T E R M E D I C A R R A R A

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Terme di Carrara

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Thermal Baths ; Tectonic design with sustainable aspects

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ABSTRACT

The report introduces the design proposal for the Thermal Baths in Carrara Marble Quarries, Italy. For centuries the site, disturbed by the human intervention, was a source of the marble material, used all over the world. Nowadays quarries are associated mostly with the industry. Our paper will consider what changes can be implemented in the location. How the area can be renowned and how it will contribute to the place with the new function.

One of our main objectives will be designing the resort that will improve the purpose of the place and the near city. All the interventions will be made with the care for the surroundings and connected to the context.

Along the report, we will follow the Integrated Design Process in favour of designing a fully holistic architecture.

READER'S GUIDE

This report is one of two documents, where this is the main paper. At the end of this paper there is an additional appendix. The report is accompanied with a drawing folder.

The paper is divided into four sections: Introduction, Analysis, Design Process and Presentation. To briefly conclude the composition it will be enhanced with the Epilogue. Each chapter follows pointed introduction and is supported with the Sub-conclusion. All the illustrations, such as diagrams, pictures and visualisations, are backed with the illustration number. All of the subtitles are collected and presented in the separate spread. The paper ends with the Appendix, where all the calculations, technical investigations are put together to support architecture with engineering.

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INTRODUCTION

Starting with the motivation, deciding about the topic of our project, we took an inspiration from a competition brief of reTH!NKING Architecture Competitions initiated in 2015. The proposed project was devise to prompt the new kind of leisure that is linked to the quarries and nature simultaneously, thermal baths. During the investigations, the importance leans on a rethinking part of how to intervene in the landscape that is already highly marked with a human interruption. Main focus points were scale, nature and detail in connection with the context, linkage to the history, capacity of relationships between building and topography and work on the big and highly detailed scale. (Rethinkingcompetitions.com, 2015)

Followed by the studies of suitable methodologies, architectural and tectonic strategies and approaches will be demonstrated. The Introduction part deliberates the issue and expresses the problem statement as a framework for the following parts of the project.

Our Motivation
Methodology
Technical and Architectural Approach
Problem Statement

Ill. 12.1 - Own Photography of the Quarry

OUR MOTIVATION

ARCHITECTURE

Architecture, a deep human expression, that lasts for centuries and becomes a mark in the urban tissue that future generations will seek to perceive . Architecture has a high potential to translate our emotions and spatial language into an art that surrounds us in the physical world.

Today, very often the modern architecture seems to forget this unique potential and tend to degrade in terms of a construction cost and return on capital. It is mainly due to the current economic pressure and lack of architectural identity, expression and quality of the detail. It is important to understand that our sense perception is influenced by the power of architectural elements; an aspect of the window as vision of the outside world, as a linkage; the door as a form of transition, connected through embracement of a wall element and the roof that gives us the feeling of safety. Juhani Pallasmaa stated in the book The Eyes of the Skin: "The elements of architecture are not visual units or gestalt; they are encounters, confrontations that interact with memory." (Pallasmaa and Holl, 2009)

In the book Architecture of Happiness, Alain de Botton expresses : "We depend on our surroundings obliquely to embody the moods and ideas we respect and then to remind us of them. We look to our buildings to hold us, like a kind of psychological mould, to a helpful vision of ourselves. We arrange around us material forms which communicate to us what we need — but are at constant risk of forgetting what we need — within." (De Botton, 2014) We need to enhance perceiving of architecture not just as a building that would keep us safe and would fill the endless spaces. We need to apprehend architecture as a the whole complex that surrounds us.

TECHNICAL AND AESTHETICAL ASPECTS OF ARCHITECTURE

As students of Architecture and Design at Aalborg university it is expected from us to design a comprehensive project with a high level of detail. We are immersing ourselves into the cross field between the aesthetics and the more technical aspect of the design process. We believe that focusing on tectonic qualities; the physical appearance, acoustics and other technical conditions, would highly strengthen the function of the design space and would be able to preposses the task to affect the user emotionally and be capable to leave strong memories in people's soul.

THE POTENTIAL OF THE PLACE WITH THERMAL BATHS

The culture of thermal baths originates from the Roman period and is highly supported by the nowadays society.

The proposed location is situated in the Marble Quarry near the coastal town of Carrara, in North- west Tuscany, Italy. Over the years the quarry has been overused and aggravates to the Quarry Waste, which provoked a huge economic and environmental issue. The location might end up with a number of inactive quarries in the future. We believe that designing a SPA resort with possibility of board and lodging service would lead to a better functioning area and would improve the city's functioning. Attracting visitors to the baths, supplied by the local water streams rich with minerals, would create a place tempting, holistic, symphonic and serene. Furthermore, the proposal emphasis would be focusing on the restoration of the existing natural part of the site and its connection to the resort.

METHODOLOGY

A complex architectural design, such as Thermal Baths Resort, requires a compound architectural and engineering investigations, in order to create a holistic proposal. The way to present a strong design, starting from the concept, is to base the framework of the project on the "Integrated Design Process" introduced by Mary-Ann Knudstrup (Knudstrup, 2004). The mentioned method enables the interaction between the architecture and engineering and a control of multiple parameters, that leads to problems' solving and improvement of the design. Integrated Design Process helps to explore the fields of architecture, design, construction and technology, functional aspects, indoor environment and aesthetics (Knudstrup, 2004).

To conduct the complexity of the project we will follow the Integrated design phases: Problem/ Idea statement, Analysis, Sketching, Synthesis and Presentation phase; in the interest of managing all the parameters that are prominent for the design of the Resort (Knudstrup, 2004).

The Integrated Design Process does not secure the architectural, technical and sustainable solutions. It guides and eases the control of various parameters on which the project depends (Knudstrup, 2004). In our design, the tectonic approach is essential to create a strong and functional proposition that fits into the existing landscape.

Tectonics is a broad field and, in the case of our project, we will explore it within all the scales- starting from the problem definition for the site and the function of the building. That will help us with the statement of the concept that leads to the fully holistic architecture.

As for the project we want the users to go through a full sensual experience, as to perceive the space with a sense of touch, taste, vision, smell and hearing. The sensuality, as a detailed part of tectonics in our case, will be broadly studied through the design process. Since our senses are affected by the surrounding in a direct and indirect manner, the investigations will be closely related to the timber construction and detailing, materials used in the design with the careful focus of its treatment, acoustic effect of the areas and the light response.

In order to enhance the capacity and possibilities of the design, a study of Juhani Pallasmaa, Carlo Scarpa, Kenneth Frampton and Gernot Bohme will be researched and explained by introducing their visions in terms of tectonics, atmosphere and sensuality. Basing on the knowledge of the prominent theoreticians, we will follow the Integrated Design Process phases.

PROBLEM/IDEA

For every design it is essential to find the reason for commencement of the architectural investigations. Here, the matter of the thesis will be formulated, that will be followed by the other phases.

ANALYSIS PHASE

In the first step of the IDP we will focus on the analysis of the facts: the site location, infrastructure, its topography and geology, vegetation, local materials, and climate. The history of Carrara Province will be also of the great importance, to bring the understanding of the former function of the area and interpret the space. Further analysis will focus on the Baths: history and of today, and its medical influence. Aside from the analyses of facts this phase will carry the great focus of the tectonic, aesthetical and sensual investigations. But also the phenomenology of the site that will include the personal perception of the space, and user target.

SKETCHING PHASE

Supporting ourselves with the gathered materials from previous phases and following the main aspects of the design: tectonics, atmosphere and sensuality, the connection of the future architecture to the existing site will be studied. Together with the construction and structure of the building, functional layout and comprehensive program, the connections to the nature (size and placement of the window openings; openness of the building), materiality and sustainable approach. In this phase, we will be following the research with the help of sketches and models for the better visualisation.

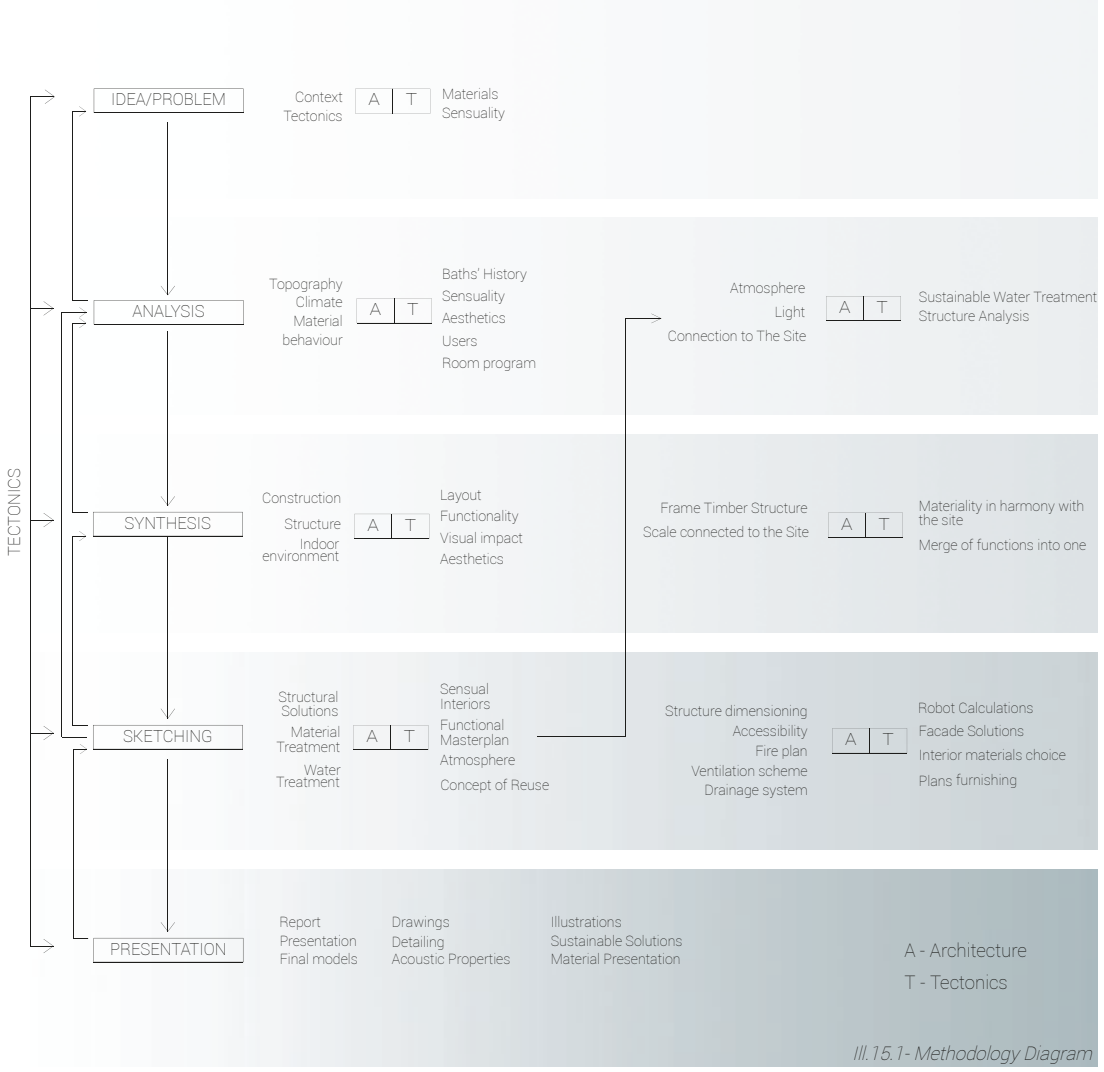
SYNTHESIS PHASE

In order to arrange our studies, we will group all the ideas and solutions. Having in mind previous phases, all the materials will be put together for the final outcome of the project to demonstrate them in the presentation phase.

All the phases are interrelated and it will be necessary along the whole process to come back to previous stages.

Along the process not only the materials and their aesthetic outcome will be investigated but also their technical characteristics: the resistance, the impact they create and how it contributes to the space perception and atmosphere.

The report will be supplied with text to explain every step of the design, sketches, model pictures, photographies, diagrams and all informative material that will help the reader to understand our concept and ideas.



Ill.15.1- Methodology Diagram

Ill.16.1- Own Photography; Marble Detail

TECTONIC AND ARCHITECTURAL APPROACH

TECTONIC APPROACH

The term 'tectonic' derives from the word 'tekton', meaning in Greek carpenter or builder. The term alludes also to the art of construction and artisan working in various materials. (Beim, 2004) The indication of tectonics has been interpreted throughout the time by different theoreticians, oscillating around the architectural construction and aesthetic outcome. Along the time the care for tectonics was rising but sometimes seemed forgotten, when the computation era arrived. Kenneth Frampton has re-defined tectonics as 'the poetics of construction', which led to the rethinking of modern architecture in terms of tectonic tendencies. He rethought the entire modern architectural tradition. Following him, the focus of architecture directed to constructional craft, continuing between the form and construction (Leatherbarrow, 1997).

Nowadays, when we think about tectonics, it doesn't narrow to only the assemblage of the building parts, moreover it presents an art of joints, an art of connecting materials, atmospheres and sensory experiences. (Leatherbarrow, 1997) There is a true potential of tectonics, that enhances the synthesis of aesthetics and construction that leads to creating a holistic space.

In the design it is necessary to follow the thought of theoreticians on the tectonics, creating the fully holistic project with the care for the construction, joints, material connections and material treatment. With the help of the theoretical knowledge, we aim to derive the architecture that influences the experience of the user, their comfort and sensory perception, following the thermal tectonics.

ARCHITECTURAL APPROACH

After all the years of acquiring knowledge, for the final academic test- Master Thesis, we want to deliver a project that connects all of our abilities, architectural and technical solutions. The aim of this paper is to present an interesting and cohesive design that collects high technical - tectonic and sustainable- values.

While approaching architecture, we want to closely follow the Integrated Design Process, that can advance our design and help with formation of the final outcome. Following the concept, while developing ideas, notions and discussing our observations, we want to create the functional design with high architectural and technical value.

It is important for this project to follow main focus points: context, scale, density, detail, nature and sustainability. That would create a fully holistic architecture that will ensure the users with complete sensual experience and they will still stay in close relation to the landscape and nature.

CONTEXT

Site of the project is strongly affected by the human intervention that was carried out for centuries in Apuan Alps. Situated among picturesque nature, area manifests characteristic quarry atmosphere- the cascades formed by marble extraction, water streams freely flowing among the stones and richness of shapes and colours. The appearance of the location affects the visitors and what is important in this case, affects the forthcoming architecture. Exploring the context, we want to work on our design in equity with existing material and presence of the space.

SCALE

The vastness of the site leaves a great impact on the visitor, marking its presence with different-scale extractions. This affects the idea for the building, directing us towards the work with different scales. We want to refer to the various dimensions of the site by exploring scales within the building. This operation can positively affect the cohesiveness of the design proposal and create enjoyable interior spaces in the resort.

DENSITY

The site area of the project is currently abandoned. That gives the possibility for the architectural intervention to spread out along the area in both, horizontal and vertical direction. The intervention in the quarry allow to reuse the spaces and let us to create new zones. By that means, the density planned on the site can be investigated and spaces with various outcome can be designed.

DETAIL

While designing architecture, the small scale details are often being forgotten. Project of the thesis carries various scales, starting from the site scale, through the design. It is essential for us to go deeper into the design and investigate detailed architecture: connections, finishings and its placement. To achieve different atmospheres and sensuality, we want to deeply focus on the materials and tectonics, since in this case every element is important.

NEO-NATURE

For centuries the terrain of the site was afflicted by the human intervention. Losing its connection to the environment, this industrial area became the present nature. It is essential for us to balance our further design with actual landscape, connecting it to an industrial natural parts. This can enrich the range of experience for the users.

SUSTAINABILITY

By using the heavy machinery, the site was being polluted for years. This is one of the reasons why we want to keep in mind sustainable investigations along whole design process. For this reason, following ecological considerations, we want to use on-site materials: stone. Important in the case to Thermal Baths will be also care for good indoor environment.

PROBLEM STATEMENT

In the site strongly influenced by a human mark by different processes of material extraction and heavy machinery, is it possible for a design to contribute to the current state of the nature and recover its potential? How to design an architecture for the common habitability, having in mind the feeling of the marble, the scent of vegetation, the sound of the materials and the vital influence of the water? How to design, having in mind that the nature is at our level not at our service?

ANALYSIS

Baths and Thermal Medicine
Focus of the Project
Case Studies
Site Analysis
Phenomenology

Ill.24.1. - German Bath House

Ill.24.2. - Roman Baths in Bath

Ill.24.3. - Rudas Bath

Ill.24.4. - Parco Thermale del Garda

HISTORY OF BATHS AND THERMAL MEDICINE

The word SPA may derive from different origins, "espa" meaning fountain or from the Latin "spagere" meaning to scatter, sprinkle, moisten. Nowadays, the term "thermal waters" is preferred. The culture of thermal baths originates from Ancient Greece and have been developed throughout the centuries, aiming for different therapeutic purposes (van Tubergen and van der Linden, 2002).

ANCIENT GREECE AND THE ROMAN EMPIRE

Thermal Baths in Ancient Greece were perceived as sacred places with a devotion to distinct deities. Bathing was a signature of purity and it was primarily used for hygienic and curing purposes. The Greeks believed that springs, rich with sulphurous, heal skin diseases, relax muscles and joint pain. Initially, bathing was intended for wealthy people in private baths. Nevertheless, with the time public baths were opened near the temples and natural hot springs. (van Tubergen and van der Linden, 2002)

The Romans were influenced by the Greeks and established their own thermal baths at mineral and thermal springs. Due to the healing abilities, the Roman baths were mostly used as rehabilitation centres for the wounded soldiers. Throughout the years in the Roman period, thermal bathing became a social experience for everyone and, with time, became the comfort centres for various sexual practices. "The culture of bathing advanced towards a sensation of relax and pleasure. Immersion of the whole body in very hot waters was a treatment that the Romans applied to cure rheumatic and urogenital diseases and to renew their appetites and thirst." (van Tubergen and van der Linden, 2002)

MIDDLE AGES

In 476 the Roman Empire fell and Christianity was on its rise. The importance of healing through worship and praying degraded the reputation of the medicinal baths and bathing was officially prohibited. Baths alteration was aiming at churches. (van Tubergen and van der Linden, 2002)

Until the XIII century, people were abstaining from bathing. Since the time onwards, public baths were rebuilt and its popularity rose with people bathing for hours for pleasure and relaxation. (van Tubergen and van der Linden, 2002)

RENAISSANCE

In Renaissance era, bathing and thermal medicine were revalued. At the time, Italian doctors and scientists attempted to analyse the water for minerals and other properties for the first time. They tried to evaluate its quality and effect on the human body.

By the time, one of the recognized treatments with the origins in Caldiero Baths, Verona, Italy expanded to other parts of Europe. The therapy comprised of healing from drinking, bathing, purging and applications of mud on the skin. The recommended duration was 15 days, in repetition every year. (van Tubergen and van der Linden, 2002)

XIX AND XX CENTURIES

During the XIX century, the bathing culture was on its growth. The popularity of science led to a curiosity of mineral waters and its medicinal use. The experimental science was born in the age. The doctors believed that for every disease there was a relevant natural medicinal spring abundant with minerals and recovering characteristics. The modern therapy can be assigned to Vincent Priessnitz and Sebastian Kneipp, who further developed the tenets of balneotherapy, where the thermal water is used for health care and hydrotherapy, where the immersion of the body in the thermal water is for therapeutic purposes.(Gianfaldoni et al., 2017)

Later in the XIX century, with a better knowledge of the medical hydrology individual treatments were subscribed according to the illness, composition of the water and its temperature. The treatments advanced in combinations of "hot and cold bath, herbal baths, mud packs, active physical exercises, massages, and diets." (van Tubergen and van der Linden, 2002)
Vincent Priessnitz first established modern hydrotherapy spa in Grafenberg, Germany in 1819, where he included the combinations of treatments. (Crebbin-Bailey, Harcup and Harrington, n.d., 2005)

The development of hotels, resorts and guesthouses at the springs became rampant. Every thermal bath had its own theatre, casino promenades and more, especially in Europe and North America. The new thermal spas became a centre of a posh life and a meeting point of elite, furthermore became as an inspirational place for painters, composers and writers. The characteristics of the thermal baths led to pleasure purposes rather than medicinal purposes. After the two World Wars with the rise of welfare, thermal baths were affordable for every common man, thus unattractive. (van Tubergen and van der Linden, 2002)

XXI CENTURY

In the beginning of the XXI, the medical influence of bathing is well-known. The water has gained the attention due to the therapeutic experience of the physicians and new studies development about hydrology, pharmacology and biochemistry. A large change was noticed in the use of mineral water and its ways of treatments for several diseases through the past decades. Today, thermal baths are highly accepted and recommended by many rheumatologists and dermatologists. It empowers the circulation, metabolism, immune module, the resistance against stress, therefore influencing the psyche and the physical condition. Nevertheless, a number of complexes is directed towards recreation with standard equipment like steam baths, saunas, whirlpools, solariums and more, in order to relax, vitalize the body and mind and to preclude expansion of disease. (van Tubergen and van der Linden, 2002)

Nowadays, the health and wellness tourism is on its growth and is the essential part of a tourism industry worldwide. The health and wellness tourism is directed not only to a physical and psychical pleasure achievement but also as a cultural and relaxing experience. (Gianfaldoni et al., 2017)

Ill.27.1 - Terme Saturnia, Italy

Ill.27.2 - Le Terme di Bormio, Italy

Ill.27.3 - Le Termas di Tibero

Ill.27.4 - Centro Termoludico de Amelie

FOCUS OF THE PROJECT

EXPLORATION OF THE CONCEPT

When it comes to the project it is important to discover a very clear conceptual idea that would hold the design together through the whole process. It is the base that will state a framework and full-fill all the design criteria. Designing through Integrated Design Process, gathering all the focus points will direct us towards a comprehensive solution expressing a simple self-explicative idea. We believe that together with the good concept, it is possible to create a design that can serve through the time and creates the connection with the users. For an architect the concept serves as a presentation of a coherent and valuable architectural project that not only carries value but also connects to the existing landscape.

LOCAL IDENTITY

The design should stay in a close relation with the existing topography of the site, fitting the context. It is important that the architecture has the conversation with the landscape, tells the story of the area by using local materials thus conceive a dialogue between people, architecture and scenery. Creating cohesive outcome, the experience should enhance the long-lasting feeling of tranquility and nature.

LIGHT

Light, an essential part of our design whereupon we would like to accent in our project. It opens the possibility of having distinctive experiences by openings' variations, placement and materials likewise of having the benefit of the daylight and natural values of the area. Along the design process, we want to investigate the openings in relation to the nature, their variations and positioning in order to achieve different atmospheres and perspectives.

ATMOSPHERE

It is important for the project to create the spaces in a way to ensure the users with full experience, to play with their senses: the sense of touch, the sense of hearing, the sense of taste, the sense of vision. Not necessarily in an ordinary way. During the design process, we want to investigate the relation between the volumes, heights and shapes in order to design spaces with different feelings, with more and less intimacy and sublimity.

TECTONICS

Tectonic approach is one of the main direction of our project, that will be investigated along the design process. We believe that focusing on the tectonic qualities will strengthen the designed space. It plays a big role in atmosphere formation and receiving of the place. During the design we want to explore the materials, connections between them and their placement, in order to have an adhesive outcome.

SUSTAINABILITY

With the care for the simplest details, during the Integrated Design Process sustainable solutions will be taken in consideration even though sustainability is not the main focus of the project. Sustainability in architecture means to bare in mind the ecological, economical and environmental aspects of the project.

CASE STUDIES

Peter Zumthor | The Therme Vals
Sensory Perception of Architecture
Álvaro Siza Vieira | Leça Swimming Pools
Landscape Integration

PETER ZUMTHOR | THE THERME VALS

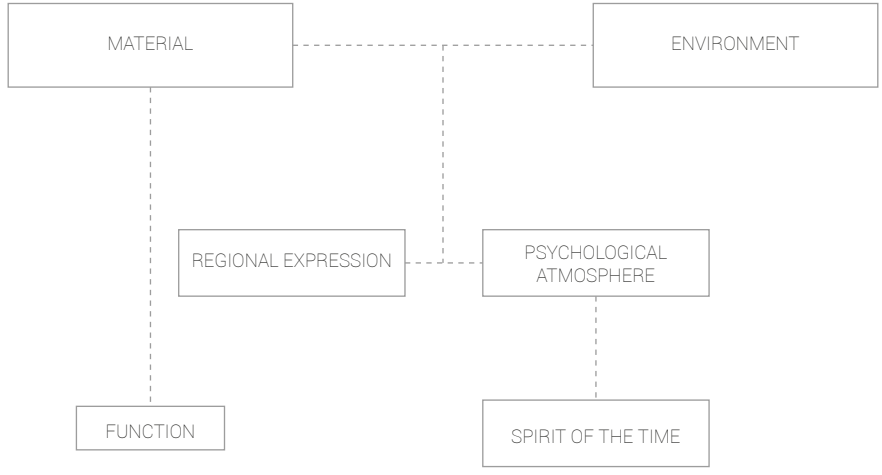
Built over the only thermal springs in the Graubunden Canton in Switzerland, The Therme Vals is a hotel and spa, which offers an immersive experience enabling visitors to follow their senses to discover the Architecture. (archINform, 2018)

The idea was to create a cave or a quarry born of the mountains. Working with the natural surrounding the baths are sinking into the slope with a green roof on top revealing a geometrical pattern. The circulation areas, pool floors, stairs, ceilings, stone benches, door openings are done in locally quarried Quarzite stone, which appears the baths as a literally monolithic. (7132therme.com, 2018)

The only revealed facade is facing the mountains with wide openings. No doors presented, the only way to reach the spa is from the main hotel passing through a corridor in the basement that cuts the mountain. (Zumthor and Binet, 1998)

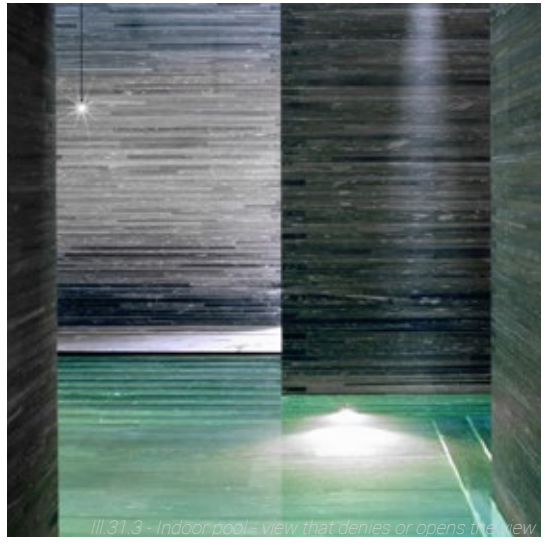
The experience of the visitors starts with passing the entering cave with artificial light, continuing through the darkly clad changing rooms and finally meeting the endless space of the bathing floor. Space is designed for visitors to re-explore the ancient benefits of bathing. Through a combination of light and shade, open and enclosed spaces by linear elements, the spa experience becomes highly sensuous and immersive. The informal layout of the internal space has a specific path of circulation which leads the bathers to predetermined aims but let them the freedom to explore the areas. The perspective is always controlled. It either denies the view or guarantee the definite spatial quality. (Zumthor and Binet, 1998)

The immobility of the walls' parallel lines and the shimmering of the water and its reflections create a contrast between monochromatic grey and the play of the light, delivering to visitors a new kind of bathing experience. (Zumthor and Binet, 1998)



Ill.31.1 - The Determinants of the Form

Ill.31.2 - Separation of the space with light



Ill.31.3 - Indoor pool - view that denies or opens the view

Ill.31.4 - Indoor pool - daylight view

Composed sound art

Splashing

Voices

Flow - stone material - foot steps

Flower scent

Progression of high and low daylight

Ill.32.1 - Floorplan The Therme Vals, sensual perception of architecture - own illustration

Program Legend

1	Point of access/exit
2	Cleaners' storeroom
3	Make-up room
4	Hall with springwater, drinking fountains
5	Changing rooms
6	Showers
7	WCs
8	Sweat stone with Turkish shower and sweat chambers
9	Indoor bath 32°
10	Outdoor bath 38°
11	Stone island
12	Rock terrace
13	Sound bath 35°
14	Fire bath 42°
15	Cold bath 14°
16	Shower stone
17	Drinking stone
18	Sounding stone
19	Flower bath 33°
20	Rest space 1
21	Outdoor shower stone
22	Rest space 2
23	Massage
24	Rest space 3
25	Disabled WCs
26	Disabled cloaks and first-aid-room
27	Disabled access
28	Bath attendants

SENSORY PERCEPTION OF ARCHITECTURE

Architecture has a profound ability to provide a deeper function than just to serve as a shelter. It supports people's desires, feelings and emotions. Architecture is an act of harmony between the human being and the world. The perception of the space is always vicarious by the senses. The sense of sight, hearing, touch, taste and smell. These senses can go along with additional sense of temperature, pain, sometimes called as kinaesthetic sense, which "inform us about the movement and position of the various parts of our bodies" (MacLachlan, 1989)

Architecture is primarily perceive as a visual experience. The sight have a power of stimulating other senses in our body. It imbibes the visual characteristics of a space. Sometimes buildings are designed to delight the eyes but fail the sensory perception of the body as a whole. (CN and Nair, 2014)

The sight perception tend to be direct, apparent whereas sound is omnidirectional. Sound can enhance the quality of the space, it creates the unique identity that connects people. "Intimacy or monumentality, invitation or rejection, hospitality or hostility. " (CN and Nair, 2014) A building has a form, volumes and materials: these three features are sound instruments playing in the interior and exterior spaces. The sense of hearing, perceive in the Therme Vals designed by Peter Zumthor, is noted with each splash, whisper and deepened coming from the narrow path reaching the open pool area.

The remembrance of the space is supported by an ethmoidal imagination. The scent can float freely around us or can be heavily hanged in the air as a feeling of finality. (CN and Nair, 2014) The sensation of steamy breath in the passage leading to the "flower bath" - experiencing the sense of smell and tactility with the aromatic petals of flowers, shown in the example of The Therme Vals.

The combination of action of nose and tongue evoke to the taste. The close connection between tactile and taste is acknowledged as well as sight influence the oral sensation. (CN and Nair, 2014) In the The Therme Vals, when entering the Thermal Baths, the visitors' first attempt is the sound of the water flowing behind the walls and tasting the spring water as a very early direct experience.

The skin is positive in translating the texture, density or a temperature of an object. The vision reveals what the touch already knows. The light and colour is in a close relation with the tactile sensation, it transmits the temperature that can be touched on the surface. (CN and Nair, 2014) As noted in one of the Pallasmaa's books: "Every touching experience of architecture is multi-sensory; qualities of space, matter and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton and muscle." (Pallasmaa and Holl, 2009)

During the design process the sensory perception will be one of the main parts of the process and these notions and knowledge will be taken into consideration.

ÁLVARO SIZA VIEIRA | LEÇA SWIMMING POOLS

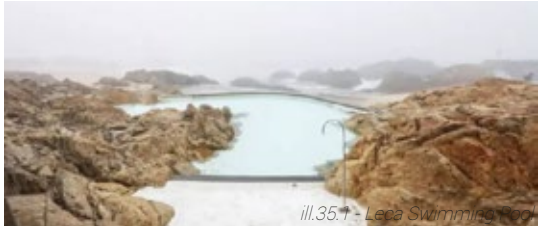
Leça Swimming Pools, by Alvaro Siza Vieira ,are located in Matosinhos- small coastline town to the north of Porto. The building is situated between the Atlantic Ocean and the access road to the coast. It is not a big complex, containing changing rooms, two swimming pools, one dedicated to adults and one for kids, and a cafe. (Balters, 2011)

In this case, architecture works as a form of disconnection between city's infrastructure and the nature, at the same time being fully out of sight. The design carries great respect for the landscape and its natural rocky coastline. Main material used in this case is concrete, that stays in the harmony with the site. Alvaro Siza carefully preserved broad part of existing rock formations around the design. He also left the rocks in the area of big swimming pool, where they are spread along its edges from the site of the Ocean while the rest of the pool's walls are low concrete slabs. (Rozi and Marinaki, 2018)

The building presents geometric and simple architecture. The plan of the complex is understandable and functional and provides the visitors with various experiences that they can detect with main senses: smell, touch and hearing. When entering to the building, the rough concrete walls start to separate the users from both, traffic and the Ocean. Here is when one can detect the water only audibly. Inside the changing rooms and corridor the daylight was let in, creating new shapes within the walls. (Balters, 2011)

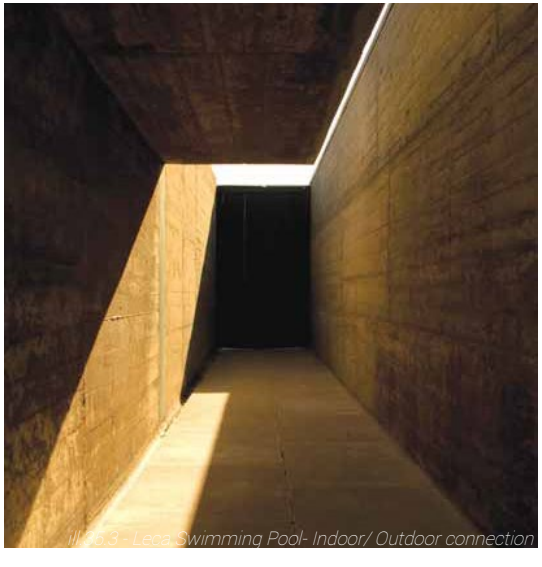
Pools are accessed from the changing rooms. They are separate spaces, with different shape and volume, connected by the platform. In the pool zones, almost from every angle, the level of the pool water and the ocean seem to be connected, blurring the limit between them. (Balters, 2011)

The project presents high architectural values, coherence, and care for the nature. Thanks to Siza's interventions and his dedication to the existing site the outcome is unique and doesn't mark the architecture as a focal point but rather as an extension of the topography. (1958-2000 Alvaro Siza, 2000)



ill.35.1 - Leca Swimming Pool

ill.35.2 - Leca Swimming Pool- Bathroom



ill.35.3 - Leca Swimming Pool- Indoor/ Outdoor connection

ill.35.4 - Leca Swimming Pool- Outdoor swimming pool

ill.35.5 - Leca Swimming Pool- connection of natural part and the modern part

Ill.36.1 - Landscape Integration Collage

LANDSCAPE INTEGRATION

The context of the site carries a great impact on the outcome of the design. It is essential to take under consideration the effect of the location's climate, the primary aspect that affects the form. The human intervention through centuries on the site caused the choice to act respecting the quarries and their aesthetics and not provoking a negative influence on the topography and the landscape.

In order to elaborate the most important principle of the design process - a creation of an extraordinary architecture that can contribute to the outstanding site and create a sort of an extension of the mountains - few theories from prominent architects are presented. In this way, Alvaro Siza, Peter Zumthor and Frank Lloyd Wright form our inspiration concerning the theme of the connection with Nature.

Looking at the Leca Pools by Alvaro Siza, it is easy to see the care of the architect for the landscape. He introduces the building complex as an extension to the context, increasing its value. He gives to the user the impression of an organic architecture that is sunk into the rock formations. His treatment of site and building integrity enhance the area, giving an offbeat experience. In our design, we want to present the architecture as an extension of the topography, and architecture that cares for what was there before - the site that for thousands of years was carrying the same characteristics (Fathy, Shearer and Sultan, 1995). The connection to the context happens, not only by connecting the building to the topography but also by the material choice and its treatment. With this choices, it is possible to improve the reading of the building and create uncommon sensuality of the space.

For the Swiss architect Peter Zumthor, design is not about the form itself. It all focuses on spaces and materials. That is why his buildings have a great integrity within. In the Therme Vals, where he merged the building with the site, the integration was not only about the use of material and form of the architecture, but also about the feeling and the purpose of the spaces (Pritzker Prize goes to Peter Zumthor, 2009). Following his thoughts, in the design of Thermal Baths in Carrara, the spaces will be thoroughly studied and connected to the materials on the site in order to present the coherence and the purpose of the architecture.

When speaking about organic architecture that has an unique relationship to the surrounding, Frank Lloyd Wright directs his readers to embrace the nature, to interfere into the landscape in a way that after imposing the design, it will have more value and will be more remarkable than before. For the American architect it was always important to allow the nature to be an inspiration for the creations, to show its truth and reality. Architecture should work with nature as one, not by exposing it but to work on the human senses with its help. In organic architecture the building and the site have a special relation. The building derives from the site, and the context enhances the building. It can be done by similarity or contrast. The building grows out of the landscape as naturally as any plant, therefore when architecture is moved it loses the roots (Saint, 2017).

Following these three great minds, we will try to contribute to the site implementing its valours with the architecture by different means. In this way, we not only want to present a coherent design but also an architecture of strong characteristics and respect for the space. All this will be shown through the layout, sections, chosen materials, structure and connections and openings towards the on-site context.

