A VISITOR CENTER AT STEVNS KLINT

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Ill 2, A misty day at Stevns Klint

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APPENDIX A
APPENDIX B
APPENDIX C

CD

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PREFACE

This report is the final outcome of a master thesis in architecture developed at Architecture & Design, Aalborg University. The project takes its point of departure in designing a visitor center at Stevns Klint focusing upon tectonic through an integrated design process. The project period spanned from 02.02.2015 to 27.05.2015.

ABSTRACT

This thesis project deals with the design of a visitor center at the Unesco World Heritage site Stevns Klint. More specifically in the periphery of the small village, Højerup, adjacent to the cliff and the sea.

The final design is highly contextual - placed, scaled and shaped to relate to the natural surroundings and the adjacent historical buildings in a humble and respectful way. The simplicity of the visitor centers exterior expression strengthens its surroundings by contrasting it. A simple roof hovers above the landscape, creating a sheltered space, that blurs the line between interior and exterior. Underneath the roof, forms the concept of an geological excavation, the basis for a large subterranean part of the visitor center. The architecture creates spatial and embodied experiences through a tectonic composition, that uses structure, construction, materials, light, acoustics and spatiality to emphasize the awareness and experience of the magnificent nature and history of Stevns Klint. Creating a place where visitors, geologist and students can learn and immerse on the topic of Stevns Klint.

TABLE OF CONTENTS

	Methodology	8
	Introduction	10
1.0	ANALYSIS	
	Stevns klint as world heritage	14
	A tectonic approach	16
	Atmospheres in architecture	18
	A modern visitor center	20
	Stevns klint	26
	Højerup	28
	Sensing the place	32
	Understanding the site	40
	Climate	42
2.0	PROGRAM	
	Functions and relations	46
	Rooms and sizes	48
3.0	PRESENTATION	
	Vision	52
	Concept	54
	Site and context	58
	Approaching the roof	62
	Above ground	64
	Below ground	66
	Foyer	70
	Exhibition	74
	Education and research	78
	Restaurant	82
	Under the roof	84
	Exterior	86
	Materials	90
	Structural principle	92
	Detailing	94
4.0	DESIGN DEVELOPMENT	
	Foam workshop	98
	Internal spaces	100
	Approaching the exterior	102
	Roof studies	104
	Structural development	106
	Parametrical development	108
	Light studies	110
5.0	EPILOGUE	
	Conclusion	114
	Reflection	115
6.0	REFERENCES	
	Literature & websites	118

METHODOLOGY

THE INTEGRATED DESIGN PROCESS

The design method by Mary-Ann Knudstrup "*The integrated design process in problem based learning"* is used as a approach to investigate holistic tectonic solutions for a new visitor center at Stevns Klint. It is a critical, analytic, theoretical and iterative approach, that has the ability to achieve interdisciplinary holistic solutions by constantly optimizing the project in relation to technical, functional and aesthetical qualities. The integrated design process consist of five phases, in which it is iterative between; problem, analysis, sketching, synthesis and presentation (Knudstrup, 2004).

The problem phase is based on a hermeneutic approach towards documents, programs, papers and articles, to form a position within the field of architecture in the theme of tectonics and visitor centers.

The analysis phase investigates the site conditions, historical context, users and relevant case studies in order to set a framework for the project. Studies of site conditions, climate, programs and users are based on empiric observations, phenomenological reflections, as well as making document analysis with a hermeneutic approach. Additionally the atmosphere of the site is investigated through a site visit having a phenomenological approach, while the case studies are based on hermeneutic document analysis. Resulting in an initial design concept, initiating the sketch phase.

The sketch phase contains many iterative loops, constantly optimizing the project in relation to technical, aesthetical and functional aspects. These loops of design proposals are investigated in all scales through analogue, physical and digital sketches and models and compared and validated in relation to the analysis phase made earlier. The approach is an empiric and analytic method based on digital tools as well as using a subjective phenomenological approach to make informed design decisions aiming for the equilibrium between aesthetical, technical and functional considerations. The subjective and intuitive phenomenological approach is of great importance, when emphasizing that the creating of sensible experiences and atmospheres are the main driver of the project. This phase should end up with a more complete and coherent concept for the design.

The synthesis phase continues the critical iterative loops until an integrated design emerges. A coherent and multifaceted architectural solution evokes, where subjective emotions and scientific models are considered and balanced into a poetic unification.

The presentation phase will focus on making the final presentation material, making sure that the final design is communicated clearly.

Ill 10, The cliff theatrically shows the forces of nature.

INTRODUCTION

A UNIQUE PART OF DANISH NATURE

“Nature has become an event … it is analyzed and described as never before … most of it looks as it did for 50 years ago, but the viewing angle has changed. At that time nature was taken for granted. Now it is an event that is advertised as Tivoli and amusement parks.” (Petersen, 2014)

Danish nature has become an important part of the public and political agenda. Due to increased mobility rural areas with a proximity to nature has a particular potential to attract dwellers and tourist - as an initiative to stimulate growth (Primdahl, 2012).

Tourist today, has a larger desire to experience rare natural sites, in their longing for authentic and meaningful experiences, that they will remember (Martinsen, 2012). The challenge is to communicate the qualities of these natural sites, to make the experience of the site more impressive, to fully utilize their potential as tourist destinations:

“The challenge is to make the experience of the real, unspoiled nature accessible without over-communicating and intellectualizing an experience that perhaps is primarily bodily … The truly sublime experience of a visit is achieved where the experience is physically as well as narrative available, while supporting the qualities that are on site and interact with the experience of the place as a whole.” (Martinsen, 2012)

Architecture has the potential to accentuate the atmospheres and uniqueness of a natural landscape, as well as the landscape can orchestra the architecture, having potential to attract for visitors.

“The landscape sells architecture, and the architecture adds value to the landscape” (Braae, 2012)

This thesis takes its offset in a preliminary program made specifically for the development of a visitor center in Højerup. The proposal for a visitor center at Stevns Klint is a unique opportunity to reinterpret the historic and natural context and as a place that can communicate the significant story of Stevns Klint, as a unique part of Danish nature and world history. This project initially raises the question:

“How can architecture support and highlight the unique nature at Stevns Klint”

ANALYSIS

1.0

1.0 STEVNS KLINT AS WORLD HERITAGE

THE UNIQUENESS OF STEVNS KLINT

In June 2014, Stevns Klint got appointed on UNESCO's World Heritage list, for its unique nature. Stevns Klint is famous throughout the world, however an almost unknown pearl in Denmark, and often misleading compared with Møns Klint (Kalklandet, 2015).

Stevns Klint is an attraction that tell millions years of world history only one hour drive from Copenhagen. The inclusion of Stevns Klint as being world heritage, has put more focus on this overlooked attraction resulting in more visitors at Stevns Klint (Leth, 2014). Therefore Stevns Municipality and the Easter Zealand museum has started a series of plans for the development of a new visitor in the small village Højerup, being the main place of communication along Stevns Klint. It is a strategy to meet the increasing amount of visitors that requires a more qualified dissemination of knowledge about the cliff, as well as trying to stimulate visitors to visit other attractions along Stevns Klint (Stevns kommune, 2014).

The characteristic profile of the cliff is formed by the oceans erosion, by eroding the bottom layers of chalk, while keeping a large overhang of the harder limestone. What make Stevns Klint unique is that it clearly reveals a black layer of clay in the centre of the cliff along its 15 km long stretch (Rothenborg, 2014). This dark layer called fish clay, contains traces of iridium, creating basis for the theory of a meteor hitting the earth 65 million years ago. This meteor caused a global disaster responsible for the extinction of over 50 percent of the worlds animal and fauna, among them, the dinosaurs. (Unesco, 2014). Stevns Klint is documented to be the best place in the world to explore and study this period in the history of the Earth due to its clearly visible geological layers, that has resulted in a lot of scientific work on the cliff (Kalklandet, 2015).

Ill. 15a, Geological layers

Ill. 15b, Fishclay

1.1 A TECTONIC APPROACH

POETICS OF CONSTRUCTION

This projects position within the tectonic framework is based on works of Kenneth Frampton, Marco Frascari, Eduard D. Sekler and Anne Beim.

The term "Tectonic" can be derived from the word tekton, which is the Greek word for carpenter or builder. Later is it described as the art of construction which is linked to another Greek word techné, meaning the art of creating (Frampton, 1995).

Today the concept of tectonic is much more complex, and can be interpreted in more than one way. It is not considered an actual action or a certain style in contemporary architecture, but more as a method to express the construction in relation to the spatial idea in order to generate atmospheres and experiences, what Kenneth Frampton calls the poetics of the construction. According to Frampton there is an interest in being true to the material in the expression of the construction, to honor the potentials and limitations of these materials. Frampton sets a focus on how different components, elements, building parts and materials should be thoughtfully put together, to reach a clear and logic structural concept, that brings an immediate understanding of the building as a whole (Frampton, 1995).

Marco Frascari furthermore emphasizes tectonic as a phenomenological concept, where the details in the architecture should create a thread that "tells the tale", by appealing to human senses (Frascari, 1984).

"In architecture, feeling a handrail, walking up steps or between walls, turning a corner, and noting the sitting of a beam in a wall, are coordinated elements of visual and tactile sensation." (Frascari, 1984, p.28).

The art of detailing is to put together spaces and materials in an aesthetic, structural and functional manner through formal and actual joints, what Frascari calls the critical field between the actual construction and the mental construing, that can furnish space so it allows various interpretations and an ongoing exploration. This also relates to understanding the potentials of the materials and the construction methods used, to make a poetic unification of structural, functional and aesthetical qualities (Frascari, 1984)

"Details can be "material joints" ... or they can be "formal joints", as in the case of a porch, which is the connection between an interior and exterior space. Details are then a direct result of the multifold reality of functions in architecture. They are the mediate or immediate expression of the structure and the use of buildings." (Frascari, 1984, p.23)

According to Eduard D. Sekler can tectonic be understood as a expressive phenomenological quality of the arrangement and construction of a structure. It is the details and the connection of elements and materials that are essential for the human perception of a building (Sekler, 1964).

"When a structural concept has found its implementation through construction, the visual result will affect us through certain expressive qualities which clearly have something to do with the play of forces and corresponding arrangement of parts in the building, yet cannot be described in terms of construction and structure alone. For these qualities, which are expressive of a relation to form to force, the term tectonic should be reserved" (Sekler, 1964, p.89).

Even though tectonic is a crucial part of understanding a piece of architecture, it cannot be understood as the only defining concept of a building:

"To speak of architecture in terms of tectonics alone would be as one-sided as to speak of it in terms of space alone." (Sekler, 1964, p.95)

According to Anne Beim tectonics deals with the relationship between concept, the form, the building technology and the constructive principles and that structure, function and aesthetics should form a symbiosis (Beim, 1999).

"Building technology and practices of construction becomes a matter of signification - tectonics - only when they are handled consciously" (Beim, 1999, p.57)

The tectonic potential thereby lies in the creation of the construction and in the materialization of the final building structure.

"Also materials may carry signification. Materials may be signified in accordance with their inherent nature, and various architects have been inspired by their different physical qualities, e.g. surfaces textures, structural strength, firmness or softness" (Beim, 1999, p.60)

By using a tectonic approach as a method it is possible to create and communicate spatial and atmospheric experiences and metaphors through the articulation of materials, structure and details. It is important to be conscious about the role of the materials in relation to their potentials and limitations in different structural systems. Therefore a tectonic approach will in this project be used to seek an poetic integration between aesthetical, functional and technical qualities.

Ill. 16a. Shelter for roman ruins, Peter Zumthor.

Ill. 16b. Tama Library, Toyo Ito.

Ill. 16c. Bagsværd Church, Jørn Utzon.

Ill. 16d. Therme Vals, Peter Zumthor.

Shelter for roman ruins, Peter Zumthur
The structure is clearly revealed during dark hours and used as an expressive quality.

Tama Library, Toyo Ito
The structure defines spaces in the space, while revealing how the forces are transfered.

Bagsværd Church, Jørn Utzon
The white ceiling becomes an architectural methaphor for the cloud while its shape functions as an acoustic strategy.

Therme Vals, Peter Zumthor
The space has through its construction created an atmospheric spaces with an emphasis on light, materials and tactility.

I.2 ATMOSPHERES IN ARCHITECTURE

AN PHENOMENOLOGICAL APPROACH

It is difficult to handle the term tectonics without entering the field of experienced atmospheres in architecture and phenomenology. Phenomenology is theory of how humans perceive the world, that makes up with the objectively approach of modern science. It is emerged from the philosophical world, where the front figure is Maurice Merleau-Ponty. He breaks with the idea that mind and body should be seen as separate elements, since he argues that the human body is our general medium for experiencing the world (Merleau-Ponty, 2002).

"Space is existential; (and) we might just as well say that existence is spatial" (Merleau-Ponty, 2002, p. 293)

Philosophical writings such as Merleau-Ponty's are something that has highly inspired the architectural theory about embodied experiences of spatial architecture, its materials and its context.

An example hereof are writings by the Nordic architect and theorist, Juhani Pallasmaa. Where Pallasma argues that architecture is a spatial discipline grounded in the tectonic language of a building and that the atmospheric quality is perceived through the entire body (Pallasmaa, 2005).

"We behold, touch, listen and measure the world with our entire bodily existence, and the experiential world becomes organized and articulated around the centre of the body." (Pallasmaa, 2005, p64)

Peter Zumthor support this notions, as well as seeing the phenomenological approach as a method to discover the nature of things, where materials not just awakens memories but also makes visitors wanting to interact with the space (Zumthor, 2006):

"Architecture is not abstract, but concrete … All design work starts from the premise of this physical, objective sensuousness of architecture, of its materials. To experience architecture in a concrete way means to touch, see, hear, and smell it." (Zumthor, 2010, p.66)

According to Zumthor the atmosphere of a space refers to the character of the immediate embodied multi-sensory experience. It is a poetic fusion of countless factors, that gives a multi-sensory atmospheric experience through memory, perception, judgment, emotions and physical presence. (Zumthor, 2006).

"I enter a building, see a room, and - in the fraction of a second - have this feeling about it" (Zumthor, 2006, p.13)

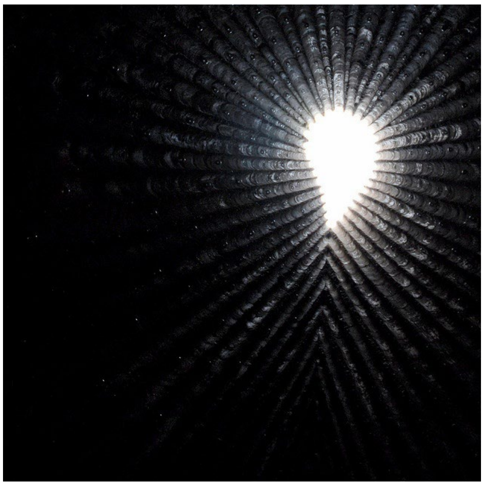
Zumthor argues that there are nine elements that are crucial to achieve strong atmospheric experiences. These nine elements concerns materiality, acoustics, temperature, organization of space, scale and proportions of space, tension between exterior and interior, movement, surrounding context and finally the use of light. Especially the focus on daylight and materials is inevitably, because play of light and shadows in spaces and how materials reflect light highly affect the experience of these spaces (Zumthor, 2006).

"The first of my favourite ideas is this: to plan the building as a pure mass of shadow then, afterwards to put in the light as if you were hollowing out the darkness, as if the light were a new mass seeping in. The second idea I like is this: to go about lighting materials and surfaces systematically and to look at the way they reflect the light. In other words, to chose the materials in the knowledge that they reflect and fit everything together on the basis of that knowledge." (Zumthor, 2006, p. 58)

Furthermore does Zumthor consider materials as a main importance when creating architectural atmospheres. Because materials can be treated, transformed and combined in multiple ways to create different atmospheres.

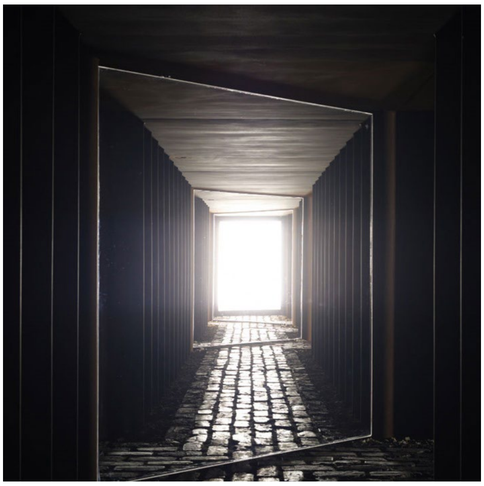
"Materials react with one another and have their radiance, so that the material composition gives rise to something unique. Material is endless. Take a stone: you can saw it, grind it, drill into it, split it, or polish it - it will become a different thing each time … There are a thousand different possibilities in one material alone." (Zumthor, 2006, p.25)

This project strives to create sensible atmospheric experiences by enabling all of the human perceptual senses and by considering Zumthor's nine elements with a special focus upon materials and light.



Ill. 19a. Feldkapelle Bruder Klaus, Peter Zumthor.

Ill. 19b. Teshima Art Museum, Ryue Nishizawa.



Ill. 19c. Inujima Art Museum, Hiroshi Sambuichi.

1.3 A MODERN VISITOR CENTER

1.3.1 INVESTIGATION OF MUSEUMS AND USERS

A new visitor center must accommodate different functions and first and foremost it must convey the different subjects through exhibition. To get an understanding of the needs of a future visitor center the similar building type "museum" is investigated to gain an understanding of contemporary exhibition demands but also how a design can be used to enhance the narrative of a certain theme.

"A museum is a public collection of objects testifying to human cultural development. It collects, documents, receives, researches, interprets and communicates these through display" (Neufert & Neufert, 2000, p.336)

The origins of museums was in the late eighteenth century, where museum not were any particularly distinct building type. It was first later they became places, that was more than a building for exhibitions, when they were considered as places with a statement of civic and national pride. In recent years there has been an acceleration in the number of new and expanded museums, due to an increase in the variety of subjects exhibited in museums today (Rosenblatt, 1998). Museums today are designed so they can handle large crowds of people, and to attract those crowds, the design are often made with a clear intention of making aware of themselves (Henderson, 1998).

"Nobody goes to a museum from nine to five, wearing a suit and watching the clock. They go for education, enlightenment, stories, culture, thrills. They want, and expect, to be intrigued by the architecture as well as the art and artifacts." (Henderson, 1998, p11)

The design of modern museums as well as visitor centers are a multifaceted task, when trying to create narrative environments with a large variety of exhibitions. The narrative approach seeks to create a strong link between architecture and exhibition, with potential to facilitate a powerful and embodied experience. (Hanks, Hale and MacLeod, 2012).

"Most museum theorist agree that today the museum has borrowed from the cinema and the theme park to become a spectacle that engages all the senses, whether staged to evoke an aesthetic experience, a historical context, or an interactive learning environment." (Marstine, 2006, p13)

Museums varies in size, purpose and organization, where especially the museums objects as well as the size of the works and extent of the collections are important to consider in relation to designing circulation patterns. The storyline of an exhibition space can be translated into different concepts, creating many possible directions and circulation patterns, as well as giving possibility to vary the exhibition from time to time (Adler, 1999).

