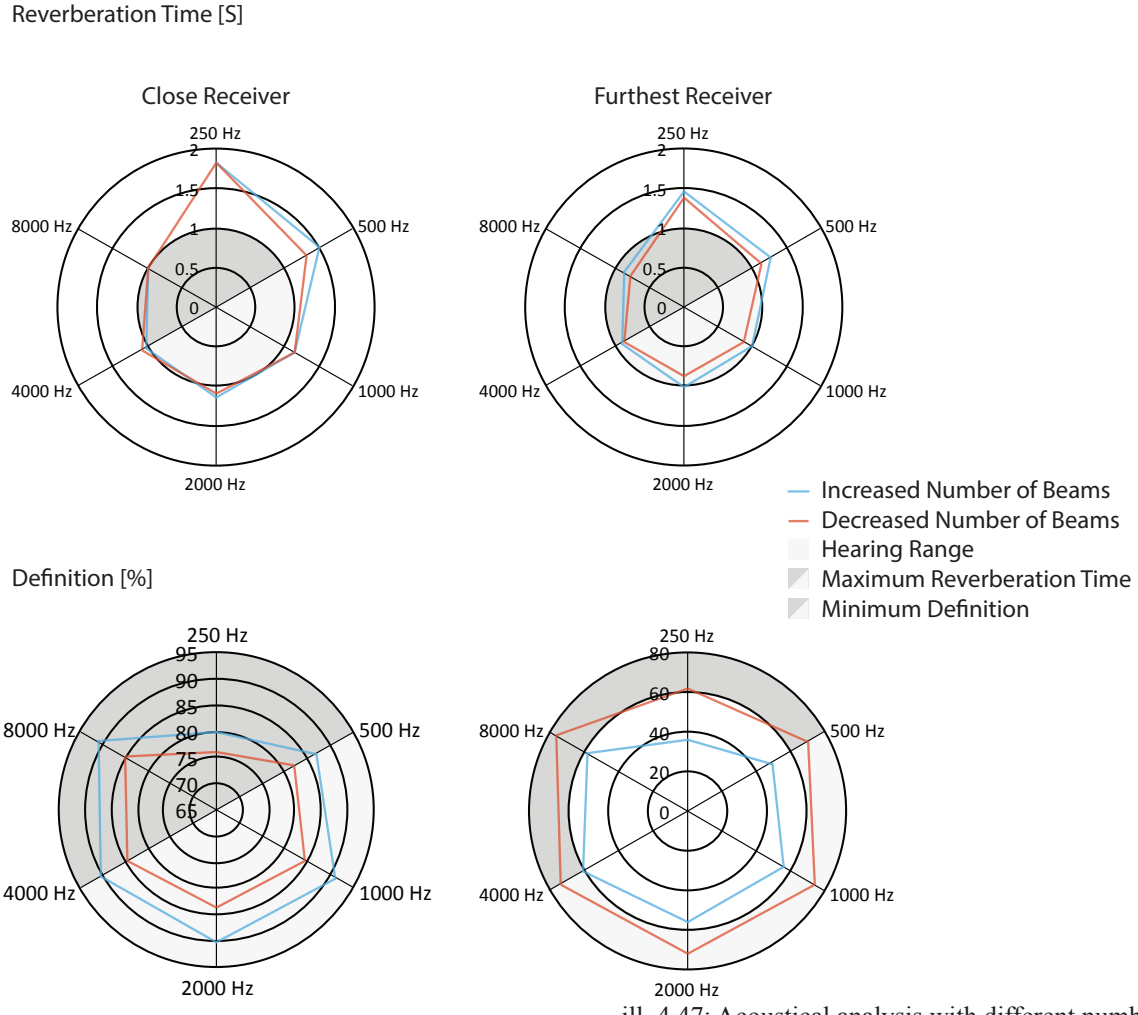


ill. 4.45: Acoustical analysis of light panels

The last exhibition space meeting the visitor is the secondary exhibition space, right beneath the Swan exhibition. The collision of these two spaces creates a section as seen at ill. 4.46., splitting the space into two, that was optimal to a space with a large volume. The ceiling is a dominant part of the room and, therefore, subject for analysis. A structure that is not only an acoustical element, but also evaluated through the notion of tectonic, looking at how the structure is perceived by the visitor and in general investigate the structure effect on the space.

The number of beams is tested acoustically, with a one meter separation between each wooden beam and one with half a meter separation. Results are showing that by incorporating a higher number of beams the acoustical properties increases the reverberation time than fewer beams, see ill. 4.47. As the absorbing ceiling is more exposed. The definition is performing slightly better with increased number of beams for the receiver closets to the source, nonetheless the receiver furthest away , the fewer beams resulting in a definition between 58 to 77 percentages against 33 to 59 percentages, see ill 4.47, meaning fewer beams creates a more adaptable atmosphere.

ill. 4.46: Rendering showing length variation between beams

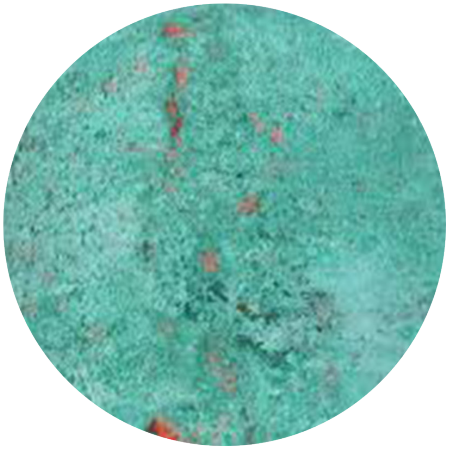


ill. 4.47: Acoustical analysis with different number of beams

Materials

Throughout the project, materials have been a parameter, with influence on acoustic properties, light absorption and atmosphere.
Due to the plate structure and the atectonic dominating construction, the material of concrete was early decided to become the main construction material. The concrete, however, was ever changing throughout the project. By varying the surface of the concrete, the design process of the material is in constant dialog of tactility acoustics, structure and light, as the material choice should be able to correlate all parameters connecting them all.
The connection to the materials was important to maintain the idea of journey of the building, how should the material in the galleries emphasize that the gallery and bridge through the void, and how should the two materials connect.

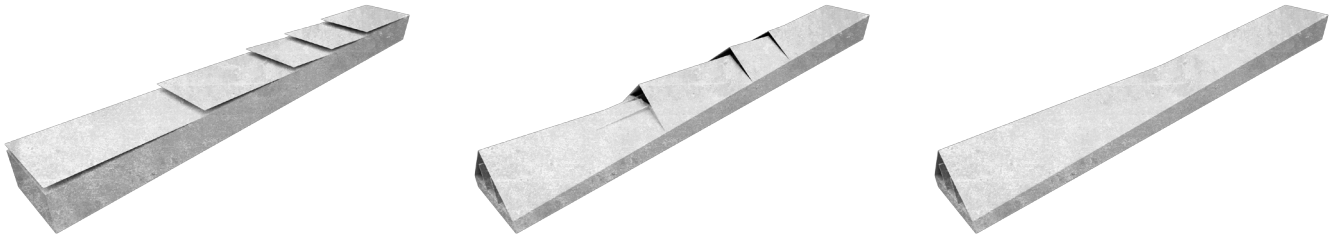
The material usage was chosen to enhance the experience of Hilma Klint, therefore, seeking inspiration in her art.
The overall decision to use contrasting materials was based around how the contrast in Hilma Klints paintings displays both conflict but also unification. The concrete became the rough, dominating construction, while the void became a guiding mean.



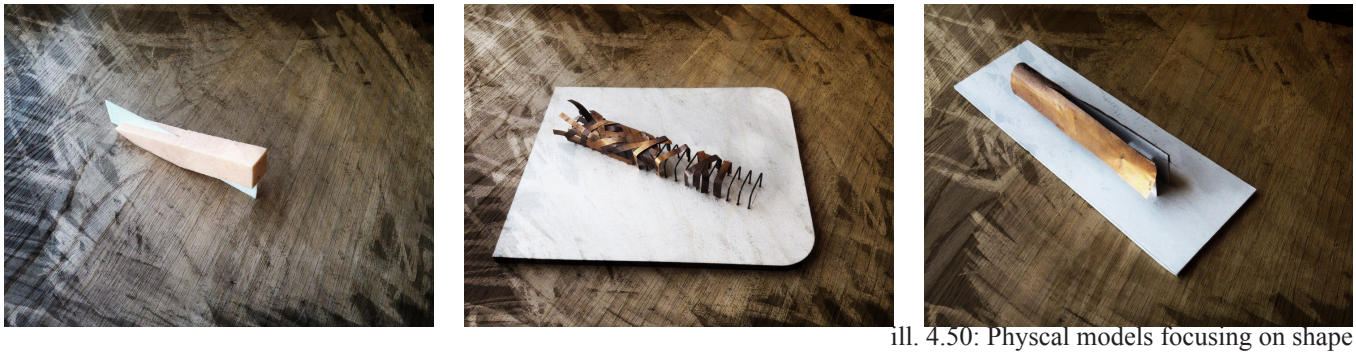
ill. 4.48: surface picture of discussed materials

Formstudies

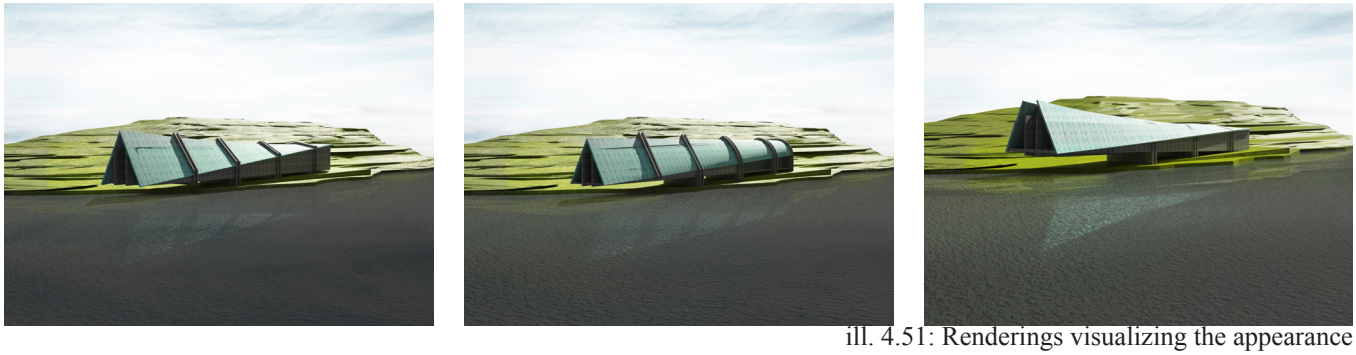
As with the materials, the form of the building took inspiration in the contrasting elements of Hilma af Klints paintings.
The building shape was developed over a series of iterations and phases, developing as parameters as acoustics, room plan, elevations etc. was developed. The initial studies sought to explore the elongated shape of the building as well as the crossing plates structure, exploring different possibilities and interpretations of the building as a quick brainstorm, widening the possibilities of the plan. A small selection is presented in illustration ill. 4.49, dealing with the overall flow of the building. Going from a solid volume with strong separation at each volume, to a building with no separation and an elegant flow along the building and an in-between in the middle. The sketches were then translated into models, exploring the themes of the quick 3D sketches. Where the overall concept of a building opening up along the journey both towards the surroundings and the sky, letting more and more light in while creating a transformation of the building, in correlation with the overall concept. These final shape designs was created in coherence with the acoustic studies, where the idea of a varying acoustic experience let to the roof becoming an absorbing surface becoming more and more dominant throughout the building. Letting the roof both allowing more and more light in while absorbing more and more sound. The roof became a contrast to the strong heavy cold and reflecting concrete structure. This contrast between the two elements was displayed through the building volume, becoming an elegant free flowing shape, almost a textile in contrast to the heavy stereotomic construction. The building, however, still needed further iteration to complete the shape. As it is overhanging the fjord, the building shape should be strong enough to flow naturally in the air. It should become almost a vector flying through space. The coherence of the roof and plates was also explored, as the two elements should become a unity instead of two conflicting elements. The final iterations were performed as a series of visualization in order to compare the shapes, as well as integration of the light intake 4.51.