"No house should ever be on the hill or on anything. It should be of the hill. Belonging to it. Hill and house should live together each the happier for the other" - Frank Lloyd Wright

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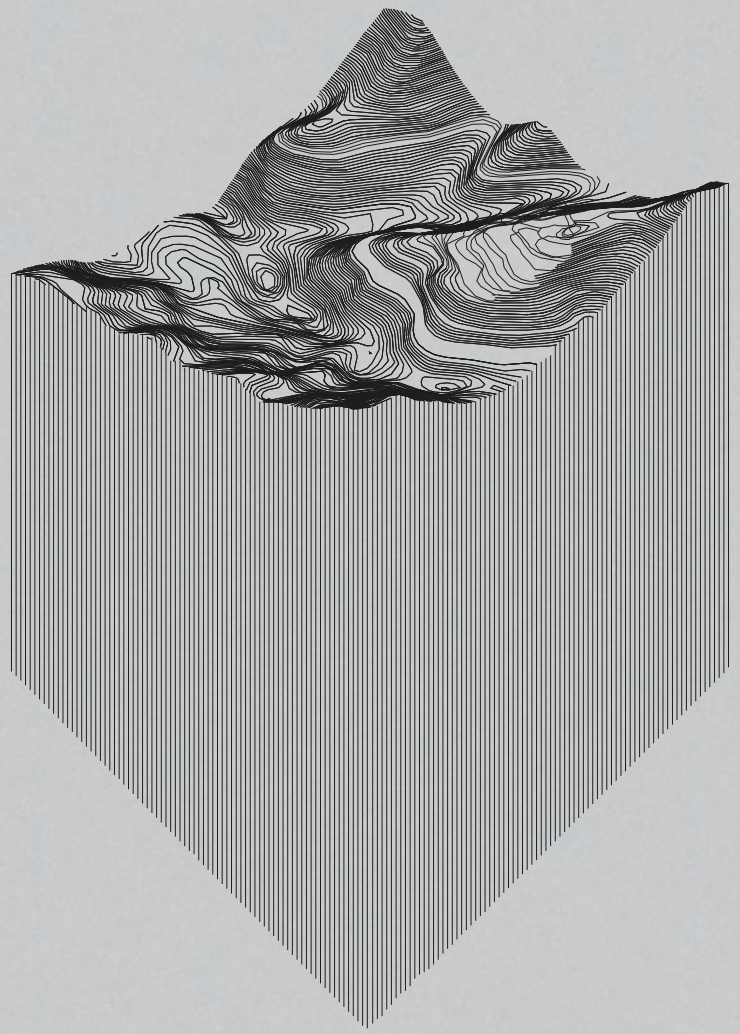


SITE ANALYSIS

Carrara Province
Location
Infrastructure
Topography and Geology
Local Materials
Vegetation
Climate Analysis
Phenomenology
Study Trip

CARRARA PROVINCE

HISTORY OF PROVINCE AND MARBLE QUARRY

The first noticeable track of colonies in the Apuan Alps dates back to the IX century B.C., when the region was inhabited by the Apuan Ligures. No quarry activity was registered until the II century B.C. At that time, Liguria was conquered by the Romans who started the development of the quarries and worker's houses in the current marble quarries area and to set a base for the current city of Carrara. Since that time, the area was associated with the quarrying processes and carving of the marble (Knight, 1982).

Along the years, Carrara Province was vested and was moving from hands to hands of new rulers. The area of Carrara had turned into the city-state in the early XIII century. During the next centuries city was acquired by Gian Gelazzo Vistoni and later become a dispute point between kin of Tomasso Campo Fregoso and Malaspina family, the future rulers of the area. The quarries of Massa and Carrara were under the power of Cybo-Malaspina family in the XVI and XVIII centuries. The kin created the 'Office of Marble' adjustments in 1564, to regulate the industry of the marble mining (Knight, 1982).

At the end of the XIX century, in the Province of Carrara, the anarchist movement had raised, mainly among the quarry workers and stone carvers. Since that time, the feeling of anarchism and general radicalism grew into the heritage of people and the area.

Later on, in 1929 the municipalities of Massa, Montignoso and Carrara merged in a single one, which was named the Municipality of Apuania (Knight, 1982).

To this very day, the quarries are an important part of the province. The Apuan Alps were home for more than 650 quarry areas. At the moment, half of them is out of use and abandoned or devoid of material. The remaining quarries are still functioning and according to the newest information the availability of the material could cover few more centuries of excavations.

EXCAVATIONS

The works in the Carrara quarries were carried out for over 2000 years. It supplied the countries in Europe, South and North America and Asia, and until today the export is at its high peak. The exported material can be rough or in the finished form, depending on the needs (Willey, 1907).

Through the centuries the methods of extraction of marble were being improved in order to make the work faster, safer and waste less of the precious material (Willey, 1907). In the Roman times, marble was derived with the use of hammer and chisel until the depth of approximately 2 meters, later the crack was filled with wooden slacks and treated with water. This allowed the extraction of marble along the vein. This practice was continued in Renaissance (Dolci and Bogazzi, 2006). For a brief period of time, in the quarries, the workers were using the dynamite which led to material destruction and big amount of waste. That is why this method had not been performed long. (Dolci and Bogazzi, 2006) Nowadays in the quarries, the extraction is executed with steel wire, wrapped with the diamond rings and covered with nylon. Along the action, wire is supplied with water. In the quarry site, there are also used the 3D machines that cut saw less and without the use of water. This method is slower but has a minor environmental impact (Dolci and Bogazzi, 2006).

CULTURE AND ART

Marble retrieved from the Apuan Alps quarries became a part of the numerous cities all over the world, mainly used as a construction and finishing material, as well as to create one of the most well-known sculptures. The first notice of the White Marble employment was in the ancient Rome, when Pantheon was constructed. The material was also used for the creation of the Trajan's Column, Column of Marcus Aurelius, Marble Arch in London or the Duomo di Siena. Michelangelo's renowned sculpture of David, was made of one of his favourite substance, the marble, coming from the Carrara Quarries. (Goldwaite, 2009) Nowadays, the extracted material is still widely used for the creation of statues, flooring and finishing of the greatest buildings but also in the smaller scale architecture.

Ill.41.1 - Carrara Cave

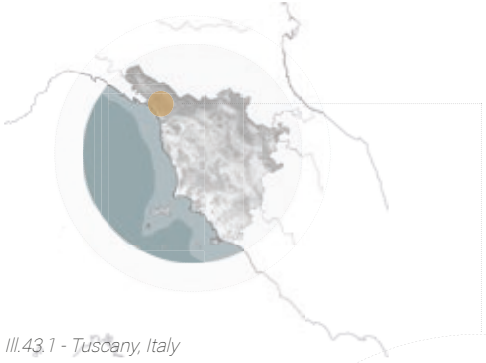
Ill.41.2 - Carrara Cave - the history of marble excavation

Ill.41.3 - Carrara Cave - the history of marble excavation

Ill.41.4 - Carrara Cave - Ponti di Vara

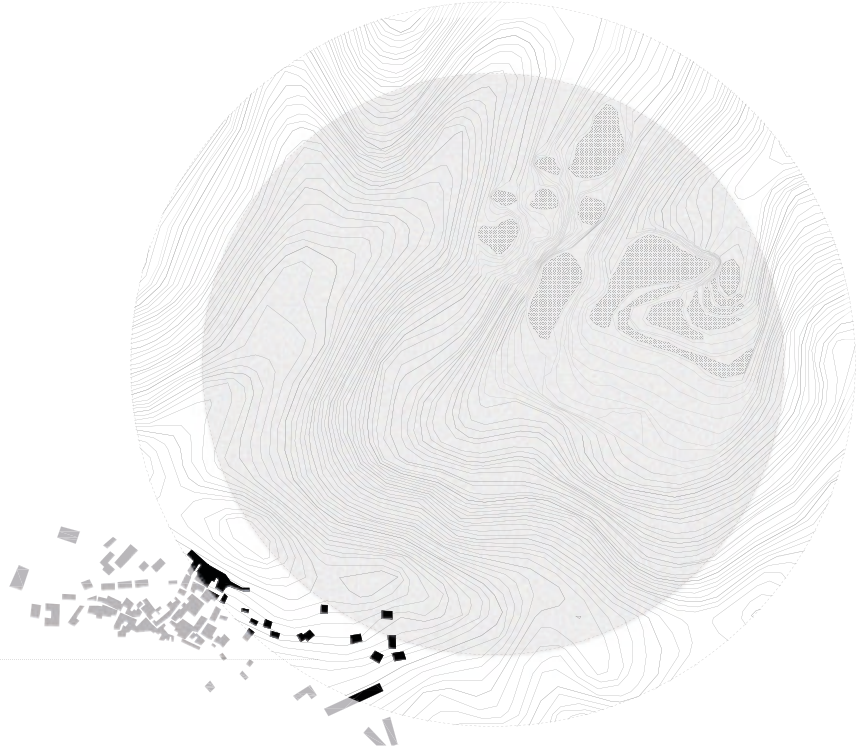
Ill.42.1 - Carrara Quarry

LOCATION



Ill.43.1 - Tuscany, Italy

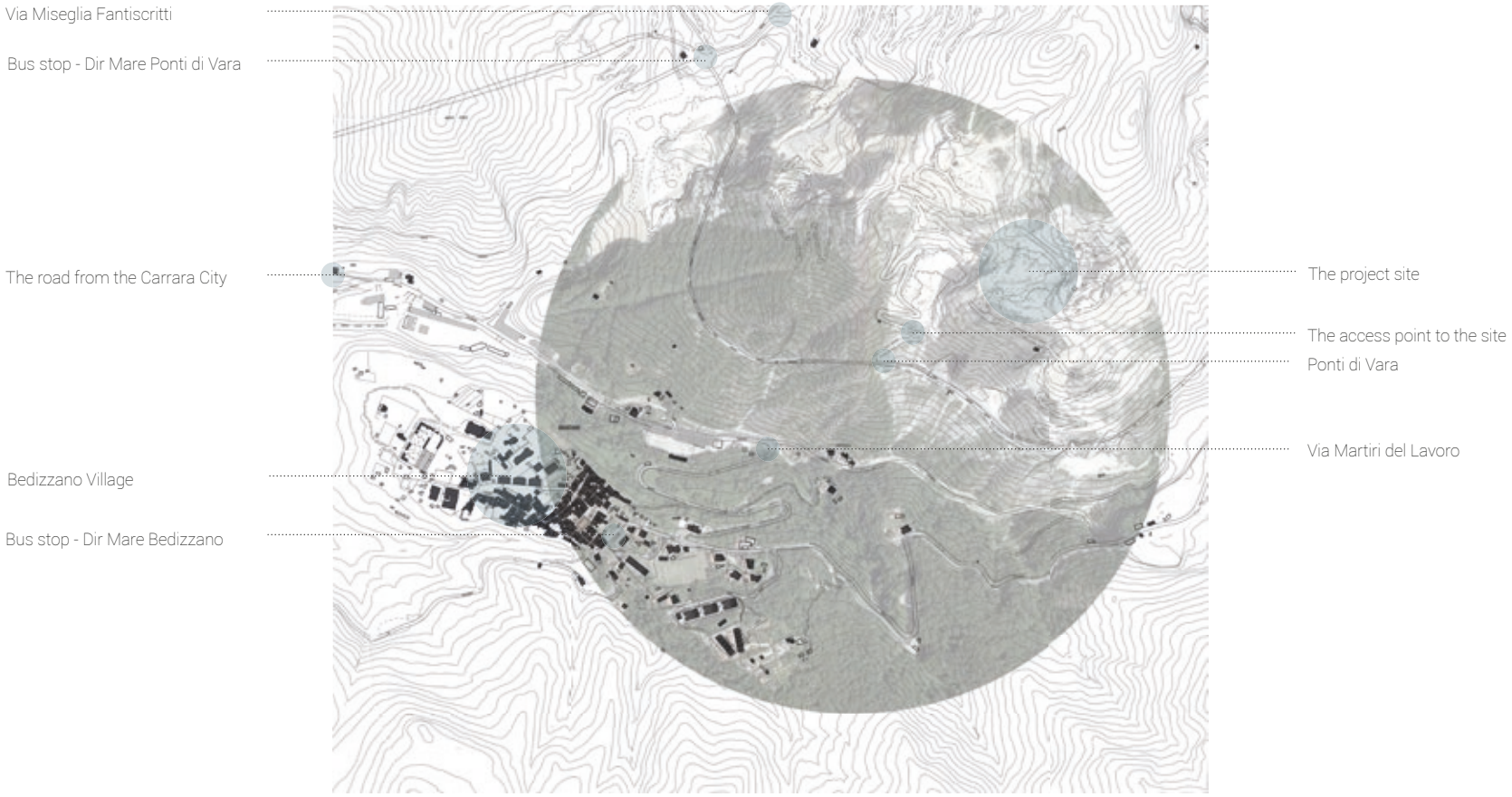
Ill.43.2 - Carrara Province, Tuscany, Italy



Ill.43.3 - Carrara Marble Quarry and Bedizzano Village , Tuscany, Italy

Ill.44.1- Map - Project Site

INFRASTRUCTURE



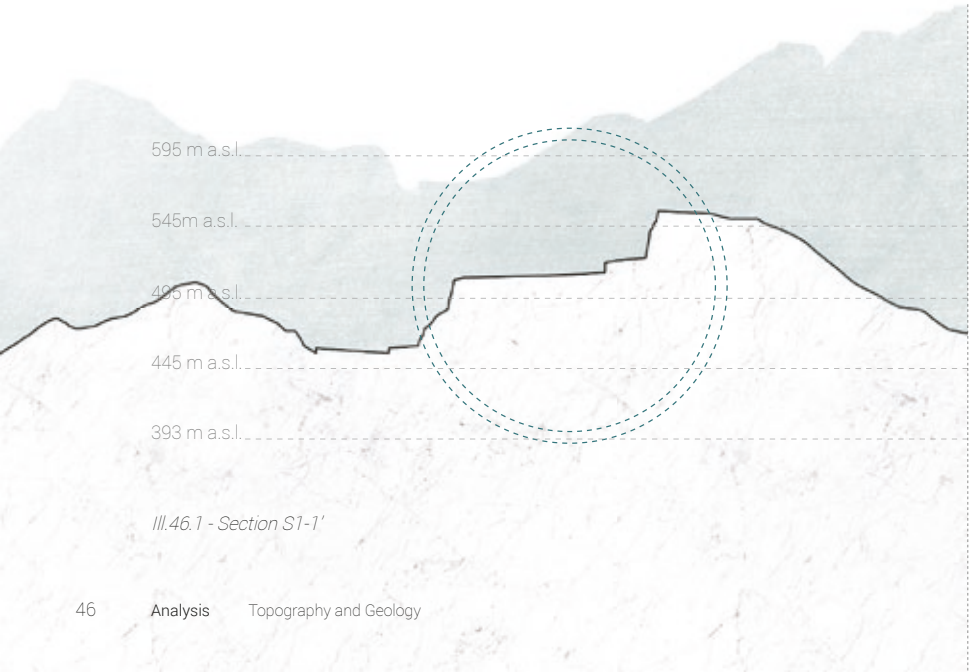
Ill.45.1- Detailed map of Bedizzano Village and the project site

TOPOGRAPHY AND GEOLOGY

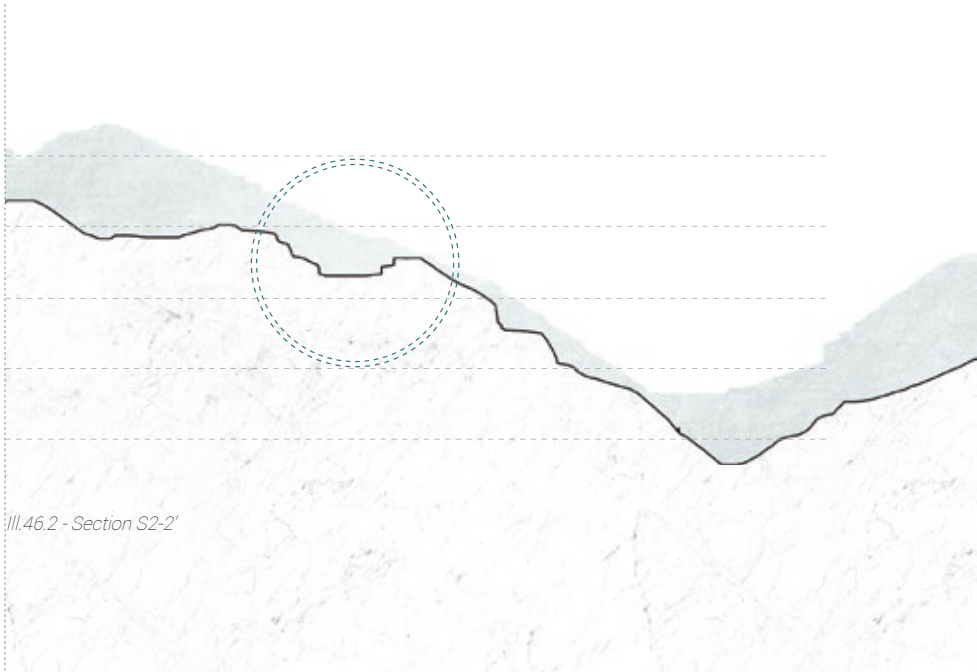
The Apuan Alps, the mountain range that houses Carrara Marble Quarries, are located along the Adriatic Coast in Northern Tuscany, Italy. Carrara itself is situated in a narrow valley that radiates out the marble mountains, to the villages of Torano, Miseglia, Bedizzano and Colonnata, which were settled by the Romans as an export marble spots.

The unique topography forms Carrara as a natural centre. It reaches through the concave of Bedizzano village and continues with the landscape shaped by the human impact of marble quarrying and hard machinery work to the very “choke point”. The terrain varies up to 400 metres, which brings variations in the climate.

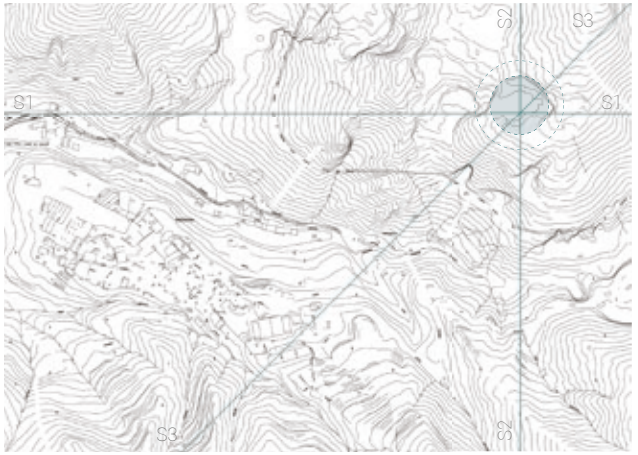
The project will be located on the area with flat terraces, that are a result of the human intervention through the centuries.



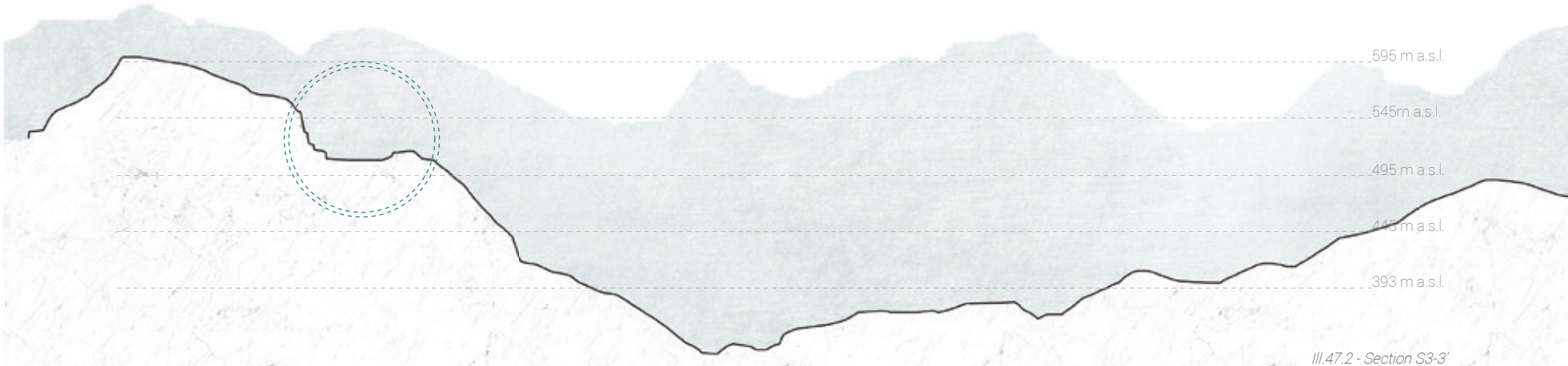
Ill.46.1 - Section S1-1'



Ill.46.2 - Section S2-2'



Ill.47.1 - Key plan - sections



Ill.47.2 - Section S3-3'

LOCAL MATERIALS

The region of Tuscany is characteristic for its great diversity in landscape and natural resources. Every town and village has its own particular character which manifests itself in soil diversity and geology supply. For this reason, every village and town are different in their architectural outcome and depending on the used construction materials, differ in the colour range (Fratini and Rescic, 2013).

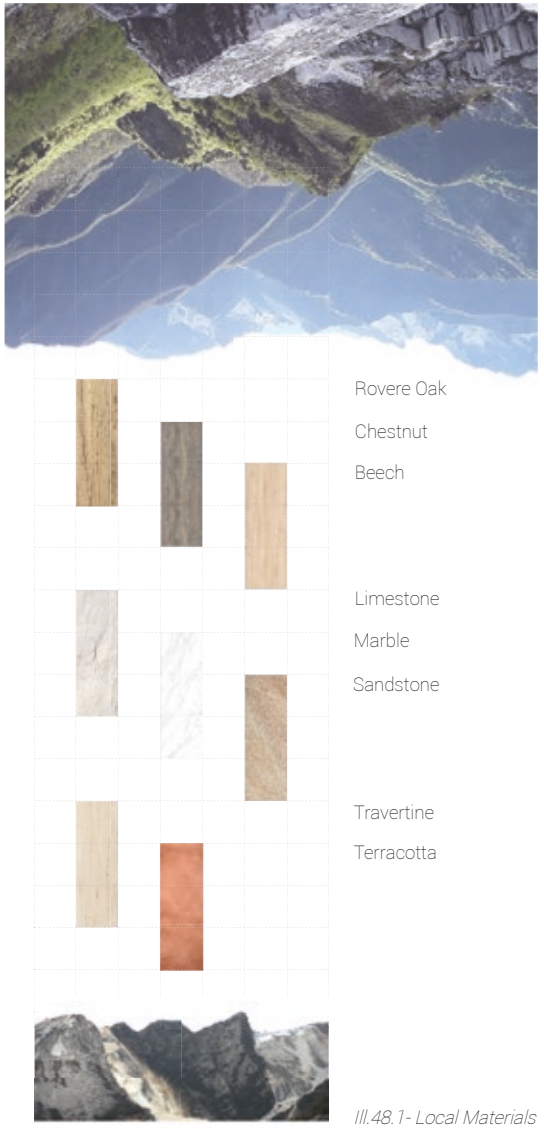
In Tuscany and its province of Massa and Carrara we can find wide range of forests and different stones that can be extracted and used as the construction material. The region has greater area of woodland and bigger variety of trees than any other region of Italy.

The local woods, most commonly used in the area are **chestnut, rovere oak, beech, elm** and **poplar.** Depending on its durability they can be used both for the construction and finishing (Giannetti, Cambi, Bottalico, Chirici, Marchi, 2015).

The big part of the world's stone trade concentrates around northern and central Italy (Acocella and Turrini, 2010). There is a wide array of construction materials, while in Tuscany most commonly used are: **limestones** and **sandstones**, **travertine** and **marble**. (Selectstone.com, 2018)

Another material that can be met in the surrounding is **terracotta**. Since the Ancient Roman times terracotta was used for the execution of the roof and floor tiles. Moreover, for its qualities it was used for the construction as well as for the decoration and finishing. Terracotta is characteristic for the wide range of warm colours, its texture and patina.

The main material resource on the site is marble and sandstone. The idea is to refer to the substance's feeling and expression by using harmonic materials to create a cohesive interplay between the building and lithologies. Moreover, it would be interesting to use a reclaimed wood beams as the finishing or structure.



Ill.48.1- Local Materials

VEGETATION

1. Populus
2. Cedurus
3. Ostraya Carpinifolia

4. Satureja Montana
5. Buddleja Davidii
6. Salix Eleagnos

7. Festuca Ovina
8. Santolina Leucantna
9. Brachypodium Genuese
10. Centaurea Ambigua

Ill.49 : Vegetation

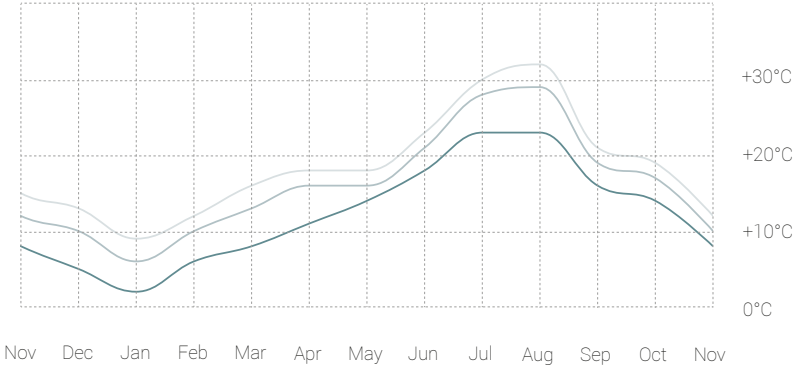
Extraction of marble in the Apuan Alps is economically important and has been performed since Roman age. It is inextricably tied to the area that experienced excavation and its destructive activity for years. Because of the quarrying interruptions, the former landscape changed dramatically, resulting in the destruction of vegetation. The site demonstrates huge contrast between the quarries and ravaneti, enormous rock waste, and natural park that is situated nearby. (Gentili, Sgorbati and Baroni, 2010)

Quarries are characterized by different-sized dump deposits that usually cover most of the surface on-site. In the quarries, the marble debris, soil and calcareous mud cover around 60% of the area. (Baroni et al., 2003). The diversity and amount of vegetation vary depending on the size and age of these ravaneties. In the older dump deposits the percentage of the vegetation is the highest. There can be found greater variation of species and bigger amount of vegetation (Gentili, Sgorbati and Baroni, 2010).

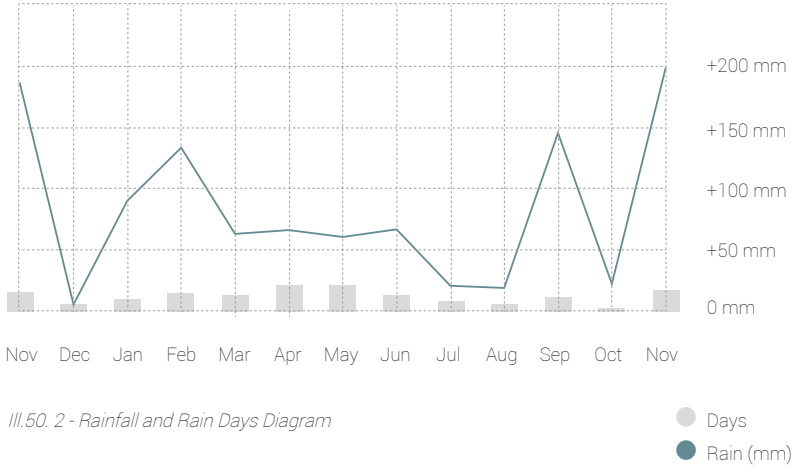
After analysing different ravaneties, there is observed very high frequency of Brachypodium genuese, Ostrya carpinifolia, Festuca gr. Ovina, Centranthus ruber and Centraurea ambigua. Out of wood species, close to the site, the most frequent is Buddleja davidii and Salix eleagnos. Low shrubs, like Asperula purpurea, Santolina leucantha and Satureja montana, are to be found in the surroundings, mostly in older deposits. (Gentili, Sgorbati and Baroni, 2010)

The vegetation on the site, due to high-stress environment, is dispersed at random around and on the sloping. The diversity in its variation and amount depends on the land stability of deposits. (Gentili, Sgorbati and Baroni, 2010)

CLIMATE ANALYSIS



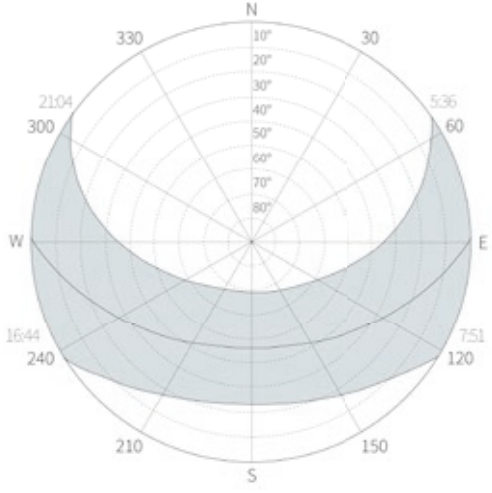
Ill.50. 1- Temperature Diagram



Ill.50. 2 - Rainfall and Rain Days Diagram

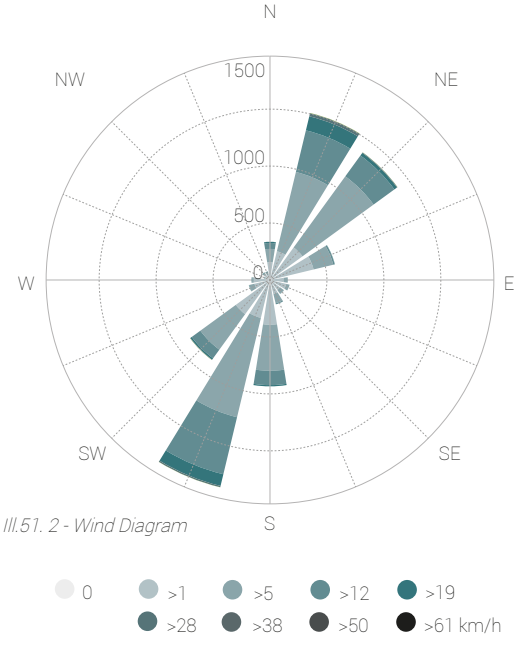
The temperature diagram shows the maximum, minimum and average temperature characteristic for the city of Carrara. The summer months are the warmest and the temperature can reach up to 30°C. Winter is the coldest period with the lowest temperatures in January.

The diagram presents the intensity of the rain and the amount of the rainy days per month. In the city of Carrara, the highest precipitating period is in the winter and first half of spring, while it gets drier in the summer. Rain factor is an important consideration aspect for the future design.



Ill.51. 1 - Sun Path Diagram

The sun chart shows the sun path's annual variation through the sky. In the summer solstice, the sun rises in the North-East at 5:36 and it sets at 21:04, while the sun angle reaches up to 80°. During the winter solstice, the sun rises at 7:51 in the South-East and it sets at 16:44 on the South-West, closing the angle at 20°.



Ill.51. 2 - Wind Diagram

The figure demonstrates how many hours per year the wind blows from the indicated directions. The speed is shown in km/h. The strongest wind blows from North-East and South-West for more than half of the year. Nevertheless, the city is also being affected by the mountains.

LOCAL CHANGES

The local climate on the site of the Marble Quarries slightly differs from the city of Carrara. Due to the height of 625 meters above the sea level, up to 400 meters difference from the city's height, the weather behaves in another way. The precipitation is little bit lover that in Carrara. Dry periods are longer and when it comes to the rainy period, the rain can hold for days. The weather can reach higher temperatures than in the city, since the quarries are more exposed to the sun rays and marble is a reflective material. This is an important aspect for the design to take under consideration and prevent the building from the high solar radiance. Whereas wind on the site can be stronger because of the height and pressure difference.

PHENOMENOLOGY

There are three distinct aspects of the space: physical, geometric and phenomenal. The phenomenology is the psychological consideration relative to structures of human consciousness and experiences. Since the phenomenal scope can't be measured it is perceived emotionally and subconsciously (Heidegger, 2013). When people enter the open space, whether in nature or build, or the architecture, they distinguish it with the senses: vision, hearing, smell, touch or even taste. All these sensual perceptions form the feeling and way of experiencing the area. To distinguish the space, people not always have to use all their senses to draw the image of the scenery.

The Carrara Marble Quarries make an impression of distant elegance, drifting down the mountains. From afar, being in the city of Carrara, we can see them in the background from almost every place. They act like a canvas of the everyday life of the city's inhabitants and passing by people. However, when being on site of the Quarries, the senses start to identify different components of the space. The first thing that hit us was the immensity of the carved mountain and the purity of the raw marble. The scenery presents an extraordinary game of bright marble, ground, and vegetation that in a manner works separately but once perceived, forms one whole. This image works as a sort of harmony between man-made and natural, the obvious balance in an unconventional manner.

Apart from the sight, our hearing is wide awake, and we can distinguish the sound of carving machinery, the quarried marble falling on the ground, the screams of the workers. But sometimes, there is no sound, just the feeling of the scale of the Alps and the silence that has a reassuring effect. Once we focus on the connection with the site, the certain smells can be distinguished. The smell of the mountains and the vegetation, the peculiar scent that often occurs in the high peaks. Sometimes we had an impression that, once closing the eyes, even the specific taste was to be noticed where we stand.

Getting closer to the stone, identifying it with our touch, the proportion of the quarries becomes smaller. The marble is rough and cold. It contrasts with the observed before purity but also augments the feeling of the extraordinary.

All the noticed elements form the phenomenology of the space. The unambiguous feeling of the mystery and curiosity for the location. But also, the excitement while approaching the stone and peaceful feeling of connection, to both extracted marble and nature. All gained experience opens the possibility of creating the space that can be a part of the site, even if standing out, in harmony with the material and nature of the surrounding.

„Space is an empty container for experience"

SITE VISIT

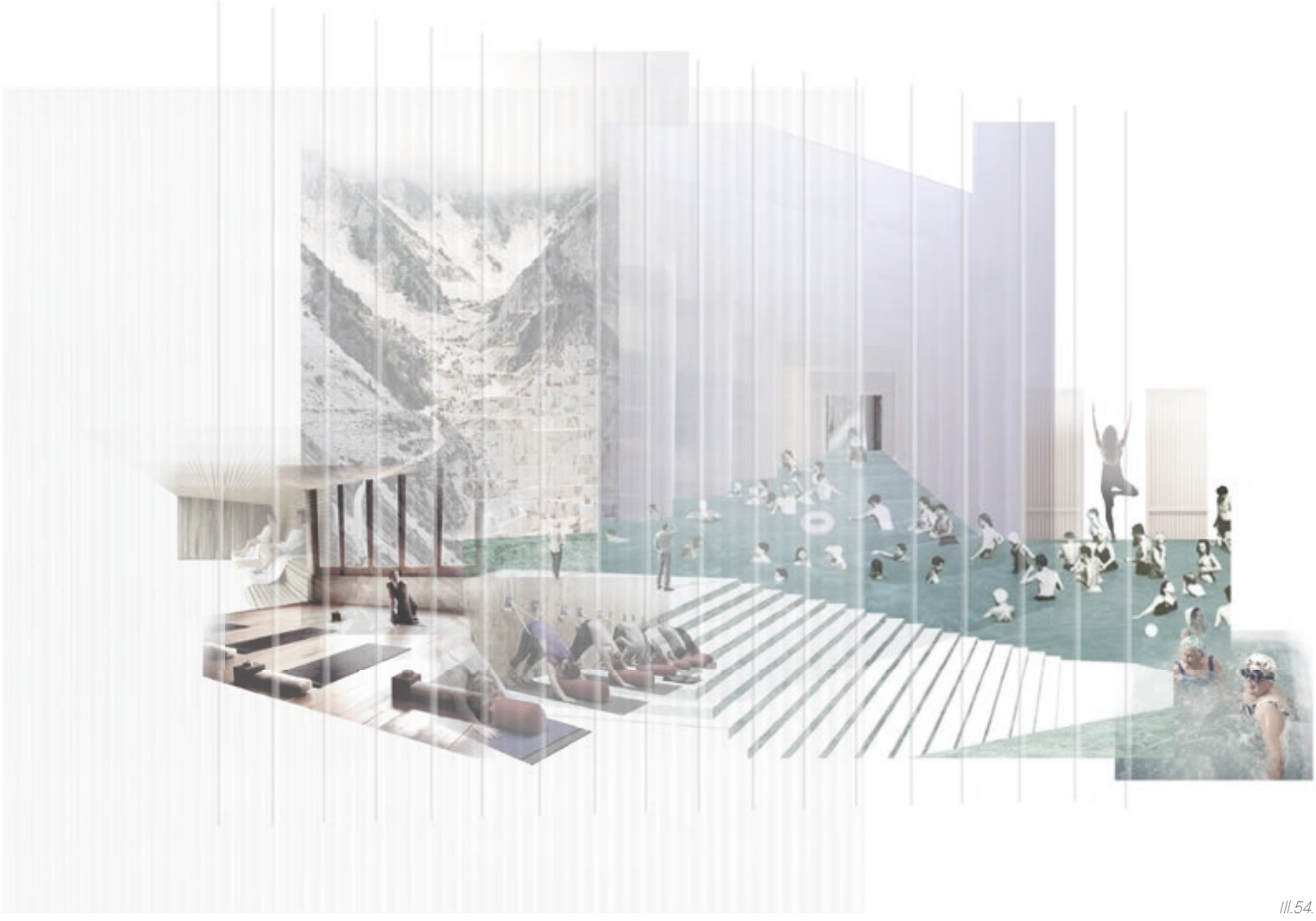
Ill.53.1 - Map of Tuscany with highlighted stops during the trip

When we first chose the thematics for the Master Thesis, it was important for us to introduce the design that comprises the knowledge and abilities that we acquired during the years of education. Moreover, to concern the project that will try to make a difference, to re-evaluate the word of today and try to think more unconventionally. This consideration brought us to introduce the new and surprising function in the area of Marble Quarries in Apuan Alps. To fully understand the site and material for further process, it was necessary for us to visit the site and reference architecture. The intention of the travel was not only to see the quarries but also to interview the local entities, gain the knowledge concerning the material and its treatment and to have a fresh intake on the topic of the thermal baths.