Today museums often is dominated by economical limitations, therefore many museums have adopted additional business models in order to generate revenues. They have to offer a larger variety of learning styles, such as providing lectures, performances, videos, classes and workshops etc. since visitors process experiences in museums in each their individual way (Marstine, 2006).

Surveys from 2012 showed that most users are motivated to visit a museum because they are interested and curious, motivated by the idea of being in a culturally important place. A reasonable part of the users use museums for mental relaxation and inspiration, using it as a oasis away from everyday life, while other users are seeking professional insight into a specific theme (Lundgaard & Jensen, 2013).

In general there is a lot of different users to take care of, when they all have different motivations, educational background and age groups. The visitor center as a building is contrary to the majority of museums site specific and relevant due to its remarkable surroundings. They both share the common function as being a main communicator through exhibitions.

Ill. 21. The cultural part of højerup seen from above.

1.3.2 MARITIME MUSEUM OF DENMARK

The Danish National Maritime Museum is located in Helsingør and is designed by Bjarke Ingels Group. It was completed in 2013 and is located next to the UNESCO World heritage site Kronborg Castle.

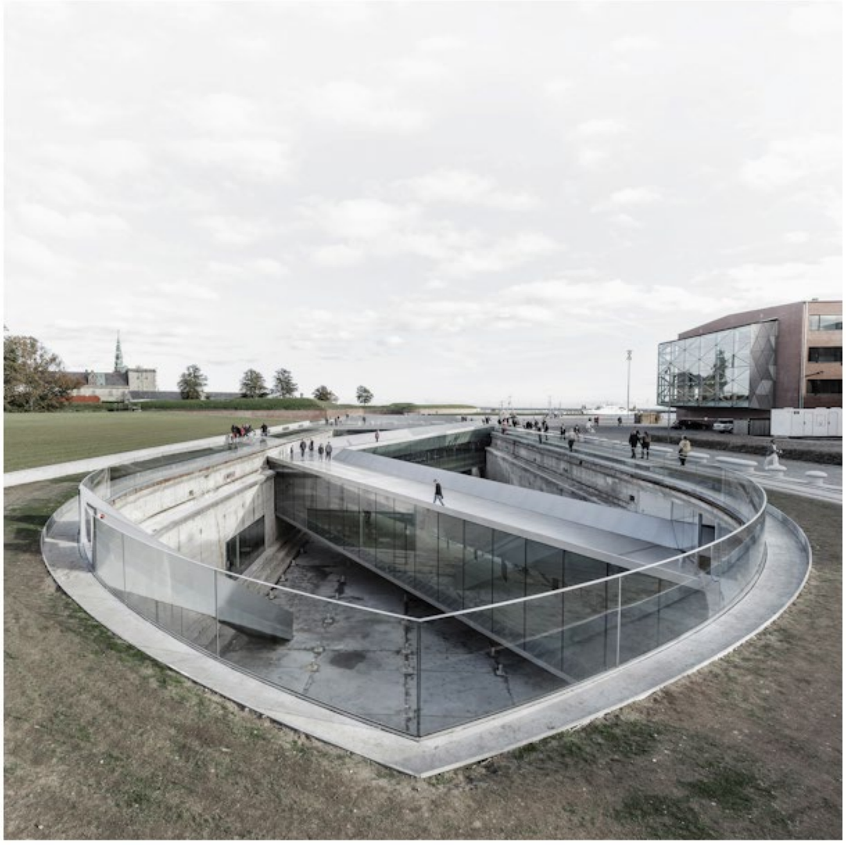
"Out of respect for Hamlet's Castle we needed to remain completely invisible and underground, but to be able to attract visitors we needed a strong public presence," (Dezeen, 2013)

The museum is situated subterranean around an old dry dock and it only reveals a minimum of its actual size which includes 5000 square meters (Big, 2015). In these spaces the museum includes exhibition, auditorium, classroom, offices, café and an outer courtyard. The museum is characterized by the exhibitions spaces spanning the dock, as three smaller bridges connecting in a zigzag move. This leaves the authentic dry dock almost untouched while at the same time it becomes the main centerpiece in the exhibition (Archdaily, 2013).

On top of the bridges, they serve as a ramp connecting the terrain level with the one level lower underground entrance. The tour starts in the ticket and retail area one floor below ground. Here a gently sloping exhibition space takes the visitor through the exhibition of Denmark's maritime history . This loop revolves around the old dry dock in one continues loop that ends two floors below the terrain.

The buildings naturally involves the visitor through its architecture and the way the exhibitions are made. The exhibition spaces floating in the dock connects to the main exhibition loop creating shortcuts, but also provides additional exhibited material for the extra interested visitor and allows the visitor to take shortcuts depending on the type of visitor.

The contrasting yet humble approach to the dry dock makes the architecture become a part of the exhibition by including the old dry dock throughout the whole exhibition enabling the visitor to understand the sizes and scales of shipbuilding.



Ill. 23a

Ill. 23b

1.3.3 TROLLSTIGEN VISITOR CENTER

Trollstigen visitor center is a part of the 18 National Tourist Routes in Norway. It is located on Norways west coast and is designed by Reiulf Ramstad Architects.

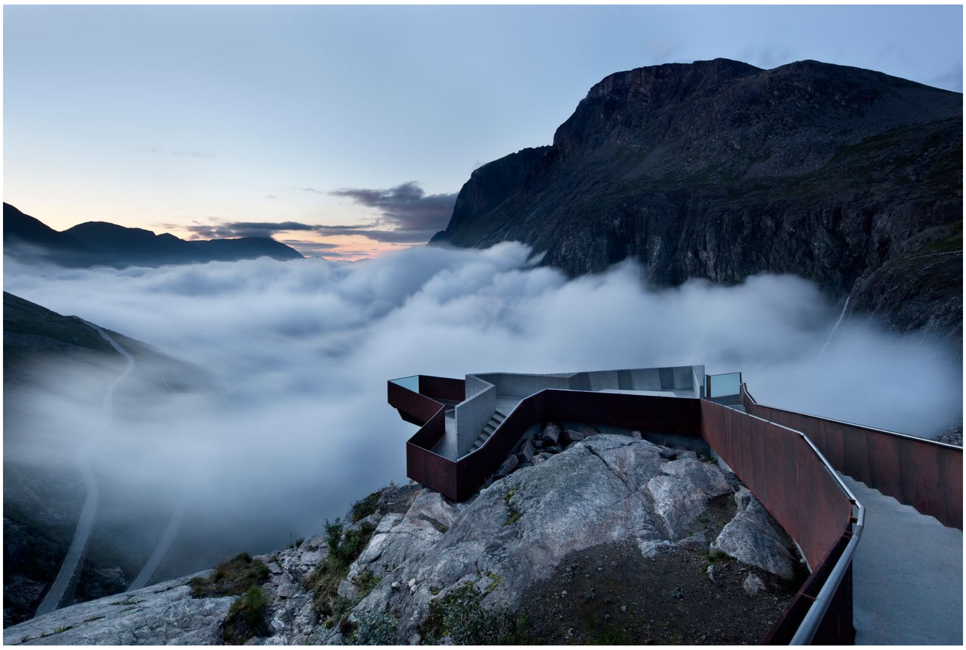
"The architectural intervention is respectfully delicate, and was conceived as a thin thread that guides visitors from one stunning overlook to another" (E-architect, 2013)

Unlike a museum this visitor center main focus is on emphasizing the landscape and enhancing the experience of it by becoming a complete visitor environment. The journey starts from the parking space meeting a main building with café, information point, service facilities, a kiosk and a souvenir store.

"The architecture should underpin the site's unique character, and give visitors an added value in relation to the travel experience" (Archipanic, 2014)

From here the journey begins through a continuous defined path which clearly contrasts the wilderness of the landscape while taking visitor through an outdoor "exhibition" through various viewpoints.

Ill. 24



Ill. 25a

Ill. 25b

1.4 STEVNS KLINT

LOCATION ALONG THE COAST OF ZEALAND

Stevns Klint is situated along the east coast of Zealand, on the south eastern peninsula Stevns. It is reachable within around 75 km from Copenhagen and around 100 km from Malmö in Sweden.

Through time man has lived along Stevns Klint and its rough nature. Back in the days the steep cliff made it unattractive to live by, mainly because of the difficulties in reaching the sea (Kalklandet, 2014). The steepness of the cliff also had its benefits making it accessible to reach chalk, lime and flint and extract these materials. The people living along the cliff has through centuries used its resources. The materials has among other been used for buildings which is evident in the adjacent buildings. (Kalklandet, 2014)

Stevns Klint stretches around 15 km and features several spots of interest variying from a coldwar bunker to quarries and a lighthouse. Along the coast only a few cities exist one of them is Højerup. It has in the municipality been decided to be the strategecally best place to give an alround visitor experience - therefore the new visitor center will be situated here.

Ill. 27, Aerial photo showing stevns klint along the coast of Zealand

1.5 HØJERUP

A STUDY OF HØJERUP

Højerup is placed in the middle of the stretch along the cliff between the light tower towards north and the cold war bunker at south. It is a small village which has approximately 160 citizens and is the only real village along the cliff (Stevns Kommune, 2014).

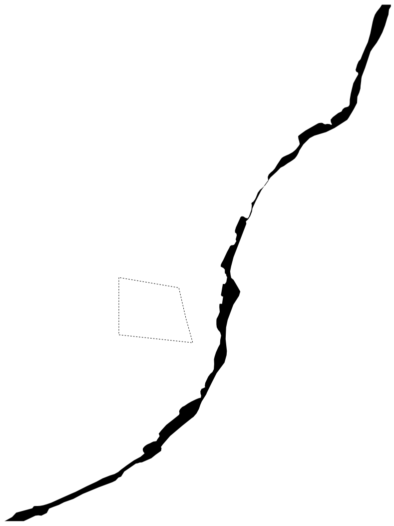
The site is situated in the outskirts of the village adjacent to the cliff and the sea. The majority of the village is secluded from the coast and the density of the built decreases towards the cliff.

Usually the site is reached by car through Højerup Bygade, the main street, that goes all the way to the site, and ends in a parking space. North of the parking space lies the new church from 1913 and a eatery (Schønherr, 2014). Continuing towards the coastline lies an old church which is characterized by its missing choir, that fell into the sea in 1928, when the upper layer of the cliff collapsed. (Schønherr, 2014). East of the parking space lies the church pond in close relation with "fiskerhuset". Close to "Fiskerhuset" are the current staircase located enabling the visitor to walk 26 meters down to the coast. South west of the parking space hidden behind the trees lies the current museum from 1970's (Schønherr, 2014).

Another point of interest is the "Place of Alvarez", that is found along the shore. It was the place where the American Geologist in 1978 examined the fish layer resulting in the theory of the mass extinction was caused by a meteor. (Schønherr, 2014)

Ill. 29a, Højeup along Stevns Klint

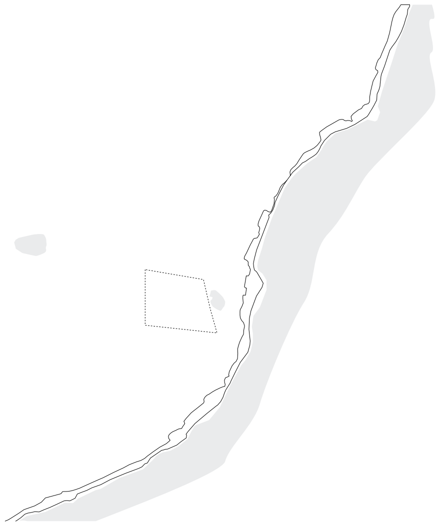
Ill. 29b, The site is placed in the outskirts of Højerup



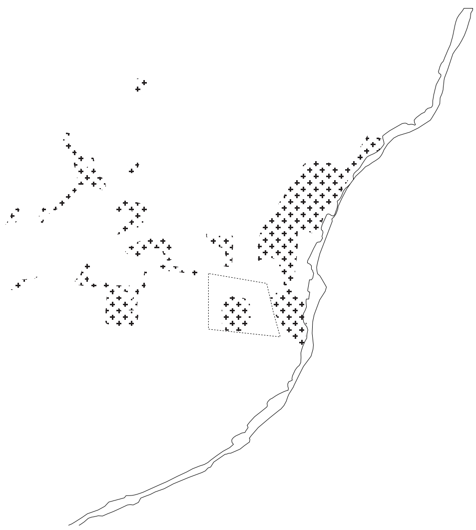
Ill. 30a, The cliff

Ill. 30b, Buildings and typologies

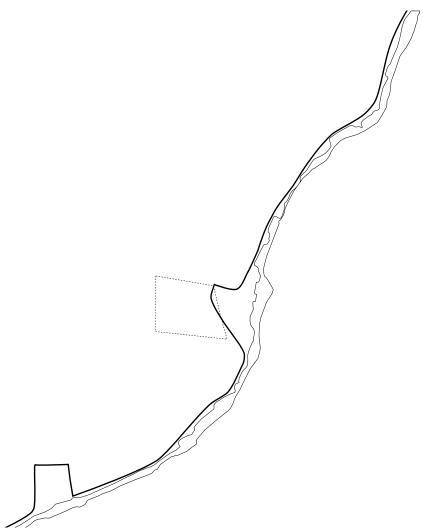
Ill. 30c, Connectivity



Ill. 31a, Lakes & sea



Ill. 31b, Lakes & sea



Ill. 31c, "Trampestien"

1.7 SENSING THE PLACE

1.7.1 A PHENOMENOLOGICAL APPROACH

The phenomenological approach has gained great influence in Nordic architecture, where Norberg-Schulz were an important figure. Christian Norberg-Schulz argues for architecture with "a sense of place", made through a phenomenological approach towards the interpretation of the natural context. Making it possible to enhance the visitors experience of the natural and cultural context in which the architecture lies through form, space and materials (Norberg-Schulz, 1995).

"The settlement and the buildings .. do not exist in isolation but as elements of a context that they represent and complement." (Norberg-Schulz, 1995, p.25)

The next part of the analysis will take it's point of departure in this sense of place. To investigate the specific potentials and limitations of the site and its context, through phenomenological and empirical studies.

Ill. 33a, The whitewashed village houses

Ill. 33b, The new church

Ill. 33c, The old church

Ill. 33d, "Fiskerhuset"

1.7.2 ARRIVING

This analysis is a investigation of the immediate perception when entering Højerup towards the site.

When entering Højerup, it gives the immediate feeling of moving into a time warp. The village is centered around a romantic village pond, while many of the buildings are built using local materials with whitewashed walls, half-timbering and limestone bricks. It is a very quiet city, only interrupted by the chirping of birds, which gives the immediate mental image of a very idyllic place.

When moving along the asphalt roads towards the cliff, your view is framed towards the old church by having large linden trees along the road. While large straw -and fallow fields on the right side of the road drives the view towards the ocean view in the horizon.

Ill. 34, Grasslands drives the view towards the ocean view in the horizon

Ill. 35, Højerup Bygade is the main way to reach the Cliff. At the end of the axis a bit offset to the right lies the "Old Church"

1.7.3 THE MEETING BETWEEN LAND & SEA

When moving towards the edge of the cliff you see a set of stairs going out in what seems to be a endless space. Coming closer and turning a corner a very steep and dramatic staircase appears. This staircase leads down to the shore, dominated by delicate white and gray stones on the beach and fine layer of seaweed. While the ocean is quietly lapping, you get the smell of ocean and seaweed and a taste of salt in the air. At the bottom of the cliff lies shattered pieces of limestone, chalk, granite in all sizes and colors variations.

You are overwhelmed at the shore when all your senses are affected by the dramatic nature. Your attention is immediately drawn towards the top of the cliff, where the trees are hanging out over the cliff, acting like a crown on the top. There are several holes in the cliff where water drips out of it, while the collapsed part of the cliff are covered by grass and peat. The cliff is experienced as this impressive and massive wall that is layered by several types of stone and a layer of fish clay, giving a hint of the million years of history it possess The erosion has made a cliff that fluctuate in the section, resulting in a changing embracing gesture when walking along the cliff.

Walking along the shore, you also gets drawn to look out over the crystal clear blue and greenish ocean. When you hear the gurgling of water, and have views towards the free horizon, you almost forget the dramatic nature right behind you.

Ill. 36a, Limestone

Ill. 36b, Water

Ill. 36c, Chalk

Ill. 37, The cantilevering parts of the cliff embraces the space

Ill 38a, View when going down to the staircase

Ill 38b, Sea view from the site

Ill 38c, Fallow field next to the site

Ill 39a, Main viewpoint next to the site

Ill 39b, Another main viewpoints along the cliff at Højerup

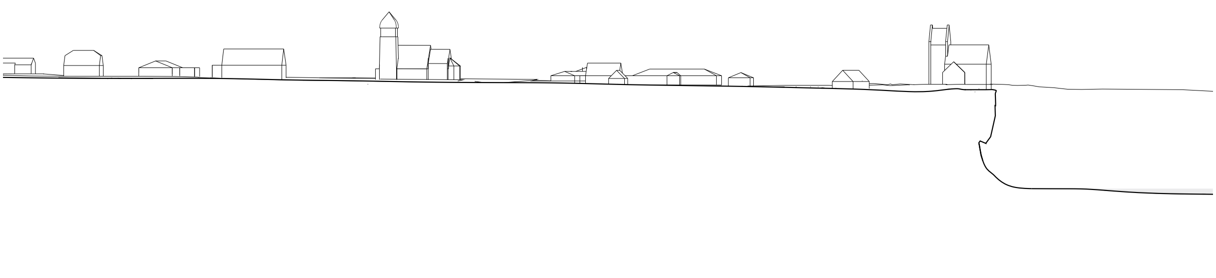
1.8 UNDERSTANDING THE SITE

ATMOSPHERE, VISIBILITY AND TOPOGRAPHY

The approximately 10000m^2 building site varies between heavy vegetation and open green spaces with a lot of trees varying in sizes and species. The site is placed in between open fields, buildings and a parking space. When arriving to the periphery of the site, a large messy parking place with gravel, turnpikes and a lot of cars dominates the immediate perception of the space. The parking area becomes the main focus on the site, where the current museum almost seems hidden. When you look around you see that you are surrounded by a lot of old well kept historical buildings.

The terrain has a gently slope falling towards the pond and the cliff on the east west direction. On the north to south direction the terrain falls slightly towards the eatery and the pond.

The site is encompassed by different regulations caused by its location close to listed buildings and near relation to the coast line and cliff. From the both old- and the new church a 300m zone entails a height regulation of a maximum of 8,5 meters within this zone. Furthermore due to the close proximity to the coast the "Coast protection line" is also applicable at the site since it is placed within 300 meters from the coast. At last it holds an Exner listing which most importantly needs to maintain significant views to the old church (Schønherr, 2014). It can be argued that some of these regulations seem irrelevant at this specific site. The coast protection line zone is already built within towards west, north and south from the site.