ill. 4.49: 3D-models of form development



ill. 4.50: Physcal models focusing on shape

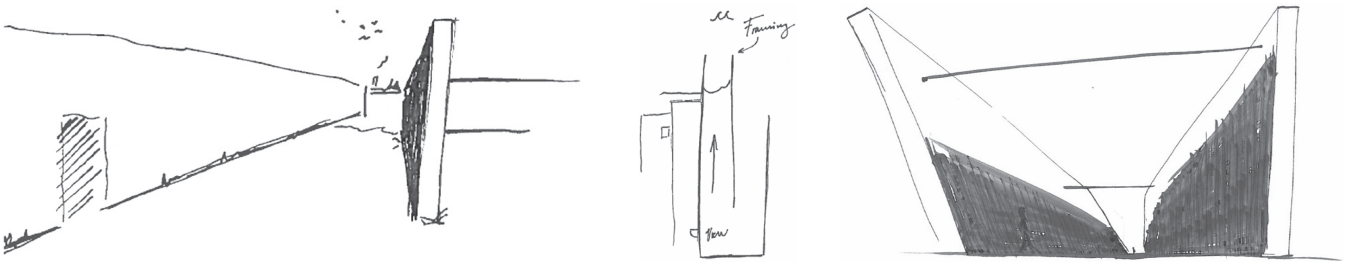


ill. 4.51: Renderings visualizing the appearance

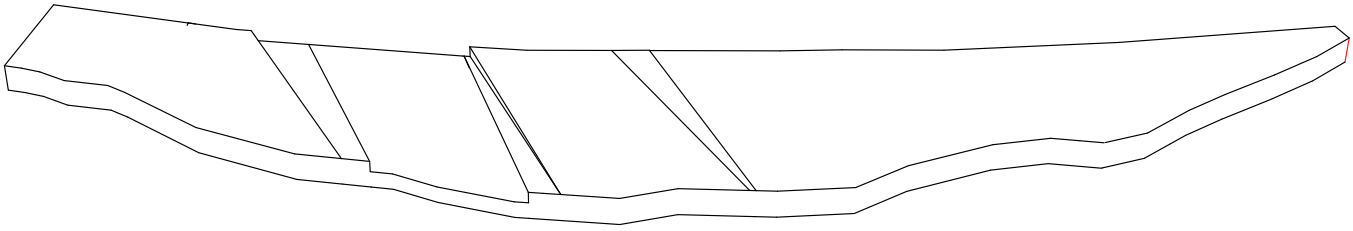
Outdoor Area

The focus was to the access on the site by having tall walls hiding the path to the building and develop a journey to the museum that enhances curiosity by creating various experiences around every corner, with the structure integrated to the access walls with a counter weight in form as the adjacent wall.
The journey brings the visitor to framed views and as a door in the frame, the entrance is going out into the water and under, and into the museum.

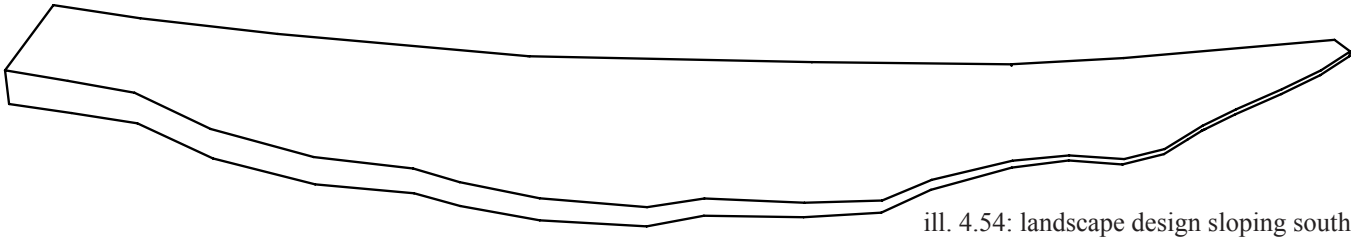
The site is flat and only one meter above sea level which can flood the site to some extend and, as the building cantilever out over the water, can get the perception, that it is about to tip over.
To avoid this effect, the site was raised four meters in the Northern end. This gave problems to the accessibility for ambulance and fire vehicles, as emergency vehicles need a large turning.
The site is lifted four meters to give more space between the cantilevered part and the water. The topography is dug away to create a path going under the building. This gave the same problems for emergency and service vehicles.



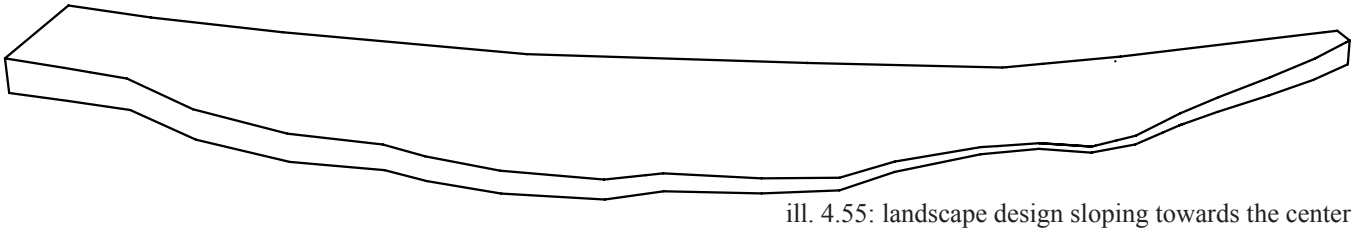
ill. 4.52: Conceptual exterior sketches



ill. 4.53: Development of site with clear landscape cuts



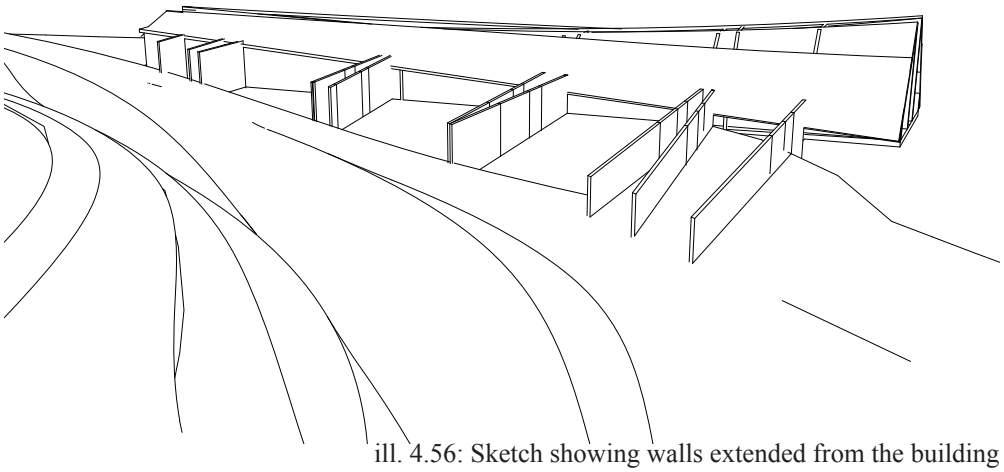
ill. 4.54: landscape design sloping south



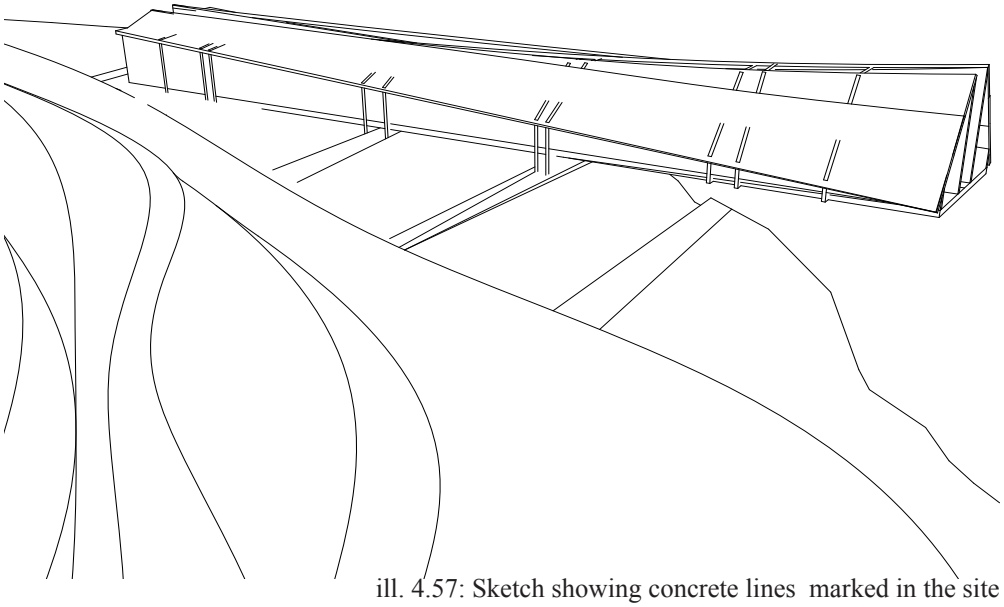
ill. 4.55: landscape design sloping towards the center

For the garden, on the East side of the building, it is important to create a clear passage to the building in case of emergencies and a road for service vehicles. The garden should express tranquility and form a stay for visitors. When walking from the parking space to the museum, it is neccesary to focus on the experienced perception of the building that can be perceived from niches created in the garden. Vegetation like beds of flowers, trees and bushes can be used to change and create textures, intimacy, guidance, shape spaces and etc. (Diekelmann, Schuster, 2002)

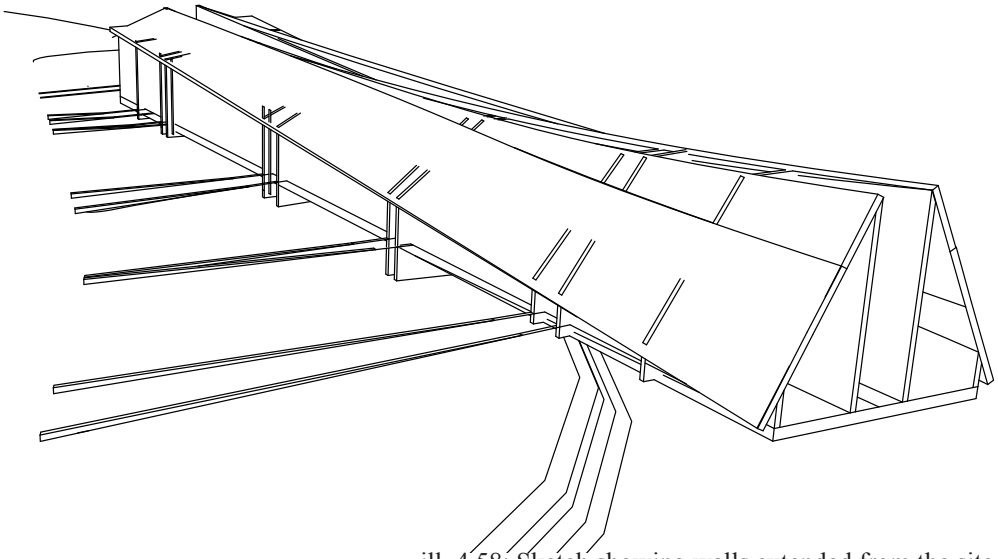
Seen on the illustration, the emphasized walls from the corridor walls, from the building, is drawn out into the garden as concrete markings, that makes outlines for niches.
As seen on (ill. 4.56) the idea was to mirror the inside circles from the mid axis hall-way, but instead of a straight passageway, it would function as a zig-zagged journey towards the building.
The walls being minimized (ill. 4.58), so they only appear slightly above the ground, which then solves the access for emergency and service vehicles.



ill. 4.56: Sketch showing walls extended from the building



ill. 4.57: Sketch showing concrete lines marked in the site



ill. 4.58: Sketch showing walls extended from the site

Be15

This project is focusing on tectonics, and therefore energy demands have been a minor part of the design process. The considerations have been on a conceptual level considering orientation etc. However the building performance have been monitored on a basic level in order to have an idea of energy performance of the building.

The strategy have been to reach the 2015 standard at 41,2 kwh/m2. Estimations have been made to get an idea of the energy consumption and with approximately values used, resulting in an current energy demand of 37,9 kwh/m2.

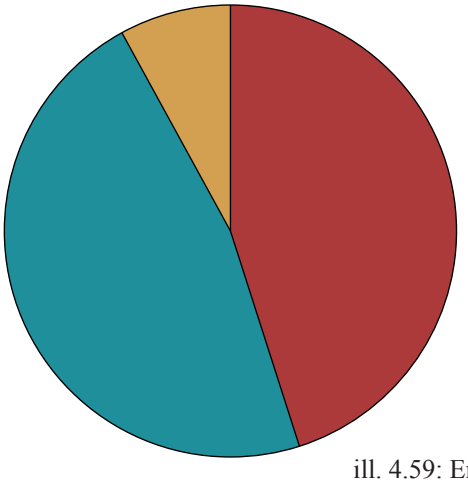
With the rotation of the building, the largest window area is on the roof and only a minimum window area to the West and East and due to the view, a large window is on the North facade. There are larger window openings, because of natural lighting, on the roof which gives the biggest heat gain and loss.