The journey started in Carrara province, where we spent couple of days, learning the history of the place, its possibilities and problems. We met both ends: local authorities and manufacturers of the Carrara Marble production process. From the site of municipality, we gained the knowledge of excavation history and the context of the Carrara Marble Quarries. Following this meeting, we acknowledge that their intent is to preserve the area and to improve the access to the quarries. Whereas meeting with the Trade director from Marmi Carrara Srl- Carrara Marble main contractor was a success in terms of explanation of the vast number of different marble material existing on the site, its mineral values and the treatment of the material with multiple outcomes. Discovering the material's aesthetics, touch of it and its affection on us, creation of new experiences. This visit let us comprehend the culture of the city and the mountains, the strong connection of the local inhabitants to the quarries and the pride of where are they from.

Our visit in Florence enable us to see and perceive some of the historic symbols of architecture, the use of marble and the modern context. This guided us through the notion of the material's connection, its structure which can be essential for our further steps.

After the trip, with the new knowledge and experiences gained, it is easier for us to temporarily close the analysis chapter and move to the design process.



Ill.54.1 - Users' Collage

USERS

The Thermal SPA resort will be employed by different target groups, depending on their needs, desires, and exploration of experience. To enhance tourism in Carrara province and precinct we believe that designing the Thermal SPA Resort would highly strengthen the economy of the province and will deepen the knowledge about the area and its history.

USERS WITH THE AIM TO HEAL AND RECOVER

The culture of thermal baths was developed since the XIX century towards medicinal way during the science expansion and its analysis of mineral waters. The curiosity continued and nowadays the culture of thermal baths is enriched with a combination of treatments fighting and revealing from several diseases. (van Tubergen and van der Linden, 2002)

People with the rheumatic disease suffer for joints and muscles with its pain, rigidity, and turgidity. Although at the time of evolution of the medical science, there are no records of cure of rheumatic disease. Nevertheless, balneotherapy, bathing in water rich with natural minerals, including steam baths, mud baths, and carbon dioxide baths, is advised to reduce the pain and to improve daily functioning. (Verhagen et al., 2015) Moreover, balneotherapy treatments have a great impact on patients with circulation disorders and with high blood pressure. Due to the location in the mountains and additionally close to the seaside with a conjunction of steam baths and other healing procedures, it is very beneficial for patients with respiratory problems and allergies. Thus improving their well-being. (Mooventhan and Nivethitha, 2014) Considering the health problems the majority of this user group will be men and women from the age of 50. Beside the suggested healing treatments, the needs of the users will be a consultation with an in-house doctor and internal specialists for an individual therapy.

USERS WITH THE AIM TO RELAX AND PLEASURE

Today, in our rush world, we do not enrich ourselves with relaxation and enjoyment anymore. Even though the working hours per week considerably decrease, also thanks to the new appliances and ever-rising technology, we still feel the time pressure from work, school, from everyday life (Economist.com, 2014).

Therefore, offering a holistic architecture in a serene environment with thermal baths would support not only a physical condition but would also have a positive result on the psyche. Beside mentioned treatments, the massage and recreation area will be designed together with a meditation room to achieve a well-being and feeling of relaxation. Furthermore, due to the mesmerizing quarry and its distinction for the diverse landscape, the site offers an exploration of the Apuan Alps and the history of Carrara Marble quarries. We would like the users to experience a fully sensational acquaintance while immersing the body in thermal waters as a feeling of touch, tasting the mineral waters to heal and revitalised, breathing the fresh air of Apuan Alps, listening to the water streams and admire the purity of the of the quarries.

ROOM PROGRAM

	Recreational area	Area [sqm]	Quantity	Indoor Environment	Light Direct	Light Diffuse	Reverberation Low	Reverberation High
Indoor Area	Indoor Pool	80	1	Water 32°	x	x	x	
	Cold Bath	15	1	Water 14°		x		x
	Hot Bath	35	1	Water 42°		x	x	
	Relax Bath	15	1	Water 35°		x	x	
	Nature Bath	20	1	Water 26°-32°		x		x
	Steam Bath	8	1	Humidity 75-100%		x		x
	Sauna	8	1	Temperature up to 80°C		x	x	
	Hydromassage Pool	20	1	Water 35°		x	x	
	Mud Bath	7	2	xx	x	x	x	
	Carbon Dioxide Bath	7	2	Water 33°		x	x	
	Massage Place	20	1	Room temperature 28°	x			
	Meditation Room	20	1	Room temperature 28°	x		x	
	Medical Room	20	1	Room temperature 28°				
	Changing Rooms	30	1	Room temperature 28°	x		x	
	Showers	10	2	Room temperature 30°	x		x	
	Restrooms	xx	2	Room temperature 28°	x		x	
	Total Indoor Net Area	~350						
Outdoor Area	Outdoor Pool	80	1	Water 36°				
	Terrace	xx	1	Outdoor temperature				
	Meditation Area	xx	1	Outdoor temperature				
	Total Outdoor Net Area	~100						

Administration and Service Area	Area [sqm]	Quantity
Reception and Entrance Area/ Lobby	90	1
Restaurant / Cafe Bar	90	1
Restaurant's Terrase	xx	1
Meeting Room	30	2
Hotel Rooms	30	xx
Kitchen	50	1
Public Restrooms	xx	4
Storage	20	1
Laundry	20	1
Technical Room	15	1
Total Service and Administration Net Area	~345	
Total Net Area	~795	

Ill.57.1 - Table - room program inspired by The Therme Vals (Zumthor and Binet, 1998)

INDOOR/ OUTDOOR POOL

- direct connection between indoor and outdoor pool
- view on the quarries, Apuan Alps
- meeting with the marble

Indoor air temperature: 26°
Water temperature: 36°

COLD BATH

- intimate space
- cold colour tones
- indirect light

Indoor air temperature: 26°
Water temperature: 14°

HOT BATH

- enclosed space
- warm colours
- touch of wood
- soft transition of direct light to indirect light

Indoor air temperature: 26°
Water temperature: 42°

RELAX BATH

- intimate space
- the experience of relaxing sound
- isolation from the outside
- the feeling of safeness

Indoor air temperature: 28°
Water temperature: 35°

NATURE BATH

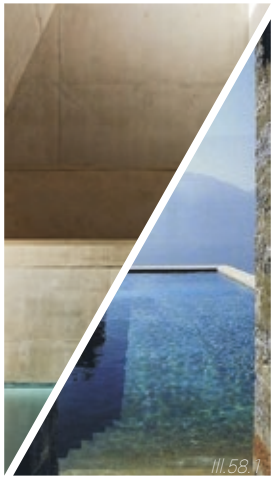
- open to the mountains
- reflection of the marble
- the sense of smell
- raw use of material
- direct light

Indoor air temperature: 28°
Water temperature: 26°-30°

STEAM BATH

- touch of marble
- direct light coming from the top and diffused by the vapour
- the contrast of the colour to the temperature

Indoor air temperature: 43-50°
Humidity: 75-100%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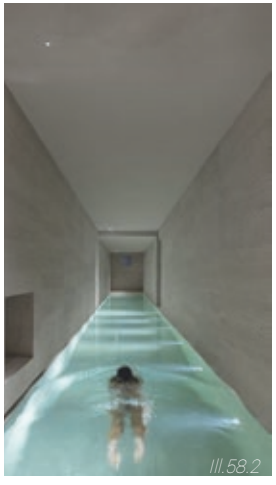
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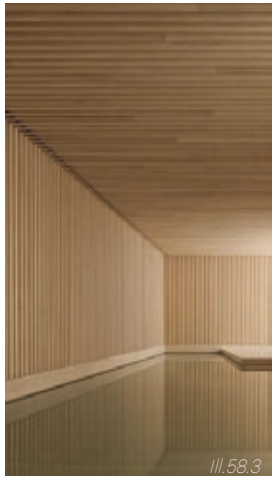
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Ill.58.4


Ill.58.5


Ill.58.6

SAUNA

- indirect light
- touch of wood
- intimate space

Indoor ar temperature: 75-100°
Humidity: 5%

HYDROMASSAGE POOL

- open pool
- individual space

Indoor air temperature: 28°
Water temperature: 35°

MUD BATH

- individual space
- intimacy, privacy
- very close contact with the skin

Indoor air temperature: 26°
Mud temperature: 36°

CARBON DIOXIDADE BATH

- individual space
- intimacy, privacy
- cold colours

Indoor air temperature: 26°
Water temperature: 33°

MEDITATION ROOM

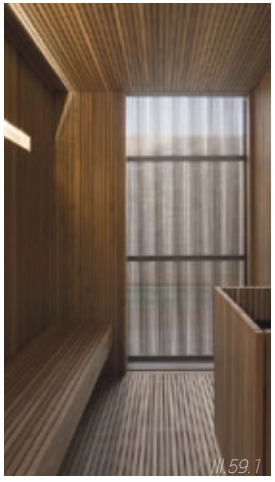
- open towards the nature - the infinite view
- direct light
- private space
- cold colours

Indoor air temperature: 25°

REST PLACE/ MASSAGE

- touch of wood
- warm colours
- diffuse light
- individual space in the common space

Indoor air temperature: 25°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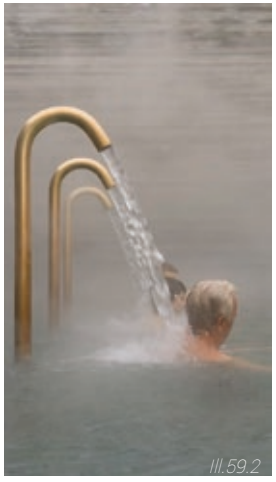
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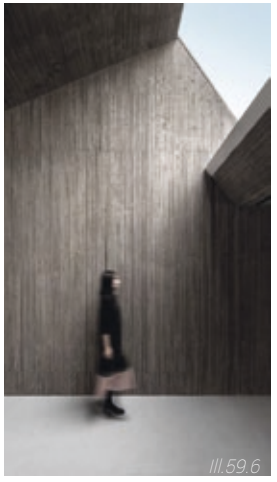

Ill.59.6

ANALYSIS CONCLUSION

The analysis chapter was introduced to better understand the site and in order to bring the reader the topic of the thermal baths and our former approach towards the design.

It is crucial to comprehend the identity of Carrara Marble Quarries, the possibilities and struggles of the site. The strong directionality of the marble slabs restrains the boundaries of creation but on the other hand, the site becomes a pure canvas for future changes.

In order to integrate the landscape into the design, it has to be thoroughly examined and the neo-nature characteristics of the space must be embraced. In this way, the design can become the man-made extension to the existing context. This concerns the industrial character of the place that can be expressed in an indirect way by the architecture.

The research concerning the history of baths enlightened the purpose of the complex. Its healing abilities towards therapeutic and rehabilitation purposes need for the social interaction and desire for relaxation and pleasure. As it was mentioned before, some thermal baths were treated as a sacred space, where here, the purity of marble stone opened the possibilities to feel like taken back to the ancient times.

The design is following the importance of sensory perception. This concerns the treatment of daylight and its contribution to the interiors and wellbeing of users, material examination- the ways of its different curation, and what atmospheres are created within the building and on-site.

Having in mind the delicacy of the project and all advantages and problems that are attached to it, what has to be done to achieve a fully holistic project that stays in harmony with the stone and rough climate?

DESIGN CRITERIA

VISUAL

- Building aesthetically connected to the site
- Vertical and horizontal connection to the site
- Materials in harmony with the Quarry
- Relaxing influence of water and stone

EMPIRICAL

- The experience of Marble Quarry and material inside and outside the building
- Sensual experience of the site and building
- Healing architecture

TANGIBLE

- Building in connection to existing topography
- Tectonic treatment of the materials: stone, wood, plastic
- The tactile contrast between the surfaces
- Tactility encourages leisure and rehabilitation

VISION

QUALITIES

Carrara Marble Quarry is an important spot of marble industry not only in Italy but also in Europe. The natural environment impresses with its surreality, surprises with its purity and diversity that was marked due to the human intervention for thousands of years. Mountains and sea, light and shadow, the hard stone and healing potential - the quality of Apuan Alps in Carrara Province. People think of Carrara Province just as a marble industry area and do not know further about its history and natural part - mountains' fresh air, curvature facing the coast of the eternal sea.

POSSIBILITIES

When rethinking about the area, its unique natural qualities have a potential of attracting visitors seeking for destinations of exploring, learning, revitalising and cure. With thermal baths, visitors will be provided with a good-class therapy domiciled in a very heart of Marble Quarries looking towards the sea with a background of Apuan Alps. To fully experience the stay the restaurant could serve meals made of local products - local fish, dairy products, a wide range of fruits and vegetables.

CONCLUSION

The thermal baths will become a centre of relaxation and healing attracting tourists, locals and patients with the special disease. It will greatly influence the way people coming to Carrara. It can advance their knowledge and enrich their soul with various of experiences. Moreover, it would help to preserve the important part of Apuan Alps and serve to future generations.

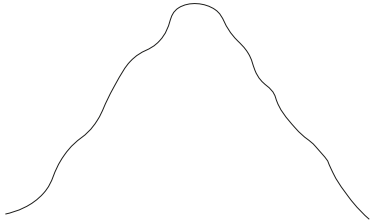
PRESENTATION

Concept
Master plan
Floor Plans
Water Treatment
Sections
Structure
Materials
Elevations
Sustainable Strategies
Details

GESTURE AND PRINCIPLE

ORIGINAL NATURAL ENVIRONMENT

- Rich and untouched natural diversification

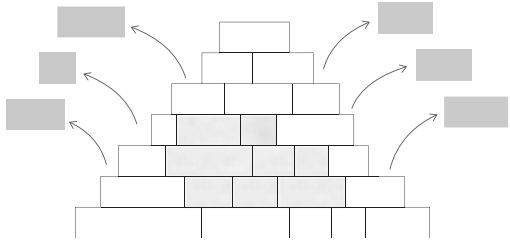


Ill.66.1- Natural Environment

- Unexploited / Unspoiled mountains

HUMAN IMPACT

- Marble deposit discovery – marble excavation – artificial industrial environment

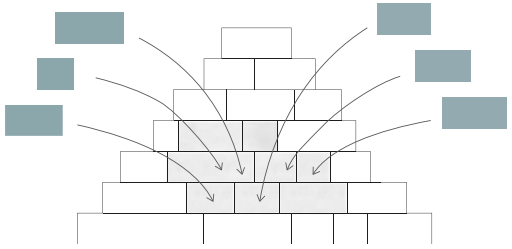


Ill.66.2- Human Impact

- Creating an industrial wound in Nature

RETHINKING THE SPACE

- Finding a new reason for the abandoned space by adding a community function
- Exploring, learning, revitalising and cure
- Preserving important part of Apuan Alps for future generations



Ill.66.3- Rethingking the Space

- Accepting Nature's wound
- Healing wounds in a wounded environment

SHAPE CONCEPT

Ill.67.1- Marble Excavation Direction

- Reverting the principle - treating the building as a block
- Following marble excavation directions
- Dividing building into these two directions - treating the building as composition of two blocks

Ill.67.1- Shape Concept

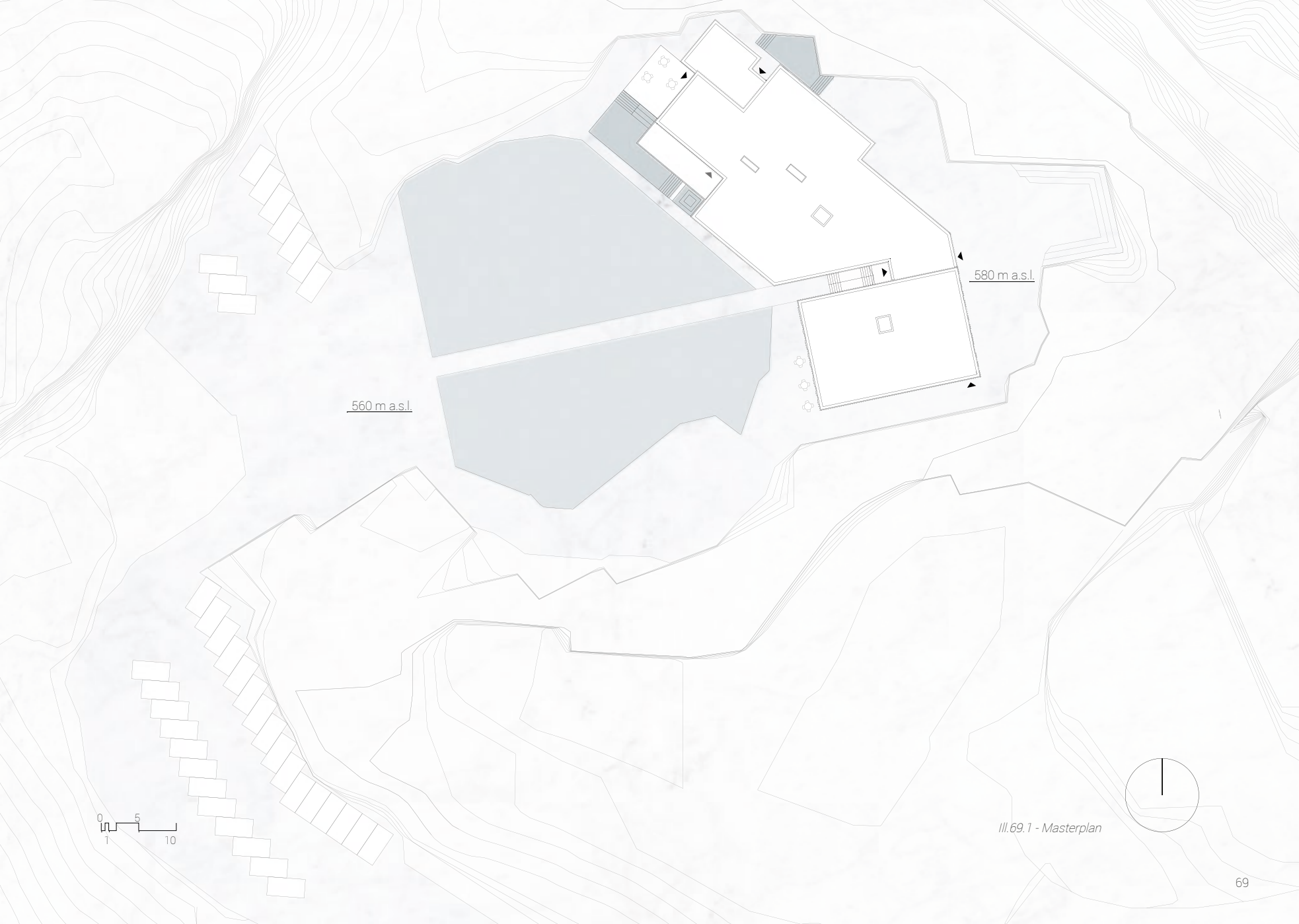
- Excavating a cut in between the blocks
- Forcing visitors to experience the wound
- Embracing and welcoming people to the healing experience

MASTERPLAN

The site of Carrara Marble Quarries holds strong characteristics of industrial impact on nature. The background serves as a pure canvas to initiate a new design and purpose of the site. The intention was to bring in an architecture that corresponds to the surroundings with its materiality and directionality. Therefore, the geometrical shapes were followed and the materials stayed in balance with the adjacent.

When arriving at the site and leaving a car - the stress from everyday life - in a curvature of the mountain, the visitor enters the unadulterated and neat experience of the quarry. Starting with the bridge linking daily life to the immersive healing experience, directing the visitor to the Thermal Baths. While walking on the path, feeling the scent of water with a base of marble formation. The water, mixed with marble minerals, creates the uncommon colour that together with bright surrounding, creates a relaxing feeling. The path continues in the narrow cut formatting a staircase leading towards the Thermal Bath.

Behind the building, the site carries similar characteristics to the entrance. No new materials than water are interposed. The modulation was introduced in the amphitheatre built within the quarried void. Here the acoustics is emphasized and the space serves for the performances.



Ill.69.1 - Masterplan

GROUND FLOOR

The final shape of the building was provoked by the aim of creating a semi-open layout, able to create various atmospheres within. The labyrinth of the pools and spaces, the playful investigation of light openings and a strong directionality are the elements that contribute to the ambience of the ground floor.

A bridge linking the outdoor parking to the building complex - everyday life to the immersive healing experience – brings visitors to a linear cut in the marble. This, represented by a staircase, leads the guests to the entrance of the Thermal Baths and Hotel, and embrace the visitors at their arrival. Here, the users spread between the two parts.

In the Thermal Baths, after changing into bathing suits, they can proceed to the wet area or, with the use of a staircase, access the spa treatments and medical area at the second floor. At ground floor, through a narrow corridor, they reach the pools' space. From there, they proceed to explore the variety of water pools and their treatments. The partially open plan enhances their will to investigate all the spaces.

Few complementary functions are designed in addition to the pools. In a central position, a drinking spring rising from the mountain itself attracts the visitors, in purpose to gather. In between the key area and the terrace, a snack bar is accessible from both the outdoor and indoor pools, creating another gathering place - amiable break before continuing the journey through the baths.

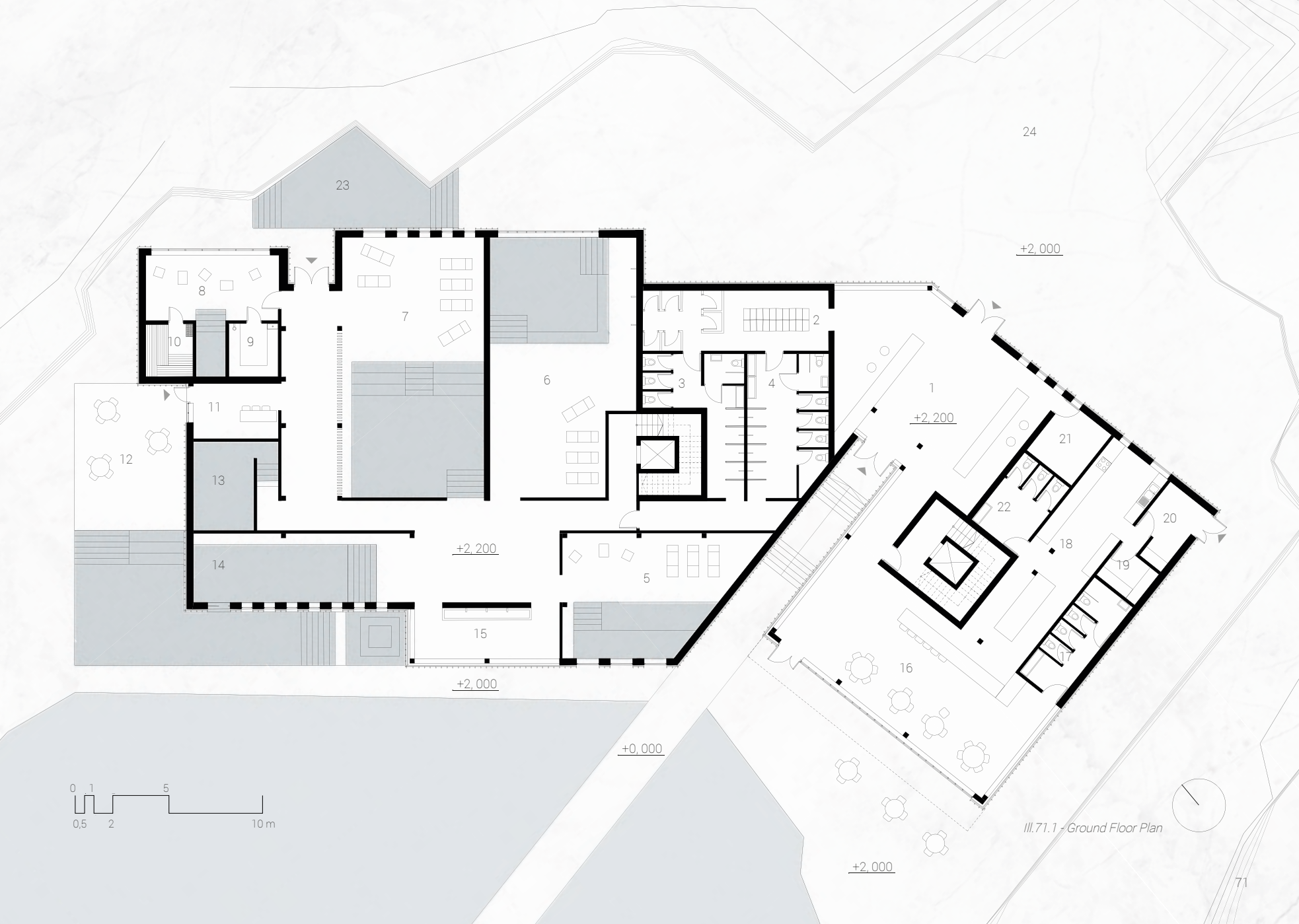
At the back of the building, distinct area groups similarly, dimensioned rooms, forming a contrast between a steam bath, a sauna, a cold bath and a resting place. These rooms are in a very close relationship, both physically and spiritually, with the mountain walls. To underline this proximity, the rooms' finishing is also made in marble.

Along the bath's complex, every room carries different characteristics: the variations of size, shape and a wise use of materials and their treatment enables to stimulate visitors' kinesthetic sense, reaching a certain level of tactility and variable ambiences.

The southern part of the ground floor is occupied by the hotel lobby, restaurant and kitchen facilities. Here, space is dedicated for both hotel guests and baths visitors. In the Ground Floor, multiple exits towards the excavated mountain are designed in order to let guests explore not only the architecture but also the extraordinary site that envelopes it.

LEGEND GROUND FLOOR

1	Entrance Hall/ Lobby
2	Changing room
3	Bathroom/ Showers
4	Bathroom / Showers
5	Hydromassage Pool
6	Hot Bath
7	Indoor pool
8	Cold Bath
9	Steam Bath
10	Sauna
11	Snack Bar
12	Terrace
13	Relax Bath
14	Indoor/ Outdoor Pool
15	Drinking Water Fountains
16	Restaurant
17	Restrooms
18	Kitchen
19	Cold Room
20	Delivery / Storage Room
21	Staff Background
22	Staff Restrooms
23	Nature Bath
24	Marble Terrace



Ill.71.1 - Ground Floor Plan

FIRST FLOOR

In the first floor, at first glance, the separation between the two parts is noticeable. Here the Bath and Hotel area are connected by the passage that hangs over a double-height entrance. The design allows the hotel guests reach the bath complex without a necessity to pass the entrance hall. The first floor of Hotel part is accommodated by six double rooms with private bathrooms together with technical room and laundry, possible to use by guests. Rooms are intensified with the view towards the carved quarry or the Apuan Alps. Staff facilities like bathrooms, changing room, meeting room and small kitchen are provided on the first floor of the complex.

When entering the bath area on the first floor several treatment rooms together with meditation room can be found. Within the other functions, there is a medical room and physiotherapy space.
Following the idea of gathering zone, which was presented in the ground floor, an exhibition area with a possibility to gain knowledge about the quarry and its history was designed in connection to the waiting space. From here the visitor is able to enter to different cures or to the terrace and admire the surrounding beauty of the nature impacted by a human mark.

LEGEND FIRST FLOOR

1	Hall with Informative Panels
2	Medical Room
3	Massage Room
4	Meditation Room
5	Terrace
6	Carbon Dioxide Bath
7	Mud Bath
8	Shower
9	Physiotherapy Room
10	Storage
11	Restrooms
12	Meeting Room
13	Kitchen Corner
14	Staff Changing Room
15	Staff Changing Room
16	Room
17	Storage
18	Laudry Room

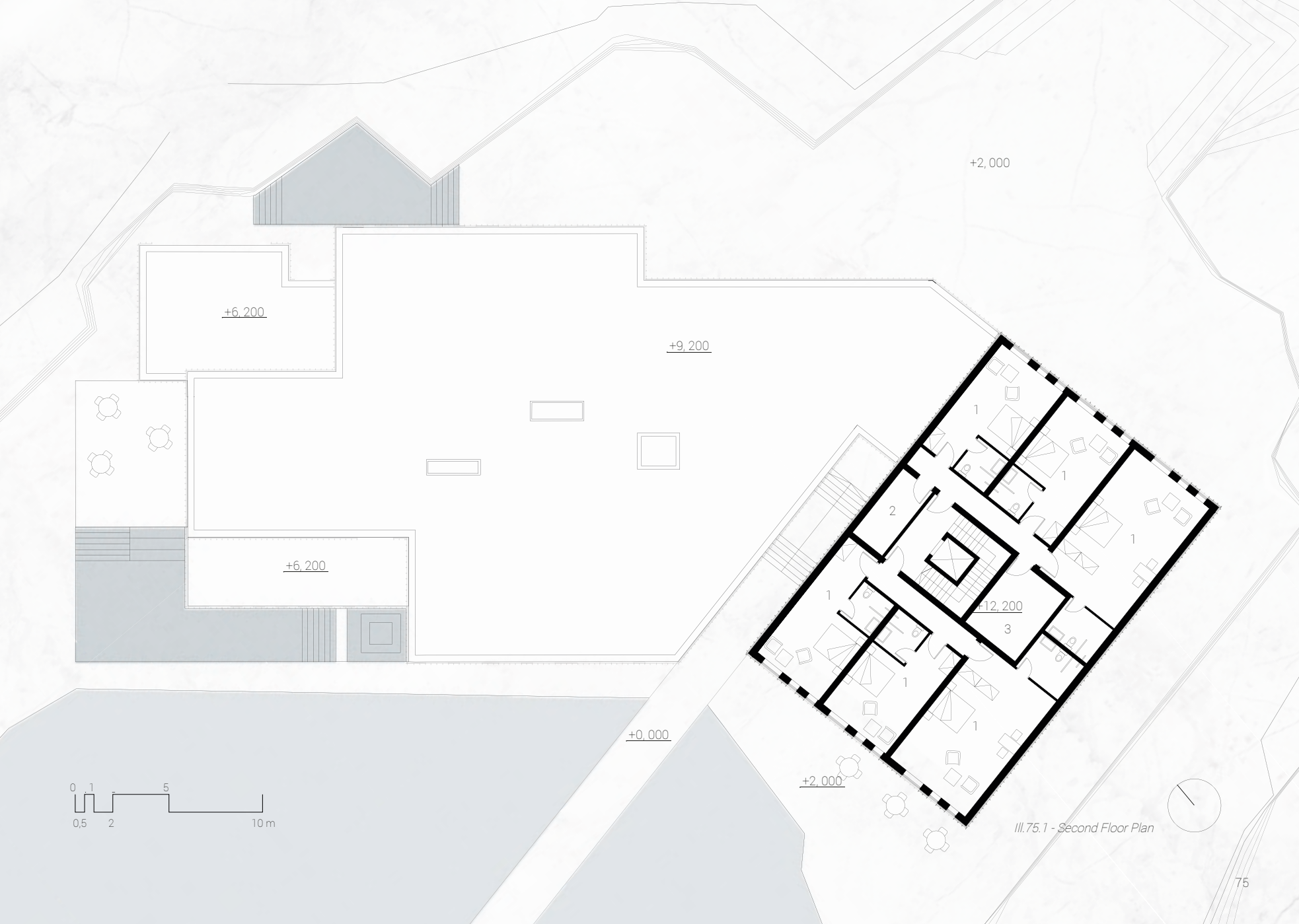
Ill.73.1 - First Floor Plan

SECOND FLOOR

The second floor accommodates other six double rooms for the hotel guests and the technical rooms. The rooms are repetition from the lower floor.
The roof above the spa complex is thought to gather the rainwater and with drainage system, further, the rainfall shifts to the filter system and later to the bathroom appliances.

LEGEND SECOND FLOOR

1 Room
2 Storage
3 Storage



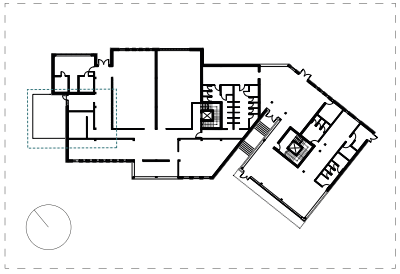
Ill.75.1 - Second Floor Plan

DETAILED FLOOR PLANS

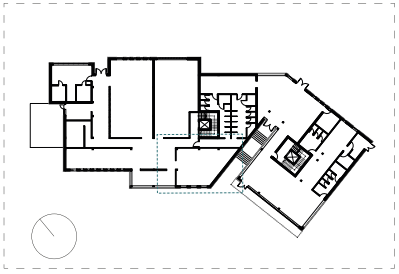
In order to design a bath complex fully holistic and satisfying for the user, detailing of an interior part was introduced. Hence a choice of materials, its textures and furniture according to the room's function was an important part during the design. Thus transferring the feeling and experience of the designed spaces.

In the bath complex, the game of materials can be observed together with its diverse joining. Along the main corridor, the marble tiles are guiding the guest to the distinct functions. The base for the main pools is covered with polished marble, while the acoustic bath is laid out with the narrow and rough stone tiles in a darker tone. This choice was introduced to enhance the cave-like feeling and strengthen the acoustic qualities.

The snack area is posed as a warm place, laid out with wooden cladding, both in the snack area as well as in the terrace area. In the direction of the discern the spaces, the different cladding was used. The furnishing of the terrace corresponds to the surrounding of the building and ameliorates the experience of the users.

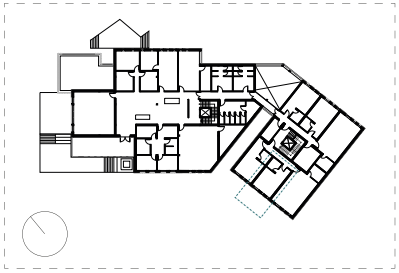


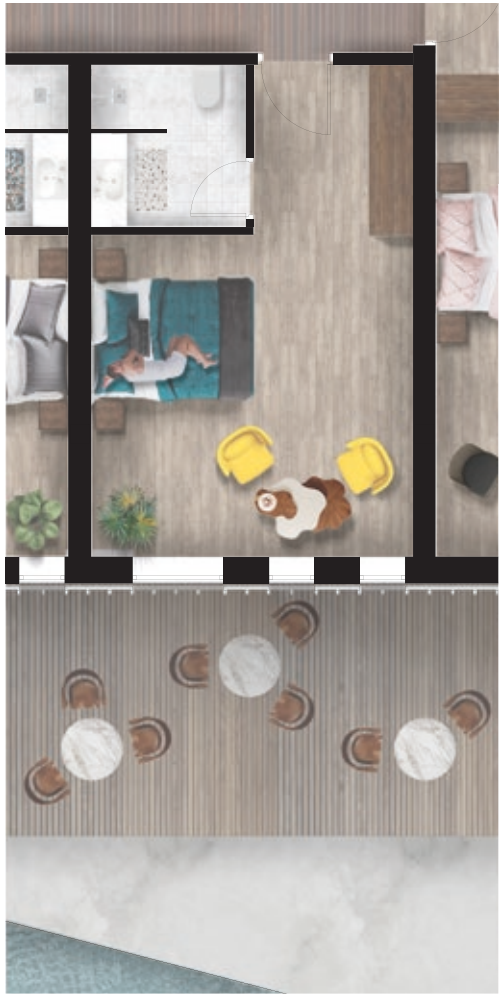
Ill.76.1- Zoomed Floor Plan; Part 1



The hydro-massage bath, incorporated into the separate room, carries warmer characteristics where the selection of materials corresponds to the temperature of the water. A unique furnishing was designed referring to the directions of the room's layout. This makes the room more individual and experience wider.

Ill.77.1- Zoomed Floor Plan; Part 2

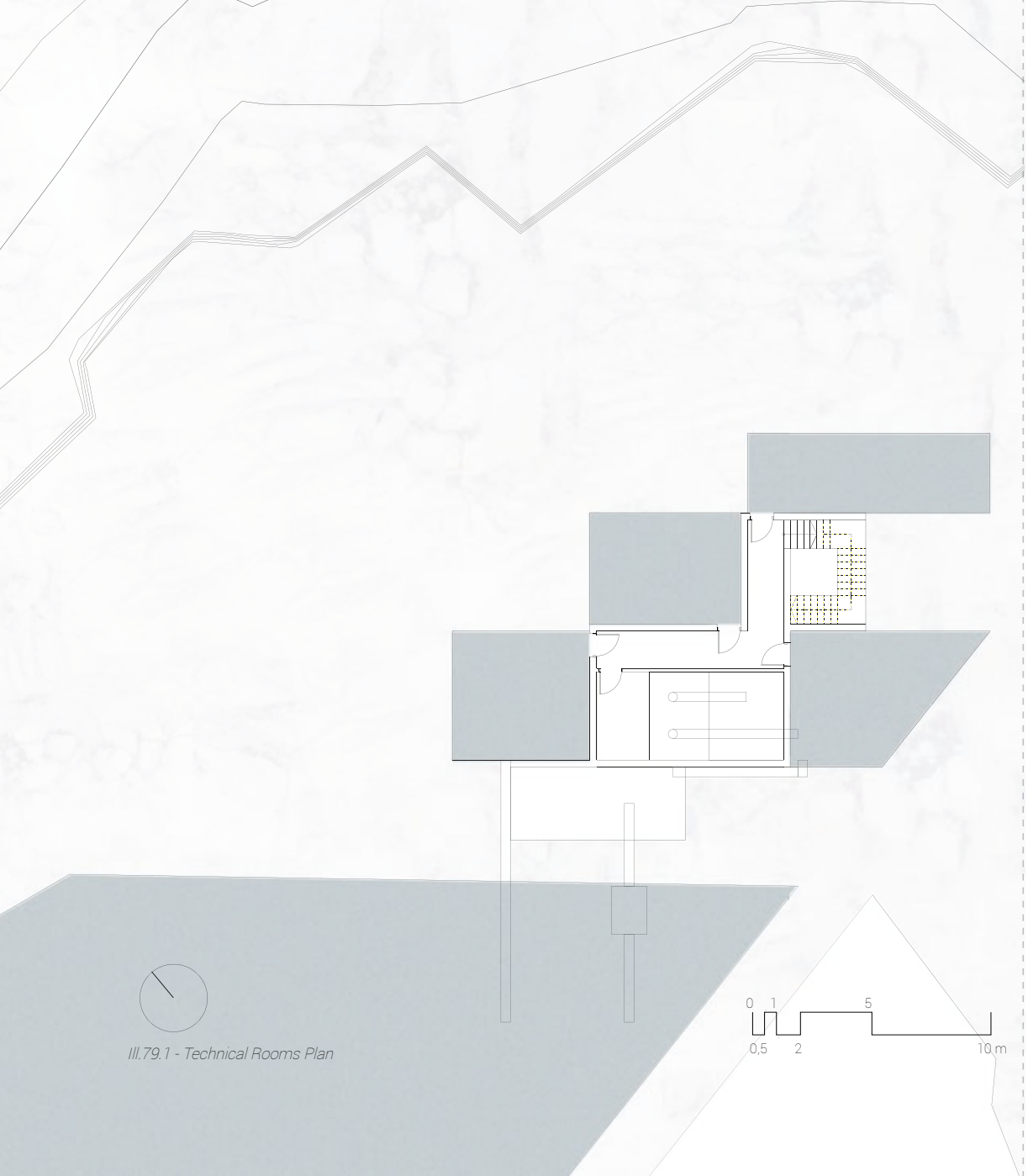




Ill.78.1- Zoomed Floor Plan; Hotel Room

The materiality of baths complex was a priority for this project, yet still, the hotel part was carefully taken into consideration. Since the experience of the Thermal baths' visitors doesn't narrow just to the water and relaxation, it was essential to provide them with a high standard of lodging. The room is equipped with common individual pieces of furniture. Every room has an astonishing view of either the mountain slopes or marble's purity. All the rooms are provided with private bathrooms. The materials introduced in the room- wooden floor together with the white plaster walls and exposed beams are to make a guest feel comfortable, delightful and experienced with the contrast of materials expression and perception.