Ill. 40, Section through site

Ill. 41a, Seen from the memorial grove

Ill. 41b, Seen from between the Fiskerhuset and the old church. The current parking conditions seen from old church

Ill. 41c, Seen from between the Fiskerhuset and the old church

Ill. 41d, Seen from trampestien when walking in a northern direction

I.9 CLIMATE

EMPIRIC ANALYSIS OF SITE CONDITIONS

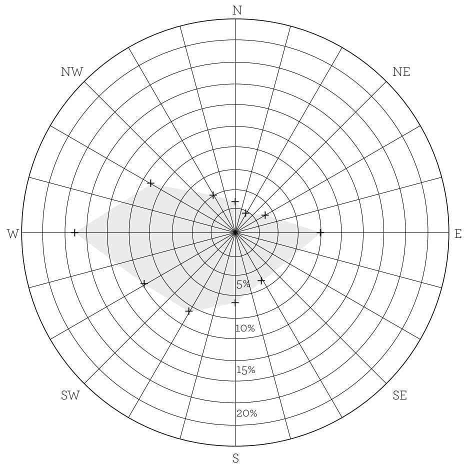
Denmark is located on the northern hemisphere, due to this the climate in Denmark is characterized by its varying seasons during the year. The different seasons sets different moods and creates different experiences depending on what time of year Stevns cliff is experienced.

"In the North we occupy a world of moods, of shifting nuances, of never-resting forces, even when the light is withdrawn and filtered through an overcast sky" (Norberg-Schulz, 1995, p2)

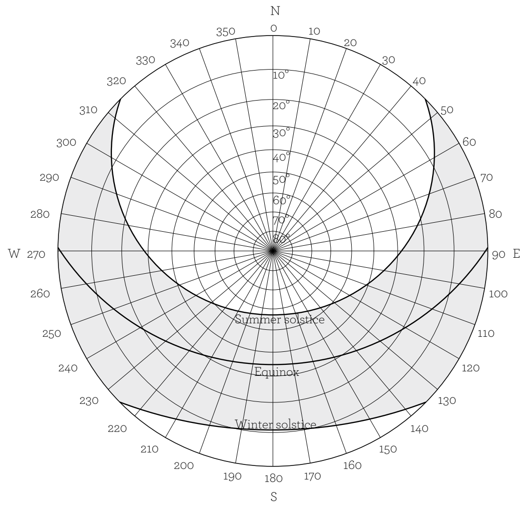
Through the year the temperature varies greatly. Through the winter time the temperature can go below zero degrees and in the summers it can be over 20 degrees (DMI, 2015). Similar with the temperature the sun height varies from the 58 degrees at summer solstice to 12 degrees at winter solstice. Due to the more seperated location of the site, it only occurs minimal shadows from surrounding buildings.

The main wind direction in denmark is from west and south west. The site is lying in a relatively open landscape although it is protected by trees and vegetation forming a windbreak from south and west.

"The most beautiful is perhaps the view over the land in storm, with driving clouds and distant showers, sweeping across the plains"" (Norberg-Schulz, 1995, p27)



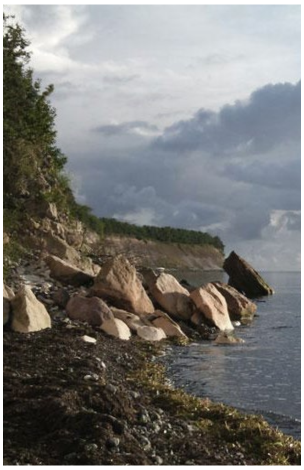
Ill. 43a, Wind



Ill. 43b, Sunpath

Ill. 43c

Ill. 43d



Ill. 43e

Ill. 43f

The seasonal changes at Stevns

PROGRAMME

2.0

2.0 ROOM PROGRAM

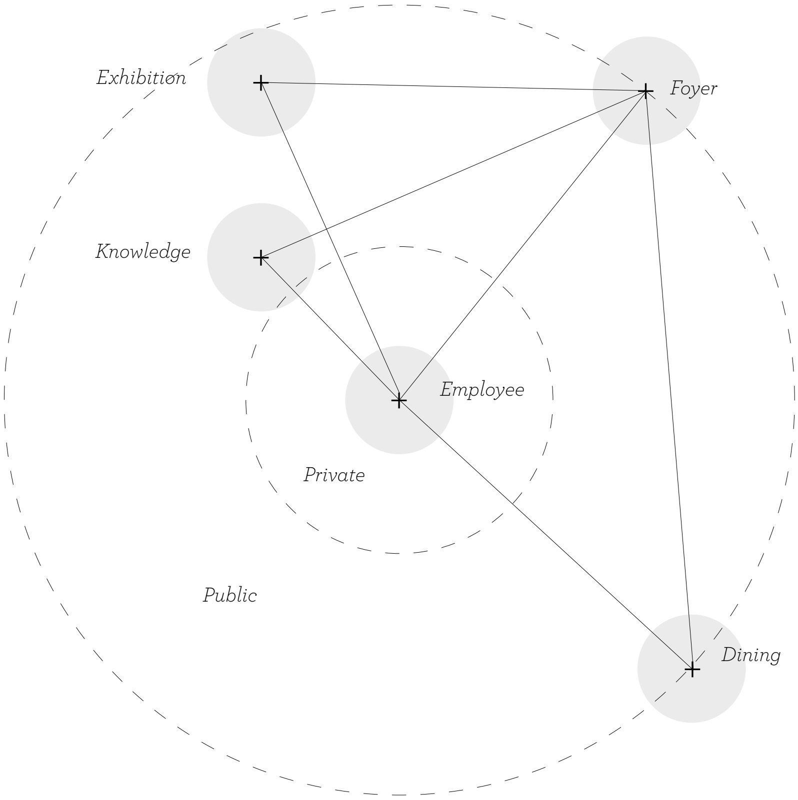
2.1 FUNCTIONS AND RELATIONS

The existing museum in Højerup does not have the necessary capacity to handle the increasing load of visitors as well as the quality of communication in the exhibitions spaces are highly outdated. Stevns Municipality has together with East Zealand Museums had a preliminary program developed for future architectural competitions. This program is used as a point of departure for the following program. It describes potentials and limitations in relation to making a new visitor center in Højerup.

The specific room program is based on several programs for similar buildings and adjusted to make a programme that can fit the specific site condition and needs in Højerup. Here further additions and specification are made with focus on the experience of the visitor.

The building will have a net area around 2200m^2 and include various functions. The main function is exhibitions that can enhance the experience of visiting the cliff afterwards, by communicating the life at Stevns, the fishclay, the meteor collision, Stevns sea, Flora and fauna, Unesco and Cliff geology.

The visitor center will in addition to this have educational functions & research facilities. This enables the building for a wider range of learning styles that can take place but also enable geology student or researches to study at the site. Also the educational center enables to host school class trips and educate them through lectures as well as through hands-on workshops. Also it includes auditoriums and conference rooms to host cultural events, private groups events and videoseminars. The visitor center will also include a restaurant that must be able to accommodate the daily visitors but also larger groups. At last staff functions will be incorporated including offices and meeting rooms.



Ill. 47, Functions and relations

2.2 ROOMS AND SIZES

ENTRY

	Function	Size	Functional demands
Entrance			
	Reception	40	Workspace for receptionist
	Visitor room	150	Orientation
	Retail	25	Overview from reception
	Toilets	20	Handicap friendly
	Wardrobe	40	Lockers, Clothes rack, Carts for school class.
	Storage	10	
Total		285	

EXHIBITION

	Function	Size	Functional demands
Exhibition			
	Exhibition area	800	Meteor impact, Stevns Sea, Geology, Unesco, Life at Stevns, Flora & Fauna
	Toilets	20	
	Storage	40	
Total		860	

DINING

	Function	Size	Functional demands
Restaurant			
	Dining area	150	Indoor seating for visitors, possibility of outdoor seating
	Cashier	10	
	Kitchen	30	
	Food storage	15	Including cold storage
	Toilets	10	
Total		215	

EXTERIOR SPACE

	Function	Size	Functional demands
Outdoor			
	Covered spaces	-	Places for outdoor dining and activities
	Toilets	15	Available outside opening hours
	Parking spaces	3-4000	150 - 200 parking spaces

KNOWLEDGE

	Function	Size	Functional demands
Education			
	Workshop/multi-room	100	Flexible room for lectures and workshops to examine fossils and rocks.
	Auditorium	150	Showing films, multi-media presentations, lectures and conferences.
	Toilets	20	
	Storage	10	
Research			
	Laboratory	15	Equipment for research
	Office	10	
Conference			
	Conference room	50	For conferences, smaller lectures and directorate meetings.
Total		355	

EMPLOYEE AREA

	Function	Size	Functional demands
Office			
	Offices	40	Open and closed offices
	Employee break room	30	Informal common space with kitchenette
	Meeting room	25	
	Copy room	5	
	Toilets	10	Employee toilets
Custodian			
	Workshop	30	Carpentry machinery
Total		140	

VARIOUS

	Function	Size	Functional demands
Technical			
	Technical space	150	Ventilation, Electricity, Heating
Cleaning			
	Cleaning	15	Cleaning wagons etc.
	Laundry	15	Washing machine, Tumble dryer
Total		180	

PRESENTATION

3.0

4.0 VISION

A VISION TOWARDS THE DESIGN

The visitor center should serve as a place for communicating the history and magnificent nature at Stevns Klint and enhance the awareness and experience of the cliff through its architecture. The new visitor center should be visible in the area, articulating its cultural function by evoking curiosity and having an enticing effect on visitors by expressing openness. At the same time should the visitor center relating to the significant site and its context in a humble and respectful way. There should furthermore be an emphasis on views, light, materiality and tactility. Thereby the architecture should through constructive, structural, functional, aesthetical means create a tectonic composition that can create spatial experiences that tells the narrative about Stevns Klint.

4.1 CONCEPT

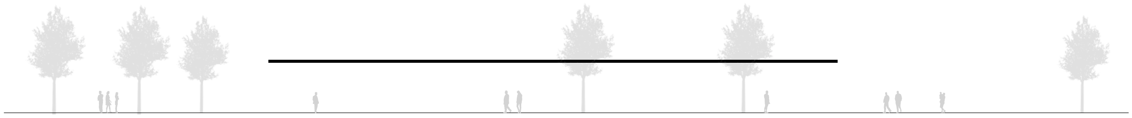
ROOF AND LANDSCAPE

The concept takes departure of the idea of creating a simple roof hovering above the landscape creating a sheltered space, letting the visitors flow freely through by erasing the boundary between interior and exterior.

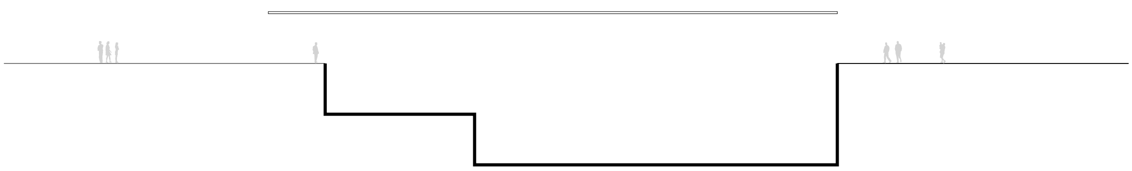
Underneath the roof is a cut in the landscape introduced as an architectural metaphor, to create a strong link to the overall narrative about geology and to integrate the raw material found in the underground in the architecture.

A wrap forms separated volumes through a light and transparent building envelope while they trough their varying sizes and heights relate to the point typology and scale seen in the surrounding village. The wrap creates varying spaces having a strong visual contact to the surroundings, allowing visitors to freely flow between interior and exterior. As well as creating visual connection between under and above ground level, to evoke curiosity and having an enticing effect on visitors.

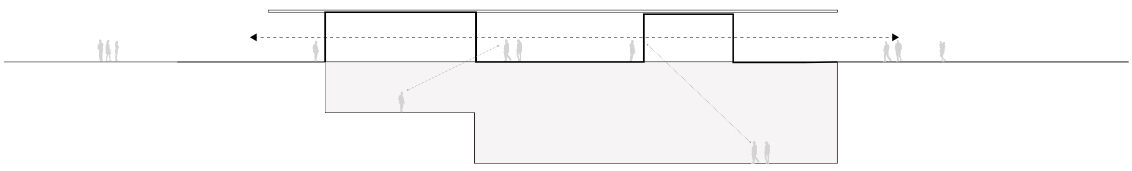
The roof underlines the horizontal lines in the landscape and its simple geometry strengthens its surrndings by contrasting it.



THE ROOF

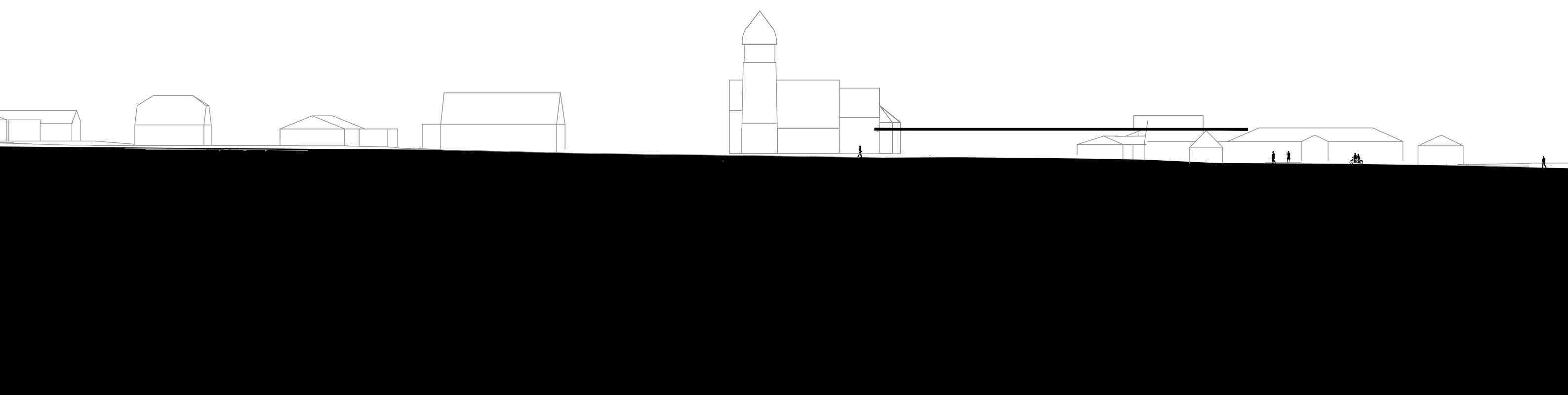


A CUT IN THE LANDSCAPE



Ill. 55c

WRAP



Ill. 56, Section through the cliff

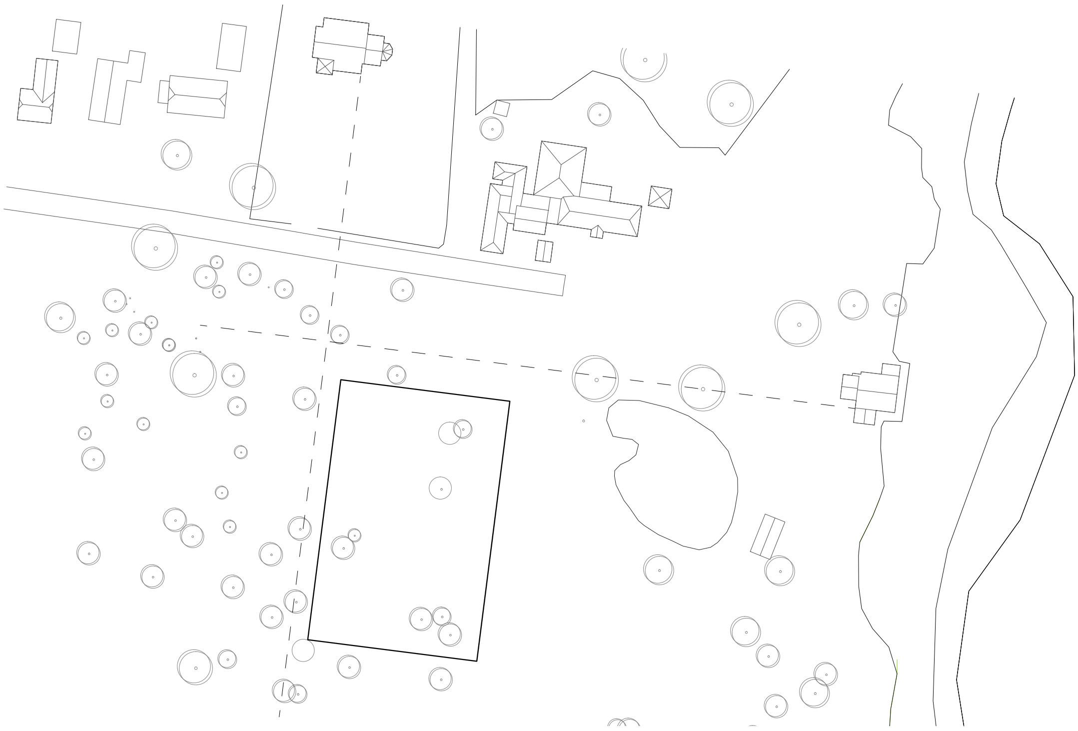
4.2 SITE & CONTEXT

A NEW PART OF HØJERUP

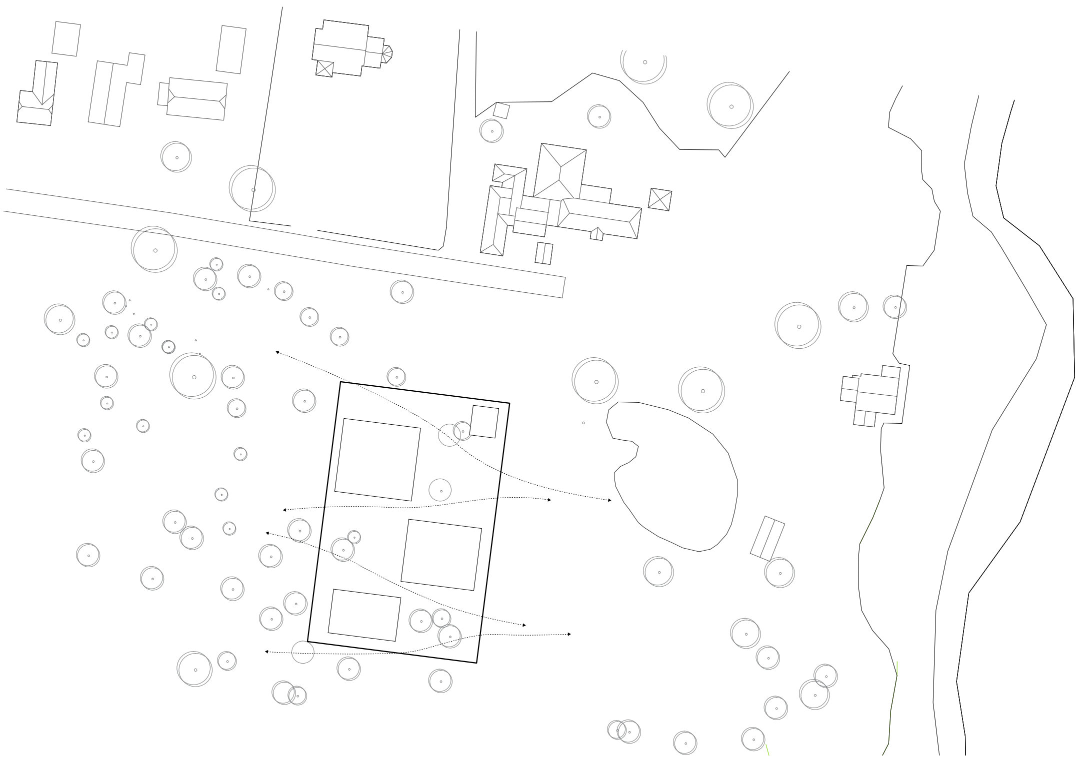
The new visitor center lies in the center of the site between the parking space towards west and the cliff towards east. The building is placed centrally on the building site, creating space and distance to the historical and cultural buildings. This space around the building, makes it possible to approach the building from multiple directions.