Mechanical ventilation is used in all galleries due to the fragile exhibits, which needs minimal temperature variations. Natural ventilation is used in the workspaces. The distribution of energy shows a large consumption of energy goes to heating, but notable is the energy for ventilation as it uses electricity. The ventilation system helps keeping a good indoor climate for the exhibits and the visitors.

There is excessive heating which is caused by the big windows on the roof. If the Be15 should be more reliable, there would be the need to add the complicated environment that exhibitions need to not add the risk of damage to the exhibits, which is a strict demand on humidity, temperatures and various special lighting fixtures.

Excessive Heating 3%

Electricity for Operation 17%



Heating 17%

ill. 4.59: Energy results of Be15 analysis

Process Reflection

The temple for Hilma started with the vision of how science and art could be utilized to create this highly phenomenologically demanding building. How the architect and engineer can utilize each other fields of knowledge to create a building where both technical and artistic elements are used creatively. Especially as the projects showing this level of creative engineering is utilized, are buildings with a high level of technical demands. As architects and engineers, the projects investigates how to further bridge the gap of the incorporation of an integrated approach. By utilizing the technical concerns of acoustic and daylight to develop the project, a strong integration of architect and engineer is established. However, in some regards the level creative engineering discussed earlier could be further utilized. Early sketches of the subject showed how this approach could utilized to create innovative solutions utilizing engineering knowledge to generate new design. However when further developing the project many of these ideas proved difficult to incorporate. Some solutions as the void rooms, used as a form of echo chamber was generated through technical consideration, but other solutions as the structural solutions, could be further examined in order to further incorporate creative engineering. As they do not show a level of innovation that some the earlier sketches did. The project in the end proved in our perception to be highly integrated project, but not innovative as the potential of creative engineering proves possible.

The structure itself leaves room for reflection. The initial vision of the cantilevered atectonic building, is somewhat diminished through the beam structure of the building. A complete concrete plate structure would offer a more pure and simple design, however changing other parameters as the evolving shape, and skylight, altering some of the qualities of interior space, while creating a stronger exterior.
Developing the project from concept to final proposal, the building was strongly developed from the inside out. As the narrative of the journey was the main design parameter. Even though the overall appearance was continually evaluated, the overall profile of the building became sub optimal. By interpreting Hilma af Klint and her art, the interior became a strong expression of her art and journey, while the reference to her is lost in the exterior. By applying a stronger reference to her in the exterior, the overall journey from before entering the museum would be stronger. Questioned whether the project should have a stronger development from the outside in. Other problems as with how people approach the building is in some ways uninspiring, as the integration as well as detailing of site and approach could be stronger. Other factors as the start of building is perceived rather heavy, while the overhanging part of the building, could have a stronger profile, benefiting the project as a landmark for the area.

Conclusion

This master thesis project has been investigating the creation of the appropriate museum for Hilma af Klint that displays both her art and history.
Through the examination of the border between architecture and engineering, the project applies a cross disciplinary approach with a focus on the phenomenological performance of the building.
Using both artistic and scientific elements, creating an atmosphere portraying the struggles and suppression of Hilma's time.
Solving it by suggestion, creating a timeline of Hilmas art and time, portraying her journey through the atmosphere of the building, where the otherwise scientific part of architecture, engineering, is using structure, acoustics and daylight, able, in collaboration with the artistic elements, to create highly phenomenologically performing building. The Building is a narrative of Hilma af Klints life and art, by creating an atmosphere invoking similar feelings of despair and hope, the architecture becomes the frame of the story, but as her art stops, the building extends her work, creating a frame to reflect on her arts relevance on today's society.

In order to prepare for the design of this building, a series of analysis investigating how architecture invoke the appropriate feelings of despair, domination, but also curiosity and hope within the darkness. How the darkness can be manipulated in a similar manner as light, how it can be appreciated and utilized. How the tectonic can express this atmosphere, where the poetic qualities become as important as the performance.

The method is based around the methodology of Mary-Ann Knudstrups integrated design process. This approach is extended with, what is proposed in this project as creative engineering, based around Cecil Balmonds approach to architecture and engineering. Investigating how he is able to push both the spatial and structural qualities of his projects, investigating how the performance of the buildings is as much a phenomenological question as it is structurally, and how the coexistence of them can elevate the architecture. As the performance and knowledge of the technical concerns, the building has been utilizing performance-aided design. By utilizing performance-aided design, the building has continuously been developed and informed by how the building performs. This integration has enabled the project to reach an integrated solution, where acoustics and daylight simulations became a concept development tool, rather than a verification tool, simply confirming that predetermined demands are meet. Where the structure is an expression of the concept, and the conventional structural solutions is challenge through an atectonic expression.

By creating a journey through the museum, the building becomes a temple for Hilma, where it is possible to experience the journey for Hilma, the buildings long shape protrudes through the landscape creating a monumental figure, on the waterfront of Lindinö towards Stockholm. By entering the building the variation of sensorial expression linked with the overall narrative adds a frame of presentation of the art, while the building itself leaves room for its own expression, forming a combination of art and architecture, where the otherwise technical demands are replaced by technical expressions.

Reflection

Initially inspired by the work of Hilma af Klint and a series of prominent architects/engineers, the project seeks to explore the boundary of architect and engineer. Taking a point of departure in Mary-Ann Knudstrups integrated design process, working towards a more holistic approach to architecture. The project explores the boundary of architecture and engineering, questioning if this approach could go beyond a holistic solution. Seeking to incorporate a creative approach of the scientific and technical aspects of architecture.

The temple for Hilma had the focus of a highly phenomenologically demanding building. Using technical concerns as acoustics to explore and develop the atmosphere of the building, letting the acoustic solutions become a defining part the conceptual journey. However, as stated in the motivation.

> - Is it possible to integrate this method as a natural part of every project, as an extension to the integrated design process?

This project choose to explore how creative engineering can be utilized towards a phenomenologically demanding building, creating another approach of defining the technical demands. However when applying this method on to projects where the technical demands are low, and functionality is in focus, how do this approach apply? A classic integrated design process includes the documentation of the demands of the building. Evaluating technical solutions through analysis and simulations in coherence with the esthetic parameters,

leading to a holistic solution. However, with preexisting solutions, in most cases. By allowing the technical demands to influence the project definition itself, it is possible in likewise manner as this project to create high technical demands, invoking a necessity of creative engineering. Being a hospice allowing people to fell the wind and sun, even during winter, or a school with the possibility to communicate across playgrounds. Developing the demands through the architectural visions of the area.
The core of this project is created through the development of technical demands. As a museum in itself is not necessarily a technically demanding building, however the Temple for Hilma is.

The root of this approach is to create the technical demands. The architectural industry is defined through people pushing the spatial boundaries and demands of each solution, creating unique solution from project to project. Pushing this thinking on the engineering aspects each project has the possibility to push the limitations allowing for new innovative solutions through each project.
The purpose of creative engineering is however not to develop innovative solutions. Depending on each project and the architectural visions of the area, a different level of creative engineering is applicable. However, it is possible to implement in any scale. The solutions utilized in the Temple of Hilma is not innovative, but the overall solution cumulates into a unique solution. By designing with technical concerns, the tools for the creative project development increases, allowing for the technical tools to push the architecture.

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Load combination

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Illustration List

Appendix

Appendix 1 - Nordic Light

Working towards a museum, with a focus on using the light, it is important to analyze why the usage of Nordic light is so spectacular.

Scandinavia with Denmark, Norway, Sweden and Finland is the home of Nordic light and with northern latitude the light appears different depending on the present season. During gloomy winters the days are short and the nights are long and then the sun is rising only reaching a low angle creating an almost horizontal illumination forming long shadows that together have a contrast full perception of the darkness and light. Whereas the summer illumination eliminate the dominance of darkness, where a still low latitude sun creates short and bright nights. Summer is the period of the year where technical requirements are easily achieved for light and over heat becomes a problem. By the right approach to daylight the conditions of winter and summer can be modified to advantages.

These conditions were explored in the early 1920s, constructing a Nordic identity that was realistic and authentic to the northern world surroundings. Light as a central element in Nordic architecture becomes symbolic then light passes its illumination role, producing fluid images that expanding the sensibility. Creating metaphors that speaks to the deeper strata of the human psyche forcing people to sense, affecting our heart and mind by feelings.

There is a seductive aspect in light fighting the darkness; the hunger for light is in the human nature and by creating this illusion a movement is stimulated in an otherwise static building. Perception of light against darkness can be done in many different ways, by creating an opening in the end of a corridor or have a series of windows in the ceiling both illustrating a metaphoric journey.
In some architectural cases the architect make the darkness when only allowing a little or non-illumination into the space forcing visitors pupils to widen, challenging their perception of the space. Often the darkness of a space seems more spatial and physical by adding small windows; making shadows grow darker.

In many ways daylight is a limited resource in Scandinavia and to optimize the use of daylight, corporation between ‘minimizing heat loss’ and maintain ‘a contact with nature’ is necessary. To satisfy these needs the window design can simply follow the path of the sun, optimizing and catching the amount of daylight from very specific parts of the sky. By adding funnels, lamellar, scoops etc., to the openings, they become a tool to distribute and diffuse the light into the space. A white interior space is preferred to reflect light, maximizing the soft diffuse light that simultaneous creating a sense awareness and harmony.

Darkness, diffusion of light and light as a contrast to

Appendix 2 - Lighting

darkness is three aspects in Nordic light that can be used advantageously in architecture; both to activate and experience our senses and using the light to create an emotional journey that explains the essence of the space.

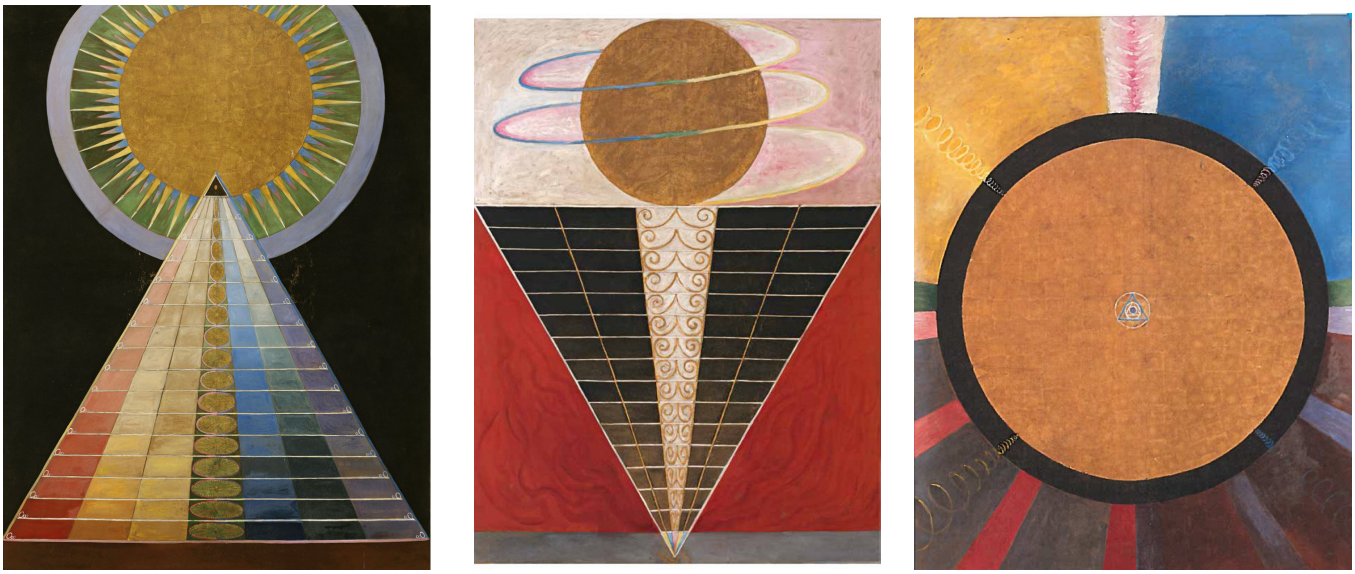
Awareness of the environment around the art and the light environment is vital in a museum to achieve good comfortable results for the user and the art. For lighting, consideration on multiple factors must be taken as it is not only to enhance a piece of art but also how the atmosphere around the exhibit is presented and at the same time avoiding damage to the exhibit from being natural or artificial lighting which both degrade the art piece (http://www.licht.de).