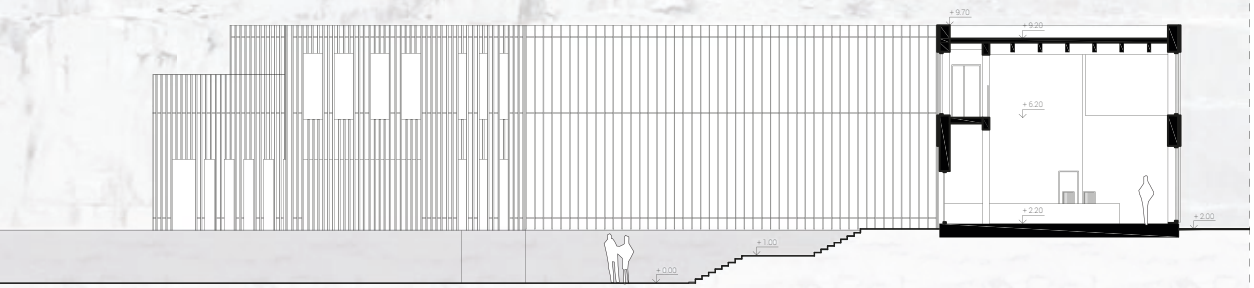
WATER TREATMENT



Ill.79.1 - Technical Rooms Plan

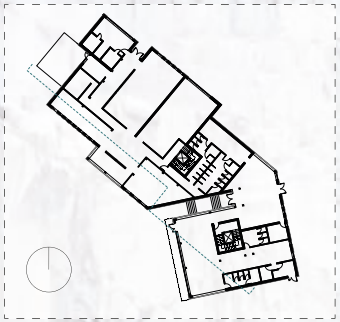
The basement accommodates the technical rooms of the pools and baths that are located on the ground floor and the technical spaces for water harvesting and storing. The rainwater collected in a collection pond is later forwarded through the pump to the filter. Afterwards, the filtered water continues to the white water tank and depending on the need it is heated and reaches the pools to support the water recovery. In the grey water tank the water flows directly from the collection pond. The black water tank is located in close distance to the exit for facile maintenance. The basement floor is directly connected to the ground floor.

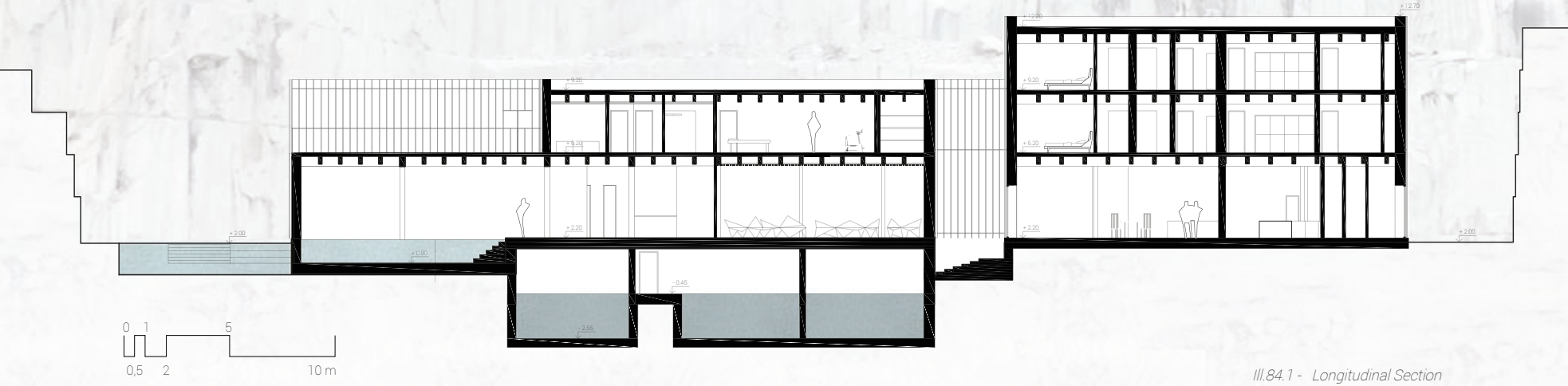
Ill.81.1 - The Thermal Bath (Vals, Switzerland)



III.82.1 - Section Through the Entrance

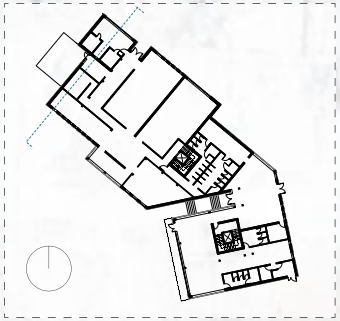
Ill.83.1- Indoor Pool Illustration

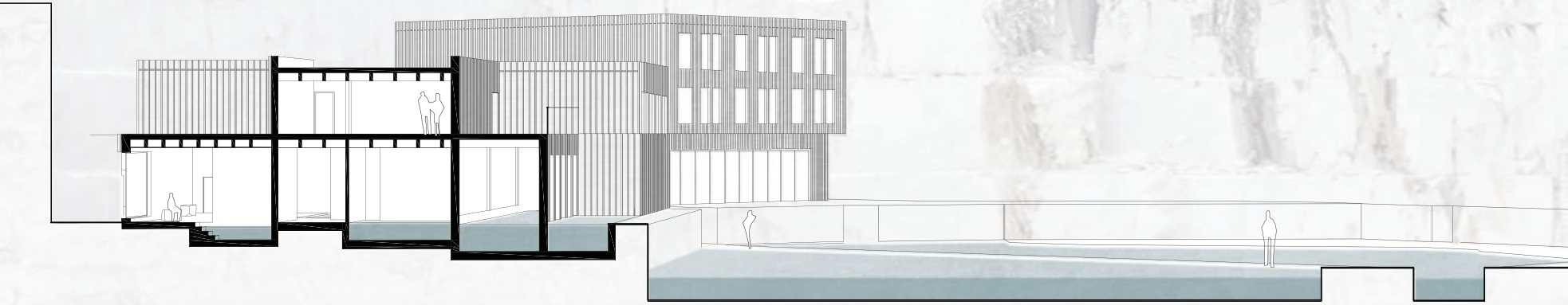




Ill.84.1 - Longitudinal Section

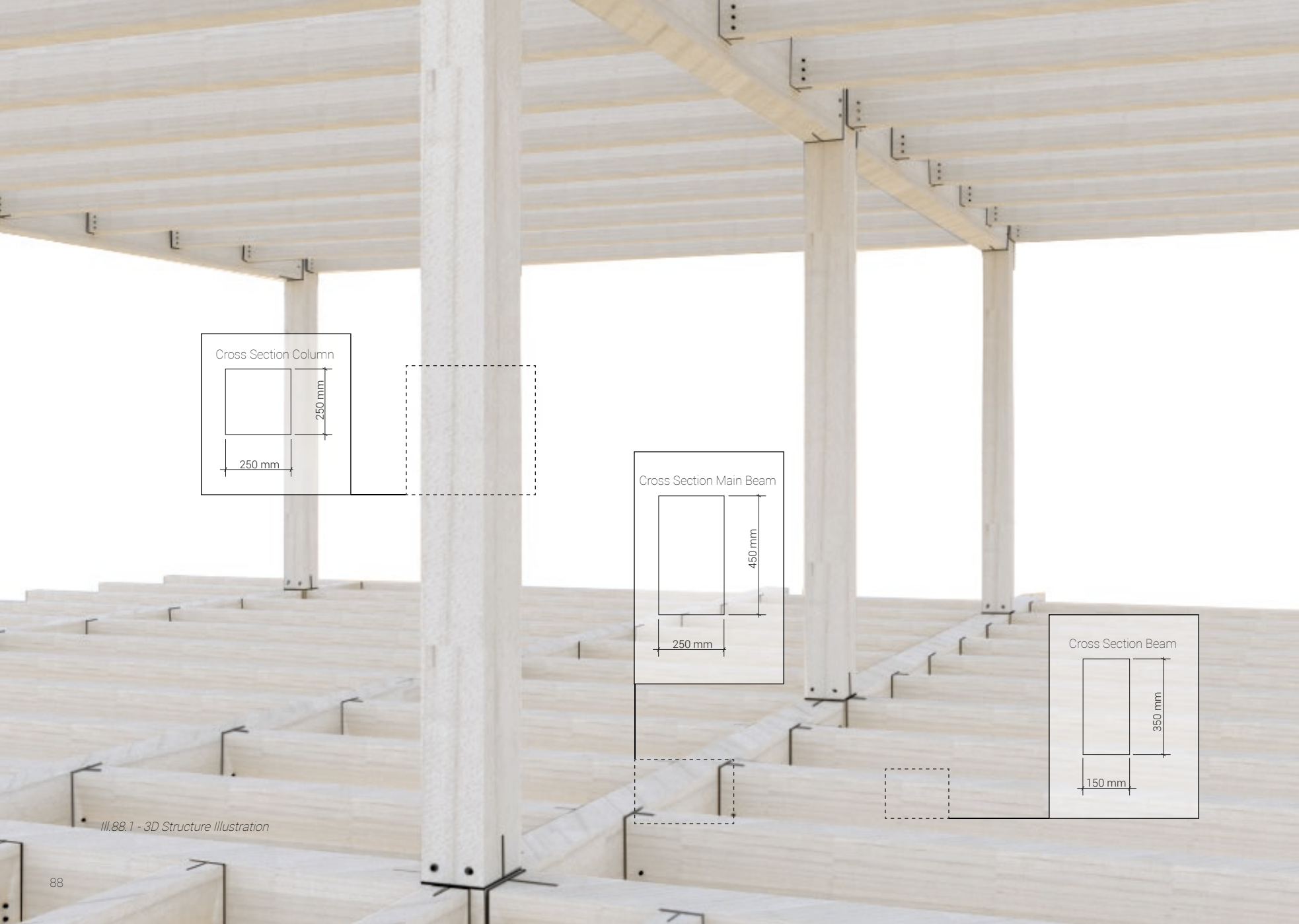
III.85.1 - Indoor Area - Entering The Bath Space



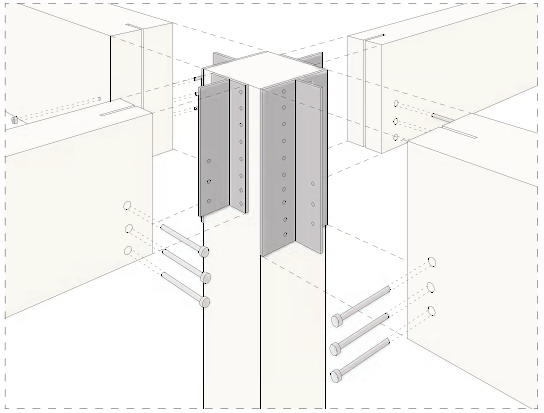


Ill.86.1 - Section 3D

Ill.87.1 - Cold Room Illustration



III.88.1 - 3D Structure Illustration



Ill.89.1-Diagram Joint Beam to Beam; Beam to Column

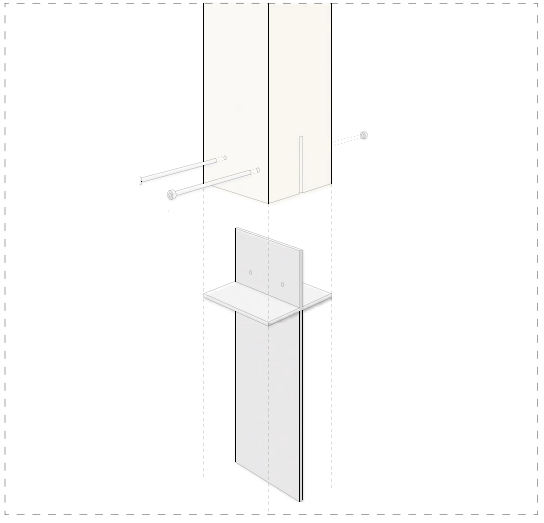
STRUCTURE

The development of the building design evoked a thought about a structure. The final structural expression represents a lightness and simplicity. The choice of timber structure and repetitive frame system holds together a fluid disposal of the floor plan and its functions. This solution enhanced the perception of individual spaces by creating and setting different boundaries. Variant recognition of the structure is achieved in different rooms, thus creating a feeling of dynamism despite a rigorous structural system.

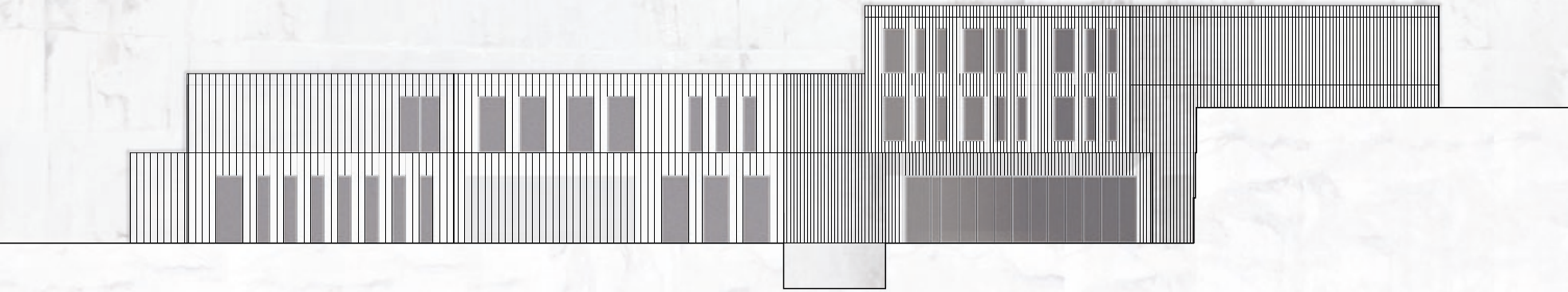
Structural calculations and detailed analysis are shown in Appendix 02, 03 and 04, page 138-143; or Design Process, page 114-116.

JOINTS

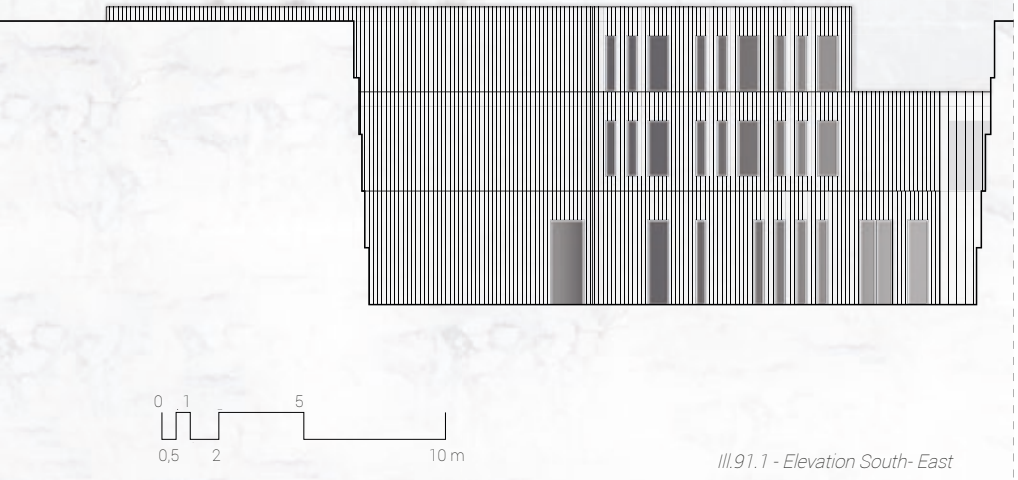
To fully keep the simplicity and purity, therefore the proposed joint solution is almost hidden revealing only a slight plate and its connection between the elements. This result strengthened a sustainable aspect by having a sliding- in joint screwed on the sides. The connection between the ground and the structure represents a vertical metal plate perpendicularly connected to the horizontal one with the screws. A bottom vertical plate is transferred to a concrete base where it takes the force further down to the ground – marble base. This joint solution is used for the connection of elements of different sections – beam to main beam, main beam to the column.



Ill.89.2- Diagram Joint Column to Ground



Ill.90.1 - Elevation South- West



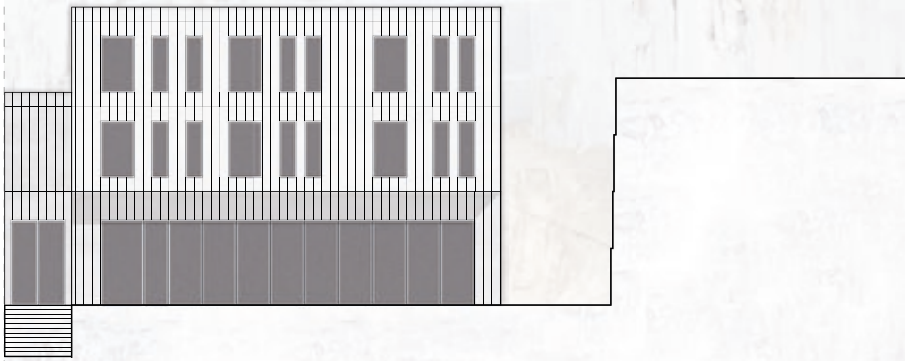
Ill.91.1 - Elevation South- East

When entering the quarry, a very first impression comes from the contrast of an embracing mountain over a little path leading to the Thermal Baths. The path, simulating a cut into the marble blocks, is a guide to an experience of a quarry, baths and Apuan Alps. The choice of translucent polycarbonate layer as a building finish enables the marble mountain to pass through together with the building's flow to reflect in the same tones. Its appearance of light and simplicity enhance the purity of the place and leaves it as a poetic spot. The verticality is underlined with the frame system and narrow pieces of transparency- the windows, strongly attached to the façade. In this way, the building's expression receive a strong identity and the aesthetics open the conversation with the site.

Ill.92.1 - Elevation North- East

Ill.93.1 - Elevation North- West

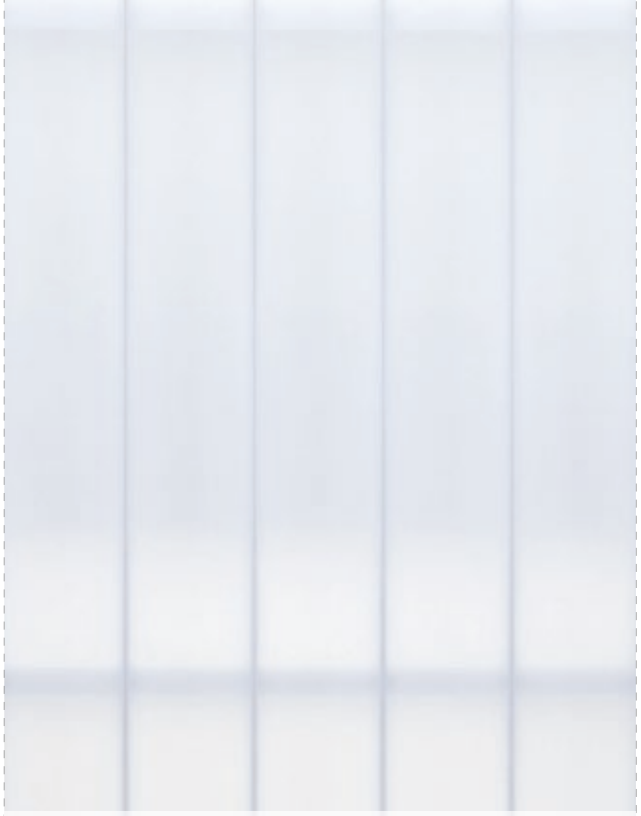
Ill.94.1 - Elevation East - North- East



Ill.94.2 - Elevation West - South- West

BEECH WOOD

- Hard timber, straight with fine to medium uniform texture, good mechanical resistance, smooth touch
- Usage: boat-building, interior cladding, construction
- Durable through time, possible colour change across the time
- Easy assembly with screws and nails
- To prevent the bacteria and humidity necessary certain treatment



POLYCARBONATE

- Light material, high resistance to impact, thermally insulating material, eminent light transmission
- Usage: industrial buildings and factories
- Good durability
- Facile assembly with screws and nails on a frame system
- Easy to maintain

CARRARA WHITE MARBLE

- One of the hardest limestone, high mechanical performance
- Usage: finish exterior façade, interior tiling and cladding
- Durable over the time

Ill.96.2 - Elevation South- West; Zoomed Elevation

Ill.97.1 - Night Building Illustration; Close View

Ill.99.1 - Outdoor Pool Illustration; View Towards The Mountains

SUSTAINABLE STRATEGIES

In order to optimize the interaction with the local microclimate, the possibilities of passive and active strategies in the Thermal Baths complex were analysed. It will not only contribute to the healing of the place but also improve the performance of the building.

A climatic influence on the site was studied for instance the sun path and the number of hours of natural light on the site, the direction and strength of wind and precipitation. This helped with orientating the building and shaping it in order to achieve its best performance.

RAINWATER HARVESTING

The water is one of the main leads in the project. Its healing and relaxing characteristics are expressed in the interior by the design of different pools and baths. To achieve a sustainable supply of appliances and baths the collection of rainwater was introduced. Rainwater collected on the roof is sufficient to provide the complex with clean filtered water for showers, sinks, laundry and toilets. Rainwater gathered in water pools situated in front of the building is later disposed to the pools and the remain water demand for appliances (refer to Appendix 12, page 156-159).

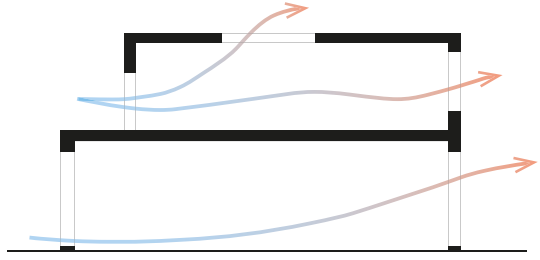
NATURAL VENTILATION

To better control the different indoor environment of each bath in the complex it is necessary to introduce natural ventilation as well as mechanical one. To achieve the thermal buoyancy and well-ventilated interiors different sizes of the windows and its placement was considered in the design. An open plan enhanced the strategy (Ill.98.1).

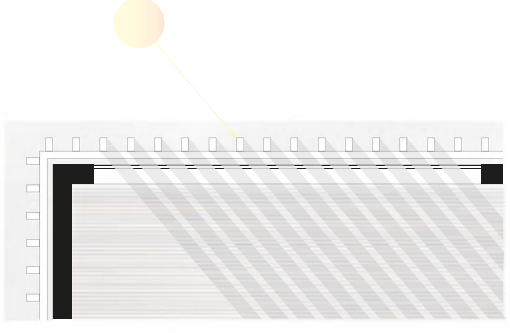
DAYLIGHT

The surrounding covered by the marble walls that can raise up to 40 meters came into consideration when arranging the functions within the plan. Due to the different atmospheres in the baths, the need of direct light, diffused or lack of natural daylight varies. Spaces that need lower daylight factor are located from the mountainside and are supported with the light that reflects from the marble slabs.

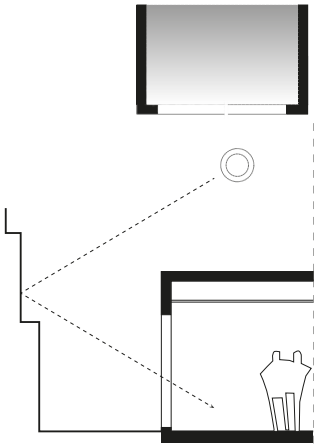
A light and transparent façade is introduced to the restaurant part which caused overheating in the room, therefore an overhang was introduced to reduce this amount. To decrease overheating in the building the use of the frame system in the outer skin works also as a shading device. To reduce the sun penetration during summer months, the polycarbonate layer was applied to override the window and lower the glare within the spaces (Ill.98.2).



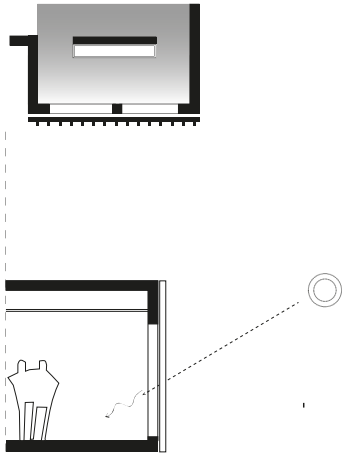
Ill.100.1- Natural Ventilation Scheme



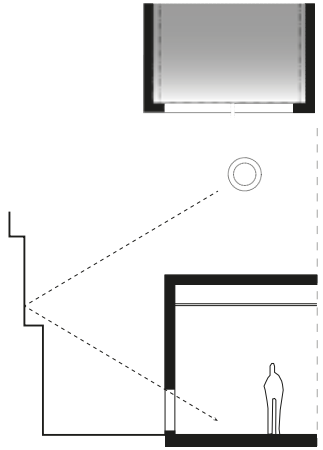
Ill.100.2- Daylight Tracing Diagram



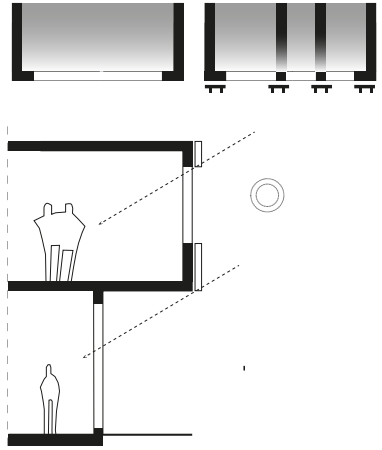
Ill.101.1- Daylight Diagram; Mountain Reflection



Ill.101.2- Daylight Diagram; Double Skin



Ill.101.3- Daylight Diagram; Mountain Reflection - Low Window



Ill.101.4- Daylight Diagram; Direct Sun Light, Overhang

The site of the Thermal Baths complex is surrounded by the excavated mountain. The material that forms the area is a White Carrara Marble, highly reflective material due to its colour and surface. The material's reflection enables the daylight to reach further in the interior. The variations in light entering the building, proceed in an investigation of different openings. As Louis Kahn said, 'light is a giver of presences and it also forms a shadow' (Schielke, 2013). The interplay between the light and darkness forms the spaces, and different game options create new atmospheres and let the user encounter new experiences moving from one space to another.

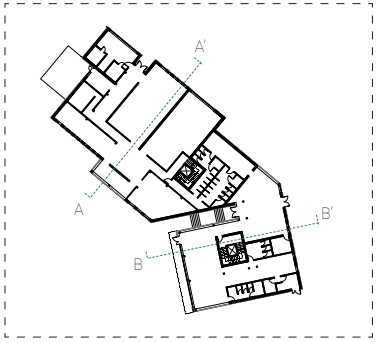
The rooms that occupy the western part of the building, where space is more open to enhance the warm and free layout, are supplied with a higher amount of daylight. Whereas in the back of the room the user can feel more intimate, mysterious breeze. That creates the contrast and fully holistic experience of architecture and surrounding neo-nature.

In illustration ill.99.2, the area with a drinking spring is overridden with polycarbonate. That turns down the amount of direct light, leaving the space amiable and cosy. The Hot Bath appears to be dim due to the darker tiling and introduced a horizontal window. In contrast with a high temperature of water and steam hovering over the surface, space becomes more relaxing, and the user is fully focused on the treatment (Ill.99.3).

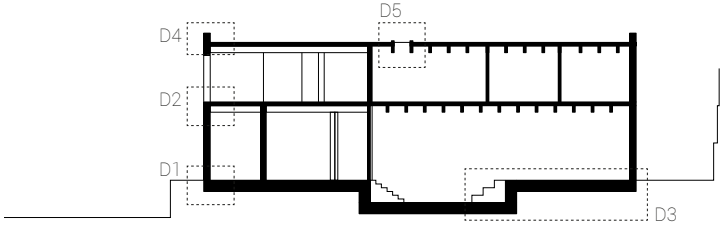
The sauna and steam bath area face the marble wall, therefore, penetration of indirect illuminance enter the room (Ill.99.1). In the hotel part with a restaurant fully open to the view is passively shaded by designed overhang to achieve a delightful indoor environment (Ill.99.4).

DETAILS

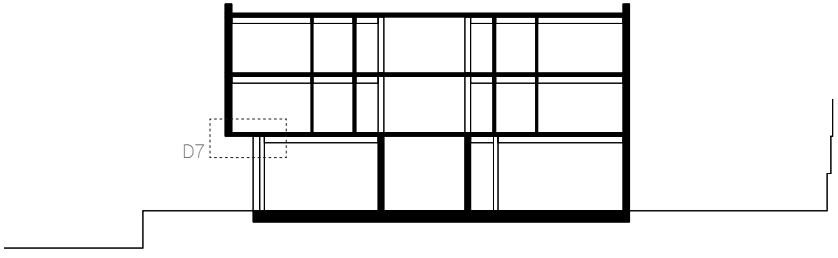
Refer to Appendix 15, page 162- 169



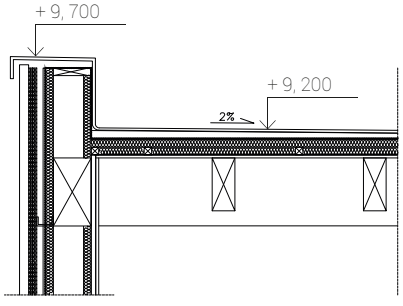
Ill.102.1- Navigation Plan

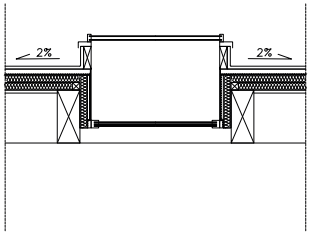


Ill.102.2- Navigation Cross Section A-A'

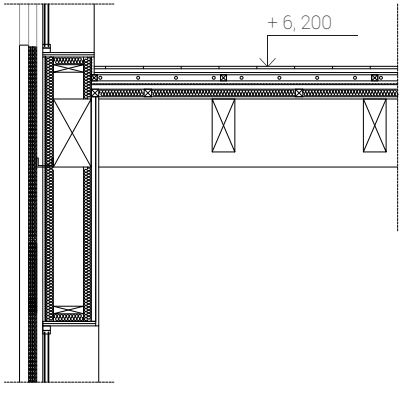


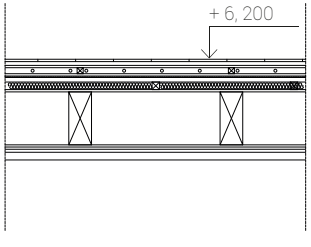
Ill.102.3- Navigation Cross Section B-B'



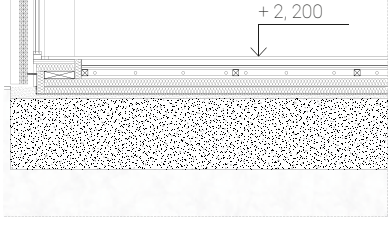


ROOF LAYERS:
Metal Roof Membrane 20 mm
OSB Board 30 mm
Waterproof Barrier
Vacuum Insulation Panel 50 mm
Vacuum Insulation Panel 50 mm
Moisture Barrier
Plaster Board 15 mm

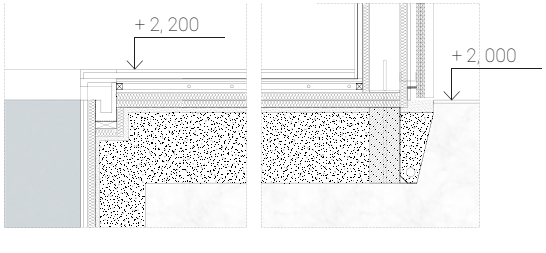




EXTERNAL WALL LAYERS:
Frame System
Polycarbonate 55 mm
Void 40 mm
Waterproof Barrier
Vacuum Insulation Panel 50 mm
Vacuum Insulation Panel 25 mm
Gypsum Board
Moisture Barrier
Wooden Cladding 15 mm



FLOOR LAYERS:
Wooden Flooring 20 mm
Subfloor 40 mm
Plaster Board 15 mm
Floor Heating 40 mm
Sound Insulation Mat
OSB Board 30 mm
Vacuum Insulation Panel 50 mm
Moisture Barrier
Plaster Board 15 mm



Ill.103.1- Detail Drawings, scale 1:50

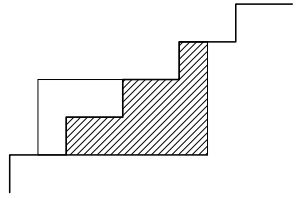
DESIGN PROCESS

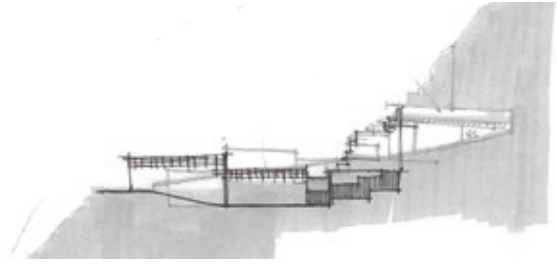
Form x Landscape Studies
Approach Studies
Interior Studies
Light Studies
Thermal Architecture
The Flow
Floor Plans
Structure
Joints
Facade | Materials
Sustainable Strategies
Acoustics
Conclusion

FORM X LANDSCAPE STUDIES

INTEGRATE

The first concept was to fully experience the existing marble quarry and preserve the current state, therefore, to integrate with the future architectural body. The volume was carved to the mountain with part of the building standing out as an inviting mass. This solution would have brought great issues lacking daylight. Furthermore, while approaching the site the perspective of the building would blend into the mountain and would not allow perceiving the functional complexion.

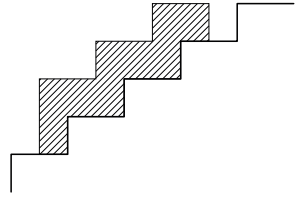




Ill.106.1- To Integrate - diagram, sketch

FOLLOW

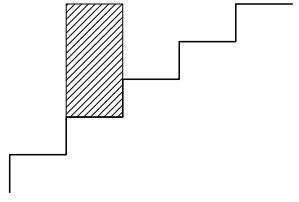
In order to further relate to the existing mountain, leads the design in the next step to fully follow the terrain. Thus solving the lack of daylight issue and the perception of the volume. However, the continuity of the terrain would constrain the visitor to freely experience the surrounded nature and the quarry itself.

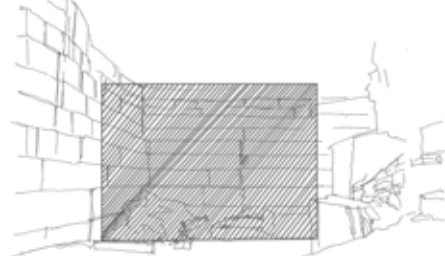


Ill.106.2- To Follow - diagram, sketch

IMPOSE

Further idea was to impose the architecture in the quarry and locate the building on the marble block. Thus, enhancing the inviting perspective and its contrasting dialogue. The location of the volume offers an alluring interplay with the view over the Carrara mountains and the reflection of the light within the quarry. The experience of the unique dialogue can start while approaching the site and can be underlined with a vertical cut through the mass.