The buildings is broken up into four smaller volumes scaled and shaped in order to relate to the point typology seen in the surrounding village. The exterior spaces are articulated by continuing and extending the existing network of pathways through and around the building. This leads the visitors naturally through the visitor center as a part of their journey and experience of Stevns klint, whether they approach from the parking space, the old church, the cliff or coming from "trampestien".

The roof continues the characteristic lines from the churches and the centralized placement on the site, keeps important views towards and from the churches, while keeping a strong connection to nature on the south/west part of the site.



Ill.59a, Continuation of the existing axis



Ill. 59b, The smaller volumes allows the visitor to flow freely through the site

Ill. 60, Siteplan

00	Visitor center
01	Parking
02	The old church
03	Fiskerhuset
04	Staircase to the shore
05	The new church
06	Church pond

4.3 APPROACHING THE ROOF

VISIBILITY AND OPENNESS

A network of pathways carve their way through the landscape leading the visitor naturally through the visitor center where the building becomes an architectural filter on the journey towards the cliff. A roof is hovering above the landscape combining four seemingly transparent volumes pushed up from the subterranean level. The varying sizes and height of these volumes relates to the point typologies and scale seen in the surrounding village, while the simplicity of their facades and geometry makes them stand out revealing its cultural status by contrast.

The two volumes that visitors can enter are higher to make aware of these spaces. While the two volumes that is not public entrances are lowered and closed of in a white semi-transparent glass, as a reference to the white chalk and limestone seen in the cliff. In the foyer volume a model of the mosaurus dinosaur hovers in the free space, evoking curiosity while giving the idea of something happening below terrain. The building lies visible from the road, while the foyer express openness and attract visitors coming from all parts of the site.

Ill. 63, Approaching the roof

4.4 ABOVE GROUND

GROUNDFLOOR

Above ground the visitor center consists of four volumes, containing a light box, foyer, restaurant and administration.

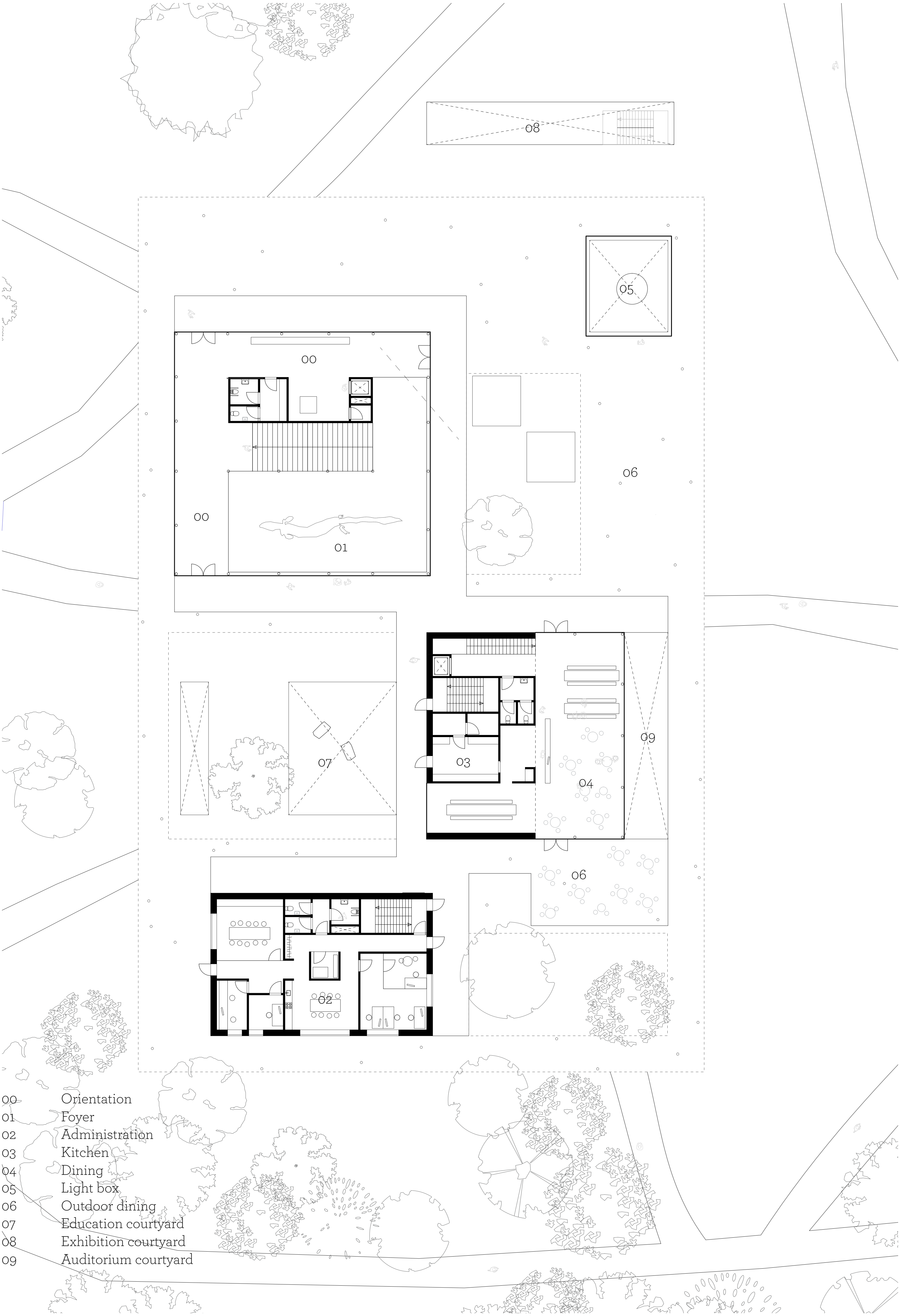
Towards the eatery and the church pond lies the light box as an element to walk around and becomes a semi transparent light beacon evoking curiosity in the dark hours.

Next to the light box lies the foyer. The foyer is an open space inviting people to enter through entrances from multiple directions. The foyer lies visible in the area where the paths naturally guides the visitor along the facade of the foyer. The foyer features an entrance plateau forming a good overview and functions as a transition space from outside to inside and from terrain level to underground level. The plateau contains toilet facilities and basic orientation about all tourist attractions along Stevns Klint, which can be closed off so it is still accessible outside normal opening hours. The plateau and the outside path enables the visitor to see down into the space and examine the model of the mosasaurus from different angles.

Placed between the foyer and the office lies the restaurant having a dining space with panorama views towards the ocean and the grasslands. A centralized core contains restaurant desk with kitchen and storage. Furthermore it holds toilet facilities, fire staircase and a staircase from the foyer and an elevator connecting the reception, education functions, foyer and exhibition vertically. Adjacent to the dining space lies a space with possibility of closing of for larger groups.

The administration lies towards south closing off towards the visitor environment while opening up towards the grasslands. In the middle of the office lies the common functions such as kitchen and common area, wardrobe, copy room and toilets. The staircase connects the administration building with the subterranean part of the visitor center enabling easy access for the employees.

Skylights and courtyards provides visual connection between levels, while ensuring daylight for the underlying functions.



00 Orientation
01 Foyer
02 Administration
03 Kitchen
04 Dining
05 Light box
06 Outdoor dining
07 Education courtyard
08 Exhibition courtyard
09 Auditorium courtyard

Ill. 65, Level 0

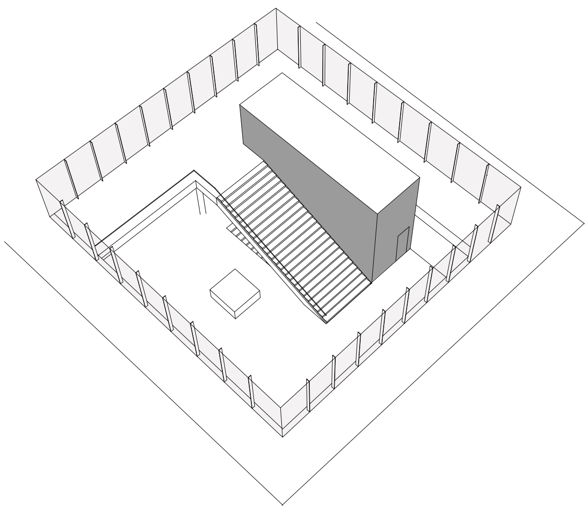
4.5 BELOW GROUND

FUNCTIONS & FLOW

From the upper foyer plateau the core is continued down and the visitor is led down to the main foyer either by the wide staircase or the elevator. The foyer space contains orientation facilities, exhibition, retail and reception combined with wardrobe. Under the main staircase along the core lies the staircase continuing one level further down to the main exhibition room. When exiting the exhibiton room the visitors are naturally led back in the foyer space or up in the dining space depending on their choice.

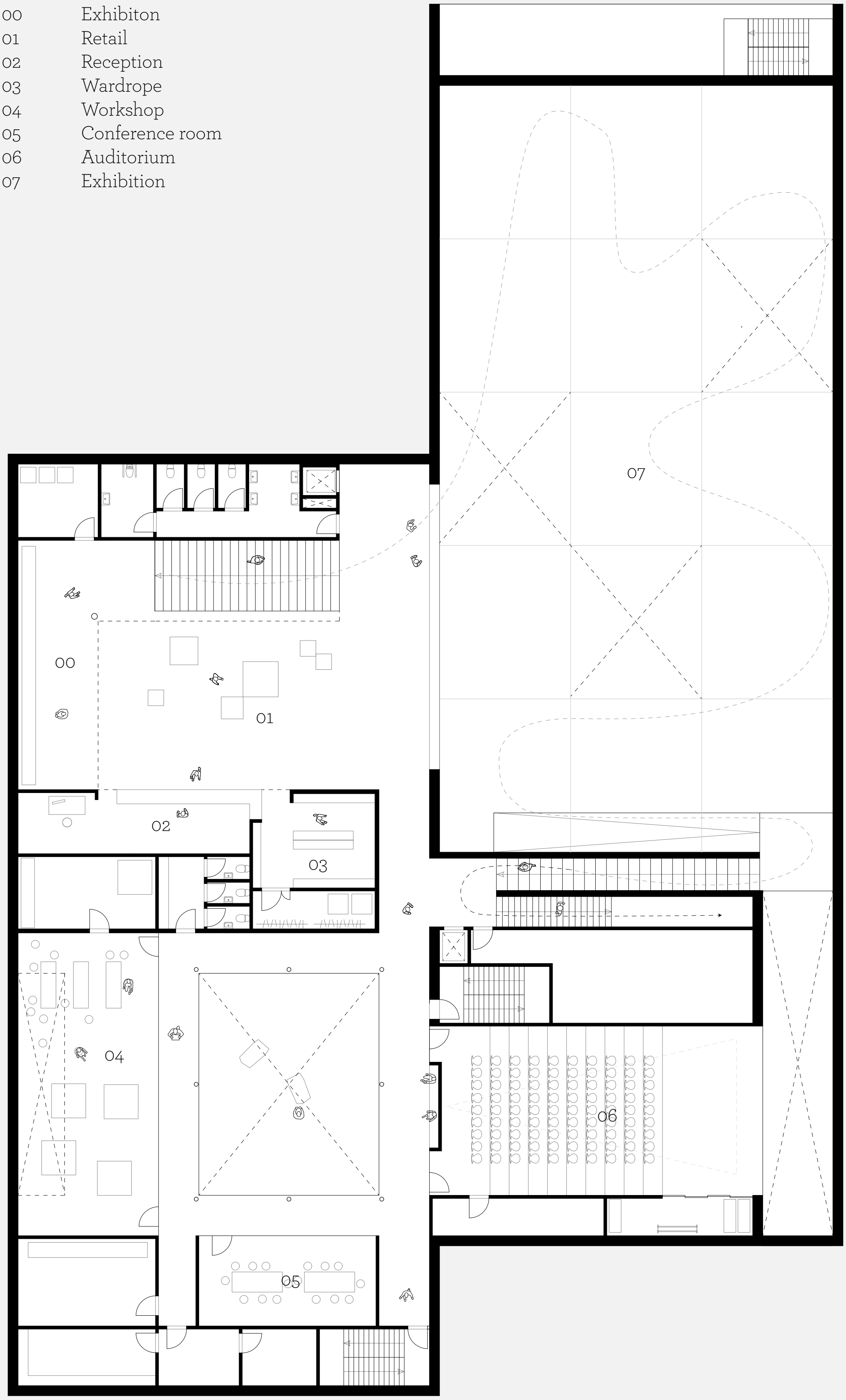
Situated around a courtyard lies the workshop area, conference room and auditorium as a more independent department. These education facilities lies in between the exhibition, foyer and administration spaces to maintain a easy connection to all of these functions, which is important for a good internal flow.

The education facilities connects to the office through one of the four escape stairs. In case of fire in the visitor center two independent fire exits always lies within 50 meters while the nearest of the escape staircases lies maximum within 25 meters.



Ill. 66, Axxonometric of foyer

00 Exhibiton
01 Retail
02 Reception
03 Wardrope
04 Workshop
05 Conference room
06 Auditorium
07 Exhibition



Ill. 67, Level -1

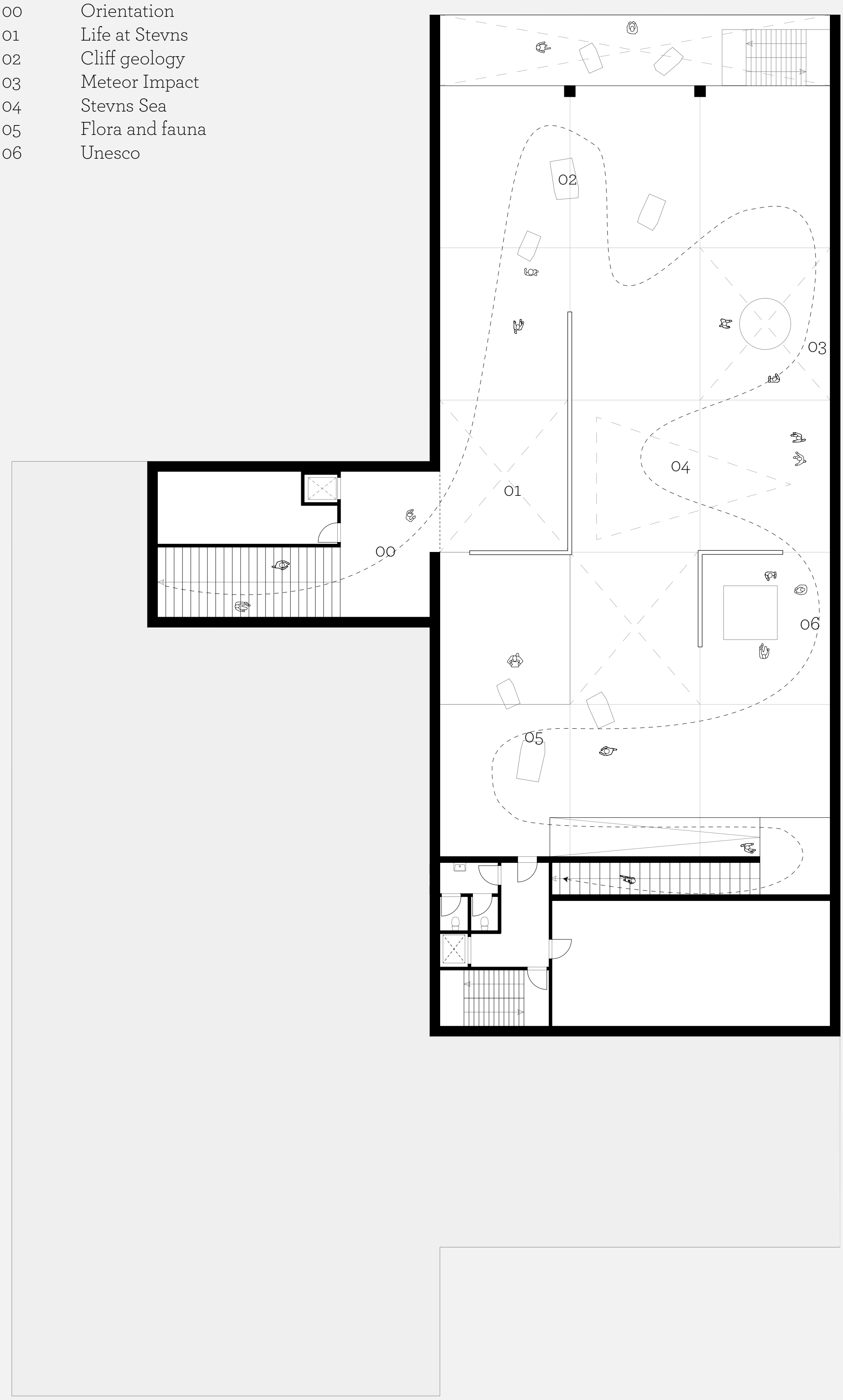
EXHIBITION FLOOR

After moving down the staircase to the foyer the visitor is led further down an underlying staircase until the large exhibition room is reached.

The visitor is naturally led through the exhibition that first leads the visitor towards the large courtyard by the end and then guides visitors towards the exit by the courtyard and the ramp in the opposite side. In this end toilet facilities and elevator are placed to connect with the education, foyer and restaurant vertically.

The exhibition room is an open space with complete flexibility to rearrange the plan layout for possible future needs. Flexible walls subdivides the exhibition space and together with the beams it forms spaces within the space for the different themes of the exhibition.

00 Orientation
01 Life at Stevns
02 Cliff geology
03 Meteor Impact
04 Stevns Sea
05 Flora and fauna
06 Unesco



Ill. 69, Level -2

Ill. 70, Foyer

4.6 FOYER

A SPACE OF TRANSITION

The foyer opens up to multiple directions, to make it possible for visitors to start or end their visit here. The visitor naturally flows inside the foyer space when following the outer pathways. Here the exterior roof continues inside as interior ceiling underlining it as one complete surface. The exhibited model of the mosasaurus hanging from the ceiling emphasizes the double height space and has a guiding effect on visitors walking by.

The foyer spaces creates views between terrain and the foyer, giving a strong connection with the pathways outside where people walk by. It is a transition space where the upper more open and transparent parts contrast the more earthbound subterranean parts.

On the groundfloor plateau the visitor is informed about the different attractions and locations along Stevn Klint, they can combine their visit with. Here the visitors are led down a wide staircase that moves the visitor along the mosaurus floating as a centerpiece in the middle of the room.