Visual comfort
Depending on what is on the display we can use various effects for light. Diffuse lighting is only ideal for two dimensional exhibits as it is only from one view side, three dimensional objects loose, depth and texture without any form of directional light as it's an exhibit that you can walk around (Shaw, 1994).

Artificial lighting
With artificial lighting, the flexibility is enhanced and easier to control plus less expensive to manipulate. There is also a huge market for the different light fixtures to the different environment/atmosphere (Shaw, 1994). The only downsides are the life of the light which has to be changed from time to time and the energy consumption which can be a significant factor on the budget of running the museum. The quality also has to be considered and again the conservation level on the artificial light to minimize damage to the exhibit.

Natural lighting
Daylight is the ideal for two dimensional exhibits and is the best for obtaining a clear and original view for color originality but you can't use direct natural lighting as the UV light will damage the exhibited piece so glare is a vital aspect when using natural light in exhibitions. When we bounce the light around off ceilings and walls we get diffused light which is favorable. The downside is the incapability to adjust the light sequel or the amount of light going in. secondly the problematic and expense to adjust the in-fall of UV (Shaw, 1994).

Appendix 3 - Selected art of Hilma



ill. 5.1: The Alter Pieces

The Alter Pieces

ill. 5.2: The Swan No. 18

Appendix 4 - Museum architecture

The onset of the museum states all the way back to the antique era from; Egyptian tombs, ancient temples and medieval church crypts and royal treasuries which all possessed smaller or larger collections. Moving up the centuries, art was starting to be showed in private collections only showed in so called *"cabinets of curiosity's"* which were showed to very few individuals as family members or friends. In the 16th century the tendency for hanging art collections in corridors of castles and country houses began to appear which had the purpose of distracting the viewer while exercising in form of walking around the corridors and passageways. As the art was still a thing for the upper class the aristocrats took responsibility and arranged exhibits in gardens, grottos, summerhouses and loggias (Newhouse, 2006).

The Monographic Museum

As artists started to exhibit their own works in their atelier others initiated opening their own private collections for the public which was, commonly, in their own homes. The common atmosphere in these museums are with low ceilings and small passageways which gives a more personalized feel to the visitors. The monographic museum has the advantage that the architecture interacts with the art in the sense of windows that gives natural and manipulating light to the exhibits and furniture which acts with the museum atmosphere and small corridors, corners and alcoves with displays which all contributes to the architectures interaction. …which is somewhat like the *sacred place*. Monographic museums are not only in homes, it can also be in a tribute to an artist where they build the museum in the spirit of the artist's studio, as it was done in Gipsotheca Canoviana by Carlo Scarpa (Newhouse, 2006).

The Modern Museum

The 19th and 20th century we start seeing the public modern museum in form of big 'self-situated' buildings with huge gallery capacity and the simple architecture and settings that doesn't interfere with

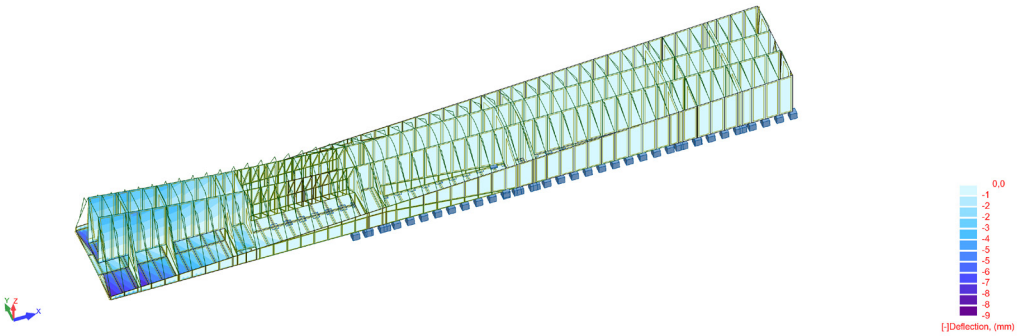
the exhibitions in form of the White Cube and the Black Box. These museums are meant to carry huge art collection and from various artists. The museums have various exhibitions and these exhibitions are "touring" the world. In mid. 90's the museums start taking all categories of art and it becomes more than just a museum, it becomes museum entertainment (Newhouse, 2006) which teaches and tells the users and let them play in designated areas. (Rocco, 2011). This period also experience a tendency to commission architects to create the museums as big monuments. It has the aesthetic idea to be open up to the surroundings and letting the outside in and focusing on the exterior look.

Conclusion on the Monographic museums vs. MoMA

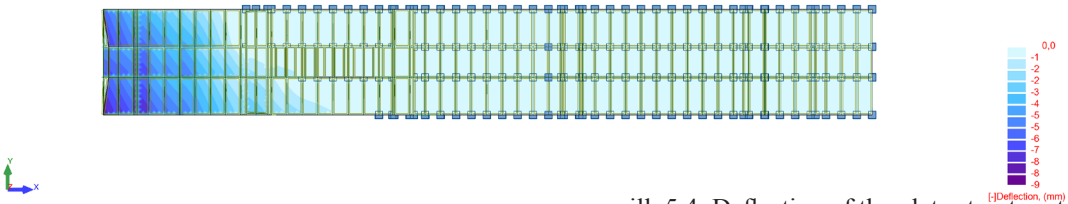
When looking at the two types of museums there is advantages and disadvantages. The Monographic museum is very personal for the visitor while the modern museum can be very depersonalized with the large scale, huge white anonymous rooms and suppressed details to not interfere with any art exhibition. These White Boxes lets the art speak for itself and only for the sense of vision. The monographic museum on this aspect can interfere to the extent of annoyance if the architectural design fail to enhance the art on display. Looking at the chances for damage on art, the modern museum lets the art go into risk as it needs to be transported, adding the various risks of transportation with changes in temperature, humidity, air pollution and physical damage etc. (Thompson, 2011).

To transitive these two types of museums to get the best features from both is the aim for the galleries. The exhibition spaces need a clear architectural look which the white box grants the space but with a combined duality that also enhances the art. The exhibition spaces should therefor deliver a clean yet interesting look that enhances the art. Hilma fint man kan specialiserer det til hilma (Monografisk) evt perspektiver til Chi Chu.

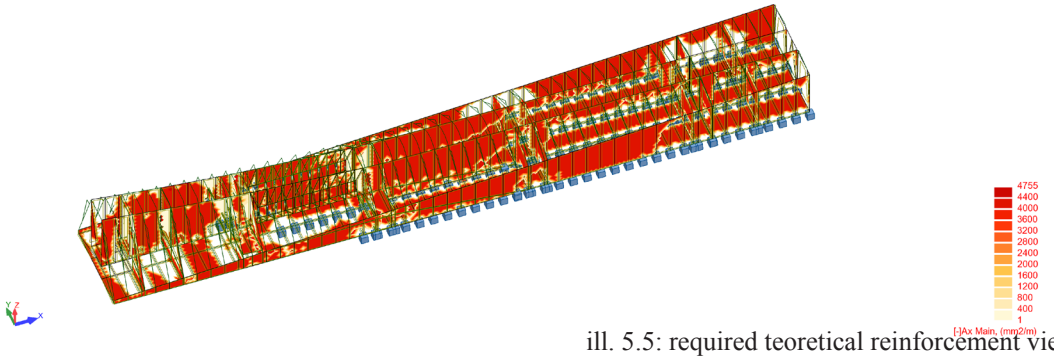
Appendix 5 - Calculation results



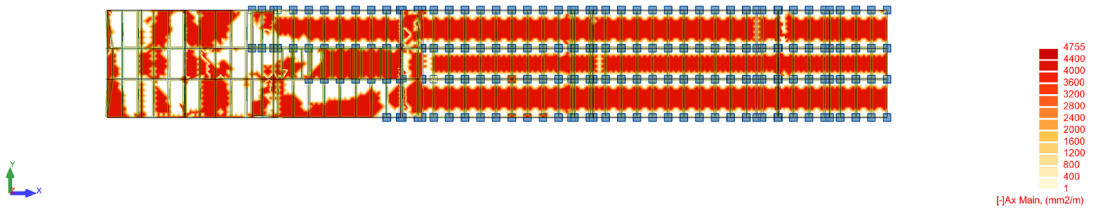
ill. 5.3: Deflection of the plate structure view 1



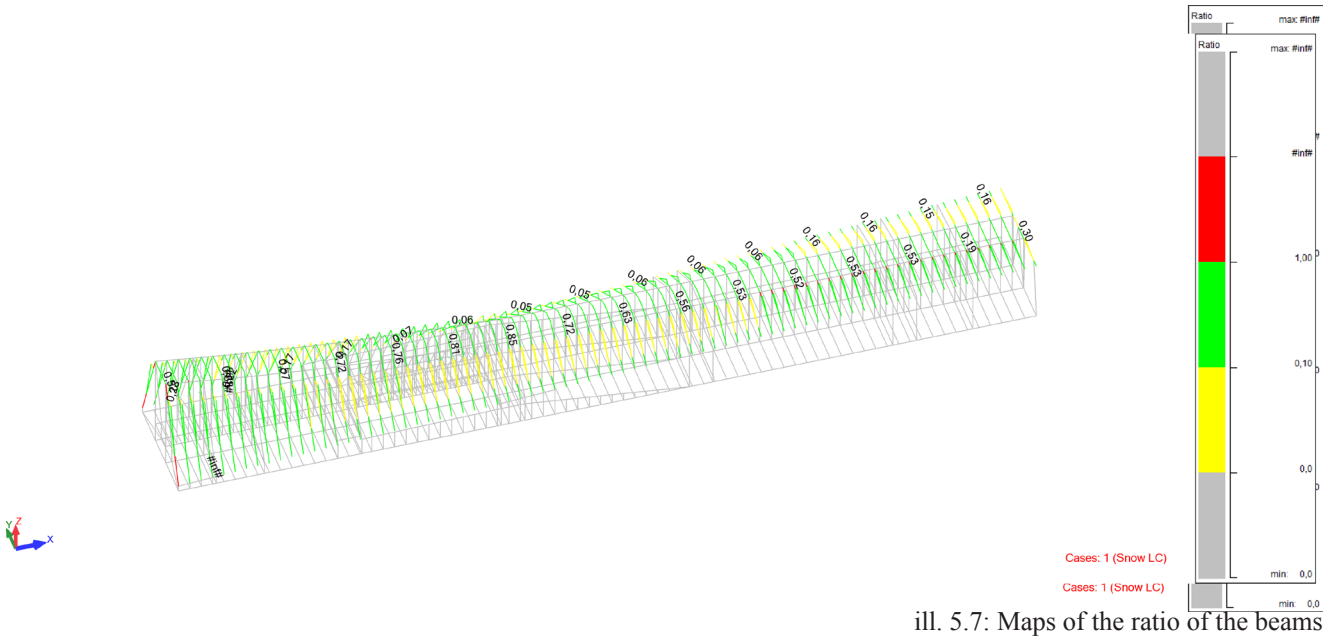
ill. 5.4: Deflection of the plate structure top view



ill. 5.5: required teoretical reinforcement view 1



ill. 5.6: required teoretical reinforcement top view



ill. 5.7: Maps of the ratio of the beams

Appendix 6 - Load Determination

A brief explaination, summarizing how the loads applied on the building is determinated. Some of the final loads are, due to the complexity of the building shape, determined through parametric design. Therefor not concluding a final load value.