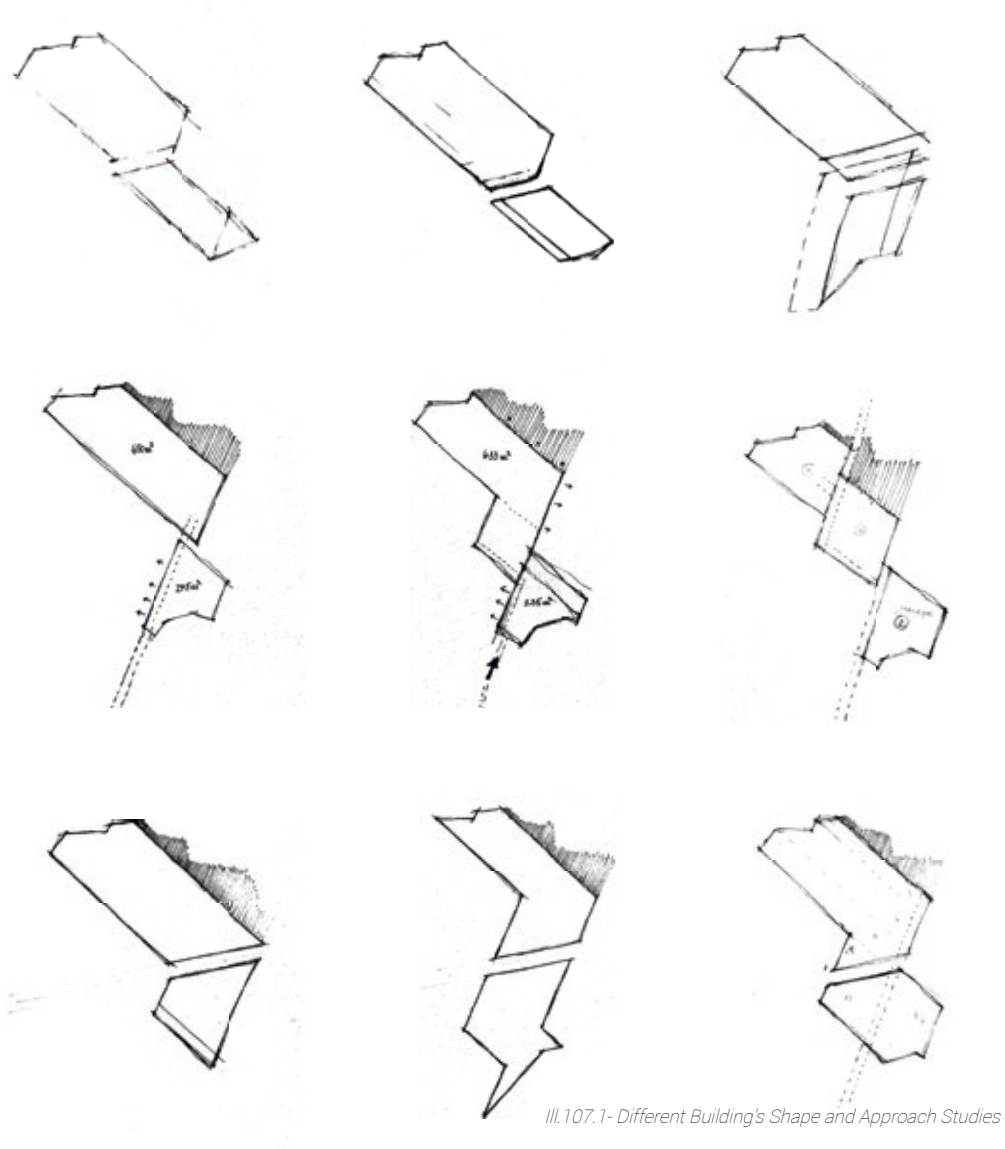




Ill.106.3- To Impose - diagram, sketch

FORM | SHAPE

The diverse terrain of the quarries offers several possibilities of interaction between the building and the mountain. The considerations have been based on previous analysis of the site and the surrounding. After understanding the investigated area and its possibilities, different form iterations were done to achieve coherent design within the existing area.



Ill.107.1- Different Building's Shape and Approach Studies

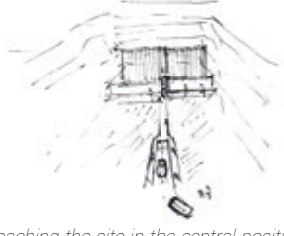
APPROACH STUDIES

A study of a placement of the building upon the site is carried out together with possibilities and qualities of the urban area. The perception of the building while approaching is considered since the very beginning of this designing part. Several options and ideas concerning the placement, the approach and the entrance itself were introduced.

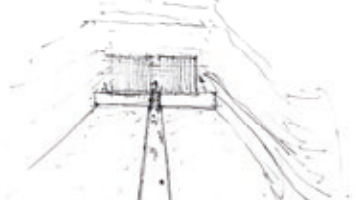
Ill.108.1- Building Position A- while approaching the site, meeting several volumes hiding an open square on the side

Ill.108.2- Building Position B- while approaching the site, facing several volumes hiding an open square behind these volumes, meeting the quarry in a close distance

Ill.108.3- Approach through the mountain - leaving the everyday life behind the mountain and coming to the open square - the quarry



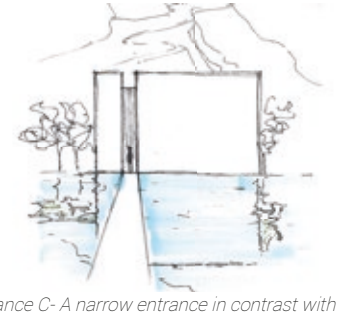
Ill.108.4- Approaching the site in the central position together with cars and splitting the machines down underneath the building, thus letting pedestrians to continue with the journey



Ill.108.5- Leaving the cars behind the mountain - fully allowing the visitor to enjoy the quarry and the surrounding leading through a direct path

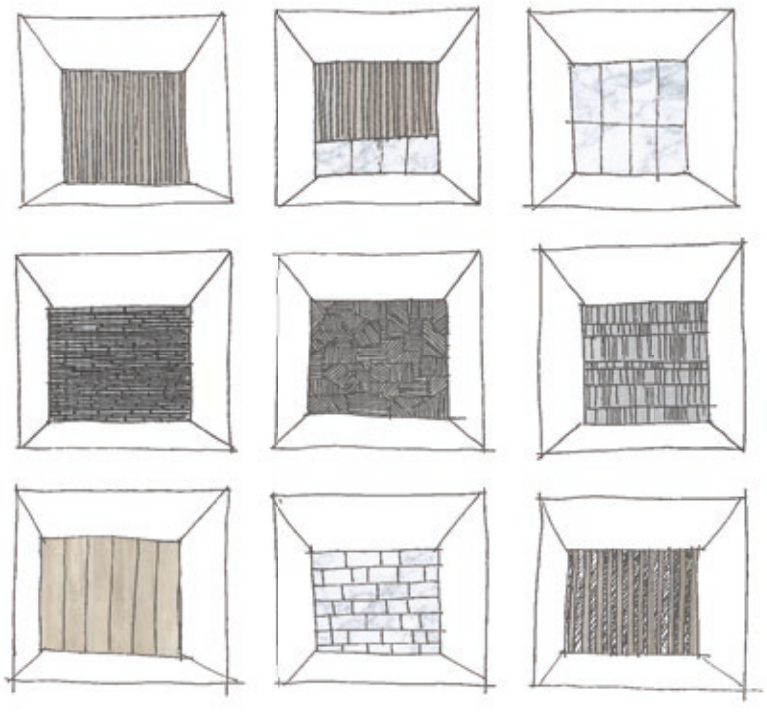
Ill.108.6- Entrance A- Having an entrance and exit as two separate passages, explained as coming as wounded and leaving as healed

Ill.108.7- Entrance B- one wide entrance, evoking on the exterior as a small dark entrance



Ill.108.8- Entrance C- A narrow entrance in contrast with a massive building - the play with the scale and contrast

INTERIOR STUDIES



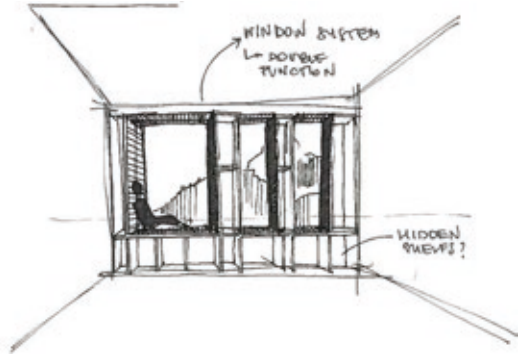
Ill.109.1 - Interior materiality and its treatment sketch

The atmosphere is a piercing feeling of the space, object, detail. Based on our senses - tactility, vision, smell, hearing and taste - we read the area and the perception of its forms, colours and shadows affect us emotionally. When designing the atmospheres, the task is to design something indefinite and difficult to express, that if made with care can be memorable and be touching (Böhme and Engels-Schwarzpaul, 2013). While designing the Thermal baths complex, the former idea was to influence the user and work with all the senses.

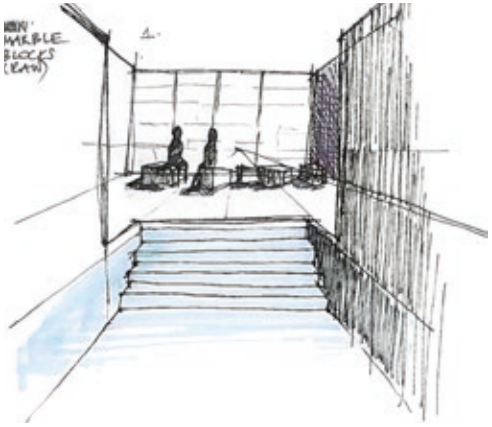
Thinking about the vision, the main concern was the choice of materials and their treatment. Since the context site carries such strong identity, rough and strong marble slabs, the aim was to harmonize and follow the characteristics of the area. Hence the choice of marble plates and tiles. During the design process wooden material was introduced. Material that perfectly contrasts with the mass of the surrounding mountain (Ill.107.1).

To enhance the experience of the internal space it is important to investigate diverse treatment and variations of sizes of wood and stone, that would influence the sense of touch and create contrast feelings among the building (Ill.107.1).

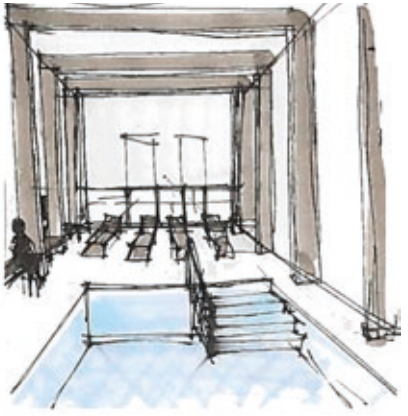
To complete the full sensory experience, the implementation of the hidden waterfall- to arouse the sense of hearing and implementation of the smell in some baths area will be considered.



Ill.110.1-Hotel room



Ill.110.2-Sauna and Stema Bath area

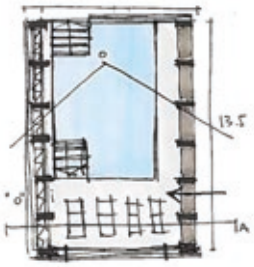


Ill.110.3-Main Indoor pool area

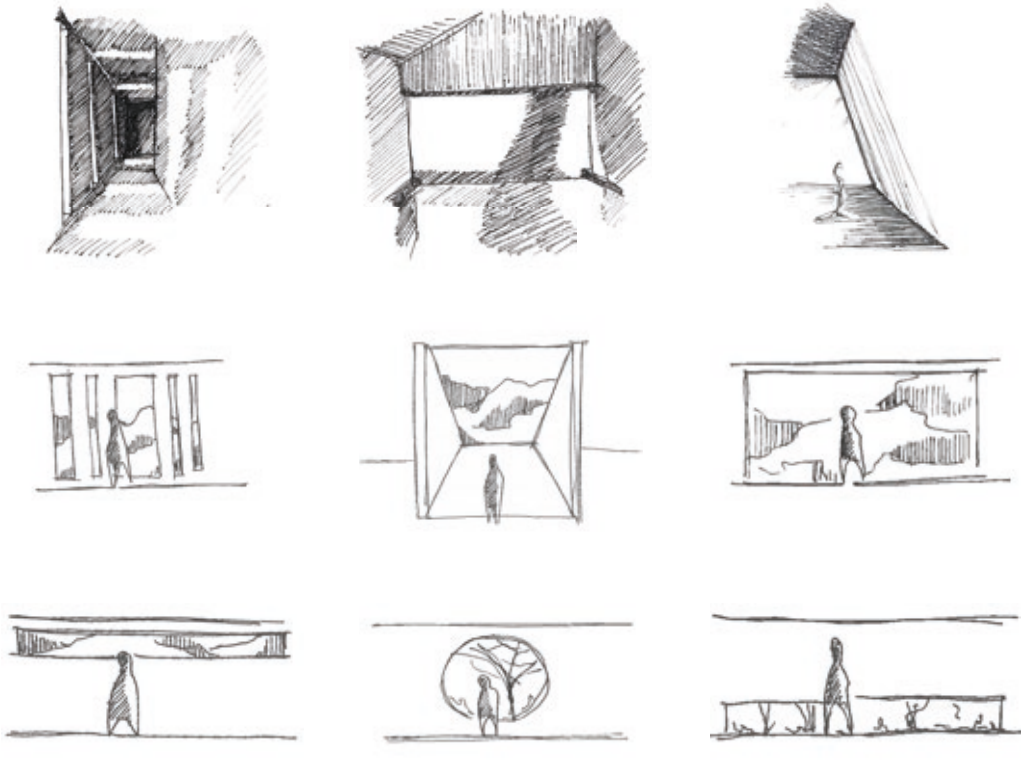
FURNISHING

When thinking about the interiors, the surface materials are not the only ones to be investigated. Since we want to incorporate different experiences through the building, therefore the treatment of the furnishing is more as an individual case, that corresponds to the specific area. For instance, deep analysis of the main areas of the sauna complex (Ill.108.2), hydromassage bath, or main pool (Ill.108.3) was done.

The further design process was developed in the hotel part where the aim was to provide the quests with aesthetic and fully functional interiors. Furniture can have more than one function, like a window bench that can be prolonged to the shelf system (Ill. 108.1)



LIGHT STUDIES



Ill.111.1 - Interior Light Studies; Sketches

One of the elements creating the space is daylight and shadows. As Louis Kahn said 'light is a giver of all presences (...) What is made by light casts shadow, and the shadow belongs to the light.' In order to create lit rooms, assure well- being of a user and also to design the extraordinary spaces that would be memorized and emotionally connected to them, therefore different light analysis were done during the process.

During the design process, studies of the sizes, shapes and placement of the window openings were developed. Knowing that we have multiple rooms that carry different functions and provide different moods, our main determination was to, due to the daylight, influence the emotions and enhance senses.

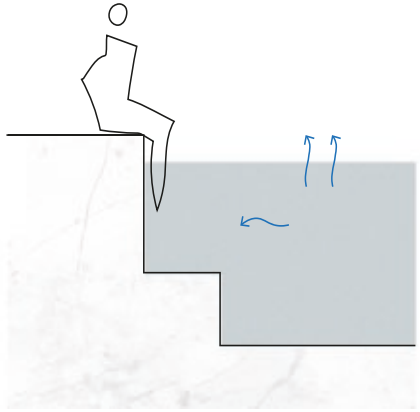
Along the process, we started to investigate not only glazing openings but also translucent possibilities. Both with the use of U-glass and polycarbonate. By using these materials that enable us to create interiors with highly diffused light and indirect aim.

To achieve bright interiors, we also tried to incorporate within the building skylights. The variety of window openings not only serves the enlightened rooms but also widens the possibility of experiencing the surrounding landscape. By designing small windows a glimpse of marvellous view is provided to the user, whereas wide windows directly connect them to the marble mass.

THERMAL ARCHITECTURE

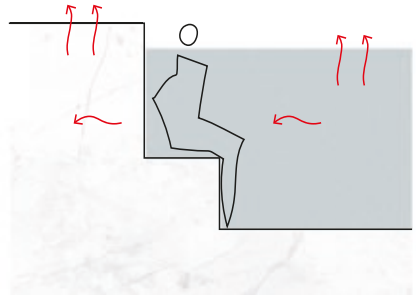
During the Design Process, the development and further analysis were done on Thermal Architecture. The theory was focused on the thermodynamic principles of thermal convection and conduction. These strategies brought the design to a wise choice of materials, disposing of some of the functions, thus creating divergent atmospheres within the building.

To fully enhance the thermal transmittance of further calculations and designing the layers of the building's envelope were evolved (see Appendix 06, page 146-147). The light building's timber structure is placed on the marble mass encapsulated with insulating layers. All this is then covered with a polycarbonate system as a second skin. The solution leads the design to a better performance of the U-Values and achievement of a diverse feeling in each of the space. Firstly, when entering the bath area, the visitor is in a rigorous corridor arriving in the centre of the Thermal Baths where the temperature is lower than in the designed rooms/ spaces limited by the walls and structure. While entering the individual spaces, which execute a peculiar behaviour, for instance in the hot bath - a warm feeling of the place or in the sauna complex - a cold sensation of the room.



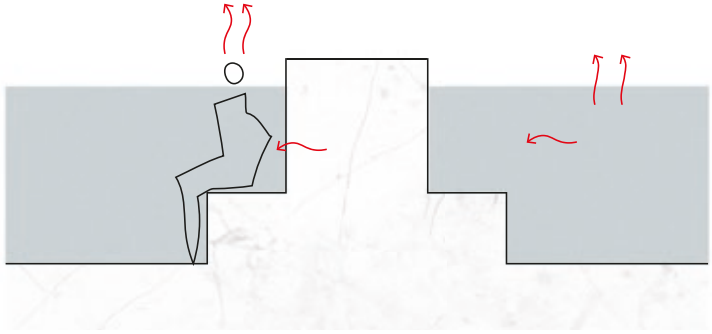
Ill.112.1 - Cold Bath vs. Marble

The perception of a cold bath is enhanced with a marble base of the bath (Ill.110.1). The expression of the marble material evokes a cold feeling, thus highlighting the purpose of the cold bath and its surrounding.



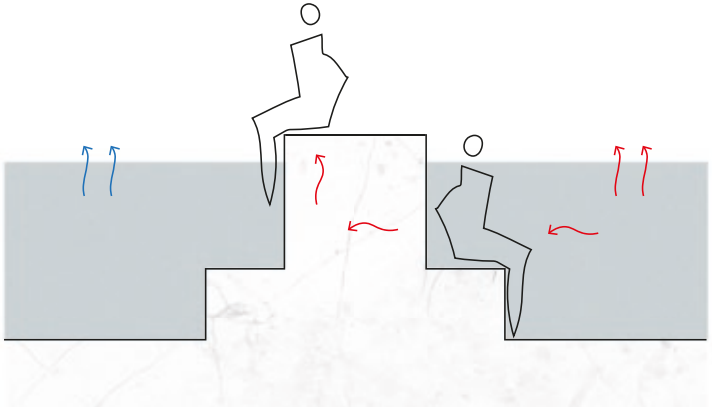
Ill.112.2 - Hot Bath vs. Marble

Designing a marble base for a hot bath evokes a perception of a cold room, however, when setting foot in the bath recognizing a warm sensation (Ill.110.2). This sense is discovered as well when touching the marble connected to the bath.



Ill.113.1 - Hot Bath in connection with Hot Bath

The thermal convection and conduction are achieved by transferring the heat energy from a hot bath to a warm pool. This heat exchange is enabled by leaving a marble mass, which works as a thermal mass, in between the pools. The thermal conductivity comes from the hot bath through the marble wall and leaving the warm pool a warmth to the air in the room (Ill.111.1).



Ill.113.2 - Hot Bath in connection with Cold Bath

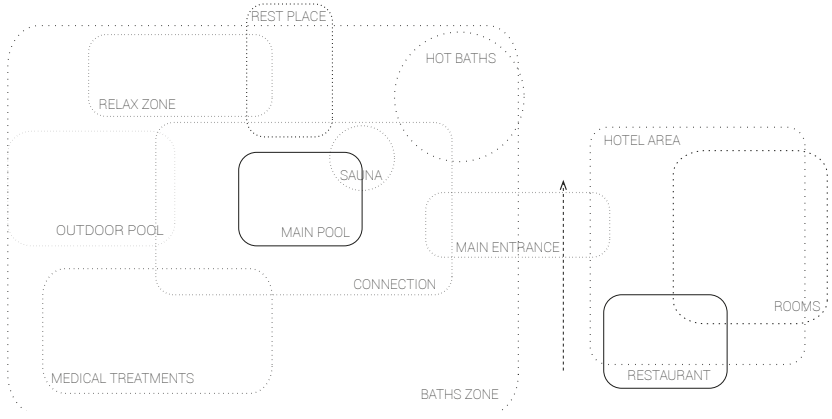
Having a cold and a hot bath divided by a marble mass creates a feeling of cold when looking at the expression of the marble material, but when entering the hot pool surprisingly warm and delightful (Ill.111.2). The warmth is transferred by thermal conductivity to a cold bath which evaporates to a cool air.

THE FLOW

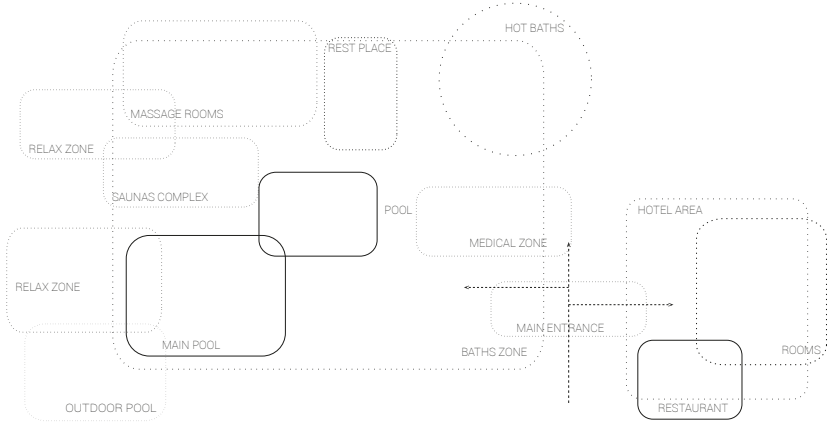
In the case of thermal baths, it is essential to form a functional and compelling layout for the comfort of the users and understandability of the geometry. Our starting point, after deciding about the necessity of the rooms and their function, was to logically combine them. We tried to take different approaches to fully understand the flow and possibilities of discovering the thermal baths step by step.

The first approach was based on the placement of the main bath, where we tried to position it as a focal point and surround it with the other functions. In order to attach the building layout to the historical disposal (Ill.112.1). Another attempt was to place the main bath on the side and connect it with an outdoor pool and meditation area. In this way, the focal point would be designated to the inner communication and there would be no gradation of the importance among functions.

Another iteration was to dispose the functions following the senses, taking into consideration the importance of daylight, connection to site and tactility of functions. Here came the idea to distribute the areas by contrast. We follow the contrast hot-cold in both, wet areas disposal and in accordance with a hot-cold game of light possible in the plan (Ill.112.2).



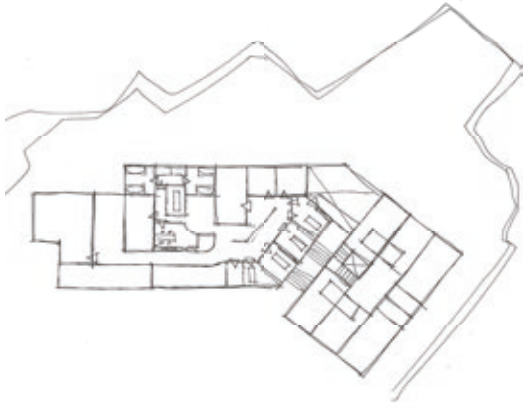
Ill.114.1- Building Flow according to the historical disposal



Ill.114.2- Building Flow- functions vs. contrast

FLOOR PLANS

Ill.115.1- Ground Floor Plan- Variation A



Ill.115.3- First Floor Plan- Variation A

Ill.115.2- Ground Floor Plan- Variation B

Ill.115.4- First Floor Plan- Variation B

Once the function program and layout was chosen, we started to work on the site, taking into consideration what conditions should be fulfilled by each room.

Moving the baths multiple times, changing their dimensions and connections between each other, we tried not to forget about the building flow. In this way, the place would be comfortable for the user, understandable and possible to discover.

STRUCTURE

WALLS

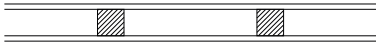
Structural studies have been carried during the design process together with the plan sketches and light analysis. A frame structural system was chosen early during the design process to keep the simplicity and light expression of the wooden construction over the heavy marble mass.

The first proposition was to keep the vertical structure inside the walls and express the room in a very simple way. Thus, letting visitors to freely wonder around without any boundaries, just between the walls' surfaces (Ill.114.1).

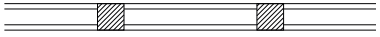
The perception of a visitor would change when the structure would reveal but not as a full mass – the walls' surface broken into segments by the vertical elements (Ill.114.2). This solution would confuse the visitor in a way of not perceiving the structural element in its complete presence.

Lastly, the structure was designed to bounder space and to be honest to its properties. Therefore, having the vertical element revealing on the surface would help the visitor to perceive its equity and would enhance the play with the light in the room (Ill.114.3).

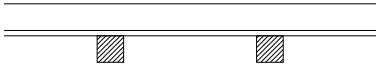
Due to the divergent functions and requirements of the rooms, the structure will be exposed in distinct ways. The working models were done to fully understand the space and its concept.

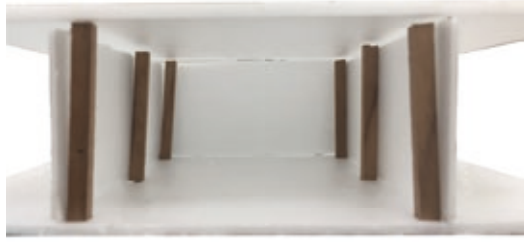


Ill.116.1- Structure inside the Wall; Model, Diagram



Ill.116.2 - Structure n between the Wall; Model, Diagram





Ill.116.3 - Structure next to the Wall; Model, Diagram

CEILING

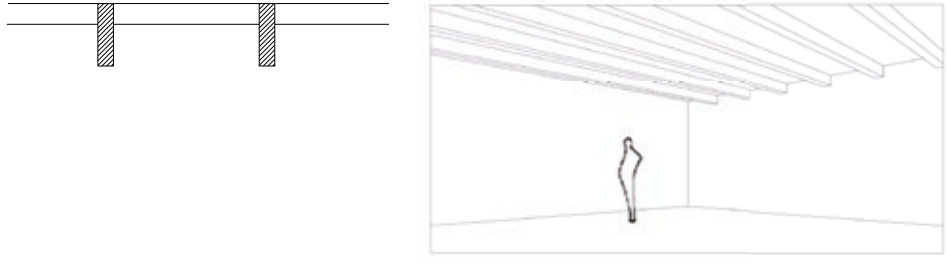
The horizontal elements are as important as the vertical ones, therefore have been tested along with the vertical elements.

Having the structure hidden in the ceiling and having thus only a plain ceiling's surface would control the purity of the space and would let the function of the room affirm by the furniture and its surrounding (Ill.115.1).

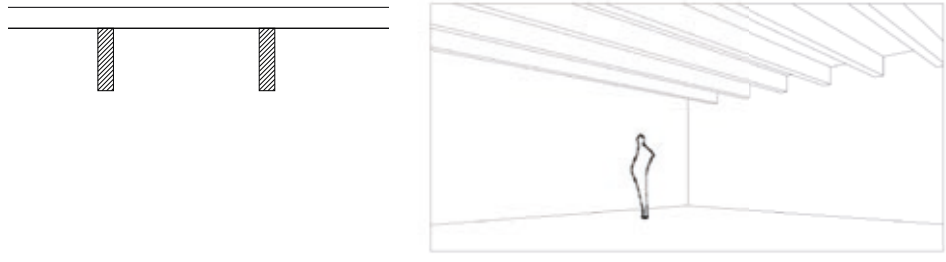
Another case was studied when the structure was half revealed and half hidden in the ceiling's construction layers (Ill.115.2). This lead to a confusing feeling of the room having a fake structure that does not support the building.

In the case where the horizontal beams are exposed the perception is controlled and it evokes a feeling of safeness, due to a recognition of the whole structural element (Ill.115.3).

Ill.117.1- Structure inside the Ceiling; Model, Diagram



Ill.117.2 - Structure in between the Ceiling; Model, Diagram



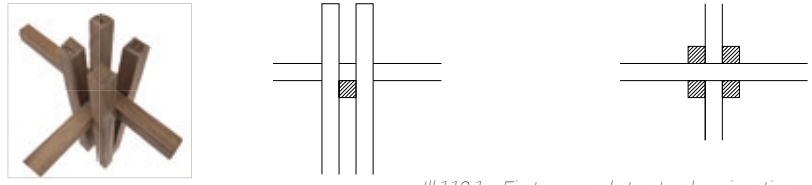
Ill.117.3 - Structure next to the Ceiling; Model, Diagram

JOINTS

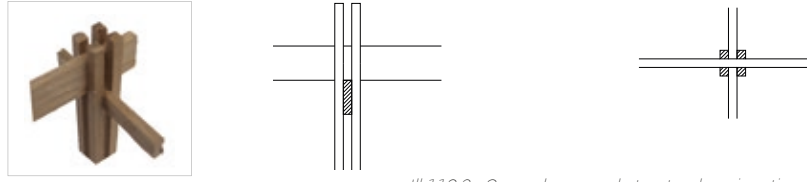
Along the design process, in order to avoid introducing entirely unfamiliar materials within the quarry, we decided to work with the glue-laminated timber. The structure and construction, apart from technical aspects, carry aesthetical characteristics. Therefore it was important to work on the presence of the construction, bearing in mind the utilisation of the material and economic features.

The first proposition was to use a column divided into four smaller sections, which would hold beams joint in between in the intersection point (Ill.116.1). This option seemed to be light and interesting to implement within the interior, however, it was not strong enough nor efficient. We still tried to investigate the proposition by changing its dimensions (Ill.116.2). But the results were still dissatisfactory.
Another system that was tested was a two-element column supporting same-sized main beam (Ill.116.3). On top of the latter, a secondary beam was placed. The problem with this solution was similar to the previous one. The main issue was efficiency concerning material and money.

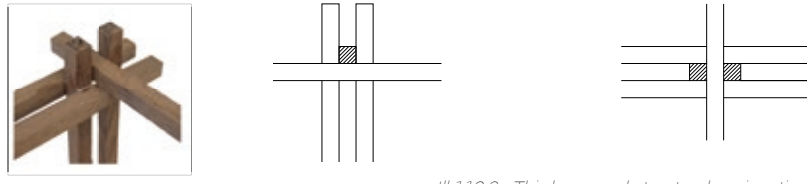
In order not to waste material and still come up with a stable construction, a simple frame system was chosen. In this way, the structure reflects the simplicity of the surrounding area. Being simplicity and light expression the priority in the building's design, metal joints were investigated, a sliding system, as well as bolted system, were considered (Ill.116.4-5).



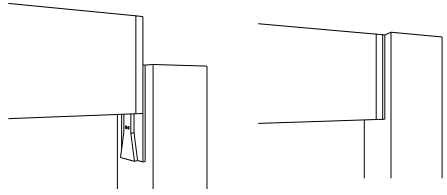
Ill.118.1 - First proposal structural conjunction



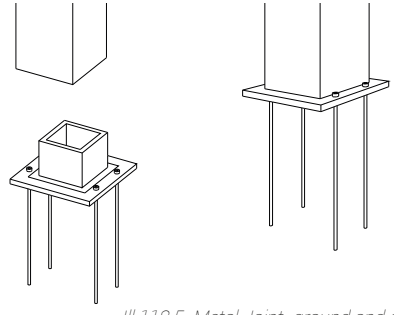
Ill.118.2- Second proposal structural conjunction



Ill.118.3- Third proposal structural conjunction



Ill.118.4- Sliding Metal Joint- beam and beam



Ill.118.5- Metal Joint- ground and column

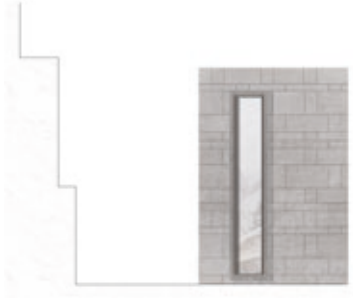
FACADE | MATERIALS

The site where the Thermal Baths are designed is characteristic for its strong identity. The texture of marble overpowers its surrounding, cutting through the view in horizontal, vertical and diagonal directions. During the design process, we aim to harmonize with the site, not overwhelm it or fade behind with the design.

One of our former ideas was to use stones that are appearing in the close distance to the site. Following the idea of contrasting the textures, shapes and colours. The thought was to use grey-coloured limestone (Ill.117.1). Nonetheless, after a discussion, we decided that the contrast can be achieved in another way. On the massive plain of the mountain, we decided to introduce the light material - wood in a bright colour (Ill117.2).

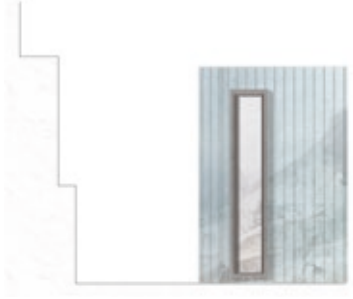
Since our site is highly industrialized, we decided to experiment within the facade with corresponding materials that leads us to use u-glass (Ill.117.3) or polycarbonate (Ill.117.4). During these iterations, it was interesting to see how the shape behaves when there are solid partitions, translucent and transparent.

When investigating the material of the facades and their expression, along with the process, we kept in mind the chosen construction and if it transfers to the outside or the translucent part is treated strictly as a double skin (Ill.117.5-6).

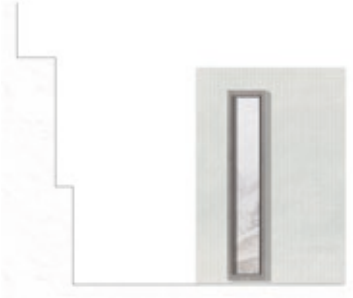


Ill.119.1- Facade- Stone

Ill.119.2- Facade -Wooden Cladding



Ill.119.3- Facade- U-Glass



Ill.119.4- Facade- Polycarbonate

Ill.119.5- Facade -Polycarbonate, dense framing system

Ill.119.6- Facade- Polycarbonate, scattered framing system

FRAMING SYSTEM

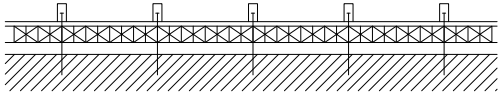
Following the tectonic thought, the expression and connection of materials appear very important while designing. After opting a polycarbonate finish as a façade and second skin to the building, therefore revealing the translucency of the building's flow, polycarbonate's frame system feels to be essential. The study is concerning options how to perform polycarbonate's frame system as well as the connection of the outer skin to the building.

The first inspection of the system was to decide about the dimensions of the frames. The case was tested by the analysis of the facade and the visual representation of all the choices.

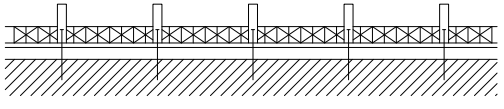
After the dimensions were fixed, we analysed the joinings in the outer skin. The first option was to implement the polycarbonate within the boundaries of the frame, prepared grid, that later is attached to the beam (Ill.118.1). A problem of this choice was how complicated the exchange of every element would be in case of the damage.

Another proposal was based on the nail, where the frame was the profile cover of its head. The solution seemed to be easy but the dimension of the protruding element was to shallow and the visual expression was not satisfying (Ill.118.3). One of the other propositions was to implement the frame system on the top of the polycarbonate, and with the help of nails to attach them to the construction (Ill.118.2). Here the question was if the construction of frame system is not too heavy and what size of connections would be able to hold it.

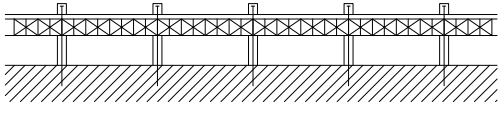
Investigating further the possibilities and struggles of the outer facade, we tried to design a structure that holds strong technical values, as well as the aesthetical. Which follows our vision and harmonise with the surrounding neo-nature.