At the end of the staircase the visitors curiosity is evoked as their view is guided towards an opening in the wall. The opening reveals a peek of the underlying exhibitions between the beams.

Following this wall it becomes a corridor connecting the foyer with the education facilities and the restaurant.

Next to the corridor is the information, retail and reception desk subracted in the wall together with the wardrobe.

Ill. 73, Section through foyer and exhibition space


Ill. 74, Exhibition

4.7 EXHIBITION SPACE

TACTILITY, LIGHT AND SHADOW

After moving down to the foyer the visitor is led further down through an underlying staircase until the large exhibition room is reached.

The exhibition space is an open and flexible space where the height of the beams creates smaller defined spaces within the space, niches where visitors can immerse themselves into a specific subject. The space can be subdivided by posters hanging from the beams, flexible walls and completely closed boxed allowing different moods in each niche.

The room is an atmospheric space that evokes feelings inspired by the contrasting atmospheres at Stevns Klint. The experience of the exhibition space is therefore an embodied experience dominated by contrast between light and shadow, high and low, closed and open and variation in tactility.
The materials on the walls and beams are in situ cast concrete with horizontal imprints of wooden planks, as a reference to the geological layers in geology and in the cliff. It appeals to human interaction through its tactility. The floors contrast by being polished concrete, that reflects light in another way.

In opposite ends of the exhibition space courtyards frames cuts in the underground of raw limestone while working as light wells and providing visual connection to terrain level.

Ill. 76, Section through restaurant and exhibition space

Ill. 78, Education

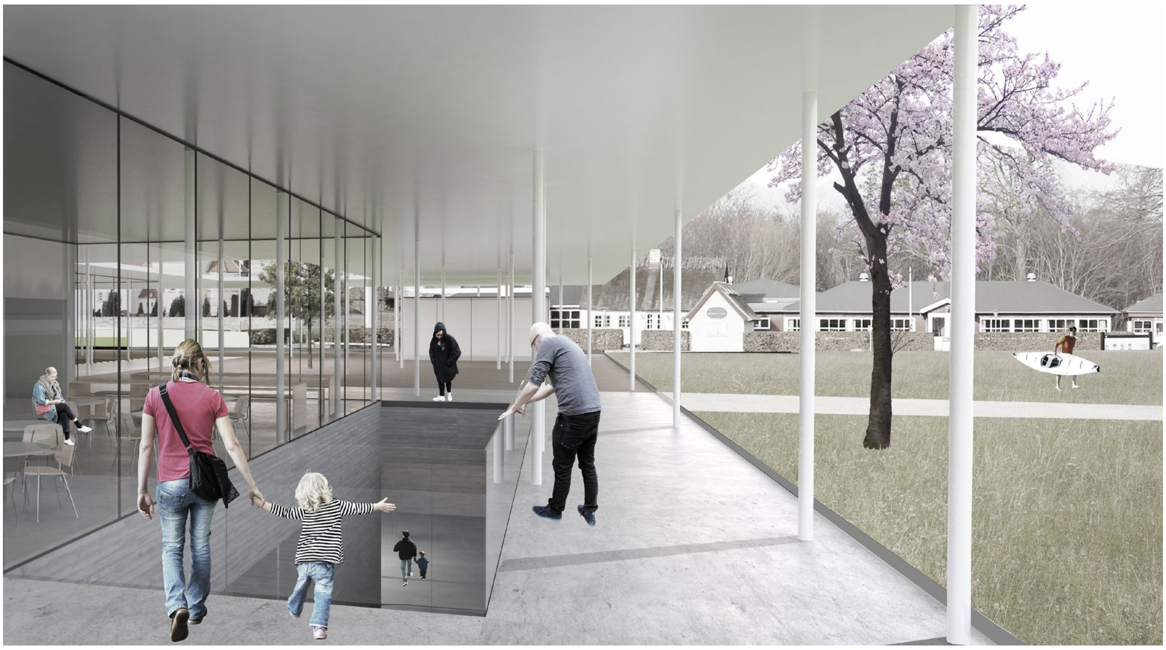
4.8 EDUCATION & RESEARCH

LEARNING FROM THE CLIFF

The educational facilities are centered around a common courtyard that frames the natural underground of limestone and creates a connection between under and above ground. The educational area is a flexible space with a close connection between courtyard, workshop and auditorium allowing for both indoor and outdoor activities. Within this part of the building it is possible to provide lectures, classes and workshops that can offer a large variety of learning styles taking advantage of its underground location as an active part of the teaching.

The structural principle from the exhibition space is continued here in the educational part and in the rest of the subterrenean parts of the visitor center giving an general embracing gesture. The size of the grid is decreased to fit the size of the space and give the space a human scale. To create a coherence in the architecture the same materials are used throughout the subterranean parts of the visitor center. As well as some of the embodied experiences that dominates the exhibition room also are to find in the educational ares, such as working with light that flushes down the concrete walls to reveal the tactility of the material.

Ill. 80, Section through education facilities and restaurant



Ill. 82, Restaurant

4.9 RESTAURANT

VIEW TOWARDS NATURE

The restaurant is a open space with focus outwards towards the surroundings. Here it opens up with views towards fiskerhuset, the church pond, the old church, the open fields and the sea.

A whitewashed core is within this space as a clear reference to the historic buildings and the way chalk has been used as treating buildings in the context, while creating a clear connection to the facades of the light box and the office.

The restaurant location has a vertical link to the exhibition and foyer space. Enabling visitors to easily continue their visit in the restaurant after seeing the exhibition, or on their way back from the cliff.

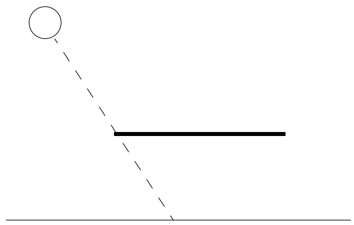
In front of the restaurant a courtyard creates views from terrain-level to the exhibition and the auditorium while providing daylight into those spaces. A subtle edge marks the start of the building, from wild nature to tamed nature inside. It is a way to start to tell the story about a excavation in a subtle way.

Ill. 84, Under the roof

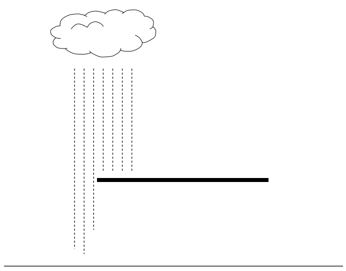
4.10 UNDER THE ROOF

FRAMING THE VIEW

The roof is hovering above the landscape creating a sheltered space for visitors on a rainy day. The seasonal changes of nature and its ever changing sky will be emphasized by the white roof. The clear white color of the roof creates a contrast to its surroundings and in that way strengthens it.
The edge of the roof is continued in the terrain as a sharp edge. This will subtle mark the space and the transition from grass to concrete and gravel. In addition to this will the sharp edge and the horizontality of the roof frame the view towards the water, old church and fiskerhuset.



Ill. 89a, Roof as sunshading.



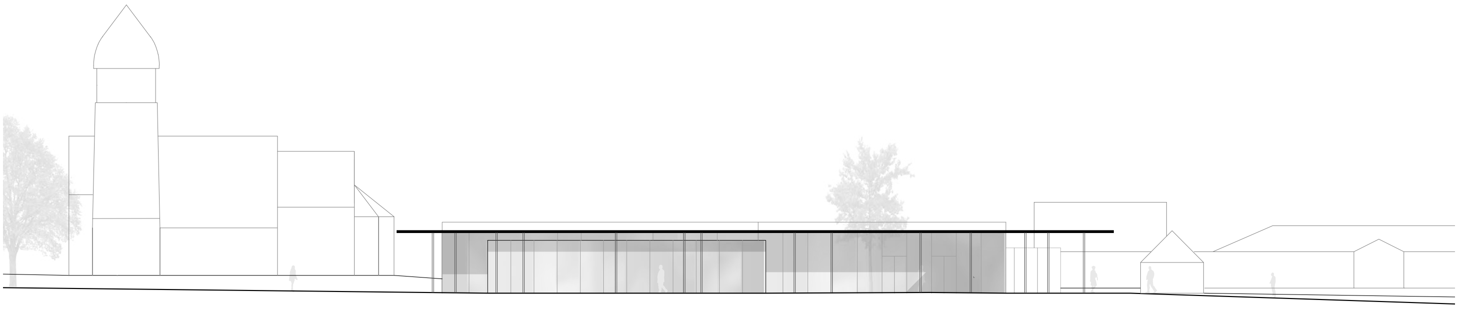
Ill. 89b, Roof as shelter for the rain.

4.11 EXTERIOR

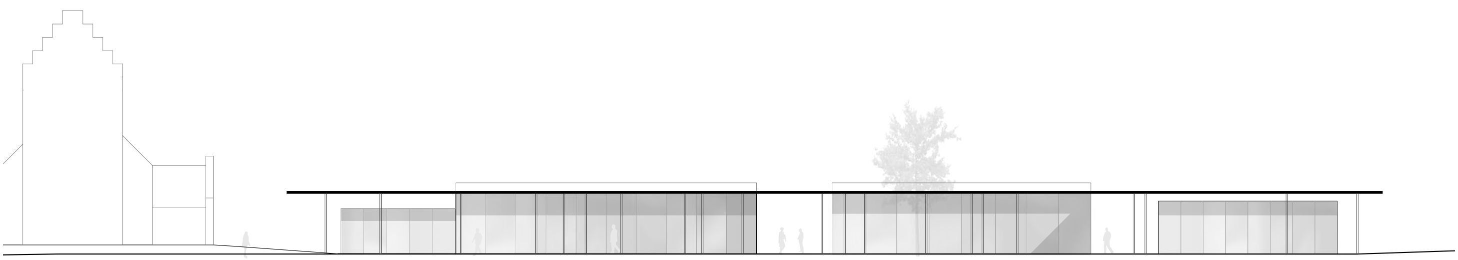
VARYING EXPRESSION

The expression of the building will change during the day and the seasons. In the dark hours the roof will be illuminated and create a guiding gesture towards it. The roof will seem like it is hovering above the boxes in one seamless surface.

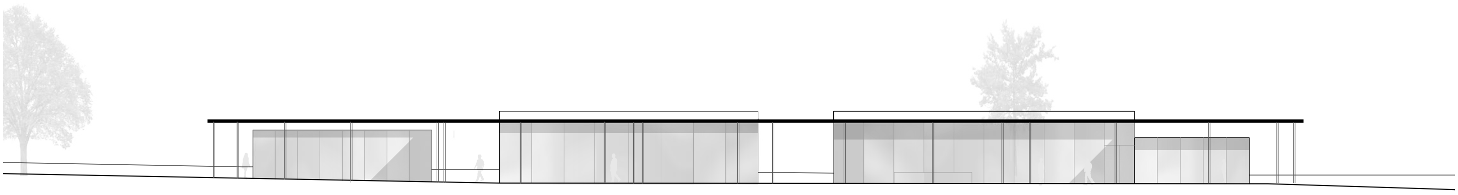
The cores in the foyer and restaurant will become visible and together with the translucent office and light box stand as glowing boxes. Referring to the overall narrative as four sharp cut blocks of chalk.



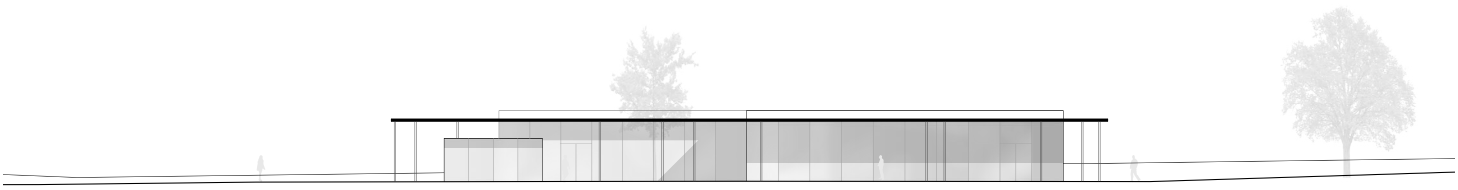
Ill. 88 a, South facade



Ill. 88 b, West facade



Ill. 89a, East facade



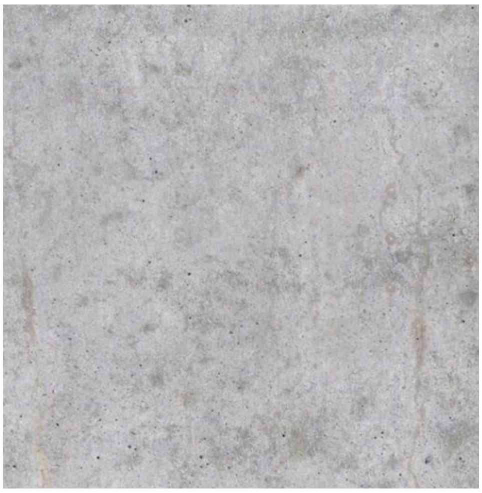
Ill. 89b, North facade

Ill. 90a, Translucent aerogel glass

Ill. 90 b, Whitewashed wall

Ill. 90c, Concrete Wood boards form work

Ill. 90d, White planed oak



Ill. 90e, Polished concrete

Ill 90f, White painted steel

4.12 MATERIALS

TACTILITY, LIGHT AND REFLECTION.

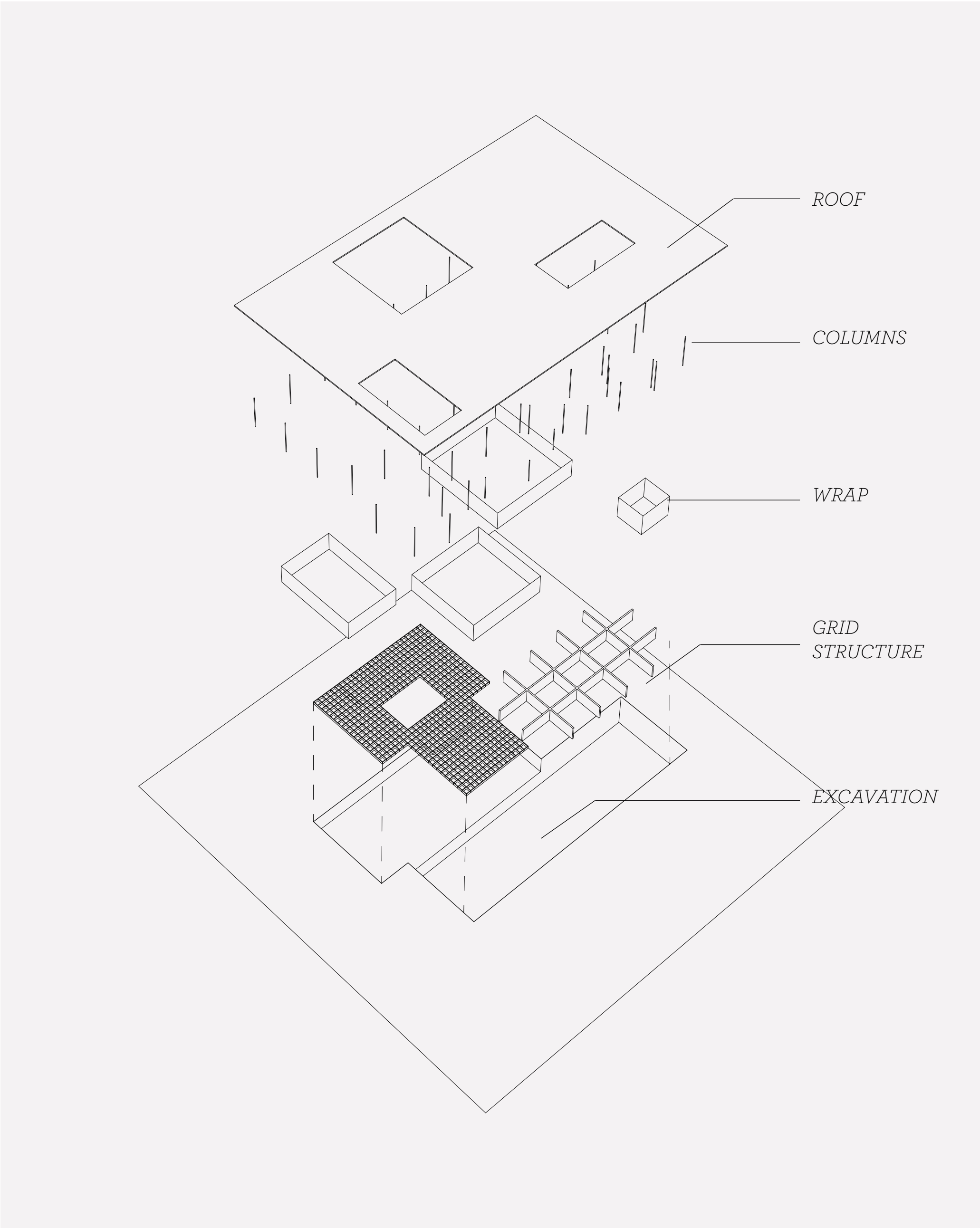
The selection of materials is based on emphasizing the difference between over and below ground. The subterranean parts of the museum has a more heavy and tactile materials and above ground more light and simple material are chosen.

As a reference to white cliff the materials above ground follows a white color palette. The hovering roof consist of shiny white painted steel boards carried by thin painted white circular steel columns. Underneath transparent boxes are clad in a combination of a white semitransparent aerogel glass, 3 layered glazing or glazing with insulation behind. See Appendix C for further information about the semi transparent glass materials and its properties.

As seen in the historic buildings in the context and part of the heritage in the area, whitewashed walls is used on the cores in the restaurant and foyer. The visitors can then move along them and feel the tactility while giving them an understanding of the way chalk has been used through time.

Concrete is the main material underground as it is ideal for construction while accentuating the idea of being in a excavation. Different treatments of the concrete creates variations while at the same time continuing the same language. The walls consist of in situ cast concrete with wood boards form work that is placed where visitors moves along and can feel the tactility. The floors are kept simple and made of polished concrete that is cast with gaps dividing the floor into smaller pieces and by its plain look clearly contrasts the rougher walls.

Elements placed within the visitor center, such as exhibition boxes, furniture, and the reception desk, will be in warm wood, contrasting the cold concrete.



Ill. 92a, Exploded diagram

Ill. 92b, Columns and roof

4.13 Structural principle

A STRUCTURAL TALE

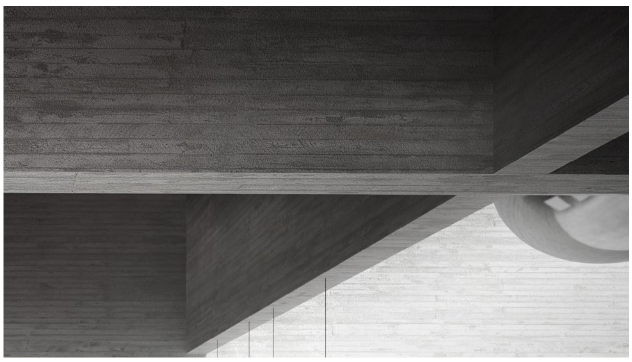
The overall structural principle is based on creating a contrast between heavy and light, formal and informal. The contrast in the construction also underlines the difference in loads between over and under ground which is clearly visible in structures.