Load Calculations -Snow

The load of the snow is defined as followed: (DS/EN 1991-1-3):

$S=u_iC_eC_ts_k$

C_e*=exposure coefficient= 1,0*

The area would be categorized as wind swept, 0,8, but the national annex states that it should not be lower than 1,0

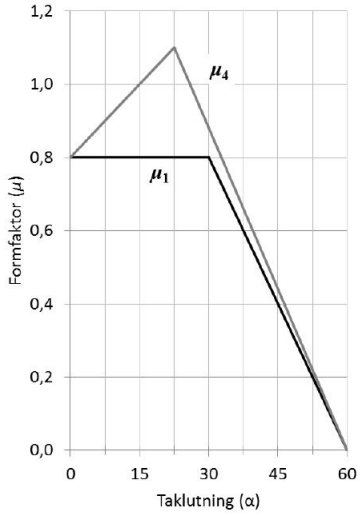
C_t*=Thermal coefficient=1,0 as all surfaces have a thermal transmittance below 1W/m*^{2}*K (DS/EN 1991-1-3),*

S_K*=Characteristic snow load=2.0kN/m*^{2} *(BFS 2015:6 EKS 10,2015)*

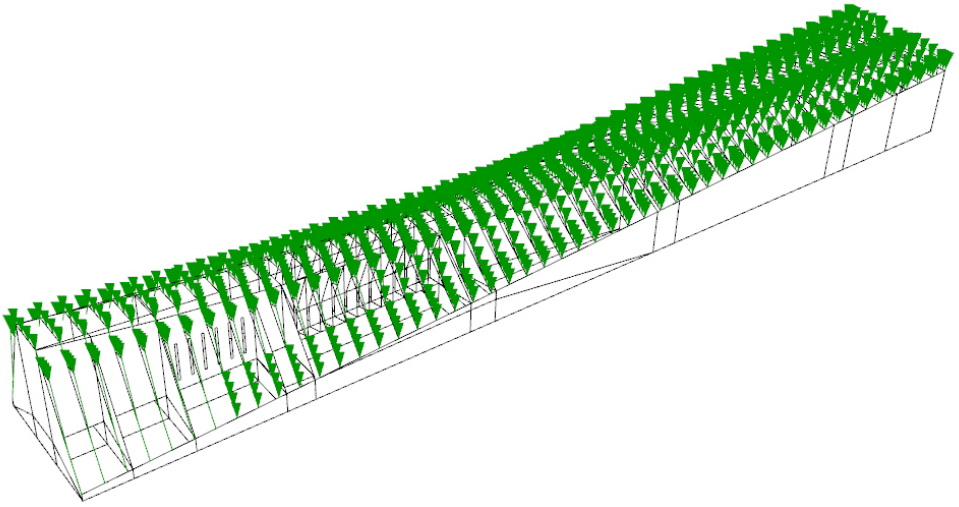
u_i*=Snow load shape coefficient*

Given by the national annex. (BFS 2015:6 EKS 10,2015)

Figure C-3a Form factors for gable roofs.



As the roof is constantly changing angle Grasshopper defines the shape coefficient.



ill 5.8 Snowload applied to the building

Load Determination -Wind

Wind Load - Calculation

The peak velocity is defined as follows, as the building is placed on a slope.(BFS 2015:6 EKS 10):

$q_{(z)}=(1+6*I_v(z))*(Kr*ln(z/z_0)*c_0(z))^2*q_b$

Basic velocity pressure: $q_b=1/2*p*v_b^2$

density of the air : $p=1{,}25 kg/m^3$

Basic wind velocity: $v_b=c_{dir}*c_{season}*v_{b,,0}$

Fundamental wind velocity, from the National annex (BFS 2015:6 EKS 10):

$v_{b,0}=24m/s$

Directional factor. Recommendation of 1.0 from the National annex (BFS 2015:6 EKS 10):

$c_{dir}=1.0$

Seasonal factor. As the building is permanent the maximum value from the National annex of 1.0 is used (BFS 2015:6 EKS 10):

$c_{season}=1.0$

$v_b=1.0*1.0*24m/s=24m/s$

The basic velocity pressure can be calculated

$q_b=1/2*p*v_b^2=15kN/m^2$

Terrain factor: $k_r=0{,}19*(z_0/z_{0,II})^{0,07}$

z=Height of the building=24m

z_0*=the rougness length=0,01m (due to terrain category I, table 4,1 (EN 1991-1-4:2005))*

$z_{0,II}$*=the rougness length of terrain category II=0,05m*

$k_r=0{,}19*(z_0/z_{0,II})^{0,07}=0{,}19*(0{,}01m/0{,}05m)^{0,07}=0{,}17$

$I_{(z)}$, *the turbulenze intensity, is defined in the National annex as:*

$I_{(z)}=1/(c_0(z)*\ln(z/z_0))$

c_0, *topography factor, is defined as:*

$c_0=1+2+s+\Phi$

Φ=*The upwind slope*=H/L_u

H=Effective height of the terrain=5m

L_u=*actual length of the slope=43m*

$\Phi=H/L_u=5/43=\underline{0,11}$

s, the orographic location factor, is defined from Table A.2: The slope is classified as shallow:

$\underline{s=0,65}$

The topography factor can then be determined:

$c_0=1+2*s*\Phi=1+2*0,65*0,11=\underline{1,14}$

Calculating the turbulence factor:

$I_{(z)}=1/(c_0(z)*\ln(z/z_0))=1/(1,14*\ln(24m/0,01m))=0,11$

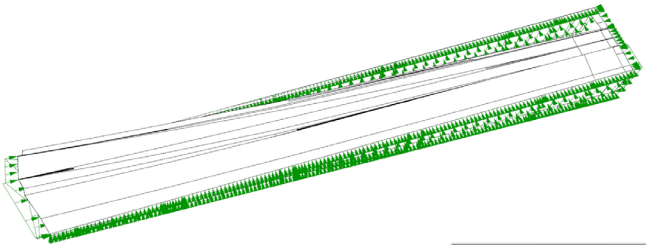
The peak velocity is determined:

$q_{(z)}=(1+6*I_v(z))*(Kr*\ln(z/z_0)*c_0(z))^2*q_b=(1+6*0,11)*(0,17*\ln(24/0,01)*1,14)^2*15kN/m^2$

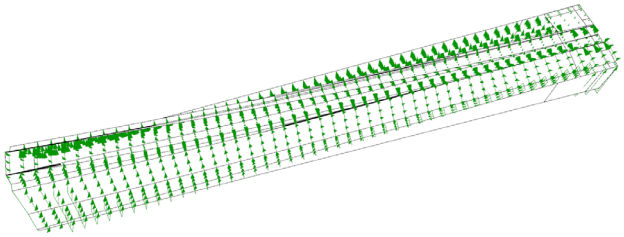
$q_{(z)}=1.2kN/m^2$

The loads are applied according to the Eurocode 1.4 EN 1991-1-3:2003, for a monopitched roof. Depitched in ill 5.10.

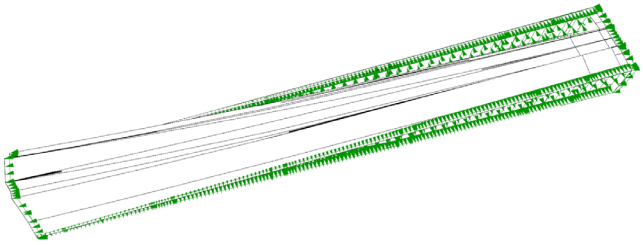
An illustration of the loads applied is seen in ill. 5.9 for the wind perpendicular to the buildng and for the wind along the building. For simplicity the loads on the walls are separated from the roof. But applied as a single case in the simulation.



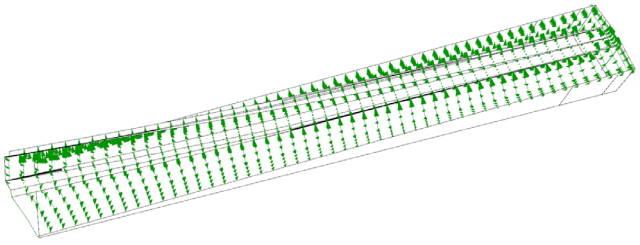
Wind Perpendicular to the building:Walls



Wind Perpendicular to the building: Roof

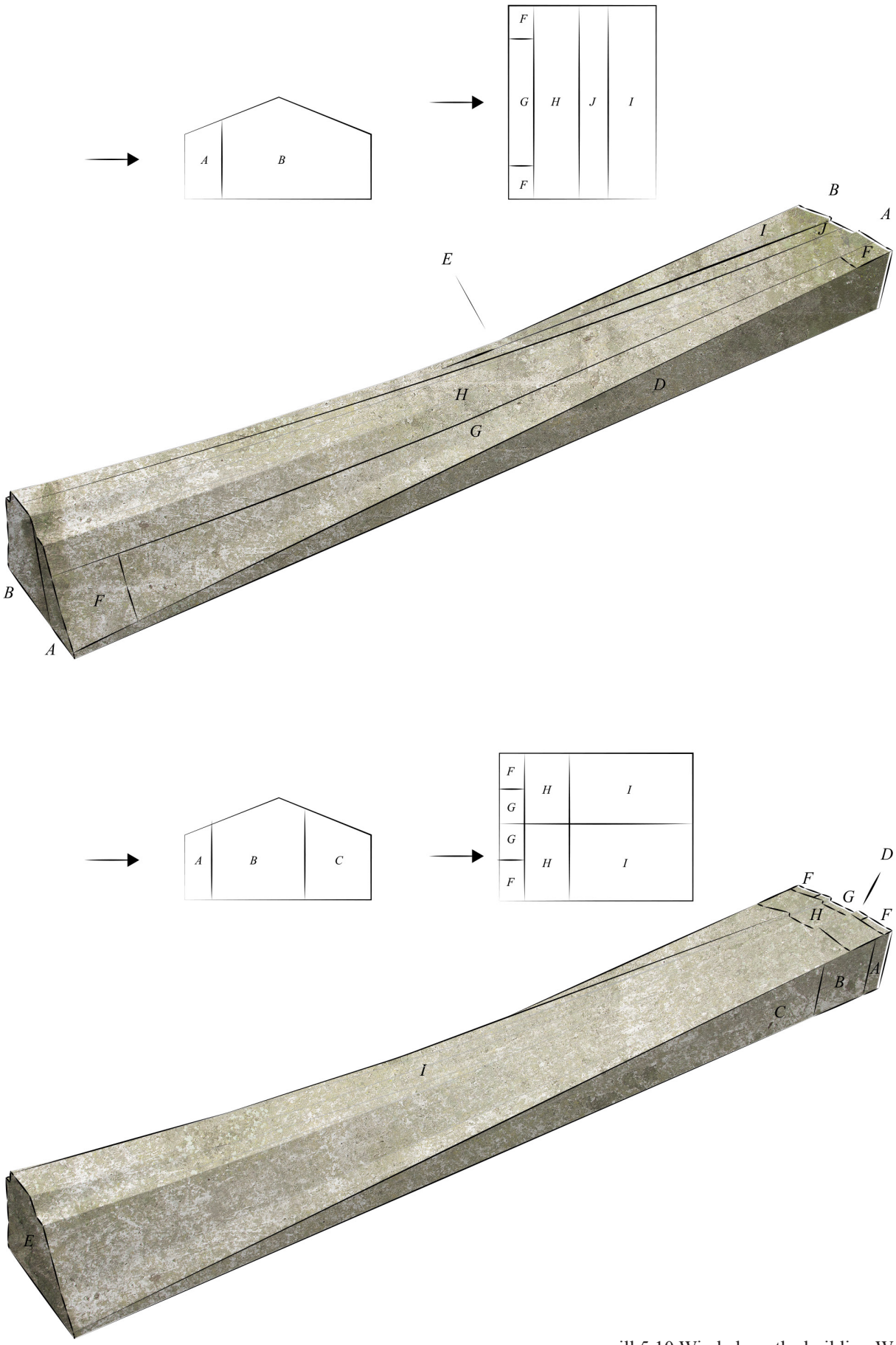


Wind along the building:Walls



Wind along the building: Roof

ill 5.9 Wind Perpendicular to the building:Walls



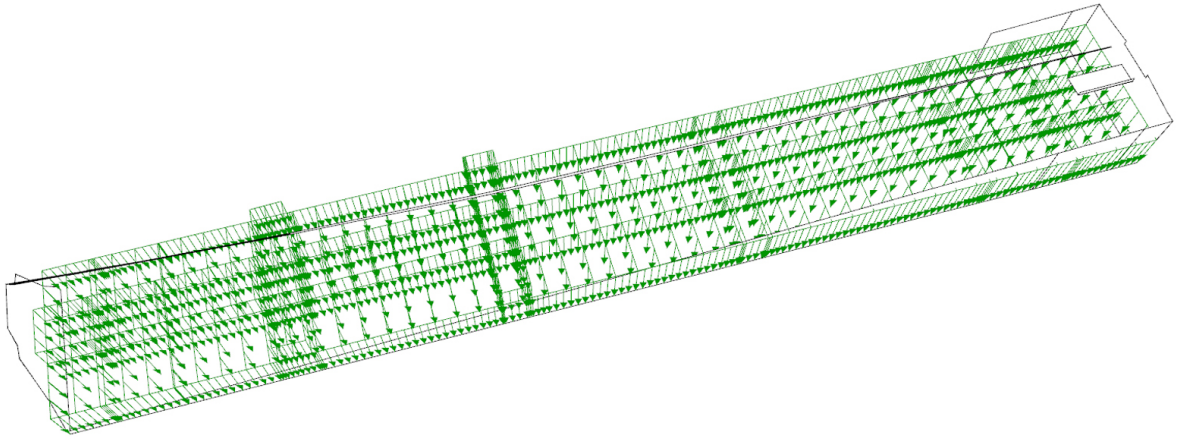
ill 5.10 Wind along the building:Walls

Load Determination - Live Load

Liveload is calculated using the Eurocode 1 part 1.1

The building type are judged to be of Category C, specifically example C3 as it states:

"...Areas without obstacles for moving people, e.g areas in museums, exhibition rooms etc...". (DS/EN 1991-1-1:2007, page 21) Consulting Table 6.2 in the Eurocode it states the live load would be 3,0 to 5,0 kN/m^2, with the museum placed in a lower populated area, and therefor lesser live load. The liveload is judged to be 3.0 kN/m^2



ill 5.11 Wind along the building: Roof

Load Determination - Dead Load

All loads are defined using EN 1991-1-1:2002.