Ill.120.1- Frame System With Polycarbonate in between



Ill.120.2- Revealed Frame System With Attached Polycarbonate

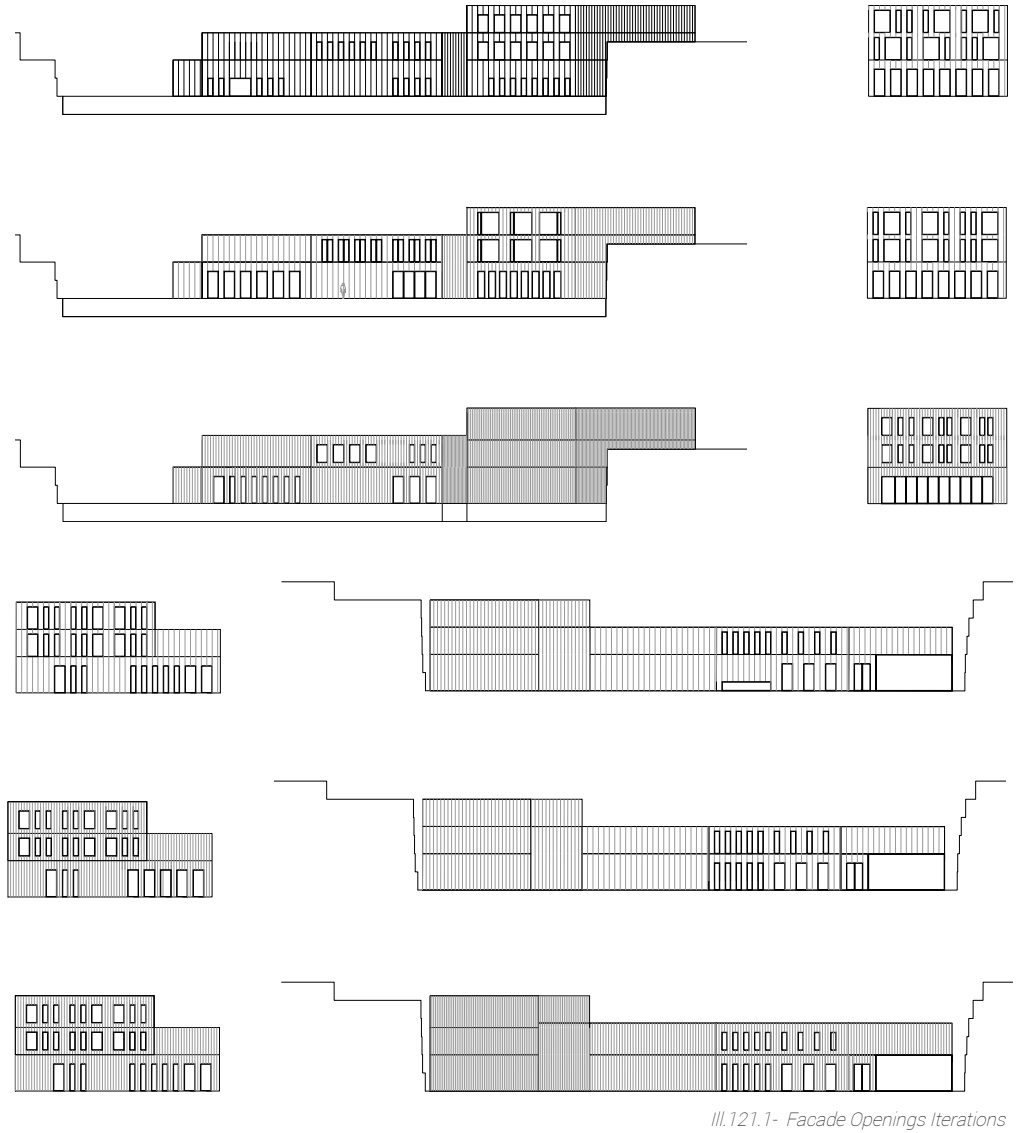


Ill.120.3- Frame System Behind Polycarbonate Layer

FACADE OPENINGS

The expression of the façade was studied together with the shape and disposition of the windows. Depending on the function hiding behind the translucent facade system several options of window widths and heights were explored. Tall and narrow windows both enhance the vertical look of the building and integrate into the chosen façade system. This solution also allows daylight to enter the interiors in segments, thus not spoiling the view of the Apuan Alps for the visitor. The play between translucent and transparent part was introduced to the elevations to enable an indirect and direct view of the flow in the building.

Considering the function of the building, a fully open elevation was designed for the restaurant situated on the ground floor of the hotel part. A game of different widths of the windows is applied to the rest of the hotel part in synergy to the bath part.



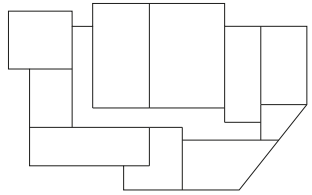
Ill.121.1- Facade Openings Iterations

SUSTAINABLE STRATEGIES

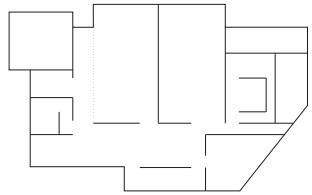
In the site exploited by marble excavation during years, it is crucial to introduce passive and active strategies, in order to minimize the destructive impact of the industry. Therefore further investigation of possibilities for the passive strategies, where the climate can be exchanged into a contribution to improve the indoor environment. Active strategies are to be studied at the same time to make the baths performance less affecting the surrounding and to decrease the energy consumption in the complex.

In order to achieve the sustainable design, the objective is to create a design where the layout, the shape of the building and its orientation is chosen due to the climate possibilities.

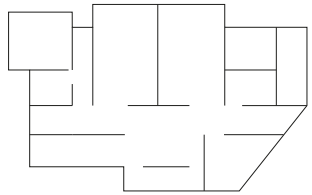
The layout was deeply studied and several options were proposed whether its functions were separated, semi-closed or open (ill.120.1-3). Therefore understanding an incidence of a designed function's disposal that has on the building and passive possibilities, like natural ventilation and daylight. The natural ventilation was improved and light reached further into the building by open space plan distribution.



Ill.122.1- Close Plan



Ill.122.2- Open Plan



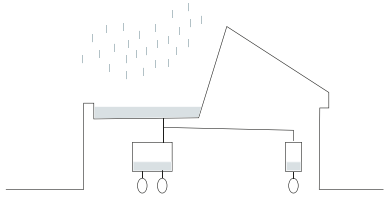
Ill.122.3 - Semi-Open Plan

The further field of investigation concerned the building's envelope. Although our building is located in Italy (DMRU 06/15), where the building regulations differ from Danish Standards, we tried to design partitions that meet Danish Building Regulation (Building Regulations, 2015) (ill.120.4).

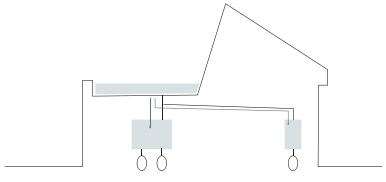
For the sake of active strategies rainwater harvesting (ill.121.1-4) and necessary appliances to support the technology were analysed (ill.121.5-6).

	ITALY (CLIM. ZONE D)	DENMARK
VERTICAL PARTITIONS	≤ 0,29 W/m2K	≤ 0,15 W/m2K
HORIZONTAL PARTITIONS	≤ 0,26 W/m2K	≤ 0,10 W/m2K
PAVEMENTS	≤ 0,29 W/m2K	≤ 0,10 W/m2K
WINDOWS, DOORS	≤ 1,8 W/m2K	≤ 1,4 W/m2K

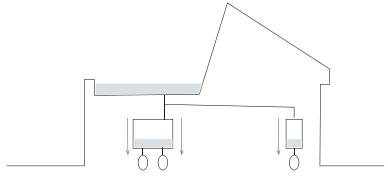
Ill.122.4- U-Value Table for Italy and Denmark



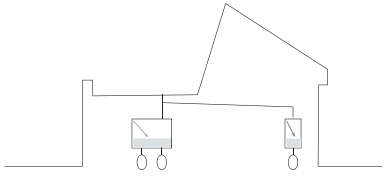
Ill.123.1- Rainwater Collection



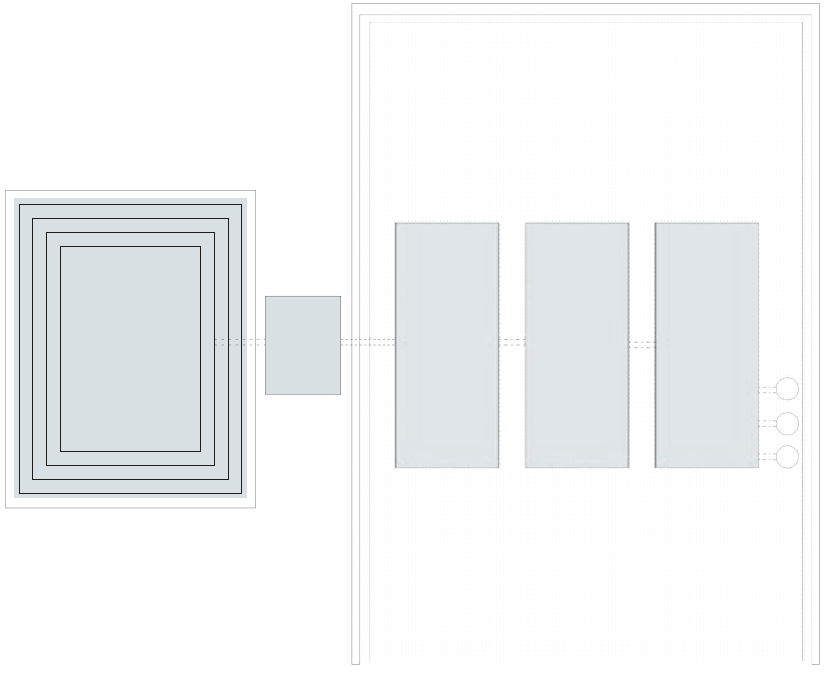
Ill.123.2- Rainwater Filtering



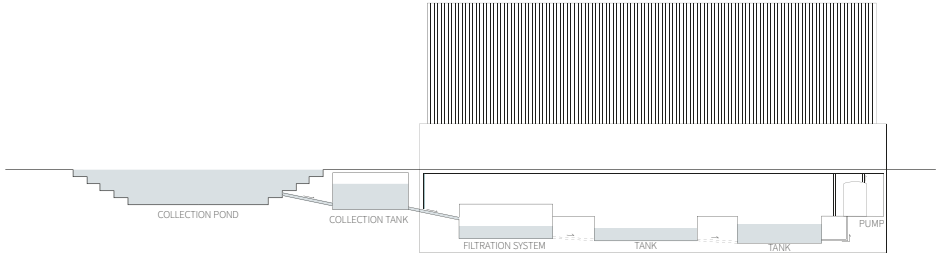
Ill.123.3 - Water Supply to Appliances



Ill.123.4 - Self-cleaning phase



Ill.123.5 - Water Tank Collection Flow; Plan



Ill.123.6 - Water Tank Collection Flow; Section

DESIGN PROCESS CONCLUSION

Designing the building following the Integrated Design Process brought us to several recessive steps through the stages of analysis, sketching coming to synthesize, present and back.

After stating a problem and conveying the analysis part of the site and its surrounding, possibilities and potentials, we were ready to interpret the local area and apply this knowledge to design the building. Starting with the sketching phase a conceptual approach to the site its appearance and contribution to the existing industrial nature was to be expressed. Designing a Thermal Baths, a place where a human body is in a close relation to the building, it was necessary to fully incorporate all five senses within the architecture. Thus, finding the atmospheres, its real expression and significant effect on the design and a user, followed by the building's flow. This segment was supported by structural analysis together with sustainable strategies. The structural analysis were developed with several proposals of its appearance in accordance with the function, together with several calculations and different iterations (Appendix 02, 03, 04, page 138- 143). This brought the design to a more rigid shape holding together a fluid building's flow.

Due to the site with a very strong character of industry and nature, it was important for us to start the experience from a very far. Thus, the site approach and the building expression was further advanced with several proposals of different materials and its articulation.

After many repetitive steps that brought us back to phases of analysing, sketching and synthesizing, we came to a conclusion that was leading us through the presentation phase, where several times was necessary to come back to the previous phases. The method of Integrated Design Process led us through the project and brought us to a fully complete design.

EPILOGUE

Conclusion
Perspectives

CONCLUSION

Throughout the project, we fully immersed ourselves into the design case of rethinking Carrara Marble Quarry. The site, as shown in detail, because of its industrial past, presents a highly transformed environment, which was affected by human intervention for hundreds of years. In this place in fact, since the Roman age, nature has been irreparably disfigured by marble excavation. The challenge that we, as architectural students, had to face was how to develop a different function for this site and how to rehabilitate and reinvent the place with the use of Architecture. We believe that our architectural addition would tremendously increase the interest in the Quarry, develop a local tourism and re-establish its purpose without further impact on the existing topography.

The idea the project is hinged on is to work with a damaged area as a curing place. In these terms, the natural wound created by millennia of marble excavations is the location of a healing complex, in which a process of wound regeneration symbolically occurs inside another wound.

The concept was translated into Architecture with some difficulties, deep investigations and through a long design process that eventually reached its conclusion respecting all the barriers that the project site imposed.

The program the design is based on was created after a detailed analysis of the quarry site, baths theme and users. This helped with understanding how the complex site morphology is and how to harmoniously insert the building, aiming to obtain reciprocal benefits. Fundamental ideas that rose from the program and drove us during the design, were landscape integration, sustainable and tectonic solutions and search for recreation and healing. These brought us to design choices which were then transformed with time and further analysis of space possibilities and human needs. All these iterations led us to the current architectural proposition.

During the thesis, multiple trials were conducted to define the user. Essential for the project was to invite multiple kinds of visitors: locals as well as national and international tourists needed to be welcome. For this reason, the Complex is dedicated to various purposes: recreation, relaxation, and rehabilitation. The aims are intersecting and creating a multifunctional context. Whatever the purpose is for the guests, they are welcome to explore the building and find the spot they are looking for: multiple intimate spaces are designed, as well as others that support building relations. Some that leave the space for private insight and those that give the possibility of sharing. The labyrinth of rooms and connections can apply to a personal labyrinth and exploring oneself.

All our investigations reflect on the outcome of the building's shape: the divided unity in the body, the directionality of the plan and elevations. This is an attempt to create a geometry that with its appearance fits within the dazzling marble slabs, creating the feeling of peace for the users but maintaining them interested and satisfied throughout the whole journey.

To give a complete feeling of the architecture it was crucial to investigate the structural possibilities of the timber, which is a warm material that creates an ideal contrast with the cold presence of marble. The purity and simplicity of the site can be seen in the structure and construction of the building, as well as in the outer skin. The materials chosen for the project, with their use and treatment, stay in balance with the surrounding and contribute to highlight the site area, especially in the night, when artificial lighting gently marks its presence. All these aspects were tackled following tectonic thinking: their design is driven by the connections of materials, their detailing and the atmospheres they create within and outside the architecture.

REFLECTION

Designing the Thermal Baths Complex, challenges were found both in the technical and architectural aspects of the project. In this process, an integration between tectonic, sustainable and aesthetic approaches led us towards the finalisation of the architectural design.

Nevertheless, the project in the current stage leaves room for further investigations and implementations, certainly being still an open chapter. Concerning the tectonic approach, having the possibility to continue the work on the subject, we would like to investigate supplementary the structure and construction of the complex. The next step would be to experiment with the dimensioning of beams and columns, differentiating the rooms and give every space distinctive feeling by variations of the structure.

Even though materials, their treatment and joinings were deeply studied, having a possibility, we would like to improve solutions within the details. Mainly, the way the building is connected to the ground, marble in this case. This surely would improve tectonic relation of the architecture and neo-nature, a connection of materials with different language and identity, which should be studied in a detailed scale.

If we had the time, we would like to dig deeper into the sustainable matter. Analysing more thermal architecture and its possibilities could also affect the sustainable water treatment. Understanding better water flows between pools with different temperature, we could minimise the energy demands for the pools and water recovery.

Keeping in mind that the Master Thesis is the last project within University, in which a lot of freedom regarding the design is given, we felt we needed to spread our creativity and come up with a design that presented a holistic character and satisfied our aesthetics. In the project of Terme di Carrara, we managed to satisfy our joined aesthetics and present the technical and architectural project, responding, in our opinion to the following question: What is the architecture that can give a new meaning to the topography of the mesmerizing site of quarries and make it regain its purpose and meaning?

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Ill.10.1 - Carrara Marble Quarry, Own photography
Ill.13.1 - Methodology Diagram, Own graphic based on Mary- Ann Knudstrup
Ill.14.1- Marble Detail, Own photography
. - German bath house, Author unknown (ONLINE) Available at: http://www.entertheroom.pl/images/SUSSU/WRZESIEN_2016/29_09/higiena/1140x490_higiena_beautyuroda_natura.jpg
Ill.22.3. – Rudas Baths, Author unknown (ONLINE) Available at: https://flavorwire.files.wordpress.com/2012/02/04-rudas-baths jpg?w=300
Ill.22.2. - Roman Baths, Baths, Author. Diego Delso (ONLINE) Available at: https://www.thevintagenews.com/wp-content uploads/2017/08/119-640x434.jpg
Ill.22.4. – Parco thermale del Garda, Photographer unknown (ONLINE) Available at: https://terme.myblog.it/media/00/02/957608441.jpeg
Ill.25.1 - Terme Saturnia, Italy, Author. Jarle Refsnes (ONLINE) Available at: https://www.acasamai.it/wp-content/uploads/2018/01/6250630396_a13037a610_b-e1517395304518.jpg
Ill.25.3 - Le Termas di Tiberio, AUthoR: Moneo Brock (ONLINE) Available at: https://www.metalocus.es/en/news/thermal-baths-termas-de-tiberio-moneo-brock-studio
Ill.25.4 - Centro Termoludico de Amelie, Graphic owner. Francisco Mangado (ONLINE) Available at: https://www.archdaily.com/487025/francisco-mangado-led-team-wins-thermal-bath-competition-in-southern-france/531f5bffc07a806cd90003c0-francisco-mangado-led-team-wins-thermal-bath-competition-in-southern-france-image
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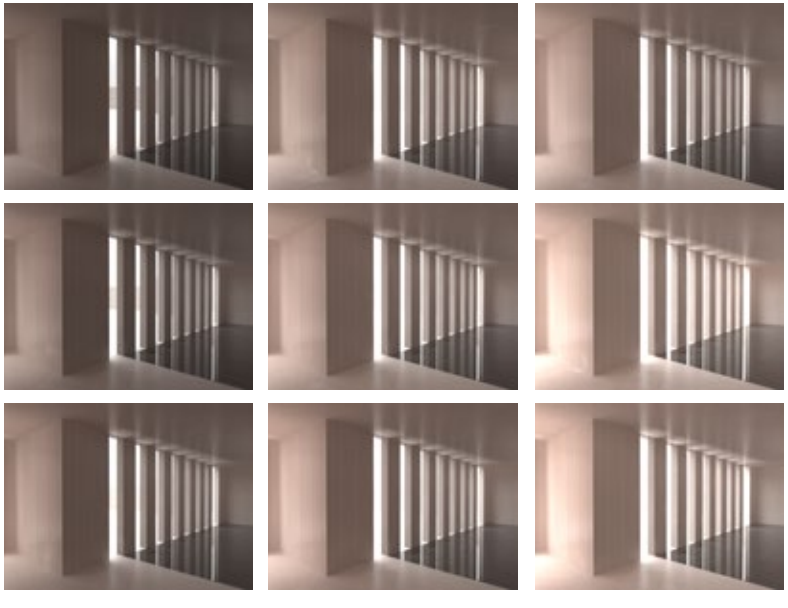
APPENDIX

APPENDIX 01 | VELUX CALCULATIONS

INDOOR-OUTDOOR POOL

June, every hour from 8 to 15



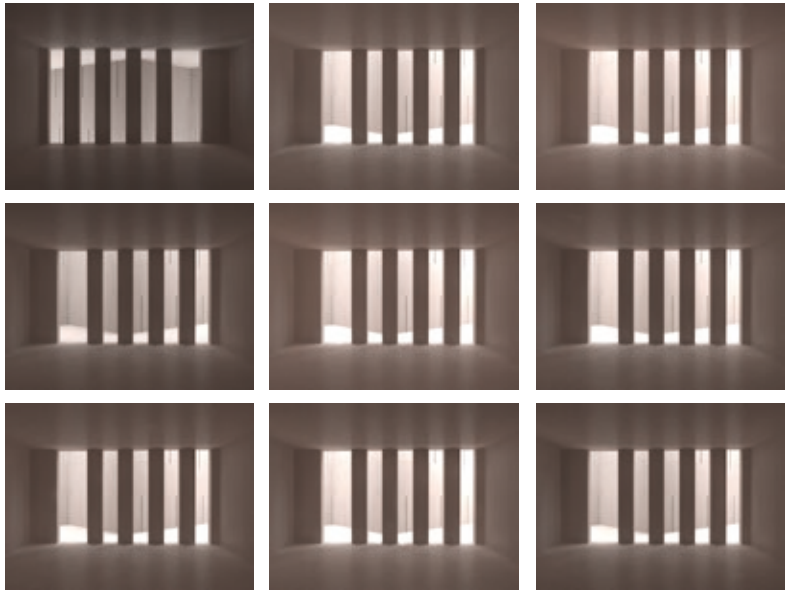
Ill.136.1 - Daylight Factor - Indoor-Outdoor Pool, June

December, every hour from 8 to 15

Ill.136.2 - Daylight Factor - Indoor-Outdoor Pool, December

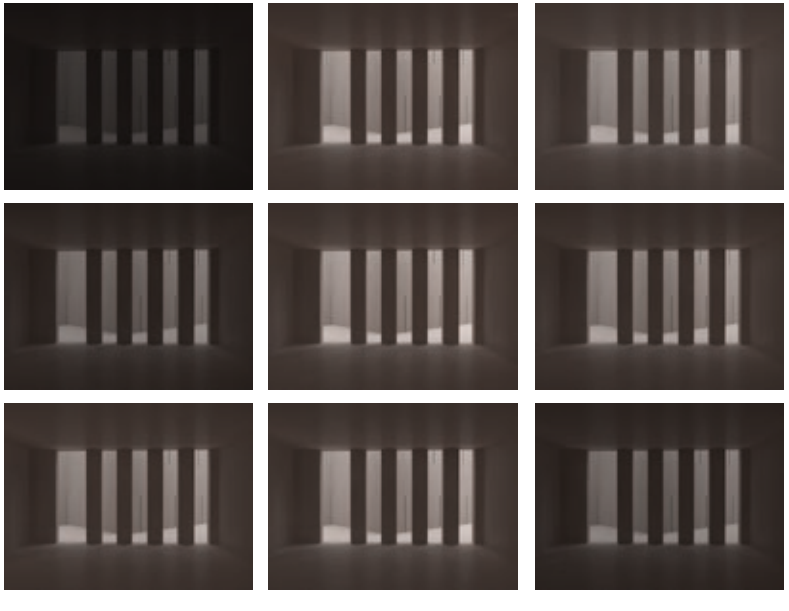
MAIN POOL AREA

June, every hour from 8 to 15



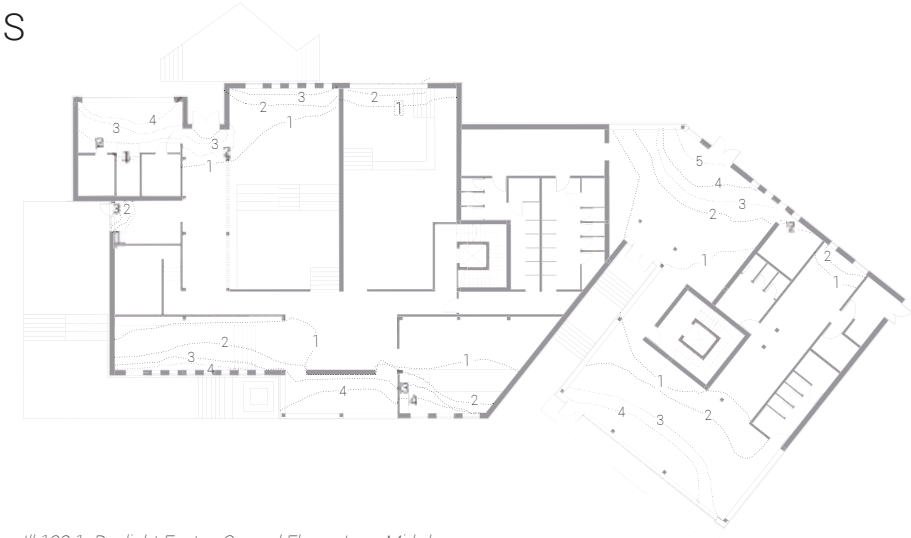
Ill.137.1 - Daylight Factor - Main Pool Area, June

December, every hour from 8 to 15

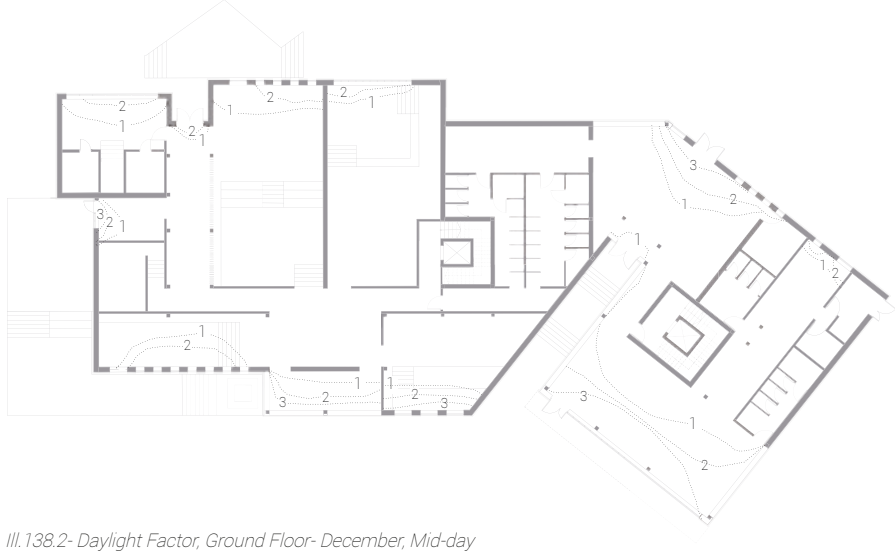


Ill.137.2 - Daylight Factor - Main Pool Area, December

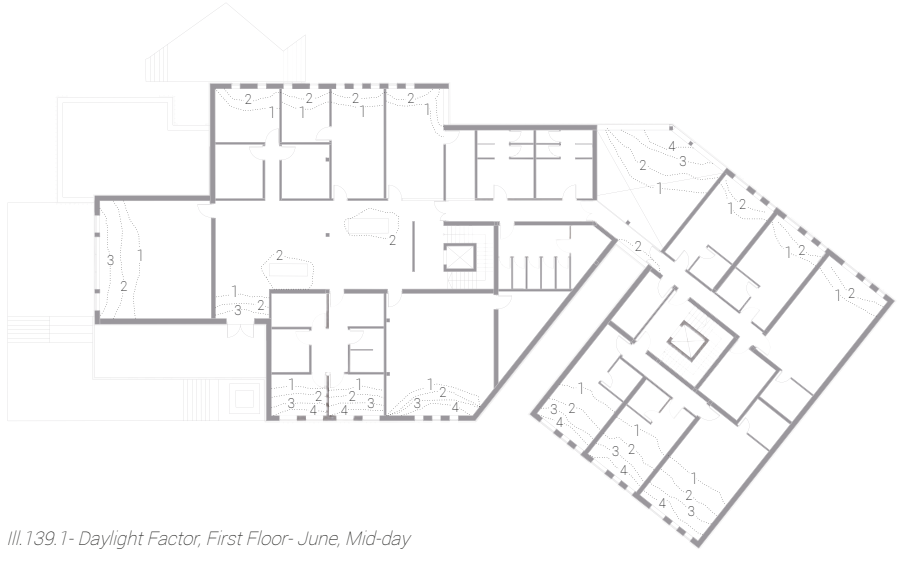
DAYLIGHT CALCULATIONS



Ill.138.1- Daylight Factor, Ground Floor- June, Mid-day



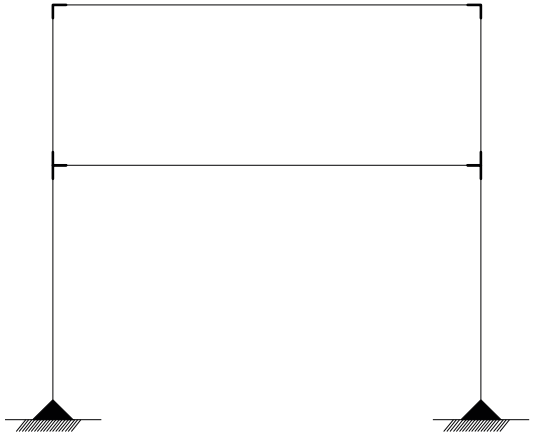
Ill.138.2- Daylight Factor, Ground Floor- December, Mid-day



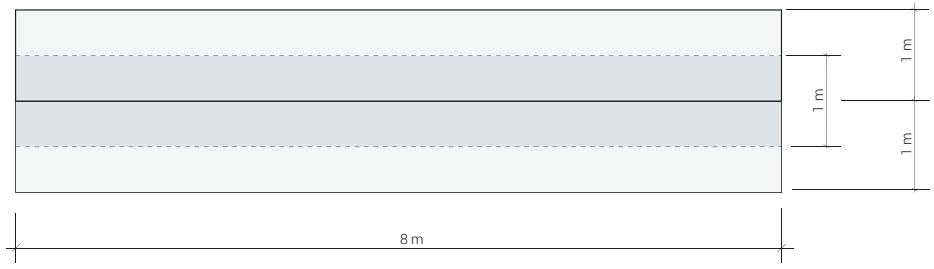
Ill.139.1- Daylight Factor, First Floor- June, Mid-day

Ill.139.2- Daylight Factor, First Floor- December, Mid-day

APPENDIX 02 | STATIC MODEL AND LOAD SCHEME



Ill.140.1- Static Model



Ill.140.2- Load Scheme

APPENDIX 03 | LOAD CALCULATIONS

STRUCTURAL LOAD
- calculated in Grashopper

LIVE LOAD 4,5 kN/m^2

DEAD LOAD (roof) 1,5 kN/m^2

SNOW LOAD

$$s = \mu_i * C_e * C_t * S_k \quad \text{(Eurocode 1, 5.1)}$$

form coefficient	0,8
c_e exposure coefficient	1,1
c_i – thermal coefficient	1
S_k – char. Snow load on the ground	1,53 kN/m^3

s= 0,8 * 1,1 * 1 * 1,53
s= 1,35 KN/m^2

WIND LOAD (Eurocode 1, 4)

Italy - Carrara 24 m/s

$Vb = C_{dir} * C_{season} * V_{bo}$
Vb = 1 * 1 * 24 m/s
Vb = 24 m/s

Terrain category: III
Z_o= 0,03m
Z_{min}= 5m

Peak Velocity Pressure

$C_{e(z)}$= 1,3 (Eurocodes 1.4 –table 4.9)
$qp_{(z)}$= 0,6 KN/m^2
$C_{pe,10)}$ value

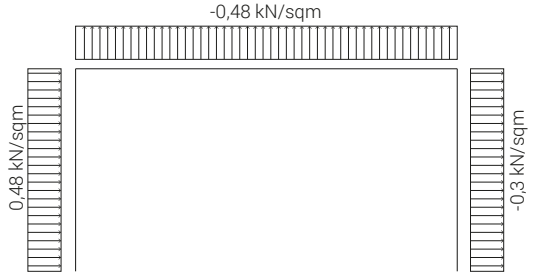
Wind Pressure

$W_e = q_{p(z)} * C_{pe,10}$

W_e zone A, B, C = - 0,48 KN/m^2

W_e zone D = 0,48 KN/m^2

W_e zone E = -0,3 KN/m^2



Ill.141.1- Applied Wind Load Scheme

LOAD COMBINATION

ULS - Ultimate Limit State (Eurocode 0, figure 6.1)

$$N = \sum Y_{G,j} * G_{k,j} + Y_{Q,k,1} * Q_{k,1} + \sum Y_{Q,i} * \Psi_{Q,i} * Q_{k,1}$$

$Y_{G,j}$ = 1.35 Unfavourable (Eurocode 0,table A1.2)
$Y_{Q,k,1}$ = 1.5 Unfavourable (Eurocode 0,table A1.2)
$Y_{Q,i}$ = 1.5 Unfavourable (Eurocode 0,table A1.2)
$\Psi_{Q,i}$ = 0.5 Unfavourable (Eurocode 0,table A1.2)

Dominant snow load:
N = 3,69 kN/m^2

Dominant wind load:
N= 2, 317 kN/m^2

SLS - Serviceability Limit State

Dominant snow load:
N= 2, 61 kN/m^2

Dominant wind load
N= 1,695 kN/m^2

APPENDIX 04 | STRUCTURAL CALCULATIONS

Strength condition of the beam

$$\frac{\sigma_{cod}}{f_{cod}} \leq 1$$

N – axial forces

A – section area

γ_m – partial factor for material property

k_{mod} – modification factor

f_{cok} – characteristic value of strength property

f_{cod} – strength value

Maximum moment

$$M = \frac{1}{8} \times q_r \times L^2$$

q_r – line load on the beam [kN/m]

L – span of the beam [m]

Self Weight

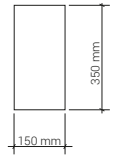
g= density x cross section area x gravity

gravity 9,8 m/s^2

Material Properties - GL32c

Density = 410 kg/m^3
f_{cok} = 26,5 N/ mm^2

MAIN BEAM DIMENSIONING



Width	0,25 [m]
Height	0,45 [m]
Load Area	8 [m]
Span	8 [m]

Applied Loads:

g_{beam} = 0,63 kN/m
$g_{main\ beam}$ = 0,45 kN/m
$g_{live\ load}$ = 36 kN/m

Load Combination ULS
N=55,458 kN/m

γ_m = 1,3

k_{mod}= 0,462

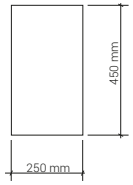
$\sigma_{cod} = \frac{N}{A} = \frac{443{,}664\ kN}{0{,}1125 m^2}$ = 3,8 MPa

$f_{cod} = k_{mod} \frac{f_{cok}}{\gamma_m} = 0{,}462 \frac{26{,}5}{1{,}3} = 9{,}41\ MPa$

$\frac{\sigma_{cod}}{f_{cod}} \leq 1$

$$\frac{3{,}8}{9{,}41} = 0{,}4 \leq 1$$

BEAM DIMENSIONING



Width	0,15 [m]
Height	0,35 [m]
Load Area	1 [m]
Span	8 [m]

Applied Loads:

g_{beam} = 0,28 kN/m

$g_{live\ load}$ = 6,75 kN/m

Load Combination ULS

N=7,03 kN/m

γ_m = 1,3

k_{mod}= 0,462

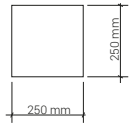
$\sigma_{cod} = \frac{N}{A} = \frac{7,03\ kN}{0,0525 m^2}$= 0,134 MPa

$f_{cod} = k_{mod} \frac{f_{cok}}{\gamma_m} = 0,462 \frac{26,5}{1,3} = 9,41\ MPa$

$\frac{\sigma_{cod}}{f_{cod}} \leq 1$

$\frac{0,134}{9,41} = 0,014 \leq 1$

DIMENSIONING OF THE COLUMN



Side length	0,25 [m]
Height	4 [m]
Load Area	40 [m2]

Applied Loads:

g_{column} = 2 kN/m

$g_{main\ beam}$ = 4,5 kN/m

g_{beam} = 16,8 kN/m

$g_{live\ load}$ = 180 kN/m

g_{wind} = -19,2 kN

g_{snow} = 54 kN

Load Combination ULS

N=327,45 kN/m

k_c = 0,7

k_{mod}= 0,462

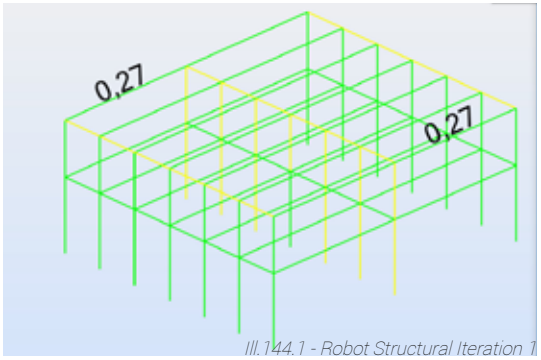
Strength condition for column

$\sigma_{cod} = \frac{N}{A} \leq k_c \times k_d \times f_{cok}$

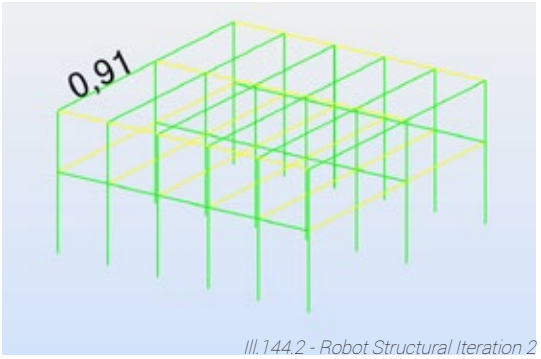
$\sigma_{cod} = \frac{327,45}{62500} \leq 0,7 \times 0,462 \times 26,5$

$5,24 \leq 8,57$

APPENDIX 04 | STRUCTURAL CALCULATIONS - ROBOT



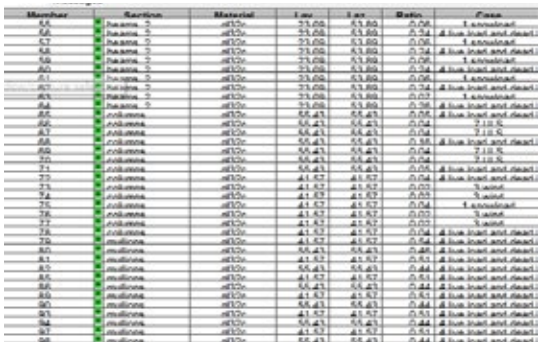
Ill.144.1 - Robot Structural Iteration 1



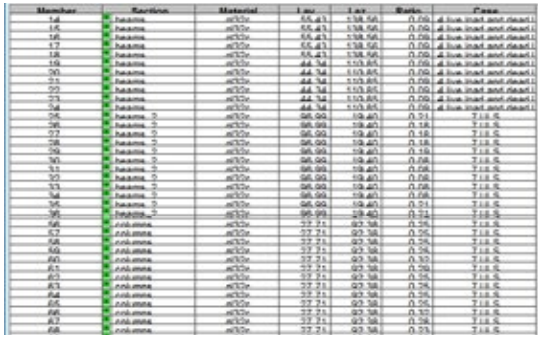
Ill.144.2 - Robot Structural Iteration 2

The design of the building its shape and atmospheres were accompanied with several iterations of structural analysis. The model was done in parametric modelling software – Grasshopper, where different solutions were build and tested by changing values of parameters. This model was then each time exported to the Autodesk Robot. Each iteration was checked according to the principle of Limited State Design, considering Ultimate Limit State and Serviceability state.