Above ground a light steel roof is carried by steel columns, following the randomness of nature. The more random location of columns above ground makes the building seem more informal.

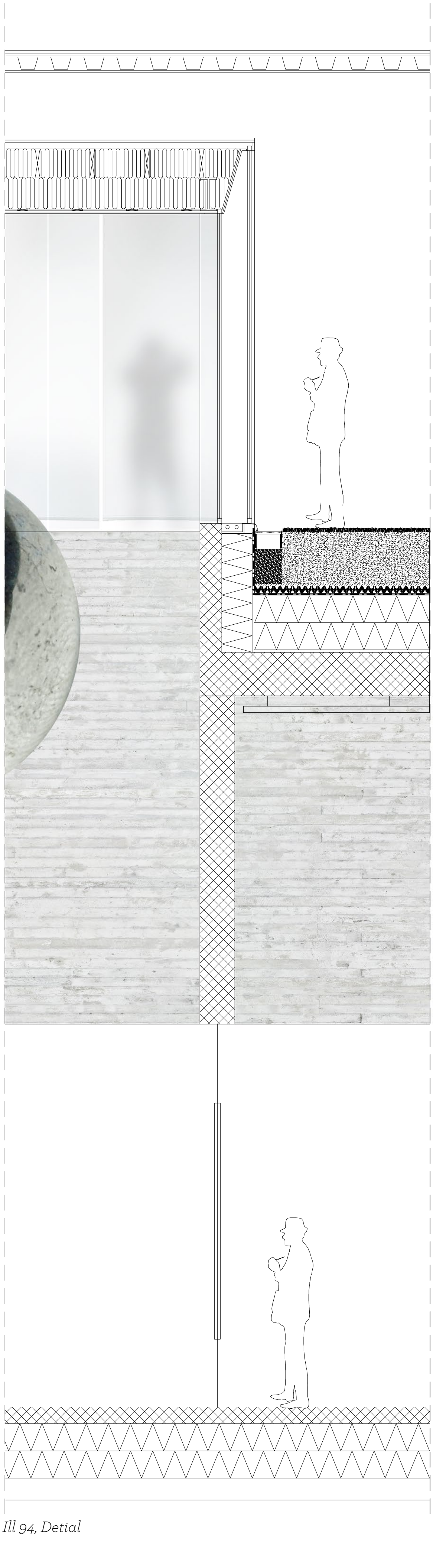
A heavy concrete construction forms the base of the subterranean parts of the visitor center, in clear contrast to the light construction above. A concrete grid is the overall principle for the construction below ground. The grid creates an embracing gesture similar to the experience of walking under the cantilevering parts of the cliff or being in a cave. By revealing the structure it indicates the play of forces and provides an structural understanding.

The in situ cast concrete tells the story of how it was constructed by revealing the wood boards used as form work while enhancing the tactility of the constructions. The detailing of the structure also work as a structural metaphor while being an acoustical better solution than a plain surface.

Ill 93a, Grid in education



Ill 93b, Grid in exhibition



Ill 94, Detial

4.14 DETAILING

EXPERIENCES THROUGH DETAILS

The light upper roof is made up by a steel structure constructed of trapezoidal metal sheets and steel beams carried by circlular steel columns together with the concrete cores. Underneath they are covered with white painted metal sheets reflecting the surroundings.

The glazing of the lightbox continues to the edge of the roof to emphazise it as a clear volume. A integrated lighting system will during the dark hours illuminate behind the glazing both in the light box and the office building and uplights will illuminate the cores in the restaurant and foyer.

The ceiling of the exhibition consist of a layer of soil enabling vegetation and small trees to grow. The ceiling is carried by the heigh beams, which creates variation between the spaces. Acoustic panels are placed between the beams ensuring the desired acoustics. See appendix B for further calculations. Between the beams and the floor hangs the exhibition materials, such as posters that can hang in fastened metal wires. A low transmission loss is ensured by having all of the constructions highly insulated.

DESIGN DEVELOPMENT

4.0

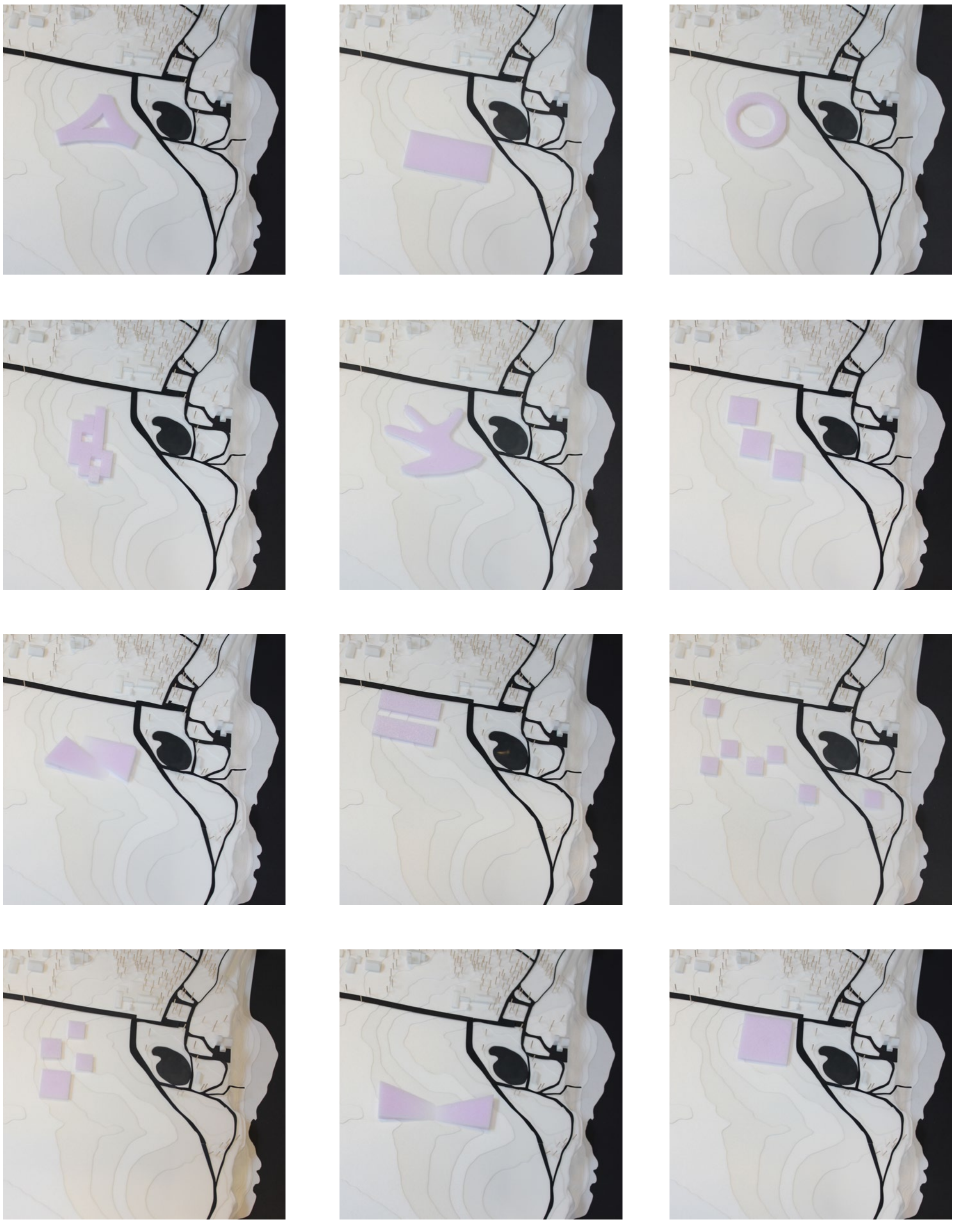
4.0 CONCEPT DEVELOPMENT

4.1 FOAM WORKSHOP

The design process takes its departure from the previously stated vision and was initiated through an urban foam workshop. The main focus was on scale and typologies and to get an understanding of how different volumes containing the required amount of square meters worked on the site. Different forms where tested and it showed that one volume including the necessary square meters seemed large in the context. Therefore there were seen potentials in dividing the building up into smaller buildings or having parts of it underground, so the building would seem smaller in the context.

In close relation with these foam studies different locations of the visitor center where tested. It was seen how the location of the visitor center had great significance on how it was approached and if the building became a natural part of the paths and flows towards the cliff. Also the size and amount of buildings influenced whether the visitor could flow freely or was forced through the building from the parking space towards the cliff.

In addition to this, the workshop also showed that there was a potential in placing parts of the building more towards the road making the building visible when arriving without ruining the important views towards the church.



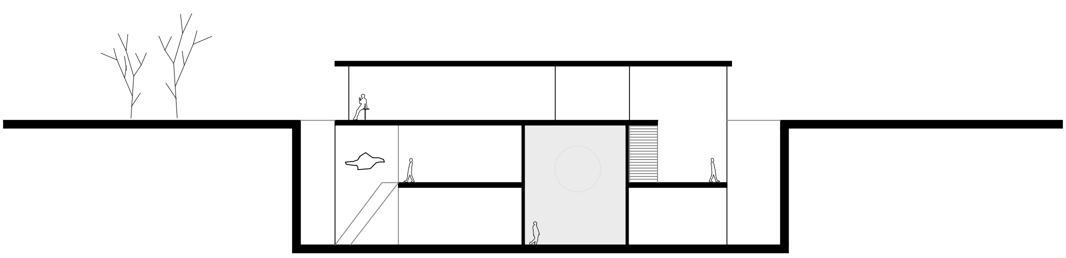
Ill. 99, Foam studies

4.2 INTERNAL SPACES

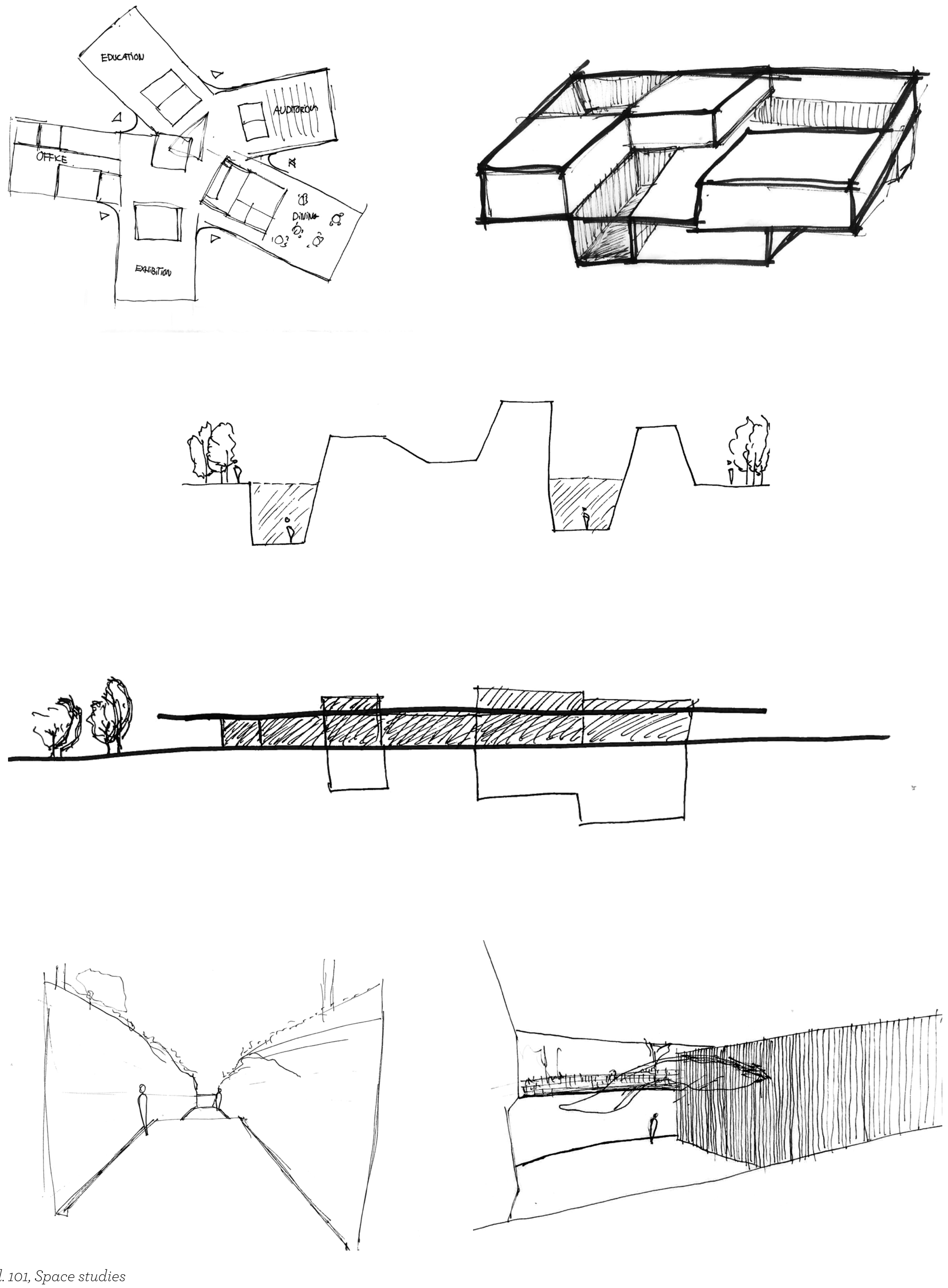
Based on relevant proposals from the foam workshop, work continued on internal organizations of the functional program in order to gain a better understanding of the building program and its potentials. The functional arrangement was therefore mainly explored in section- and plan. Focus was upon creating an optimal internal layout according to connections with each other, connections with the context, considering important views to the nature and to seek potential spatial possibilities.

The studies showed that forms which worked well in the context did not always fulfill the internal layout demands. While a layout where everything were placed above ground could easier enable a good internal flow but would on the other hand not work as good in the context.

As the process continued the understanding of the individual functions different needs gave the opportunity to decide which parts of the building needed to be above ground and which could be placed underground. There where seen potentials in having large parts of the building underground to make it possible to create spatial experiences with a vertical connection. It made it possible to create double and triple height spaces while maintaining a smaller building volume above. While these subterranean parts of the design could be utilized to tell the narrative about Stevns Klint. It could be to show the raw underground in the building, thereby telling the story about geology. Another possibility was to frame specific views towards the fields or even framing the ocean as a last exhibition.



Ill. 100



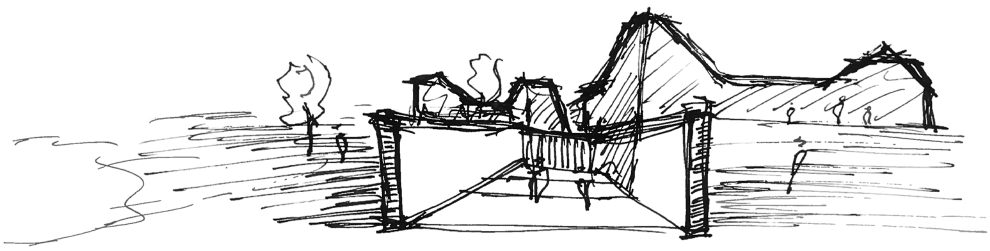
Ill. 101, Space studies

4.3 APPROACHING THE EXTERIOR

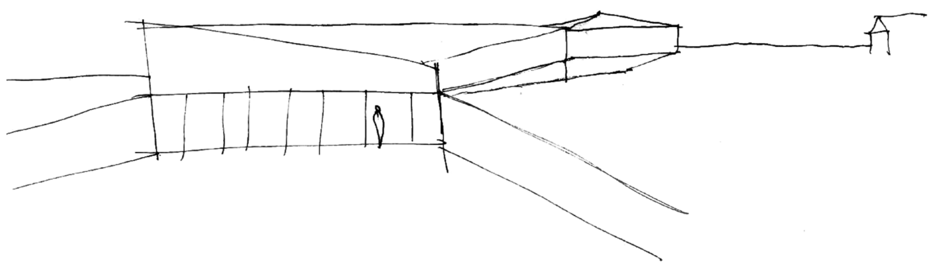
The exterior shape, size and expression of the building was further investigated from the studies on plan and sections with a special focus on how they were approached.

The possibility of entering the building underground were exploited as a continuation of the story of the subterranean. Difficulties were seen in having access from multiple places since the underground access started to form a strong direction and flow for the visitor. Therefore an idea of having a foyer space that where both underground and above ground emerged. It would give the idea of an subterranean building, while being easy accessible from different directions on terrain level.

Different kinds of volumes was further investigated, showing that sharp-cut volumes and organic shapes did not have the same potentials to create a connection between interior and exterior, that a roof would have. Potentials where seen in an idea of having a roof that spanned smaller volumes and courtyards since it was able to create visual connection between levels and blur the line between interior and exterior spaces.

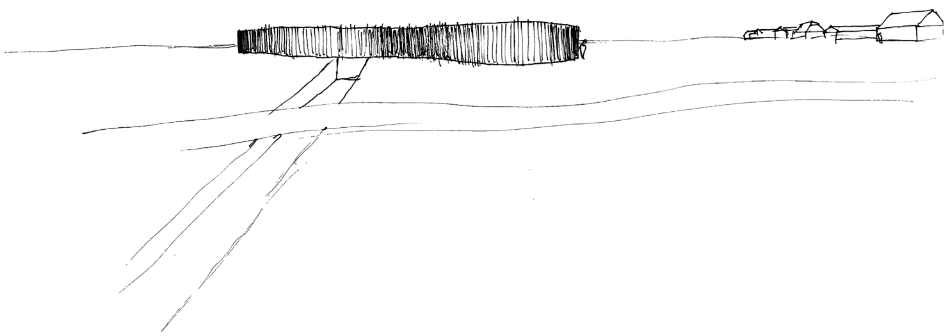


Ill. 102 a, Varying ceiling heights

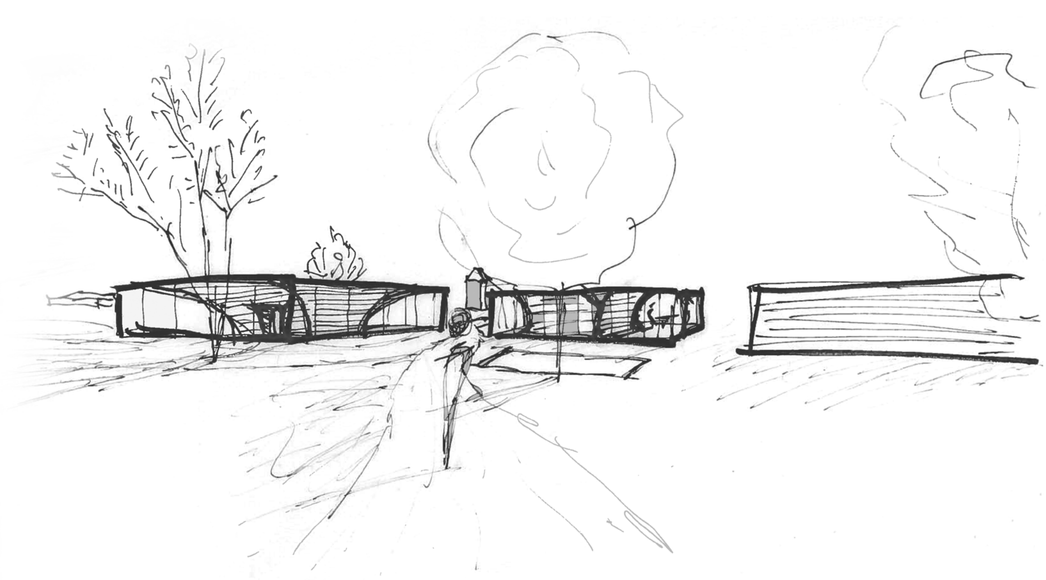


Ill. 102 b, Monolithic

Ill. 103 a, Roof over excavation



Ill. 103 b, Organic shape



Ill. 103 c, Smaller volumes

Ill. 104, Roof studies

4.4 ROOF STUDIES

Based on the idea from the previous studies the concept of simple pavilions together with the roof is further developed through different studies.