The deadload consist mainly of the constrution weight. The weight of the concrete is 14 kN/m^3

The weigt of the construction wood is: 4,2 kN/m^3

The selfload of the construction is applied using grasshopper for a more precise calculation the cladding of the roof are therefore added.

The construction consist of:

*22mm plywood: 0,022m*4,5kN/m^3=0,099kN/m^2*

Wooden lammelas: average size depth of the plywood subtraction gaps, becomes 40mm.

*0,04m*7kN/m^3=0,28kN/m^2*

*22mm plywood: 0,022m*4,5kN/m^3=0,099kN/m^2*

*400mm wood every second meter:0,4m*0.1m/2* 4,2 kN/m^3 =0,34kN/m^2*

*1mm Copper roofing: 0.001m*88kN/m^3 = 0,088*

Adding to a total load of the cladding of: 0,9 kN/m^2

Load combinations

The load combinations are created in accordance with the Eurocode standards and are performed for in total 9 different scenarios due to the calculations being performed with a wind direction from to sides. Resulting in the following load combinations:

Dominating dead load - ULS

Dominating live load – wind 0 degrees - ULS

Dominating wind load– wind 0 degrees - ULS

Dominating Snow – ULS

Dominating live load – wind 90 degrees - ULS

Dominating wind load– wind 90 degrees - ULS

Dominating Snow – wind 90 degrees – ULS

Dominating live load – wind 0 degrees - SLS

Dominating wind load– wind 0 degrees - SLS

Dominating Snow – SLS

Dominating live load – wind 90 degrees - SLS

Dominating wind load– wind 90 degrees - SLS

Dominating Snow – wind 90 degrees – SLS

Each loadcase defined as followed (Jensen, 2011):

ULS

Dominating live load: 1,0 K_{fi}+1,5 K_{fi}+1,5*0,3 K_{fi}+1,5*0,3 K_{fi}*

Dominating Snow load: 1,0 K_{fi}+1,5 ψ_1* K_{fi}+1,5*K_{fi}+1,5*0,3 K_{fi}*

*Dominating Wind load: 1,0 K_{fi}+1,5 *ψ_1* K_{fi}+0+1,5K_{fi}*

Dominating Dead load: 1,2 K_{fi}+0+0+0

The SLS state is calculated with characteristic values:

SLS

Dominating live load: K_{fi}+K_{fi}+0,3 K_{fi}+0,3 K_{fi}

Dominating Snow load: K_{fi}+ ψ_1 K_{fi}+K_{fi}+0,3 K_{fi}*

*Dominating Wind load: K_{fi}+ψ_1 *K_{fi}+0+K_{fi}*

The consequence class of the building is CC2 as the consequences of failure is deemed medium, and falls within the definition of a public building. Therefor K_{fi}=1.0

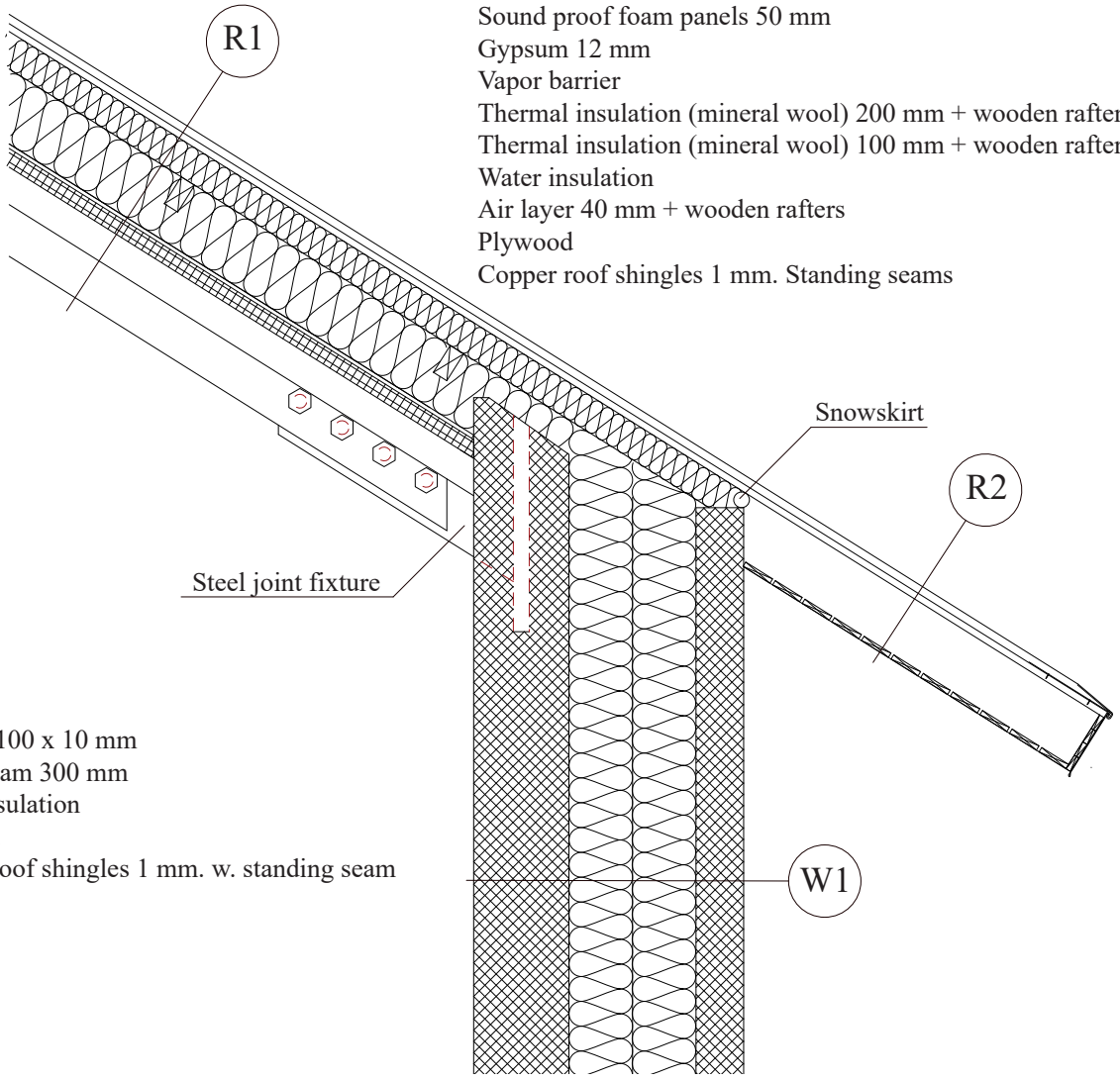
The ψ_1 factor for liveloads are defined under category C and therefor 0,6

Appendix 7 - Roof detail

Technical Detail Wall & Roof 1:20

R1

Construction wood beam 400 mm
Sound insulating panel wood slats 10 x 10 mm
Fabric in insulation
Sound proof foam panels 50 mm
Gypsum 12 mm
Vapor barrier
Thermal insulation (mineral wool) 200 mm + wooden rafters
Thermal insulation (mineral wool) 100 mm + wooden rafters
Water insulation
Air layer 40 mm + wooden rafters
Plywood
Copper roof shingles 1 mm. Standing seams



R2

Lathing 100 x 10 mm
Wood beam 300 mm
Water insulation
Plywood
Copper roof shingles 1 mm. w. standing seam

W1

Concrete insito 300 mm
Vapor barrier
Thermal insulation (mineral wool) 200 mm + wo
Thermal insulation (mineral wool) 200 mm + wo
Water insulation
Air layer 40 mm + wooden rafters
Concrete insito 100 mm

ill 5.12 wall and roof detail

Appendix 8 - Acoustic analysis

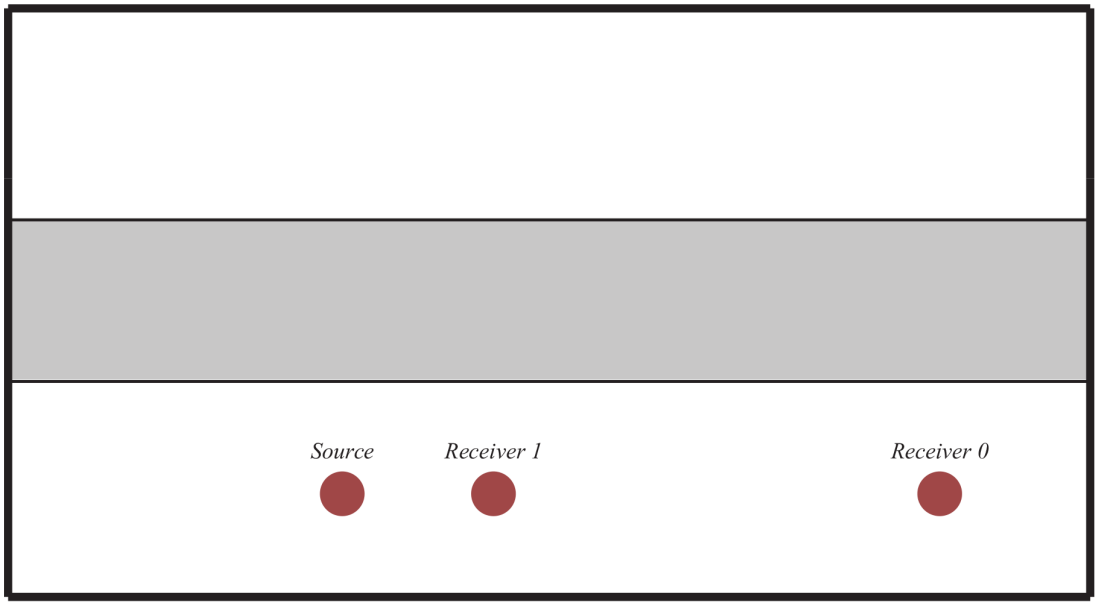
Acoustical test of initial form studies

T30[S] Receiver 0	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Square	2.58	2.56	2.74	2.73	2.76	2.8	2.55	2.37
Circle	2.87	2.88	3.11	3.1	3.1	3.1	2.66	2.4
Triangle	2.6	2.61	2.62	2.61	2.6	2.55	2.26	2.17

T30[S] Receiver 1	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Square	1.71	1.71	1.9	1.88	1.9	2.06	2.46	2.43
Circle	2.16	2.15	2.22	2.2	2.19	2.22	2.07	1.99
Triangle	1.99	2.02	2.28	2.3	2.3	2.51	2.48	2.34

D50[%] Receiver 0	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Square	40.83	40.85	45.43	45.54	45.71	50.34	62.1	66.74
Circle	49.15	49.18	55.65	55.76	55.96	62.12	74.99	78.33
Triangle	43.56	43.63	49.38	49.37	49.67	55.1	68.22	72.15

D50[%]Receiver 1	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Square	12.59	12.61	14.84	14.89	14.98	17.45	25.42	29.2
Circle	16.81	16.91	20.43	20.42	20.57	24.51	36.21	40.36
Triangle	11.81	11.77	14.37	14.5	14.6	17.54	27.28	31.09