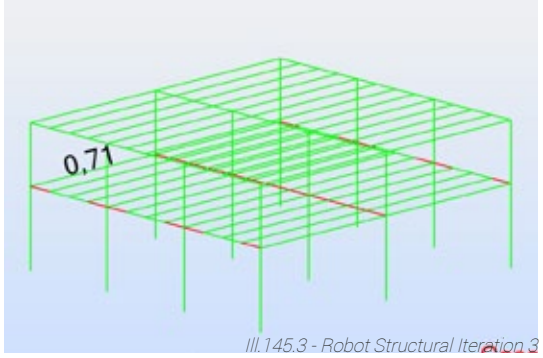
The iterations were based on the earlier structural thoughts chosen during the design process. A repetition of timber frame structure was analysed with divergent cross sections designs. Considering the rigorous repetitive structure, the biggest span of 8m was chosen to be analysed further due to the worst possible results.



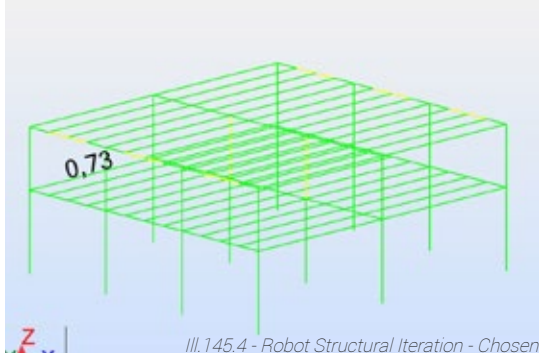
Firstly, the calculation has been done considering a repetitive frame structure. The designed cross section of the column is 250 x 250 mm, with secondary and primary beams of cross section 400 x 200 mm. This solution leads to a waste of material and over-dimensioning considered elements.



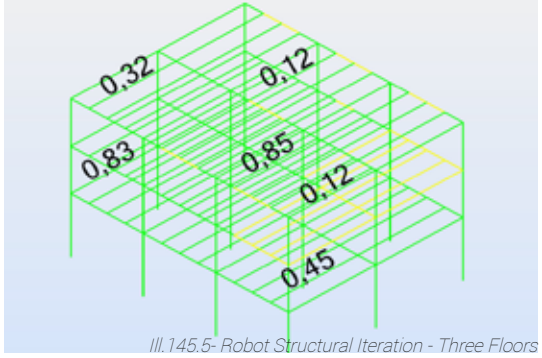
Continuing with the frame structure having a narrow cross section of the elements, thus trying to improve the structural and aesthetics aspects. Having a singular cross section of 500 x 150 mm for each of the elements. These results prove show similar outcomes as the first iteration.



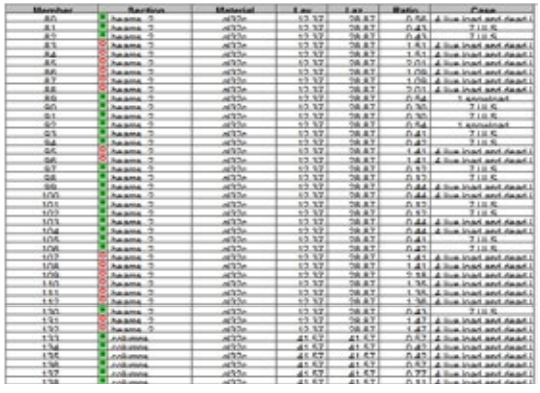
Ill.145.3 - Robot Structural Iteration 3

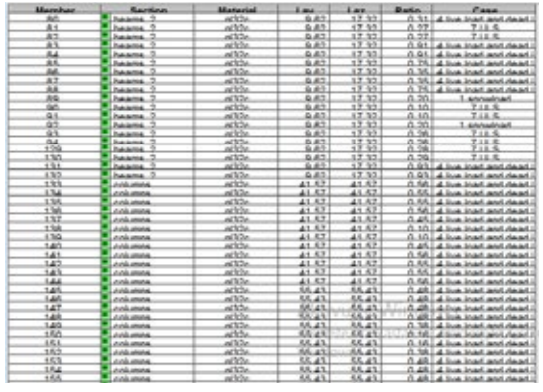


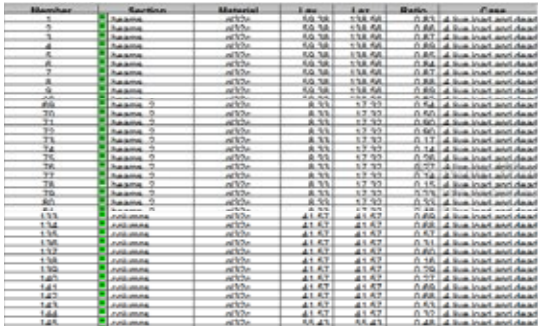
Ill.145.4 - Robot Structural Iteration - Chosen



Ill.145.5- Robot Structural Iteration - Three Floors





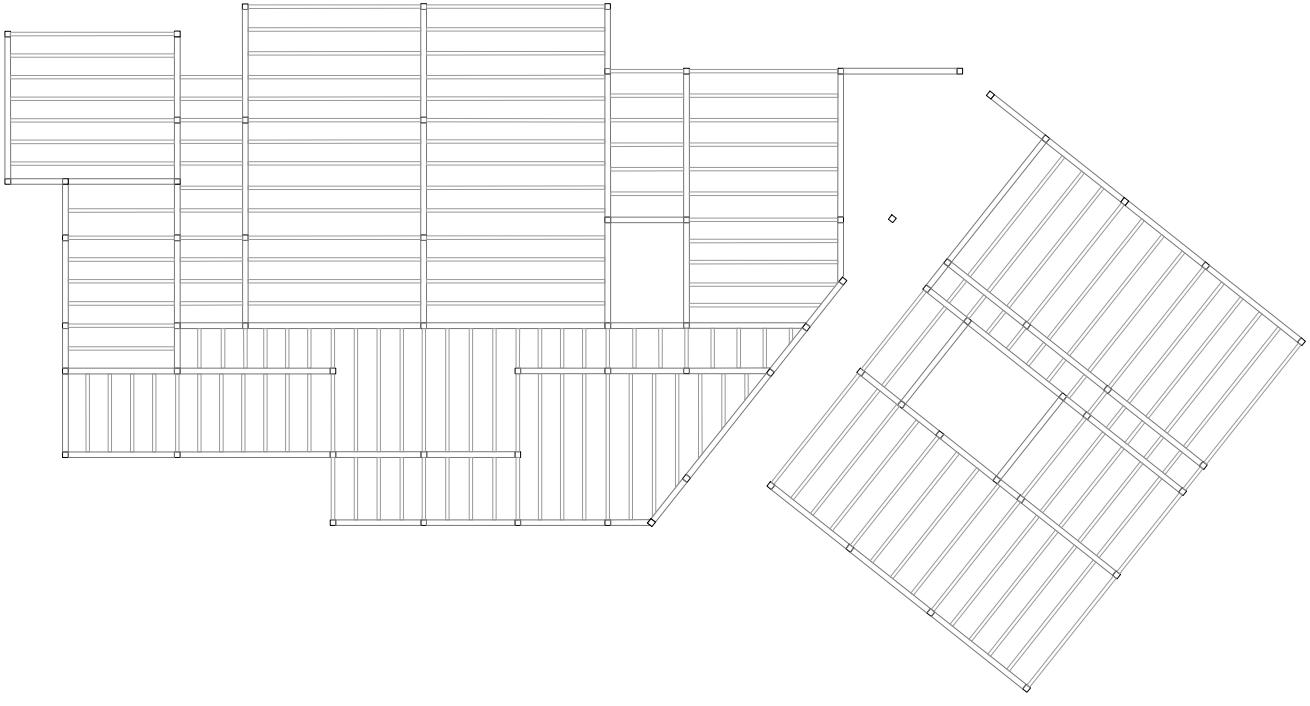


Considering early calculations, the parameters of the design slightly changed. Continuing with a span of 8 m, span between the columns of 6 m and between the beams 1 m. Designing cross section for a column of 250 x 250 mm, beams and primary beams of 350 x 150 mm. The primary beams resulted to be scant.

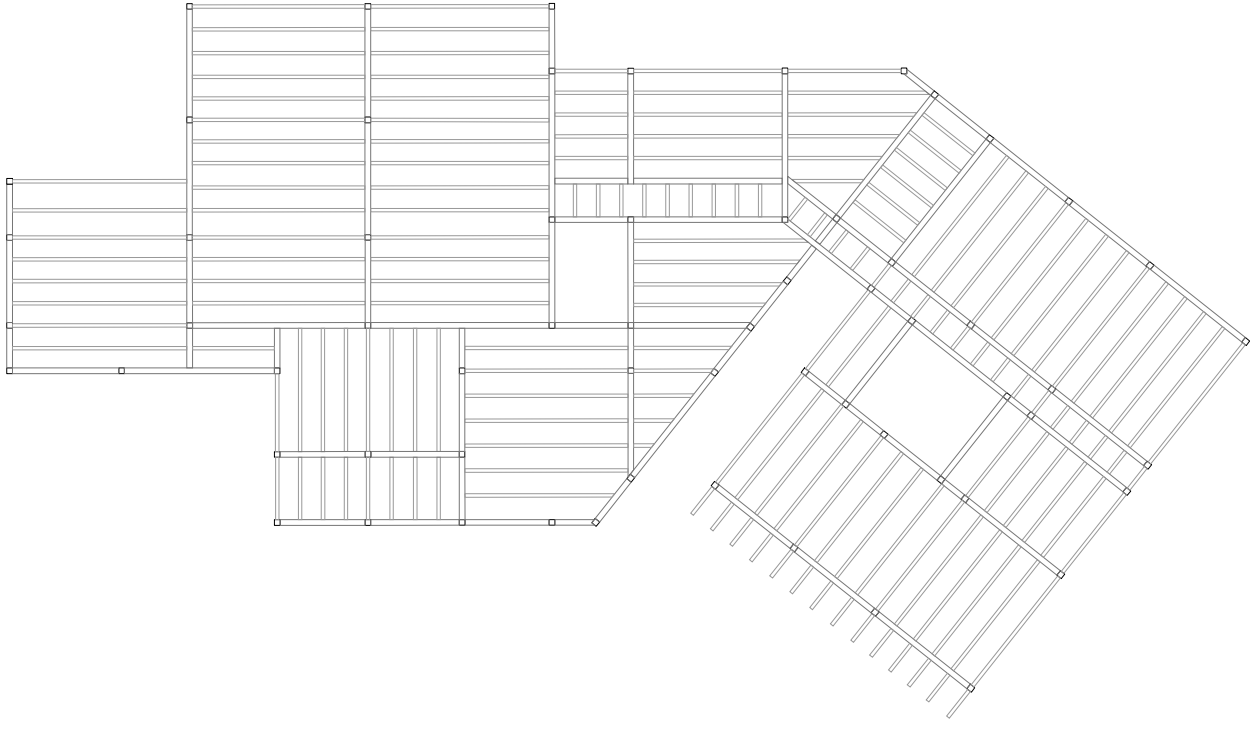
By changing the cross section of the primary beam to 450 x 250 mm emerge as an optimal solution. In ill.143.4 is shown that all the elements resist to the loads applied, therefore this parameters are used in a resulting design. The calculations were further calculated by hand to see and understand another alternative of structural evaluation.

In the calculation a third floor of the hotel part was introduced to be fully assured that the designed structure is prime. In the calculation is shown that the structure with chosen cross section can resist to another loads and therefore be the suitable in all of the cases of the building.

APPENDIX 05 | STRUCTURAL SCHEME



Ill.146.1- Structural Scheme - Ground Floor



Ill.147.1- Structural Scheme - First Floor

APPENDIX 06 | U-VALUE CALCULATIONS

$R = d/\lambda$

$U = 1/R$

R- resistivity

d- material thickness

λ- thermal conductivity coefficient

U-value- thermal transmittance

(Building Regulations, 2015)

1. External Wall

	d (m)	λ (W/mK)	R (m²K/W)
R_{se}			0,13
Frame system	0.06		
Polycarbonate	0,055	0,21	0,26
Void	0,04	0,025	1,6
Plaster board	0,015	0,2	0,075
Waterproof barrier		negligible	
Vacuum insulated panel	0,05	0,007	7,14
Vac. insul. panel/construction	0,25		7,32
Plaster board	0,015	0,2	0,075
Moisture barrier		negligible	
Wooden cladding	0,015	0,13	0,12
R_{si}			0,06
Total	0,5		16,78

$$U = \frac{1}{0{,}13 + 0{,}26 + 1{,}6 + 0{,}075 + 7{,}14 + 7{,}32 + 0{,}075 + 0{,}12 + 0{,}06}$$

$$U = \frac{1}{16{,}78}$$

$$U = 0{,}060 \frac{\mathrm{W}}{\mathrm{m^2k}}$$

2. Roof

	d (m)	λ (W/mK)	R (m²K/W)
R_{se}			0,04
Metal roof membr.	0.02	0.17	0,12
OSB	0,03	0,13	0,23
Waterproof barrier		negligible	
Vacuum insulated panel (VIP)	0,05	0,007	7,14
Vacuum insulated panel (VIP)	0,05	0,007	7,14
Timber frame system	0,05		0,18
Moisture barrier		negligible	
Plaster board	0,015	0,2	0,075
Beech construction	0,35		
R_{si}			0,13
Total	0,515		15,055

$$U = \frac{1}{0{,}04 + 0{,}12 + 0{,}23 + 7{,}14 + 7{,}32 + 0{,}075 + 0{,}13}$$

$$U = \frac{1}{15{,}055}$$

$$U = 0{,}066 \frac{\mathrm{W}}{\mathrm{m^2k}}$$

3. Ground Floor

	d (m)	λ (W/mK)	R (m²K/W)
R_{se}			0,04
Floor tile finishing	0.02	2,07	0,01
Subfloor	0,04	0,14	0,29
Moisture barrier		negligible	
Plaster board	0,015	0,2	0,075
Floor heating	0,04	0,15	0,27
OSB board	0,03	0,13	0,23
vacuum insulation panel	0,1	0,007	14,28
Waterproof barrier		negligible	
Sand	0,03	0,15	0,2
Drainage gravel	0,30	0,7	0,43
Quarry marble			
R_{SI}			0,14
Total	0,5		15,97

$$U = \frac{1}{0{,}04 + 0{,}01 + 0{,}29 + 0{,}075 + 0{,}27 + 0{,}23 + 14{,}28 + 0{,}2 + 0{,}43 + 0{,}14}$$

$$U = \frac{1}{15{,}97}$$

$$U = 0{,}063 \frac{\mathrm{W}}{\mathrm{m^2 k}}$$

4. Roof above Sauna

	d (m)	λ (W/mK)	R (m²K/W)
R_{se}			0,04
Metal roof membrane	0.02	0.17	0.12
OSB board	0,03	0,13	0,25
Waterproof membrane		negligible	
Vacuum insulated panel	0,05	0,007	7,14
Vac. insul. pan./joists	0,05		7,32
Foil vapor barrier		negligible	
OSB board	0,03	0,13	0,23
Beech beam	0,35		
Moisture barrier		negligible	
OSB board	0,02	0,13	0,15
Wooden cladding	0,02	0,13	0,15
R_{SI}			0,13
Total	0,57		15,53

$$U = \frac{1}{0{,}04 + 0{,}12 + 0{,}25 + 7{,}14 + 7{,}32 + 0{,}23 + 0{,}15 + 0{,}15 + 0{,}13}$$

$$U = \frac{1}{15{,}53}$$

$$U = 0{,}065 \frac{\mathrm{W}}{\mathrm{m^2 k}}$$

5. Floor

	d (m)	λ (W/mK)	R (m²K/W)
R_{se}			0,13
Tile finishing	0.02	2,07	0,01
Subfloor	0,04	0,14	0,29
Waterproof barrier		negligible	
Plaster board	0,015	0,2	0,075
Floor heating	0,04	0,15	0,27
Sound insulation mat		negligible	
OSB board	0,03	0,13	0,23
vacuum insulation panel	0,05	0,007	7,14
Moisture barrier		negligible	
Plaster board	0,015	0,2	0,075
Beech beam	0,45		
R_{SI}			0,13
Total	0,66		8,35

$$U = \frac{1}{0{,}13 + 0{,}01 + 0{,}29 + 0{,}075 + 0{,}27 + 0{,}23 + 7{,}14 + 0{,}075 + 0{,}13}$$

$$U = \frac{1}{8{,}35}$$

$$U = 0{,}11 \frac{\mathrm{W}}{\mathrm{m^2 k}}$$

APPENDIX 07 | MATERIAL PROPERTIES - VACUUM INSULATED PANEL

Ill.150.1 - Vacuum Insulated Panel, illustration

Vacuum insulation panel is intended for construction applications. It consists of membrane walls- to prevent air from entering the panel, a panel of rigid and highly porous material- glass fibre and chemicals (getters) to collect gases leaked through membrane materials. It is covered in a high barrier film.

Vacuum insulated panels, according to Standard DIN 4108-10, table 1, can be used for ceilings, walls, floors, flat roofs, top floor ceiling and exterior insulation in wood frame construction.

The insulation is unique for its rectangular edges and corners which are made in a special 'ca-G-seam' technique where panels are joined together almost seamlessly. It is approved for general construction purposes (va-Q-tec, 2018).

PRODUCT DATA:		
Standard dimensions	1000mm x 600 mm 500mm x 600 mm	
Thickness	10-50 mm	
Density (raw panel)	180-210 kg/m3 (for thickness >10 mm) 180-250 kg/m3 (for thickness ≤ 10 mm)	Standard DIN EN 1602
Thermal conductivity	0,0070 W/mK (for thickness> 20mm) 0,0080 W/mK (for thickness 10-15mm)	Standard EN 12667: 2001
Thermal conductivity (with insulation)	0,020 W/mK	
Temperature stability	-70°C to +80°C (with possible temporary +120°C for 30 minutes)	
Humidity stability	0%-70%	
Internal gas pressure	<5mbar	
Spec. heat capacity powder plate	0,8 kJ/kgK	
Compressive strength	160 kPa (at 10% compression)	Standard BS EN 826: 2013
Tensile strength	60kPa	
Service life	up to 60 years	
Recyclability	90%	

APPENDIX 07 | MATERIAL PROPERTIES - POLYCARBONATE PANEL

Ill.151.1 - Polycarbonate Panel, detail

Polycarbonate DANPALON® MICROCELL POLYCARBONATE
- Honeycomb panels
- Colour SOFTLITE OPAL

The chosen polycarbonate panels are mix of strength and translucency. They were manufactured according to specification ISO 9001 and ISO 14001. The panels are designed with the tight spacing between the ribs which effects with a superior quality of light. They have high resistance to impact and precipitation. Thanks to the high concentration of cells, the mechanical properties and rigidity is highly improved (Danpal, 2018).

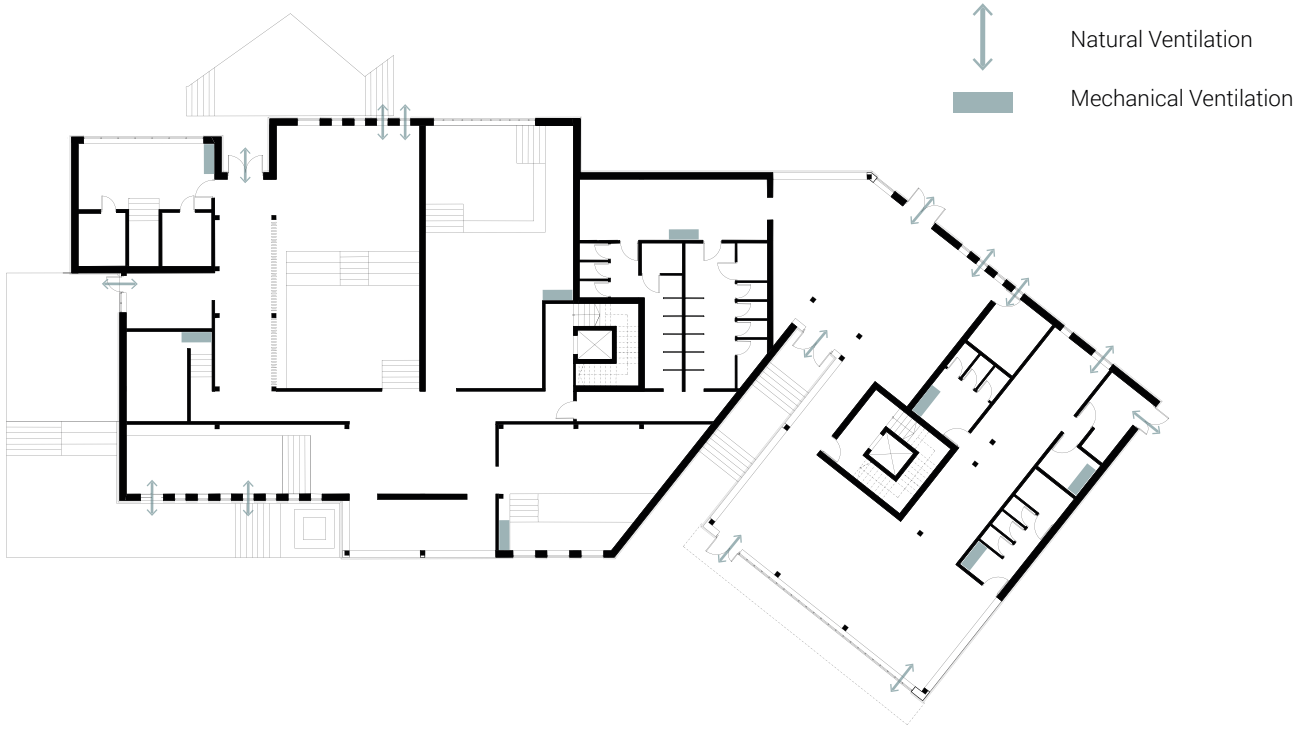
- 100% leakproof
- Free thermal movement
- Easy installation
- Lightweight
- Highly secure
- Made with microcell technology
- Certified system

TECHNICAL PROPERTIES	
Thickness	55mm
Width	≤ 900 mm
Span between the support	up to 3,2 m
U-value	1,4 W/m2K
Reaction to fire	B-s1, d0
• Flammability: (Standard EN 13501- 1:2002)	
- Self-ignition	570°C
- Smoke density of plastic	54%
• Weathering: (Standard ASTM D1003)	
- Transmission will not decrease more than	6% after 10 years
• Long service temperature	-40°C- 120°C
• Expansion/ contraction: linear thermal expansion	0,065 mm/m°C (Standard DIN 53460)
• Standard	Quality Management Standard SI: ISO 9001

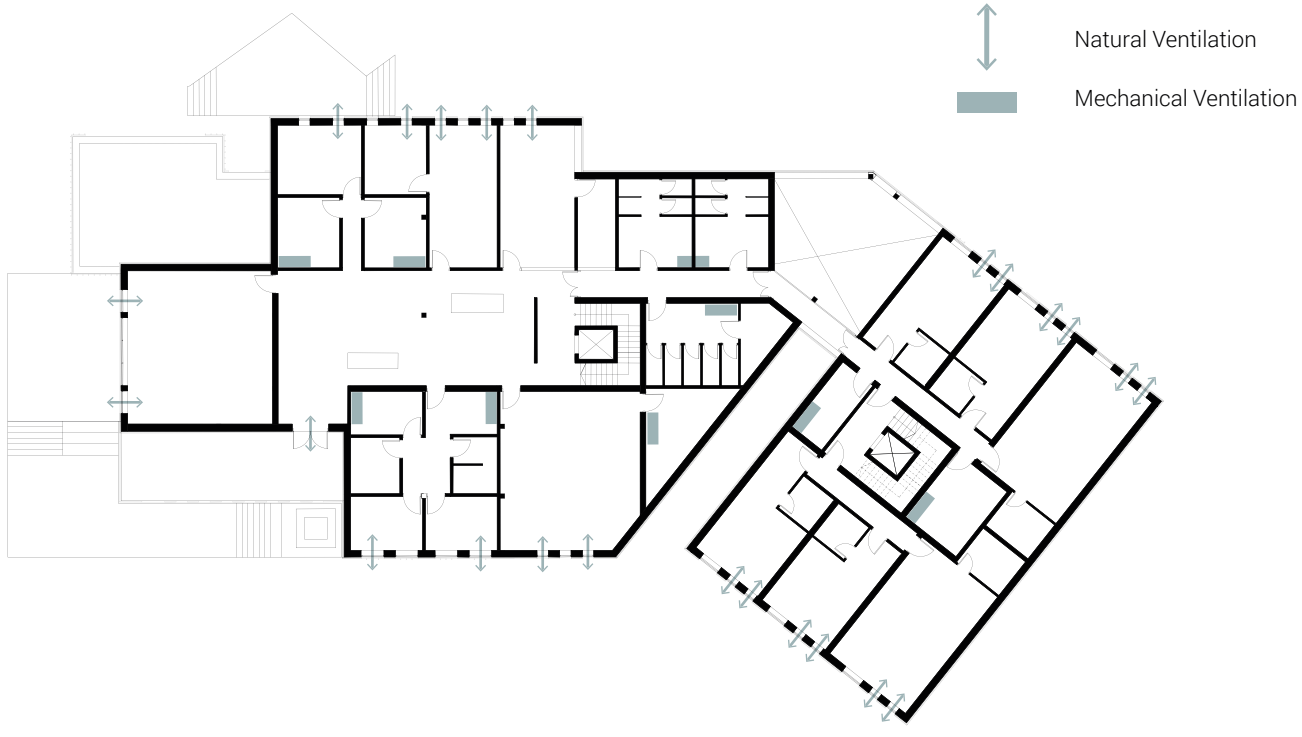
OPTICAL AND THERMAL PROPERTIES

68%	of visible light transmission
58%	of total solar radiation transmission
34%	of total solar reflection
0,73	solar heat gain coefficient

APPENDIX 08 | VENTILATION SCHEME

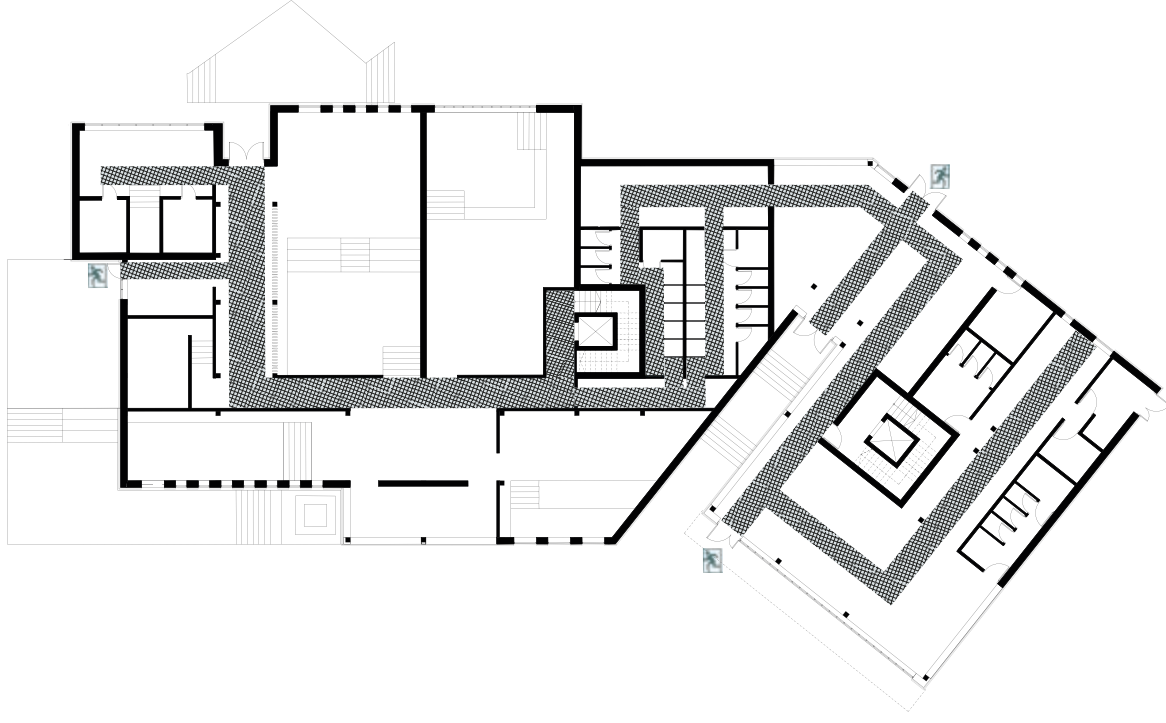


Ill.152.1 - Ground Floor Plan; Ventilation Scheme

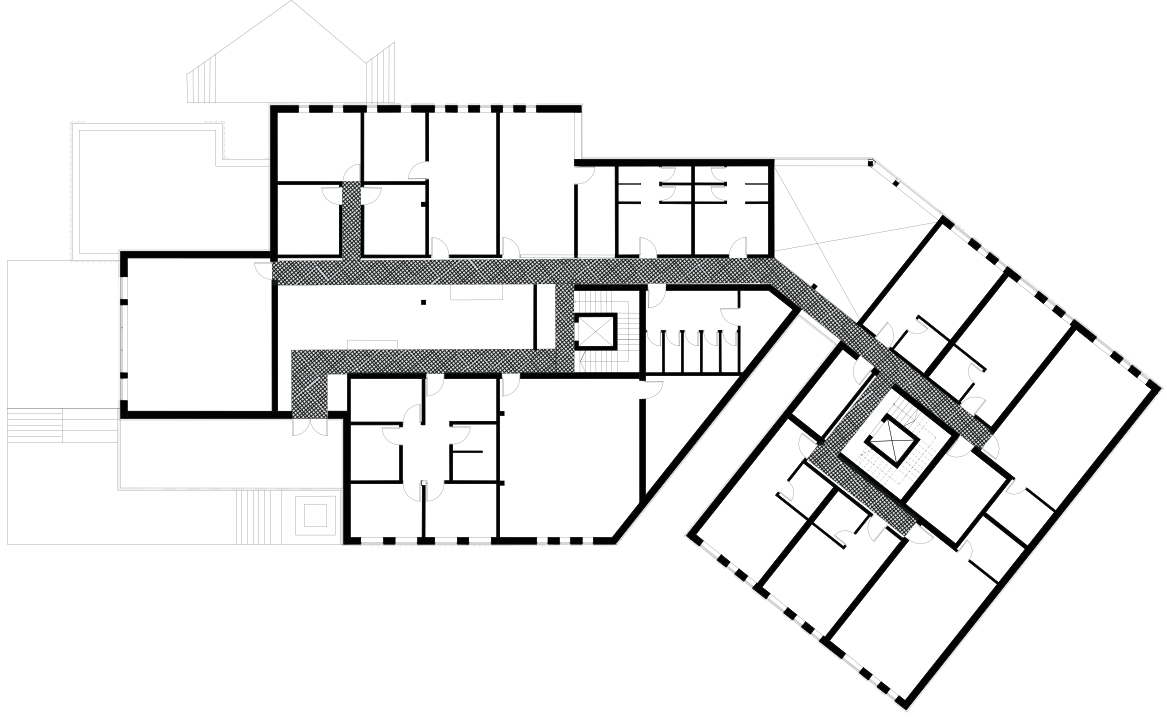


Ill.153.1 - First Floor Plan; Ventilation Scheme

APPENDIX 09 | FIRE PLANS

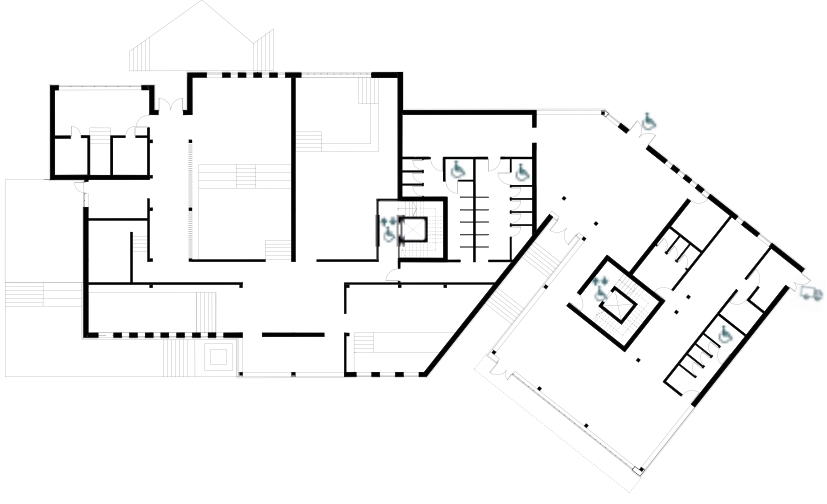


Ill.154.1 - Ground Floor Plan - Fire Plan

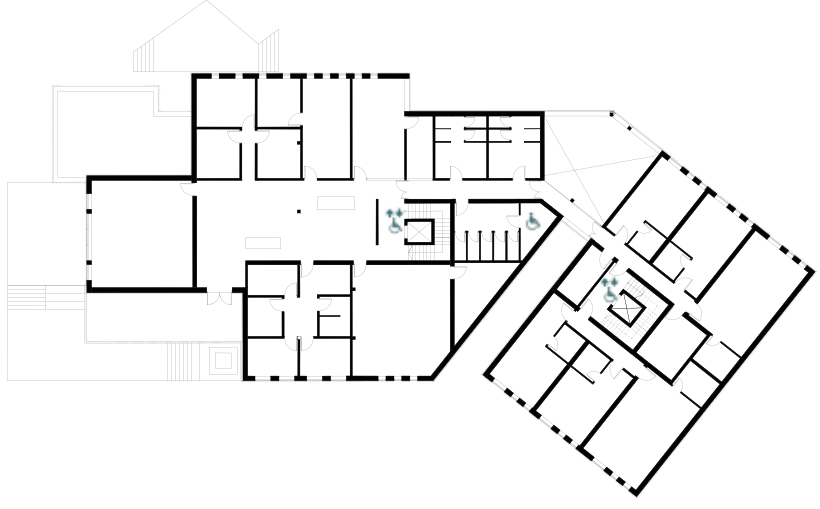


Ill.155.1 - First Floor Plan - Fire Plan

APPENDIX 10 | ACCESSIBILITY PLAN

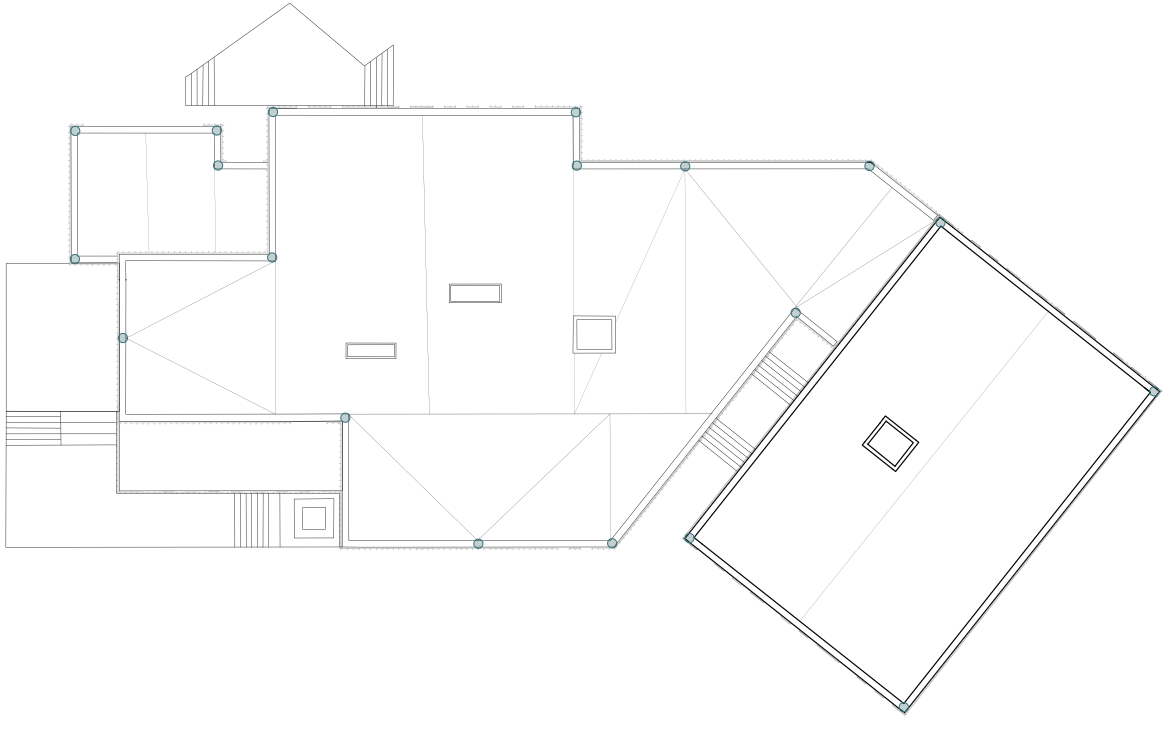


Ill.156.1 - Ground Floor Plan - Accessibility



Ill.156.2 - First Floor Plan - Accessibility

APPENDIX 11 | DRAINAGE SYSTEM



Ill.157.1 - Roof Plan - Drainage System

APPENDIX 12 | WATER DEMAND

FIXTURE TYPE	FLOW RATE	UNIT	DURATION	UNIT	AVERAGE DAILY USE	NUMBER OF OCCUPANTS	TOTAL WATER DEMAND
SHOWER	7,57	lpm	1,5	min	0.65	100	741,94
LAVATORY FAUCET	1,51	lpm	0,25	min	3	100	113,56
URINALS	1,90	lpf	1	flush	1,74	50	166,56
TOILET	4,84	lpf	1	flush	1,74	50	420,18
KITCHEN FAUCET	6,81	lpm	0,25	min	1	15	26,50
						TOTAL/day	1468,74

Ill.158.1- Table- Total Water Demand

(Non-Potable Water Calculator, 2018)

Total Water Demand (gpd) = (Flow Rate x Duration x Average Daily Use x Number of occupants) + (Flow Rate x Duration x Average Daily Use)

Shower= (7,57 x 1,5 x 0,65 x 100) + (7,57 x 1,5 x 0,65) = 738,075 + 7,38 = 745,46 L/day
Lavatory faucet= (1,51 x 0,25 x 3 x 100) + (1,51 x 0,25 x 3) = 113,25 + 1,13 = 114,38 L/day
Urinals= (1,90 x 1 x 1,74 x 50) + (1,90 x 1 x 1,74) = 165,30 + 1,65 = 166,95 L/day
Toilet= (4,84 x 1 x 1,74 x 50) + (4,84 x 1 x 1,74) = 421,08 + 4,21 = 425,29 L/day
Kitchen faucet= (6,81 x 0,25 x 1 x 15) + (6,81 x 0,25 x 1) = 25,54 + 0,26 = 25,8 L/day

745,46 + 114,38 + 166,95 + 425,29 + 25,8 = 1477,88 L/day
1477,88 * 30,25 = 44 705,87 L/month

HARVESTABLE RAINWATER (IN AVERAGE FOR A YEAR)

Average yearly rainfall: 82, 25 mm
Surface of the roof: 520,54 m2

Expectable rainwater harvesting= rainfall x roof area
ERH = 48 527,50 L/ month

Monthly
(Volume)= (Area) x (Precipitation) x (% Efficiency) *
*In our case the efficiency percentage we appointed 80%

(Sustainabilityworkshop.autodesk.com, 2018)

1. January
530 m2 x 95mm x 0.8= 40 280 L

2. February
530 m2 x 80mm x 0.8= 33 920 L

3. March
530 m2 x 85mm x 0.8= 36 040 L

4. April
530 m2 x 90mm x 0.8= 38 160 L

5. May
530 m2 x 70mm x 0.8= 29 680 L

6. June
530 m2 x 50mm x 0.8= 21 200 L

7. July
530 m2 x 29mm x 0.8= 12 296 L

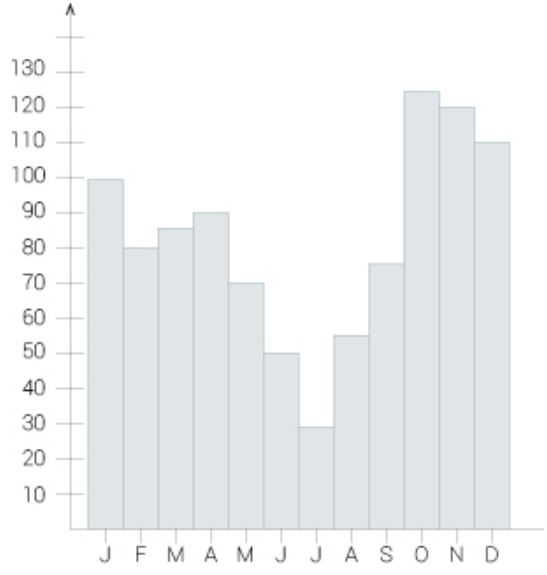
8. August
530 m2 x 55mm x 0.8= 23 320 L

9. September
530 m2 x 75mm x 0.8= 31 800 L

10. October
530 m2 x 125mm x 0.8= 53 000 L

11. November
530 m2 x 120mm x 0.8= 50 880 L

12. December
530 m2 x 110mm x 0.8= 46 640 L



Ill.159.1- Monthly precipitation diagram

When calculating the water demand for showers, faucets and toilet, for the whole Thermal baths complex, we took under considerations the optimal case scenarios. Looking at the amount of water demand, it is easy to observe that the demand of 44 705,87 L per month in 1/3 of the months is fulfilled, while in others there will be a need to use the water from the grid or collective pond system.