The studies were all based on the idea of floating between interior and exterior and the idea of creating larger outdoor spaces. Therefore different sizes of a roof was tested according to how much they would cover. In addition to this the roof was tested through different shape iterations, ranging from an organic roof shape as contrasting element to a offset roof based on the underlying functions.

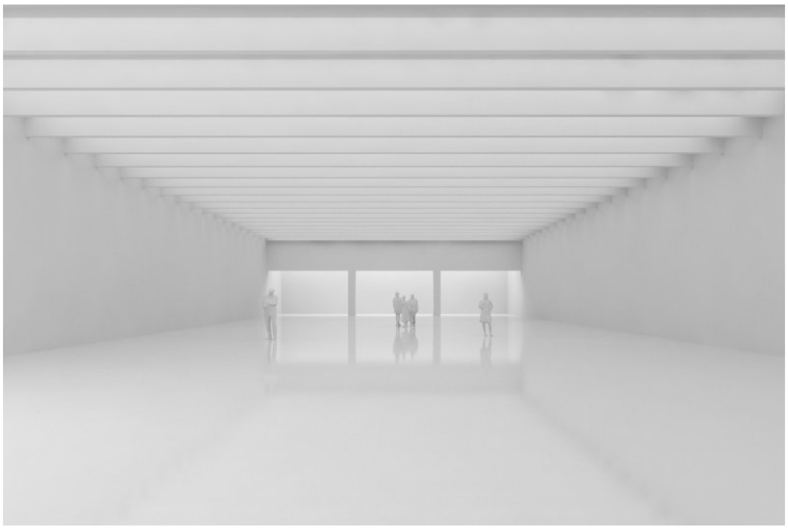
The simple rectangular roof with rectangular holes was seen as optimal since it would create a covered space where cuts lets daylight into the space and the line between exterior and interior is blurred.

4.5 STRUCTURAL DEVELOPMENT

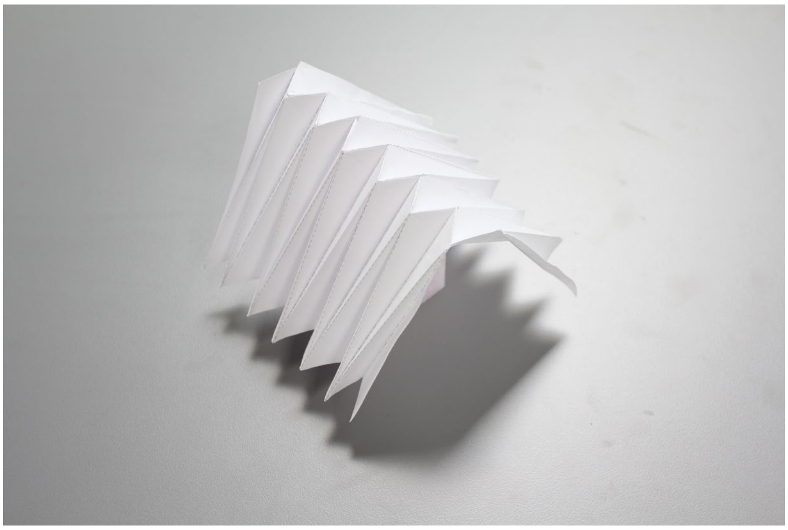
4.5.1 STRUCTURE STUDIES

In this phase of the design process, the focus was on exploring different solutions for the roof structure in the exhibition space. Various options were tested to determine whether there should be any columns in the exhibition space, and which kind of roof structure that best could give the wanted atmosphere. Different test were made testing different types of structures, sizes, densities according to technical criteria, visual expression, spatial experiences and functional qualities.

Potentials where seen in a construction that created a large coherent exhibition space without any columns which a more dense roof structure had the potential to create. After this investigation it was chosen to work further with a grid, as it could create this embracing gesture. This leads to further investigations of a grid construction through parametric evaluation in Robot, to be able to compare the structural qualities with spatial and aesthetically qualities.

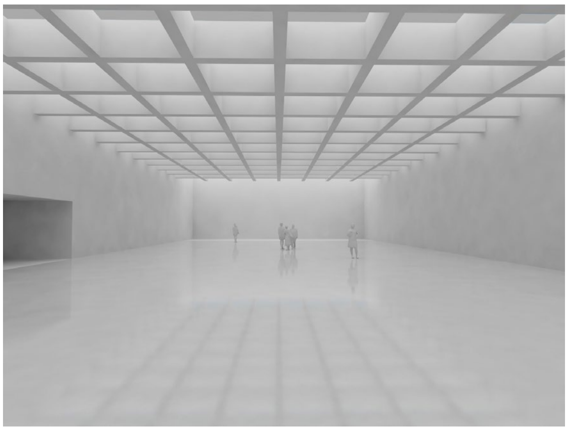


Ill. 107a, Beams

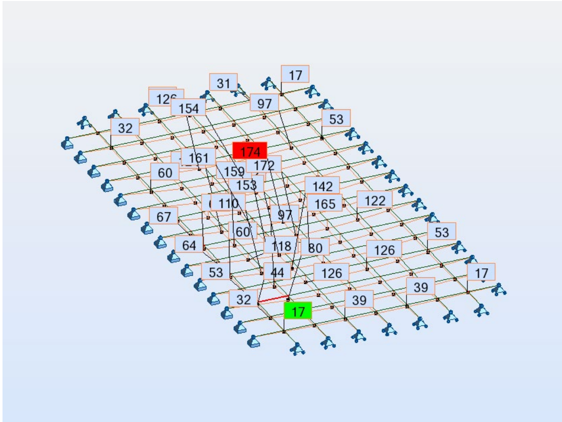


Ill. 107b, Origami ceiling

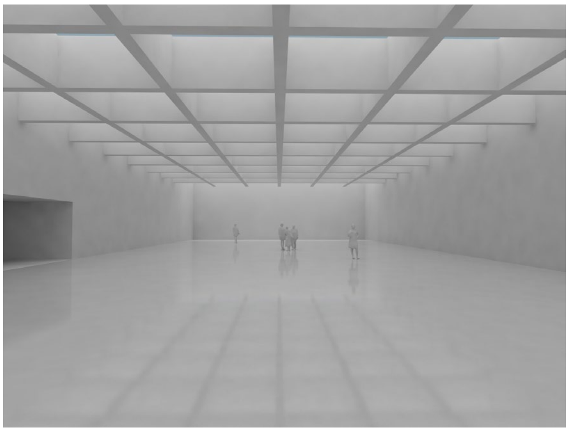
Ill. 107c, Columns



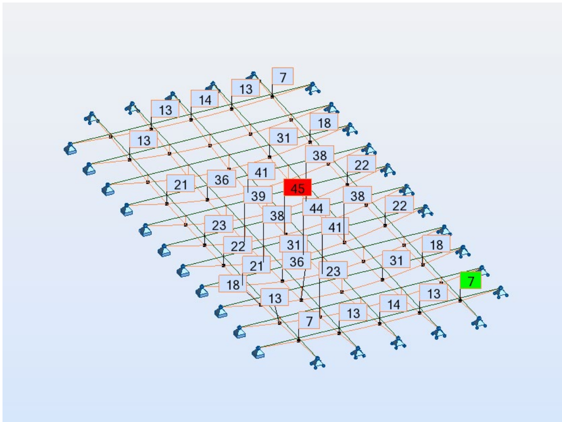
Grid size: 2375 x2437,5 Height: 1000, Width: 270



Max deformation: 174mm

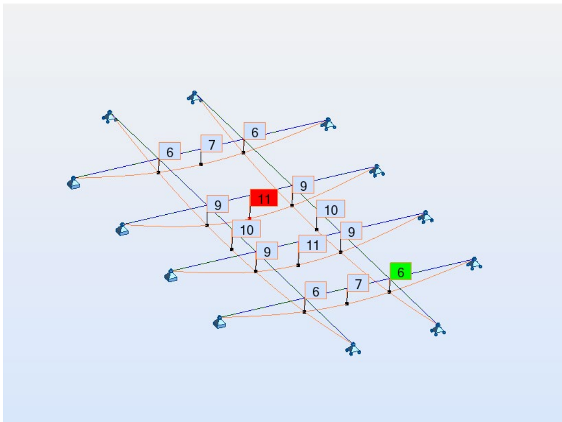


Grid size: 3160x 3250, Height: 1500, Width: 270



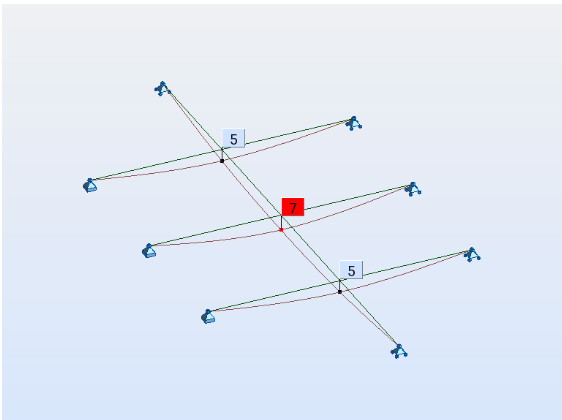
Max deformation 45mm.

Grid size: 6500 x 7600, Height: 3000, Width: 270



Max deformation: 11mm.

Grid size: 9500 x 9750, Height: 3500, Width: 270



Max deformation 7mm.

Ill. 108

4.5.2 PARAMETRIC STRUCTURAL DEVELOPMENT

The grid structure was explored in a parametric setup through the Rhinoceros plug-in Grasshopper and the GH2R-plugin that enables iterative feedback loops from and to the structural analysis software; Robot Structural Analysis.

The studied constructions is a grid of concrete beam where different grid and beam sizes was investigated according to architectural qualities and deformation in the structure. The"Service limit state" combination are used for calculating deformation in the structure. It is therefore characteristic values for material strength as well as characteristic loads that are used. For further information about the type of concrete, steel and loads see appendix A1 and A2. The various grid solutions were supported similar to the static scheme ill. 109

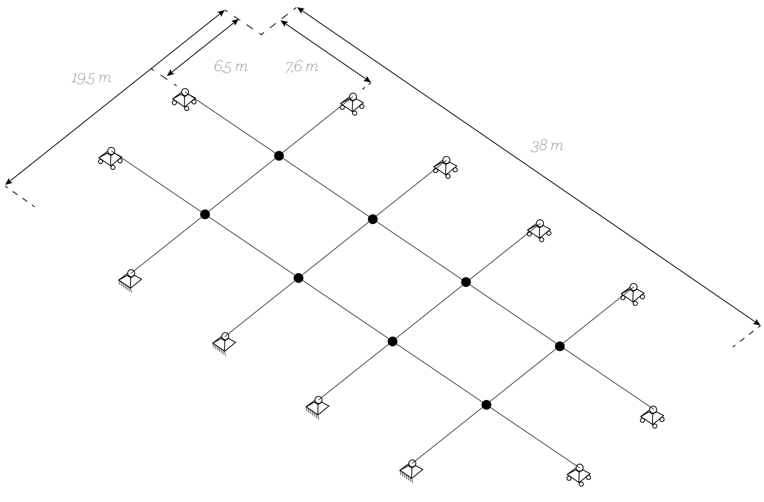
The maximum deflection allowed is given by:

dmax = l/400 = 19500/400 = 48mm

The illustrations shows a selection of the studies where the grid size is changed and the height of the beam while the width was kept. The criteria were to create an open and flexible space without any columns.

The larger grid size created an interesting space within the beams and subdivided the space into smaller niches. Spatially the high beam also gave a more human scale in the open room, since the ceiling height seemed lower when looking at the space as a whole.

The chosen beams with a grid size of 6500mm x 7500mm are further designed and calculated as prestressed concrete beams, to minimize the risks of visible cracks. A calculation on the prestressed concrete beam in "Ultimate Limit State" can be found in appendix A3.



Ill. 109 Static scheme

4.6 LIGHT DEVELOPMENT

LIGHT AND SHADOW

To substantiate the atmosphere of being in a cave in the exhibition room, a study of light and shadow was made. Different iterations were made, varying from a fully lit room to a room where the only light source was through the courtyards. The fully lit room did not give the varying feeling of moving between light and shadow but became a more monotone room. The solution with light only from the courtyards enhanced the focus on the courtyards but creating an overall dark room. A solution where skylights are placed between each beam fulfilled the idea of a contrasting room, where light is hollowing out the darkness in specific areas of the exhibition space, enhancing the atmosphere of being in a cave. At the same time would a room with large contrast between light and dark, better utilize the idea of having different moods in each of the grids according to the specific subject.


Ill. 111a, Courtyards


Ill. 111b, Even distribution of light


Ill. 111c, One sky light


Ill. 111d, Three sky lights

EPILOGUE

5.0

5.0 CONCLUSION

This project deals with the design of a visitor center at Stevns Klint. An Analysis of the site was made, in order to understand the surrounding context, the local climate and the historical background. The site is situated in the periphery of the small village Højerup, adjacent to the cliff and sea in a green open space with dense vegetated zones. The build environment are dominated by historical buildings with a fine detailing and a large parking space being the center of attention.

Analysis on "Museum Architecture" was made to understand the demands of a modern visitor center. The modern visitor center should have a strong link between architecture and exhibition while offer a variety of learning styles and experiences to attract more visitors. Furthermore it is important to know that the visitor center is site specific, only relevant due to its remarkable nature and surroundings. Theoretical discussions was made in order to form a position within tectonics and atmospheres in architecture. The tectonic approach in this project is based on works of Kenneth Frampton, Marco Frascari, Eduard D. Sekler and Anne Beim, and focuses upon creating tectonic architecture through the articulation of construction, materials and structure. Following these thoughts there is also a focused on creating sensible atmospheric experiences, based on Maurice Merleau-Pontys & Juhanni Pallasmaas thoughts on phenomenology and architecture, by enabling all of the human senses and by considering Peter Zumthor's nine elements, with a special focus upon light and materials.

The vision for the visitor center was a design that could communicate the history and magnificent nature of Stevns Klint and enhance the awareness and experience of the cliff through its architecture. The visitor center should be visible in the area, expressing openness and having an enticing effect on visitors while relating to its context in a humble and respectful way.

The proposed design emerges from the concept of having a simple roof hovering above the landscape in one seamless surface, creating a sheltered space that erases the boundary between interior and exterior, building and nature. The roof underlines the horizontal lines in the landscape emphasizing the view towards the ocean, the horizon, the historical buildings and the natural surroundings. Underneath the roof smaller geometric volumes appears, seemingly looking up from the underground. These transparent and semi-transparent volumes express openness and together with the proposed courtyards evokes curiosity by giving enticing bits of visual connection to the underground parts of the visitor center. The varying size and height of the volumes relates to the point typologies and scale seen in the surrounding village, while the simplicity of their facades and geometry makes them stand out revealing its cultural status by contrast. The exterior expression of the architecture is both modest and subtle in the surroundings while making aware of itself by contrasting the natural surroundings and the adjacent historical buildings with a high level of detailing in their facade expressions.

The subterranean parts of the visitor center emerges from the concept of having an excavation under the roof, creating a strong link to the overall narrative about geology and to integrate the raw material found in the underground in the architecture. The foyer space is an open transition space, that connects the ground level with the subterenean parts of the visitor center and the visitors with the exhibition. Inviting visitors to enter from multiple directions, while giving a guiding gesture downwards to evoke curiosity. The foyer space leads to the underlying exhibition room. The exhibition room is an atmospheric space that evokes feelings by grasping the contrasting atmospheres at Stevns Klint, through structure, light, acoustics, materiality and tactility. The atmosphere of the exhibition space is an embodied experience dominated by contrast between light and shadow, high and low, closed and open and variation in tactility. A grid of beams spans above the visitors in this space, creating an embracing gesture similar to the experience of walking under the cantilevering parts of the cliff. The beams divides the exhibition room into smaller spaces, creating niches where the visitor can immerse themselves into a specific subject. In both ends of the exhibition geological cuts in the underground are framing the raw limestone, while functioning as light-wells and giving visual connection to the surroundings.

The exterior spaces are articulated by continuing and extending existing gravel pathways through the site, in a way so they lead visitors through the visitor center as a part of the their journey and experience of Stevns klint, wheter the visitors approach from the parking space, the old church, the cliff or coming from "trampestien".

The visitor center combines various functions under one roof with a natural transition from public to semipublic to private. In the subterranean parts of the visitor center the same materials and structural principles is used, creating a coherence in the architecture. By revealing the structure throughout the subterranean parts of the visitor center it indicates the play of forces and provides an structural coherence throughout the building. The structural principle of the ground level follows the informal language of nature, while the subterranean parts follows the more formal and sharp cut language of a geological excavation. Following the same idea, the courtyards frames the underground of raw limestone in different ways.

Another common element throughout the building is that light and materials are used to show the distinction between heavy and light, below and above ground, and to accentuate the tactility. The materials on walls and beams are throughout the subterranean parts in situ cast concrete with horizontal imprints of wooden planks, as a reference to the geological layers in geology and in the cliff. While floors contrast by being polished concrete, that reflect light in another way. Above ground the material palette follows a white color palette as a reference to the white chalk and limestone seen in the cliff. The roof are made of shiny white painted steel with white columns, while the light box and office are in a white semitransparent glass. The foyer and the restaurant are primarily in glass while having whitewashed cores.

The final design is highly contextual. It is placed, scaled and shaped in order to relate to its surroundings in a humble and respectful way. By having large parts of the visitor center underground, the exterior only reveals limited parts of the building in respect for the natural surroundings and the adjacent historical buildings. While the simple geometry of the visitor center strengthens its surroundings by contrasting it.

In the end, the visitor center at Stevns Klint is a building with a large range of qualities. It is a place not merely to exhibit as seen in traditional museum architecture. It is an architectural filter that through a tectonic composition creates spatial and embodied experiences that emphasizes the awareness and experience of the magnificent history of Stevns Klint as a part of a journey towards the cliff. The visitor center tells the narrative about Stevns Klint, through the poetic unification of aesthetical, functional and technical qualities.

5.0 REFLECTION

This section reflects upon the outcome of this thesis in a broader perspective.

Looking back on the initial question raised in introduction: *"How can architecture support and highlight the unique nature at Stevns Klint"* This projects answer is a simple and humble approach to the surroundings, creating an architecture that does not try to compete with the complexity of nature or its surroundings but contrasts it and strengthens it by its simplicity. One could argue that a simple exterior expression of a visitor center could be an obstacle to attract enough visitors - that an more iconic building would draw even more attention to the place.