Plan: Circel, Triangal and Square

ill 5.13 Acoustic initial form test

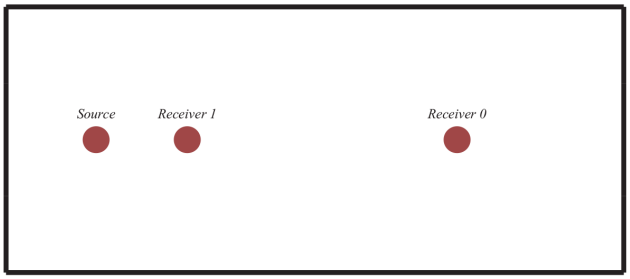
Acoustical test of Primordial Chaos

T30[S] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Concrete Floor	1.72	1.45	1.49	1.59	1.52	1.42
Wooden Floor	1.67	1.58	1.47	1.52	1.48	1.32

T30[S] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Concrete Floor	1.71	1.48	1.54	1.69	1.58	1.48
Wooden Floor	1.64	1.55	1.35	1.54	1.5	1.34

D50[%] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Concrete Floor	65.65	76.63	78.03	72.48	74.2	76.26
Wooden Floor	68.73	76.93	80.18	73.31	73.93	76.14

D50[%] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Concrete Floor	43	53.87	55.85	50.85	52.02	54.48
Wooden Floor	47.17	55.27	57.64	51.15	52.9	54.89



Plan

ill 5.14 Acoustic test Primordial Chaos

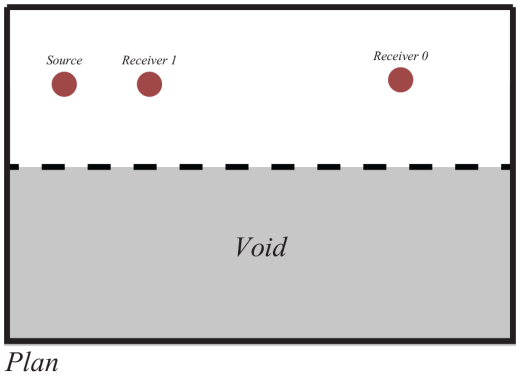
Acoustical test of The 10 Largest

T30[S] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
No Transparency	1.2	1	0.83	0.72	0.73	0.66
With Transparency	1.32	1.02	0.8	0.78	0.8	0.69

T30[S] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
No Transparency	1.29	1.17	0.9	0.85	0.86	0.7
With Transparency	1.25	1.29	0.85	0.88	0.91	0.75

D50[%] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
No Transparency	67.1	78.04	86.81	83.62	83.29	84.59
With Transparency	67.49	78.29	86.78	84.74	84.48	85.03

D50[%] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
No Transparency	45.21	56.33	65.82	67.04	64.91	69.33
With Transparency	45.91	56.3	67.78	65.36	67.45	68.86



Plan

ill 5.15 Acoustic test The 10 Largest

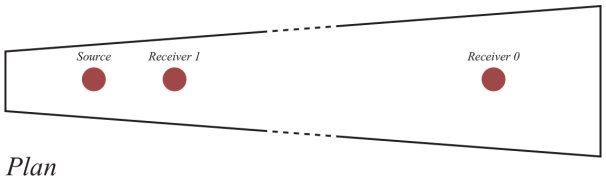
Acoustical test of Corridor

T30[S] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Smooth Concrete	1.73	0.94	0.91	1.06	0.96	0.86
Rough Concrete	1.44	0.84	0.95	0.86	0.83	0.73

T30[S] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Smooth Concrete	1.93	1.26	0.95	1.42	1.26	1.13
Rough Concrete	1.8	1.14	1.05	1.26	1.23	1

D50[%] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Smooth Concrete	71.6	88.22	91.98	84.4	84.3	84.89
Rough Concrete	75.7	88.5	92.21	85.55	85.98	86.59

D50[%] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Smooth Concrete	36	67.34	73.53	58.36	58.15	59.31
Rough Concrete	41.15	64.76	74.19	60.17	59.62	61.67



Plan

ill 5.16 Acoustic test Corridor

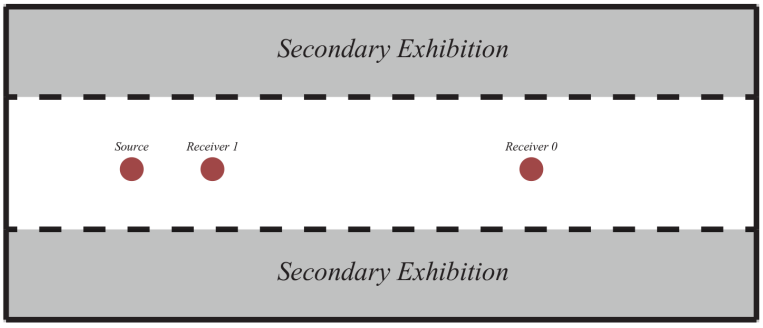
Acoustical test of Centered Exhibition

T30[S] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Clear Sky Light	1.73	1.48	1.33	1.29	1.13	1.13
With Light Diffuser	1.38	1.17	0.94	0.97	0.88	0.85

T30[S] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Clear Sky Light	1.68	1.46	1.42	1.27	1.26	1.13
With Light Diffuser	1.46	1.26	1.03	1.03	0.95	0.88

D50[%] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Clear Sky Light	62.06	67.73	72.04	71.46	74.56	76.34
With Light Diffuser	69.19	72.81	75	75.05	78.17	78.4

D50[%] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Clear Sky Light	35.5	42.59	47.24	45.7	49.15	51.73
With Light Diffuser	46.55	50.81	54.17	54.69	56.23	57.78



Plan

ill 5.17 Acoustic test centered exhibition

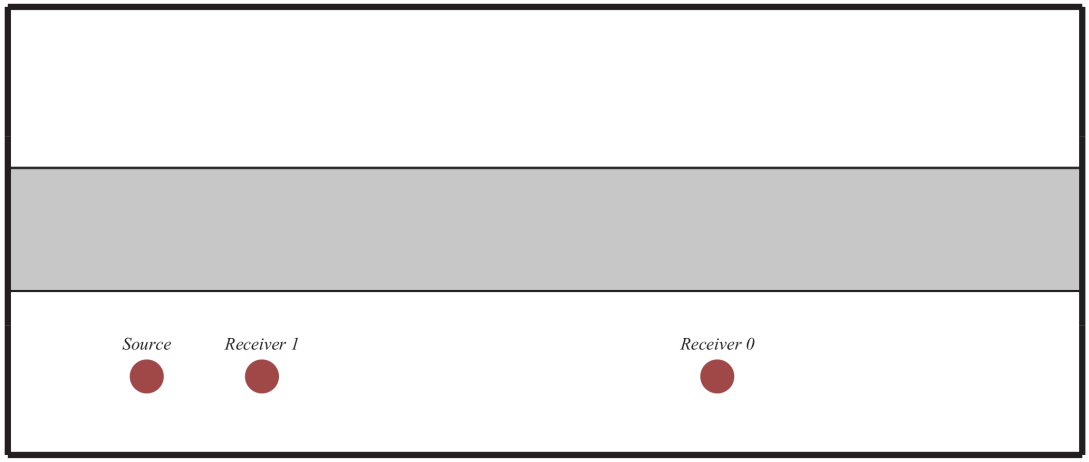
Acoustical test of Secondary Exhibition

T30[S] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Increased Number of Beamns	1.49	1.22	0.92	0.93	0.85	0.82
Decreased Number of Beams	1.49	1.06	0.92	0.9	0.89	0.82

T30[S] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Increased Number of Beamns	1.58	1.36	1.07	1.1	1.01	0.97
Decreased Number of Beams	1.51	1.21	0.94	0.95	0.97	0.86

D50[%] Receiver 0	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Increased Number of Beamns	79.97	86.56	90.96	90.29	90.74	91.22
Decreased Number of Beams	76.15	81.82	84.26	83.74	84.68	85.51

D50[%] Receiver 1	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Increased Number of Beamns	35.86	48.56	55.95	56.32	61.4	59.75
Decreased Number of Beams	61.68	69.84	73.75	72.45	74.64	77.37

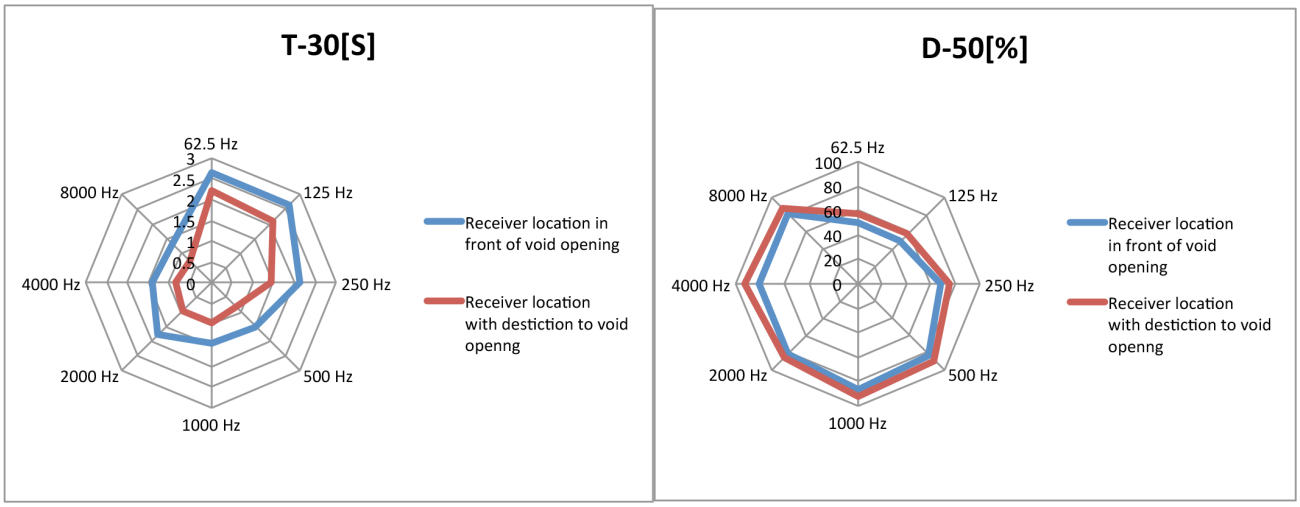


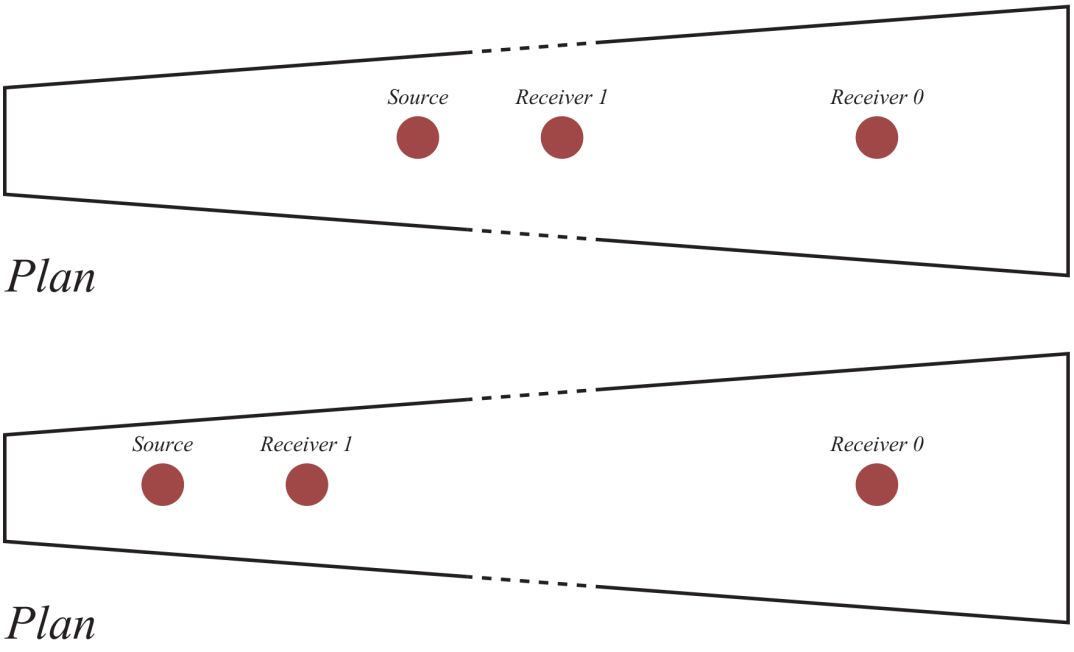
Plan

ill 5.18 Acoustic test secondary exhibition

T30[S]	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Receiver location in front of void opening	2.65	2.65	2.13	1.52	1.45	1.78	1.4	1.31
Receiver location with distinction to void openng	2.2	2.1	1.44	0.84	0.96	0.96	0.83	0.73