HARVESTING WATER FROM THE COLLECTIVE POND

Ill.160.1- Water demand- pool diagram

Pool's volumes: (Recreonics, 2018)

Volume= length x width x depth (average)

A.	54,03 m2 x 1,6 m= 86,45 m3
B.	35,89 m2 x 1m= 35,89 m3
C.	30,38 m2 x 1,1m= 33,42 m3
D.	17,78 m2 x 0,8m= 14,22 m3
E.	5,52 m2 x 0,8= 4,42 m3
F.	21,09 m2 x 1,1= 23,19 m3
G.	78,47 m2 x 1,2= 94,16 m3

Minimum flow rate for required turnover (circulation)
(Jocogov.org., n.d.)

	Turnover rate
POOL	6h (360 min)
SPA	0,5h (30 min)
WADING POOL	2h (120min)

Flow rate= $\frac{Quantity\ of\ water}{turnover\ rate\ (min)}$

Basic pool circulations (quantity of water) = volume x 7,4

This is the minimum flow rate required at all times fo r this pool recirculation pump. We need the pump with 1,8L capacity but there should be always used oversized one. It is due to the fact that filter when gets dirty, decreases the flow rate. For this reason, the capacity should be increased of 25%. (Jocogov.org., n.d.)

A: 646,65/360= 1,80 L/min (lpm)
1.80 lpm + 1,80lpm x 0,25 = 2.25 lpm capacity

B: 268,46/360= 0,75
0,75 lpm + 0,75 lpm x 0,25= 0,95 lpm capacity

C: 249,98/360= 0,69
0,69 lpm + 0,69 lpm x 0,25= 0,86 lpm capacity

D:108,31/360= 0,30
0,30 lpm + 0,30 lpm x 0,25= 0,38 lpm capacity

E: 33,06/360= 0,09
0,09 lpm + 0,09 lpm x 0,25= 0,11 lpm capacity

F: 173,46/360= 0,48
0,48 lpm + 0,48 lpm x 0,25= 0,60 lpm capacity

G: 704,32/360= 1,96
1,96 lpm + 1,96lpm x 0,25= 2,45 lpm capacity

Pool water demand (total): 1 537,59 L/day -> 46 512,10 L/month

Water evaporation loss (Dengarden, 2018)

$$E = \frac{7{,}4\ P\ A\ (0{,}447\ w)^{0{,}78}}{T + 459{,}67}$$

E- evaporation rate (L/day)

A-Pool surface (m2)

W-Wind speed above pool (mph)

P-Water's vapor pressure (mmHg) at ambient temperature 15°C - 12,79

T-temperature (°C)

Outdoor pool G (in a year scale)

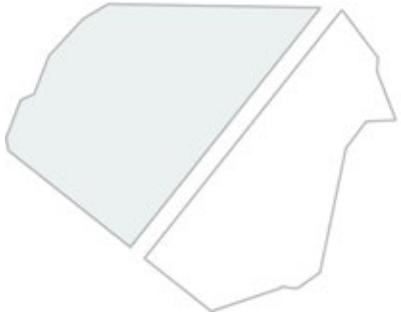
$$E = \frac{7{,}4 \times 12{,}79 \times 78{,}47 \times (0{,}0447 \times 30)^{0{,}78}}{15 + 459{,}67}\ L/day$$

$$E = \frac{9335{,}58}{474{,}67}\ L/day$$

$$E = 19{,}67 \frac{L}{day} \times 30{,}25\ = 594{,}94\ L/month$$

Taking under consideration the evaporation loss, the monthly demand for water equals 47 107,04 L/month.

Water Collection Capacity (Sustainabilityworkshop.autodesk.com, 2018)



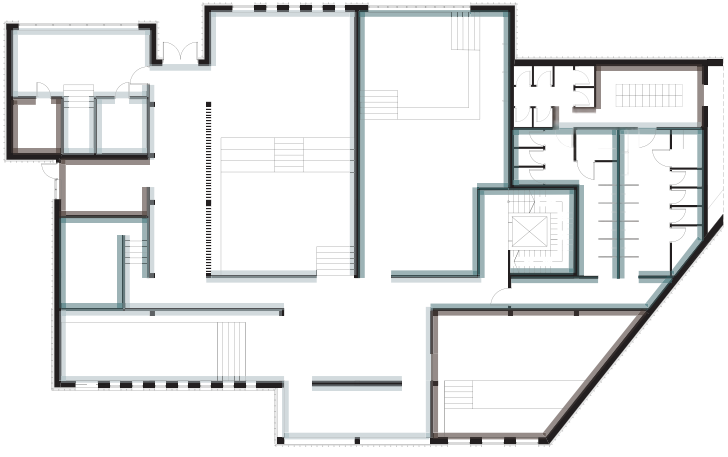
Ill.161.1- Collection pond- diagram

Average yearly rainfall: 82, 25 mm
Surface of the collection pond: 869,94 m2

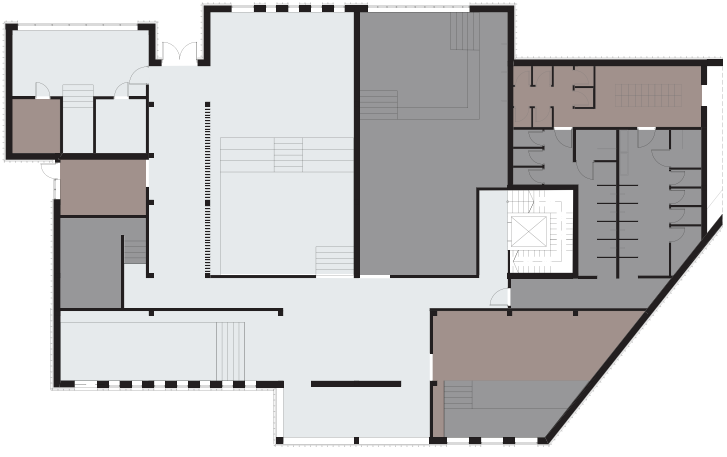
Expectable rainwater harvesting= rainfall x surface
ERH = 71 552,57 L/ month

With the one part of collection pond it will be enough to support the pool water demand and contribute to the water demand for the complex, whenever the roof rainfall harvesting is not enough.

APPENDIX 13 | INDOOR MATERIALITY



Ill.162.1- Material Treatment Diagram- Walls; Bath Area



Ill.162.1- Material Treatment Diagram - Floor; Bath Area

Rough Wall Material

Polished Wall Material

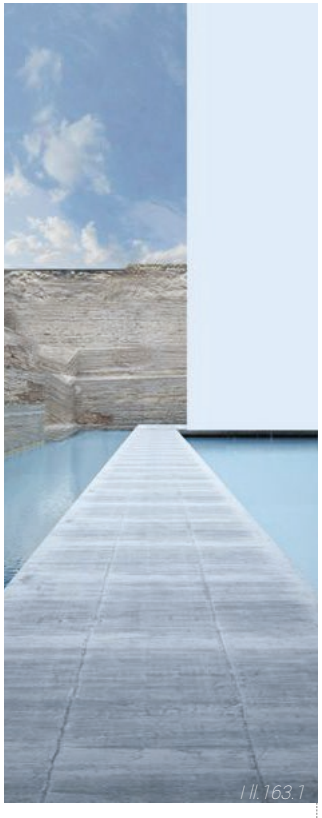
Wooden Wall Material

Rough Floor Material

Polished Floor Material

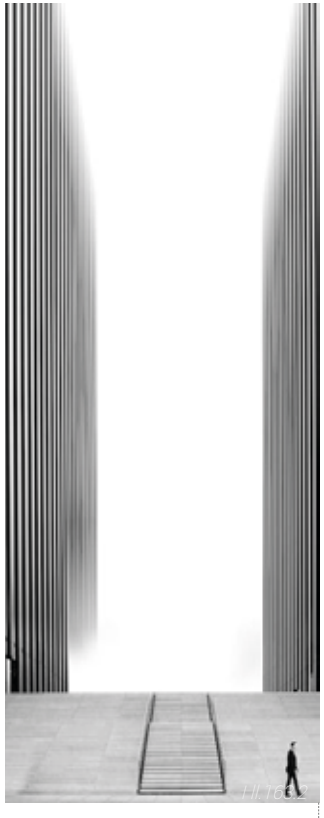
Wooden Floor Material

APPENDIX 14 | INSPIRATION



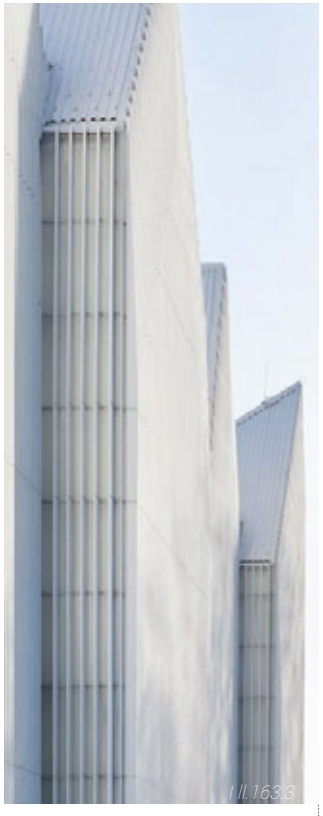
Ill.163.1

The Path



Ill.163.2

The Access



Ill.163.3

Materiality

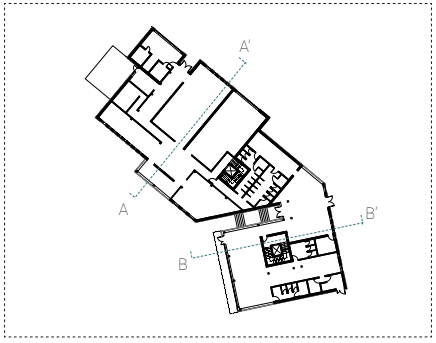
Ill.163.4

Timber Structure

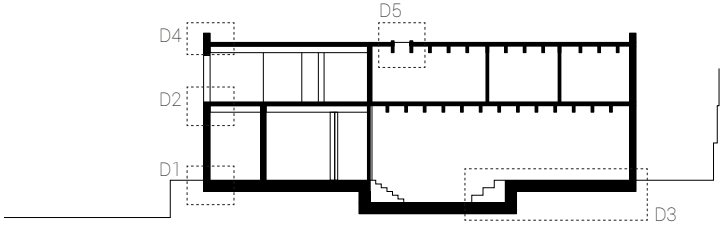
Ill.163.5

Rigorous Perspective

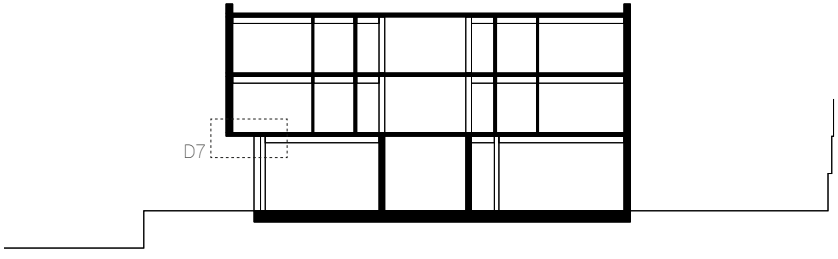
APPENDIX 15 | DETAIL DRAWINGS



Ill.164.1- Navigation Plan

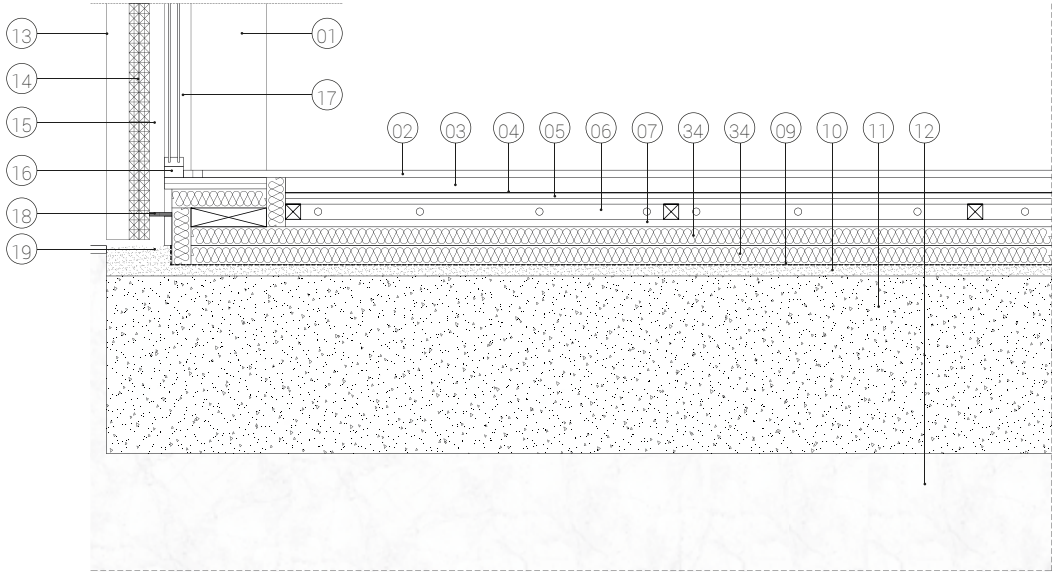


Ill.164.2- Navigation Cross Section A-A'



Ill.164.B- Navigation Cross Section B-B'

(Volz et al., 2012)



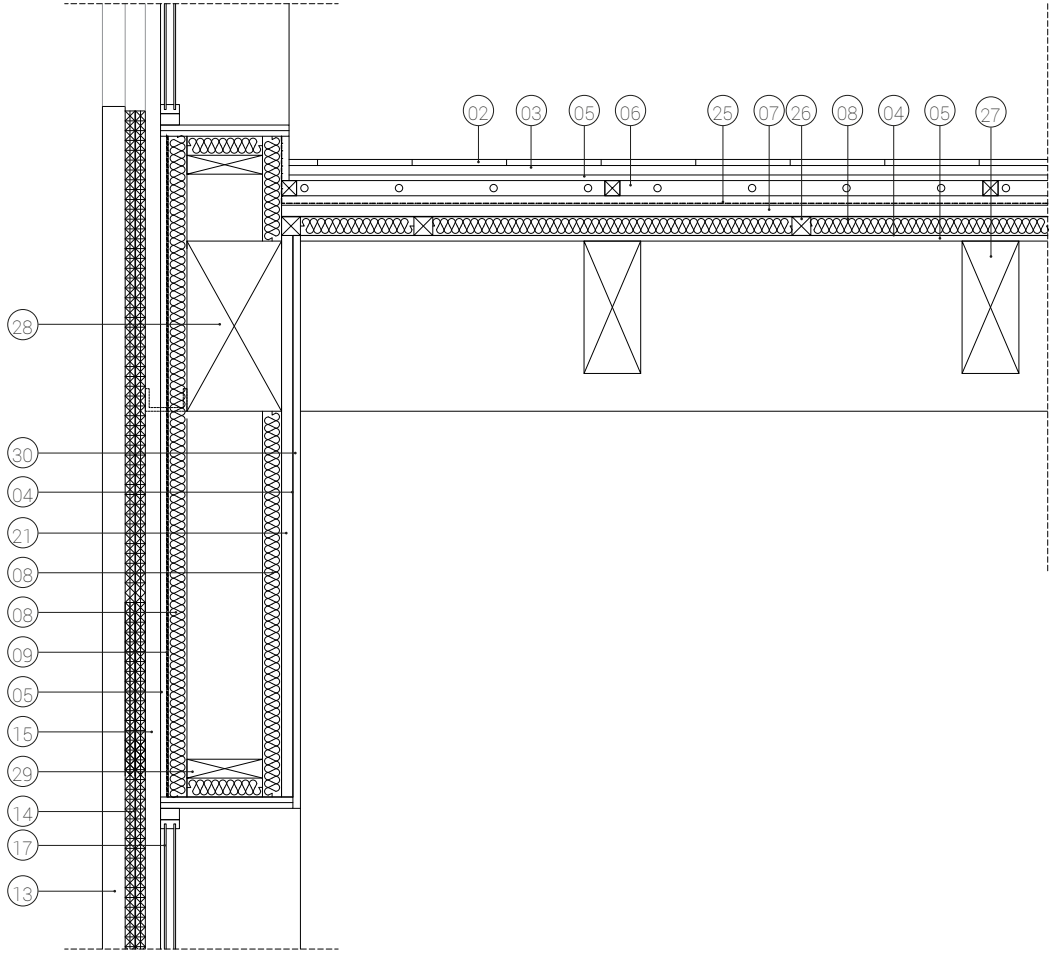
Ill.165.1 - Detail D1, Floor - Ground; Scale 1:20

LEGEND D1

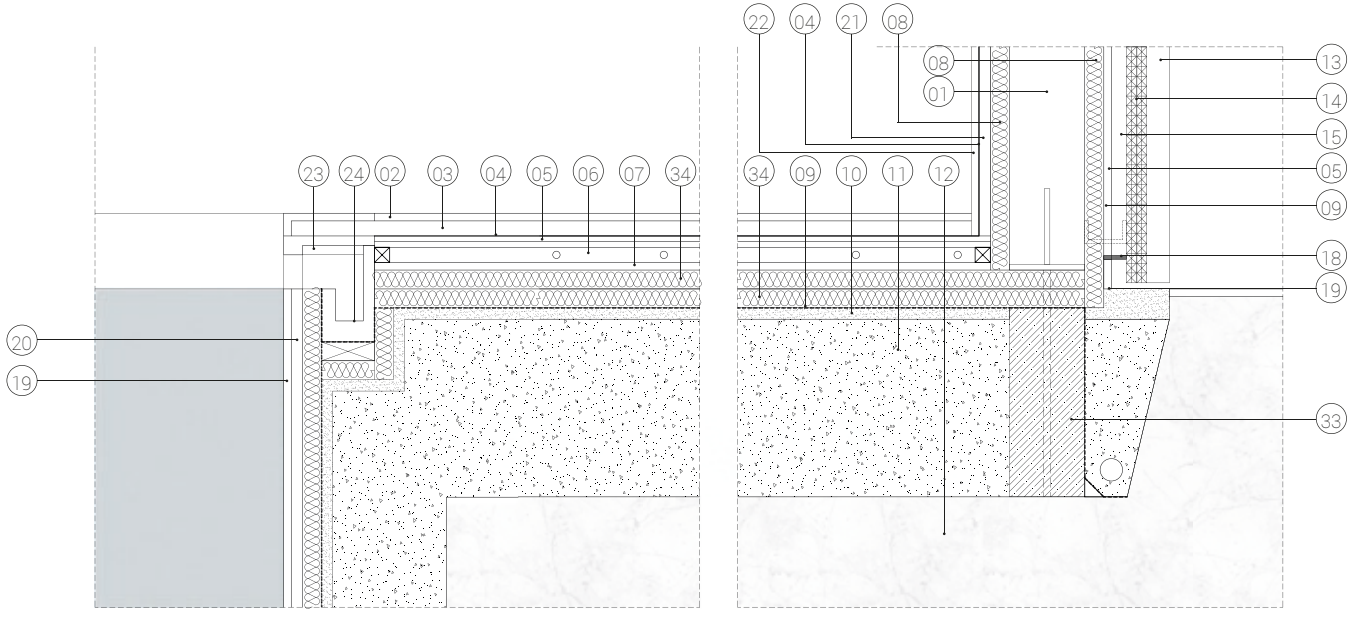
01	Column 250x 250 mm
02	Floor Tiles 20 mm
03	Subfloor 40 mm
04	Moisture Barrier
05	Plaster Board 15 mm
06	Floor Heating Pipe with Sand/ Cement Mix 40 mm
07	OSB Board 30 mm
08	Vacuum Insulation Panel 50 mm
09	Waterproof Barrier
10	Sand 30 mm
11	Drainage Gravel 300 mm
12	Quarry Marble
13	Frame System
14	Polycarbonate 55 mm
15	Void 40 mm
16	Window Frame
17	Double Glazed Window
18	Grid
19	Marble Slab 20 mm
20	Adhesive Layer
34	XPS Insulation

LEGEND D2, D3

01	Column 250x 250 mm
02	Floor Tiles 20 mm
03	Subfloor 40 mm
04	Moisture Barrier
05	Plaster Board 15 mm
06	Floor Heating Pipe with Sand/ Cement Mix 40 mm
07	OSB Board 30 mm
08	Vacuum Insulation Panel 50 mm
09	Waterproof Barrier
10	Sand 30 mm
11	Drainage Gravel 300 mm
12	Quarry Marble
13	Frame System
14	Polycarbonate 55 mm
15	Void 40 mm
16	Window Frame
17	Double Glazed Window
18	Grid
19	Marble Slab 20 mm
20	Adhesive Layer
21	Gypsum Board
22	Marble Tiles 20 mm
23	Wooden Baten
24	Drainage Channel
25	Sound Insulation Mat
26	Wooden Joints 50 x 50 mm
27	Beam 350x150 mm
28	Primary Beam 250x450 mm
29	Wooden Joint 250 x 50 mm
30	Wooden Cladding 20 mm
34	XPS Insulation



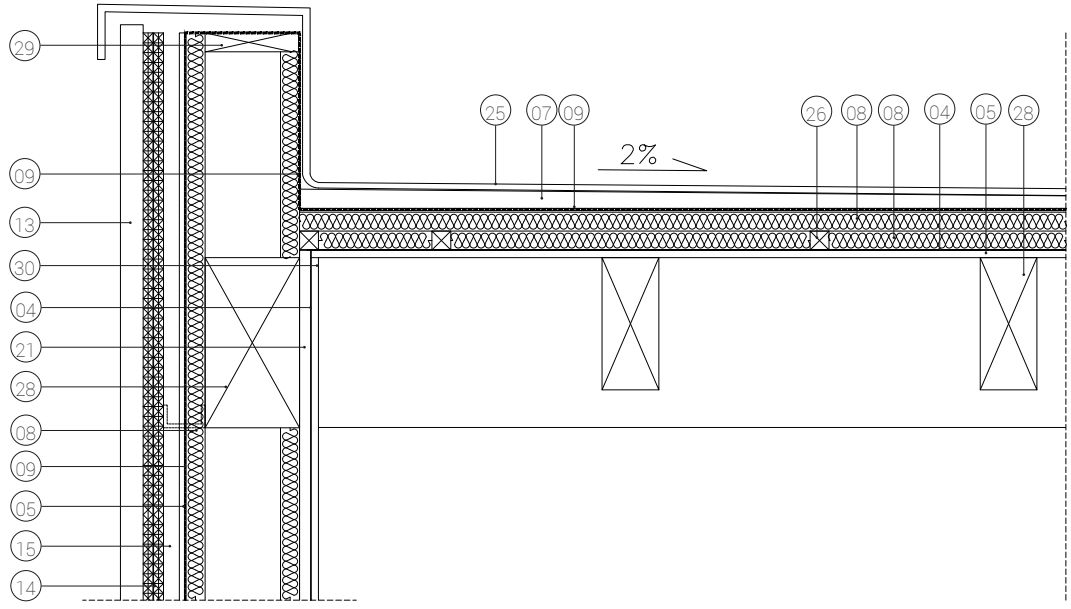
Ill.166.1- Detail D2, Ground Floor - Second Floor, Scale 1:20



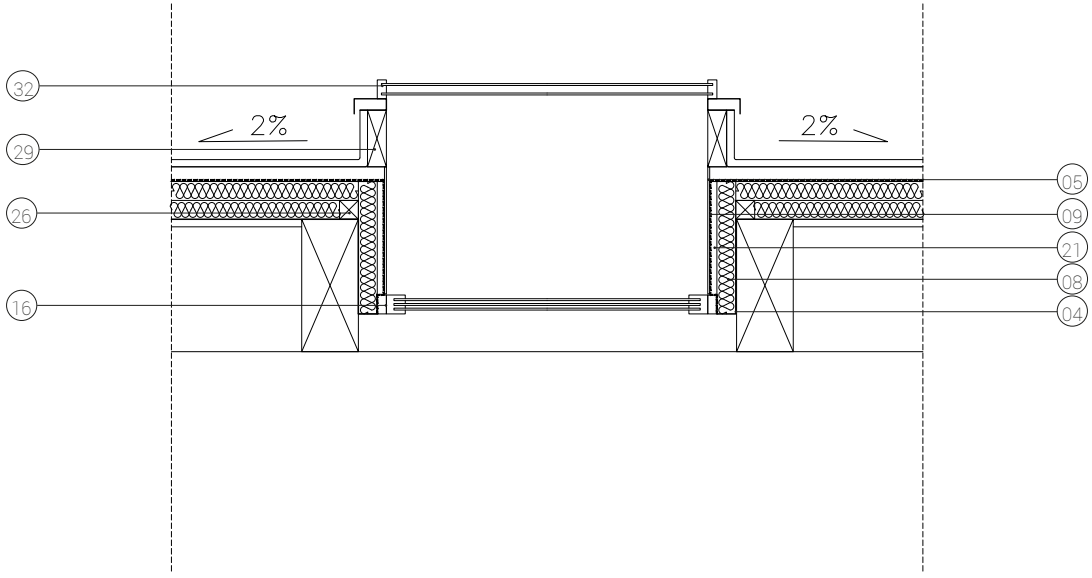
Ill.167.1- Detail D3, Floor Pool- Ground; Scale 1:20

LEGEND D4, D5

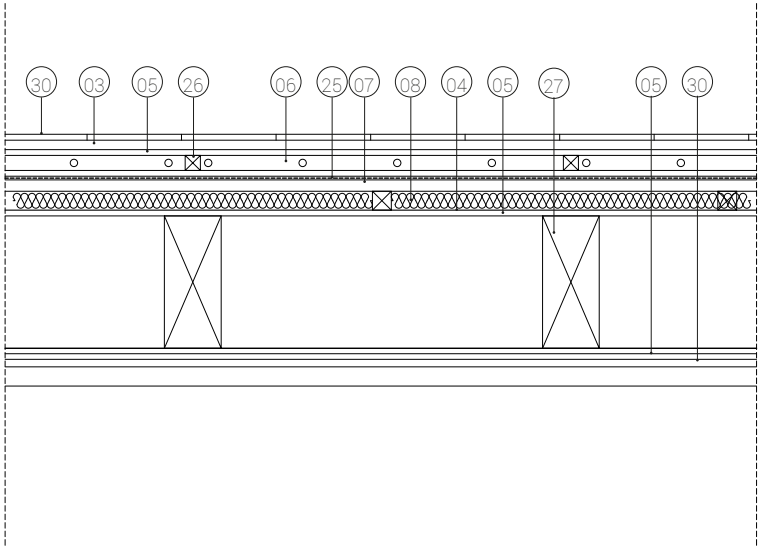
01 Column 250x 250 mm
02 Floor Tiles 20 mm
03 Subfloor 40 mm
04 Moisture Barrier
05 Plaster Board 15 mm
06 Floor Heating Pipe with Sand/ Cement Mix 40 mm
07 OSB Board 30 mm
08 Vacuum Insulation Panel 50 mm
09 Waterproof Barrier
10 Sand 30 mm
11 Drainage Gravel 300 mm
12 Quarry Marble
13 Frame System
14 Polycarbonate 55 mm
15 Void 40 mm
16 Window Frame
17 Double Glazed Window
18 Grid
19 Marble Slab 20 mm
20 Adhesive Layer
21 Gypsum Board
22 Marble Tiles 20 mm
23 Wooden Baten
24 Drainage Channel
25 Sound Insulation Mat
26 Wooden Joints 50 x 50 mm
27 Beam 350x150 mm
28 Primary Beam 250x450 mm
29 Wooden Joint 250 x 50 mm
30 Wooden Cladding 20 mm
31 Metal Roof Membrane
32 Skylight Frame With Heat Recovery System
33 Concrete Mix



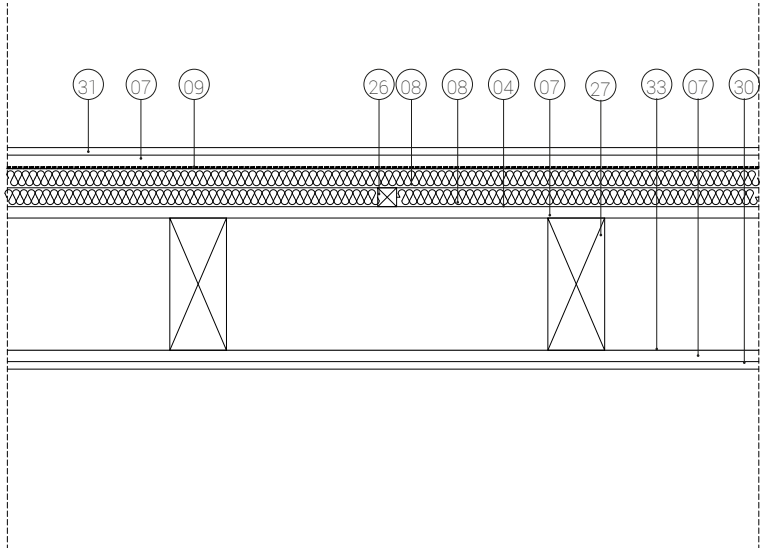
Ill.168.1- Detail D4, Roof Detail; Scale 1:20



Ill.169.1- Detail D5, Skylight Detail ; Scale 1:20



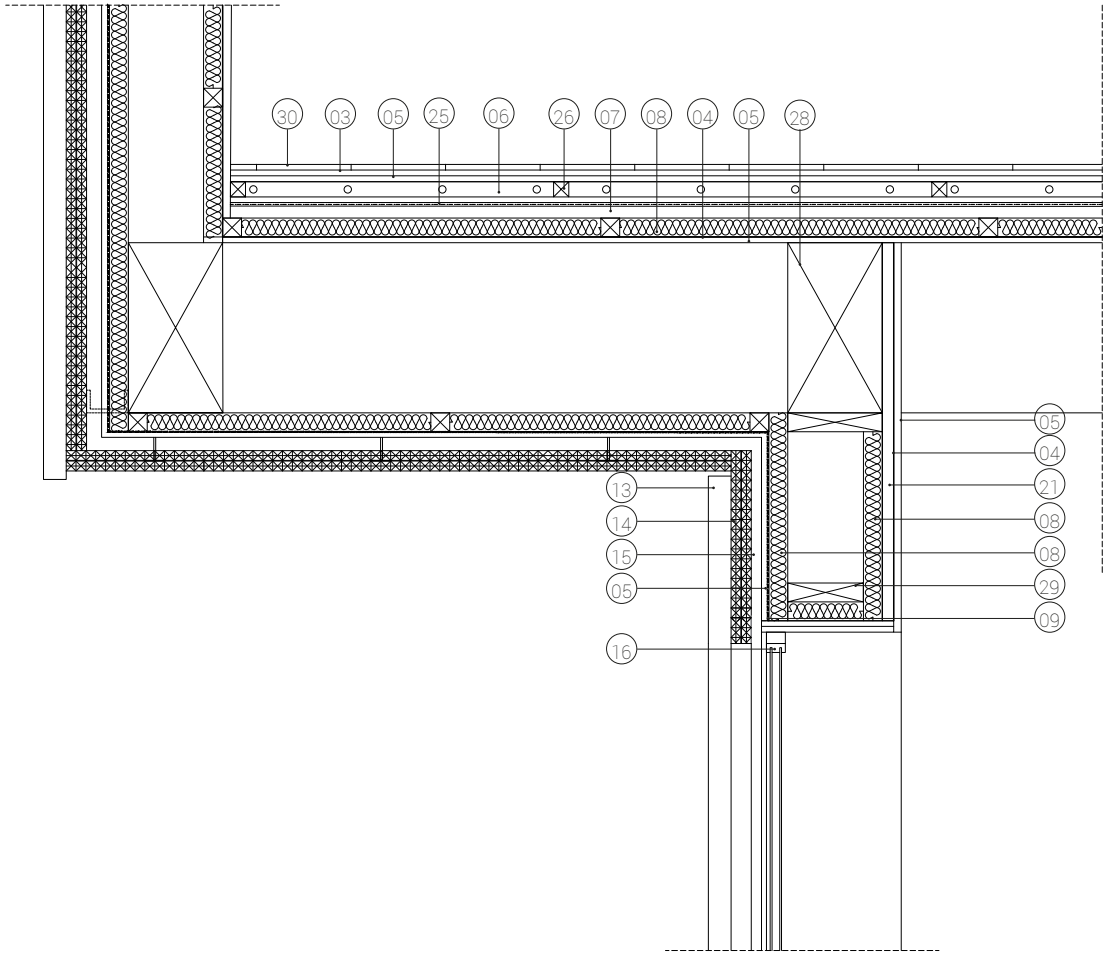
Ill.170.1- Detail D6- Floor Detail with Suspended Ceiling; Scale 1:20



Ill.170.2- Detail D8- Roof above Sauna; Scale 1:20

LEGEND D6, D7, D8

01 Column 250x 250 mm
02 Floor Tiles 20 mm
03 Subfloor 40 mm
04 Moisture Barrier
05 Plaster Board 15 mm
06 Floor Heating Pipe with Sand/ Cement Mix 40 mm
07 OSB Board 30 mm
08 Vacuum Insulation Panel 50 mm
09 Waterproof Barrier
10 Sand 30 mm
11 Drainage Gravel 300 mm
12 Quarry Marble
13 Frame System
14 Polycarbonate 55 mm
15 Void 40 mm
16 Window Frame
17 Double Glazed Window
18 Grid
19 Marble Slab 20 mm
20 Adhesive Layer
21 Gypsum Board
22 Marble Tiles 20 mm
23 Wooden Baten
24 Drainage Channel
25 Sound Insulation Mat
26 Wooden Joints 50 x 50 mm
27 Beam 350x150 mm
28 Primary Beam 250x450 mm
29 Wooden Joint 250 x 50 mm
30 Wooden Cladding 20 mm
31 Metal Roof Membrane
32 Skylight Frame With Heat Recovery System
33 Foil Vapour Barrier



Ill.171.1- Detail D7- Overhang Detail; Scale 1:20

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APPENDIX ILLUSTRATION LIST