Since we started the project in February, the possibility of a future visitor center in Højerup has been further debated and having second thoughts whether the visitor center should be placed in Højerup or another place along Stevns Klint. Since this project took its point of departure in architecture that was highly contextual, informed by the specific site. A new site along the stretch of Stevns Klint, would require a completely new design without doubt, but perhaps it could reuse some of the concepts so it could foster some of the same qualities as in Højerup.

Although this project solves the demands and criteria developed through the program there is still a lot of significant parameters that could influence the design, if it was going to be built. The project does for example not look into economical aspect of the design. When economy and architecture meets, different contradictions rises. This projects seeks to explore the possibilities of a visitor center that fulfills the criteria set up in the vision. Through an integrated design process this project was constantly optimizing functional, aesthetical and technical aspects of the design seeking the optimal design in all aspects. Creating high quality spaces and solutions that may have been left out in the real world. If economical aspect was a criteria, building underground may for example not have been possible due to a limited budget.

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6.0

6.0 REFERENCES

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APPENDIX

APPENDIX A

A.1 DATASHEET

Width	$w = 0{,}270m$
Height	$h = 3\ m$
Lenght	$l = 19{,}5$
Distance between beams	$cc = 7{,}6$
Effiecient height	$d = 2{,}85$

Concrete C20

Compressive strenght	$f_{ck} = 20\ MPa$
Max strain	$\varepsilon_{cu} = 0{,}0035$
Density	$\rho = 1800\ \frac{kg}{m^3}$

Steel Liner 12.5

Strenght	$f_{yk} = 1760\ MPa$
Max strain	$\varepsilon_{cu} = 0{,}08$
Elasticity modulus	$E_{sk} = 210000$

Consequence class

CC3 - High $K_{FI} = 1{,}1$

Control class

Normal $\gamma_3 = 1{,}0$

Design Factors

Insitucast concrete

$$\gamma_c = 1{,}45 \cdot \gamma_3 = 1{,}45 \cdot 1{,}0 = 1{,}45$$

Steel

$$\gamma_s = 1{,}2 \cdot \gamma_3 = 1{,}2 \cdot 1{,}0 = 1{,}2$$

Design values

Concrete $f_{cd} = \frac{f_{ck}}{\gamma_c} = \frac{20}{1{,}45} = 13{,}79\ MPa$

Steel $f_{yd} = \frac{f_{yk}}{\gamma_c} = \frac{1760}{1{,}2} = 1467\ MPa$

Area of reinforcement

$$A_s = \left(\frac{\pi}{4} \cdot \text{Ø}^2\right) \cdot n_{reinforcement} = \left(\frac{\pi}{4} \cdot 12.5^2\right) \cdot 24$$

$$A_s = \ 2945\ mm^2$$

A.2 LOADS

Permanent loads are calculated as a worst case scenario assuming that there is soil, vegetation and people on top of the construction. Furthermore there is another light roof on top of this.

$$g_{roof} = 0{,}55 kN/m^2$$

$$g_{beam} = \frac{h \cdot b \cdot l \cdot \rho \cdot g}{l \cdot cc} = \frac{3 \cdot 0{,}27 \cdot 19{,}5 \cdot 1800 \cdot 9{,}82}{19{,}5 \cdot 7{,}6} = 1{,}881\ kN/m^2$$

$$g_{soil\ \&\ construction} = 900 \frac{kg}{m^2} \cdot g = 8{,}826\ kN/m^2$$

$$g_{Permanent} = g_{roof} + g_{beam} + g_{soil\ \&\ construction}$$

$$g_{Permanent} = 0{,}55 + 1{,}881 + 8{,}826 = 11{,}257\ kN/m^2$$

Variable loads:

$$g_{snow} = \mu_i \cdot C_e \cdot C_t \cdot s_k = 0{,}8 \cdot 1 \cdot 1 \cdot 0{,}9 = 0{,}72\ kN/m^2$$

$$g_{People} = 3\ kN/m^2$$

It is presumed that a high snow load together with a high people load not will happen at the same time. People load is therefore included as a variable load since it is highest.

The design lineloads are calculated using the design values for materials strenght as well as design loads. A presumtion is made that the beam lying in the opposite direction will take 1/8 of the loads since it is spanning double the distance.

Resulting in following design lineload combination:

$$P_{Total} = \frac{7}{8} \cdot K_{FI} \cdot (\gamma_g \cdot g_{Permanent} \cdot cc + \gamma_q \cdot g_{People} \cdot cc)$$

$$P_{Total} = \frac{7}{8} \cdot 1{,}1 \cdot (1 \cdot 11{,}257 \cdot 7{,}6 + 1{,}5 \cdot 3 \cdot 7{,}6) = 115{,}265\ kN/m$$

A.3 ULS - PRESTRESSED CONCRETE BEAM

This calculation is a continuation of the earlier parametric study and calculation of the roof structure in the exhibition room, since they are considered to have the highest loads and the largest spans in the building.

It is decided to use a presstressed concrete construction, to limit risks of large cracks, that will have a poorly affect on the aesthetics of the beams.

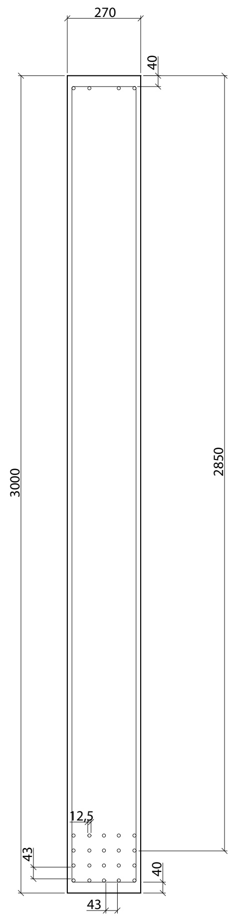
Cover layer and reinforcement distances in the cross section are designed according to fig. 5.8 in Teknisk Ståbi (Jensen, 2011). The required width of beams in relation to the amount of reinforcement bars are designet according to table 5.7 in Teknisk ståbi (Jensen, 2011). The design of the cross section are inspired by examples of prestressed reinforcement cross sections (Spæncom, 2015).

In the cross section there is used 20 pieces of prestressed reinforcement in the bottom and 4 pieces in the top, which have a yield moment on 173kN pr. cord (Spæncom, 2015). According to DS411, it is not allowed to strain more than 80 percent of the yield moment, therefore it results in a max. stress on:

$$173 \cdot 0{,}8 = 138{,}4 \text{kN/line}$$

To be on the safe side with the reinforcement strenght, it is chosen to stress with:

$$F_{s0} = 110kN/line$$



Cross section of beam with dimensions in mm.

The force of the cords can be determined from the arithmetic approximations:

If $0 \leq \varepsilon \leq 7$

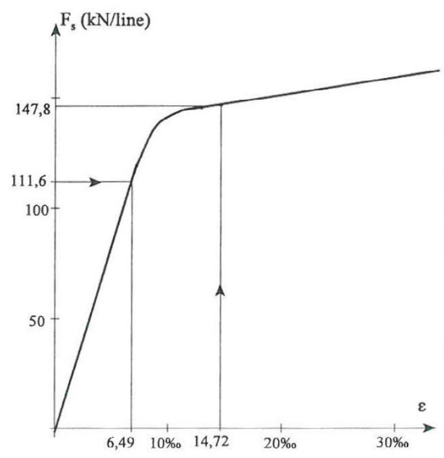
$$F_s = 17{,}205 \cdot \varepsilon$$

If $7 \leq \varepsilon \leq 10$

$$F_s = 0{,}2551 \cdot \varepsilon^3 - 9{,}237 \cdot \varepsilon^2 + 109{,}03 \cdot \varepsilon - 277{,}7$$

If $10 \leq \varepsilon \leq 35$

$$F_s = 136 + 0.8 \cdot \varepsilon$$



Ill. 125a. Characteristic stress-strain curve for L12.5 cords.

Inserting $F_{s0} = 110kN$, gives $\varepsilon_{s0} = 6{,}39\ °/_{\circ\circ}$

The next step is to guess on a pressure height:

$$x = 894\ mm$$

Additional strains can then be found by following formula:

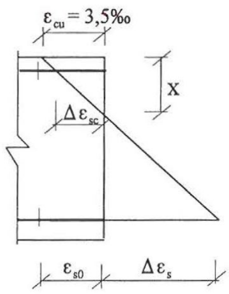
$$\Delta\varepsilon_s = \varepsilon_{cu} \cdot \frac{(d - x)}{x}$$

Cords in the bottom:

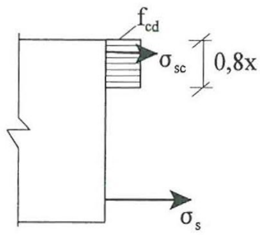
$$\Delta\varepsilon_s = 3{,}5°/_{\circ\circ} \cdot \frac{(2850 - 894)}{894} = 7{,}65°/_{\circ\circ}$$

Cords in the top:

$$\Delta\varepsilon_{sc} = 3{,}5°/_{\circ\circ} \cdot \frac{(894 - 40)}{894} = -3{,}34°/_{\circ\circ}$$



Ill. 126a. Strains



Ill. 126b. Stresses

The resulting strains are then:

Cords in the bottom:

$$\Delta\varepsilon_{s,total} = \Delta\varepsilon_s + \varepsilon_{s0} = 7{,}65°/_{\circ\circ} + 6{,}39°/_{\circ\circ} = 14{,}05\ °/_{\circ\circ}$$

Cords in the top:

$$\Delta\varepsilon_{sc,total} = \Delta\varepsilon_{sc} + \varepsilon_{s0} = -3{,}34\ °/_{\circ\circ} + 6{,}39°/_{\circ\circ} = 3{,}05°/_{\circ\circ}$$

The force of the cords can now be determined from the arithmetic approximations.

Cords in the bottom, where $10 \leq \varepsilon \leq 35$

$$F_s = 136 \cdot 0.8 \cdot \varepsilon = 136 + 0.8 \cdot 14{,}05°/_{\circ\circ} = 147{,}24\ kN/line$$

Cords in the top, where $0 \leq \varepsilon \leq 7$

$$F_{sc} = 17{,}205 \cdot \varepsilon = 17{,}205 \cdot 3{,}05°/_{\circ\circ} = 52{,}42\ kN/line$$

The compression force in the concrete is determined:

$$F_c = 0{,}8 \cdot x \cdot b \cdot f_{ck}$$

$$F_c = 0{,}8 \cdot 0{,}894 \cdot 0{,}27 \cdot 20 \cdot 10^{-3} = 3862{,}08\ kN$$

It is controlled that the static condition is met:

$$\frac{F_s \cdot n_{liner}}{\gamma_s} + \frac{F_{sc} \cdot n_{liner}}{1} - \frac{F_c}{\gamma_c} = 0$$

$$\frac{147{,}24 \cdot 20}{1{,}2} + \frac{52{,}42 \cdot 4}{1} - \frac{3862{,}08}{1{,}45} = 0{,}13 \approx 0\ kN$$

The static condition is approximately fulfilled, whereby it is assumed that the pressurezone height is correct.

The yieldmoment for this x-value can now be calculated and controlled that it is higher than the maximum design moment the construction is exposed for. Meaning that following must be fulfilled:

$$M_u \geq M_{rd}$$

The yieldmoment is found by taking moment on the reinforcement cords in the bottom.

$$M_u = (d - 0{,}4x) \cdot \frac{F_c}{\gamma_c} - (d - 0.04) \cdot 4 \cdot F_{sc}$$

$$M_u = (2{,}85 - 0{,}4 \cdot 0{,}894) \cdot \frac{3862{,}08}{1{,}45} - (2{,}85 - 0.04) \cdot 4 \cdot 52{,}42$$

$$M_u = 6049\ kN \cdot m$$

The largest moment the construction need to tolerate is hereafter calculated:

$$M_{rd} = \frac{1}{8} \cdot P_{Total} \cdot l^2 = \frac{1}{8} \cdot 115{,}265 \cdot 19{,}5^2 = 5478\ kN \cdot m$$

It can therefore be concluded that the construction can take the largest moment on the construction without reaching the yield moment.

$$M_u \geq M_{rd}$$

$$6049 kN \cdot m \geq 5478\ kN \cdot m$$

APPENDIX B

ACOUSTICS

Estimation of reverberation times for critical rooms are calculated with Millington's equation. This equation is chosen because there is a large variation in the different materials absorbance:

$$T_{Sab} = 0{,}161 \frac{V}{\sum_{i=1}^{n} -S_i \cdot ln(1-\alpha_i)}$$

By looking up absorbance coefficients for the different materials in the different frequencies it is possible to calculate the reverberation times.

The workshop room is one of the most critical rooms due to its function as a workshop with group work, and it primary materials with a lot of hard reflective surfaces. The calculated estimated reverberation times for the workshop room are in average below T ≤ 0,6sec, which is acceptable for a educational room with group work.

The estimated reverberation times for the exhibition room are rather higher, but they are in average below T ≤ 1,5 sec, with only the low frequences of 125Hz above 2 seconds in reverberation time. This will result in a deeper reverb emphasizeing the experience of being in a cave. The hearing sense will here substantiate the other atmosphere created by other architectural means, making the exhibition room a even more dramatic room.

Furthermore there is made initiatives towards a better acoustic climate in the exhibition room through the design of the concrete formwork of the beams, because they are made in a way so they reflect in different directions to limit echo.

Building component	Material	Area	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz
			α	α	α	α	α	α
Floor	Concrete Smooth finish	105	0,01	0,01	0,02	0,02	0,02	0,03
Ceiling	Acoustic panels	80	0,41	0,77	0,8	0,58	0,34	0,35
Walls	Concrete, Rough finish	87	0,01	0,02	0,04	0,06	0,08	0,1
Walls	Glass	34	0,18	0,06	0,04	0,03	0,02	0,02
Doors	Glass	2	0,18	0,06	0,04	0,03	0,02	0,02
Windows	Glass	25	0,18	0,06	0,04	0,03	0,02	0,02
Tables, chairs, shelves	Wood	5	0,15	0,11	0,1	0,07	0,06	0,07
People	Clothing, skin	3	0,25	0,35	0,42	0,46	0,5	0,5
Partition	Curtains	9	0,3	0,45	0,65	0,56	0,59	0,71
Tsab			**0,68**	**0,27**	**0,24**	**0,40**	**0,635**	**0,57**

Ill. 129a. Estimation of reverberation time for educational workshop room.

Building component	Material	Area	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz
			α	α	α	α	α	α
Floor	Concrete Smooth finish	780	0,01	0,01	0,02	0,02	0,02	0,03
Ceiling	Acoustic panels	552	0,41	0,77	0,8	0,58	0,34	0,35
Walls	Concrete, Rough finish	659	0,01	0,02	0,04	0,06	0,08	0,1
Walls	Glass	68	0,18	0,06	0,04	0,03	0,02	0,02
Beams	Concrete, Rough finish	1050	0,01	0,02	0,04	0,06	0,08	0,1
Windows	Glass	237	0,18	0,06	0,04	0,03	0,02	0,02
Exhibition, walls and boxes	Wood	150	0,15	0,11	0,1	0,07	0,06	0,07
People	Clothing, skin	5	0,25	0,35	0,42	0,46	0,5	0,5
Tsab			**2,1**	**0,94**	**0,83**	**1,3**	**2,0**	**1,8**

Ill. 129b. Estimation of reverberation time for the exhibition room

APPENDIX C

C.1 VENTILATION STRATEGIES

It is important to consider the ventilation strategies, to minimize the risk of excessive temperatures. during the sommer and to minimize need of heating during winters. The general strategy for the building, is that it will take advantage of mechanical ventilation during winter season, to reuse heat, while natural ventilation will mainly will be used during summer periods to lower the energy use.

Due to the varying room heights in the subterranean parts of the museum and the different skylight and courtyards there is potential for using thermal buoyancy to utilize the stack effect for natural ventilation. The foyer space, restaurant and office potential has furthermore potential to be ventilated through cross ventilation to utilize the potential of natural ventilation better.

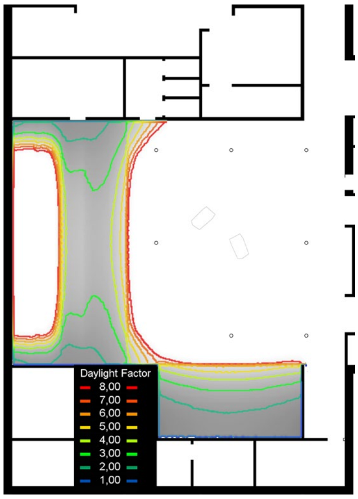
The exhibition room will have the largest volume and is therefore ideal to use the displacement principle for the mechanical ventilation, to avoid the need for changing all air in the room. It is a strategy that focuses on creating clean air only in the occupation zone, and therefore requiring a smaller amount of air.

The mechanical ventilation strategy is to have decentralized mechanical ventilation system, with a low SEL-value and high heat-recovery. Technical shafts in the upper parts of the building, will connect to the decentralized technical rooms in the subterranean parts of the building. These seperate mechanical ventilation units enables the possibility to control necessary air exchange according to the functions individual needs.

C.2 DAYLIGHT STRATEGIES

The amount of daylight have been tested with Velux Daylight Visualizer in the most critical areas of the visitor center. The illustrations shows an example of a daylight study in the workshop room and conference room in the educational part of the visitor center. They are estimated to be the most critical areas, because they are both placed subterranean while they have requirements for a suffientient daylight factor since they are used for educational purposes.

The calculations showed that the average daylight factor in both rooms are above 3 percent, and in the workshop room it is even above 5 percent in average.



Ill. 130. Example of regular glazing together with aerogel glazing

C.3 ENERGY PERFORMANCE STRATEGIES

The subterranean parts of the visitor center consist highly insulated constructions. The ground floor facade are based on a flexible system varying between 3 different types of constructions. All of them will have a outer layer glass creating a uniform facade making them look more transparent and light while being highly insulated with low u-values. The system will consist of 3 layered glazing, aerogel glazing and blinded glazing with insulation behind. The total window area is 25% of the building total floor area which is advised for reaching 2020 goals.

The chosen 3 layered windows has a low u-value to minimize transmission losses. The aerogel glazing consist of a double layered pane of glass with a insulating layer of aerogel, resulting in a u-value on 0,31 (w/m2*k) (Aerogelnorge, 2015). The Aerogell glass has a semitransparent appearance and allows diffuse light to enter. The last will function as a regular wall and will have a blinded glazing with similar expression to aerogel .

It is important to consider shading to minimize the risk of overheating in summer periods. The roof is therefore designed to create the necessary shadow during summer periods, where the sun angle is high, and in the winter periods it will let the lower sun into the spaces. External shading and surroundings trees will during late spring and early autumn be able to create necessary shading to have a satisfying indoor climate. Automatical external shading devices are intergrated flush in the roof line with possibility of manually adjustment. In addition to this will the choice of heavy building materials with high thermal mass level out eventual peaks.

Ill. 131, Example of regular glazing together with aerogel glazing