D50[%]	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Receiver location in front of void opening	49.84	49.49	68.05	82.18	86.57	80.26	80.35	81.51
Receiver location with distinction to void openng	57.64	57.62	75.17	88.5	92.21	85.5	92.21	86.59

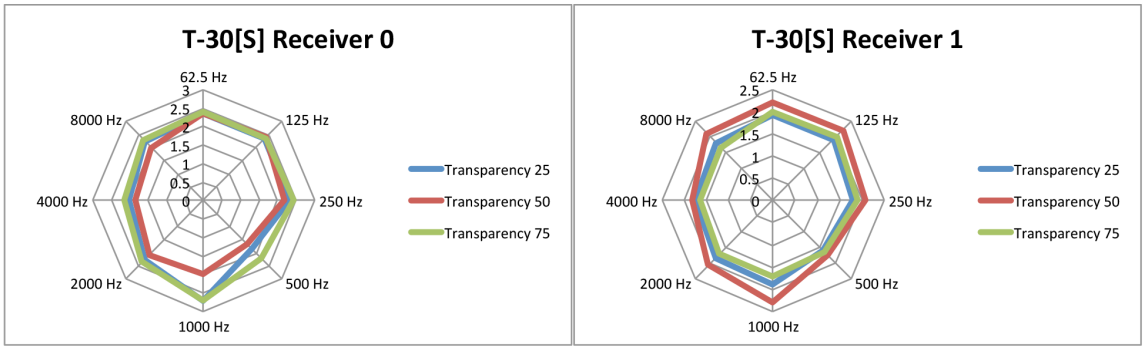




ill 5.19 Acoustic test corridor two receiver locations

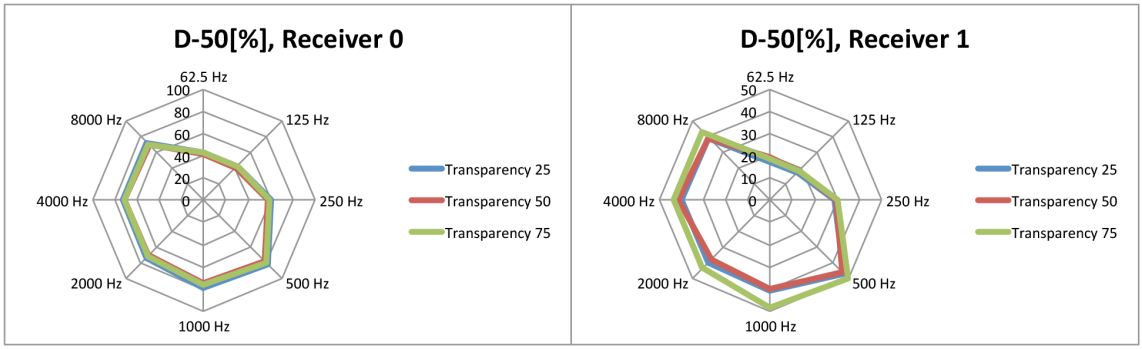
T30[S] Receiver 0	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Transparency 25	2.37	2.35	2.33	1.84	2.72	2.26	2.03	2.25
Transparency 50	2.37	2.41	2.18	1.65	1.99	2.08	1.85	2.02
Transparency 75	2.39	2.38	2.43	2.21	2.7	2.35	2.13	2.32

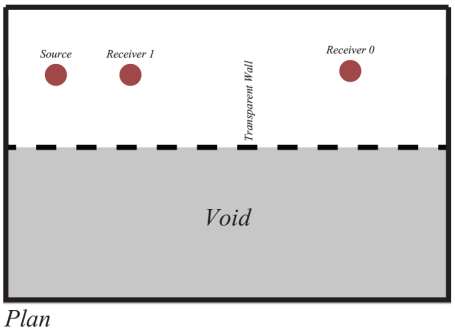
T30[S] Receiver 1	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Transparency 25	1.92	1.94	1.81	1.59	1.89	1.83	1.76	1.81
Transparency 50	2.22	2.24	2.08	1.76	2.3	2.05	1.83	2.1
Transparency 50	1.99	2.03	1.9	1.62	1.71	1.71	1.65	1.67



D50[%] Receiver 0	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Transparency 25	42.87	43.19	60.65	80.65	79.12	73.46	72.9	73.18
Transparency 50	41.35	41.6	57.76	77.83	75.18	70.16	71.19	69.88
Transparency 75	43.05	42.83	59.68	78.65	76.7	71.86	71.87	71.58

D50[%] Receiver 1	62.5 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Transparency 25	17.47	17.6	28.51	46.75	40.74	39.62	40.29	39.89
Transparency 50	19.02	18.81	29.4	46.21	39.94	37.95	41.46	39.5
Transparency 75	18.67	18.6	30.12	49.39	48.4	43.13	43.74	43.35

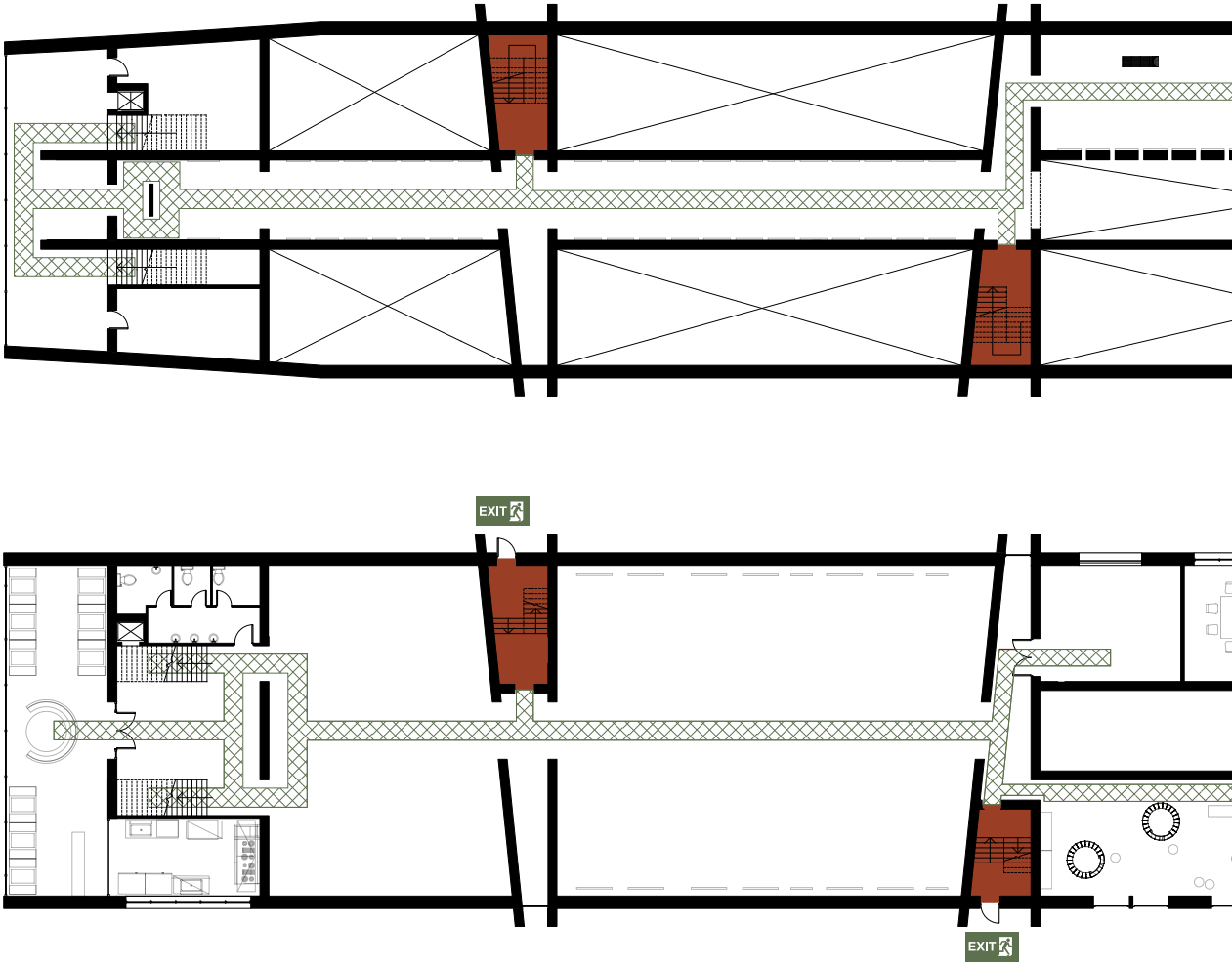


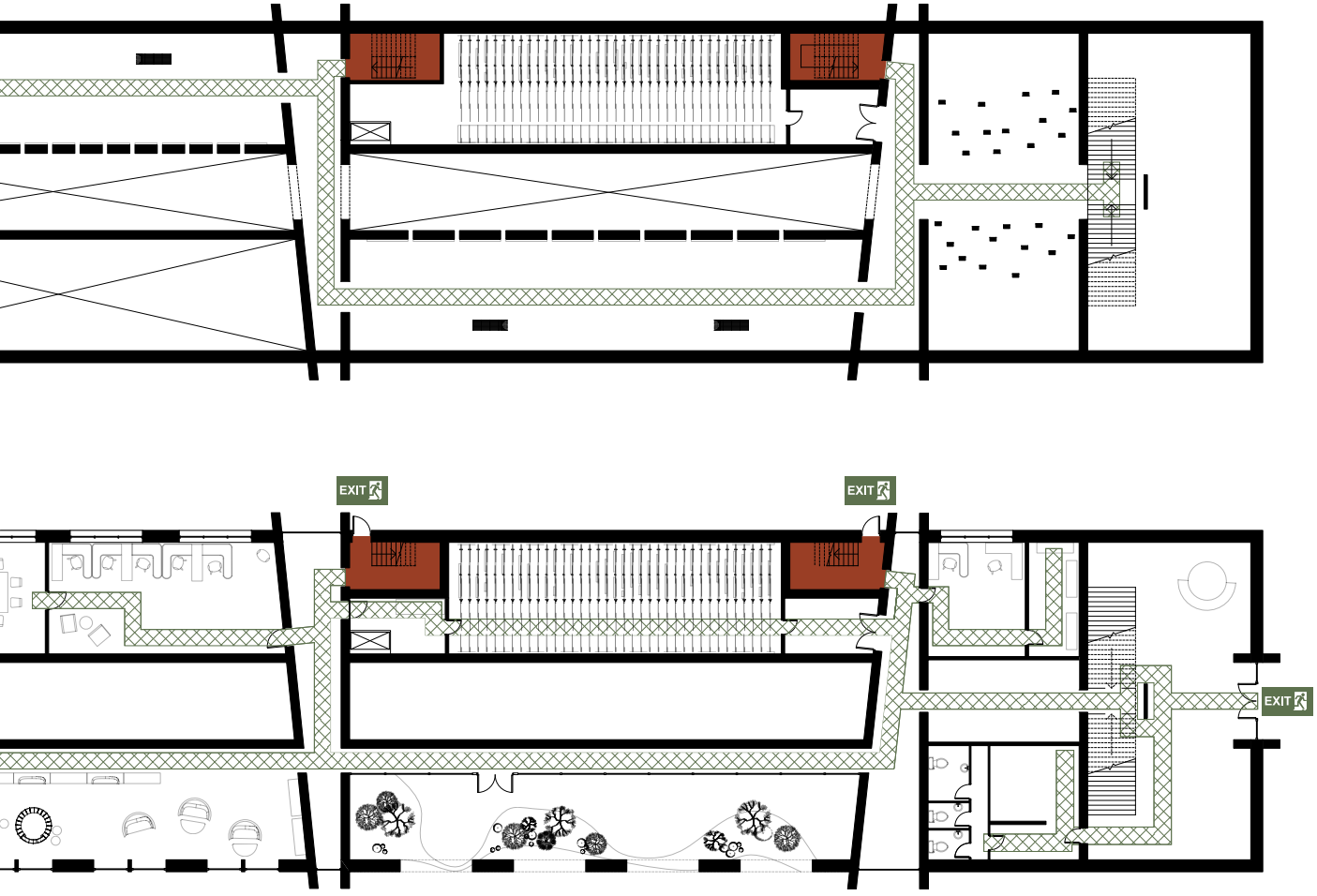


Plan

ill 5.20 Acoustic test transparancy

Appendix 9 - Fire Plan





Escape Routes

Fire Section

Fire Exits

ill 5.21 Fire Plan